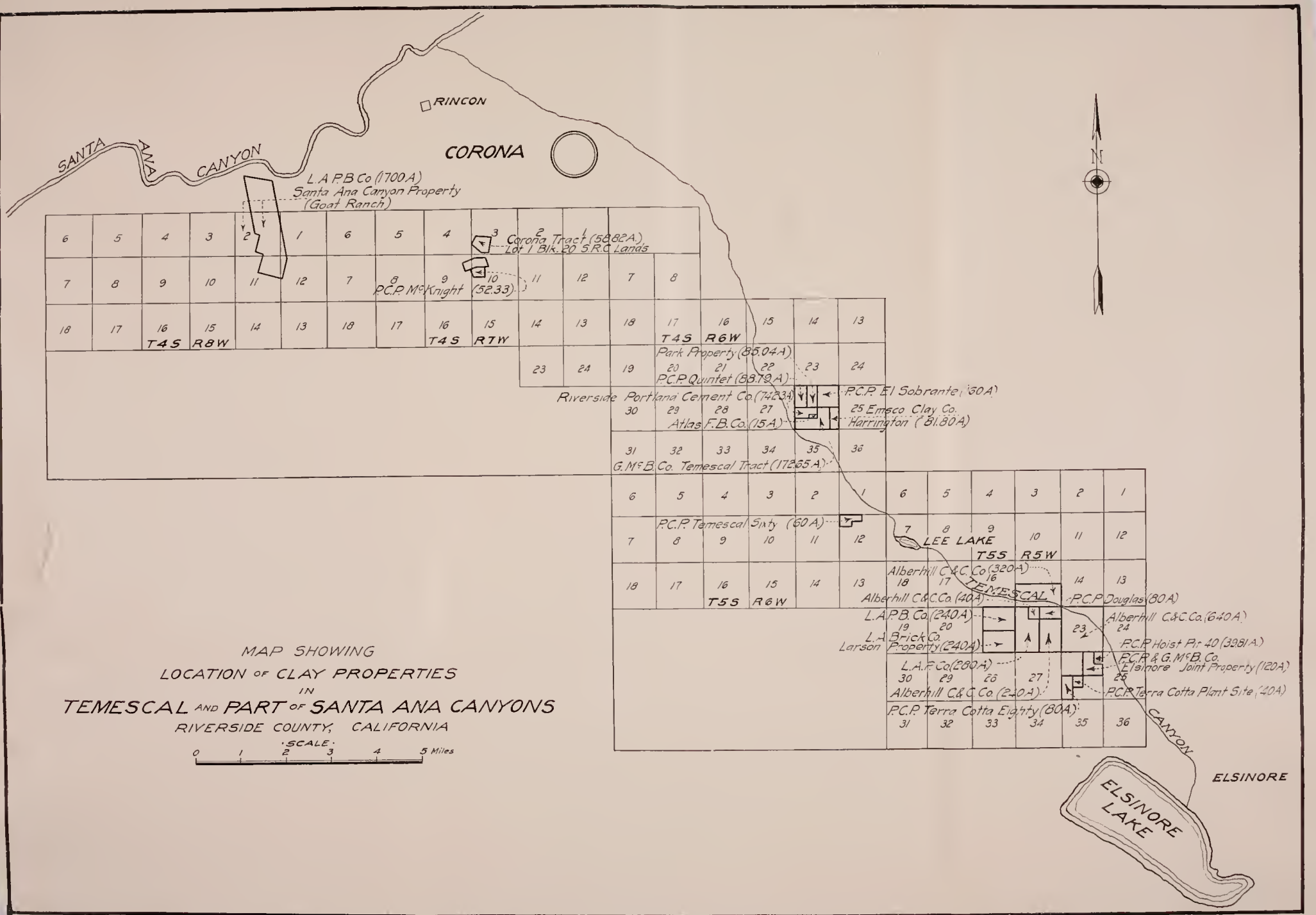
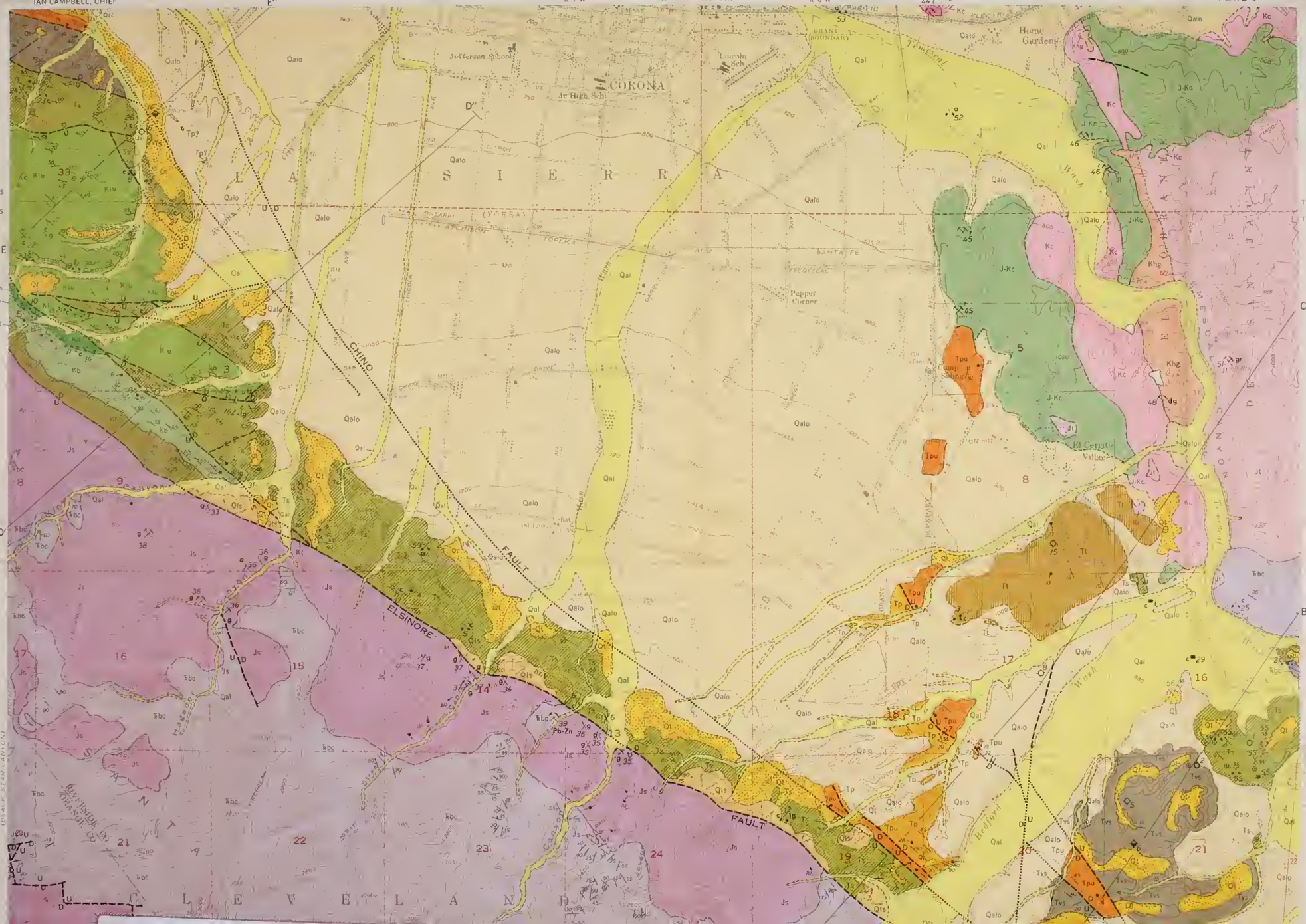


PLATE X. Property map of Alberhill-Corona district, Riverside County. (By courtesy of Robt. Linton.)

DIVISION OF MINES
IAN CAMPBELL, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

BULLETIN 178
PLATE 1



EXPLANATION

SURFICIAL DEPOSITS

QUATERNARY — *Recent*

- **Qls** — Landslide
- **Qal** — Alluvium
  Gravel, sand, silt
- **Qalo** — Older alluvium
  Sand, gravel, and rubble; buff and gray in color

QUATERNARY — *Pleistocene (?)*

- **Qt** — Terrace deposits
  Rubble, gravel, and sand; reddish-brown to buff in color

SEDIMENTARY ROCKS

TERTIARY — *Pliocene*

- **Tp** — Pliocene undifferentiated
  Thick-bedded sandstone and conglomerate with lesser amounts of sandy silts and shales, marine

TERTIARY — *Miocene* — *Upper*

- **Tpu** — Puente formation, undifferentiated
  Sandy siltstone and shale, minor amounts of sandstone, conglomerate and diatomite, marine; contains abundant Mohnian and a few Luisian foraminifera

TERTIARY — *Miocene* — *Middle*

- **Tt** — Topanga formation
  Buff sandstone, conglomerate, and sandy siltstone, marine

TERTIARY — *Upper Eocene to lower Miocene*

- **Tvs** — Vaqueros (lower Miocene) and Sespe (upper Eocene? to lower Miocene?) formations, undifferentiated
  White, buff, red, and green sandstone, conglomerate, sandy clay and siltstone, in part nonmarine, upper part contains early Miocene or lower middle Miocene marine fossils

TERTIARY — *Paleocene*

- **Ts** — Silverado formation
  Upper part marine greenish-gray sandstone and conglomerate, buff siltstone and shale, lower part nonmarine or brackish water coarse-grained micaceous sandstone, conglomerate, clay, and minor lignite. Residual clay at base

CRETACEOUS — *Upper Cretaceous* — Ladd formation

- **Klu** — Ladd formation, undifferentiated
  Greenish gray sandstone and conglomerate, buff siltstone and shale, marine
- **Kh** — Holz shale member
  Gray to black silty shale and siltstone with limy concretions, marine
- **Kb** — Baker Canyon conglomerate member
  Buff sandstone and buff and gray to greenish gray conglomerate, marine
- **Kt** — Trabuco formation
  Red, buff and grayish-green massive conglomerate, minor sandstone, probably nonmarine

IGNEOUS & METAMORPHIC ROCKS

CRETACEOUS (?)

- **Kmp** — Micropegmatite granite
  Pink, fine-grained granular rock
- **Khg** — Home Gardens quartz monzonite porphyry
  Light gray biotite quartz monzonite

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA - PETE WILSON, GOVERNOR
THE RESOURCES AGENCY - DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION - EDWARD G. HEIDIG, DIRECTOR

SPECIAL REPORT 165
PLATE 2A
HYDROTHERMAL DEPOSITS

METAL MINES AND PROSPECTS
NORTHERN AREA

MAP NO.	NAME	COMMODITY	APPENDIX NO.
5.	Unknown Name Prospects	Au	167
6.	Unknown Name Prospect	Au	168
41.	Mountain Group (Crowell Mine, Erenreich Gold Mines)	Sb	214
52.	Unknown Name Prospect	Au? Sn?	169
55.	Unknown Name Prospect	Au? Sn?	170
56.	Unknown Name Prospect	Au?	171
57.	Unknown Name Prospect	Au?	172
67.	Corona Lead-Zinc Mine	Pb,Zn	213
70.	Unknown Name Prospect	Au	173
71.	Unknown Name Prospect	Au	174
79.	Collins Copper Prospect	Cu	115
92.	Cajalco Tin Mine (Temescal Tin Mine)	Sn	259
96.	Holmes Ranch	Sn	261
98.	Black Rocks Prospect (North and South Black Rocks)	Sn	258
99.	Unknown Name Prospect	Au,Ag	175
100.	Unknown Name Prospect	Au	176
114.	Unknown Name Prospect	Au,Ag	177
115.	Unknown Name Prospect	Au,Ag	178
116.	Prospect Mountain	Au,Ag	155
117.	Unknown Name Prospect	Au,Ag	179
118.	Unknown Name Prospect	Au,Ag	180
120.	Arlington Tunnel	Au	126
121.	Unknown Name Prospect	Au,Ag	181
122.	Unknown Name Prospect	Au,Ag	182
123.	Hoag Mine	Au	140
125.	Unknown Name Prospect	Au,Ag	183
126.	Dr. Musick	Au	133
127.	Unknown Name Prospect	Au,Ag	184
128.	Unknown Name Prospect	Au	185
129.	Unknown Name Prospect	Au	186
130.	Golden Nugget	Au	137
131.	Gavilan Mine	Au	135
132.	Ida Leona Mine	Au	141
133.	Morris-Washington Prospects	Au,Ag	152
138.	Santa Fe Mine	Au	160
139.	Santa Rosa Mine (Rosalia, Mina Rosalia Old Mina Rosalia, Northern Belle)	Au,Ag,Cu	161
140.	Golden Chariot	Au,Ag	136
141.	Jumbo Mine	Au	143
142.	Indian Rose Queen (Indian Rose Quartz Queen)	Au	142
143.	Little Maggie (Maggie)	Au	147
144.	Unknown Name Prospect	Au	187
146.	Unknown Name Prospect	Au	188
147.	Unknown Name Prospect	Au	189
150.	Unknown Name Prospect	Au	190
151.	Colorado-Justice Claims	Au,Ag	131
152.	Corona (Peggy)	Au	132
153.	Unknown Name Prospect	Au	191
154.	Top-of-The World (La Plomo, Victor, Victor-La Plomo, Steele)	Au	164
155.	San Antonio Mine	Au	159
157.	Virginia Shay (Missing Link, Shay, Virginia)	Au	203
158.	C & C Consolidated	Au,Ag	130
159.	Unknown Name Prospect	Au	192
160.	Unknown Name Prospect	Au	193
161.	Stanford Mine	Au	163
162.	Unknown Name Prospect	Au	194
163.	Unknown Name Prospect	Au	195

MINERAL RESOURCE ZONE (MRZ) CATEGORIES

MRZ-1: Areas where available geologic information indicates there is little likelihood for the presence of significant mineral resources.*

MRZ-2a: Areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present. Areas classified MRZ-2a contain discovered mineral deposits that are either measured or indicated reserves as determined by such evidence as drilling records, sample analysis, surface exposure, and mine information. Land included in the MRZ-2a category is of prime importance because it contains known economic mineral deposits.

MRZ-2b: Areas underlain by mineral deposits where geologic information indicates that significant inferred resources are present. Areas classified MRZ-2b contain discovered mineral deposits that are either inferred reserves as determined by limited sample analysis, exposure, and past mining history or are deposits that presently are subeconomic. Further exploration work and/or changes in technology or economics could result in upgrading areas classified MRZ-2b to MRZ-2a.

MRZ-3a: Areas containing known mineral occurrences of undetermined mineral resource significance. Further exploration work within these areas could result in the reclassification of specific localities into MRZ-2a or MRZ-2b categories.

MRZ-3b: Areas containing inferred mineral occurrences of undetermined mineral resource significance. Land classified MRZ-3b represents areas in geologic settings that appear to be favorable environments for the occurrence of specific mineral deposits. Further exploration work could result in the reclassification of all or part of these areas into the MRZ-3a category or specific localities into the MRZ-2a or MRZ-2b categories.

MRZ-4: Areas of no known mineral occurrences where geologic information does not rule out either the presence or absence of significant mineral resources.*

*The distinction between the MRZ-1 and MRZ-4 categories is important for land use considerations. It must be emphasized that MRZ-4 classification does not imply that there is little likelihood for the presence of mineral resources, but rather there is a lack of knowledge regarding mineral occurrence. Further exploration work could well result in the reclassification of land in MRZ-4 areas to MRZ-3 or MRZ-2 categories.

Metals

(h-#) Hydrothermal Mineralization (Gold, Silver, Copper, Tin)

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

MAGNETIC NORTH AND DECLINATION

LOCATION MAP

SCALE 1:48,000

MOSAICKED FROM GUASTI, FONTANA, PRADO DAM, CORONA NORTH, RIVERSIDE WEST, BLACK STAR CANYON, CORONA SOUTH, LAKE MATHEWS, AND STEELE PEAK U.S.G.S. 7.5' TOPOGRAPHIC QUADRANGLES.

GRAPHICS AND DRAFTING BY CAROL ALLEN, BRUCE FOGGY, LOUISE HUCKABY, FRANCES RUBISH, JOY SULLIVAN, PEGGY WALKER, AND JIM WILLIAMS.

MINERAL LAND CLASSIFICATION MAP OF THE NORTHERN TEMESCAL VALLEY AREA RIVERSIDE COUNTY, CALIFORNIA

(AREAS CLASSIFIED FOR DEPOSITS FORMED BY HYDROTHERMAL PROCESSES)

by
Dinah O. Shumway

1991

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA - PETE WILSON, GOVERNOR
THE RESOURCES AGENCY - DOUGLAS P. WHEELER, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION - EDWARD G. HEIDIG, DIRECTOR

SPECIAL REPORT 165
PLATE 4A
AGGREGATE RESOURCES

CONSTRUCTION AGGREGATE MINES AND PROSPECTS
NORTHERN AREA

MAP NO.	NAME	COMMODITY	APPENDIX NO.
1.	Triangle Rock Products, Inc., Mira Loma Pit	Conc Agg	113
4.	Stringfellow Quarry (Bly Brothers and McGilliard, Shannahan)	Riprap,Conc Agg	111,251
7.	Jensen Quarry North	Base Agg	76
9.	Atkinson Quarry (Ormand Quarry)	Riprap,Conc Agg	93,243
10.	Crestmore Quarry (Riverside Cement Co.)	Conc Agg,Lmst	100,218
11.	Service Rock	Conc Agg	110
12.	Unknown Name Gravel Pit	Base Agg	88
13.	Borrow Pit	Base Agg	48
14.	Owl Rock Products, Prado Pit	Conc Agg	107
15.	Borrow Pit	Base Agg	49
16.	Riverside County Gravel Pits	Base Agg	80
18.	Borrow Pit	Base Agg	50
20.	Transit Mixed Concrete Company, Corona Pit	Conc Agg	112
21.	Coplin Granite Pit	Base Agg	75
23.	Borrow Pit	Base Agg	51
24.	Borrow Pit	Base Agg	52
27.	Old City Quarry	Base Agg	78
28.	Riverside County Gravel Pits	Base Agg	81
29.	Riverside Sand Company	Base Agg	87
30.	Borrow Pit(s)	Base Agg	53
31.	Borrow Pit	Base Agg	54
33.	Riverside County Gravel Pits	Base Agg	82
35.	Borrow Pit	Base Agg	55
36.	Borrow Pit	Base Agg	56
37.	Borrow Pit	Base Agg	57
38.	Borrow Pit	Base Agg	58
73.	Corona Rock Co.	Conc Agg	99
74.	All American Asphalt and Aggregates Company (Temescal Canyon Rock Quarry)	Conc Agg	92
75.	CalMat, Corona Quarry (Temescal Canyon Rock Quarry, L.S. Hawley Quarry)	Conc Agg	96
78.	Fontana Paving Company, Corona Plant	Conc Agg	102
91.	Santa Ana River Rock, Eagle Valley Quarry	Conc Agg	109
97.	Harlow Quarry	Riprap Conc Agg	104,245
101.	Mobil Sand Company	Conc Agg	106
108.	C.L. Pharris Co., Dawson Canyon Pit	Conc Agg	94
109.	Chandler's Palos Verdes, Glen Ivy Pit	Conc Agg	98
110.	R.J. Noble Co., Coldwater Canyon Pit	Conc Agg	108
111.	J.F. and T. Sand Pit	Conc Agg	105
112.	C.L. Pharris Co., Maitri Pit	Conc Agg	95
113.	Chandler's Palos Verdes, Corona Pit	Conc Agg	97
124.	Markhan Road Pit	Base Agg	77
134.	Borrow Pit	Base Agg	59
135.	Borrow Pit	Base Agg	60
136.	Borrow Pit	Base Agg	61
137.	Borrow Pit	Base Agg	62
145.	Unknown Name Quarry	Base Agg	90
148.	Unknown Name Quarry	Base Agg	91

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Construction Aggregate

CS(b-#) Crushed Stone - base aggregate (includes the uses base and subbase
CS(c-#) Crushed Stone - concrete aggregate (includes the uses asphaltic concrete aggregate and Portland cement concrete aggregate)
SG(c-#) Sand and Gravel - concrete aggregate (includes the uses asphaltic concrete aggregate and Portland cement concrete aggregate

● DRILL HOLE

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

MAGNETIC NORTH AND DECLINATION

LOCATION MAP

SCALE 1:48,000

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MINERAL LAND CLASSIFICATION MAP OF THE NORTHERN TEMESCAL VALLEY AREA RIVERSIDE COUNTY, CALIFORNIA

(AREAS CLASSIFIED FOR AGGREGATE RESOURCES)

by
Russell V. Miller

1991

O

CALIFORNIA-STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

EIGHTH ANNUAL REPORT

492.7

OF THE

STATE MINERALOGIST.

FOR THE YEAR ENDING OCTOBER 1, 1888.

SACRAMENTO:
STATE OFFICE, : : : : : J. D. YOUNG, SUPT. STATE PRINTING.
1888.

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To the Honorable R. W. WATERMAN, *Governor:*

SIR: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature, entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880,'" approved March 21, 1885.

Respectfully,

J. Z. DAVIS.
S. HEYDENFELDT, JR.
GEORGE HEARST.
W. S. KEYES.
G. W. GRAYSON.

OCTOBER 1, 1888.

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with salt, soda, or other deleterious mineral to an extent that renders it unfit to drink.

MORANGO KING GOLD MINES.

This group of gold mines, consisting of the Morango King, Overly Scott, and Glasgow, is situated in Morango Mining District, on the eastern slope of the mountains, eighteen miles south of Old Woman's Springs, and forty-six miles north of Seven Palms Station, on the Southern Pacific Railroad, at an altitude of five thousand feet above the level of the sea. The ledge runs northeast and southwest for five hundred feet, then bends and runs north and south, and dips into the hill at an angle of 60 degrees. The ledge forms a sort of horseshoe curve around the hill on which it is situated. The geological formation consists of granite on the foot-wall, and slate on the hanging-wall. About the center of the Morango King ledge is a shaft sunk to a depth of one hundred and eighty feet. At one hundred feet below the surface are two drifts, each thirty feet in length, running on the ledge. Ore in bunches is met with, both in the drifts and shaft. This ledge crops out for about three hundred feet. Eighty feet northeast of this shaft another has been sunk to a depth of thirty feet on the ledge, which here averages four and one half feet in width. The ore from the above shafts is piled up on a dump containing from seventy-five to eighty tons, and is free milling, showing, occasionally, particles of free gold. Near the northern end of the Overly Scott Mine, there is sunk a fourteen-foot shaft, the ledge at this point being seven feet wide. Five miles west of these mines plenty of water and timber can be had for all mining purposes. Antelope Springs are situated one and one half miles east of the mines and four hundred feet below them. Water can be piped from these springs to a suitable mill site in the valley, eight hundred feet below the mines.

SAN BERNARDINO COUNTY.

By W. A. Goodyear, Assistant in the Field.

A portion of what concerns this county is taken from W. A. Goodyear's notes of trips made by him in 1872.

About half a mile southwest of Colton is Slover Mountain, a hill a quarter of a mile or so in diameter at its base, which rises some six hundred or seven hundred feet above the valley. It consists chiefly of limestone, which, however, varies greatly in character. Some of it is very fine-grained and pure white, and of a quality which, if it could be obtained in sound, unspotted blocks of uniform texture and sufficient size, would make a fine statuary marble. But much of it is very coarsely crystalline, often showing cleavage planes half an inch or more in diameter; yet even this coarse rock is much of it very compact, takes a fine polish, and makes a handsome marble. Some of it contains considerable graphite scattered through it in streaks and spots, and some of it contains micaceous iron. Some of it also contains a good deal of silica, and therefore will not make good lime.

Aragonite (wrongly called "onyx") also occurs here in veins and bunches, most delicately and beautifully striped and banded with various shades of yellow and brown, as some agates are. If (as is not improbable) it can be obtained in slabs of sufficient size, it will make extremely handsome mantel-pieces, table-tops, etc.

In the north end of the hill the rocks strike about north 70 degrees east, magnetic, and dip 45 degrees southeast. But in a large part of the hill the

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metamorphism has gone far enough to greatly obscure, and in places entirely obliterate the stratification. A mill has been built here for sawing, cutting, and polishing the marble, which is being used to a considerable extent for building and ornamental purposes in San Bernardino and elsewhere. A good deal of lime is also being burned at various points around the foot of the hill. But a mile or two distant from here, on the opposite (or south) side of the Santa Ana River, all the hills are granite.

All the rocks in the neighborhood of the Arrowhead Springs (referred to in the Sixth Annual Report, Part I, page 70) are granite and gneiss, and the waters of the springs contain considerable sulphur. The "Arrowhead" itself is a great spot on the mountain slope, just back of and above the springs, which is comparatively free from brush, and is shaped thus:

Its extreme length is said to be one thousand three hundred and twenty feet, and its width across the shoulders three hundred and fifty feet. It is a conspicuous object from all points in the valley for a distance of many miles to the south. It is said that the early Mormon settlers used to call it the "Arrowhead of the Lord."

There are many artesian wells in the San Bernardino Valley, and amongst them the largest one which the writer has yet seen in the State is located some two or three miles east, or a little south of east of the City of San Bernardino. It is in low ground on the north side of, and only about one hundred yards distant from the Santa Ana River. It is two hundred and twenty feet deep, and when uncapped flows a solid jet of water seven inches in diameter and twenty inches high above the top of the pipe, which rises two or three feet above the ground.

About three quarters of a mile southeast of Casa Blanca Station, on the Riverside division of the California Central Railroad, a rather dark-colored granite is being quarried to some extent for building purposes. There has been from time to time within the last year or two considerable talk in the newspapers concerning a reported valuable discovery of coal near South Riverside. This locality was visited on May nineteenth. It is in the northeastern foothills of the Santa Ana range of mountains, some three or four miles south 25 degrees west, magnetic, from South Riverside. Here a bed of coal strikes about north 70 degrees west, magnetic, and at the surface dips 65 degrees or 70 degrees northeast. A tunnel runs in about sixty feet, and from the tunnel a shaft has been sunk about one hundred and seventy feet deep. The coal, so far, has been very irregular in thickness as well as quality. At the surface is a very impure streak from one to two feet thick. About fifty feet down it widened out to four feet of tolerably clean but soft coal. But below this again it pinched out to only three or four inches, and was very irregular in its dip. At the bottom of the shaft it was dipping about 50 degrees *southwest*. The locality is some two hundred or two hundred and fifty feet above the valley. The rocks here are sandstones and clay shales, quite soft, and containing much gypsum, and a good deal broken up.

About half a mile southeast of here is another locality where prospecting was being done for coal. There is here a great amount of carbonaceous matter irregularly scattered through the rocks, which strike northwesterly and stand nearly vertical. But it is nevertheless unfortunately the fact that what has hitherto been discovered is not good, and the present outlook for anything better is very poor.

Close by the latter locality there is a deposit of so called "Mineral Paint," *i. e.*, a sort of compact variety of red ochre, which, on being placed in water, very quickly crumbles and falls into small fragments in a manner

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suggestive, by its rapidity, of the way in which well-burned quicklime slacks.

Traveling about three and one half miles southeasterly from South Riverside, up the Temescal Valley, and then about three and one half miles northeasterly among the hills, we reach the famous "Temescal Tin Mines," on the western part of the Mexican Grant known as "El Sobrante de San Jacinto," and where the aneroid barometer read one thousand two hundred and eighty feet. The country here is granite. The tin occurs associated with much manganese, some arsenic, iron, and other substances, in veins which traverse the granite in a northeasterly and southwesterly direction. The vein on which most work has been done strikes about north 30 degrees east, magnetic, and dips some 60 degrees northwest. E. N. Robinson, in charge of the property, states that there are over fifty such veins, with nearly parallel strike and dip, within a region here about seven miles long in a northwest and southeast direction, and some four miles wide. The existence of tin at this locality has been known for twenty-five or thirty years. But no reduction works were ever erected, and sufficient work has never yet been done underground to prove whether there are any mines here that will pay. If they are ever successfully worked, it will be necessary to crush and concentrate all the ore before smelting; and it is some distance from the mines to any point where a sufficient supply of water could be obtained.

At a point about two miles south 60 degrees east, magnetic, from South Riverside, a quarry of hard, dark-colored porphyry has recently been opened up, to furnish rock for macadamizing streets in Los Angeles and elsewhere. The rock is a good material for the purpose, and a belt of it at least a mile or two in width stretches for a considerable distance in a northwest and southeast direction, along the western side of the Rancho El Sobrante de San Jacinto, and extends east to within about one mile of the tin mines, where the granite comes in. About a quarter of a mile below the quarry, on the left bank of Temescal Creek, extensive crushing works, unfinished at the time of my visit, were being erected, and two seventeen-inch by ten-inch jaw rock breakers (large and heavy machines) were already in place. These two crushers alone ought to turn out a product of not less than two hundred tons of rock crushed to the proper size for macadamizing purposes in each day of ten hours run.

At the Temescal Post Office, about eleven miles southeast of South Riverside, there were (May 20, 1888) two artesian wells three hundred feet deep, with ten-inch pipes. One of them was capped; but the other one, whose pipe rose about five feet above the ground, was flowing a stream of good water one and one half inches high over the top of the pipe.

About a mile above the Post Office there is, in a "mesa" of granitic debris, a deposit of clay which has been thought to be valuable, but which does not look very good.

On the southwest side of the Temescal Cañon, about a mile below the Post Office, are the "Temescal Hot Springs," where there is a bath house. These springs are of sulphur water, with a temperature of 95 degrees to 100 degrees Fahrenheit.

On the second day of June, 1872, the present writer climbed the highest point of Mount San Bernardino, commonly called "Old Grayback," and got some barometric observations on the summit, which constitute, so far as he knows, the first measurement ever made of the height of this mountain. The following quotation is made from an article subsequently written by him for the "San Francisco Evening Bulletin," and published by that paper in its issue of July 3, 1872:

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"I ascended the mountain, in company with Mark Thomas, of San Bernardino, on the second of June, 1872. The instrument used at the summit of the mountain was a Green's mercurial barometer of the best kind, and in perfect order.

"Simultaneous observations were taken at the town of San Bernardino, with a small aneroid barometer, also of Green's make. But, owing partly to the inherent defects of aneroid barometers, and partly to the fact that, through an oversight, the temperature of the air at the town of San Bernardino was not observed, I have considered the observations of the aneroid as untrustworthy, and have deemed it better to compare the observations at the summit of the mountain directly with those of J. B. Wells, United States Signal Service Observer at San Diego, and also with those of Thomas Tennent, at San Francisco, on the same day. The result is a discrepancy of about a hundred feet in the altitude, as determined from the two localities. The comparison with San Diego gives for the height of the mountain about eleven thousand six hundred and fifty feet, and the comparison with San Francisco about eleven thousand five hundred and fifty feet above the sea.

"Of these two results, the one obtained from San Diego is probably somewhat the more trustworthy, as in this case the distance between the two stations is only about one hundred miles, while from San Francisco to the mountain it is something over four hundred in an air line.

"From the above facts I conclude that we may safely assume eleven thousand six hundred feet as a very fair approximation to the actual height of the mountain, with a probability, however, that whenever it may be more accurately determined, it will be found to slightly exceed rather than to fall short of this figure.

"The peak which forms the initial point of the United States land surveys in this part of the State is not the highest part of the mountain. The highest summit, the one which I ascended, is the one known at San Bernardino as the "Grayback." Its crest forms a ridge three or four miles long in an easterly and westerly direction, with the highest point at the eastern end, and some seven or eight miles distant, in a direction a little south of east from the initial point of the land surveys.

"The San Jacinto Peak, immediately south of the San Gorgonio Pass, lacks but a few hundred feet of being as high as Mount San Bernardino itself. By the aid of a hand spirit level which I had with me, I estimated that the "Grayback" was some five hundred or six hundred feet higher than the San Jacinto Peak, one thousand or one thousand two hundred feet higher than the initial point of the land surveys, and one thousand five hundred to two thousand feet higher than San Antonio Peak, the highest peak of the San Gabriel Range, to the north of Cucamongo, and west of the Cajon Pass. And it may be noted that, assuming the correct altitude of the "Grayback" to be eleven thousand six hundred feet, the last of the above estimates agrees well enough with Professor George Davidson's determination of the height of the San Antonio Peak, which makes it nine thousand nine hundred and thirty-one feet ('field computation') above the sea."

Writing now in 1888, there is nothing in the above quotation which needs correction.

On the southern flank of Mount San Bernardino, a belt of unaltered sandstone, shales, and pebbly conglomerates some four or five miles in width, stretches a long distance in an easterly and westerly direction and rises to heights of four thousand to five thousand feet above the sea against the sides of the range. These rocks have been greatly disturbed, and in the cañon of Mill Creek exhibit a great synclinal fold. The rocks near the

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mouth of the cañon dip northerly at tolerably high angles. A little further north, for a certain distance they lie nearly horizontal; while still farther north and higher up the cañon, near where it makes a great bend a little below the "Potato Ranch," they dip at high angles to the south. Above these unaltered rocks the greater portion of the mountain is granite, which, however, varies largely in texture and composition. Some of it is porphyritic with very large crystals of feldspar, and much of it is more or less gneissoid in structure. But besides the granite there are also considerable quantities of highly metamorphic rocks in the range, as is proven by the bowlders strewn along the bed of Mill Creek, many of which are gneiss, some of micaschist, some of dark colored hornblendic slates, and some of a coarse-grained, white and handsome marble. Some diallage or hypersthene rock was seen high up near the summit of the mountain. Mr. Mark Thomas states that on the north side of the San Bernardino Range, the quantity of unaltered sandstones, etc., is enormous, and that they reach up as far as Holcomb Valley. No fossils were found in these unaltered rocks. But they cannot probably be older than the Cretaceous period, and their presence here so high up on the range proves that the great mass of the range itself was uplifted from beneath the ocean subsequent to their deposition.

The quantity of the metamorphic stratified rocks in this range, though absolutely quite large, is nevertheless very small in comparison with that of the granite and granitoid rocks; and the same statement holds good for the whole San Gabriel Range, from the Cajon Pass west almost to the Los Angeles River, that range also being mainly granite.

And, by the way, I wish here to earnestly protest, in the name of common sense, against any such changing of the names of high mountain peaks and ranges as has somehow or other within the last few years crept into fashion in this part of Southern California.

The old name of the whole range of mountains from the Cajon Pass west to the Los Angeles River, was the "San Gabriel Range;" the name being taken from that of the old mission in the valley below—and that name is as good as any other—and its highest peak, only a few miles west of the Cajon Pass, is "San Antonio Peak." But, the vulgar name of "Old Baldy" has been applied to San Antonio Peak by somebody who perhaps fancied it poetical; and the whole San Gabriel Range has been dubbed "Sierra Madre" by somebody who either did not well understand Spanish, or else was in the careless habit (I care not, even if it were, as somebody has asserted, some of the old mission padres themselves) of calling every high mountain range a "Sierra Madre." There is no such thing as a "Sierra Madre" anywhere in this part of the country; and that name, together with "Old Baldy," ought to go where "Fisherman's Peak"—an unjust and ridiculous misnomer for Mount Whitney—has already gone, viz., into oblivion.

The rocks of the Calico Mining District, so far as the writer has seen them, *i. e.*, for a radius of at least a mile around the town of Calico, are exclusively volcanic in origin. They consist partly of massive eruptions and partly of heavy accumulations of detrital materials in the shape of clays, sandstones, breccias, and conglomerates, whose constituent particles were almost all derived from the disintegration of earlier volcanic eruptions, though they do occasionally contain fragments of granite, etc., torn from the more deeply underlying rocks by the earliest eruptions and afterwards scattered about amongst the volcanic debris.

"King Hill" (on the southern flank of which some of the most important mines are located) is very largely a massive eruption, and that eruption must have been far subsequent in date to the accumulation of the

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detrital materials which surround it and which it uplifted. The same period of massive eruption which produced King Hill as one of its small spurs probably also involved more than one hundred square miles of country around to the north of here—possibly several hundred.

It is certain, however, that since that time great portions not only of King Hill itself, but also of the detrital rocks which flank and surround it, have been greatly altered and metamorphosed by the solfataric action connected with the formation of the mines. Few, if any, veins were formed, and certainly none of a character that has been sometimes represented. There is no regularity whatever in the stratification of the detrital rocks here. On the contrary, they are folded and crumpled like masses of paper in every direction—a common result of volcanic uplifts.

Near the Runover Mill, at the very southern foot of the hills at the edge of the plain, there is a massive volcanic rock which Mr. W. Lindgren has called "hornblende-andesite," and which he thinks is "later than the sandstones." In this he may be right, and this rock may belong to the same period of massive eruptions as King Hill itself. But the evidence on this point is scarce. To the north of this the detrital rocks extend irregularly up the southern flank of King Hill, almost as far as the outcrop of the Silver King Mine; and still further north the same formations again make their appearance about the Bismarck and the Humbug Mines north of King Hill, where some of them occupy a nearly horizontal position.

In at least two of the most productive mines of this district, viz., the Silver King and the Oriental, No. 2, there is *no vein at all*. The rocks, both massive and detrital, have simply been shattered and cracked through and through in all directions. But no "crack" has in these mines ever opened into a fissure in which a vein could form; nor has any definite mineralized belt ever been formed in this region with limits of any sort, such that any United States Court would hold it to be a "vein," even within the broad limits of legal signification which have been allowed to the word "vein" in decisions rendered. As already stated, the cracks run in every direction, and they are very numerous; and the whole body of rock, both massive and detrital, has been more or less permeated, and very irregularly impregnated in all directions with sulphate of baryta, chloride of silver, and some other minerals.

The talk about a "vein" with a "foot" and "hanging" wall in the Silver King and Oriental No. 2 Mines proceeds from the following facts:—Some of the cracks above mentioned are more extensive and can be traced for longer distances than others. And it so happens that, in the Silver King ground, one of these cracks (the miscalled "foot-wall") has been followed in the mining works for a distance of one thousand feet, or somewhat more, with a general strike of about north 65 degrees to 75 degrees west, magnetic, and a dip of 70 degrees to 85 degrees to the south. But this same crack forks and splits at numerous points, in directions of both strike and dip; and along the surface of the ground, on what is called the "Silver King Outcrop," there were at many points several different cracks, or seams, any one of which could with equal justice and reason have been chosen by parties interested as the main one, and *called* the "foot-wall," or anything else. It also happens that in the Oriental No. 2 claim, which lies next southwest of and adjoining the Silver King (the boundary line between the claims running north 63 degrees west, magnetic), there is another crack, which has been followed for a considerable distance in a general (though varying) northwesterly direction, and near which considerable bodies of rich ore have been found. And this seam has been dubbed the "hanging-

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wall," the distance between the two varying all the way from twenty feet or less, to one hundred feet and more, and all the country between these cracks has been called "the vein." But there is also another extensive crack in the Oriental No. 2, which might just as well be called a "hanging-wall"—and there are many other cracks. In one place in the Oriental No. 2, a piece of very rich ground was stoped out between two cracks which for a distance of forty feet or so were nearly parallel and nearly vertical, and only some three or four feet apart, leaving beautifully smooth and regular walls for that distance. This place, at first glance, looked wonderfully like a vein; but it was not—for neither crack had opened out to any width. Each had its own two surfaces of fracture independent of the other, and the material stoped out between them, rich as it was, was like all the rest of the ore from these mines—nothing but the partly decomposed country rock, which happened here to be more highly impregnated with chloride of silver than it was in some other places.

It is indeed true that, as a general rule, most of the rich ore bodies here have been found in the immediate vicinity of the most extensive cracks; and it is also true that frequently the ore-bodies accompanying any given crack have been found to lie for some distance chiefly on the same side of that crack, though this last rule by no means always holds. And this state of things is exactly what might have been expected in a formation of this character. It is simply a mass of volcanic rocks of various characters and ages, which have been greatly altered, decomposed, shattered in all directions, and irregularly impregnated with silver ores and other minerals. There is, probably, more or less silver in almost every ton of rock in the neighborhood of Calico, but how much of it will pay to mine and work can only be determined by actual experiment.

The name of "liparite" has been applied to the rock which forms the mass of King Hill, in which these mines are, and correctly so according to the nomenclature of Baron von Richthofen in his "Natural System of Volcanic Rocks," for it is a "porphyritic rhyolite."

Many of the cracks here show well marked "slickensides" on both walls; but there is little evidence of any "King System (or any other "system," for that matter) of Faults" here. There is absolutely no evidence whatever of any fault or throw approaching five hundred feet in magnitude since these mountains were uplifted; and there *has* been a *great deal of erosion* since then.

Some other facts concerning this district are given in the communication read by Waldemar Lindgren, Esq., of the United States Geological Survey, before the American Institute of Mining Engineers in February, 1887. But some of the statements therein contained are not correct.

The following information and statistics concerning some of the Calico mines are kindly furnished by Mr. J. R. Scupham, Mining Engineer:

The Oriental-Garfield Mines, Calico District, San Bernardino County, California. This mining property, belonging to John S. Doe, of San Francisco, is very extensive, consisting of some thirty-six claims and parts of claims, with a well appointed fifteen-stamp silver mill.

The mines are situated in the heart of the Calico range of hills, and are reached by well constructed wagon roads, chiefly in the beds of three deep cañons. At the extremity of the ridge, between the junction of two of these cañons, the mill is situated, so that the ore can be delivered at the mill from any part of the property by a short down-grade haul.

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The silver is found in the form of chloride and embolite chiefly, and impregnates, to a greater or less extent, all classes of the rocks.

The deepest openings in the district show some sulphide ores; hence we have a basis for the supposition that below the "water-line" the ore will change as usual to the prevailing sulphides.

The ore at present being worked in the Garfield Mill comes chiefly from three groups of mines, each supplying a slightly distinctive class of ore.

The first of these is the Oriental-Mammoth group. This supplies a rich, brittle ore, having a gangue of baryta in decomposed porphyry. This group of mines was bought from the Oriental Mill and Mining Company, and is now in good production.

The second group is the Silver Monument. This is a great mass of friable liparitic tufa, impregnated throughout with chloride of silver, from eight to sixty ounces per ton, and containing also some manganese and chloride of lead. The whole hill is being quarried out and sent to the mill, the cost of mining being less than 20 cents per ton.

The third and most important group is the Garfield-Occidental. The Occidental ore-bodies are very extensive and are chiefly in volcanic sandstone.

The Garfield ore-bodies have been very rich, and are found in the hard, massive liparite. The richness of the sorted ore first taken from the mine was phenomenal. To illustrate, I quote briefly from the Superintendent's report:

"Work begun on the Garfield Mine in December, 1882. Worked two men until April 1, 1883, and shipped eleven tons of ore which yielded $5,885. Then put on six men, and in the month of July following shipped to San Francisco thirty-three tons that yielded $26,440, and two hundred and thirty-three tons to the Oro Grande Mill that yielded $30,756. In September shipped ninety-six tons to the Odessa Mill that yielded $8,736, and nine tons that yielded $7,200, or about eight hundred ounces per ton. Stopped extraction of ore and began work on main tunnel. From November, 1883, to January 1, 1885, shipped to Odessa Mill two thousand four hundred tons of ore that yielded $290,400, and also had a large amount of unassorted ore worked at Barber's Mill."

The ore from these three groups of mines is mixed on the mill dump and milled in about equal quantities. In this way it yields up its silver readily to the simple pan process, the ore working up to about 85 per cent of the contained value. The continuous pan system is used.

The following is the tabulated result of the working of this property for one year, taken by permission from the books of the Garfield Mill, and the balance sheets of the Selby Smelting Company:

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CALIFORNIA STATE MINING BUREAU.

WM. IRELAN, JR., State Mineralogist.

ELEVENTH REPORT

OF THE

STATE MINERALOGIST,

(FIRST BIENNIAL,)

TWO YEARS ENDING SEPTEMBER 15, 1892.

SACRAMENTO:
STATE OFFICE, : : : A. J. JOHNSTON, SUPT. STATE PRINTING.
1893.

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EDITOR'S REPORT TO BOARD OF EXAMINERS.

SAN FRANCISCO, July 22, 1893.

To the State Board of Examiners:

GENTLEMEN: In accordance with your instructions of March 18, 1893, I have edited the manuscript of the Biennial Report of the State Mineralogist under the provisions of the Act approved March 11, 1893.

It will be remembered that when this manuscript was originally submitted, the Board of Examiners declined to publish it entire, and printed only the brief report of the Trustees of the State Mining Bureau and the introduction to the report by the State Mineralogist. This report also called forth from the Governor the following expression, printed in his message to the Legislature:

I have carefully read the biennial reports of the various State officers and public institutions, with the exception of those of the State Mineralogist as originally prepared, the State Agricultural Society, the Railroad Commissioners, the Bureau of Labor Statistics, the State Board of Horticulture, and possibly one or two others, which are so voluminous that none but the unemployed and those directly interested and expecting to derive personal benefit from them can have time to read. While it is the duty of those who prepare these reports to inform the public fully in regard to the conduct of their institutions, very often too little time is devoted by their authors to condensing their statements. Intelligent people do not require arguments, but simply facts, from which they draw their own conclusions. The enormous cost of printing some of these volumes seems to have escaped attention in many cases; notably in that of the State Mineralogist, the cost of printing which, as presented, would have been over $10,000. I have no doubt that this is a valuable contribution, but I believe that $2,000 worth of intelligent editorial work bestowed upon the manuscript would have saved four times that amount in the cost of printing, and the volume would have been of greater value to those interested. People will not read long, tedious reports, and if it were not for the condensed statements given out through the press the people of the State generally would have very little information in regard to our public institutions.

The Legislature then passed an Act, which was approved March 11, 1893, making an appropriation for editing the manuscript of the report of the State Mineralogist for the two years ending September 15, 1892. This Act is as follows:

AN ACT MAKING AN APPROPRIATION FOR EDITING THE MANUSCRIPT OF THE REPORT OF THE STATE MINERALOGIST FOR THE TWO YEARS ENDING SEPTEMBER 15, 1892.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. There is hereby appropriated out of any moneys in the State Treasury not otherwise appropriated, the sum of five hundred dollars, or so much thereof as may be necessary, the same to be expended under the supervision of the State Board of Examiners, to pay for editing the manuscript of the biennial report of the State Mineralogist, for the two years ending September fifteenth, eighteen hundred and ninety-two, said manuscript having been filed with the Governor on said date.

SEC. 2. This Act shall take effect immediately.

There were in all 2,307 pages of this manuscript, largely type-written. I have condensed all that relates to the counties of the State very materially, as in some instances I found much duplication of former reports. By comparing the reports previously published, with the man-

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script, the duplicated matter was eliminated. In other cases, where there was no duplication, there was still room for condensation, by leaving out the less important matter, in order to reduce the volume of the report. In editing this manuscript I have endeavored to retain only what will be of use to the practical miners of this State, so as to confine the report within reasonable dimensions, as suggested by the Governor in his message to the Legislature.

Several of the special articles prepared for this report can well be omitted altogether, since they do not relate directly to the mining interests of California, though they may be of scientific value. These, so far as I am able to judge, have been carefully prepared, and are doubtless valuable for publication through other channels. I do not recommend their omission because they may be unworthy of publication, but simply because, in my opinion, they are out of place in the report of the State Mineralogist, as not being of practical utility to the mining public. Among these are the following:

"Catalogue of California Fossils. Part II, Bibliography and References; Part III, Additions to the Tertiary and Quaternary Fossils; Part IV, Remarks on Fossils collected in Orange County by Dr. S. Bowers; Part V, Descriptions and Figures of New Cretaceous and Cret. B (or Eocene) Fossils of California, with Notes and Figures of Tertiary Species." By J. G. Cooper. This is partly a continuation of an article in the Mining Bureau report of 1888, and was omitted from the report of 1890, though prepared for that. There are 116 pages of manuscript. There are also six full-page plates, figuring sixty-seven species of Cretaceous and Tertiary fossil shells.

"Aboriginal Pipes of California," by Dr. Lorenzo Yates. Of this manuscript there are 35 pages, with five plates containing fifty-two engravings. This article is mainly interesting to the student of American history and ethnology. It gives the forms, uses, and history of the tobacco pipe among the native American races. It refers to and describes the pipes made by the aborigines of South and Central California; and there are many quotations from other authors describing the pipes of other Indian tribes. The ceremonial uses of pipes are also described; as also the methods of manufacture.

"Aboriginal Shell Money of California," by Lorenzo G. Yates. In this manuscript there are 57 pages and seven full-page plates, with seventy-nine cuts in all. The paper covers a description of the ancient media of exchange among the sea-coast tribes; different kinds of shells used; scientific names of shells used by the aborigines of this State; also beads; quotations from reports of Bureau of Ethnology; wampum, etc.

All three of these papers would be better adapted for publication by an academy of sciences or an ethnological society.

"Santa Rosa Island," by C. D. Voy; 48 pages of manuscript and five full-page plates. There is nothing in this which relates to mines or minerals. It refers to the discovery of the island, shape, climate, contour, points, anchorage (no harbor), volcanic material, bluffs and ridges, sand drifts, mountains, fossils, mammoth remains, topography, ethnology, zoölogy, and flora.

"San Miguel Island," by C. D. Voy; 34 pages and eleven full-page plates. There is nothing in this chapter about minerals or mines. It gives a history of discovery, geographical location and dimensions, harbors, shape of island, soil, shells, volcanic material, Quaternary fossils,

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Pliocene fossils, surface of island, bluffs, ethnology of aboriginal population, shell heaps or kitchen middens, ancient stone implements, stone disks, zoölogy, flora, etc.

Both of these papers of Mr. Voy show research and would be useful for a geographical or ethnological society.

The lithographs for these papers mentioned have been made and printed.

An article by the late Henry De Groot on "Hydraulic Mining" covers 90 pages of manuscript and has numerous engravings. It covers practically the same ground as the article by John Hays Hammond on the "Auriferous Gravels of California," published in the report of the State Mineralogist for 1889.

One of the chapters written by Mr. Fairbanks, entitled "Notes on the Geology of Los Angeles, Ventura, Santa Barbara, San Luis Obispo, and Monterey Counties," covering 54 pages of type-written manuscript, I have omitted. The work done there was purely scientific in its nature, and no attempt had been made to connect it with the mining resources of the region. As the field would have to be again visited, in order to bring out the economic and industrial relations of the geology, the present State Mineralogist retains this manuscript and Mr. Fairbanks was put in the same field to complete his investigations.

An article to which your attention is directed is the excellent one by Mr. A. H. Ricketts, entitled "A Dissertation upon the Origin, Development, and Establishment of American Mining Law." This covers 110 type-written foolscap pages. It is a first-class article, and of practical use to miners everywhere. It does not, however, relate exclusively to California, but from the nature of the subject, is of application all over the United States. Should the appropriation for public printing warrant, this article should be published.

As to the condensation of the work of the Assistants in the Field, more or less has been done on most of the chapters. Much of the information gathered had already appeared in the reports of the Bureau. From the two chapters on Nevada and Sierra Counties, 311 pages of manuscript were taken out.

In Sierra County some of the same field had been covered by Mr. Preston and Mr. Wiltsee. In some other instances the Assistants had gone over the same ground; that is, two had visited the same region at different times and some of the work was duplicated, each having worked independently.

To give you an idea of the rest of the condensation, it may be stated that from Mr. Fairbanks' chapter on "Geology and Mineralogy of Shasta County," 24 pages were eliminated from the 90 pages, a reduction of about 5,600 words. From his chapter on "Geology and Mineralogy of Tehama, Lake, Colusa, and Napa Counties," from 73 pages 19 were taken out, a reduction of about 1,900 words. From his chapter on "Geology and Mineralogy of San Diego and Orange Counties," 13 pages were taken from 108. As previously stated, his chapter on Los Angeles, Ventura, etc., amounting to 56 pages, has been entirely left out, that more complete work may be done upon it. All this manuscript of Mr. Fairbanks was type-written and had been carefully prepared.

Mr. Watts did work in twenty-six counties, and from the total of 100,000 words 73,440 words were left, a reduction of about 26,560 words.

In the work in three counties by Mr. Storms, the manuscript was

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thousand words were also taken from his manuscript, in the article
- Mine Timbering."

The manuscript of Mr. Preston was correspondingly condensed. It
proper to state that Messrs. Fairbanks, Watts, Storms, and Preston
cheerfully rendered me assistance with their respective manuscripts
the work of condensation. Messrs. Wiltsee and Hobson were out of
State.

There are several minor chapters which may be omitted without gr
detriment. These are the North Fork District of Fresno County,
chapter on San Benito County, and that on Salton Lake.

It is to be regretted that in the case of some of the articles which
recommended to be omitted, the engravings belonging to them have
been made, but these were finished when the report was origina
transmitted and there was no thought of cutting down its proporti

It may be stated that the manuscript shows no signs of having b
edited, aside from the mere paging of the leaves and arranging in or
A large amount of material had been left in which had already appea
in the last report or those of previous years. Where two assistants h
worked in the same county at different times no attempt had been ma
to compare their reports and erase one of the duplicated portions.
some instances engravings had been made of the same thing to go
separate chapters written by different Assistants, and these engravin
are ready for use. The Assistants, performing their individual wo
under general instructions, had written out their observations witho
knowing the details of the reports of others in the same field.

It is apparent that most of the manuscript had been recopied in th
office from the original reports handed in by the author s. Part of this
copying was evidently done by persons entirely unfami iar with mining
matters, and the result was there were many absurd er rs. These mis-
takes could not have been made by the original write for many were
obvious in the extreme. This was not the case ir ll the copying
in parts of it: there had been no revision after th copying.
No instructions had been given, apparently, for th ield Assistants
to be concise in their reports. On the contrary, in y instances the
matter had been elaborated with the evident intentio making a very
voluminous report. The system of tabulating the ls of operation
of individual mines immediately after each descri leads in every
case to useless repetition.

Assigning two men to the same county or district then not com-
pared the results of their work or their reports, le confusion and
for which the Assistants are not to be bla here has been
any system in this regard, judging by th as shown by
manuscript.

The original manuscript handed to me for revi sted of 2,30
entirely type-written. The paging now re , from which
reduced about 300 pages for erasures in manuscript.
The entirely erased pages are left in. T e the report
about 844 pages of manuscript.

I have not included the article on v," by Mr.
which is 110 pages of foolscap, typ the Board
publish this, then there will be 954 ript.
article on "Mine Timbering," by W. nineteen

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ngravings, is a good one, carefully prepared. It deals, however, largely ith Nevada and Dakota methods, adapted to more extensive operaions than are general in this State, where there are few, if any, large hambers requiring the class of timbering mainly considered in this rticle. If considered too extended for this report, this article might be eparately published at another time as a bulletin of the Mining Bureau, r the benefit of those who are interested in the subject.

The report as now submitted to you is almost exclusively confined to ining in the counties of California. Of course many of the engravings d lithographs which have been made will be useless. The engravings repared for this report have been made at a great expense. There re now printed, ready for use, 10,000 copies of each of the maps and thographs, yet comparatively few of them will be made use of by the tate.

Very respectfully,

CHARLES G. YALE.

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To his Excellency H. H. MARKHAM, *Governor of California:*

SIR: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau,' approved April 16, 1880," approved March 21, 1885.

J. Z. DAVIS.
W. S. KEYES.
THOS. B. BISHOP.
W. S. LYLE.
W. S. WOOD.

SAN FRANCISCO, September, 1892.

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REPORT OF TRUSTEES OF STATE MINING BUREAU.

The last Legislature of the State directed that the reports of the Mining Bureau be issued biennially instead of annually, as heretofore. Further, and as the Trustees respectfully suggest, in the exercise of a mistaken economy, the appropriation for the support of the Survey and Museum was reduced to the sum of $25,000 per annum. Of this amount three fifths was assigned for the work in the field, and two fifths for the exhibition rooms, the laboratory, and the working staff in the city of San Francisco.

The State Mineralogist has, owing to the smallness of the funds at his disposal, been obliged to greatly curtail the range of his investigations, but has, in our opinion, used due discretion in the selection of his expert assistants in the field of labor assigned to each of them. Full details of their work will be found in the report of the Mineralogist.

MUSEUM.

By the exercise of the very closest economy, Mr. H. S. Durden, the efficient Custodian of the Museum, has been enabled to keep within the appropriation, and not noticeably diminish the well-earned prestige of the State's exhibit of its precious and useful ores and minerals and its economically valuable oils, earths, waters, and building stones.

There have been catalogued up to date a grand total of 13,164 different specimens and groups of specimens. In this list is included 1,164 exhibits, which represent the additions since August 20, 1890. These consist mainly of ores, minerals, clays, and fossils, collected by the Field Assistants. Many of these fossils are new to science, and are now placed in the hands of competent specialists.

Donations to the Museum have been up to the usual average, but no large loan collection has been offered, nor in fact could any considerable loan exhibit be received, as the rooms are now so fully occupied that many interesting specimens are hidden from view in boxes, awaiting available space. Some room has been gained, so to speak, by altering and rearranging a portion of the shelving, and by returning to the owners certain loan collections of birds and curios, interesting enough of themselves, but not strictly in line with the purpose of a State economic and mining exhibit.

VISITORS TO THE MUSEUM.

The attendance at the rooms, as shown by the register, shows a gratifying increase. From October 1st, the date of the last report, up to the month of August, 1892, 77,605 different persons have registered their names, and of these 3,528 were pupils from the public schools of the city.

In view of the manifest popularity of the State's exhibit, the Trustees respectfully repeat that the usefulness of the Bureau would be enhanced were more commodious quarters obtainable through a somewhat increased appropriation.

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LABORATORY.

Much useful work has been done in the laboratory, and much useful information has been gratuitously given to citizens in all parts of the State.

There have been received and answered 9,311 letters of inquiry, touching all manner of technical subjects, earth, ores, etc.; 2,814 specimens have been examined, and replies given either in person or by letter. Many of these answers have been the means of developing new enterprises, such as quarries, oil fields, borax and magnesite works, manganese, slates, etc.

LIBRARY.

Since October 1, 1890, there have been added to the library some 800 volumes and a large number of useful pamphlets. Most of these are the result of exchanges with kindred institutions at home and abroad. Lack of available funds has prevented much increase by purchase. The catalogue of the library is now complete, and will soon be in the hands of the printer.

FACILITIES FOR RECEIVING SPECIMENS.

The Trustees desire to repeat their sense of obligation to Wells, Fargo & Co., and to the Pacific Coast Steamship Company, for their kindness and public spirit in transporting, free of charge, all packages destined for the use of the Bureau up to twenty pounds in weight.

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STATE FAIR—COLUMBIAN EXPOSITION.

As permitted by the Act creating the Board, the Trustees, with the assistance of the Mineralogist and Custodian of the Museum, prepared an exhibit for the State Fair held at Sacramento in September of 1892. They are still further making ready for a large exhibit at the Columbian Fair to be held at Chicago, Illinois, in 1893. No effort will be spared to do credit to the State and to the Bureau.

We are greatly obliged to the editors and publishers of the following newspapers and periodicals which have been regularly received at the Bureau, free of charge, during the past year:

Calaveras Prospect, San Andreas, California.
Calaveras Citizen, San Andreas, California.
Central Californian, Fresno, California.
Daily Tidings, Grass Valley, California.
Daily Union, Grass Valley, California.
Downieville Messenger, Downieville, California.
Financial Mining Record, New York City.
Fresno Expositor, Fresno, California.
Humboldt Daily Standard, Eureka, California.
Inyo Independent, Independence, California.
Mining Exchange and Review, Denver, Colorado.
Middletown Independent, Middletown, California.
Mining Industry, Denver, Colorado.
Oakland Daily Tribune, Oakland, California.
Placer Argus, Auburn, California.
Placer Herald, Auburn, California.
San Leandro Reporter, San Leandro, California.
Santa Ynez Argus, Santa Ynez, California.
Siskiyou Telegram, Yreka, California.
Visalia Delta, Visalia, California.
Wallace Press, Wallace, Idaho.
Weekly Star, San Francisco, California.
West American Scientist, San Diego, California.
Wood River Times, Hailey, Idaho.

FINANCIAL ACCOUNT.

FROM OCTOBER 1, 1890, TO JULY 1, 1891.

Balance on hand October 1, 1890	$38,584 14	
Paid into Mining Bureau Fund	5,228 80	
		$43,812 94

Contra.

Salary of State Mineralogist (9 months)	$2,250 00	
Salaries of geological assistants	10,750 20	
Traveling expenses of geological assistants	3,514 23	
Clerical assistance	855 65	
Freight and expressage	50 45	
Sundries, geological work	353 85	
Map account	7,122 15	
Rent of Bureau	2,250 00	
Salaries of Bureau employés	5,630 00	
Library	366 64	
Laboratory	147 42	
Freight and expressage	810 97	
Minerals and Museum	445 88	
Postage	681 82	
Sundries	954 72	
		$36,133 93

Balance

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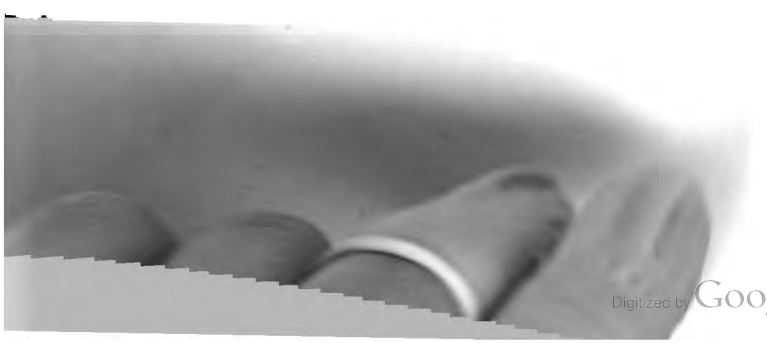
FROM JULY 1, 1891, TO JULY 1, 1892.

Balance on hand July 1, 1891	$7,628 96	
Paid into Mining Bureau Fund	5,128 05	
Bureau appropriation, forty-third fiscal year	10,000 00	
Geological appropriation, forty-third fiscal year	15,000 00	
		$37,706 97

Contra.

Salary of State Mineralogist	$3,000 00	
Salaries of geological assistants	10,250 00	
Traveling expenses of geological assistants	4,583 75	
Clerical assistance	101 50	
Freight and expressage	6 68	
Sundries	144 50	
Rent of Bureau	3,000 00	
Salaries of Bureau employés	8,050 00	
Library	247 67	
Laboratory	148 39	
Freight and expressage	367 16	
Minerals and Museum	135 25	
Postage	105 75	
Sundries	638 06	
Clerical assistance	125 00	
		$30,903 71
Balance		$6,803 26



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To his Excellency H. H. MARKHAM, *Governor of the State of California:*

SIR: In accordance with the provisions of an Act of the Legislature entitled "An Act to amend Sections 332, 333, and 334, and to repeal Section 335 of the Political Code of the State of California," approved March 12, 1872, relating to public reports, and in pursuance of the provisions of "An Act to provide for the establishment and maintenance of a State Mining Bureau," approved April 16, 1880, I herewith transmit my report.

WILLIAM IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, CAL., September 14, 1892.

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GEOLOGY OF SAN DIEGO COUNTY; ALSO OF PORTIONS OF ORANGE AND SAN BERNARDINO COUNTIES.

By Harold W. Fairbanks, F.G.S.A.

The topography of this region has been quite thoroughly described by W. A. Goodyear, in former reports of the State Mining Bureau. The structure of San Diego County is comparatively simple. Three main divisions might be made: the desert on the east, the Peninsula range of crystalline rocks in the middle, and the nearly level mesa on the west. The Peninsula range is supposed to represent the southern continuation of the Sierra Nevadas, but in just what relation it stands to the Sierras has been a matter of dispute. The Peninsula range in San Diego County forms one main mountain chain. It maintains this simplicity of structure southward, forming the backbone of the peninsula of Lower California. Northward it becomes broader and more complex, rising in the lofty San Jacinto and San Bernardino ranges on the east, and the Santa Ana range on the west, while the region between is filled with mountains and valleys irregularly disposed.

Complex as is the topography of this region, the geological problems, though often difficult to solve, are quite simple. The higher mountains are formed wholly of ancient crystalline schists and massive rocks, respecting the age of which a great diversity of opinion has existed; while the region bordering the coast consists of unaltered Cretaceous, Tertiary, and Quaternary deposits.

Owing to the very limited time given me to prepare my field notes for the press, they will be given substantially as they were taken in the field, without any attempt at systematic arrangement.

The crystalline rocks of San Diego County are varied in character, and of much interest. No opportunity has been given me to study the large collection made, and the determinations given are simply the result of superficial examination, and are subject to correction.

The bay of San Diego is bordered on the east by gently sloping mesas of modern Tertiary and Quaternary age. These unaltered strata are characteristic of the western slope of the Peninsula range through its whole extent. They sometimes rise as high as 3,000 feet; though in San Diego County they do not exceed 1,500 feet. The upper portion of these beds consists to a great extent of coarse, loosely cemented conglomerates. The rivers issue from the higher mountains through narrow valleys or cañons, and have cut valleys, often quite broad and with very steep sides, through the mesas to the ocean.

The Otay mesa has a height of about 500 feet, the western portion being somewhat higher than the eastern, indicating a recent elevation near the coast. The soil of the mesa is adobe, due to the decay of porphyry mountains to the east. Under the adobe there is a calcareous marl, often many feet thick.

The first exposure of the older rock seen as one goes up the Otay

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River, is in a hill rising through the mesa about in the center of the grant. It is a part of the extensive porphyry intrusives, which, in southern San Diego County, form a number of high mountains between the granite and the mesa. To this formation belong the San Miguel and Otay peaks. This exposure on the Otay River is a felsitic breccia. It contains a felsite base (intimate mixture of quartz and feldspar), in which are imbedded fragments of felsite and chlorite. No more rocks appear for about 2 miles up the river. Then we reach the base of the long ridges which lead up to the Otay Peak. Some interesting rocks are exposed where the stream issues from the cañon. The greater portion are fine dark to greenish aphanitic rocks, with green chloritic or epidotic nodules. Bunches and dikes of coarse to fine grained porphyritic rocks occasionally appear. They probably belong to the diorite porphyrites. The rock continues very much the same for several miles farther east; at times it is almost wholly feldspar. In the cañon above El Nido Post Office it changes to a light green feldspar porphyry. Near the western edge of the Jamul grant a dark-colored porphyry takes its place, and a little farther east it becomes jet black, with small white feldspar crystals, producing a very pretty effect.

The mesa conglomerates extend along the top of the low hills bordering the valley nearly to the eastern edge of the Jamul grant. A great variety of rocks appear along the Campo road between the Jamul grant and Sheckler's, on the Cottonwood. Near the eastern end of the grant the porphyry is followed by fine-grained granitic rock, frequently becoming schistose. Numerous dikes and bunches of dark diorite cut through this rock. As Dulzura Post Office is approached, these rocks change to mica and hornblende schists, and are filled with intruded dikes of diorite porphyrites. Bodies of massive syenite and coarse granite were also seen. About Dulzura many of the dikes have the appearance of diabase. Between Dulzura and Sheckler's the country rock is largely micaceous and chloritic schists. Massive granite forms the high, rugged mountains east, extending in an arm westerly across the road. The schists have a northwest strike, vertical dip, and are evidently of metamorphic origin. They form a strip of country extending in the line of strike from near Sheckler's to the Sweetwater River, and are situated between the wide belt of porphyry on the west and the coarse intrusive granites on the east, which rise to form Lyon's Peak and other rugged mountains.

The first rock met east of Sheckler's, on the Campo road, is coarse hornblendic granite, so decomposed that a fresh specimen could not be obtained. Dikes of fine-grained granite intersect it in every direction. Three miles west of Potrero, mountains of olivinitic diabase rise on the north side of the road. This rock is very similar to many large bodies of intrusives through the mountains between Julian and the Tia Juana River. It has evidently been intruded into the granite, for dikes extend out, intersecting the latter rock.

Potrero is located in a valley of several hundred acres in extent, and surrounded by granite mountains. It has an elevation of 2,400 feet. South of Potrero, along the boundary line, the mountains show large areas of the dark dioritic and diabasic rocks. The hills immediately south of the valley consist of hornblendic gneiss; strike east and west. Eastward, toward Campo, the rock is chiefly a coarse white granite, very easily decomposed. It shows a slightly gneissoid structure for a number of miles. It does not seem to represent the bedding of a sedimentary

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rock, but of parallelism of the constituents, induced in the magma by movement or pressure. Long, drawn out, lenticular inclusions are often present, and are arranged parallel to the schistose structure. These consist largely of hornblende, with little feldspar.

In the vicinity of Campo the topography of the country changes from that of high mountains and deep, narrow valleys, to an elevated mountain plateau with meadows and rounded granite ridges. The mountains are covered with brush, while live oaks are numerous in the valleys. The country maintains these features while gradually rising to the divide 8 miles east of Campo. The granite is so deeply decomposed along the summit region that no good samples could be obtained. Campo has an elevation of 2,600 feet. The bare, rounded ridges closely resemble those left by glacial action, but their slope is produced simply by the cleaving off successively of the more angular portions in great slabs. Many fine examples of this manner of decay appear about Campo. The corners are decomposed faster than the smooth surfaces, and thus finally a shelly concentric structure results. The fresh massive central portion weathers out like water-worn bowlders. The presence of rugged angular ridges results either from a less inherent tendency to decay, or to a comparative freedom from crushing. Four miles northeast of Campo is an outcrop of coarse hornblendic granite, with large six-sided mica scales and numerous yellow crystals of titanite. The height of the divide is 3,800 feet. Near the summit the rocky ridges all disappear and the country becomes covered with granitic sand. Erosion here is evidently very slight. The country descends gradually on the east to Jacumba Valley, being sandy for some distance. This finally gives place to bare, rocky ridges and cañons. Veins of fine granite, and others of feldspar and quartz, are abundant on the eastern slope.

Before reaching Jacumba Valley a body of mica and hornblende schist is encountered. The schists do not form a regularly defined belt, but often appear as inclusions in the granite. These inclusions have a very variable strike, and from their relation to the granite it is evident that the latter is intrusive.

Jacumba Valley empties northward into the desert through a narrow gorge. It has an elevation of 2,600 feet, the same as that of Campo. It is several square miles in extent, the greater part of which is in Lower California. The warm springs here are considered quite medicinal. The schists just described occupy a large area west and north of the cañon through which the valley empties. They are cut in every direction by dikes of granite and others, consisting of a very coarse aggregate of quartz and feldspar with a little muscovite mica. A high mountain several miles north of the valley is distinctly ribbed all over by them. The schists extend northward toward those which outcrop on the eastern slope of the Laguna Mountains and at Julian, but are cut off by a body of intrusive granite. They undoubtedly belong to the same series. Gold-bearing veins have been found in them a little north of Jacumba Valley.

At the north end of Jacumba Valley, and on the west side of the outlet, is an area of volcanic rock, probably basalt. It forms a tableland, gently sloping toward the valley, and rising 600 or 700 feet at its northern end. It is underlaid by gravels and conglomerates. Just east of this is a black butte, rising perfectly symmetrical to the same height. It consists of bedded lavas, with tufa at the bottom. In spite of the

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fact that it is shaped like a crater, its structure is different, and it is probably a remnant of the flow which once covered the outlet to the valley.

The high range of mountains between Jacumba Valley and the desert has an altitude of something over 4,000 feet, but where the road crosses it, it is only 3,100 feet. Basalt outcrops also on the eastern side of the valley. North of the road to Mountain Springs it forms a series of plateaus, the highest of which reaches a height of 3,900 feet. It forms the summit of the range, being 800 feet above the granite forming the pass. South of the pass several miles the granite rises much higher and the lava lies along its western slope, extending an unknown distance below the line.

Large deposits of water-worn bowlders and gravels lie along the eastern slope of Jacumba Valley. Among them are pebbles of porphyries, black quartz, and others not seen in place in this part of the county. A short distance west of the summit they are found in beds with gravel and sandstone, dipping southwest. These late Tertiary deposits are overlaid by the volcanic beds. The volcanic plateau which rises so high north of the pass has a thickness of 500 to 600 feet. Massive and bedded lavas form the upper half of this thickness, the lower portion consisting of a volcanic breccia. The beds lie nearly horizontal. On the west are two lower terraces, also capped with lava and abutting against the higher. The whole is underlaid by sand rock of granitic origin. It is nearly level in places, in others it dips to the southwest. It is very strange that these lava beds, with nearly level flowage lines, should be found at such greatly varying elevations about Jacumba Valley, and be underlaid everywhere by such similar tuffs and sandstones. My investigations disclosed no volcanic vent, and it is possible that the lava issued from fissures, as was noticed elsewhere in the county. Another interesting question is the origin of the sandstones and conglomerates. The sandstone underneath the high plateau is higher than the divide at that spot, and the only granite within miles that exceeds it in height, is the narrow ridge which rises on the southeast. The erosion must have been very great along the ridges since the sandstones were deposited, but the valley cannot have changed much. There may have been great elevation along the crest of the range bordering the desert since the deposition of sandstone, tilting up the sandstone and lava on the eastern slope, but elevating without great disturbance those near the summit. Southeast of Mountain Springs is a body of bedded tufas reaching an elevation of 2,300 feet, and dipping to the east away from the range at a considerable angle.

The presence of these modern sandstones at so great an elevation nearly on the crest of the Peninsula range is a very interesting fact. Either Jacumba Valley was a lake, or a great elevation has taken place in comparatively recent times, raising the valley from the sea-level. Appearances indicate that during late Tertiary times this range was almost submerged beneath the sea.

The rocks between the summit and Mountain Springs are chiefly gneissoid, at times granitic. They contain bodies of fine dark mica schist, and many dikes of very coarse muscovite granite. The descent to the desert is very abrupt over bare granite ridges. Mountain Springs, an old stage station, is located on the side of the mountain at an elevation of 2,300 feet. From the springs the road descends along the dry bed of

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an arroyo to the desert. The most of the distance is through a rocky cañon, where there is an excellent opportunity to study the relations of the gneiss and granite. For some distance down from the springs the rocks continue to be gneissoid, but through the lower end of the cañon they become more massive and coarse, and all the veins characteristic of the gneisses of the higher mountain region disappear. At the upper end of the cañon is a dike of very coarse granite, with large biotite crystals instead of muscovite. This is the only instance in which biotite was seen in one of these coarse dikes. Banded gneiss, varying from very thin to very thick bedded, alternate with other rocks, to all appearances massive granites, but in surface decay the latter break up into slabs of varying thickness, parallel to the schistose structure of the gneisses. The banding is caused by an excess of mica or hornblende, chiefly the latter, arranged in parallel layers. These strata are often very thin, varying from one fourth to one half inch and upwards in thickness. They are very regular, but often discontinuous; stop, and in course of a few feet begin again. These features are generally supposed to indicate metamorphic origin, but at one spot a body of dark mica schist is cut by a dike a foot wide or more of this dark banded gneissose rock. This dike cuts across the stratification of the mica schist, showing conclusively the intrusive nature of at least a part of these gneisses; and it is quite possible that the inclusions of mica schist are the only really sedimentary rocks present. In places the rocks which show this banding have the constituents arranged in the bands independent of any direction. At one spot a distinct, well-defined mass of mica schist, 15 feet across, is imbedded in a granitic rock. At one side this gneissoid structure extends through the inclosing rock and abuts sharply against the mica schist. The banding shows no constant direction; in the cañon it is northeast. The bands sometimes become wavy.

As the cañon opens out to the desert, hills appear on either side formed of volcanic tuffs. They dip northeast 30°. Underneath is a sandstone wholly unconsolidated and dipping in the same direction 40°. This contains no lava pebbles. The fragments of the tuff are quite varied in character and generally quite angular. They are imbedded in a volcanic mud, free from granitic detritus. In some of the strata appear thin beds of lava, seeming to represent a flow. These tufa hills extend northwesterly along the base of the granite mountains for 10 miles or more. It is not known how far they go in a southerly direction. In places they form mountains of considerable size high up on the side of the range. The range of mountains between this point and Carrizo Creek appears also to have some volcanic beds on its southern slope. The open desert at the foot of the mountains has an elevation of 1,200 feet. It slopes gently for miles in an easterly direction and consists largely of loose sand.

Between Mountain Springs and the summit is another illustration of the fact that lamination in a crystalline rock is no proof of its sedimentary origin. A small dike less than 2 inches thick cuts across a coarse biotite gneiss at an angle of 30°. It is separated from the gneiss by a thin layer of quartz and feldspar. It is made up of the same constituents as the gneiss, arranged so as to show a well-pronounced gneissoid structure. This is very similar to the large dikes seen in the cañon.

The road was followed back to Campo, and from there the Laguna

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Mountains were climbed. The road ascends a long, narrow cañon on the southern slope. At the entrance to the cañon, 4 miles southeast of Buckman's Springs, the mountains are high and rocky, being formed of thin-bedded gneisses, which, in many places, blend into mica schists. They strike parallel to the mountain axis, a little west of north; dip 70° northeast. Three miles up the cañon the gneiss becomes thick-bedded and is finally replaced by mica diorite, which forms the hills on both sides. Granitic dikes outcrop near the junction and sometimes apparently in the diorite. There is often a blending between the two, as if the intrusion of both took place nearly at the same time. The region east of the southern end of the mountains is formed of coarse granite, decomposed to a considerable depth. The mica diorite extends northward, forming the whole central and western part of the mountains. On the east it is bordered by a slightly higher ridge, forming the crest of the mountains. This rock does not decompose as easily as the granite and gneisses on the west, and there consequently remains a mountain plateau having an elevation of about 5,500 feet. There is a considerable amount of pine timber and open meadows. The dark diorite forms one of the highest peaks of the Laguna Mountains, rising 6,250 feet. The highest portion of the mountains lies to the northeast, and is formed chiefly of a quartzose mica schist. From the eastern crest of the range a most magnificent view of the desert is obtained. The strata on the crest strike north 15° west, dip 70° northeast. The descent of 4,000 feet to Vallecitos is very abrupt. Near the crest it is almost as steep as the dip of the rocks. The mica schists in places approach gneiss in composition, but all of this series of rocks forming the crest and eastern slope very probably belong to the Metamorphic Series. South of this point the Laguna Mountains do not terminate so abruptly, but extend out in long, gradually descending ridges for many miles. The mica diorite extends north of the Laguna about a mile, when the schists on both east and west sides unite and extend north toward Banner. They are intruded by granite and diorite in many places. The body of diorite forming the Laguna plateau is about 8 miles long and 1½ to 2 miles wide. The highest peak is not over 200 feet lower than the Cuyamaca, rising 6,300 feet. The diorite seems to have been intruded in the middle of a considerable area of mica schists, for this rock outcrops on all sides. On the west, toward Pine Valley, they carry the gold veins of the Pine Valley district. The descent is very abrupt to Pine Valley and Buckman's Springs. The schists and gneisses extend about 3 miles south of the main portion of the mountains, when they are replaced by coarse hornblendic granite.

Buckman's Springs has an elevation of 3,400 feet. Here are some very excellent soda springs, the only ones I know of in this section of the State. A coarse, dark diabase outcrops in the edge of the mountains just north of Buckman's and also a little farther south, on the west side of the valley.

A narrow cañon leads up to the divide which separates the valley of the upper Cottonwood from Pine Valley. The western prolongation of the diorite of the Laguna Mountains appears near the road on the divide. The prevailing rock is, however, of a granitoid nature and filled with many large bunches of massive white quartz. Pine Valley has an elevation of 3,800 feet. Gneisses and hornblendic and micaceous schists outcrop between the valley and the divide east of Descanso. The strike

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is north and south. One mile southeast of Descanso there is another outcrop of the coarse diabase or gabbro which forms so much of the Cuyamaca peaks. Descanso has an elevation of 3,400 feet. The rock which outcrops for a number of miles along the road to Stonewall is a coarse, easily decomposed granite, rising in rounded knobs over a rolling, brush-covered country.

The Pine Valley district lies in a belt of gneissose, mica schist, and quartzose rocks, which extend in a direction a little west of north. They begin about 2 miles south of Pine Creek and extend, probably unbroken, through to Banner and Julian. It is 4 miles north to the Deer Park district. The metamorphic schists widen as this district is approached. They extend from the desert slope to Deer Park, where a body of diorite has been intruded, and from there westward 2 miles to the Cuyamaca grant. A half mile west of the camp the slaty mica schists and quartzites are well defined. A vein of gold-bearing quartz has been traced for several miles in these rocks, and a number of locations have been made on it. The strike is north and south, dip 80° to the east. A body of white crystalline limestone lies in this formation, about 1½ miles southwest of Deer Park. The body of micaceous diorite which extends through this camp is about a mile long, and is quite gneissoid in places. Near its southern end it incloses narrow bands of hornblendic and feldspathic rock, containing garnets. The veins are numerous in this diorite, and extend in every conceivable direction. The diorite has been greatly crushed at some time, with fissures in every direction; hence, the irregularity of the quartz veins. The veins are generally bunchy, and not often very large. They seem simply to follow the exceedingly irregular fracturing of the diorite, which is decomposed to a considerable depth. The work thus far in this district has been confined to the surface, so that nothing can be said in regard to the permanency of the veins. The elevation of the camp is 4,600 feet.

Two miles northward an outcrop of coarse biotite muscovite granite was met. It is about 2 miles long and 1 mile wide, having schists on all sides of it. This is the only example of typical granite (according to Rosenbusch) that was seen in Southern California. A broad valley, occupied by Mr. Harper's ranch, has been eroded in the center of this granitic mass.

Northward, along the crest of the range overlooking the desert, mica slates appear. They are so little metamorphosed as to closely resemble argillaceous slate. They strike a little west of north, dip 70° to 80° east, and maintain the same character north to Banner and Julian.

The road from Julian to Stonewall crosses mica schist and gneisses for about half the distance. Then we met outcrops of a dark basic rock, ranging from fine to very coarse texture. It extends southward and covers a large extent of country. The three Cuyamaca peaks, the highest in the southern part of the county, are formed of this rock. This rock was again met about half a mile west of the Stonewall Mine. It extends westward across the mountains for at least 2 miles, and some miles south of the main peak. In places it has a schistose structure. Near the outlet of the Cuyamaca reservoirs it is filled with vein-like aggregates of coarse hornblende crystals, which are probably the result of secondary crystallization in fissures or cracks of the almost consolidated magma.

The formation in the vicinity of the Stonewall Mine is biotite gneiss. Toward the east it is not sharply defined from the mica schists. On the

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west it is generally more granitoid, though at one spot near the lake there are finely laminated schists, dipping 70° southwest. Southward, also, the gneisses become more massive and coarse. At the northeastern base of the main peak a body of coarse granite is partly inclosed in the norite. This norite assumes a dioritic habitus near the granite, with the development of biotite mica.

The valley of the Cottonwood was followed down several miles, when it was left and the Morena Valley traversed to its head. The mountains south of the valley are formed of a dark syenite. North and northwest the higher mountains consist of granite, with a great development of mica and hornblende schists along the slope facing the valley. Many granite dikes have been intruded into the schists. North of Mr. Candler's there is a great dike of pegmatite, carrying small garnets, tourmaline, mica, and large masses of quartz. This pegmatite dike cuts across the cañon, forming a precipice on its lower side. On the upper side the soil has been retained, forming a small but fertile valley. The strike of the mica schists on the north is quite unusual, being north 75° west, dip nearly vertical. Dark syenite lies on the west of this little valley. Morena Valley has an elevation of 3,400 feet. A rough road leads over the mountains west to McClain's ranch, a distance of 10 miles; the highest point reached having an elevation of 4,000 feet. Near the summit there outcrops a body of coarse eruptive rock, probably a diorite. It consists of coarse hornblendic aggregates in a light-colored feldspathic matrix. This is followed by syenite, and that by coarse white granite as far as McClain's. The granite about the valley is coarse, with dark, fine crystalline inclusions. It has every character of a truly eruptive rock, even to the minute spaces between the components, left at the time of crystallization. The road now descends to a branch of the Cottonwood, and from the creek there is a long, gradual ascent to the pass north of Lyon's Peak. The north side of the pass is formed of another high and rugged granite range. This section is one of the wildest to be found in San Diego County. The mountains are bare granite, often precipitous; the valleys small and covered with brush. Crystalline limestone is reported to have been found in the granite 5 or 6 miles northeast of Renney's Pass. A very interesting eruptive rock outcrops east of the pass, on the north side of the road. In places it resembles the norite from Cuyamaca peaks. The rock consists largely of large, dark, cleavable crystals filled with small granular crystals of a green color, probably olivine. A large portion of the dark crystals are undoubtedly pyroxene, though there are some showing hornblende cleavage. This is one of the most peculiar and interesting rocks seen in the county, but, from lack of any opportunity to make a microscopic examination, no more definite definition can be given.

Coarse granite extends some distance west of the pass. It is decomposed to such a depth that no specimens could be obtained. A mile west of the pass a fine granite, apparently metamorphic, replaces the other. It contains much quartz, little mica, and yellowish feldspar. Some distance down the new grade a large body of diorite outcrops. It is one of the southern arms of a great mass of coarse, dark rock which forms the high mountains about Dehesa Post Office, on the Sweetwater. A large portion of this rock very closely resembles that forming the Cuyamaca, and is probably a gabbro.

Near the foot of the grade, 2 miles east of Jamul Post Office, this rock

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is very coarse, with large hornblende crystals. It extends out in the form of arms or dikes into the adjoining granitic rocks. This rock is very tough and heavy. Gneiss outcrops for 2 miles westward. It varies between thin-bedded micaceous strata and thick-bedded, almost granitic forms. It strikes north 15° east, dips 70° to 80° east. Farther down, toward the Oakdale House, this is replaced by coarse eruptive granites. Just below the Oakdale House there is a very interesting contact between granite, quartz porphyry, and diabase. The first rock exposed below the house is a rather dark micaceous syenite. Beyond this the rock becomes coarser, containing large grains of quartz and glassy feldspar, with inclusions of a very dark diabasic rock. In a little cañon which comes down to the road from the east, this rock comes into contact with one which varies from a feldspathic mica schist, through a gneiss, to a quartz porphyry. The junction is very irregular and the two rocks are slightly mixed; sometimes branches of the syenite are partly inclosed in the porphyry. Some portions of the syenite show gas pores, or spaces left at the time of consolidation, one fourth to one half an inch in diameter. They are partly filled with secondary quartz. The next rock exposed up the cañon is a mica schist; strike 15° west, dip vertical. Quartz porphyry follows this, then an irregular dike of granite, in which are imbedded nodules of quartz porphyry, some nearly a foot in diameter. Above the granite there appears a granitoid gneiss, with many cavities, arranged with their longer axes parallel to the schistose structure. This changes into a coarse, knotty granite, containing large

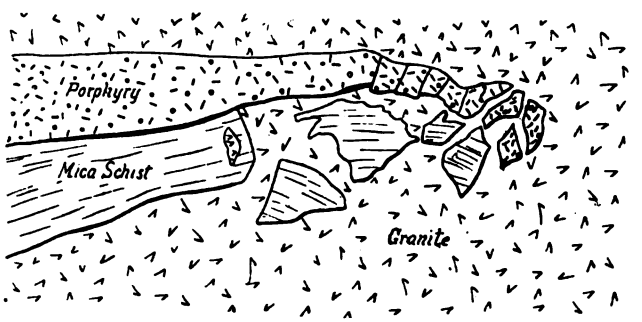

Fig. 9.

nodules of dark petrosilex. A slight blending is noticeable. Farther up this is succeeded by a micaceous quartz feldspar porphyry, showing a somewhat gneissoid structure. It is cut at right angles to this structure by jointing planes lying thickly together. It has a milky, vitreous luster, and contains inclusions of very coarse granite. The next rock exposed is a diabase 200 feet across. It is coarse in the middle and aphanitic on the edges. Adjoining it are bunches of granite and a fine, dark, compact mica schist, showing traces of little pebbles in places. The schist changes to a petrosilex, which comes in contact with a dike of very coarse granite. At the upper edge of this granite outcrop, and inclosed in it, is a stratum of fine, dark mica schist and a dike of quartz porphyry. At one end these inclusions are hidden, but at the other they have been bent, fractured, and the pieces separated some distance in the granite. (Fig. 9). This is a most interesting example of the intrusive nature of the granite.

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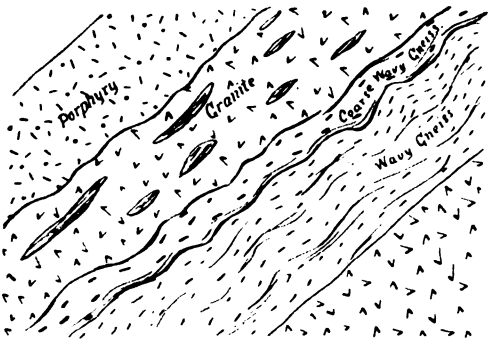

Fig. 10.

The granite dike is bounded on its upper side by one of aphanitic diabase 2 feet wide, followed by granite again. Nodules of the diabase appear in the edge of the granite. A stratum of wavy quartzose gneiss 10 feet wide follows the last dike of granite. It changes across the strike into a coarser gneiss, and that into irregular and partially blended masses of coarse granite, filled with long fragments of porphyry similar to a dike on the east. (Fig. 10.) The quartz porphyry is very compact and brittle, and has a conchoidal fracture. The porphyry dike has a width of 8 feet. About it is still another dike of granite 12 feet across, and containing many long fragments of a diabasic rock, which appears next in the succession.

The diabase is cut by small, interlacing granite seams for 6 or 8 feet, and also contains some large, irregular, lenticular masses of the same rock. Still farther is another dark dike cut squarely across by granite. Fine granite and quartz porphyry dikes occur still farther east. The porphyry dikes all run about north 35° west, average dip 70° southwest. They extend along the summit of a ridge for more than half a mile, when the coarse granite becomes the country rock. On the summit of the hill at the head of the cañon are strata of metamorphic rock, and also some veins of pegmatite, cutting across the porphyry. This wonderfully varied succession of rocks does not cover a width of more than a quarter of a mile. The relations exhibited here prove that the porphyry and diabase, as well as the schists, are older than the granite. The strip of country between the ancient porphyries of San Miguel and the coarse granite of Lyon's Peak and the ranges north is remarkably rich in its variety of intrusive rocks.

On the north bank of the Sweetwater, just above where the Spring Valley road crosses, is a large exposure of coarse granite, containing so many inclosures of a dark dioritic rock as to present the appearance of a conglomerate. It is cut by bunches and ramifying dikes of fine granite and diorite.

At Dehesa the granite is replaced by norite, which forms a high mountain on the north side of the river, and extends southeasterly 3 or 4 miles, forming two high peaks. In this are veins of hornblende aggregates, and in general appearance the rock bears the closest resemblance to that on the Cuyamaca.

The crystalline rocks exposed between the Sweetwater and El Cajon Valley generally show more of a dioritic composition than granitic.

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They have a glassy feldspar, much hornblende, and little quartz. There are two varieties: one is light colored, and forms most of the country; the other is darker, occurring in bunches and dikes. Southwest of the valley the rocks are more granitic. On the road to Spring Valley they give place to a hard, light-colored felsitic rock, containing specks of chloritic matter. Masses of granite appear in places, intruded into the rock. As it decays it becomes jointed, and seems to be reduced mostly to kaolin. Near the railroad, northwest of Spring Valley, rocks outcrop which belong to the series of dark intrusives, tuffs, and porphyries so extensively developed west of the granite. The rock here has a fragmental appearance in weathered specimens. It has a dark green color, and is of uncertain composition. The most western exposure of this rock, before it becomes covered by the mesa, has much the same character. It is without doubt an ancient intrusive, very greatly altered. It contains bunchy dikes of white feldspathic composition, which easily reduce to kaolin. The whole exposed width of these rocks west of the granite at this point is over a mile, about half of which is tufaceous. By tufaceous is not necessarily meant a fragmental intrusive deposited in water, but for lack of any other term it is used to designate those fragmental intrusives of plutonic origin which are so abundant in California.

Between the Oakdale House and the Sweetwater River, on the road to the dam, dark quartz mica diorites outcrop. They have been intruded by coarse granite in veins and bunches. A body of dark aphanitic rock, of uncertain origin, is inclosed in the diorite near the river. It may be a portion of the aphanitic rocks associated with the porphyries farther west. A little distance down the river the diorite is succeeded by conglomerate rocks, containing small garnets. The fragments are feldspathic in composition. Dark feldspathic porphyry then forms the prevailing rock for some distance. It shows great variations. Much of it contains no distinct crystals of feldspar, but is mottled by light green felsitic bodies of irregular outline. These contain chloritic substances, which decay out, leaving holes. There is a great variety of these ancient intrusives exposed along the sides of the river north of San Miguel Peak. None of the other crystalline rocks in San Diego County appear so old or show so much alteration.

Farther down the cañon the rock assumes a fragmental appearance, having masses of feldspar in a dark matrix. It finally becomes a pronounced breccia, being formed largely of angular, felsitic fragments. The base in which these fragments lie decays away and leaves them standing out on the surface. This may be a tuff formed in water, but the matrix has undergone such alterations that nothing certain can be said about it. This breccia continues to the lower end of the cañon. An interesting, light-colored dike was observed here. It is so filled with minute spherical amygdules as to resemble in structure an oolitic limestone. The breccia continues as far as the Sweetwater Dam, where it is replaced by feldspar porphyry. The porphyry shows much variation; in places no feldspar crystals are present, chlorite taking their place. These rocks disappear a quarter of a mile west of the dam, and mesa-like hills extend down to Chula Vista. These consist of soft sandstones and some calcareous deposits. Dark rocks, belonging to the series just described, outcrop near the mesa road from San Diego to El Cajon. It forms a long ridge south of La Mesa. The rocks are in part tufaceous, and in part dark green and massive, with felsitic inclusions. Near the

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Eleven-Mile House the granite is filled with dark, bowlder-like inclusions. Hornblende is an important constituent of the granite. It is more than likely that many of these so-called granites are really diorites. The mesa formation terminates in an abrupt escarpment on the west of Cajon Valley. The valley comprises many thousand acres of very fertile land. Granitic knobs rise in many parts of the valley, showing that the alluvium deposit is underlaid by it at no great depth. North of the valley, for a number of miles, the crystalline rocks are covered by the mesa conglomerates. Granitic rocks are the only ones exposed for many miles east of Lakeside. Just above Forster's there is a small outcrop of gneiss and mica schist; strike north 35° west, dip 70° northeast. The rock exposed along the grade is a coarse biotite granite, with much quartz and glassy feldspar. A dike of quartz porphyry varying to granite porphyry outcrops by the road at the top of the grade. This does not seem to be sharply defined from the adjoining granite. A dark hornblende granite or diorite begins here and outcrops along the road for several miles toward Ramona. Three miles from the town there appears a dark rock with a somewhat resinous luster. It is probably a diabase. The Santa Maria is a large, plateau-like valley, with low granite hills surrounding it. Light-colored granite, becoming somewhat hornblendic, extends some distance east of Ramona, when it is replaced by a dark diorite. The latter extends along the road for 2 miles. It has glassy feldspar, and in places much mica. Four miles west of Ballena the granite is filled with pegmatitic veins, running in a northwesterly direction. They carry brittle crystals of black tourmaline, garnet, and muscovite mica. East of Ballena the rock becomes coarser and somewhat gneissose, with an abundance of mica. There are no bedding planes, simply a parallelism of constituents. This schistose structure has a northwest direction. The gneiss changes to mica schist on the grade above Santa Ysabel. The schist alternates with occasional strata of quartzite; strike north 25° west. The quartzite is a white, fine, granular variety, containing a little mica. Coarse gneiss outcrops again farther up the grade; at the top it becomes finer, carrying some hornblende, and alternating with strata of fine mica schist; dip northeast. The gneiss often becomes granitoid. The lamination has no constant direction, and resembles a flowage structure. This granitoid gneiss extends to within a mile of Julian, when there is quite a sharp transition to a gneissoid mica schist. That gives place to a fine schist, and a quarter of a mile west of Julian to a pearly hydro-mica schist. The schists strike north 20° to 30° west, dip 70° northeast. At Julian the rock is a dark, thin-bedded mica schist, usually termed a slate. There are also dark felsitic rocks and some gneisses. The belt of dark slaty mica schists is about half a mile wide. Toward the Balkan Mountain the rocks become more gneissoid. This mountain seems to be formed wholly of gneiss and mica schist. In some places the rock is nearly massive, and contains a large amount of quartz.

The rocks forming the mountains near the road from San Felipe to Vallecito are nearly all gneissoid. The real desert begins on leaving San Felipe Valley. The road extends southeast for 5 miles and then turns southwest, descending a narrow, rocky gorge to the head of Vallecito Creek. Near where the road turns to the southwest, the gneisses are cut by innumerable dikes of coarse granitic composition. Many of these run parallel, cutting across the strike of the gneisses, and give the

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appearance of a bedded formation. In the cañon, before reaching Vallecito Creek, mica schist appears. It is bent and twisted into every conceivable direction, and varies exceedingly in structure and composition in the course of a few feet. The dip is northeast, and often at a small angle. The granite dikes often carry garnets, being quite similar to those between Julian and Banner. They were probably intruded after the eruption of the granite, and the related metamorphism.

At Mason's granite and gneiss both appear as intrusives in the schists, and are themselves cut by coarse dikes similar to those described. Between this point and Banner, in a direct line, gneiss is the prevailing rock. The high mountain east of Banner is more granitoid.

There is a sandy valley of considerable extent about Mason's; eastward a low ridge is crossed, and the road descends to Vallecito Valley between barren granite mountains, gradually descending until the open desert is reached. When the granite is hard these mountains are very rugged, but in places they are covered so deeply with soft, decomposed material as to closely resemble the Tertiary deposits farther east. The mountains often show pale purple to brown tints. On examination they appear to consist of a white granite, which has been so shattered as to break up into pieces, averaging not over 2 inches in diameter. This rock presents a very similar appearance for miles, particularly on the north side of the creek.

At Palm Springs the soft clay beds of late Tertiary age begin to appear. They dip in all directions, though that to the south and southwest is the most common. Toward Carrizo Station these are often covered by granitic detritus. The Tertiary beds widen out where the road strikes Carrizo Creek, and at Carrizo Station they have a width of nearly 10 miles. They rest against a granite range north of the creek and south along a long ridge which terminates in Carrizo Mountain. They also extend a long distance up Carrizo Creek. Four miles below the station harder sandstones and strata of shells cap the clay hills. This shell layer near the creek is 10 feet thick and contains pectens and oyster shells, belonging to the Miocene-Tertiary. The clay hills which surround Carrizo Station form a veritable Bad-Land. They show many different colors, and are perfectly devoid of any vegetation. They have been eroded into a most confused network of hills and cañons, and are so soft that it is difficult to travel over them. Six miles below this station and a mile north of the creek there rises a rugged granite range, facing the open desert. It rises from the desert quite precipitously nearly 2,000 feet, but blends westward into the ridges which run east from San Felipe. The granite is coarse and deeply decomposed. Sharp, angular grains of quartz stand out so prominently as to tear anything with which they come in contact. The thin-bedded shell strata rest against the slopes of the mountain, and near the southern end rise against the eastern slope at a very high angle in sharp, jagged points. These strata rise above the granite ridges at the point where they occur, and dip fully 70° to the east. (Fig. 11.) Resting on the summit of this granite ridge, and immediately west of the steeply inclined and jagged points of the Tertiary strata, is the southern outcrop of a bed of coarse, hard sandstone, which rises along the summit of the ridges to the north and dips west, extending down the western side of the range for a thousand feet or more, dipping at an angle of about 30°. This sandstone outcrops along the crest of the ridge for nearly a mile. It is, however, not absolutely

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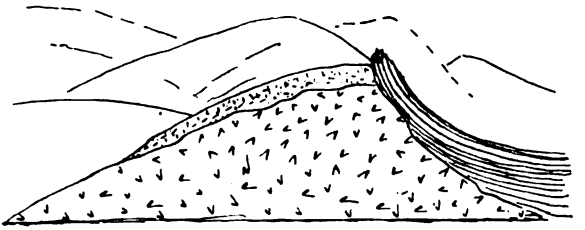

Fig. 11.

continuous, the granite rising through it in places. Near the southern end it is so highly metamorphosed as to be with difficulty distinguished from the granite at the contact. In fact, the two formations have become so intimately united, that a fracture of the granite made near the sandstone, instead of stopping at the contact, extends into the sandstone, so that the two rocks break off together. The contact is so exceedingly irregular that it seemed at first sight as if the sandstone had been intruded by the granite. Deep, narrow crevices extend into the granite, and are filled with sandstone. Some granite bunches are almost inclosed in the sandstone. The most interesting feature of this sandstone is the presence in it of an abundance of well-preserved corals of a type fully as old as the Cretaceous. Fragments of two species of a large oyster and poorly preserved specimens of univalve and bivalve shells are also abundant. There are at least two species of coral, many specimens being at least a foot in diameter. The sandstone is literally filled with them toward the southern portion of the outcrop. They also extend down into the crevices and cavities in the granite. The sandstone shows somewhat less metamorphism toward the north, where it contains some strata of pebbly conglomerate. The granite is intersected by many veins of coarsely crystallized feldspar and quartz. From these veins many of the pebbles in the conglomerate have been derived. At the highest point of the ridge the sandstone has the greatest thickness. Here it is broken up into great blocks 15 feet square, piled in the greatest confusion, as if by an earthquake. One great mass overhangs the almost precipitous granite escarpment at an elevation of 1,000 feet above the desert. Many fractures extend from the sandstones through into the granite. The sandstones, as well as the granite mountains north, have been baked a dull red color by the intense heat of the sun. To account for the peculiar position of this sandstone, as well as the steep inclination of the Tertiary beds at the southern end of the mountain, we must suppose that an extensive fault has taken place along the edge of the range facing the desert. The general inclination of the Tertiary beds to the west and southwest is also evidence of an uplift along this line.

Carrizo Mountain was ascended from the north by following up a wash through the clay hills. At the foot of the mountain there is a small outcrop of ancient volcanic rock greatly altered. This rock rests against the limestone which forms a large part of the north end of the mountain. The limestone is crystalline in every portion. The strike, as well as that of the schists and quartzites by which it is inclosed, is north 30° to 40° west, dip 75° to the southwest. The color of the limestone varies from white to streaked and variegated. It was carefully examined for fossils, but no traces of them could be found. The limestone is, however,

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filled in many places with the holes of borers, and one small incrusting coral and one barnacle were found. The elevation of the north peak is 1,700 feet, and these were found nearly at the top. Everything points to a great elevation here in times so recent that the atmospheric agencies have not yet had time to remove the surface exposed to the ocean waters. Another factor enters into this time computation, however, and that is that in this climate, where the rainfall is so slight, a great many years are required to effect slight changes. Toward the south peak the rock is almost wholly micaceous and quartzose schists. Judging from the great amount of metamorphism shown by these rocks, fossils, if they ever existed, must have been destroyed. At various points on the northern end of the mountain are horizontal deposits of a soft, shaly sandstone full of fossils, similar to those found north of Carrizo Creek. The corals are very large and perfect. Some nearly entire specimens of large oysters were also obtained, but most of the bivalve shells are represented only by casts. With all the exploration which has been done, it seems probable that these beds have never before been seen.

Professor Blake, geologist of the Pacific Railroad Survey, passed up Carrizo Creek in 1853, but, from the statements made, it seems his observations were confined to the immediate vicinity of the road. His is the only geological party that has visited this region up to the present time. The vicinity of Carrizo Mountain is a favorite one for prospectors, and every winter it is visited by a number of parties. As yet no important discoveries have been made, and I cannot say that I think the region is a favorable one. Silver has been reported from the southern slope of Carrizo Mountain, and at one time there was considerable excitement. The mountain, though formed wholly of metamorphic rocks, does not appear to have been mineralized to any extent. Only one dike was seen on the mountain, and that was of a coarse, granitic nature.

There is not the slightest doubt as to the presence of a non-conformity between the Miocene-Tertiary and the coral-bearing sandstones. Specimens of the coral were sent to the National Museum, and were pronounced similar to some from the lowest Cretaceous of Texas. As to the age of the limestone and associated metamorphic rocks, they are unquestionably Carboniferous or older. A float piece of silicious limestone was found containing some shells, but no opportunity for their investigation has yet occurred. The Tertiary beds are covered, wherever any of their original surfaces yet remain, by a great variety of washed bowlders.

With regard to the structure of this eastern slope of the Peninsula range, I can hardly agree with the views before expressed, that there are to be seen here evidences of an enormous fault, to which the steep escarpment toward the east is due. The eastern side of the range, so precipitous in places, has been compared to that of the Sierras in structure and general features. It is true that this descent is very abrupt in places, but in others it is almost as gradual as the western slope. For instance, the gradually descending ridges which extend east from Banner for nearly 30 miles, show no indication of any fault, save at the mouth of Carrizo Creek, where there has undoubtedly been a fault of considerable importance. The very abrupt descent east of the Balkan and Laguna Mountains is due solely to enormous erosion, for both north and south ridges extend past them for many miles into the desert.

The San Jacinto Mountains also send out long arms into the desert, and below the boundary Signal Mountain and a connecting range seem

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to be merely a spur of the main system. The rocks of the metamorphic belt at Julian and Banner, and farther south, dip to the northeast, indicating a great fold rather than fault, with the most strongly pronounced intrusive granites and diorites at some distance on each side.

It is not generally known that an ancient auriferous gravel channel exists in the county. It begins about a mile north of the old stage station, and 3 miles west of Ballena Post Office, where there rises a hill shaped like a whale's back (hence the name Ballena), covered with washed gravel and bowlders. The main portion of the channel which has escaped erosion begins south of the stage station, capping a hill which has an elevation above the sea of 2,400 feet, being a little lower than the so-called Whale Mountain. The gravel is 50 to 100 feet thick, and has a width of 2,000 feet or more. It rises 300 to 500 feet above the valleys and cañons on its sides. It extends in a direction a little south of west for about 4 miles, terminating on the south of Santa Maria Valley. A granite ridge runs 2 or 3 miles farther in the same direction, probably preserved by the gravels, which are now gone. A pretty valley, a mile long, has been eroded in the eastern end of the gravels, down to the underlying granite. Placer mining has been carried on for years here in a small way by Mexicans. Gold is said to be scattered everywhere through the gravels, which are often very firmly cemented. Lack of water, for the ridge is higher than any of the surrounding country, has prevented work on a large scale. Lately a mining district has been organized, and it is proposed to bring water 7 miles in pipe. In the gravels are washed bowlders, many of them being 2 feet in diameter and well polished. The remarkable thing about them, however, is that they are nearly all porphyries. The most abundant is a red feldspar quartz porphyry. Quartzite bowlders of all colors are numerous, and there are a few of the basic diorite so common in portions of the county. Garnets are said to be very abundant in the gravels, and many bowlders of a schist carrying them are also present. The matrix of this rock could not be made out in the field; it is very tough and heavy, and has never been seen in place. The red porphyry bowlders resemble those on the mesa farther west, but have never been found in place. Never, in the mountains east or north, has porphyry of this kind been seen, either by myself or described by others. From the old stage station the upper course of the stream was north and south as far as it can be traced. There are indications that one branch extended easterly toward Julian. These gravels appear on a hill surrounded by deep cañons, about 2 miles east of the top of the grade above Foster's. At the top of the grade the hills on the west are flat-topped, and covered with gravels to a depth of 150 feet. These have much the same character, and probably belong to the same channel. More investigation is needed to determine whether the course of the old stream was down toward the San Diego River, in Cajon Valley, or west toward the high mesas south and southeast of Poway Valley. It seems probable, however, that the stream flowed west, and that the mesas have been formed partly from the bowlders which they brought down. This mesa, as well as the gravels at the head of the grade, has an elevation of 1,500 feet. The source of the porphyry bowlders and the garnetiferous schists of this old river is a matter of great perplexity. The gravel deposit has every characteristic of an old river channel, and not that of an elevated arm of the sea; besides, the presence of gold in the gravels indicates their derivation from the country farther

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east. The gold may have been derived from Julian or Mesa Grande, or some more remote point. The river must have flowed across the gold belt, but then the question arises, how could a river of such magnitude have existed so near the summit? The only way out of the difficulty is to suppose that a great uplift has taken place along the crest and western slope, coupled with an enormous amount of erosion; and that this stream once, before this great change took place in the configuration of the country, headed many miles to the northeast, far beyond the drainage of the western slope. The bowlders consist largely of hard rocks, and are very smoothly rounded and polished, indicating that they have been transported a long distance, and subjected to attrition through a protracted interval. It is quite possible that this river emptied into or near San Diego Bay, and that the immense beds of bowlder conglomerates about the bay owe their formation largely to this river action.

The first outcrop of crystalline rocks in Mission Valley is about 3 miles above the old Mission, where the San Diego River enters a cañon. It is a volcanic tufa, consisting of grayish to greenish fragments of a fine-grained rock imbedded in a brown matrix. This has a width of about half a mile. Along the cañon, dikes of a greenish amygdaloid have been intruded in the rock, and are particularly numerous north of the river. One of these dikes in the cañon was observed to be amygdaloidal in the center. Farther up the cañon there is a great variety of tufas. The first contains feldspathic and hornblendic fragments nearly blended in a base consisting of crystallized feldspar and dark chloritic particles. Above this is a dike of brownish crystalline rock, much altered; the only distinguishable mineral being feldspar, in small crystals. Then follows another tufa, with nearly blended micaceous fragments. The next rock is a fine crystalline one with very regular bedding planes, a foot or more thick; dip 30° to 40° southeast, strike north 35° east. Then follows a dark, aphanitic, structureless rock for some distance. At one point a branching dike of almost pure feldspathic material spreads out into this aphanitic rock in radiating arms. Apparent bedding planes run through them, as well as the country rock, showing that these planes are not those of sedimentation, but are due to some secondary cause. These rocks occupy the cañon for 1½ miles, and are all undoubtedly of volcanic or intrusive origin. A series of rocks of metamorphic origin outcrops a thousand feet along the cañon. The first of these is a micaceous felsite. That is followed by fine-grained granitic rocks carrying garnets, and this by a hornblendic felsite. The latter finally becomes mixed and blended with a coarse micaceous diorite, containing a glassy feldspar. This rock is the chief one exposed through the cañon. It has granitic and syenitic facies. The tuffs exposed at the mouth of the cañon extend in a direction a little east of south for 3 miles, until covered by the mesas which extend west from Cajon Valley. They show a comparatively uniform character, the fragments being generally nearly blended. The ridge which these rocks form is separated from the granite by an elevated mesa a mile wide. The tuffs are exposed along Chaparral Cañon to within 2 miles of the mission.

The granite ridge at the lower end of Cajon Valley does not extend more than 2 miles north of the cañon, when it becomes covered with bedded deposits and bowlders of late Tertiary age. Granite does not appear in Sycamore Cañon until the northeast boundary of the Cajon grant is reached. High hills of gravel and bowlders lie east of the

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cañon and extend toward Foster's. The main body of granite is met at the head of the cañon. It extends along the east side of the road to Poway Valley. Bunches of dark, coarse diorite occur in it in many places. The gravel mesa south of Poway Valley has an elevation of 1,200 feet. Small areas of gravel also remain on the hills northeast of the valley. The granite ridge, flanked by porphyries, does not outcrop very prominently south of Los Peñasquitos Cañon. The ridge southwest of Poway Valley seems to be formed largely of gravels, rising 1,500 feet.

The usual brecciated tuffs outcrop in the gulches and along the creek just above Los Peñasquitos ranch house. They appear along the old road to Escondido for 2 miles. A body of chloritic granite appears in the center in the form of a long dike, extending from the Peñasquitos Creek a mile or more north of the road. Toward the east the breccia becomes finer and almost loses its fragmental character. Between this formation and the granite a dark micaceous felsite, probably metamorphic, outcrops. The fragments in the tuff are diabasic at times and at others largely petrosilicious and feldspathic. The crystalline rock on the east is, perhaps, more nearly diorite than granite, as the feldspar is chiefly a glassy one. Black Mountain is formed of this dark breccia, while the high range of mountains which rises on the north and extends northwesterly between San Bernardino and the ocean, is formed partly of granitic rocks and partly of the tuffs and porphyries, the latter lying on the west.

A rolling, hilly country, containing much good land, stretches north toward Escondido. Remnants of the mesa conglomerates remain in places on the eastern edge of the Peñasquitos grant. The granite is coarse and rises in huge, rounded knobs along the road. A little south of San Bernardino Post Office there rises a conical peak of micaceous diorite. A somewhat similar rock, but more diabasic in appearance, forms the mountain immediately west of the Post Office. This formation extends northwesterly for several miles, having a width of about a mile. The rock over much of this area closely resembles the gabbros and olivinitic diabases from the southern part of the county. It is penetrated by dioritic and granitic veins, in which the structure is often pegmatitic.

At the point where the road stops at the entrance of the cañon of Diablo Creek, this basic formation is replaced on the west by a massive, jointed quartz rock, containing a little feldspar and chlorite, and in places becoming granitoid. It often has a fragmental character, with the quartzose bodies imbedded in a matrix more granitic, or simply darker and chloritic. This rock is quite uniform for 3 miles down the cañon, quartz being the predominating constituent. It is very probable that this represents an original sedimentary terrain. It is followed on the western slope of the range by the dark tuffs before described. Here the matrix is often porphyritic, with a fluidal structure. Portions are real porphyries. A mile east of Olivenheim it resembles diorite porphyrite. The last exposure seen on the west was of the usual tufaceous character. This formation narrows northward, and on the road to San Marcos shows the width of a mile.

Northwest of San Marcos there is a large body of metamorphic rock, chiefly felsite schists and feldspathic quartzites. These extend in a northwest direction toward Buena Vista, but there are not many exposures. Dark diorite outcrops south of Buena Vista, and extends west for a mile and a half, when it sinks under the Tertiary deposits. The last outcrop

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seen was a dark micaceous diorite. A mile west of this point there is quite an outcrop of diabase containing an excess of dark feldspar. The sandy clays extend west from this point to Oceanside. Near Buena Vista station the diorite is impregnated with green copper carbonates, and a considerable amount of work has been done, but evidently no paying bodies of ore were found. Syenite outcrops near Kelly's ranch house, and in the hills east. The crystalline rocks come nearer the ocean here than at any other place in the county.

Between Escondido and Moosa Cañon, granites, with bunches of dark diorite, are the only rocks seen. A broad, sandy valley extends up San Luis Rey River to within 5 miles of Pala, when the high granite mountains close in, forming a cañon. The valley widens at Pala, and for many miles a broad, sloping deposit of bowlders and gravel borders the river, and rises high against the foot of Smith's Mountain. It is often 2 miles wide and represents a great amount of erosion. A mile northeast of Pala is a high hill of diabase, similar to that in the southern part of the county. On the eastern slope of this hill is an enormous pegmatite vein, carrying a very interesting set of minerals. This vein is twenty or more feet wide, and dips west at a small angle. There are masses of great size of almost pure mica and feldspar, or quartz and feldspar—in the latter case very fine specimens of graphic granite have been formed. Near the southern end of this vein is a deposit of lepidolite mica, 10 feet thick at the widest part, and appearing in detached bodies for several hundred feet. It is fine-grained and shows a pale purple color. In places it is pure, in others filled with large radial aggregates of pink tourmaline (rubellite). Some of the aggregates are a foot across, others are long and slender, with arborescent forms. North of the main deposit it is found in quartz in fan-shaped aggregates, the crystals being more than a foot long, but greatly decomposed. Black tourmaline is abundant in the pegmatite surrounding the lepidolite, but in poor, brittle crystals. Green tourmaline is present in places in the form of minute grains. Garnets are also to be found in places. The vein as a whole is inclosed in the diabase.

The western end of Smith's Mountain shows many bodies of dark dioritic rocks. The major part of the rock is, however, gneiss and mica schist, all very easily decomposed, leaving an immense amount of bowlders and gravel along all of the gulches. Mica schists cover an extensive area along the southern slope of Smith's Mountain, on the Pauma grant. These are undoubtedly a continuation of the schists of the Julian belt, but carry no minerals. The belt of schists extends nearly if not quite through to Julian. Warner Valley is located at the head of San Luis Rey River. It is entirely surrounded by granite mountains. There is not as great a variety of intrusive rock here as in other parts of the county.

Point Loma forms a peninsula, the greatest length of which is about 6 miles, and greatest breadth, 1½ miles. During Quaternary times it was an island, but owing partly to an elevation of the coast, and partly to the detritus brought down by the San Diego River, it becomes joined to the mainland. It rises 400 feet in almost perpendicular cliffs at its southern end, gradually lessening in height toward Old Town. The rock of which it is formed consists of soft shales and sandstones, the latter often quite consolidated. The strata at the extreme end of the point dip south, but in a short distance turn and maintain a quite

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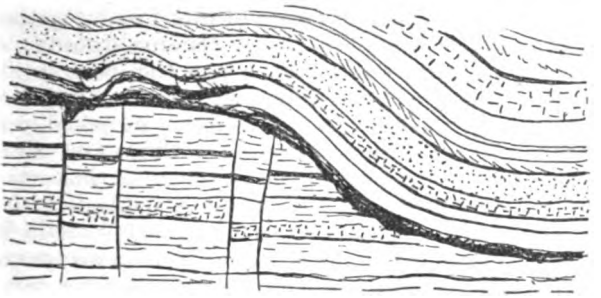

Fig. 12.

uniform dip to the northeast nearly the whole length of the peninsula. This abrupt elevation evidently owes its origin to a fault accompanied by an uplift, and not to erosion. Beginning at Ocean Beach, and following along the base of the cliffs to the light-house, hundreds of faults can be counted. Near Ocean Beach fifteen can be counted in the space of 200 feet. The direction of these faults is nearly at right angles to the strike. The most of them are nearly vertical and clean cut. The throw varies from a few inches to many feet. Sometimes the north and sometimes the south wall has risen. An interesting overthrust fault is exposed in the cliffs north of Ballast Point. (Fig. 12.)

A conglomerate of late Tertiary age overlies the Cretaceous rocks unconformably on the extreme end of the point. These conglomerates are firmly cemented and form high cliffs. They dip at an angle of 30° to the southeast. The pebbles are in part derived from the sandstone of the point, and in part from the crystalline rocks east of the mesa. Near the top of this conglomerate are immense, semi-angular bowlders. These have rolled down to the beach and are strewn around the end of the point. Many large ones are to be found a little west of the new light-house, but the greatest of all is on the eastern side. It is fully 10 feet in diameter, and formed of the same kind of rock as that on which the mesa rests 8 miles east of San Diego, viz: a green volcanic tuff. It is a very interesting question as to how these immense bowlders have been transported so far and left in the beds near the top of the cliffs. I can account for it only by supposing that the point with relation to the country back of San Diego was several thousand feet lower at one time, and that a river of great volume, flowing over a steep channel, entered the bay at this place, depositing irregular beds of bowlders. This old river may have been the same one which formed the auriferous gravel channel before mentioned. The fault planes on Point Loma extend through the conglomerate beds, indicating that the elevation took place after the bowlder beds were formed.

An interesting collection of fossils was gathered from the lowest strata exposed, and from the bowlders in the conglomerates. This collection numbers something over sixty Cretaceous species, many of which are new. The fossils are not abundant, nor are they well preserved. Nearly all of these are characteristic Chico (Upper Cretaceous) fossils. There is, however, one species found here in considerable abundance, but rather poorly preserved, which Dr. White has described under the name of *Coralliochama Orcutti*, and which he has made the chief foundation for a new division of the Cretaceous, termed the Wallala Beds. The name

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was given on account of the occurrence of this fossil, together with several other species, at or near Fort Ross, Sonoma County, and also at Todos Santos Bay, Lower California, where the best specimens were found. These beds stand in an unknown relation to the other Cretaceous deposits stratigraphically, but have been supposed, on account of the fossils, to indicate a division between the Chico and Shasta groups. I believe, however, that the occurrence of the most important fossil of this supposed division on Point Loma, in the same beds with undoubted Chico fossils, destroys the validity of the supposed Wallala Beds.

In a bluff at the northeastern end of the Point Loma peninsula, west of Old Town, there is a stratum of calcareous sandstone, carrying many fossils belonging to the Eocene, or lowest Tertiary. The strata dip northeast at a small angle, and though they cannot be traced continuously west to the outcrops of Cretaceous rocks, yet from the fact that they have the same dip, leads me to the belief that the two beds are conformable. This younger deposit corresponds to the Tejon, or Division B, of Professor Whitney. Everywhere in the State there exists the closest relation between the Chico and the Eocene. Here on Point Loma they are undoubtedly also conformable, but each is distinct as regards its fauna, for they are separated by nearly a thousand feet of unfossiliferous strata.

False Bay occupies the basin of a synclinal, for the strata dip northeasterly from Point Loma and south from the Soledad Hills. A violent disturbance, forming a great uplifted fold or perhaps a fault, has taken place along a line extending southeast from La Jolla through the Soledad Hills. At the eastern end of False Bay there is a small exposure of Eocene strata, dipping west. Near the mouth of Rose Cañon the strata dip southwest, and at the mouth of the cañon they dip 40° northeast. Along the road which leads over the hills to La Jolla the rocks are tilted at a very high angle to the southwest. The highest point of the Soledad Hills, rising 700 feet, lies over this disturbed region. Unconsolidated bowlder deposits lie on the top of the hills. The strata on the east side of Rose Cañon are well exposed, but do not seem to partake of the disturbance shown on the west. This is probably no unconformity, as they contain Eocene fossils, and the Eocene in other spots appears to be conformable with the Chico. Along the coast between False Bay and La Jolla the strata dip south at a small angle. At La Jolla, near the caves, they have been folded so as to dip very steeply to the southwest for nearly a quarter of a mile across the strike. Near the eastern end of the cliffs a reversal takes place, and they dip northeast at nearly as great an angle. Around the little bay there are no exposures, but a mile northward begins a very high line of cliffs, which extend through to the mouth of Soledad Cañon. This fold at La Jolla brings to the surface fossiliferous strata, bearing a number of species similar to those at Point Loma; among them is the *Coralliochama Orcutti*. The strata of the high cliffs north of La Jolla dip northerly at a small angle, and show only a few fossils of the Eocene age. The cliffs rise fully 400 feet. At the bottom of the cliffs are shales; higher up are great beds of conglomerate bowlders, chiefly a reddish porphyry.

Coal is reported to outcrop above the water at very low tide somewhere along this stretch of cliffs. It of course must occur in strata of Tertiary age. The coal vein struck in a boring at La Jolla must be Cretaceous. About 3 miles up the coast from La Jolla, there appears a dike of basalt cutting the Tertiary shales. At high tide it is nearly

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covered by the ocean. It has a course about 30° east of north, and stands vertical. It begins on the north, close in under the high cliffs, but does not extend into them, the only signs being a fault in line with the dike. It is not more than 2 feet wide at the northern point where it is exposed. It is dark and compact and so decayed as to be easily taken for an argillite. The walls of the dike are very smooth and regular, except near the southern point, where it runs into the water. Here it swells to a width of 30 feet. The edges of the dike are compact, while the vesicular portion is in the center, where there is often a flowage structure developed. The central portion is more or less laminated parallel to the wall, and thus is generally a well-pronounced columnar structure developed the whole width. The columns lie horizontally across the dikes and are 12 to 15 inches in diameter. The cavities are wholly or in part filled with calcite. Metamorphism of the adjoining shales is apparent for 2 feet away, but the sea water has so decomposed the shale that it is not so strongly marked as it would otherwise be. The dike projects above the water in places for a distance of 1,000 feet, making its total exposed length about 1,800 feet. In the mesa southeast of Rose Cañon, and along the San Diego River, and back of San Diego, the formation belongs almost wholly to the late Tertiary. It is not certain whether the Miocene is present or not. A number of Miocene fossils have been found in the county, but perhaps the most of them have come from Carrizo Creek. Many fossils are given in Dr. Cooper's list, as being found in the Pliocene of San Diego, which are more characteristic of the Miocene in other localities. I see no reason for doubting that the Miocene is present, but so intimately related to the Pliocene as to be stratigraphically inseparable from it. In the region between Rose Cañon and the northern boundary of the county, I do not know that Miocene fossils have been found, but in Orange County they are well characterized.

The region occupied by San Diego Bay and the mesa back of it is composed, as far as we know, of Quaternary, Pliocene, and perhaps Miocene strata. Sandstones characterize the lower formation, and loosely cemented conglomerates, increasing in thickness toward the mountains, the upper. These were deposited in a sort of basin, of which Point Loma and the Soledad hills formed the northern and western borders. Many oscillations of level have taken place, the most recent being an elevation of 40 feet, shown by an old beach line on Point Loma. The shells in this beach are the same as those now living in the adjoining ocean. It is a peculiar fact that the mesas are slightly higher near their western terminations than farther east, indicating a recent uplift along the ocean. Water is scarce through this mesa formation. At the end of Point Loma there is a strong sulphur spring exposed at low tide. Its waters may possess medicinal properties, and should be examined.

On the southern shore of False Bay is a large deposit of calcareous tufa. The central portion is quite pure and a number of feet thick; just how thick is not known. It extends along the shore some distance, and often contains bowlders and shells. This is evidently a deposit from some former spring of great size. The mesas lying west of the extensive volcanic tuffs have been derived largely from the decay of the latter, and have heavier soil. North of Soledad they become more sandy, and maintain this character to the Santa Margarita Creek. This light soil, however, is being successfully cultivated in many places and for

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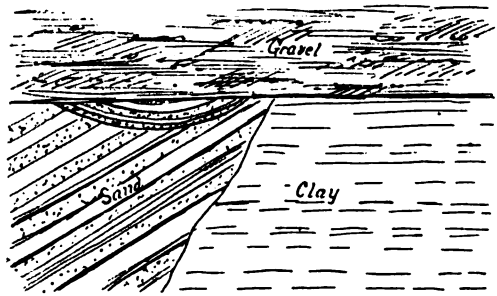

Fig. 13.

certain kinds of fruit, without irrigation. The surface of the higher portion of Point Loma, as well as some of the mesas north, is covered with spherical nodules, a quarter to half an inch in diameter, of sand cemented with red oxide of iron. These literally cover the ground in places so that it is difficult to walk. The origin of these at first seemed very puzzling, but on examining the face of a cliff on the top of which these were found, an explanation was reached. They were seen to grow smaller away from the surface of the ground until a depth of 2 feet was reached, when they cease. Their formation is due to the oxidation of the iron in the sandstone, and its segregation in little nodules on the same principle as the formation of concretions.

The cliffs of Eocene sandstone along the ocean grow gradually lower north of Soledad Cañon. At Encinitos the cliffs are higher again and for a short distance the strata dip south, but toward Oceanside they resume the northerly dip and disappear several miles south of that place. Faults grow less numerous the farther we get from Point Loma. The mesa is low about Oceanside; it was either never very prominent or else the erosion has been great.

On the north bank of the Santa Margarita Creek, near the ranch house, is an interesting cliff of Quaternary sands and gravel, showing a number of strata deposited under different conditions on an old beach. (Fig. 13.)

The Tertiary beds north of the Santa Margarita Creek are very different in outline from those south. Instead of their extending in a gradual slope from the older mountains to the ocean, there arises in them, near their western border, a range of mountains, known as the San Onofre Mountains. These extend parallel to the ocean at an average distance of 2 miles. They rise north of the Santa Margarita Creek and extend to the San Onofre Creek. They have a gradual slope on the west, rising to an elevation of 1,400 feet, but are quite abrupt on the east. Los Flores Creek cuts through the southern end of this range, showing that while the soft, clayey sandstones between it and the Santa Margarita Mountains slope only 5° to 10° southwest, the rocks of the range itself dip west at an angle of 35° to 40°. The formation is a breccia, the fragments of which are argillitic, micaceous, and hornblendic schists. Some of these fragments are of great size, one bowlder of hornblende schist being 8 feet in diameter. Pebbles of white quartz and other hard metamorphics are also present. The soft, coarse sandstone in which the fragments are imbedded show no traces of any granitic matter. The range was ascended 2 miles north of the Los Flores ranch house,

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and found to consist entirely of fragmental schists, such as those mentioned, dipping southwest at an angle of 45°. The mountains were also climbed at their northern end, near San Onofre Creek. Here there is a very abrupt escarpment on the eastern side. The strata dip toward the ocean at a high angle, while the irregular hills and ridges of soft, light-colored sandstone lying east toward the Santa Margarita Mountains are nearly level. After a careful study of the range the conclusion was reached that its origin was due to a great fault, represented by the very abrupt eastern slope, tilting the elevated portion to the west at a high angle. I believe that this fault took place after the deposition of the Tertiary strata. As far as my observation went the Tertiary beds on the east do not rise to meet the San Onofre range, as they would to a certain extent if it were present when they were deposited; on the contrary, they dip toward it. West of the range the ocean is bordered by very high cliffs of Quaternary clays, and in only two or three places do the Tertiary rocks outcrop. Small patches of sandstone outcrop near the road at the western foot of the mountains; they also dip west at a high angle. Many of the fragments at the northern end of the range show their derivation from a massive crystalline rock. The hornblende schists are generally garnetiferous. Blue glaucophane schists are also very common. South of Mission Viejo Creek, Orange County, there is an outcrop of rock, apparently in place, which greatly resembles these schists. Good outlines of these mountains, indicative of structure, can be seen to great advantage from the San Luis Rey Mission. On the west slope of the San Onofre Mountains, 4 miles north of Los Flores, is an outcrop of a garnetiferous hornblende schist, which certainly appears to be in place. This rises 10 feet above the side of a gulch, and is fully 20 feet across. One mile north and in line of strike with the last is another outcrop of similar rock, which is so large that it certainly seems that it must be in place. The only point north of the San Onofre where this breccia appears is at Arch Beach, Orange County. The Santa Margarita Mountains are bordered by very extensive bowlder deposits, which rise as high as 1,500 feet on their western slope.

The topography of the northwestern part of the county between Temecula, Elsinore, and the ocean, is very complicated. This section is occupied by rugged, brush-covered mountains and narrow, deep valleys, with the exception of the Santa Rosa plateau, where the configuration of the county has been entirely changed by extensive lava eruptions, stretching over a distance of 10 miles. This mountain region narrows toward the north to form the Santa Ana range. The variety of rock formations is very large. The northern portion is unsurveyed. On the south are the two large grants, the Santa Margarita and the Santa Rosa. Between these lies De Luz Valley. The Santa Margarita Mountains extend north and south, forming the eastern borders of the grant and rising to an elevation of 3,100 feet. The granite of the region about De Luz Valley is far from being homogeneous. A part of it is undoubtedly intrusive, and a part may represent an original sedimentary formation. Bedding planes are present in much of this supposed metamorphic granite, but generally no schistose structure. The presence of the De Luz warm springs is perhaps due to a dike of dark, aphanitic diorite, which has cut through the granite in an irregular manner. A very interesting breccia outcrops in the bed of the creek below the warm springs. (Fig. 14.)

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Fig. 14.

The fragments are chiefly granite and an aphanitic rock. They are quite angular, showing only a slight rounding of the corners. Some of the larger fragments are a foot in diameter. The boundaries are very irregular. Long arms of the inclosing granite project into the breccia. The base or matrix varies from a coarse syenitic rock to an aphanite. It often seems to present a blending of different kinds of fragments. Besides the large inclusions there are scattered through the matrix small angular pieces, which are so regular in outline and distribution as to give to the rock the appearance of a porphyritic structure. The granite in the hills west of the valley contains much biotite and quartz in long, rounded grains, presenting a pseudo-porphyritic aspect. This appearance is characteristic of much of the granite of this section. Imbedded in the granite are masses of dark aphanitic rock. The lower granite hills are covered with considerable sandy soil. There are isolated peaks of a coarse white granite, much like that of the Sierra Nevada, arranged in some sort of regularity in north and south lines. One rugged peak of this coarse granite rises 2,500 feet west of the valley. At the northern end of the valley the bedding planes in the finer grained granites are very regular; strike north 45° west, dip 65° southwest. There is, however, no schistose structure present.

A half mile above the warm springs is another conglomerate or tuff, which seems so related to the granite that the latter must really be eruptive. In a little valley southwest of De Luz and just east of the Santa Margarita grant there is a large outcrop of diabase. It has been intruded in a fine-grained, jointed granite. Farther down the valley, on the road to De Luz Station, there is a narrow outcrop of black quartz feldspar porphyry, followed on the east by a dark felsitic mica schist; strike northwest, dip 60° southwest. Immediately west of the deep cañons which lead down to De Luz Creek, rises the Santa Margarita Mountains. They consist of a fine-grained granite, verging at times on a quartz porphyry. The main crest is 2 miles long, the highest peak of which is nearly 3,200 feet. The rock is perfectly massive, but shows apparent bedding planes; strike north 30° west, dip 80° northeast. The porphyritic facies of this formation occur in the western slope. On the western slope of the main range, at an altitude of 2,500 feet, there is a plateau-like area of a thousand acres or more of fine grass land. It is

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dotted with white oak trees. The western slope of this plateau is very abrupt and brushy. The formation is partly porphyry and partly dark diabase and diorite. The most interesting fact connected with the Santa Margarita range is the occurrence of sandstone at an elevation of 2,600 feet on its western slope. The sandstone occupies very limited detached areas in the heads of the gulches, and is evidently the remnant of a once far more extensive formation. The sandstone is largely kaolinitic, and has evidently been derived from the adjoining rocks. At the foot of the southern end of the mountains appears very quartzose rocks, probably of metamorphic origin. Coarse granite has been intruded into them in small bunches. Granite extends southwesterly in the form of a wedge as far as the Santa Margarita ranch house, and is there covered by modern deposits. Between De Luz and Fallbrook the country is gently rolling, with knobs of granitic rocks projecting here and there. About Fallbrook, and for some distance east, the granite does not outcrop much, owing to its easy decomposition. A little east of De Luz Station is a small body of mica schist; dip 30° east, strike north 15° west.

The road from Fallbrook to Temecula leads through a long, narrow valley. On either hand rise high mountains of bare granite. Immense bowlders, 20 to 30 feet across, line the valley, having fallen from the cliffs. The granite here is a coarse rock, rich in biotite, and though great masses could be obtained free from checks, yet does not seem durable. The valley owes its origin to a difference in rapidity of decay along certain lines. On this section there appears no trace of the schist belt extending northwest from Julian. This coarse granite is undoubtedly intrusive and has cut it off.

A wholly different series of rocks is exposed in the Temecula Cañon, not more than 2 miles north of the country just described. This cañon is deep and rocky, taking a very direct course from Temecula to the ocean. At the upper entrance there is a narrow exposure of granite. This is followed by quartzite, dipping 45° southwest. The rocks shortly become massive and are replaced by dark syenitic ones with an excess of hornblende. Two miles down, granite appears for a short distance, and in it a quarry has been opened. The rock can be obtained in blocks of any size from great masses which have broken off and rolled into the cañon. Gneissoid rocks soon replace the granite, and these are followed by hornblendic rocks, which vary from a schistose to a massive structure. In places they contain feldspar and pass into syenites; in others the rock is almost pure hornblende. The greater portion of these rocks are of metamorphic origin. The dip is generally vertical, strike east and west to northwest. The syenites are followed by mica schists, and these by coarse biotite granite about 5 miles above Howe Station. In the granite are many pegmatitic veins, carrying biotite, garnets, and tourmaline. Fine-grained granite, varying at times to syenite, forms the rock along the cañon for many miles below this point.

The most interesting geological feature about this northwestern part of San Diego County is the long plateau, confined chiefly to the Santa Rosa grant. This plateau lies near the western corner of the grant, and extends east nearly to Murrieta. The lava is broken up into detached tables by erosion, which become very strongly pronounced toward the western end of the flow. The western body of lava is the highest. It has a length of nearly 2 miles and is broken into three peaks or ridges, sloping generally a few degrees to the east; height

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2,850 feet. There are two terrace-like tables lower down its southern slope. The lava is, perhaps, a hundred feet thick at its eastern end, and has been so much eroded toward the western portion that the underlying sandstone is exposed along the crest of the ridge, with lava lying in broken masses along its sides. The sandstones form quite an extensive bed under the lava flow, being 200 or 300 feet thick, and horizontally bedded, wherever bedding is present. The upper part is very soft and granular, the lower portion is hard and stained reddish. It carries many bowlders 6 to 8 inches in diameter, different from any other rock seen in the adjacent mountains: quartzite mica schist, aphanitic rocks, and some granitic ones. These are washed smooth. The sandstones contain much kaolinitic matter, and at one spot show an incipient crystallization. A number of contiguous grains, over a space half an inch in diameter, show the same orientation. Near the bottom the sandstones are impregnated with iron. The western ridge in particular shows a great amount of erosion. The lava is nearly gone in places, but occurs southward in scattered outcrops for half a mile. At the northern end the sandstone rises fully 300 feet above the lava. Lava is present on its sides. Much of the sandstone closely resembles a granite decomposed *in situ*. Fragments of the mica schist resemble that in the hills west of Temecula. Northward half a mile is the deep cañon of the San Mateo. The country descends very rapidly from the lava ridge, especially so on the north, where the cañon is fully 1,500 feet deep. It is a number of miles in any direction to mountains which are as high as this lava-capped sandstone ridge, and the amount of erosion must have been enormous since it was deposited. Mesa Redonda has an elevation of 2,750 feet, and is separated from the lava just described by a valley fully 800 feet deep, and nearly a mile broad. Mesa Redonda is formed by a lava table, probably basalt, 150 to 200 feet thick. It is quite precipitous on three sides. The lava is bedded, dipping 5° to 8° northeast. Underneath is a body of coarse, friable sandstone, similar to that just described. Some pebbles and bowlders of lava lie in the upper portion of the sandstone. The sandstone consists of angular quartz grains and kaolinic matter, and often presents the appearance as if it had been partly fused by the lava. In the top of the sandstones are pebbles of quartz, feldspar, and mica schist. The sandstone shows no bedded structure, but seems to form a mantle over the hill, following the irregularities of the underlying granite. It descends 700 feet on the southern slope of the mountains which rise so abruptly from De Luz Valley. The lava has spread out in thin sheets on the southern slope of the mountain, descending more than a thousand feet on the east side of Cottonwood Creek. These thin beds are not massive, but are formed of angular lava bowlders. The flows were so thin that they either broke up on cooling, or later through atmospheric agencies. Fig. 15 is a sketch of Mesa Redonda from the north.

Cienega Peak lies east of Mesa Redonda and is separated from it by two gulches opening in opposite directions. It has an elevation of 2,400 feet, and the mesas east rise still less. Sandstone underlies this as it does the other lava flows. Near the eastern end of the southern slope, a lava flow has broken out from a basin-like depression which opens southward, and flowed down the mountain for a mile, descending a vertical distance of 1,800 feet. It appears to have broken up entirely into angular bowlders. The stream was probably very liquid, like the

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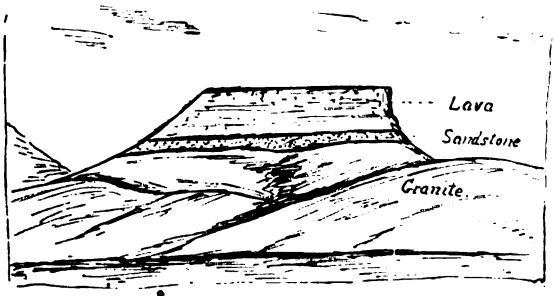

Fig. 15.

others, and formed a thin flow. It takes a slightly winding course and slopes often 30°. One short branch appears on the western side about half way down, and another on the east near the bottom. The lava descends in successive terraces, like steps, from the crater depression. The width varies from 500 to 700 feet, terminating in a straight line about a hundred feet above the bed of the cañon at the head of De Luz Valley. This distance may represent the amount of erosion since the stream flowed. There are also cañons worn to some depth on each side. The surface of the flow is rounding, and appearances indicate that it descended over a surface not much different from the one now shown. A large part of the bowlders in the creek for several miles are lava.

Fig. 16.

Fig. 16 shows this lava stream as it lies on the mountain side, and also Cienega Peak, from which it flowed. These lava beds appear very prominent from De Luz Valley. The long, winding flow is known locally as the Oak Ridge, on account of its being covered with oaks, while the adjacent mountains are barren and brushy. It is hard to reconcile the appearance of these isolated peaks, with often precipitous sides, and deep valleys between them, showing a great amount of erosion, with the thin sheets spread out on the southern side of the mountain in so many places, which from their position indicate so little erosion since

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they flowed. It is possible that the mesas, with the high precipitous cliffs, represent remnants of an older flow, and yet the lithological character of the lava seems to point to a single origin. With the exception of the long southerly flow and another short one west of it, the lava everywhere presents bluffs on its southern side, with deep gulches between them. Toward the northeast and east there is a gentle slope. A large part is coarsely vesicular; dense massive portions are mixed irregularly in places with the vesicular. The lava table-lands lie nearly 2,000 feet above De Luz Valley. This abrupt escarpment extends east as far as the lava does, though less marked. There has either been an enormous erosion in the region lying south, or a great fault elevating the plateau. A detached portion of the lava plateau caps the hills west of Murrieta, extending in a north and south line for a distance of 2 miles. Whether these detached portions all had their source in one great flow and have been separated by erosion, or were formed from different sources, was not fully determined. It seems probable, however, that the main portions did belong to one flow, from the fact that they have a uniform slope and are underlaid by similar sandstone, which may once have been the bed of a stream.

The range of mountains lying west of the valley which extends from Temecula to Elsinore, also has the appearance of having been elevated by a fault. From the entrance to the Temecula Cañon, northward past Elsinore, and along the eastern base of the Santa Ana Mountains, these abrupt escarpments and indications of a fault become more pronounced. The eastern part of the Santa Rosa plateau, with its lava fields, forms the southern end of the escarpment. The valley in which are located the towns of Temecula, Murrieta, and Wildomar, rises gradually toward the east. The western portion is very fertile. Artesian water is found at Murrieta. The eastern portion, which rises toward the granite mountains, is more gravelly, while east of Temescal there is a stretch of many miles of these dry gravel hills, probably of Quaternary age. The town of Temecula has an elevation of 1,000 feet. Immediately west and north of the cañon there arise hills of metamorphic rocks, having an elevation of 1,800 feet. They are covered with dense brush on their eastern slopes, but contain some fertile valleys to the west. For several miles the rock is almost wholly matamorphic. It extends south to the cañon and north to the lava plateau. It is chiefly a fine, dark mica schist; strike indistinct but north 60° west, to east and west, dip vertical. On the west it changes to a quartzite. Dikes of granite cut this rock; one is noticeable for several miles by its more pronounced croppings over the hills.

East of Murrieta the granite begins near the boundary of the grant, and forms a line of barren hills extending northerly. East of these the country is less rocky and quite fertile. Many springs abound in the granite through this section. Near the Hot Springs is a dike of granite porphyry. Numerous bunches of a dark, coarse, dioritic rock are scattered through the light-colored country granite. They weather away more slowly than the granite. The metamorphic rocks of the Santa Rosa plateau extend north to the entrance to the cañon, up which the road passes to Parker Deer's. The strike in the cañon is a little east of north. The metamorphic rocks terminate in a range of hills which form the southern boundary of the Rinconada. Northward the country is formed of rugged granite mountains. The Los Alamos opens westward

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into deep cañons, which lead down to the coast. A dark dioritic granite is included in the usual light-colored variety, sometimes in bowlder-like masses and sometimes in dike form. The metamorphic rocks extend 2 miles west of Parker Deer's house. They include mica felsite and dark vitreous quartzite. They are often intruded by granite bosses and dikes of quartz porphyry. The lava table-land lies just south of the ranch house. It is about 40 feet thick, and has underneath a kaolinic stratum 12 to 14 feet thick, which is impregnated with bog iron; one assay has shown 10 per cent. This is quite similar to the sandstone under the table-land farther west, but is less quartzose. A similar deposit, impregnated with iron, was seen north of Mesa Redonda. The Santa Rosa grant consists chiefly of broad, open valleys, having an altitude of 1,700 to 1,800 feet, with rocky ridges between them.

On the trail from Santa Rosa to Howe Station, the metamorphic rocks extend to within a mile and a half of the latter place. They are chiefly light-colored, granular quartzites. Dikes of diabase and gabbro appear in many places on the Santa Rosa grant. Ores of gold, silver, and copper are found in the metamorphic rocks of the grant, but they have never been developed. Selected samples of galena assay several hundred dollars to the ton in silver. The veins are, however, small and bunchy, and it is not probable that they can be profitably worked. The granite varies from one with mica, as the only dark constituent, to one with much hornblende. It is uniformly coarse and of undoubted eruptive origin, judging from the manner in which it has broken through the metamorphic rocks.

The table-land west of Murrieta is about a mile broad and fully as high as that near Parker Deer's house. It is separated from the lava farther west by a mile of brush-covered hills. The lava was supposed to extend no farther than the big cañon west of Murrieta, but a close examination revealed a small outcrop on the hills about a mile south of Wildomar. The elevation is about 600 feet above the valley. It is perhaps one fourth of a mile across. In places it extends down the hill nearly one third of its elevation above the valley. It presents the appearance of having flowed out of the summit of the hill when it had much the same form as now, and down over its sloping surface. This eruption is fine-grained, and not vesicular. Much of it has a conglomeritic character, appearing to have been broken up when almost solid, and then cemented. The fragments are more or less rounded and elongated, and are at times almost blended in the matrix. There are signs of former solfataric action on the summit, there being a considerable deposit of a light yellowish material, consisting chiefly of alumina and magnesia. Under the lava is sandstone 10 to 20 feet thick, composed of quartz grains and kaolinic matter, exactly similar to that under Mesa Redonda. It would be easily taken for granite decomposed *in situ*, but for the large quartz grains. The sandstone has an apparent southerly dip. It is very difficult to account for the presence of the sandstone under the lava, unless we suppose it covered the adjacent country, and was only preserved by the greater permanency of the lava. Another hill of lava was found 200 feet lower, about a mile south of this, and west of the cañon leading up to Parker Deer's. It occupies a sort of depression between three hills, with gulches cutting into it between them. The lava is very similar to that just described.

A long, high ridge running northwest and southeast, adjoining the

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lava, is very interesting. It is about 200 feet higher, and covered with dense brush, as is all the country in this vicinity. The greater part of the hill is formed of a coarse tuff, whose fragments stand out in sharp relief on the surface of the huge projecting, bowlder-like masses. The matrix, which is darker and softer, weathers out, leaving the surface of the rock covered with a great variety of fragments. Some are scoriaceous or amygdaloidal, others are very coarsely crystalline and porphyritic with feldspar or hornblende. Some of the fragments are themselves tufaceous, containing large masses of hornblende in a dioritic matrix. On the southern end of the hill, a great variety of dikes intersect the tufa. This is in all probability the neck of an old volcano, but appears to have no relation to the modern lavas near it. Owing to the exceeding difficulty of traversing these hills, the exact relations of the formations were not ascertained. About 10 miles east of Temecula, near the point where the creek takes a turn to the southeast and enters a cañon, there has been another lava eruption, but the time at my disposal did not permit me to examine it. A great variety of rocks are exposed along the road from Elsinore to Menifee Valley. For nearly 2 miles east of the station the rock is a white, glassy diorite, with an excess of feldspar. At the point where the road crosses the railroad, metamorphic schists appear. The rock is a fine, dark mica felsite. It is so compact that it breaks with a conchoidal fracture. A great irregularity in strike and dip exists; the average strike is a little west of north, dip northeast. As far as the top of the grade, the rocks are in part metamorphic and part dioritic. There are many dikes; some fine-grained granites, others micaceous diorite porphyrites. The hills along the west side of Menifee Valley seem to be mostly metamorphic, with some bunches and veins of granite.

All of the mountainous region lying south of the road from Temecula to San Jacinto is granite or diorite, excepting a strip of micaceous schist and gneisses near Glen Oak Valley. These strike northwest toward Menifee.

No opportunity was given me to examine the mountainous regions comprised in the San Jacinto range. The line of hills lying northeast of the town and having a northwest direction are composed largely of gneiss and mica schist, with some bodies of white crystalline limestone. In the line of strike these hills finally disappear north of San Jacinto Lake, under Quaternary clays and gravels, which form rather an abrupt rise from the San Jacinto Valley and extend northerly to the San Bernardino Mountains. The deposits show a great deal of disturbance. A part of them may be Tertiary. Dikes of dark, heavy diabase and diorite are common about the sulphur springs north of San Jacinto.

The hills for a distance of 3 miles north of Elsinore are formed of slate and mica schists; strike north 70° west, dip vertical to 45° east. This is a continuation of the same series of rocks exposed on the road to Menifee. A lenticular body of limestone occurs in these slates about 3 miles north and east of Elsinore. It is highly metamorphosed, has a gray to dark color, and is traceable for 500 or 600 feet. At one spot a stratum of quartzite divides it. It was carefully examined for fossils, but none were found. About 4 miles from Elsinore granitic rocks appear, followed by dark diorites in the vicinity of the Good Hope Mine. The Pinacate district, taken as a whole, is rather peculiar. At first sight it seems to be formed of granite, dark diorite, gneiss, mica schist, and other metamorphic rocks, arranged in the most

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irregular manner. The belt of metamorphics northeast and east of Elsinore is terminated on an irregular east and west line by these granitic bodies, which inclose portions of the schists, and extend into the main body as long, dike-like arms. In the vicinity of the Good Hope Mine the strata of metamorphic rocks inclosed in the granitic rocks have a north and south strike, and are traceable for a mile or more. The veins of the Good Hope Mine are in a dike of light-colored biotite granite. It has considerable width on the surface, 100 feet or more, but below ground some distance it is not over 12 feet. On the surface it is greatly decomposed and cut by numerous small veins, which are so scattered that they hardly pay for working. Below they unite to form larger veins, generally one on the foot and another nearer the hanging wall. The latter is more irregular, often running out at a small angle. The foot wall, a dark compact diorite, is very regular. The walls are separated by well-defined clay seams from the vein matter, the decomposed granite. Clay seams also separate the different veins. The foot wall diorite forms the country rock indefinitely eastward. The hanging wall is a fine, dark brown mica schist. The quartz is generally friable, and the granite vein matter much decomposed. The quartz at a depth of 300 feet carried one third of the gold in the sulphurets. A small amount of silver is also found. This vein is located for over a mile; direction a little east of north, dip 65° west. It is remarkable that there is no barren quartz; all the ore pays for working. In the lower workings the veins become more regular.

The Good Hope is the first mine in this district to reach a paying basis, and that has succeeded in finding a regular, defined quartz ledge. About 3 miles northwest is another vein, which has an east and west direction. It seems to lie wholly in granite, save for a narrow stratum of mica schist on one wall. The vein is located for a mile, but no extensive development has yet been made on it. On the hills, a short distance southwest, is an old Mexican mining camp. Many small veins are found in the vicinity, generally in a dark micaceous diorite. There are also bunch-like masses of coarse white granite, blending into gneiss and the gneiss into mica schist. The strike is exceedingly irregular, changing from north and south to east and west in the course of a few feet. Toward Elsinore mica schist, quartzose, and feldspathic rocks replace the greater portion of the granite. For some distance the schists are cut up by dikes of fine-grained granite, running in different directions, and small bunches of the same rock, often only a few feet across, but sharply differentiated from the schists. Judging from the exposure here, I think we might say that at the time of the metamorphism the action was so intense as to change the sedimentary rocks to mica schists and gneisses and through these to squeeze the liquified portions of the same formation in dikes and fissures. Small fragments of mica schist were noticed in the eruptive masses. In a region like this it is often difficult to draw the line between eruptive and metamorphic rocks. It has been shown before that lamination is no sure indication of sedimentary structure.

Lake Elsinore is bordered on the west by a high and rugged granite range. In the mountains west of Elsinore the granite which cuts off the metamorphic rocks on the Santa Ana range is again replaced by the Metamorphic Series, which are here very greatly altered. They strike a little west of north and dip vertical or at a steep angle to the east.

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The boundary of the granite is very irregular, and masses outcrop in the metamorphics near the main contact line. Much of this crystalline rock perhaps more truly belongs to the diorites.

The new silver mines lie just north of the San Diego County line, and west of the divide, a position which brings them into Orange County. The formations in which the veins occur vary from a dark brown felsite, often micaceous, to a finely banded quartzose rock. The latter is very compact, and often almost massive. In places hard, blocky argillites appear. The two or more veins found here carry galena bearing silver, and also much magnetite and iron sulphurets, with some of the baser metals. The veins are characterized by a dark red gossan cap on or near the surface. Carbonates are found in this. These deposits exist as impregnations along a fissure, which is not very strongly pronounced. The ore is usually quite massive. The little gangue present is calcite. Not enough development has been made here at the time of my visit to show how extensive the deposits are. The metamorphic rocks extend north along the mountains, forming the summit and eastern slope for a number of miles. Granite borders them on the west toward San Juan. It is probable that this belt of mineral-bearing rocks runs continuously through to Silverado Cañon. At some time this Elsinore basin opened out through the Temescal Valley, but now a low divide separates it from the head of Temescal Creek. Gravel-topped hills lie along the mountains west of the creek. At the terra cotta works a drill was sunk over 600 feet without reaching the bottom of the basin. The Cheney Coal Mine is located 5 miles northwest of Elsinore, in the same basin. The beds dip to the west and southwest, having clay below, and sandstone followed by clay above. The coal is 7 to 8 feet thick, generally solid, but in places showing a parting in the middle. A great deal of faulting has taken place, but there seems to be no system about it. The throw of the faults sometimes amounts to 30 feet, often disturbing the pitch of the vein, and making it greater. The strata evidently belong to the Miocene-Tertiary, for a little farther down the valley fossils of that age are found. This old Tertiary valley, undoubtedly an arm of the sea, opened into the large valleys of San Bernardino and Los Angeles Counties, and extended southerly to Temecula; though south of Elsinore the Tertiary is covered by Quaternary gravels. The depth is unknown, but the width is quite narrow, being from 1 to 2 miles. Not more than a quarter of a mile northeast of the coal mine the metamorphic rocks, quartzites, and hard, blocky argillites outcrop. East of Temescal Creek northward the mountains are formed of a quartz feldspar porphyry of a dark gray color; at times it blends into portions not distinctly porphyritic.

Three miles north of the San Diego County line granite appears again on the east flank of the Santa Ana range and extends north to Cold Water Cañon. Between Temescal Creek and the mountains is a broad, sloping gravel and bowlder deposit of great thickness, resting on the Tertiary. Two miles south of the Temescal Post Office there is an outcrop of soft sandstone carrying Miocene fossils. It dips southwest at an angle of 30°. Extensive clay banks of various colors and nearly horizontally bedded lie along the flanks of the mountains both east and west of the creek. An interesting series of rocks is exposed up Cold Water Cañon. This cañon has been eroded near the northern termination of the granitic portion of the Santa Ana Mountains. The first rock exposed is a mica-

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ceous diorite, decomposed to a great depth, but very tough when fresh. This is followed by syenite. A mile up the cañon, near the western edge of this rock and wholly inclosed in it, is a small mass of jasper schist and a lenticular body of semi-crystalline limestone. No traces of fossils were found in it. West of the syenite is another diorite dike. Then follows banded jaspery rocks, sometimes verging on micaceous felsite or quartzites. There are also some slates, and all are often greatly contorted; strike north to northeast. North of the cañon these rocks extend to the summit, while south the Santiago Peak, the highest of the range, and the ridges leading up to it from the east, consist of a coarse quartzose granite, with but little if any triclinic feldspar. A variety of dikes occur near the the summit north of the cañon, among them hornblende porphyry, porphyritic granite, and syenite. Fossils were found on the ridge leading up to the summit, north of Cold Water Cañon. They occur in a grayish rock, apparently a fine micaceous felsite. They are poorly preserved, on account of the extreme degree of metamorphism to which the rocks have been subjected. The rocks have become so altered by pressure that they will not break on the lines of bedding, but perpendicular thereto. The fossils consist of impressions of a small bivalve shell. Only about a dozen specimens could be found. The rocks are more altered than any others I have ever seen carrying fossils. These are the first fossils reported from the metamorphic rocks of the Santa Ana range. These fossils when determined will give a clue to the age of the metamorphic gold-bearing rocks of this portion of the State, and also of the granite, concerning which much diversity of opinion has existed.

Dawson Cañon, which heads in the Temescal Mountains, was explored and found to contain interesting geological features. A fine opportunity is given for the study of the relation of the granite to the extensive porphyry intrusives. For 2 miles east of Temescal Creek no eruptives appear; the rocks being wholly of the Metamorphic Series, with exposures of highly altered sandstones, clay shale, conglomerates, etc., striking northwest and dipping southeast at 45° to 50°. About 3 miles up the cañon the argillaceous rocks are replaced by a coarse granite, rich in mica and quartz. This is the prevailing rock up the cañon for 2 miles, and it apparently extends much farther east. It shows a great variation in appearance; much of it contains large crystals of flesh-colored orthoclase. In this granite, particularly on the north side of the cañon, there are dikes of many kinds of rocks. Large dikes of beautiful diorite porphyrites, both light and dark colored, appear in places. At one spot 4 miles from the mouth of the cañon, there are rectilinear dikes of fine-grained granite, intersecting each other like artificial stone fences. For the distance of a mile east, after the granite begins in the cañon, the hills north show nothing but metamorphic schists. The porphyry in the mountains south does not reach the cañon. The great mass of this rock is dark, but in the vicinity of the granite it is lighter colored and more feldspathic, sometimes assuming a granitic structure. In places it is a gray, hard rock, of almost conchoidal fracture, and faint feldspar crystals. The granite near the contact is usually sharply defined, and has a faintly porphyritic appearance at times. The line of junction of the two formations is sharply defined, not only lithologically, but physically. It is difficult to say which is the older. No granite appears in dikes in the porphyry, but there are many dikes of a porphyry-like

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appearance, resembling the light-colored porphyry in the granite itself. The line of junction is very irregular, and it is certain that the two formations do not belong to the same eruptive mass.

East of the head of Dawson Cañon there is another outcrop of considerable extent of metamorphic rock, micaceous felsites, and other dark schists. A mile west of the Gavilan Mines is a high conical peak formed of coarse, dark diabase. The mines of this district are in white biotite granite, continuous with that of the Pinacate district. The metamorphic rocks south of Dawson Cañon strike east and west, dip north, and extend in a westerly direction nearly to Temescal Post Office. North of the cañon, 2 miles from its mouth, there are a number of outcrops in vein-like forms and in bunches, of a black crystalline material, evidently tourmaline, identical with that at the Temescal Mine. These occur in the metamorphic sandstone and shales. The next large cañon in the Santa Ana range north of Cold Water Cañon shows highly disturbed Tertiary strata at its mouth, dipping away from the range at a high angle. They are soft, white clayey deposits, containing small nodules of selenite. The first of the older rocks exposed in the cañon is a hornblende porphyry, with variations to a granular diorite. For 3 miles up the cañon the only rocks seen are crushed and silicified ones of the Metamorphic Series. They dip, as a usual thing, at a high angle to the east, though in spots it is to the west or horizontal. Quartzose sandstones prevail, with blocky argillitic rocks and conglomerates. Near the summit there are dikes of green tufaceous porphyries.

Temescal Valley is underlaid by clays of a great variety of colors. They are being used very extensively for the coarser kinds of pottery and drain pipe. The Miocene deposits of the valley dip westward from the Temescal range, and instead of also dipping away from the Santa Ana Mountains basin-like, they dip west into the latter range. The dip of these beds 3 miles south of South Riverside is 5° to 10° southwest, and as the Santa Ana Mountains are approached the dip increases, and at a distance of a fourth of a mile, up to the metamorphics, it varies from 45° to vertical. The strata are not exposed all the distance across the valley, but there is no sign of a fold or overthrow; everything seems to point to a gradually increasing dip. This is indicative of an elevation of the region toward Temescal, or a sinking of the Santa Ana Mountains. This is undoubtedly the fault line which follows the range for such a long distance south. Several thin seams of coal outcrop for a distance of 10 miles along the base of the mountains. They have been opened in a number of places and all the strata found dipping into the mountains. The coal seams are often only a few hundred feet away from the metamorphics, and dip toward them at a very regular angle of 45°. Judging from the position of the strata it is not probable that the coal underlies the valley, and as it is so close to the mountains, formed wholly of rocks of the Metamorphic Series, it cannot be of great extent. I believe that appearances point to the whole of the coal beds having been eroded, save the limited, steeply inclined portion at the foot of the mountains. A crowding of the strata against the mountains during the movements along the fault line, have given rise to the steep dip. The highest portion of the Tertiary beds has an elevation of 1,500 feet. A very even, gently sloping plain extends from this elevation toward South Riverside. It is formed of unconsolidated wash from the mountains, deposited on and dipping in the opposite direction from the Ter-

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tiary. The Tertiary formation consists of clays in various conditions of consolidation, others chalky in appearance, and a great thickness of argillaceous quartz-sand loosely cemented. Poorly preserved fossils are found in places. Near the southeastern corner of Mr. Hoag's ranch is a hill with hardened concretionary sandstone outcropping around it. Nearly every portion of this contains fragments of bones supposed to be cetacean. Artesian wells are obtained near Temescal Post Office at a depth of 300 feet. The water is abundant and of excellent quality, and is flumed to South Riverside.

Bunches of granite outcrop in the metamorphic rocks along the east side of Temescal Creek north of Dawson Cañon. At the dam of the San Jacinto Company there is a large outcrop of the beautiful diorite porphyrite, similar to that seen in Dawson Cañon. This extends northwesterly along Temescal Creek toward South Riverside, where it is quarried. It makes an excellent and durable building stone, being compact and free from much mica or hornblende. West of this is a narrow strip of coarse granite, followed by diabase. North of Mr. Hoag's ranch, and west of the dam, is a dike of black porphyry. Westward the crystalline rocks are overlaid by the Tertiary.

The dam commenced across the Temescal Creek at this point, where it enters the cañon, was intended to have been extended down to the bedrock, and thus bring to the surface the water which flowed beneath the surface channel. The diorite porphyrite is followed on the east by black porphyry.

Geology of the Temescal Tin District.—The Temescal Tin Mine is located in the northern part of the San Jacinto grant, and about 5 miles southeast of South Riverside. This portion of the grant consists of rolling hills. On the west is a large body of porphyry, extending nearly to the Temescal Creek.

The first rock exposed along the road to the mine east of the creek is a dark flinty one. This is followed by a body of black porphyry, with white feldspar crystals. The porphyry is about a mile across, and is followed on the east by massive black crystalline rock, and that by a felsite. These rocks are soon replaced by granite, in which there are dikes of fine-grained, highly quartzose granite. Little black veinlets of tourmaline aggregates are very numerous in the granite, extending through all the rock up to the porphyry. They have a northeast direction. The material forming them is the same as the gangue of the tin veins. A half mile south of the road is a cañon. Here the porphyry is seen extending up to the granite. The granite is greatly broken near the contact, and though there is no blending of one into the other, there is a confused mixture of broken portions of both rocks. Bunches and dike-like bodies of granite are inclosed in the porphyry. The little veinlets of tourmaline seem to have replaced the feldspar and mica, leaving the quartz. These veins grow larger toward Cajalco Hill. Just west of the works is a great mass of the black veinstone, the gangue of the tin ore. This rises in high, rugged croppings, and covers an area of about 300 by 250 feet. This is the greatest body of vein matter to be seen in the district. The tin deposit worked lies in an eastern prolongation of this cropping. The course of the veins is north 45° east, dip 65° to 70° northwest. The country rock is a coarse hornblendic biotite granite. The vein has the usual character of mineral deposits, swelling at times to a width of 8 feet, and then contracting to much less. The highest grade ore is found in

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the narrower portions, where it is sometimes almost pure tin oxide, running as high as 70 per cent. The vein matter does not consist wholly of tourmaline, but contains quartz grains scattered through it in about the same porportion as in the granite. The tin is not found in the quartzose part of the gangue to any extent, but in the irregular vein-like deposits of pure tourmaline, which lie in the quartzose gangue. The tin occurs in this in bunches and stringers of nearly pure ore, or disseminated through it. This is particularly the case where the width of the vein is 6 to 8 feet. Where it pinches, the whole vein is sometimes formed of the tourmaline aggregate and tin ore. The vein has usually clay seams on both walls; sometimes it is frozen to one wall; wherever the walls come together and cut out the vein matter, the seams remain. The tourmaline vein matter is an aggregate of needle-like crystals. There are two varieties of tin ore: the yellow, appearing in thin layers in an uncrystalline form; the brown, in granular form in the massive specimens, or in small, clear, reddish brown crystals lining cavities. In the latter case it forms handsome specimens. A small amount of arsenical pyrites is present in places in the vein, and iron pyrites in the granite. The quartzose portion of the vein matter often blends into the granite walls, and there are bodies of evidently granitic origin wholly inclosed in the vein matter. A careful study of the vein matter, and its relation to the walls, shows that it is simply a portion of the granite, in which the feldspar and dark silicates, hornblende, and mica have been removed and tourmaline substituted. The quartz has the same character and color as that in the granite, and many transition stages in the process are shown. Where the action has been more intense, near and along the fissures, the quartz has been wholly removed and the tourmaline deposited, together with the tin. Cajalco was the center of this action. The veins decrease in size farther away.

At the time of my visit the mine had been opened to a depth of 180 feet, by two working shafts. The total length opened on the vein is 300 feet. Two levels have been run and work was in progress on the third. The main ore body lies in the center of the workings, and extends downward in the dip of the veins. The ore milled averaged 5 per cent of tin oxide, though large portions, as before stated, are very high grade. The company has also prospected Cajalco Hill by tunnel and open cuts, and one or more of the veins south by shafts. At the time of my visit two of Husband's pneumatic stamps were in operation. They weigh 900 pounds each, and drop one hundred and thirty-five times per minute.

South and southeast of the works are many bunchy veins of the black tin gangue. They often carry considerable iron. They extend, generally nearly parallel, in a northeast and southwest direction. Some appear as mere bunches on the surface. These veins closely resemble the main vein at Cajalco Hill, and are due to the same action, and it has been supposed that many of them will be found to carry tin, though it is not present on the surface. About 2 miles south the granite is replaced by a banded feldspar porphyry. This cuts off the tourmaline veins. The granite about the works, and especially toward the contact with the porphyry, is cut by many dikes of a fine-grained granite, having an excess of quartz and feldspar. Associated with the porphyry are strata of metamorphic rocks, of a hard, dark, quartzose character. A quarter of a mile northwest of the mine is a bunch-like outcrop of porphyry, carrying silver and copper carbonate. The black veins outcrop for a

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distance of 2 miles northwest from the mine, extending into the porphyry, which replaces the granite in that direction. The granite extends eastward for many miles.

The general geological features which obtain here are: A semi-circular area of granite over 2 miles in diameter, surrounded on the northwest and south by porphyries and joined on the east to a great body of granitic rocks extending indefinitely in that direction. Around the border of this granite protuberance are many dikes of a fine-grained granite. Cutting through the granite in a northeast and southwest direction are the black tourmaline veins, which form the gangue of the tin ore when it is present.

Tin occurs here under conditions different from any other known deposit. Tin veins are almost always found in granitic formations, but such an extensively developed tourmaline veinstone is remarkable. The direction of the fissure system shown here is an uncommon one in California. The veinstone, together with the associated metals, has probably resulted from a process of sublimation along lines of fracture, removing those portions of the granite easily affected, over a large area, as at Cajalco Hill, and in the immediate contact completely replacing it with the massive aggregate of minute tourmaline crystals.

Thanks are due to the manager, Captain Harris, for the facility freely afforded me for examining the mine, the works, and the country about.

North of South Riverside the Tertiary beds dip at a small angle to the north. The Santa Ana River has cut its course through the hills at the northern end of the Santa Ana Mountains. No outcrop of the metamorphic rocks appears in the cañon. The Tertiary strata no longer dip toward the west, but in the Chino hills north of the river show a great anticlinal arch. Along the south side of the river the beds dip 70° northeast; farther west, near the heart of the range, they dip 60° southwest, strike north 30° west. Near the upper end of the cañon there are fault lines dipping toward the range, which show an elevation of the hanging wall. Bedrock Cañon is the first large one which opens to the Santa Ana River from the western slope of the mountains. Opposite the mouth of this cañon the greatest amount of water appears in the bed of the river, indicating the presence of hard rock only a little distance below. Coal veins are located near the head of this cañon, one 700, the other one 1,300 feet above the river. They dip only a few degrees to the southwest. They are exposed on cliffs facing the mountains to the northeast. Below them are very hard sandstones carrying fossils, probably Cretaceous. One prospect shows a number of seams within a width of 8 feet. The widest is 29 inches, the others much smaller. The other prospects show only one 39-inch seam. Their position, lying so flat high on the mountains, indicates an uplift without great disturbance, while the gypsum mines farther down on the flank of the mountains dip at a high angle to the southeast. It may be that all of the coal deposits of the western slope of the Santa Ana Mountains belong to the Cretaceous, and have been greatly separated by faulting and folding. A deposit of white, granular gypsum has been opened in Gypsum Cañon, 2 miles south of the river. The beds have a thickness of 8 or 10 feet. At one spot a large mass of crystalline dolomite was found. The deposits run with the strata, north and south, and dip west 60°. As we approach Olive, the few croppings seen still dip south or southwest, but at a less angle. South of the mouth of

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Silverado Cañon a line of hills extends north and south, bordering the Santa Ana Plain. The western portion of these hills is formed of basalt considerably decomposed. The basalt varies from scoriaceous to fine-grained and compact. Its eastern edge was seen to rest on Miocene sandstones, and it dips west at a small angle, perhaps 10°. The lava seems to have been squeezed up in fissures, judging from the way in which it outcrops. Its greatest elevation is 800 feet. At some places the sandstones, where not covered with lava, have been silicified, turned to quartzite, or rendered granitic in appearance. This may be due to an intrusive neck of lava, or more probably to the action of thermal springs.

An interesting fold of the Tertiary strata was observed at the entrance of Santiago Cañon. The sandstones and conglomerates on the eastern side dip to the northeast at an angle of 30°, while those on the west side dip in the opposite direction. The valley has been eroded in the summit of an anticlinal. The rocks of the eastern side rise again against the side of the mountains, thus forming a synclinal. Up the cañon the sandstones on the west maintain a southwest dip of 45° to 50°, and strike north 40° west. The cañon finally leaves the anticlinal, and the rocks dip southwest on both sides. Toward the summit of the hill, north of the Harris Coal Mine, the dip increases to 70°, but on the top they turn so that the strata lie horizontal. Here they consist of clay shale. The strata at the coal mine swing around, and one mile northeast they strike north and south and dip west. This hill seems to form the southern termination of the anticlinal ridge north of Santiago Cañon. Southeast of this point there is a simple monoclinal fold or slope away from the older rocks of the high mountains. There has apparently been a fault extending northwest in this anticlinal ridge, bringing up the clay shales which farther south were shown to belong to the Cretaceous. Harris Coal Mine shows a seam 18 inches wide, shale forming the foot wall and sandstone the upper. There is a fault of 200 feet cutting this coal seam. The sandstone at the mouth of Silverado Cañon dips south 30°, forming bold cliffs. A half mile up the cañon there are heavy beds of clay shale inclosed in the sandstone. Cretaceous fossils appear in the shales, as well as in a coarse sandstone which underlies them. This sandstone is replaced by conglomerates near the contact with the underlying Metamorphic Series. The sandstone rises to a height of 2,500 feet, with bold, almost perpendicular cliffs facing the mountains. Portions of the sandstone containing the fossils are often very much hardened.

The first crystalline rocks met are dark and fine grained, with traces of bowlder-like inclusions, and are evidently eruptive tuffs. Above these are green, dioritic rocks. These intrusives are followed for several miles by sandstone and shale, in which the stratification is often obliterated. In other places thin layers of sandstone and shale are wonderfully contorted. The dip is at a high angle either east or west. In the vicinity of the old Silverado Camp there are dikes and bunches of a green dioritic rock. The mines in the Silverado district are again being developed to some extent. The mineral belt is about 2 miles wide, and extends nearly north and south. The country is formed to a great extent of dikes of greenish to blackish rocks, often showing distinct hornblende crystals. The dip of the metamorphic rocks is east about 45°. There is one main mineral vein located, beginning about a mile

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north of Silverado, and extending in a southerly direction for 7 or 8 miles. The Quincy Mine is one of the most northern ones. The vein has a width of 2 feet; the ore, silver-bearing galena in a calcite gangue. It carries but little base metal of any kind. The ore has a peculiar appearance, the galena being distributed through the gangue in little leafy crystals or aggregates. The fissure is well defined and regular, with a pale green syenitic rock on the hanging wall, and a dark diorite on the foot wall. This hanging wall rock weathers to a light gray color, producing a rock known as porphyry among the miners. South of this mine a side vein carries much antimony. The Quincy has been opened along a length of 500 feet. The ore is quite uniform, producing one eighth in concentrates. The Quincy camp has an elevation of 2,300 feet. South of Silverado Cañon, in Silver and Pine Cañons, a great amount of work was done during the former excitement. The sides of the steep, rocky cañons are fairly honey-combed with tunnels, which were undertaken without sufficient prospecting, and, of course, never struck anything. The New York Mine spent much money, but did not prove a success. West is the Princess, and farther still, about 1,200 feet above the cañon, is the Blue Light Mine, on which much work has been done and rich ore taken out. The mines south of the cañon are in a feldspathic rock, which weathers white. It is undoubtedly an intrusive porphyry, for traces of feldspar crystals are to be seen. The mines are characterized by a large amount of zinc-blende, iron pyrites, and not a large percentage of lead, making them more difficult to reduce. The porphyry is mineralized in many places where no traces of the precious metals occur. Litigation and poor management seem to be the chief factors in stopping work in this district. Though some of the ore runs into hundreds of dollars to the ton, the most of it is medium to low grade.

About a mile and a half down the cañon from the old Silver Post Office, and in a cañon coming in from the south, is a cropping of dark, somewhat argillaceous limestone inclosed in shales. The limestone does not seem to have been highly metamorphosed, yet the fossils which it contains are almost obliterated. The faint impressions are those of coral stems, stromatopora, and some other low forms of life. Half a mile farther down the cañon is a cropping of brecciated marble. At many points, particularly on the north side of the cañon, there are great masses of apparently conglomeritic character, but with a crystalline structure. The matrix has a green to brown color, and in it are imbedded pebbles of the same degree of fineness, but often distinguished by much brighter red, purple, and green colors. In this cañon, as in others of this range, the water holds much lime in solution, and extensive tufas are frequently to be seen. The basal members of the Cretaceous at the mouth of Silverado Cañon consist of conglomerates passing up into sandstone, and those into shales; dip 55° away from the mountains in the highest ridge, but in the course of a quarter of a mile becoming much less. The change in dip is very sharp, giving the appearance of a fault.

A cañon which enters Silverado Cañon from the northeast near its mouth was followed up nearly to its head for the purpose of investigating some limestone outcrops. The first outcrop in this cañon is the usual dark porphyry. Beyond this the stream has cut a deep cañon through an immense conglomerate of porphyritic and quartzose pebbles. The porphyritic pebbles are dioritic and part red and black porphyries.

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Some of them are similar to dikes farther up the mountains. Through this great conglomerate bed there are dikes of black porphyry, with pale feldspar. Tufaceous porphyries form a large part of these dikes. The base is purple and the pebbles light green, or the reverse. These conglomeritic porphyries differ from the great beds of sedimentary origin, in having all the pebbles of a uniform character with a crystalline matrix. The sedimentary beds contain pebbles of all sizes and description, in a matrix of small pebbles or coarse sand. Farther up the cañon the great body of the rock is crushed shale and black to gray sandstone; dip vertical, inclining most generally to the east, strike north and south. Two miles up the cañon is a dike of diorite porphyrite, coarse in the middle and fine on the edges. Four miles up is a stratum of gray limestone. More outcrops appear on the north side of the cañon, but whether they belong to the same stratum or different cannot be told, on account of the crushing undergone. These deposits are bunchy, swelling in one case to a width of 100 feet. It is not crystalline. The color is from black to gray. It contains fine specimens of a bivalve shell, and faint traces of corals and univalve shells. These beds are said to extend to the summit, and undoubtedly further examination would reveal more fossils. Several specimens were sent to the National Museum and pronounced Carboniferous in age. We have here, then, the first announcement of the age of the Santa Ana range. This range stands in such intimate relation to the granite and crystalline schists farther south, that an approximate determination of the latter is made possible. Professor Whitney and others following him have classified this range as Cretaceous. Their grounds are utterly untenable stratigraphically, but this discovery of Carboniferous fossils makes the evidence of greater age certain.

On the eastern side of the range, near its northern end, the sandstones were observed to be silicified, being filled with a network of quartz veinlets, exactly similar to the silicification of the metamorphic rocks of the Coast Range proper.

The lowest Cretaceous beds are between Silverado and Williams Cañons, but the fossils are very similar to those generally found through the Cretaceous of this region. The lowest beds are a duplicate of those seen at the mouth of the Silverado Cañon, though apparently a thousand feet lower in the series. Between the two beds there is another conglomerate stratum, carrying bowlders different from any seen in the Santa Ana Mountains. Many of the porphyry bowlders in the basal Cretaceous conglomerates resemble the porphyry about Temescal. The Santa Clara Coal Mine, at the mouth of Silverado Cañon, is undoubtedly in strata of Cretaceous age, though no fossils are found in the strata above till the Miocene is reached. Up the Santiago Cañon as far as Madame Modjeska's place, the fossils are chiefly confined to the eastern side of the cañon, but the character, dip, and strike of the strata on both sides are the same. The Cretaceous is separated from the metamorphics by a line of cross cañons. The highest portions of the Cretaceous terminate in a line of hills with sharp eastern escarpments.

Shrewsbury Cañon comes in just below Modjeska's. After passing the Cretaceous, through which the cañon has cut, the Metamorphic Series was seen to consist of slates and sandstones, followed by light-colored granitic rocks, chiefly hornblende and triclinic feldspar. The metamorphic rocks generally dip to the east.

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A mile above Modjeska's the Santiago Cañon cuts through bold cliffs of Cretaceous sandstones and conglomerates, and higher up still has eroded a cañon in the Metamorphic Series. The cliffs, a little back from the stream, rise probably 1,000 feet. Sandstone belonging to the Metamorphic Series outcrops in the cañon for some distance, and is followed by conglomeritic porphyries, containing purple and red bowlders. In some places the inclusions are angular. These rocks are extensively developed about the Santiago Mines and higher up in the mountains.

Just below the Alma Mine, on its western side, the creek has cut through dikes of diorite, which are coarse in the center and fine on the edges. On the hill south of the Alma Mine the diorite is on the opposite or eastern side of the vein. Although the exposures are poor, all the crystalline rocks have the character of intrusives. No blending into the metamorphic rocks has been noticed. About 3 miles up Shrewsbury Cañon several claims are located on the southern continuation of the veins of the Silverado district. Near the head of Santiago Cañon these again appear well defined, and considerable active work was going on here at the time of my visit. The veins here have a direction a little east of south, dipping to the east somewhat less than 45°. It appears that the mineral belt follows a certain line, generally quite regular, without any particular reference to the dikes and bunches of intrusives scattered irregularly here and there. The fissure system has taken a comparatively regular line and the walls may or may not be intrusive. The Alma Mine, the northern claim of the Santiago Silver Mining Company, has been worked by the former operators in a very irregular manner. The veins and stringers as far as exposed lie wholly in the crushed quartzose argillites. A tunnel is now being run to open what is supposed to be the main vein, several hundred feet farther east, and which has syenite on the hanging wall. Other tunnels are being run along the creek, one near a body of granitoid rocks, others in slate or quartzite. The ore is a leafy galena, arranged often in narrow bands with the crystalline orientation different in alternating bands. Sometimes it occurs in the form of large solid bunches. Thus far the ore deposits have been found quite irregular, but it is thought that the main body has not yet been reached. Very little base metal is present. South, on the hill, the Morrow claims have been bonded by the same company and are being opened. On the summit of the hill diorite lies on the eastern side of the veins. Down the southern slope the veins lie wholly in metamorphic rocks; the foot wall being more silicious, the hanging argillaceous. The mineralized portion has a width of 20 feet. A small vein occurs in the upper side, and a heavier one, sometimes reaching 3 feet, on the foot wall. There are occasional stringers in the crushed portions between. The gangue is calcite, with some quartz, all mixed with the broken clayey slates. More zinc-blende and iron pyrites are found here, also a little antimony. In the Alma Mine the richest galena is very fine, and sometimes resembles antimonial ores.

South of these mines, toward Trabuco Cañon, another claim is being worked. South of the Trabuco the conglomerates hide the lode, except at one spot, where it appears and has been worked. The Cretaceous formation grows lower as the Trabuco is approached, and does not appear prominent south of it. In all probability it is covered by the Tertiary, for the elevation and consequent erosion have not been as great in this direction.

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Along the road that leads from Madame Modjeska's down to Los Allisos Creek, the sandstones preserve a general southwest dip, at an angle varying from 15° to 30°, and often faulted. Two miles southwest of Modjeska's, fossils of a Tertiary character, probably Miocene, were found in sandstones, which are separated by no physical break, nor any nonconformity from the Cretaceous beds. These sandstones continue down to El Toro, dipping west. The elevation of El Toro is 500 feet.

The ore of mercury lately discovered is found about 2 miles east of Tustin, in an outlying hill of Tertiary sandstone, partly surrounded by the Santa Ana Plain. The hill rises over 100 feet, and is about 1,000 feet long by perhaps half that in width. It is several miles south of the lava deposit near the entrance to Santiago Cañon. The sandstone dips north at a small angle, and consists of a loose aggregate of quartz grains cemented by a kaolinic material. The whole hill has been affected by mineralizing agencies, and can be distinguished a long distance by its red color. Deep red tints and a bright yellow can be seen everywhere. No hardening or metamorphism of the sandstone has taken place. On the north side of the hill is one or more veins of baryta, or heavy spar, running in an east and west direction, and dipping south. They are usually not over a few inches wide. These carry in places the metallic, steel-colored mercury, which on its surface presents a reddish tinge. This mineral is distributed in small masses, usually somewhat vein-like, in the baryta. It is not present in any great quantity. In places the ore appears in minute stringers in the somewhat indurated aluminous sandstones adjoining. A tunnel several hundred feet long has been run into the hill from the south, but it encountered nothing but bright red and yellow sandstones. Another short one on the north met only some little veins of baryta. A short incline has been run down on the veins. Appearances do not indicate that the mineral is present in any quantity. Specimens are in the hands of Professor Dana, but no published analyses have yet been made, so nothing definite can be said about its composition. The deposit must be in some way related to the volcanic action a little distance north.

SUMMARY.

Our knowledge of the geology of this portion of the State has been quite limited and fragmentary up to the present time. Professor Blake, in connection with the Pacific Railroad Survey, crossed San Diego County from east to west, but his notes are confined to the immediate vicinity of the route. Professor Whitney, of the old State Geological Survey, published very little on the geology of San Diego County. W. A. Goodyear, while under Professor Whitney, and later in the employ of the State Mining Bureau, traveled through the county and gave us some additional information. The geologists of Wheeler's survey did not get farther south than Orange County. Professor Whitney, in his report on the general geology of the State, devotes a little space to the region south of Los Angeles, chiefly the Santa Ana and Temescal Mountain regions.

A great diversity of opinion has existed with reference to the age of the granitic and metamorphic rocks. The geologist of Wheeler's survey speaks of the granitic rocks of the Santa Ana range as Azoic. Professor Whitney goes to the opposite extreme, and says that the metamorphic

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rocks of the range are Cretaceous or Tertiary. It must be remembered that these are the rocks through which the so-called Azoic rocks have been intruded. Professor Whitney's words, with reference to this region, are: "It is not easy to say, after our hasty examination of this region, what is the age of the metamorphic rocks. They are believed to be partly Cretaceous and partly Tertiary." Professor Whitney's definition of the Coast Ranges is that series of mountains near the coast which has been elevated since the deposition of the Cretaceous. Now, in order to satisfy this definition of the Coast Ranges, he includes the Santa Ana Mountains under that designation, and says that the line between the Cretaceous and the older rocks runs in a southerly direction up the Temescal Valley, and in San Diego County makes a turn to the west, coming out to the ocean near Oceanside. If Professor Whitney had made any examination at all of this section, he would have seen that this line was wholly artificial. It cuts through granite for 10 or 12 miles. This granite is absolutely continuous with that of the higher ranges of San Diego County, and also with that of the Santa Ana range. I had made up my mind, before finding the fossils, that the metamorphic rocks of this range were equivalent to the crystalline schists of the Julian gold belt. This is a belt of schists which runs through the heart of the Peninsula range, from the Mexican line through the Santa Ana Mountains. The schists strike across the summit line at a small angle, and are broken only where granite has been intruded through them. The schists first appear in Jacumba Valley, where they carry a little gold. Extending northwest they appear along the eastern slope of the Laguna range. One portion has been broken off and crowded to the west by the mica diorite forming those mountains. Northward the schists again unite, and in the vicinity of Banner and Julian contain the chief mineral deposits of San Diego County. North of Julian they are less prominent until the western slope of Smith Mountain is reached, where their width is considerable. Between Pala and Temecula Cañon, a body of coarse hornblendic granite has been intruded through them so extensively that their continuity is broken. On the Santa Rosa grant these schists occupy an area several miles in diameter, being less metamorphosed than those farther south. At the northern boundary of the grant, they are again cut off by granite, which has a width of over 7 miles. West of Elsinore the schists appear again, and undoubtedly extend through to Silverado Cañon. Another outburst of granite borders them on the east until Santiago Peak is reached. On the Santa Rosa grant silver occurs in these metamorphic rocks, and increases in amount northward. There are many other small bodies of crystalline schists in San Diego County, but none can be traced so far along such a plainly defined line. This line seems to represent the axis of least metamorphism in the Peninsula range. I believe that there is no question but what the metamorphic rocks of the Santa Ana range are equivalent in age to a large part of those in San Diego County. Although none but Carboniferous fossils have yet been found, it is probable that the Metamorphic Series contains rocks much older as well as younger. I believe that the great convulsion which upheaved and metamorphosed the older rocks, and intruded granite into them, took place as it did in Central and Northern California, between the Cretaceous and the Jurassic. There is no break in the line of granites and crystalline schists the whole length of California.

The mineral deposits of San Diego County are chiefly gold. It is found

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in greatest quantity along the line of schists just described, but does not seem genetically related to them any more than to the granite at Deer Park or Mesa Grande. A fissure system is more regular in schistose than in massive rocks, a fact well illustrated in San Diego County. At Julian and Banner the gold-bearing veins are somewhat remarkable in having no relation to intrusive rocks. Small deposits of gold are known to occur at Dulzura and Escondido. The silver veins of the Santa Ana range are peculiar in regard to the great variety of formations in which they occur. From the new camp west of Elsinore, where there are no intrusive dikes near the deposits, north through the Santiago and Silverado districts, there are no two claims with the same kind of ore or wall rocks. The fissure system has been formed along a line of weakness, due, perhaps, to the dikes, but the mineral deposits seem to have no other relation to them.

Dynamic action is far less pronounced in San Diego County than in other portions of California farther north. The crystalline rocks as a whole are fresher and less crushed.

The numerous eruptions of lava in the region explored are of late Tertiary age. At that time a decided uplift, accompanied by faulting, took place, and as a result of this fissures were formed, through which the lava flowed. There are no signs of volcanoes. The lavas are basic, probably largely basalt, but no microscopic examinations have yet been made.

Everything points to a very recent submergence of the Colorado Desert. It is probable that during Quaternary times, the whole mountain range was submerged between 2,000 and 3,000 feet, and that the great beds of unconsolidated gravels and bowlders, which overlie the Tertiary, were then formed. The country rose at the beginning of the Modern period, and the deep cañons have largely been eroded since.

The crystalline rocks of San Diego County are remarkable for their variety and the interesting features which they represent. The crystalline schists represent the oldest formation. In them the granite has been intruded, and in the granite have subsequently appeared the basic rocks, of which the gabbro, on the Cuyamaca, is the most characteristic. Many of the porphyries are younger than the granite, but the extensive body of tuffs and dark porphyries, beginning west of San Marcos and widening toward the south, is of uncertain age. It has undergone greater decomposition than any other crystalline rock, and has every appearance of being one of the oldest.

The time gap between the lowest of the unaltered beds and the crystalline rocks is represented by the greater portion of the Cretaceous. The discovery of sandstones on the borders of the desert, which may prove to be of Lower Cretaceous age, will lessen this gap considerably.

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CALIFORNIA STATE MINING BUREAU
FERRY BUILDING, SAN FRANCISCO
FLETCHER HAMILTON State Mineralogist

San Francisco] [December, 1917

REPORT XV

OF THE

STATE MINERALOGIST

Mines and Mineral Resources

OF PORTIONS OF

CALIFORNIA

Chapters of State Mineralogist's Report
Biennial Period 1915-1916

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ADMINISTRATIVE STATEMENT.

The general survey of the mineral resources of California, which was inaugurated during the sixty-fourth and sixty-fifth fiscal years, was vigorously prosecuted during the sixty-sixth and sixty-seventh, the results of this effort being included in the volume presented herewith.

With but few exceptions, detailed data relative to the mines, quarries, and oil wells of every county in the state are now available for the information of the general public, in no matter what phase of the industry they may be interested.

It will be noted that an attempt has been made to also convey helpful advice to the prospector, particularly as regards the counties containing vast stretches of desert and arid regions where climatic conditions are unfavorable, and where it is often a matter of life and death to secure water and food, and sometimes fuel and other supplies.

In addition to the work, the result of which is made available through the medium of this volume, the activities of the Bureau have been broadened to an extent never before undertaken, and it is believed that the ends attained have fully justified the time and money expended.

War demands for practically every mineral produced in the state have been responsible for unwonted activity in mining, and as a result the inquiries, both personal and written, which have been daily received and answered, make up a volume of labor which does not appear in the printed records, but which consumes a large proportion of the time of the State Mineralogist, as well as that of his staff.

Publications.

As a means of meeting new and special demands, as well as of forwarding the general development of the mineral resources of California, it is a pleasure to report the following finished work which has been accomplished, aside from the material contained in this report:

Bulletin No. 69, on the "Petroleum Industry of California," mentioned in the biennial report of 1913-1914 as being in preparation, was issued in October, 1914. It covers the subject of our crude oil resources very thoroughly, and is accompanied by a folio of eighteen areal, structural, and geological maps.

Bulletins Nos. 70 and 71, annual statistical reports for the calendar years 1914 and 1915, respectively, show the mineral production of California for those periods. This annual bulletin has been enlarged and improved in every respect, and in addition to the mere figures of

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output there have been included descriptions of the uses and characteristics of many of the mineral substances found in this state, as well as a brief mention of their occurrence.

Geologic Map of California, lithographed in 17 colors, which makes available for reference for the first time a detailed record of the geology of every portion of the entire state. Accompanying this map has been issued Bulletin No. 72, entitled "Geologic Formations of California."

Following the above, Bulletin No. 73 was issued for free distribution, entitled "First Annual Report of the State Oil and Gas Supervisor of California." This report contains 278 pages and 26 illustrations, outlines the work and policy of the Department of Petroleum and Gas, describes in detail causes of damage to oil wells by infiltrating water, contains typical geological cross-sections and other technical matter, oil well logs, etc., for the information and guidance of the operator in the field. This report also shows the production of petroleum in California, the area of proved oil lands, contains a review of work in the various fields which was completed during 1915 and 1916, describes practical methods of shutting off water, contains data on strength of casing, and cause for failure of derricks, describes the manufacture of gasoline from natural gas, and includes a directory of oil companies, showing date of incorporation, capital stock, number of wells and location of property.

Mineral Production of California.

As a means of briefly indicating the immense forward strides which mining has recently taken here, the following tables have been included, showing the comparative yield of mineral substances of California for the calendar years 1914 and 1915, as compiled from the returns received at the State Mining Bureau in answer to inquiries sent to producers:

The following table shows the values of the several minerals produced in California during the calendar years 1914 and 1915:

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Substance	1914	1915
Antimony ore		$35,666
Asbestos	$1,530	2,860
Barytes	3,000	620
Bituminous rock	166,618	61,468
Borax	1,483,500	1,663,521
Brick	2,288,227	1,678,756
Cement	6,558,148	6,044,950
Chromite	9,434	38,044
Clay (pottery)	167,552	133,724
Coal	28,806	26,662
Copper	4,055,375	7,169,567
Dolomite		14,504
Feldspar	16,565	9,000
Fuller's earth	5,928	4,002
Gems	3,970	3,565
Gold	20,653,496	22,442,296
Gypsum	78,375	48,953
Infusorial earth	80,350	62,000
Iron ore	5,128	2,584
Lead	183,198	225,426
Lime	378,663	286,304
Limestone	517,713	156,288
Lithia		1,365
Magnesite	114,380	283,461
Manganese ore	1,500	49,098
Marble	48,832	41,518
Mineral paint	847	1,756
Mineral water	476,169	467,738
Natural gas	1,049,470	1,706,480
Petroleum	47,487,109	43,503,837
Platinum	14,816	21,149
Potash	460	19,391
Pumice	1,000	6,400
Pyrite	230,058	293,148
Quicksilver	557,846	1,157,449
Salt	583,553	368,737
Sandstone	45,322	8,438
Silica (sand and quartz)	22,688	34,322
Silver	813,938	851,129
Slate		5,000
Soapstone and talc	4,500	14,750
Soda	115,396	83,485
Stone, miscellaneous	4,860,357	5,011,108
Tungsten concentrates	180,575	1,005,467
Zinc	20,381	1,617,383
Totals	$93,314,773	$96,663,369

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The following table shows the value of the mineral production of the various counties in the state for the calendar years 1914 and 1915:

County	1914	1915
Alameda	$870,427	$861,683
Alpine		
Amador	3,211,109	4,063,762
Butte	1,755,782	1,622,245
Calaveras	2,005,954	2,161,893
Colusa	32,251	16,003
Contra Costa	1,149,321	1,309,505
Del Norte	5,938	4,524
El Dorado	149,226	428,336
Fresno	7,484,473	8,152,300
Glenn	30,553	46,667
Humboldt	233,332	358,686
Imperial	250,529	77,433
Inyo	2,085,112	2,771,042
Kern	28,040,296	25,335,184
Kings	740	18,608
Lake	63,503	72,534
Lassen	4,568	870
Los Angeles	4,665,504	4,168,612
Madera	203,009	145,063
Marin	554,137	160,528
Mariposa	187,505	412,326
Mendocino	560	24,536
Merced	[1]111,701	94,032
Modoc	1,252	8,681
Mono	16,060	109,425
Monterey	114,254	84,986
Napa	971,748	884,221
Nevada	3,330,940	3,492,946
Orange	8,831,763	6,617,112
Placer	1,097,098	963,860
Plumas	161,308	745,715
Riverside	1,580,805	1,349,591
Sacramento	2,629,244	2,562,281
San Benito	436,259	642,065
San Bernardino	1,616,537	2,674,042
San Diego	315,267	211,129
San Francisco	119,889	128,270
San Joaquin	129,930	248,394
San Luis Obispo	63,465	227,632
San Mateo	246,478	177,891
Santa Barbara	2,686,309	3,984,966
Santa Clara	266,956	635,229
Santa Cruz	1,642,958	1,581,531
Shasta	5,047,838	8,350,133
Sierra	725,129	729,518
Siskiyou	385,825	514,094
Solano	1,683,866	1,335,923
Sonoma	326,144	276,104
Stanislaus	[2]5,882	191,771
Sutter		
Tehama	300	4,702
Trinity	747,282	499,511
Tulare	161,252	184,599
Tuolumne	1,050,928	1,171,438
Ventura	1,000,729	904,767
Yolo	736	2,040
Yuba	2,823,282	2,862,430
Asbestos, unapportioned	1,530	
Totals	$93,314,773	$96,663,369

[1]Includes output of a gold dredge in Stanislaus County. [2]See Merced.

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Other Activities.

In addition to the foregoing, work on a set of county mineral maps of standard size and scale has been satisfactorily forwarded, although considerable time will yet elapse before it will be possible to make them available for distribution. These maps will show the location of every known mineral property in the various counties, as well as being up to date as regards highways, wagon roads, towns, post offices, stage routes, streams, etc.

The work of the Petroleum Department has continued to expand, and arrangements have been provided for specially constructed office quarters in two of the principal oil fields, which will provide ample space for filing valuable records in fireproof vaults. In these buildings there are also to be maintained peg models of the oil fields for the benefit of those interested.

The Mineral Museum which is maintained by the Bureau in the Ferry Building, San Francisco, has always been one of its most interesting adjuncts. This museum is visited by many thousands of persons annually, and it affords striking visual evidence of the diversity of the mineral products of the state in a manner which could be obtained by no other means.

The Laboratory, in which free determinations are made of all mineral specimens sent in by citizens of the state, is an assistance to the mining public which can not be adequately estimated. Not only prospectors, but engineers and geologists in large numbers, avail themselves of the opportunity thus presented to obtain accurate and authoritative information relative to samples and specimens of doubtful or unknown value which they have discovered or otherwise obtained. This assistance is of particular value as regards the rarer minerals, the appearance of which may often be unfamiliar even to mining men of long experience.

The Library, Reading Room and general offices in the Ferry Building have been renovated and remodeled, with the single idea in view of increasing the ability of all members of the Bureau to satisfactorily serve the interests of those who call for information and advice.

The Library is well known to the western mining public. It contains more than 5000 volumes of scientific and technical reference books covering all features of the mineral industry, as well as allied subjects.

Future Plans.

As regards the future plans of the Bureau, it may not be amiss to state that there is in press a compilation of the United States and California Mining Laws, brought up to date. A catalog of the publications of the Bureau from the date of its inception in 1880 is also

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in press; likewise, a preliminary report on manganese and chromium, which is to be followed by a bulletin on the same subject, the manuscript of which has been practically completed, and will be sent to the printer at an early date.

Field work has been completed, and compilation is well under way, on bulletins which will cover the following subjects: Quicksilver Resources of California, including chapters on metallurgy and ore dressing; Magnesite in California; Tungsten, Molybdenum and Vanadium in California.

Steps have also been taken to prepare a preliminary report, similar to the one on manganese and chromium, which will include information primarily intended to assist the buyer and seller of mineral substances in getting in touch with each other as regards nickel, molybdenum, antimony, tin, tungsten, graphite, strontium, and potash.

Plans have also been completed for the installation of a complete file of the Bureau's publications in its branch offices at Los Angeles, Santa Paula, Santa Maria, Taft, Bakersfield, and Coalinga. Not only will all publications be available for reference at these points, but bulletins and reports which are issued for free distribution will be supplied in sufficient numbers to meet the requirements of the local public.

Acknowledgment.

The hearty co-operation of the California mining public, which has at all times been accorded members of the Bureau, is a very important item, and one which has made possible the successful carrying out of the various plans which have been here enumerated. Sincere appreciation and thanks for this co-operation is hereby gratefully acknowledged.

It may appear, in some individual instances, that little compensation is received for the time and attention asked by the Bureau, but such minor sacrifices may result in great benefit to the mining public, as well as to the entire nation, when the information obtained has been correlated and placed in its proper position relative to the problem which may require solution.

The State Mineralogist also takes pleasure in making this public acknowledgment of the enthusiastic and efficient services which have been rendered by all members of the Bureau staff, and as a means of emphasizing this fact, and also illustrating the proportions which the

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Bureau has attained, there follows the personnel of the staff as of June 30, 1916:

Personnel.

F. McN. Hamilton, State Mineralogist.
R. P. McLaughlin, State Oil and Gas Supervisor.
W. W. Thayer, Secretary and Cashier.
M. J. Kirwan, Deputy State Oil and Gas Supervisor.
R. B. Moran, Deputy State Oil and Gas Supervisor.
Chester Naramore, Deputy State Oil and Gas Supervisor.
R. E. Collom, Deputy State Oil and Gas Supervisor.
Walter W. Bradley, Mining Statistician.
Edgar Woodcock, Determinative Mineralogist.
W. Burling Tucker, Field Assistant.
Emile Huguenin, Field Assistant.
Clarence A. Waring, Field Assistant.
J. J. McDonald, Assistant Mining Statistician.
W. E. Condon, Geological Draftsman.
A. H. Brod, Laboratory Assistant.
Henry McCann, Clerk.
E. M. Connor, Stenographer.
Emma Cooney, Stenographer.
Walter A. Greer, Stenographer.
Edith Husted, Stenographer.
I. M. Johnson, Stenographer.
Arthur Nagle, Night Watchman.
H. F. Williams, Janitor.

FLETCHER HAMILTON,
State Mineralogist.

December, 1916.

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RIVERSIDE COUNTY.

INTRODUCTION.

The following report on the mineral resources of Riverside County is based on field work performed during the summer and early autumn of 1914.

The examinations of the mineral deposits in the desert section of eastern Riverside County, had, on account of the climate, been deferred until autumn, and it was at the inception of this work that, on November 11th, while at Mecca, the writer was stricken by an illness which terminated his field work for the season. Through the courtesy of the State Mineralogist, a well trained and efficient geologist, Mr. Clarence A. Waring, was detailed to complete the unfinished work in eastern Riverside County, and from his observations and written descriptions the new material relating to this area has been derived.

HISTORY.

Riverside County, organized by act of the state legislature on March 11, 1893, from portions of San Diego and San Bernardino counties, has an area of 7,240 sq. mi., and a great variety of agricultural and mineral resources. Further, from the diversity of its surface, it affords marked variations in climatic conditions, and, in many areas, offers to the tourist and health seeker, unsurpassed attractions in the several seasons of the year.

TOPOGRAPHY.

The surface of Riverside County, like that of much of southeastern California, is characterized by bare mountain ranges, separated by nearly level arid belts of varying width. The minor ranges of mountains rise abruptly from the desert plains, having the appearance of being the summits of larger ranges whose bases are buried beneath the loose deposits of the desert. The principal range of Riverside County is that known as the San Bernardino Mountains, the principal summits of which are San Bernardino and San Gorgonio, measuring respectively 10,630 and 11,485 ft. in altitude. This range is flanked on the southwest by the broad valley and plain of western San Bernardino County which terminates to the southeast in the narrow valley known as the San Gorgonio Pass, the summit level of which at Beaumont, measures 2570 ft. South of San Gorgonio Pass is the lofty range of southeast trend known as San Jacinto, with its lofty peaks, San Jacinto and Tahquitz, measuring respectively 10,805 and 8825 ft. in altitude. To the eastward the slopes of the San Jacinto Range decline rapidly toward

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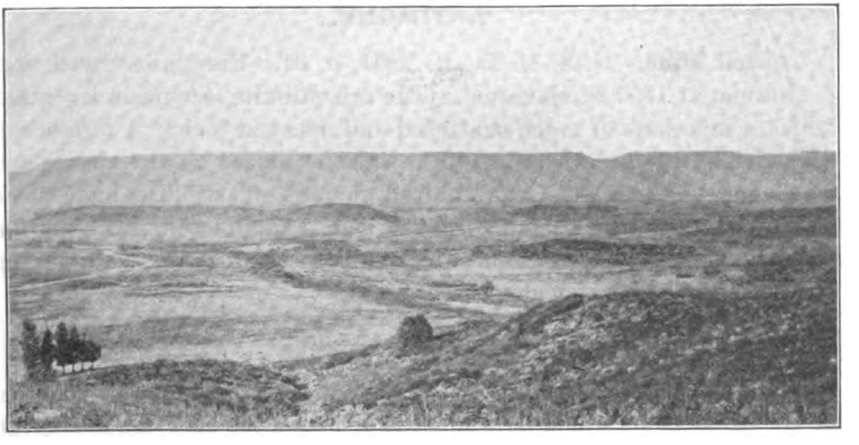
the plain known as the Coachella Valley and desert, Coachella being the corruption of the old Spanish name Conchilla. To the southeast, the Coachella Valley terminates in the Salton Sink, which has been carefully mapped by the U. S. Geological Survey and has been discussed in our report on Imperial County.

Central Riverside County is marked by several small desert plains. One of these, south of Riverside and west of Perris, is a striking topographic feature. This and others are clearly shown on the U. S. G. S. topographic map known as Southern California Sheet No. 1, to which the reader is referred for further detail.

GEOLOGY.

The geology of Riverside County has not yet been studied in detail. The first careful reconnaissance made through this region was in the latter part of the year 1853, when Professor William P. Blake, as geologist of the expedition under Lieutenant R. S. Williamson to determine a route for a transcontinental railroad, traversed the San



Santa Rosa volcanic plateau from Murrietta Hot Springs, Riverside County.

Gorgonio Pass together with the Coachella Valley and the Salton Sink. The important results of this work are published in Vol. V, of the reports of the expedition, issued as Senate Document 78, of the 33d Congress, 2d Session. But little geologic detail of interest escaped the notice of this keen observer. In 1892, Mr. Harold W. Fairbanks, under the auspices of the State Mining Bureau, made a careful geologic reconnaissance of San Diego and Orange counties, the former of which then included most of Riverside County. His results are published in the XIth Report of the State Mineralogist, pp. 76–120. To this report the

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reader is referred for much interesting detail. See also "Guide Book of the Western United States," Part C, the Santa Fe Route, U. S. Geological Survey, Bull. 613.

MINERAL RESOURCES.

The mineral resources of Riverside County are varied and of material importance, having amounted in 1914 to $1,579,586.[1] But it has never been a large producer of metals, and, as the figures show, its chief mineral wealth lies in nonmetallic products. The details of the deposits from which these are mined are given in the following pages.

METALS.

The metals which have been produced in this county in sufficient quantity to be recorded in its statistics are gold and silver. Iron is known to exist in very large deposits, which could be mined successfully if industrial conditions were more favorable. Copper, manganese, and tin are also known to occur in limited quantities.

ANTIMONY.

Crowell Mine. C. S. M. B., R. XIII, p. 31. Five miles southwest of Corona, at 1700 ft. elevation. The ore, stibnite, occurs in irregular bunches in a mass of much shattered and decayed rock. A number of superficial cuts have been made at various places on the claim, and from one of them several hundred pounds of stibnite have been taken out. The workings had caved, and a satisfactory examination was impossible. The ore found was of excellent quality. J. Irving Crowell, of Corona, owner.

COPPER.

This metal is rather widely distributed in Riverside County, and the principal deposits, which lie well eastward towards the Colorado River, were briefly described in Bulletin No. 50, from which some of the following descriptions have been taken.

Thus far, there has been only a nominal production of copper, the total for 1914 aggregating but $4802.

Badger State Group. See Bull. 50, p. 337. Ten claims in the east slope of the Ironwood Mountains. Granite is the country rock. There are a vast number of stringers from 6″ to 4′ wide, the walls being of porphyry and limestone. The ore contains copper, gold and silver. There is much iron in these claims. About 300 feet of development work has been done in open cuts, shallow shafts, etc., which reveal

[1]See C. S. M. B., Bull. No. 70, pp. 98–99.

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good ore. Owned formerly by S. P. Cressinger, Los Angeles, but now in the Crescent Group.

Randolph & Hamilton Claims. These consist of 2 groups and 7 claims in Santa Maria Mountains. The deposits consist of copper and chromic iron, and some gold, at an elevation of about 1750 feet. A shaft 21 feet deep has been sunk and 4 or 5 cuts made. The copper value is 7% to 8%. Iron largely predominates. There is much limestone as country rock, and some porphyry. Former owners, Randolph & Hamilton, Ehrenberg, Arizona. The claims are now held by Floyd Brown, Blythe City.

Anderson Claims. There are 26 claims in this group, located in the northern part of the county. The strike is northwest. The ore carries copper with a little silver and the veins vary from 2′ to 6′ in width. The hanging wall is granite. A shaft 80 feet deep has been sunk and a tunnel 100 feet long driven, with considerable other development work in shafts, etc. Six men were employed. Anderson & Co., owners. These claims are probably in the Monte Negro District. They lie in T. 2 S., R. 12 E.

IRONWOOD OR McCOY MOUNTAIN DISTRICT.

This district contains a mineralized zone of copper, silver, gold, and lead ores. High grade sulphide deposits exist, principally in the form of kidneys. Besides these, native copper is occasionally met with. The district is 22 miles from the Colorado River and about 20 miles southwest of Blythe Junction on the A., T. & S. F. Ry.

Crescent Group. Ironwood or McCoy Mountains, 17 miles from Blythe, Secs. 19, 20, 29, 30, T. 4 S., R. 20 E. Forty claims, 3000 feet of tunnels and drifts. A total of $35,000 expenditure, $6,000 spent last year. Owner, Harwood Robbins, Riverside. Mr. Robbins has incorporated under the name of the Ironwood Mountain Mining Co., but the corporation at present holds no claims.

Mountain King Group. See Bull. 50, p. 342. Three claims on the east side of Ironwood Mountains. The country rock is porphyry and quartzite. The ledge is said to be 30 feet wide. The strike is northwest and southeast, and the dip northeast. The ore, which is azurite and malachite, contains besides the copper, both gold and silver. A shaft 40 feet deep has been sunk, and four open cuts have been made, all revealing good ore. Elevation 1800 feet. Owners, formerly, Adams & Cressinger, Los Angeles; now in the Crescent Group of Harwood Robbins.

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PALEN MOUNTAINS.

Orphan Boy Claims. See Bull. 50, p. 341. On the west side of the mountains, 2 miles south of Packard's well. Abandoned.

Fluor Spar Group. Bull. 50, p. 343. Three claims on the west slope of the Palen Mountains, one mile southwest of Packard's well. The country rock is largely porphyry and limestone. The ledge is said to be about 100 feet wide, and strikes northeast and southwest. The ore carries copper, gold, and silver. The copper occurs in azurite, malachite, and some cuprite. There are two open cuts 20 feet or more in depth. Elevation 1800 feet. The claims contain fluor spar, Iceland spar, and limpid quartz. Owner, Andrew F. Burleigh, New York.

Palen Copper Mines. C. S. M. B. Bull. 50, p. 341. Copper, Silver Glance, and Ophir claims. West side of Palen Mountains, 10 miles east of Palen well. Former owner, H. A. Adams, Los Angeles. Now abandoned.

Homestake Group. See Bull. 50, p. 341. There are 5 claims in this group, on the east slope of Palen Mountains, 8 miles northwest of McCoy Springs, at an elevation of 1600′ to 2350′, and 3 or 4 miles from the Orphan Boy and Ophir mines on the west side of the mountains. The claims are all on the same ledge, which is said to be 20′ to 50′ wide, and carries copper and silver glance, azurite, and malachite. The development work consists of two shallow shafts and three open cuts. Owner, Harwood Robbins, Riverside. Relocated, 1914.

Crescent Copper Group. Mr. C. A. Waring reports as follows: This group consists of five claims located in the north end of the McCoy Mountains in Secs. 29 and 30, T. 4 S., R. 20 E., S. B. M. About 50 claims were originally located but most of these have been abandoned. They are owned by Mr. Harwood Robbins, of Riverside. The claims are about 12 miles west of the main stage road from Blythe Junction to Blythe. Water has been obtained from the McCoy tanks which were supplied from Chandler's well. This well was dry when visited in November, 1914.

The copper is said to be present in the form of cuprite and chalcocite. The lode, varying in width from 4′ to 8′, pinches out in places. The country rock is schist. Considerable work has been done on the property, it being claimed that 3000 ft. of tunnels and drifts have been driven. It is said that in no place has work been carried to a greater depth than 160 ft. The assessment work is done by the two Goldburg Bros. of Blythe City. Although it is said that some of the ore ran as high as 35% copper, the average is rather low. Some coarse gold running as high as $8.00 to $10.00 per ton is said to accompany the copper values. The McClure claims in the Little Maria Mountains to the north are reported as showing a good grade of copper ore.

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Other Prospects. Numerous low grade copper deposits are reported in the Big Maria Mountains, east of the United States Gypsum claims. Only prospecting and assessment work has so far been done in the region.

About 1½ miles south of the Crescent Group is the **St. John Mine,** owned by R. L. Kennedy, of Los Angeles. A 75 ft. incline shaft has been sunk. Some of the ore is said to have smelted 41% copper.

GOLD.

This precious metal is sparsely and widely distributed in Riverside County and many gold mining districts have been recorded, few of them, however, with any large production.

While the geologic occurrence of gold varies greatly in this county, the geographic distribution may be discussed under two principal heads.

I. The region near Perris and Elsinore.

II. The eastern desert area between the San Bernardino Range and the Colorado River.

PERRIS GOLD MINES.

Gold has been sought for and mined in this section of Riverside County since an early date, and there is evidence that Americans operated here in the early years of California's statehood.

Miners who worked here 40 years ago say that, at that time, in Cottonwood Cañon, was an old arrastra bottom in which was growing an elder tree 12 inches in diameter. On Redtop Mountain, in T. 6 S., R. 3 W., was found a location notice dated 1857.

In 1876 there was some excitement at Binkley's diggings in Sec. 2, T. 6 S., R. 4 W., near the junction of Cottonwood Cañon with that of the San Jacinto River. There was also activity at Tyler's diggings in Sec. 10. About 1880, Mexicans were working gold placers between the Good Hope Mine and the San Jacinto River.

W. H. Storms, who visited this region in 1894, writes as follows:* "An ancient river-bed may be traced for a long distance north and south in this vicinity. The source of this old channel, which bears gold, is to the north, but its exact locality is unknown. The main channel may, without difficulty, be followed from 2 miles north of the Good Hope Mine for several miles southward toward Elsinore."

Much work has been done at intervals in this area, but the production has not borne out the original promise.

In the more systematic operations on quartz veins which followed, the Good Hope was the chief producer with a record of some $2,000,000. The Gavilan mines also achieved substantial production.

*C. S. M. B., R. XII, p. 220.

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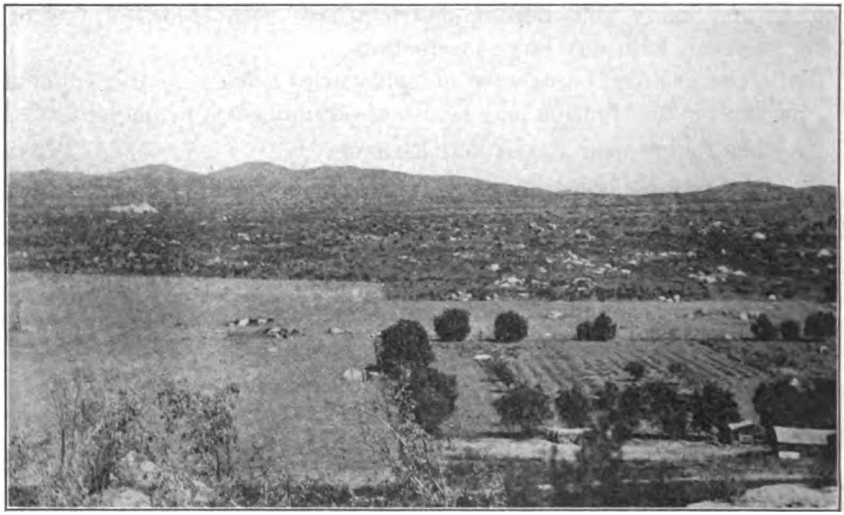
THE GAVILAN MINES.[2]

About 6 miles west of Perris, on the old Rancho El Sobrante de San Jacinto, owned by an English syndicate, is a plain some miles in area known as the Gavilan.

The country rock is diorite and is cut in many directions by intrusive dikes of pegmatite which contain little muscovite, but black tourmaline is abundant in them, and frequently was accompanied by the gold-bearing rock. Here, were many veins of moderate size, but of good grade, and, on these veins were the Gavilan mines which, years ago,



Gavilan Flat, looking north from Jumbo mine. Tailings dump of Gavilan mine to left in background.

produced considerable gold, the rock being crushed in numerous arrastras, of which the beds, to the number of 50 or more, were scattered about the neighborhood. It is said that the Mexicans, at one point, worked a large shoot down to water level, and judging from the old dumps, the old workings must have been of great extent. In later years, under American management, the ore was hauled to a stamp mill in the Pinacate District. At the time the ranch became the property of the San Jacinto Estate, Ltd., of London, nothing had been done here for many years. Between 1890 and 1892, the old workings were carefully examined and a company was organized at Riverside to operate some of them under lease. A new shaft was sunk 180 feet, and a substantial production was achieved. No work has been done here for some time, the old mill having been sold and taken to Mexico. The local representatives of this British syndicate have offices at Arlington.

[2]C. S. M. B., R. XI, pp. 336-337; XIII, p. 311.

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PINACATE DISTRICT.

About 4 to 6 miles northeast from Elsinore, and about 5 to 8 miles west and southwest from Perris, on the A., T. & S. F. Ry., are the mines of the Pinacate District, named from a small settlement which, before the railroad was built, stood a little south of the site of Perris.

This is largely an area of granitic rocks, succeeded by diorites in the vicinity of the Good Hope Mine. Northeast and east of Elsinore are metamorphic rocks determined on an irregular east and west line by bodies of granite which inclose portions of the schists, and extend into the main body in long, dike-like spurs. In the vicinity of the Good Hope Mine, the metamorphic rocks inclosed in the diorite have a north and south strike, and are traceable for a mile or more.

There are numerous small springs in the district, but timber is very scarce.

In early years this district produced a large amount of gold, the quartz having been worked in arrastras, of which over a hundred beds were formerly visible.

Between 1876 and 1882 much active mining was done here and a substantial production was achieved.

At present, with the exception of the Lucky Strike, all mines are idle and inaccessible. Therefore, little can be predicted about the future of this district. Many of the owners have full faith in their properties and expect to resume work when financial conditions improve.

Santa Rosa: See R. VIII, p. 526; XI, p. 385; XII, p. 225; XIII, p. 314. In the northwest quarter of Sec. 31, T. 4 S., R. 4 W., is the old Mina Rosalia, later called the Santa Rosa, which was opened along the surface by cuts and shafts for over 1000 ft. The upper portion of the vein is said to have been worked out many years prior to 1892, when new capital was interested and a new shaft was sunk at the north end of the property. The vein was about three feet wide and the country rock on either side of the vein was soft and decomposed, requiring much timber. The mine has produced a large amount of gold, extracted at first in arrastras, and later in a 20-stamp mill, which still stands at the mine, but in poor condition. It was understood that, at the north end, the shoot of pay rock was still intact, and it was to recover this that new work was inaugurated in 1892. The balance of the shoot to the south was said to have been worked out down to the water level, at a depth of about 200 ft. At present there is water in the mine and the workings can not be examined. Owners, Hook Bros., Perris.

Golden Chariot: See R. XIII, p. 311. South extension of Santa Rosa. Elevation, 2360 ft. Shaft, 310 ft. One level near bottom. Vein strike N. 10° W., dip 55° SW. Owners, C. L. French and J. M. Day, Redlands.

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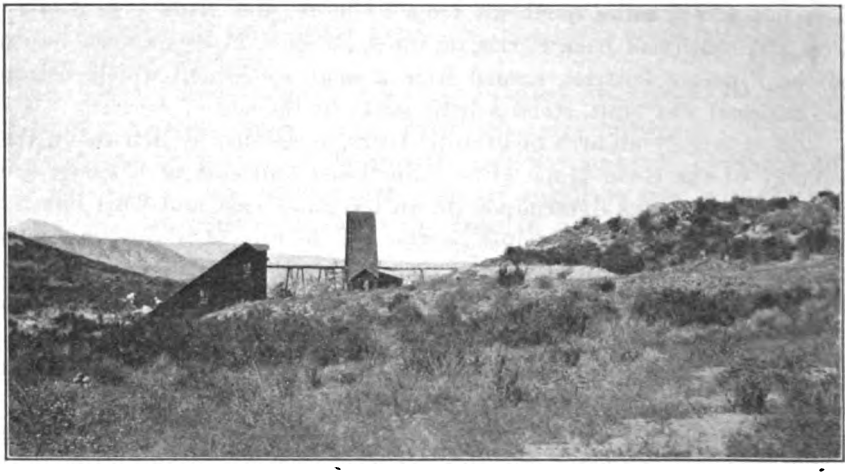
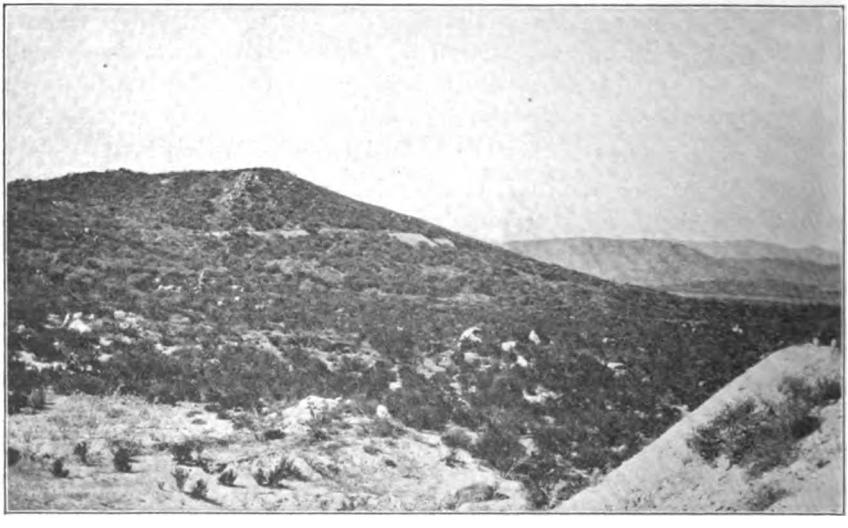


Santa Rosa Mine, looking west.



Santa Fe Mine, looking southwest from the Santa Rosa.

Jumbo: See R. XIII, p. 312. Here a 2200-foot vein, parallel to that of Santa Rosa, and 300 ft. east, strikes N. 10° W., and dips 80° SW. The workings consist of one 50-ft. shaft. Owner, E. A. Bethurum, Redlands.

Santa Fe: See R. XII, p. 224; XIII, p. 314. One-third of a mile southwest from the Santa Rosa, is the old Santa Fe Mine, which in days past was a producer of gold, but its workings have long been abandoned. The strike of the vein was nearly east and west. A cross-cut tunnel was driven 700 feet into the hill to cut the vein, and appar-

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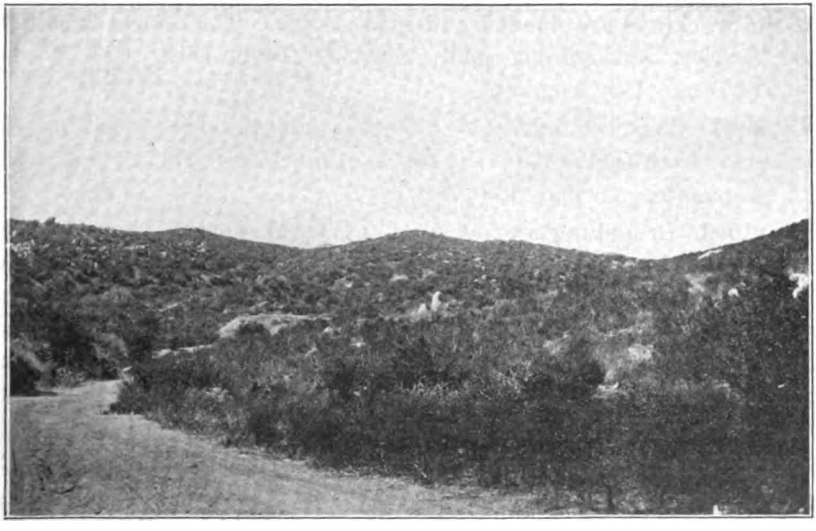
ently intersected the latter at about 500 feet. The 5-stamp mill, formerly in use, has been removed. Owners, R. Woods & Son, Auburndale.

Perris: See R. XIII, p. 313. Elevation 2200 feet. Sec. 31, T. 4 S., R. 4 W. Vein strikes W., dips 80° S., shaft 60 feet, 25-foot drift runs east from bottom of shaft. It is a heavy fissure in granite, accompanied by a dike, but carries little quartz. Owner, W. F. Dray, Forestville, Placer County.

Little Pete: See R. XIII, p. 312. Elevation 2000 feet. Near the Perris claim. Thirty-foot incline on a small east and west vein, containing arsenical pyrites. Owner unknown.

Indian Queen: See Report XIII, p. 311. NW. ¼ Sec. 32, T. 4 S., R. 4 W. Vein strikes northwest; dips 70° SW. Shaft, 65 feet. Owner, — Morrison, Goldfield, Nev.



Surface view of Indian Queen and Little Maggie claims.

Little Maggie: See Report XII, p. 223; XIII, p. 312. Adjoining Indian Queen on the southwest. On several small veins in diorite. Strike east; dip 45° S. Quartz high grade. Crosscut tunnel to cut vein at 40 feet. There are many other claims nearby on similar fissures. Formerly owned by — Hasson, of the Los Angeles Times.

Colorado or **Justice:** See Report XIII, p. 310. In SW. ¼ of Sec. 32, T. 4 S., R. 4 W. Vein small; quartz high grade. Owner, J. Boyer, Perris. The mine is on his ranch.

Steele Mine: See Report VIII, p. 527; XI, p. 284; XIII, p. 314. In SE. ¼ of Sec. 32, T. 4 S., R. 4 W., is the Victor Mine, formerly "El Plomo," and better known as the Steele Mine. The vein is in metamorphic rocks, the footwall containing much quartz and biotite mica.

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The hanging wall is a dark gray diorite, quite fine-grained in texture, containing much hornblende. Small pegmatite dikes cut the formation in all directions. Black tourmalines are numerous in the pegmatite. The vein is described as a foot or more in width, of highly crystalline quartz, in which were disseminated small amounts of iron and lead sulphides and lead carbonate. The ore was quite rich in gold. A tunnel 900 ft. long was driven to develop the vein, on which an incline shaft had been sunk to a depth of 200 ft. Besides this work there are numerous superficial workings, in which quartz of good grade was exposed. No work has been done here for many years. Owner, un known.

Missing Link: (Virginia-Shay) See Report VIII, p. 526; XI, p. 385; XII, p. 225; XIII, p. 313. Six miles west of Perris, in NE. ¼ of Sec. 32, T. 4 S., R. 4 W. Several holes have been sunk on the vein but the workings are flooded and inaccessible. The quartz is said to have carried considerable gold. Owner, Hugh Duff, 626 Wesley Roberts Bldg., Los Angeles.

C. & C. Consolidated: See Report XIII, p. 310. West of the Virginia. Elevation 1800 ft.; 150-ft. tunnel and shaft, and small vein in granite. Owner, unknown.

Stanford: Branching and overlapping fissures in massive eruptive rock. Veins or shoots irregular and best developed at the intersection of fissures or in veinlike masses between fissures. Sometimes the veins are closely parallel in a zone. Then the whole mass may be mined. Shaft, 125 ft. A crosscut tunnel meets the shaft at 70 ft. from surface. Five-stamp mill. There are many prospects near the Stanford. Owner, Mark Herrin, Riverside.

Ophir Mine: Now Lucky Strike. See Report XIII, p. 313. After having lain idle for some years, work has been recently begun on this property. Owners. W. Newport and F. Whiting, Ethanac. See photo, p. 74.

Gold Prince: North Extension of Good Hope. This property is of old record, but is now unknown.

Good Hope Mine: See Report VIII, p. 527; R. IX, p. 151; R. XI, p. 106; R. XII, p. 221 and R. XIII, p. 311. About 4½ miles southwest of Perris in NW. ¼ Sec. 15, T. 5 S., R. 4 W.

The veins of this mine strike N. 14° E., and dip 65° W. They are in a dike of light colored biotite gneiss. The mine is in gray diorite. The hanging wall is largely of mica schist. Near the surface are several veins from 3′ to 20′ apart. These, in depth, appear to unite. The fissure in places contains a heavy clay gouge, the result of continued movement and the crushing of the rock adjacent to the fault plane. The vein quartz shows clearly the effect of this movement by its fractured condition, and the subsequent infiltration of carbonate of

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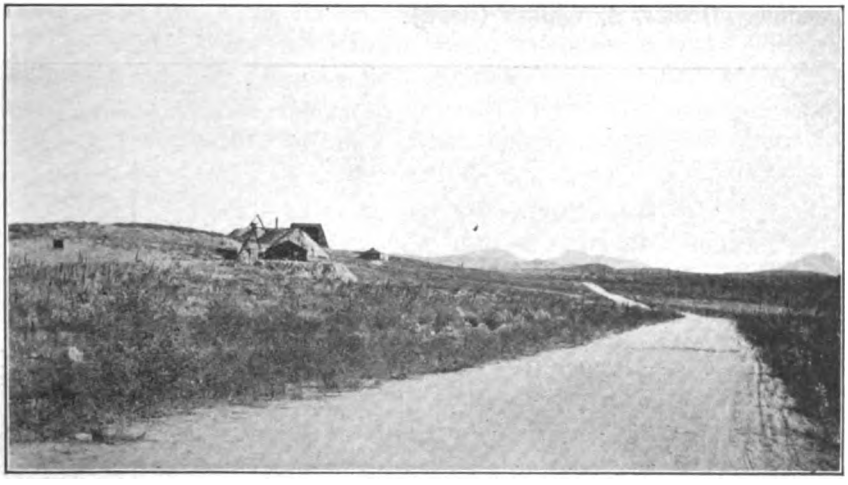
lime into the interstices thus formed. This renders much of the quartz friable, and it usually crumbles on exposure. The vein commonly appears as two separate bands of irregular width.

The fissure was a double one, a vein of quartz forming in each branch. The footwall vein at some points contains very high grade ore, carrying finely disseminated iron sulphide. The quartz was free milling, though ordinarily carrying more or less auriferous iron sulphide of high grade.



Good Hope Mine, looking north.

A 20-stamp mill was built here and operated, but only part of the equipment remains. This mine has not been actively productive for some years, though some work has been done within two years. Owners, Hook Bros., Perris. It is now under lease to the Good Hope Mines Co.; president, E. Groenendyke, 301 Story Bldg., Los Angeles; J. J. Abramson, secretary and manager, 612 San Fernando Bldg., Los Angeles.

Metifee Mine: See R. XI, p. 385; XIII, p. 312. Elev. 1500 feet. This mine is located about 8 miles south of Perris. The vein consists of quartz, gold-bearing in places. The footwall is chloritic schist, beyond which is diorite. The hanging wall is diorite, the hornblende having changed partly to chlorite. The vein is from 1 ft. to 30 in. wide, and strikes northeast, dipping 80° NW. to a depth of 40 ft., where it flattens out to 65°. The quartz is said to have milled about $15.00 per ton, and contained but a small percentage of sulphides. There are four shafts on the vein; 30′, 55′, 100′, and 125′, the main shaft being 5′ x 11′ with 2 compartments. There is a steam hoist and a 5-stamp mill. Owner, Tom Chaffin, at the mine.

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Lucky Boy (Walker) Claim: See Report XI, p. 385; R. XII, p. 223; R. XIII, p. 312. On the Walker Ranch, 2 miles south of Menifee, and 1 mile northeast of the Menifee Mine. In 1892 a new quartz vein was discovered on a low mound at the base of low, rolling hills. The vein was 4″ to 1′ in width, heavily mineralized, but much broken. Two distinct faults occurred in a length of 90 feet, where the vein was exposed. Two shafts of 50′ and 60′ were sunk. The rock would pan out about $40.00 per ton, but too small an amount of work has been accomplished to make any estimate of the value of the vein possible. Owner, S. Walker (dead).

Lucky Strike Mine (formerly Ophir), looking south.

Alice: See Report XII, p. 221; R. XIII, p. 310. Altitude 1500 feet. A 12-ft. incline shaft cutting vein 20 ft. Five-stamp mill. Four miles south of Menifee. Estate of J. M. S. Egan.

Mammoth: See Report XIII, p. 312. Elevation 1600 ft. Nine miles south of Perris in Sec. 8, T. 6 S., R. 3 W. Vein averages 7 ft. in thickness, ranging from 4′ to 10′. Strike northeast, dip 15° NW. The croppings are exposed 400 ft. around the side of the hill. Superficial cuts were made at various points. At the end of a 100-ft. cut is a 200-ft. incline on the vein. Crosscut connects with air shaft, 60 ft. to surface. The country rock is grano-diorite. The quartz of the vein is evenly impregnated with pyrite and shows free gold. Owner, A. A. Adair, of Riverside.

Leon: See Report XII, p. 223; R. XIII, p. 312. On Briggs ranch in NW. ¼, Sec. 18, T. 6 S., R. 3 W. The ore is in a quartz vein 1′ to 2′ thick, strike northwest, and dip 85° SW. There is a shaft

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150 ft.; also crosscut tunnel 25 ft. toward vein, lower down hill. This is a promising prospect. There is no mill. Owner, Chas. Briggs, Los Angeles, address unknown.

SAN JACINTO MOUNTAIN REGION.

Mr. C. A. Waring reports on this as follows:

The Hemet Belle Mine. The Hemet Belle mine is located at an elevation of 5000 ft. in the San Jacinto Forest Reserve, in Sec. 31, T. 6 S., R. 4 E., S. B. M. It is accessible by automobile road from Hemet to Kenworthy, about 25 miles. The mine is at present worked part of the year by Mr. E. E. Chilson, of Kenworthy. It is equipped with a 5-stamp mill. Water is obtained from a mountain spring. The gold is in quartz veins in gneiss which occurs in contact with granite. The veins are seldom more than 6″ to 8″ wide, and the average value of the ore is $15.00 to $20.00 per ton. Some high values are said to occur in pockets.

GOLD MINES OF THE EASTERN DESERT.

The desert area of central and eastern Riverside County has an average length from west to east of about 100 miles and a width from north to south of about 45 miles.

In many of the mountain ranges which, here and there, rise above the desert wash, which has filled the intervening valley, are exposed metalliferous veins carrying gold, copper and silver-lead. Gold is the more frequent metal in its occurrence and is found at many points, though, up to the present time, no great production has been achieved.

The mineralized areas or districts, which have been worked at times, are as follows, it being remembered that a mineralized area is necessarily in a mountain range.[3]

Piñon Mountain.
Monte Negro or Twenty-nine Palms District.
Eagle Mountain.
Chuckawalla or Hathaway Mountains, Chuckawalla District.
Hodges Mountain or Palo Verde Mountains.
Palen Mountains.
Ironwood or McCoy Mountains, Ironwood District.
Santa Maria Mountains.
Arica Mountain District.
Riverside Mountains, Bendigo District.

PIÑON MOUNTAIN DISTRICT.[4]

The mines are 12 to 14 miles northeasterly from Indio, about 5000 ft. above sea level. The more prominent veins have a northwest strike and variable dip. They are in branching fissures of a type common in

[3] A number of the properties mentioned in the Reports of the State Mining Bureau as being in this region have long been abandoned and are now forgotten.
[4] R. XII, p. 224; XIII, p. 313.

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massive rocks such as granite.[5] From the several claims of this group some very high-grade rock has been taken, which was crushed in a 2-stamp mill a mile from the mines. The deepest work on these veins is 70 ft. from the surface. Tingman, of Indio, owner.

The Hexahedron Mine: See Report XII, p. 223; XIII, p. 311. Seven miles northeast of Piñon Mountain, 25 miles northeast of Indio. The ore is in a mineralized felsite dike, which strikes nearly east and west. At the west end it is small (not over 4 ft.), but widens toward the east. The ore shoot lies in a hillside. It is 75′ long, 15′ to 20′ wide, and dips 45° N. At the place where gold was found, it lies exposed along the north slope of the hill, the overlying rock having been eroded. Dikes of green diorite, much decomposed at the surface, cut the felsite and adjacent rock irregularly and, in this vicinity, the felsite contains gold. Iron oxide, copper carbonate and dendritic infiltrations of manganese oxide are the indications of mineralization. Portions of the rock are spangled with small points of gold. In the vicinity of this mine are some prospects on which a few holes have been sunk. Owner, Indio Mining and Milling Company; president, J. S. Garrison, Victorville; Roy Garrison, superintendent at mine.

Lost Horse Mine (Field No. 24): See Report XII, p. 223; XIII, p. 312. This property is in Sec. 31, T. 2 S., R. 9 E., 19 miles north and a little east of Indio in a direct line, and about 28 miles by wagon road and seven miles north of Piñon Mountains, at altitude 5000 ft. The vein strikes east and west and dips 85° N. It cuts through laminated micaceous quartzite, which strikes north and south. Occasional dikes of granite are present, but the vein cuts all the other formations. It is exposed at several points for a distance of 800 ft. along its course. Its width varies from 6 in. to 5 ft., and exhibits an overlapping tendency, the footwall becoming the hanging wall of the next shoot below. The workings consist of an 80-ft. tunnel, a 50-ft. winze and a 50-ft. drift, east from the bottom of the winze. Most of this work is in good rock. There is also a vertical shaft 235 ft. deep. Between 1890 and 1900 about $350,000 were produced. With more abundant water and a larger mill, this property, which consists of two claims, might become a large producer. Owner, J. D. Ryan, Union Oil Bldg., Los Angeles.

MONTE NEGRO DISTRICT.[6]

This is near the north boundary of Riverside County, in R. 12 E. This mining district was organized about 1890 and considerable development work was accomplished by the claim owners. At present little if anything is being done.

[5] W. H. Storms, Bull. 18, pp. 22-26; Min. & Sci. Press, May, 1906, p. 348.
[6] R. XI, p. 368; XII, p. 224; XIII, p. 313.

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The Monte Negro camp was on the south side of the range of hills 45 miles northeast of Mecca Station, 20 miles north of Eagle Mountain, and about 6 miles south from Virginia Dale. It is 35 miles south from Cadiz Station on the Santa Fe. The mineral belt is about 1½ miles wide and 5 miles long; the veins trending north and south.

This district has attracted much attention through the discovery, on one of the claims, of masses of gold-bearing quartz of extreme richness.

From Mecca Station, 189 ft. below sea level, the road ascends till, in 27 miles, a divide is reached near Cottonwood Springs, at an altitude of 3157 ft. Thence it again descends 19 miles to the foot of the wash, which extends 2 or 3 miles from the base of the mountains, where the altitude is 1300 ft. The altitude at the camp is 1520 ft. The mines lying back in the mountains are at higher, though varying altitudes, the greatest elevation being 3500 ft., at the Ramona or Ingersoll mine. Neighboring peaks rise from 200′ to 800′ higher.

The rocks exposed in the Monte Negro uplift are chiefly eruptive, diorite, quartz porphyry and fine-grained porphyritic rocks, cut by later dikes of felsite and a dark green or black eruptive.

Epidote occurs abundantly throughout the region, usually associated with micaceous iron ore, which occurs everywhere in veins and bunches. This iron ore contains no precious metals, and is of no economic importance.

The region although entirely eruptive and in part volcanic (large fields of basalt occurring on the western slope) is in the immediate vicinity of a mountain called Pinto, or Painted, composed of metamorphic strata, chloritic and hornblende rocks, quartzite and mica schist predominating.

The mineral veins of the Monte Negro District are all of the fissure type, and are simple in form. The gangue is quartz, carrying iron and copper sulphides and their secondary products, iron oxide and copper carbonate, together with gold and silver. No lead or zinc was observed. The value of the ore lays in its gold content, silver occurring very sparingly and the bullion from this ore was worth about $17.00 per ounce. The ore ranged in value from $20.00 to $100.00 per ton.

Wood was not obtainable in the vicinity of the mines and water was scarce, but was obtained by sinking a well in a basin near Virginia Dale, a few miles north, where there are 2 mills. In the wash, 3 miles south of the most southerly Monte Negro mines, a shaft was sunk 140 ft., but no water was obtained. Bedrock was not reached at that depth, and it is probable that water may be secured by continuing this shaft downward. On the south, the nearest water is 22 miles away at Cottonwood Springs, where the ore has been worked in an arrastra.

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The principal mines of this district which is now idle, were the Great Eastern, Venus, Columbus, Summit, Porcupine, Schiller, Hillerman, Annie Rooney, Ethel, Republican, Ramona, McKinley Bill and Revenue. Few men now remember these properties.

Ingersoll (Ramona): See Report XIII, p. 313. Vein stated to strike north and south, nearly vertical, and 1′ to 3′ wide. Shafts 40 ft. and 80 ft. deep. Former owners, Elser Ingersoll et al., San Bernardino. Not known at present.

O. K. (McKinley Bill): See Report XIII, p. 313. Vein in diorite, 1′ to 4′ wide. Two shafts, 30′ and 40′ deep. Ore hauled to Virginia Dale mill. Owner, Elser Ingersoll et al. of San Bernardino. An old mine now forgotten.

S. S. Mine: See Report XII, p. 224; XIII, p. 314. This was in the Monte Negro region, 4 miles south of Virginia Dale, discovered during 1894. It has produced some very high grade ore. T. R. Lyon, of San Bernardino, former owner. Now forgotten.

Gold Galena Mining Co. Near the south boundary of San Bernardino County, is the property of this company. They have offices at 230 Douglas Bldg., Los Angeles; president, F. C. Longnecker, 6016 Romaine avenue, Los Angeles; secretary, B. A. Straus, and manager, C. E. Stead. The properties are nine claims in Secs. 4, 8 and 9, T. 3 S., R. 9 E., S. B. M. The feature of this ground is a vein of substantial width which contains galena carrying gold. The workings are down from 70′ to 100′. There is no mill and no bullion has been produced up to date.

New El Dorado Consolidated Mining Co. This comparatively new company is operating in Sec. 17, T. 3 S., R. 10 E., S. B. M. Little more than assessment work has been done and no production has been attained. The company has an office in the Central Building, Los Angeles. Mr. Fred Vaile is manager.

CHUCKAWALLA DISTRICT.

The Chuckawalla Mountain Range lies in T. 5 to 8 S., R. 15 to 19 E., S. B. M. It was formerly known as the Hathaway Range, and is so named in the early reports of the State Mining Bureau. Its present name is a corruption of Chuckwalla, the Indian name of a lizard which frequents these hills. In its northwest portion lying in T. 5 to 7 S., R. 15 and 16 E., S. B. M., is a mineralized area in which gold, copper and silver-lead occur and where prospecting and mining have been conducted on a limited scale for many years. It was once known as the Pacific Mining District and, in the Xth Report, pp. 900–901, are some notes on it by C. R. Orcutt, made during a visit in 1888, at which time it was in San Diego County. In these notes are mentioned

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a number of properties, and Mr. Orcutt's descriptions are here given in abbreviated form, though the claims are mostly forgotten:

"**Sunnyside**: Ore iron-stained quartz, with argentiferous galena, said to have average $50.00 per ton in gold and silver. A 20-ft. shaft was sunk on the vein. The mine was owned by Hendsch & Frederick, of San Diego, but it is now abandoned.

"**Opulent**: An extension of the Sunnyside. From this mine came the first specimens of wulfenite, recorded from San Diego County. A little galena occurs here. Once owned by Milton Santee, of San Diego, and W. F. Hendsch.

"**Golden Rule**: A claim worked years ago with good results; 50 ft. shaft. Malachite and chrysocolla occur here.

"**Red Cloud**: So named from the abundance of cuprite. A 30-ft. shaft was sunk, and a tunnel commenced.

"**Alice**: Ore contains an abundance of chrysocolla. It was said to carry both gold and silver in paying quantities. Owned by Santee and Hendsch.

"**Champion**: A blind lead of good promise. It yielded gold, silver and lead in paying quantities. Argentiferous lead ores and also wulfenite were characteristic here.

"**Great Western**: A ledge 50 ft. or more in width yielding an average of $20.00 per ton in gold, with a trace of silver. The Keystone, Blackbird and Monarch claims are on similar veins."

In the southern part of T. 6 S., a cañon traverses the range from southeast to northwest. In and near it are a number of mining properties, and 3 miles from its northwest end are Mill Springs, near which are several of the claims described by Orcutt. About 10 years after his visit, some 40 claims in this area were taken over by the Red Cloud Mining Company, of which S. P. Cressinger was president. Several of these are now held by J. M. Huston, of Los Angeles, under the name of the **Redhead Group**, which includes the Great Western, White Wing, and Red Head.

Sterling: See Report XIII, p. 314. Considerable superficial work, and a 10-stamp mill. Former owner, Sterling Mining Company, Los Angeles. This was once a part of the Red Cloud Group. The mill was later moved to the Lost Horse Mine, in the Piñon District.

About 2 miles from the east portal of the cañon are the well known **Corn Springs**, at present held under a placer location by J. M. Huston, of Los Angeles. About 2 miles south of Corn Springs is the Bryan Mine, which was operated from 1898 to 1900 by Adams & Pickering, the ore being treated in a two-stamp mill at Corn Springs. It now belongs to J. M. Huston.

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One and a half miles southwest of Corn Springs are claims once operated by the **Happy Jack Mining Company** and the **Chuckawalla Mining Company**, and now controlled by Dr. Wood, of Long Beach, and H. I. Seward, of Los Angeles. The ore from these properties was treated from 1896 to 1898 in a small rotary mill. Development here reached a depth of 300 ft.

Coffee: See Report XIII, p. 310. Chuckawalla Mountains, 4 miles west of Corn Springs. The vein strikes northwest. Shaft, 56 ft. on 18 in. vein at northwest end of claim. This was worked jointly with the Richey Mine. Former owners, Coffee & Co., Salton.

Bankers Group: About one mile south of the Coffee and Richey mines are the claims of the Bankers Mining Company, of Los Angeles. President, A. A. Irish, 402 Grosse Bldg., Los Angeles.

Near the northwest extremity of the mountain range, in Sec. 35 or 36, T. 5 S., R. 15 E., is the **Granite Mine**, on a vein trending north and south. This mine, having been worked at intervals for several years and having passed through the hands of several owners, now belongs to Silas Masters, of Riverside.

A few miles east, on the north slope of the mountain, some surface springs have been gathered into what is known as the Granite Tanks.

San Diego: See Report XII, p. 224; R. XIII, p. 313. This mine is on the same vein as the Granite adjoining it on the southeast. The rock is of high grade, heavily oxidized. Former owner, E. E. Bowles, of San Diego.

Boulder: See Report XIII, p. 310. This claim is in the Chuckawalla Mountains, at 2000 ft. altitude, about one mile west of the Granite Mine. The veins strike north and south and dip nearly vertical. There are three shafts: 30′, 50′ and 100′, also a tunnel 200′ on the vein, and open cuts. Formerly owned by the Boulder Mining Company, of Los Angeles. This mine gave its name to the Boulder well in Sec. 31, T. 4 S., R. 16 E., S. B. M., now held by the Southern Pacific Railroad.

Lane: See Report XIII, p. 312. A prospect on Chuckawalla Mountain, with superficial development. It lies between Granite Mine and Corn Springs, about 4 miles northeast of the latter. The quartz was treated in an arrastra. Former owners, Lane & Son, of Salton.

Throughout the rest of the Chuckawalla Range, in a distance of some 20 miles, no deposits of any interest have been opened.

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HODGES MOUNTAIN.

The next mineralized area to the southeast is in Hodges or Palo Verde Mountain, which lies in T. 7 and 8 S., R. 21 E.

The following properties are in this mountain:

	Owner.
Double Eagle	Justus Smith, Palo Verde
Palo Verde Group	Justus Smith, Palo Verde
Punch	A. P. Wiley, Palo Verde
Senate Mine	A. P. Wiley & L. A. Stanchfield, Palo Verde
American Flag M. & M. Co.	C. A. Ludden, Pomona

No production has been reported, and probably only assessment work has been done.

Dos Palmas, Gold Prospect near: See Report XII, p. 221. There are several gold claims 18 miles north of the old Dos Palmas stage station, which have been described as valuable prospects. The veins are of good size, and the ore of good grade. Water is obtainable within 6 miles of Cañon Springs. One of the claims is described as being on a ridge between two cañons 1500 feet apart. The vein is 3′ to 6′ wide, and the pay shoot 1′ to 3′. Two tunnels, one of 90′ and the other of 190′, have been driven on the vein.

Free Coinage and **Charity Mines:** See Report XII, p. 221; XIII, p. 311. There are two locations, made in 1893. They adjoin, about 5 miles north of Cañon Springs, 12 miles northeast of Dos Palmas, and 18 miles north of Durmid Station. The Free Coinage vein had 28″ of free-milling ore and a 6″ vein of quartz, containing galena and carbonate of lead, which carry some silver. E. E. Bowles, of San Diego, owner.

Fish: See Report XII, p. 221; XIII, p. 311. Six miles northeast of Dos Palmas and 12 miles northeast of Salton. Elevation 1000 feet, 90 feet of tunnel and other superficial work on a quartz vein. Two-stamp mill with gasoline engine at Cañon Springs, 6 miles from mine. Owner, A. C. Fish, San Bernardino.

Messenger: See Report XIII, p. 312. Eagle Mountain, 40 miles northeast of Mecca, vein 3′ to 4′ wide; shaft 100 ft.; drifts 50 ft. north and south. Owner, W. H. Bradley, Boyle Heights, Los Angeles. This is in the Iron Chief Group of claims.

ARICA MOUNTAIN DISTRICT.

Mr. Clarence A. Waring writes as follows:

The Gray Mine is located in Sec. 7, T. 2 S., R. 10 E., about 6 miles southwest of Blythe Junction, at an elevation of about 1500 feet. It is accessible by a rather sandy automobile road from Blythe Junction. When visited during the latter part of November, 1914, the mine was leased to "The Assets Realizing Mines Company," the president of which is Mr. J. V. Priest, Los Angeles Investment Bldg., Los Angeles.

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The mine is being actively worked with 10 men and preparations were being made to ship ore.

Work is being done on 2 different parts of the property. The upper workings consist of a 340-foot vertical shaft with about 700 feet of drifts along the strike of the quartz ledge which is N. 20° W. These workings are equipped with one 60 h.p. and one 25 h.p. Fairbanks gas engine, an air hoist and a 4-drill compressor. Compressed air is piped from this plant to the lower workings where 2 drills are used in drifting. It is said that these workings consist of about 300′ of drifting and cross-cutting and a 227′ winze.

The ledge on which the work is being done varies from 6″ to 2′ wide, and the average assay is said to be about $8.60 per ton. The ore is free milling down to 150 feet, below which sulphides predominate. The hanging wall and footwall are both of schist. Water is pumped from Brown's well about 4½ miles to the southwest. This well is 328 feet deep and is on the stage road from Blythe Junction to Blythe City.

The Brown Mines. Located on the same ledge as the Gray mine, the Brown mines adjoin it to the north and south. Mr. Floyd Brown's mine to the south has a three-stamp mill, and some of the free milling ore on the surface has been worked. Mrs. Floyd Brown's mine is located north of the Gray mine. The work at both the Brown mines has consisted mainly of assessment work. Mr. Floyd Brown resides at Blythe City.

SANTA MARIA MOUNTAIN DISTRICT.

A few gold prospects are reported in the Santa Maria Mountains. Between the "Little Marias" and the north end of the McCoy Mountains in the NW. ¼ of Sec. 8, T. 4 S., R. 20 E., some placering was done by the Crescent Copper Company in the early days.

THE BENDIGO DISTRICT (RIVERSIDE MOUNTAINS).

Mr. C. A. Waring reports as follows: The formations exposed in the northern part of the Santa Maria and Palen mountains are said to recur in the Riverside Mountains to the northeast. The latter mountains are said to consist of schists and limestones, which are folded and faulted to a considerable extent. They are said to be more mineralized than the mountains to the south.

The following groups are known:

Calzona Mines. The Calzona mines property, formerly known as the McKesson Group, was discovered in 1898, and includes 12 claims and 13 mill sites. These are located mainly in the S. ½ of Sec. 31, T. 1 S., R. 24 E., and in the SE. ¼ of Sec. 36, T. 1 S., R. 23 E. The names of the claims are the Sanborn, Contact, Golden Gate, Burke, Burke Extension, Saddle Rock, Copper Reservation, Globe, Copper Belt, Black Butte, Riverside, and Blackwell. The property is owned by Dr. Robert

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M. Vermilyea, of Redlands, president; F. C. Lee, of Vista, secretary-treasurer, and A. W. Martin, of San Diego.

In February, 1914, it was reported that 4 men were employed in mining on the property, and that several tons of ore had been shipped. The ore is said to have brought $60.00 per ton. The values of gold and copper are said to be in limestone along its contact with schist. The ledge is pockety and possibly the values represent picked ore. The ledge is faulted down against schist at a depth of about 1500 ft. The ore is mined by an 800-ft. tunnel and a 200-ft. shaft. Water is pumped about 2½ miles from the Colorado River to the east. The nearest railroad station and post office are at Vidal, about 6½ miles to the northeast. Good automobile roads lead from the mines, which are at an elevation of about 1200 ft., to the railroad stations at Vidal and Calzona.

The Jackknife Group. This group of claims owned by Messrs. Cal Morgan and H. D. Bradley, of Calzona, is located principally in Sec. 1, T. 2 S., R. 23 E., and Sec. 6, T. 2 S., R. 24 E. It includes the Combination, Combination Fraction, Jackknife Extension, Jackknife Nos. 1, 2 and 3, Margie, Single O, Betsy and other claims to the southwest in Sec. 1, T. 2 S., R. 23 E. They are at an elevation of about 1200 ft. and about 6 miles southwest of Vidal, the nearest post office and railroad station.

In February, 1914, it was reported that four men were employed, and that several tons of ore had been shipped to date, and that the ore brought $66.00 per ton. It is said that the gold is now recovered by chloriding. The values in gold and copper are in pockets along the contact of limestone and schist, which strikes N. 55° E., and dip about 50°. Probably the material shipped was selected ore which would account for the high average value. The ledge on which the Morgan and Bradley mines are located is over 1000 ft. lower in the formation than that on the Calzona property. The ledge is faulted down against schist at a depth of about 1700 ft. Water is pumped about 3 miles from the Colorado River to the east. A 6 h.p. Fairbanks-Morse gasoline engine is installed on the property.

The Steece Mines. The Steece property is located southeast of the Jackknife Group, principally in Sec. 6, T. 2 S., R. 24 E. It includes the Ruby, Washington, Bluebell, and Black Warrior claims, and 8 others. It is owned by Richard Silliland and Ed. Arnold, of Calzona.

It is said that the main shaft is down about 500 ft., and that water is pumped from the Colorado River. The ore body follows the contact between schist on the south or footwall side and limestone on the north. The ledge strikes N. 55° E., and dips at an angle of about 50°. The ledge is about 1800 ft. lower in the formation than that on which the Jackknife Group is located. The ledge is faulted down against schist at a depth of about 3700 ft.

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The Gold Dollar Group. This group consists of eleven claims, Gold Dollar Nos. 1 to 10, and Gold Dollar Fraction, in Secs. 35 and 36, T. 1 S., R. 23 E., and Sec. 1, T. 2 S., R. 23 E., S. B. M. They are owned by Messrs. Ware and McMillan, of Calzona. Only assessment work so far has been done.

The Oxbow Group. This group consists of the Oxbow, Oxbow Nos. 1 to 6, and the Oxbow Fraction claims near the center of Sec. 36, T. 1 S., R. 23 E., S. B. M. The claims are owned by Messrs. John and Dennis Burke, of Calzona. Only assessment work has been done.

Alice Group. This group consists of 8 claims in Secs. 25 and 36, T. 1 S., R. 23 E., S. B. M. The names of the claims are the Lucky Boy, Comet, Good Enough, Fraction, Longworth, Homestake, Alice, and Mineral Hill. The group was formerly known as the Pipinco Group, and is owned by Mr. B. L. Vaughn, of Needles, California. The mines, at an elevation of 1600 ft., are 6 miles south of Vidal, the nearest railroad station. Water is pumped about 5 miles from the Colorado River. In February, 1914, it was reported that 3 men were working at the mine, and that 90 tons of ore had been shipped to Needles. The gold is said to occur in schist.

Meek and Sass Mines. Messrs. Meek and Sass of Los Angeles hold the Earnie and Melville claims and others in Sec. 1, T. 2 S., R. 23 E., adjoining the Morgan and Bradley claims.

Four **placer claims,** namely, the New Moon, Sunset, Riverside and Midnight, have been taken up in Secs. 20, 29, 30, 31 and 32, T. 1 S., R. 24 E.

IRON.

This most important metal is found in this county in a deposit of great importance, which lies in the desert region of Riverside County, T. 3 S., R. 14 E., forming part of an elevation known as Eagle Mountain. It also occurs in Turtle Mountains near the county line of San Bernardino.

IRON ORES OF EAGLE MOUNTAIN.

The important iron ore deposits of this area are large and valuable and when commercial conditions improve and proper fuel becomes available they will form the basis of an important industry for the Pacific Coast.

A careful study of this region was made for the U. S. Geological Survey in 1909 by E. C. Harder and J. L. Rich. The results of that work are published in U. S. G. S., Bull. No. 503, accompanied by colored geological maps and sections; and to which the reader is referred for full details.

These deposits are in the northern part of the Eagle Mountains, central Riverside County, T. 4 S., R. 14 E., about 40 miles northeast of

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Mecca, on the Southern Pacific Railroad, 45 miles south of Cadiz, on the main line of The Atchison, Topeka and Santa Fe Railway, and 50 miles southwest from Blythe Junction on the Phoenix Branch of the latter railway. This recently completed branch connects with the main line at Cadiz, passing about 35 miles northeast of the Eagle Mountains.

The area is best reached from Mecca, on the Southern Pacific Railroad, by about 50 miles of road. The Iron Chief mine may also be reached from Dale, San Bernardino County, about 20 miles north. Dale is 45 miles from Amboy, on the Santa Fe Railway, with biweekly stage service. The east end camp may also be reached from Parker or Blythe Junction by wagon.

These deposits are considered the largest in the southern section of the state.[7] "The iron ores with associated metamorphic minerals occur as replacements in the dolomite. Locally, as at the east end of the area, they have replaced the entire series of dolomite lenses, leaving the associated quartzite but little altered. Elsewhere they occur within the dolomite lenses or beds, in bands or as irregular masses roughly parallel to the bedding. * * * The trend of the iron-bearing belt along the north limit is approximately N. 70° W., its extent in this direction being about 6½ miles. Its width of outcrop varies from 500 feet to 2500 feet. * * * The ore is predominantly hematite, but here and there consists of masses of magnetite. Much of the hematite contains disseminated magnetite, making it slightly magnetic, but probably less than 10% of the entire quantity of ore is magnetic. A considerable percentage is very pure and of high grade, containing between 62% and 67% metallic iron and less than 0.06% phosphorus. Much of the ore, however, is mixed with gangue material, such as metamorphic minerals and unreplaced rock. The principal minerals occurring with the ores and metamorphosed dolomite are serpentine, mica, amphibole, garnet, epidote, pyroxene, and titanite."

Several groups of claims have been located on these deposits, and a relatively small amount of development work done. These claims are described in detail in the bulletin referred to above.

MANGANESE.

Ore deposits of this important metal, so necessary in the manufacture of steel, are found at several points in Riverside County, but only one has as yet been developed into a producing mine. This is known as the **Black Bird Mine**, and is in the McCoy Mountains, 12 miles west of Mineral, a station on the Southern California Railroad, the new railroad now being constructed from Blythe Junction to Blythe. It is said that 1000 tons of manganese were shipped from this deposit during the spring of 1916 and that it is now exhausted.

[7] E. C. Harder, op. cit.

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One locality, long ago known and located, is northeast of Elsinore, in Secs. 23 and 24, T. 5 S., R. 4 W.

The following description of the exposures has been written by a Los Angeles mining engineer, F. E. Fielding, and partly verified under the present writer's direction:

One group, of 6 locations, lies west of The Atchison, Topeka and Santa Fe Railway, the other group, of 9 locations, lies on the east of the railroad about ½ mile farther north; one portion of the property reaches the railroad, while the farthest point of any location is less than 1½ miles distant. For convenience in description the 6 locations west of the railroad may be designated as West Group and the 9 locations east of the railroad as the East Group.

(Sec. 23.) On the **West Group** was visited what was pointed out as the principal vein, though another parallel vein is said to exist. This vein outcrops at the top of a hill some 1500′ to 2000′ distant from and approximately 400′ to 500′ above the railroad. Here is an outcrop of 3 ft. wide, upon which a hole 3 ft. deep has been sunk. Some 75′ to 100′ distant, toward the railroad, a 10-ft. shaft has been sunk showing the vein to be 4 ft. wide at the surface. Below this point is a tunnel 20 ft. in length driven in the footwall so the width of the vein is indeterminable.

(Sec. 24.) On the **East Group** are three parallel veins, outcropping at intervals for several hundred feet in length. The central vein outcrops show an indefinite width, being considerably broken and covered with detritus. This vein may be 16′ to 20′ in width, as the distance from the apparent foot to hanging wall would indicate. The width can only be determined by trenching.

The following report on manganese in eastern Riverside County is by Mr. C. A. Waring:

M'COY MOUNTAINS.

The Schellenger Claims. On the north end of the McCoy Mountains in Secs. 13 and 24, T. 4 S., R. 19 E., Mr. E. E. Schellenger, of Blythe, has 4 manganese claims. The deposits, which are from 4′ to 8′ wide, have a northwest strike. A 20-ft. shaft, sunk to one side of the outcrop, has so far failed to strike the ledge and it is thought by Mr. Schellenger that the ore body may dip rather steeply. The deposit is said to be in a region of faulting. The manganese ore is said to carry considerable barite and fluorite.

Prospects of manganese are also reported in the region southeast of McCoy Mountains, on the **Patterson ranch,** where considerable lime accompanies the deposit. Not enough work has been done to determine the importance of these deposits.

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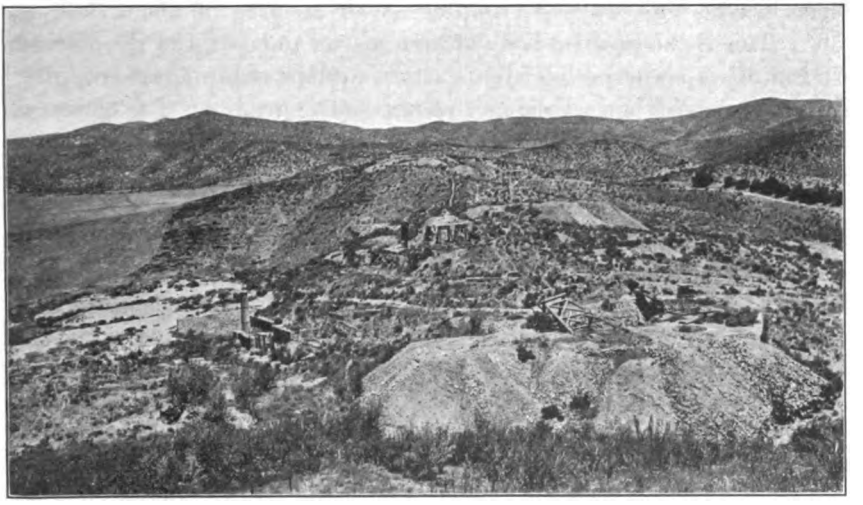
Palo Verde Region. Messrs. Lugo and Justice Smith have done assessment work on some manganese claims northwest of Palo Verde.

TIN.

The Temescal tin deposit was discovered about 1853 and in 1860 a company was formed to work the mine. The outbreak of the Civil War, the following year, caused operations to be suspended and nothing further was done until about 1880.

The earliest description of this deposit in 1884 by Henry G. Hanks, State Mineralogist, will be found in Report IV, p. 120. Other references to it will be found in Mineral Resources of the United States, U. S. Geological Survey, 1882, p. 434; 1883, p. 434; 1891, p. 161. Also, in U. S. G. S., Bulletin 260, and in U. S. G. S., Sixteenth Annual Report, 1894, Part III, p. 536.



Temescal (Cajalco) Tin Mine, looking northeast, Riverside County, California. Photo by Gerald A. Waring, July, 1916.

This deposit was carefully described in 1892 by H. W. Fairbanks, R. XI, pp. 111–113. Also, by the same author in the American Journal of Science, 4th Series, Vol. IV, pp. 39–42. For the position of this mine, see Elsinore Quadrangle, U. S. G. S.

From the data in the XIth Report, by H. W. Fairbanks, the following description is abridged:

"The Temescal tin mine is located in the western part of the Sobrante de San Jacinto grant, and about 5 miles southeast of Corona. This portion of the grant consists of rolling hills. On the west is a large body of porphyry, extending nearly to the Temescal Creek.

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"The rocks exposed along the road to the mine east of Temescal Creek are mostly felsites and porphyries. These rocks are soon replaced by granite, in which are dikes of fine-grained, highly quartzose granite. A half mile south of the road is a cañon. Here the porphyry is seen extending up to the granite, which is greatly broken near the contact and, though there is no blending of one into the other, there is a confused mixture of broken portions of both rocks. Bunches and dike-like bodies of granite are enclosed in the porphyry. Small black veinlets of tourmaline aggregates are very numerous in the granite, extending through all the rock up to the porphyry, with a northeast strike. The material of these veinlets constitutes the gangue of the tin veins. The veinlets of tourmaline are aggregates of needle-like crystals and seem to have replaced the feldspar and mica of the granite, leaving the quartz. The veins grow larger toward Cajalco Hill. Just west of the works is a great mass of the black veinstone, the gangue of the tin ore. This rises in high, rugged croppings, over an area of about 300′ by 250′. This is the greatest body of vein matter to be seen in the district. The tin deposit worked lies in an eastern prolongation of this cropping. The country rock is a coarse hornblende-biotite granite. The course of the vein is N. 45° E., dip 65° to 70° NW., and it has the usual character of such deposits, swelling at times to a width of 8 feet, and again contracting to much less. The highest grade of ore is found in the narrow portions, where it is sometimes almost pure tin oxide, running as high as 70%. The vein matter does not wholly consist of tourmaline, but contains quartz grains scattered through it in about the same proportion as in granite. Tin is not found to any extent in the quartzose part of the gangue, but occurs in bunches and stringers, or disseminated in the irregular veinlike bodies of tourmaline, which lie in the quartzose gangue. This is particularly the case where the width of the vein is 6′ to 8′. Where it pinches, the whole vein sometimes consists of the tourmaline aggregate and tin ore. The vein usually has clay gouges on both walls; sometimes it is frozen to one wall; wherever the walls come together and cut out the vein matter, the gouges remain.

"There are here two varieties of tin ore: the yellow, occurring in thin layers in an uncrystalline form, and the brown, in granular form in the massive specimens, or in small, clear, reddish brown crystals lining cavities. In the later case it forms handsome specimens. A small amount of arsenopyrite is present at places in the vein, and pyrite in the granite. The quartzose portion of the vein matter often often blends into the granite walls, and there are bodies of evidently granitic origin wholly enclosed in the vein matter. A careful study of the vein matter, and its relation to the walls, shows that it is a portion of the granite, in which tourmaline has been substituted for the feldspar and for the dark silicates, hornblende, and mica. The

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quartz has the same character and color as that in the granite, and many transition stages in the process are shown. Where the action has been more intense, near and along the fissures, the quartz also has been wholly removed and the tourmaline deposited, together with the tin. Cajalco was the center of this action. The veins decrease in size farther away."

At the time of Mr. Fairbank's visit in 1892 the mine had been opened up to a depth of 180 feet, by two working shafts. The total length opened on the vein was 300 feet. Two levels had been driven and work was in progress on a third. The main ore body lay in the center of the workings and extended downward in the dip of the veins. The ore milled averaged 5% of tin oxide, though large portions, as before stated, were of very high grade. The company prospected Cajalco Hill by a tunnel and by open cuts, and one or more of the veins south by shafts. At the time of the visit two of Husband's pneumatic stamps were in operation. They weighed 900 pounds each and dropped 135 times per minute.

South and southwest of the works are many bunchy veins of the black vein matter. They often carry considerable iron. They extend, generally, nearly parallel, in a northeast and southwest direction. Some appear as mere bunches on the surface. These veins closely resemble the main vein at Cajalco Hill, and are due to the same action, and it is supposed that many of them will be found to carry tin, though it does not appear on the surface. About 2 miles south the granite is replaced by a banded prophyry, which cuts off the tourmaline veins. The granite about the works, and especially toward the contract with the prophyry, is cut by many dikes of fine-grained granite, having an excess of quartz and feldspar. Associated with the porphyry are metamorphic strata of a hard, dark, quartzose character. A quarter of a mile northwest of the mine is a bunch-like outcrop of porphyry, carrying silver and copper carbonate. The black veins outcrop for a distance of 2 miles northwest from the mine, extending into the porphyry, which replaces the granite in that direction. The granite extends eastward for many miles.

In brief, the general geologic features here are: A semicircular area of granite over 2 miles in diameter, surrounded on the northwest and south by porphyries and adjoining on the east a great body of granitic rocks extending indefinitely in that direction. Around the border of this granite boss are many dikes of fine-grained granite. Cutting through the granite in a northeast and southwest direction are black tourmaline veins, which form the gangue of the tin ore when it is present.

Tin occurs here under conditions different from those in any other known deposit. Tin veins are almost always found in granitic rocks, but so extensively developed a tourmaline veinstone is remarkable.

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The direction of the fissure system shown here is uncommon in California. The veinstone, together with the associated metals, has probably resulted from a process of sublimation along line of fracture, removing those portions of the granite easily affected, over a large area, as at Cajalco Hill, and in the immediate contact completely replacing it with the massive aggregate of minute tourmaline crystals.

NONMETALS.

Under this head are included the more valuable of this county's mineral products. Clay alone aggregated in 1914 a total of nearly $70,000 and the other nonmetallic minerals amount in value to a very substantial sum.

The principal materials under this head are Clay, Gypsum, Cement, Stone, Magnesite, and Gems.

ASBESTOS.

About 15 miles in an air line S. 14° E. of Palm Springs are the old workings of an asbestos mine, now held by **Frank H. Jackson** of Los Angeles. It is most easily reached from the railroad at Hemet, whence there is a good wagon road as far as Kenworthy. The road from Kenworthy to the workings is very rough but passable with a team and a buckboard. The topography of the region is mapped on the San Jacinto and Indio special maps of the United States Geological Survey.

The picture, Fig. 4, was taken from the road looking northward toward Palm Springs, lost in the haze to the left, and Asbestos Mountain to the right. The cross marks the location of the asbestos workings, a portion of which is shown in Fig. 5.

The country rock exposed in the Santa Rosa Mountains is chiefly granite. About ¼ mile southwest of B. M. 3871, southwest of Piñon Flat an area of metamorphic limestone with surface exposure about ½ mile wide (see Fig. 4) strikes N. 45° W., with a dip of 50° NE. This limestone overlies the granite unconformably and is overlain by a coarse granitic gneiss which is well exposed in Omstott Creek and on the southwest side of Piñon Flat. The gneiss contains a great deal of biotite with some orthoclase.

The asbestos occurs in veins as slip-fiber traversing a granular dull green cortlandite (olivine-hornblende) rock carrying some secondary magnetite. It is the amphibole (tremolite) variety and in places along the larger veins aggregates of the acicular gray crystals can be obtained two feet or more in length. The hardness is about six and the crystals fiberize with difficulty. After the asbestos has been exposed to the weather it softens up into a loose white fiber. Owing to the fact that the fibers are quite brittle and rather easily fusible probably the best

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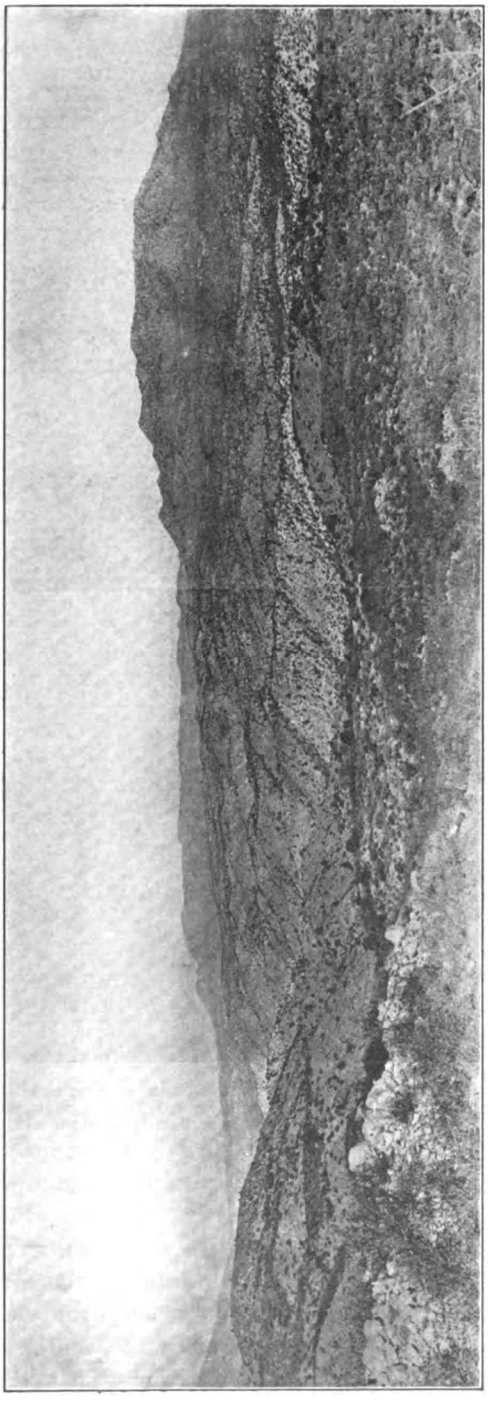

Fig. 4. View northward from head of Palm Cañon, Asbestos Mountain to the right. The cross marks the mine workings. The streak of white cutting across the head of the cañon is limestone. Photo by C. A. Waring.

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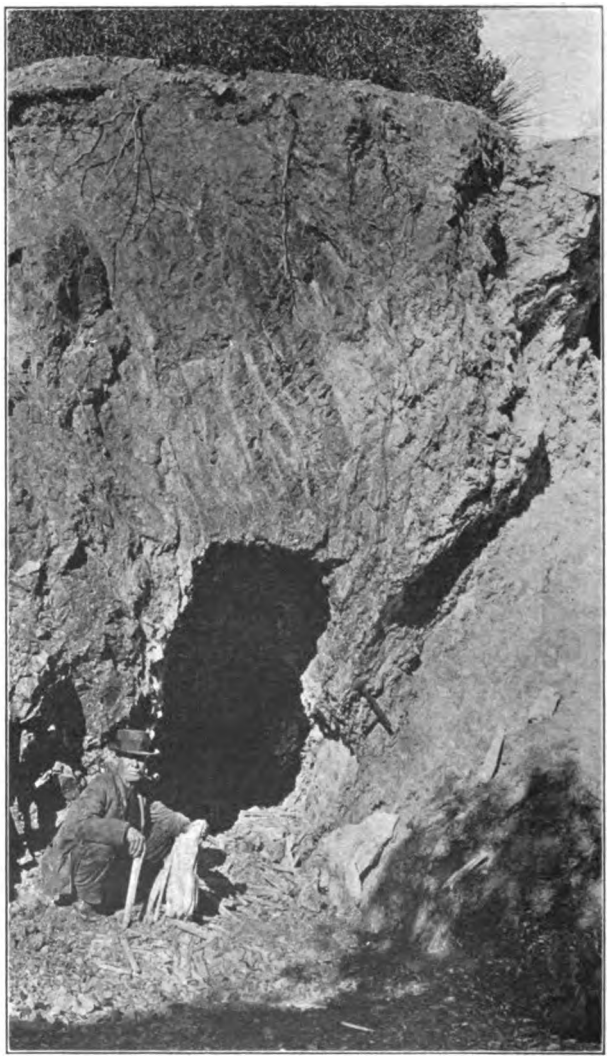

Fig. 5. Face of cut where asbestos has been mined, Riverside County. The prospector's pick marks the main ledge of asbestos, and small stringers appear throughout the mass of cortlandite. Photo by C. A. Waring.

use to which the product could be put would be as a protector against acids.

The largest vein of asbestos seen in the mine was two feet thick and below it were about three feet of talc. Both hanging wall and footwall are cordlandite. The deposit has been opened up by means of tunnels and open cuts. The first product of the mine, in the early days, was packed out as far as the head of Vandeventer Flat and shipped to San Diego where it was used in mineral paint. Only assessment work is

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at present being done, and about thirty tons of asbestos are piled ready for shipment. Seven claims have been located along the deposits. The natural point of shipment at the present time would be from some point along the Southern Pacific Railroad about fifteen miles to the northeast. The claims are owned by Mr. E. E. Chilson, of Kenworthy.

CEMENT.[8]

Cement, as used in building, is a compound of lime, alumina, and silica that hardens in contact with water. It differs from quicklime in that it does not slake, expand, crumble, nor give off heat when wet, but chemically combines with part of the water into a firm, artificial stone. There are two principal classes of cements: the natural rock, or Rosendale cement; and the artificial product or Portland cement, to which may be added a third, the Pozzuolana or slag cement.

NATURAL ROCK CEMENT.

A limestone which in nature contains sufficient clay or other aluminous material, mixed with the carbonate of lime, so that it requires only burning and grinding to form a cement, is called a waterlime, or natural cement rock, and the product is natural or Rosendale cement, sometimes called Roman cement. Natural cement rock was discovered in the United States near Chittenango, N. Y., in 1818. Later it was found in large quantities elsewhere in New York and in Pennsylvania, Indiana, Kentucky and other states. Ulster County, New York and Louisville, Kentucky, were for a long time the center of this important industry. Natural cement is generally inferior to Portland, and in most places, its market has been taken by the artificial product.

In California such a natural cement rock occurs in Orange County, where, near El Toro, a deposit, claimed to be of good quality, is found. In 1860 and for several years following a natural hydraulic cement was obtained at Benicia, Solano County, and utilized in building operations in San Francisco.

PORTLAND CEMENT.

Portland cement is a compound consisting chiefly of silicates and aluminates of lime, produced by the calcination to incipient vitrification of a mechanical mixture of calcareous and argillaceous materials, the clinker thus produced being subsequently ground to a fine powder. Its chemical composition varies considerably, the principal constituents being lime, silica, alumina, and oxide of iron, which are apparently in the following proportions: lime, 60% to 64%; silica, 20% to 24%; alumina, 6% to 10%; iron oxide, 3% to 5%. These constituents, as a rule, amount to about 96%, the remainder consists of small quantities of sulphuric anhydride, magnesia, alkalies, etc.

[8]Bull. 38, pp. 171–173.

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The use of Portland cement is principally based on its characteristic quality of hardening rapidly under water or in a moist atmosphere.

Portland cement was first manufactured in England, and so named in 1824 by Joseph Aspdin, of Leeds, who patented a calcined mixture of limestone and clay. The name was based on a resemblance of the set cement to the famous Portland limestone used in building. The growth of the industry was at first slow. Not until 1851 was it brought prominently before the world, and, soon after, its manufacture began in Germany, France and elsewhere on the continent. The increase in output was rapid from this time, especially in Germany and England, which exported large quantities to the United States.

In America, the first Portland cement was manufactured in 1875 by Mr. Saylor, at Siegfried, in eastern Pennsylvania. Soon after, a second factory was established in western Pennsylvania. For nearly twenty years the growth of the industry was slow, but during the last decade of the nineteenth century there was a phenomenal increase in the product. This was due to the greatly increased use of cement, which, without marked decrease in importation, increased the home product in one decade more than 1200 per cent.

The enormous increase in the domestic production of Portland cement is a matter of much interest, yet, when one considers the varied uses to which it is put, and the many other ways in which it might be used, it will be a matter for great surprise if the increase in production does not continue for many years.

Uses of Portland Cement.

Because of the ease with which it can be moulded or formed into desired shapes, its hardness and durability when set, and its resistance to moisture and vermin, Portland cement will increase in importance in structural and engineering work. It has not only replaced ordinary lime mortar in masonry, especially in foundations, but in the form of concrete is replacing stone and brick and, for many uses, wood and iron in building.

Cement is used in the manufacture of artificial stone, and in concrete, which is used for monolithic structures, in walls, foundations, bridge construction, reservoir dams, etc.

The composition of Portland cement is already given above. Variations in the different constituents influence the character of the cement to a certain extent. Cements rich in lime set more slowly, but harden better than those poor in lime. Cements rich in silica set more slowly than those rich in alumina, but they are better for use under salt water. The addition of 0.33% to 0.75% of fluorspar is helpful in making the materials clinker more easily. Gypsum or sulphate of lime in small quantities somewhat delays the setting of the cement and

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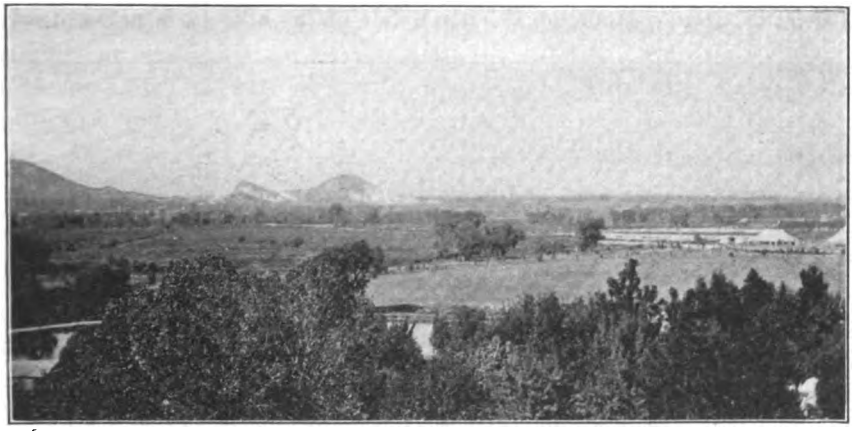
adds to its final strength. More than 4% or 5% is injurious, and many specifications require that less than 2% be added.

Riverside Portland Cement Co., Tyler Henshaw, president; W. H. Metcalf, secretary; corporation office, Mills Bldg., San Francisco, Cal.; John Treanor, manager; business office, Trust Ins. Bldg., Los Angeles.



Riverside Portland Cement Co. plant as seen from Fairmount Park.

Quarries of Riverside Portland Cement Co. Upper quarry, limestone; lower quarry, diorite.

Quarry and works at Cement Plant near Crestmore, F. F. Parker, superintendent.

This company was organized in October, 1909, and its quarry and plant are about 5 miles northwest of Riverside, in Secs. 2 and 3, T. 2

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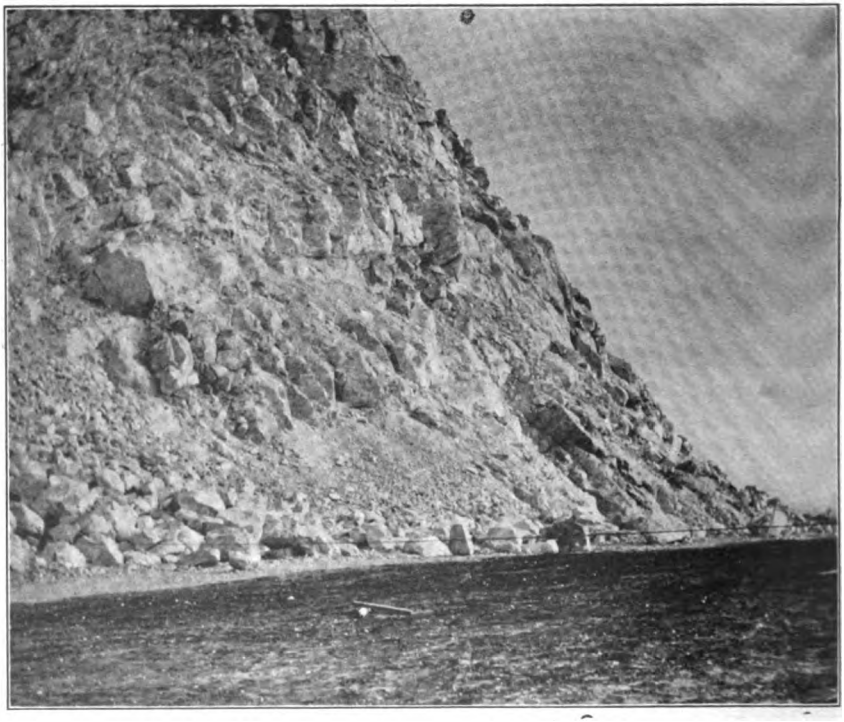
S., R. 5 W., S. B. M. The limestone which is coarsely crystalline, is quarried in a butte similar to many which occur in this region, but which are generally of granite. This limestone butte near Riverside, in some respects, resembles Slover Mountain southwest of Colton, which is the source of limestone for the California Portland Cement Company. Both show mixtures of blue and white calcite, but the Riverside County stone, on the north side of the hill, has a particularly



Limestone Quarry of Riverside Portland Cement Co.

rich blue color. The limestone is in two beds separated by quartzite. The strike is northeast and the dip is 25° SE. On the west side of the mountain the limestone is underlain by mica diorite, an intrusion of which has caused the local uplift and tilted the sedimentaries toward the southeast. Above the limestone is micaceous quartzite, in turn overlain by another bed of limestone.

This limestone was formerly quarried by the Blue Sky Marble and Onyx Company,[9] of Riverside, some of it being used for building purposes in Riverside and Los Angeles, and some for ornamental purposes in San Francisco. There were, also, two kilns at the quarry; the product having been put on the market under the name of "Lily White" lime. About 75,000 barrels of lime were burned at the quarry.

[9]Bull. 38, pp. [illegible].

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Analysis of Riverside Blue Marble.[10]

Lime	55.85%
Equivalent to lime. carbonate	99.73%
Magnesia	0.30%
Iron	Trace

This analysis shows it to be a remarkably pure carbonate of lime. The mass of igneous rock beneath the limestone on the west is a very fortunate occurrence for the cement company since it supplies the aluminous material needed to complete the mixture. Lithologically the rock is a mica diorite. It is coarse in texture and so far decomposed that it is excavated with an electric shovel.

When this decomposed diorite is pulverized and mixed with the limestone the raw mixture has the following composition:

Silica	15.18%
Iron oxide and alumina	5.06%
Lime	76.34%
Magnesia	2.90%
Total	99.48%

After burning and grinding, the finished cement gives the following average analysis:

Silica	22.98%
Iron oxide and alumina	8.80%
Lime	63.10%
Magnesia	2.42%
Sulphuric anhydride	1.42%
Total	98.72%

The raw materials are passed through Gates' crushers which reduce them to 3 inches and under, and then are dried separately in rotary driers. They then pass to ball and tube mills for grinding and after mixing are burned in 18 rotary kilns 8 ft. in diameter, 10 measuring 100 ft. in length and 8 measuring 120 ft. From the kilns the clinker passes on conveyors to piles for cooling. In these piles it remains two or three weeks. From these piles it is taken to be ground in ball and tube mills, and thence to a Bates automatic weighing machine for packing. The McCaslen system of conveyors is used throughout.

Riverside Portland Cement Manufacture.

The limestone used is of exceptionally high grade, running 98% pure. Clay materials of the ordinary type of composition, consisting mainly of silica, iron and alumina, are also used. The particular clay material used carries approximately 8% of lime.

These materials are quarried in the usual manner and brought into the mill separately, each being ground so that approximately 40% will pass a 100-mesh screen, and 100% pass a 10-mesh screen, at which

[10]Analysis furnished by the Sky Blue Marble and Onyx Co., John A. Wessener, analyst. See Bull. 38, p. 75.

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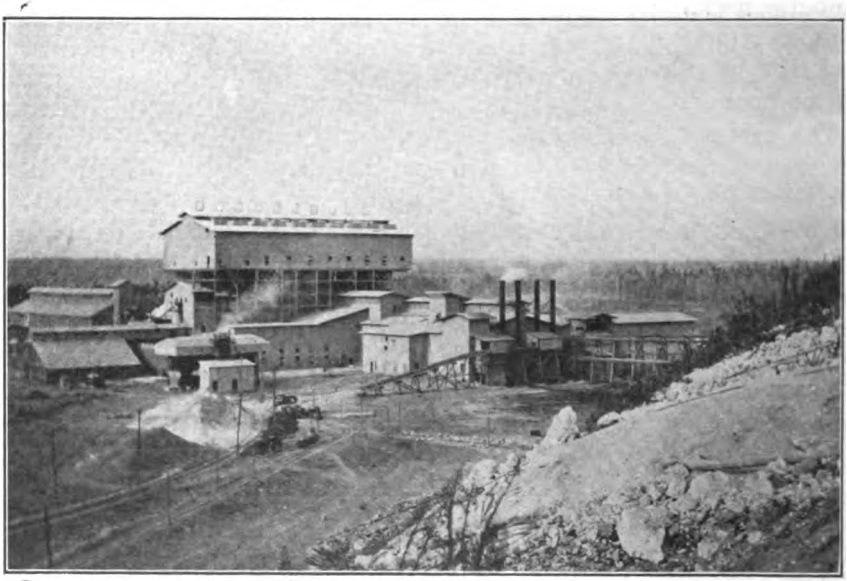
fineness a blend is made of the material, making what is commonly known as the "raw mix."

This material is then ground, from 96% to 97% passing 100-mesh screen before burning. No calcining whatever is done in the drying, simply subjecting the materials to sufficient heat to drive off free moisture. This material is then burned in the usual manner in rotary kilns, being subjected to sufficient heat to combine the two materials



Cement plant of Riverside Portland Cement Co.

thoroughly, forming what is commonly known as clinker, ranging from the size of peas to 2 inches in diameter. It then passes through rotary coolers, where it is sufficiently cooled for regrinding.

At this point it is weighed and 3% of gypsum added, the latter being added to regulate the setting time of the finished product. The clinker is then ground so that 96% to 97% passes a 100-mesh screen, and 80% to 82% passes a 200-mesh screen. It is then conveyed and stored in what is known as cement storage, from which point these materials are drawn and sacked according to the demand, the Bates type of automatic machine being used for packing.

Dust Precipitation.

The dust-laden gases from the kilns pass up through the stacks which are at present capped on top. Gases leave the stacks at a point about 80 feet above the ground, and pass horizontally through dust precipitation apparatus. Each kiln has a separate "treater" and electrical apparatus. The treater consists of a box about 30 feet long on each side of the stack. Each box contains rows of plate electrodes 15 feet long

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vertically and one foot apart. Between these rows of plates are placed the discharge electrodes which consist of fine wires hung vertically 1 foot apart, and 6 inches from each plate electrode. As the plates and electrodes are vertical, the gases pass at right angles to the plates and wires. At the end of each treater farthest from the main stack, the gases discharge into a short outlet stack.

Below the plates and wires each treater has hoppers and once each hour the dust is shaken from plates and wires with small air hammers. This operation requires about a minute. The dust falls into the hoppers and then into cross conveyors. It then passes to a main conveyor and out of the building either to the dust packing plant or to storage.

The original installation comprises 10 sets of these treaters, one for each of the original 10 kilns. The volume of gases to be handled averages about 50,000 cu. ft. per minute per kiln and each treater catches 5 to 10 tons of dust per day. The dust precipitation takes place at a voltage of about 50,000. This is a uni-directional discharge produced by rectifying a high voltage (50,000 volt) alternating current by means of a simple mechanical rectifier. Each treater requires about 3½ kilowatts for its operations.

The original installation has been running about two years without depreciation and with an average efficiency of over 95%. A short time ago an additional kiln was installed at the plant and this has been fitted with a slightly different type of treater in which the gases pass through vertical pipes, 1 ft. in diameter, with a discharge wire in the axis of each pipe. In this new kiln the company is now producing cement from the dust caught in the treaters on its original ten stacks. The average potash content of the dust is about 2% and in the new kiln this potash is concentrated so that the average potash content in the dust resulting from the burning of dust is about 20%. A portion of this potash-bearing dust is being sold to fertilizer manufacturers.

CLAYS.

Brick clays, in this county, as elsewhere, occur locally at many points and are not of great commercial importance, but the most prominent member of the nonmetallic group is found in the plastic clay of the Temescal Valley.

PLASTIC CLAYS OF RIVERSIDE COUNTY.

In western Riverside County extending along the Temescal Valley for 10 miles from Elsinore on the southeast to and beyond Corona on the northwest is a zone of plastic clays of superior quality. In many places they resemble the important white, gray, black, red and variegated Cretaceous clays of New Jersey and eastern Pennsylvania, and like the latter, the Temescal clays vary locally in thickness, color and other properties, consisting at different points of white, red, and

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mottled plastic clay, and gray and black flint fire clay. The extent and thickness of these clays, together with the great plasticity of some and the highly refractory qualities of others, give them much importance and these deposits will grow in commercial prominence as the population of southern California increases, and transportation lines are farther developed. Many openings have been made in these beds at different points from which, during a number of years, clay has been taken for the factories at Elsinore, Corona and Los Angeles.

GEOLOGY OF THE TEMESCAL VALLEY CLAYS.

The valley in which these extensive deposits lie was in Tertiary time an arm of the sea opening northward into the valley of western San Bernardino County, and extending southerly to Temecula. Its width is from one to two miles, but the depth is unknown, as, at the terra cotta works near Alberhill a drill hole was sunk over 600 feet without reaching the bottom of the basin.

These clays are of a great variety of colors. They are in various conditions of consolidation, and some are chalky in appearance, and there are thick beds of loosely cemented argillaceous quartz sand. These deposits dip westward from the Temescal Range, and instead of also dipping away from the Santa Ana Mountains, at many points they dip west into the latter range. Three miles south of Corona the dip of the beds is 5° to 10° SW. and, as the Santa Ana Mountains are approached, the dip increases, and at distance of a fourth of a mile up to the metamorphics, it varies from 45° to vertical. At the California Clay Manufacturing Company workings the dip is eastward.

Poorly preserved fossils are found in places. Near the southeastern corner of the Hoag Ranch is a hill with hardened concretionary sandstone outcropping around it. Nearly every portion of this contains fragments of bones supposed to be cetacean.[11] Two miles south of the old Temescal post office is an outcrop of soft sandstone, dipping 30° southwest and carrying Miocene fossils.[12]

In the region between Corona and Alberhill, at various points, the clay deposits are overlain by debris of disintegrated granite, varying from a few inches to many feet in thickness, but south of Elsinore the Tertiary deposits are now covered by Quaternary gravels.

CLAY AND CLAY INDUSTRIES.[13]

Clay can not accurately be defined in technical terms and yet the name has been adopted into technical literature as a convenient word. It is a substance varying so widely in its chemical and physical properties, that it is difficult to frame a definition that will include them all.

[11] H. W. Fairbanks, Report XI, p. 111.
[12] H. W. Fairbanks, Report XI, p. 110.
[13] R. IX, pp. 240–261—Pottery. Mrs. Linna Irelan; pp. 287–308. Clays, W. D. Johnston; and Bull. 38, p. 190 *et seq.* For convenience much of the discussion on Clays is abridged from Bull. 38.

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It is sometimes defined as an earthy substance composed essentially of the mineral kaolin, a hydrous silicate of alumina. But it has not been proved that kaolin is the essential base, or that it is always present.

Clay is also described as an earthy substance in which silicates of alumina predominate, thus excluding any large proportion of siliceous sand, calcareous or magnesian matter, and oxides of iron and manganese.

One definition includes in clay "all earthy and stony substances which are or may be used in the manufacture of clay wares."

The report of the U. S. Census Office, "Mines and Quarries," 1902, p. 861, gives the following definition of clay: "Any earthy substance which, if mixed with water and moulded, will retain its shape after drying, and which upon subjection to high temperature loses its plasticity and becomes hard and brittle."

ORIGIN OF CLAYS.

The source of the silicate of alumina, which is an important part of all clays, is found in the aluminous minerals of crystalline rocks, especially in feldspars. In weathering, the alkalies are separated, combine with carbonic or other acids, and are carried away in solution. The alumina and part of the silica frequently combine with water, forming kaolin.

The hydrous silicates of alumina are very stable compounds at ordinary temperatures. The constituent elements may not always combine in the same ratio as in crystalline kaolinite, but they are present in some form and constitute an important part of all clay, shale and slate deposits, and hence form a very material portion of the surface rocks of the earth.

When hydrous silicate of alumina or similar clayey material is segregated and forms a considerable portion of any deposit, the product is called clay, but it occurs also in large quantities mixed with other materials in other rocks, as with sand in sandstone, with gravel in conglomerates, and with carbonate of lime in limestone. When clayey limestones disintegrate by the action of carbonated waters dissolving the calcium carbonate and carrying it away in solution, the insoluble aluminum silicate is left behind as residual clay. Disintegration of sandstones and shales forms a mixture of clay and sand, which, when carried away by rain and streams is frequently separated into sand and clay deposits.

Thus clays may be divided, on the basis of origin, into residual clays, or those occurring in the place of the original rocks from which they have been formed, and transported clays, which have been deposited by water which has transported them from their original position.

Glacial clay (boulder clay or till) is a special class of transported clay in which the agent has been ice. Besides the clay of disintegration

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that has been picked up by the glacier, glacial clay consists in part of a finely-ground fresh-rock material, which was formed by the boulder-shod mass of ice pulverizing the rocks over which it passed.

Chemical Composition.

"Kaolinite, which is the basis of all clay, is a hydrous aluminum silicate (Al_2O_3, 2 SiO_2, $2H_2O$). All clay in its natural state contains impurities, the kind and quantity of which determine its character; from the purest varieties, called kaolin, clays range through all stages of impurity down to a material which contains so little kaolinite that it can not be classified as clay."

"The foreign material of clay is frequently divided into fluxing and nonfluxing constituents, depending upon whether or not they increase the fusibility of the clay. The most common fluxing constituents are lime, magnesia, potash, soda, lithia, iron, and manganese. The fusibility of the clay is affected by the condition of the fluxing constituents as well as by their quantity. For instance, a small percentage of iron oxide, finely divided and intimately diffused through the clay will prove a more active flux than twice the amount scattered through it in coarse grains. The common nonfluxing constituents are silica and organic matter, but this statement is not wholly exact, as silica may slightly increase the fusibility. These constituents may be present in quite a variety of forms.

Physical Properties of Clays.

Some of the qualities which make clay valuable are: (1) plasticity and mobility when wet; (2) retention of the molded form when dry; and (3) hardness and durability when burned. Plasticity when wet is a property common to all clays but flint fire clay.[14]

Plasticity is a result of the microscopic texture of clay. (See Report IX, California State Mining Bureau, p. 287). Kaolinite, which is formed *in situ*, and composed of crystalline scales, is only slightly, if at all, plastic, while kaolin, which has been transported, and is composed of infinitesimal globular particles, makes a highly plastic clay. Flint clay becomes plastic when finely ground.

In drying, clay loses part of its interstitial water, and in burning, loses the remainder and part of the water of crystallization. The hardening of clay from the action of high temperature is permanent, the nature of the material is changed, and it no longer becomes plastic on the addition of water.

Shrinkage. All clays that are molded wet, shrink on drying (air shrinkage) and undergo further shrinkage when burned (fire shrinkage). This shrinkage is due, in great part to loss of water, which

[14]Possibly some persons would add Fuller's Earth to the exceptions, but it need not at all be classified with the clays.

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exists in clay as water of crystallization, and as a film around the particles or inclosed between them.

Air shrinkage is largely due to the loss of water of the second class, as indicated by the fact that the shrinkage is from 2% to 10%, while it takes from 14% to 35% to make the clay plastic. The difference indicates, in a general way, the volume of the interstices.

Clays differ greatly in the amount of their shrinkage. In general, the more plastic and purely argillaceous clays, shrink more than sandy, siliceous ones. Hence, if the brickmaker has a clay that is too "fat," he adds sand to it. Clay that has once been burned undergoes no further shrinkage on subsequent burning, hence burned clay is frequently used as a "grog" to lessen shrinkage, especially in refractory products, where sand might lower the fusing point.

Fire shrinkage is caused, in part at least, by the loss of water of crystallization along with the remaining interstitial water. It is also affected by the amount of organic or other volatile matter present. Moreover, some substances which expand on heating, if present in the clay, may more than counterbalance the shrinkage of the argillaceous part.

It is important to know the shrinkage of the clay that is to be used for products of definite dimensions, so that the mold may be made of the proper size. Laboratory tests made on a large number of different kinds of clay gave the following results, each being the average of several specimens of that kind:

Laboratory Test on Shrinkage.[15]

	Air average shrinkage.	Fire shrinkage, average
Flint fire clay	3.5%	9.9%
Kaolin	5.0%	8.8%
Potter's clay	7.0%	5.4%
Brick	5.5%	4.5%
Shales	6.0%	4.6%
Gumbo	9.0%	1.5%

Fusibility of clays. The clay manufacturer must necessarily know the fusing temperature of the clay he is using, in order that he may not injure or destroy his ware by overburning or underburning. The term "fusibility" applied to clays has a significance different from that of the same word applied to metals. When clay is heated beyond a red heat, it shrinks and becomes close-grained and harder. It finally reaches a point where shrinkage ceases and it becomes very hard and strong, and the individual grains are no longer recognized. This is called complete vitrification, although the clay still retains its form and shape.

[15]Bull. 38, p. 193.

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If the temperature is further increased, the clay begins to warp and sag, and blister, and becomes scoriaceous, which stage may be called scoriaceous vitrification. A further increase in temperature may produce a complete vitrification to a molten stage, from which it cools to a hard, glassy, rock-like slag. The temperature at which the various stages of vitrification occur are different for different clays, and are largely functions of the chemical and physical composition of the clay.

Clays which resist vitrification at high temperature are called fire clays or refractory clays, but the line of separation between refractory and nonrefractory clays is an arbitrary one. (See Fire Clays.)

Color. Clays may be white, black, red, yellow, brown, blue, or variegated. White clays are free from metallic oxides, and frequently occur among the purest forms of kaolin. Black clays are generally colored by carbonaceous material diffused through them, and are frequently made white by burning. The yellow, brown, red and frequently the blue colors are due to iron in some form. In yellow clay the iron is in the form of the hydrous sesqui oxide, the common bog ore; in the red, the color is due to anhydrous sesqui oxide, or hematite; the blue color may be caused in part by iron carbonate, silicate, or sulphide, and sometimes wholly or in part by organic matter.

The color of clays after burning is frequently different from that before burning. They may be divided into those which burn white, buff and red.

The color of the burned clay is influenced not only by the amount of iron in the clay, but also by the physical and chemical condition of the iron, the other elements associated with the iron, the temperature and length of time in burning, and the character of the gases in the kiln. The color of the burned product is thus very largely influenced by the skill of the burner.

In the finer grades of ware, the desired color or colors are obtained by mixing the proper pigments. Almost any desired color or shade of color, except white, can be obtained in this way. For white wares, clay free from metallic oxides is necessary.

POTTER'S CLAY.[16]

Potter's clay is a term rather loosely used. The usual idea conveyed by the term, probably, is that of a smooth, plastic clay, too fusible for highly refractory purposes and containing less iron than ordinary brick clay. It is adapted to the manufacture of stoneware, earthenware, terra cotta, and sewer pipe. Wares manufactured from potter's clay are usually light buff in color, and when burned to incipient vitrification are strong and slightly porous, requiring a glaze to

[16]Bull. 38, pp. 196-197.

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render them impervious to liquids. The stoneware glazes are commonly either salt glaze or one formed from slip clay. Much stoneware is made with a brown slip glaze on the inside, and a blue-gray salt glaze on the outside.

The requisites of a good stoneware clay are: (1) It should be extremely plastic, so that it may be easily moulded and turned into the thin walls of the vessels required and yet retain its shape without injury. To mold readily, it should be high in clay base, that is, a "fat" clay; (2) It should be low in iron, as a light-colored ware is desirable; (3) It should be free from coarse sand or other coarse material. It is frequently necessary to remove such material by a process of washing, in which the coarse materials are separated by gravity. The washing process will remove the iron if it should be present in crystals or lumps, the condition in which it causes the greatest injury; (4) It should be fusible enough to vitrify at a moderate temperature, less than 2000° F. If the vitrifying point should be too high, the burning would be too expensive; (5) The clay should have a range of at least 200°, and better 300°, between incipient and complete vitrification, as it is not easy to control the temperature of the furnace within narrower limits, and all the ware in the kiln would pass the stage of incipient vitrification, but should stop short of complete vitrification. If it has not reached the first stage it will be soft, porous, and lacking in strength, and if completely vitrified it would be glassy and brittle, and probably be out of shape; (6) It should be capable of drying at a moderate speed without checking or cracking, otherwise there will be increased storage and drying room required, increased stock, and therefore more capital and greater expense; (7) It should be free from salts that are liable to cause blisters in burning.

Yellow or Rockingham Ware is a class of pottery differing from stoneware in the manner in which it is burned. In stoneware, the burning is complete in one operation, while yellow ware is first burned in the biscuit kiln to form the body, and then burned again to develop the glaze. A less refractory clay may be used in the yellow ware but, since the glazes fuse at lower temperatures, the same clay may be used for either stoneware or yellow ware.

Earthenware is the lowest form of pottery, and can be made with proper precautions from almost any common yellow clay. It is softer and more porous than stoneware or yellow ware.

SLIP CLAY.

Slip clay is a variety that runs low in fusibility, and is used in forming the glaze on stoneware and earthenware. The following analysis of a slip clay shows the composition of one of the best known and most widely used clays of this class in the United States:

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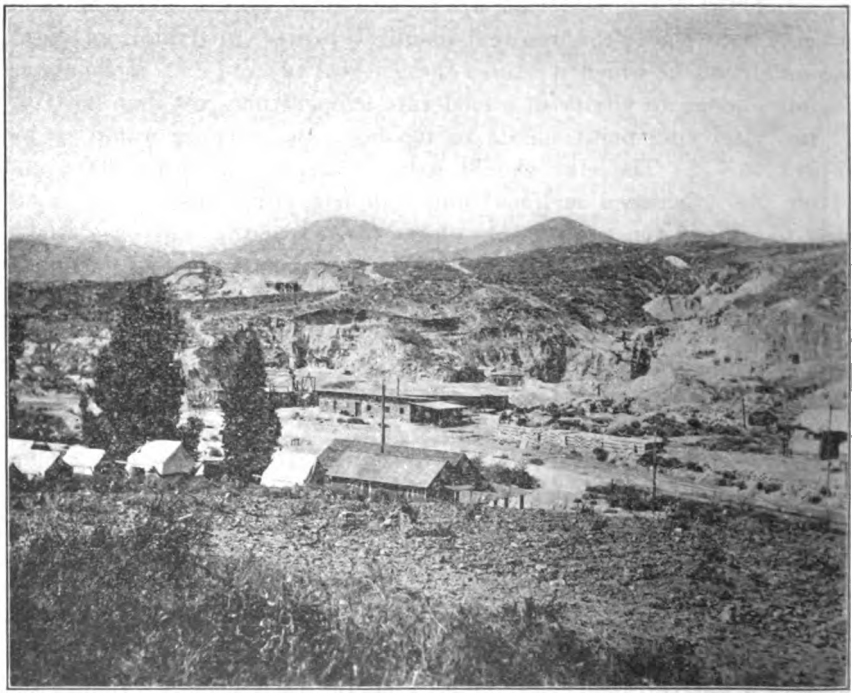
Albany Slip Clay.

	Per cent
Silica (SiO_2)	56.75
Alumina (Al_2O_3)	15.47
Iron (Fe_2O_3)	5.73
Lime (CaO)	5.78
Magnesia (MgO)	3.32
Alkalies	3.25
Water	8.87

Much of the slip clay used in California is obtained from Albany, N. Y.



Clay pits of Alberhill Coal and Clay Co., at Alberhill.

FIRE CLAY.

Fire clay, as the name signifies, is one that resists high temperatures, and hence is more refractory than the common clays. It has a lower percentage of the fluxing substances, such as alkalies, iron and manganese. It is commonly associated with coal beds or other vegetable deposits and it is thought, in some instances, to owe its qualities to the action of vegetation or vegetable matter which has extracted from the clay the fluxing constituents, such as iron alkalies and alkaline earths.

There are two classes of fire clays: The soft or plastic, and the hard or flint. The latter occurs in hard rock masses, does not slake in water,

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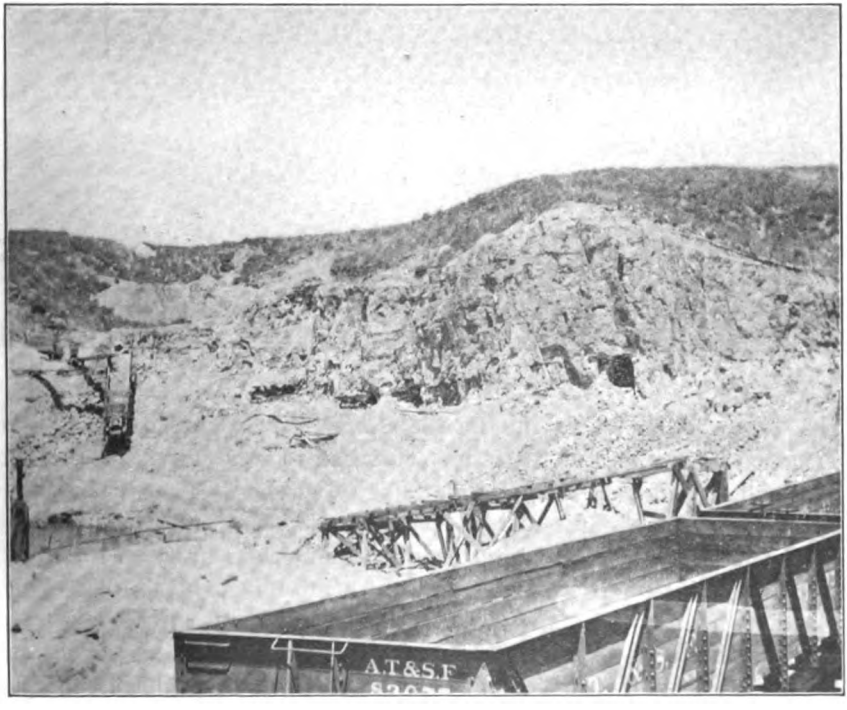
and is not plastic in its natural condition. Fire clays are used for making fire bricks, stove and furnace linings, gas retorts, glass pots and for other refractory purposes. They are also used for making high-grade building bricks, and some low-grade fire clays are used for making paving bricks.

List of Los Angeles Manufacturers Using Riverside County Clay:

Simons Brick Company, 128 West 3d St., uses Ione (Amador County) clay also.
Pacific Sewer Pipe Company, 825 East 7th St.
Los Angeles Pressed Brick Co., 404 Frost Bldg.; uses Ione (Amador County) clay also.
Independent Sewer Pipe Co., Tropico. Suspended in 1915.
St. Louis Fire Brick and Clay Co., 2464 East. 9th St.
Ramona Tile Co., Van Nuys Bldg.
Consolidated Pacific Cement and Plaster Co., San Fernando Bldg.
Acme Plaster Co.
Inglewood Brick Co., Washington Bldg., also make sand-lime brick.
California China Products Co., National City, San Diego County.



Alberhill Coal and Clay Co., pit at Alberhill.

OPERATING COMPANIES.

The Alberhill Coal and Clay Company, 430 Union Oil Bldg., Los Angeles, ships clay from several openings at Alberhill, the terminus of the railway spur from Elsinore. This company is the largest producer of clay in the Temescal Valley. The holdings are in Secs. 15, 22, and 23, T. 5 S., R. 5 W. At the tipple of the abandoned coal mine is a large

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clay pit. The upper portion of the deposit consists of 10 ft. of red and gray variegated clay, underlain by 6′ to 8′ of a mixed fire clay and granitic sand, and in turn underlain by gray to black clay with thin streaks of coal, and at the base, underlying the coal seams is a bed of blue plastic fire clay, with 3′ to 4′ exposed.

About half a mile southeast of the pit and about 200 ft. higher on the hill, is another pit, from which the clay is hauled by wagon to the railway. Here, a high-grade fire clay is obtained.

Harrington Clay Pit, in Sec. 35, T. 4 S., R. 6 W., leased to M. W. Findley, president of the Independent Sewer Pipe Company, and by

Clay pit of Alberhill Coal and Clay Co., at Alberhill.

him formerly sublet to the Pacific Sewer Pipe Company, is in the Temescal Cañon, about 10 miles southeast from Corona. It lies on the east side of the valley, about 300 ft. above its floor. A section of the face of the pit shows several varieties of clay, as follows: At the top 2′ to 6′ of sand and boulders, underlain by from 10′ to 20′ of red and white mottled plastic clay. Beneath this are 4′ to 10′ of white plastic refractory clay, and at one end of the quarry is a red clay with pisolitic structure resembling a ferruginous bauxite.

The clay from this pit is hauled in wagons to the Chase railroad spur south of Corona, for shipment to Los Angeles.

Pacific Sewer Pipe Company, 825 E. Seventh street, Los Angeles; E. M. Durant, president; Archibald Douglass, secretary. This company, formed by the consolidation of several others, controls clay beds at Corona and Alberhill and at intermediate points. At present it is shipping clay from Alberhill only. Part of its raw material is bought

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from the Alberhill Coal and Clay Company. A little clay is used from Antelope Valley north of Rosamond, Kern County.

This company owns the pit three miles southwest of Corona, formerly owned and operated by Mr. McKnight. It produces a black flint clay,

Clay pit of Alberhill Coal and Clay Co., at Alberhill.

besides some blue refractory clay. This clay lies on the top and south side of a low hill in a bed dipping 35° S., and has been mined by tunneling at the base of the hill. The black flint clay is about 20 ft. thick, overlain by 10 ft. of blue clay and about 20 ft. of reddish plastic clay, capped by coarse, granitic sand. Large quantities of highly refractory clay are obtained here.

This company also owns a large pit in the valley about a mile southwest of the Harrington pit. The clays are similar to those in the latter, but occur in different order. At the surface there is an overburden of from 5′ to 25′ of sand and boulders. At one side of the pit the sand is underlaid by white plastic clay from 15′ to 25′ thick, underlain by red mottled clay; at the opposite side of the pit the clay rests on red mottled clay, of which a portion has a pisolitic structure. Both the red and white clays are smooth and plastic but, in places, contain diffused quartz grains, which prohibit their use in fine ware, unless the clay be carefully selected, or the coarse particles removed by some system of washing.

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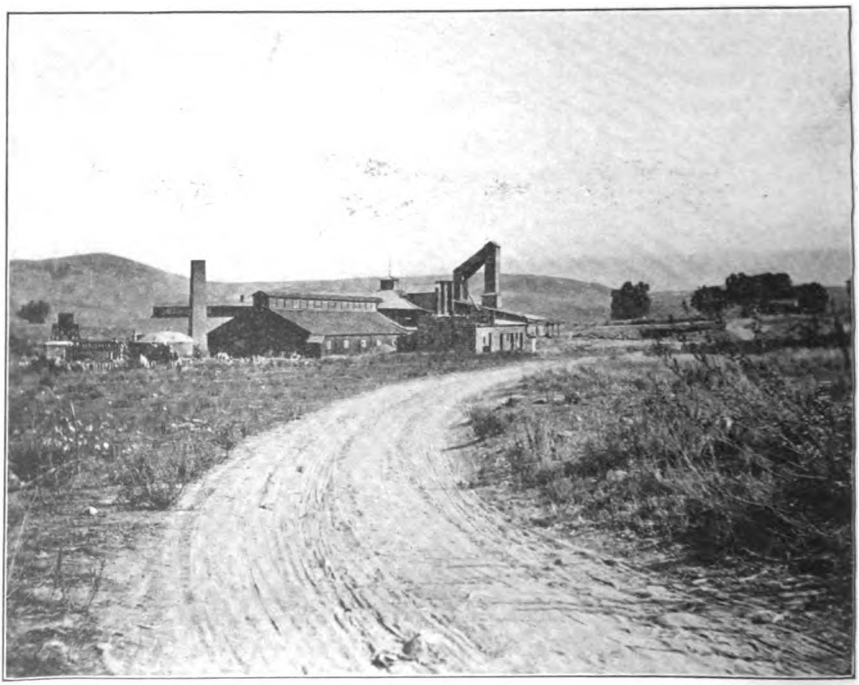
This company also operates the clay pit at Alberhill, near Elsinore, formerly owned by W. G. McVicar.

This company controls six manufacturing plants.

No. 1. At Terra Cotta, three miles northwest of Elsinore, formerly owned by the California Fireproof Construction Company, and previously by the Dolbeer Estate of San Francisco. This was used for making



Plant No. 1 of Pacific Sewer Pipe Co., at Terra Cotta.

sewer pipe, earthenware, and hollow bricks, sewer pipe being the chief product, but it is now idle. The clay was procured from Alberhill. On the hillside near the factory are two clay pits from which clay was formerly mined.

No. 2. Half a mile west of Corona, on the south side of the Santa Fe Railway, formerly belonging to the Corona Pressed Brick and Terra Cotta Company. This plant has been dismantled.

No. 3. These works are one mile west of Corona, on the north side of the Santa Fe Railway. Formerly owned by the Pacific Clay Manufacturing Company. Here are made sewer pipe, both salt-glazed and unglazed tiles, flue linings, chimney pipes, fire bricks, conduits for electric wires, and terra cotta. The Acorn brand of fire brick is made here from the refractory clay of the McKnight quarry, previously described. The different kinds of pipe, etc., are made of clay obtained 10 miles

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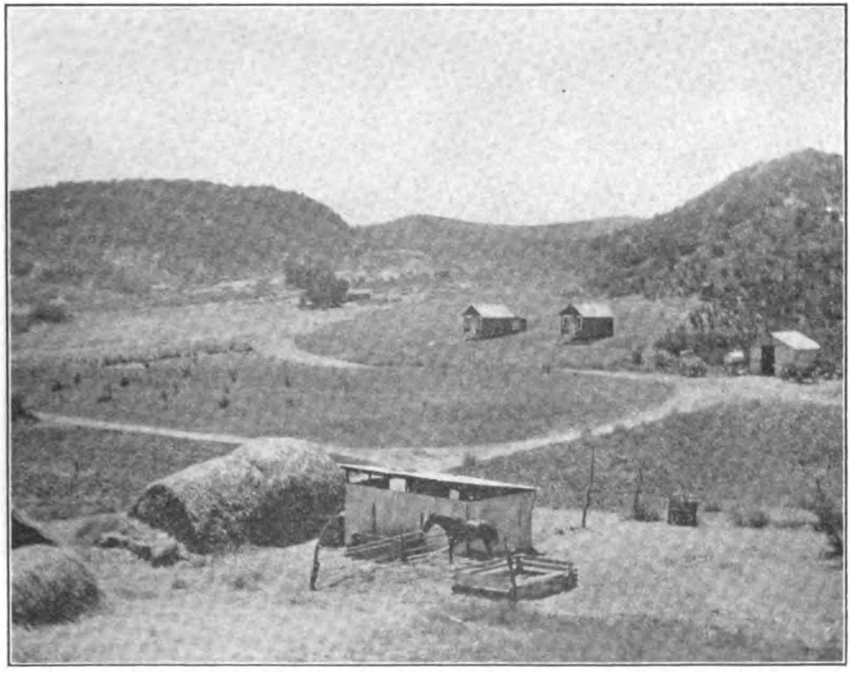
south of Corona. The factory is well equipped with machinery. There are eight round, downdraft kilns in use, heated with oil fuel.

No. 4. At 423 North Avenue 26, Los Angeles. Formerly operated by the Los Angeles Stoneware and Sewer Pipe Company. This is used for stoneware, Terra Cotta flue lining, fire brick, pressed brick, enameled brick, drain-tile, sewer pipe. Here are manufactured all kinds of stoneware, earthenware, fire brick, vitrified, salt-glazed sewer and water pipe, from 3″ to 36″ in diameter; conduits for underground electric wires, Terra Cotta chimney pipes, flue linings, etc.



California Clay Mfg. Co. pits near Alberhill.

The following materials are used at this plant for stoneware: clay from the Alberhill Coal and Clay Company, Alberhill; and kaolin from Rosamond, Antelope Valley, Kern County. For sewer pipe: clay from Alberhill Coal and Clay Company, and local clay from the northeastern part of Los Angeles City. For fire brick: fire clay from Alberhill Coal and Clay Company. For flower pots: local clay. For glazing: slip clay from Albany, N. Y. and from Michigan; also, imported feldspar, flint, china clay, and English ball clay.

The clay, duly mixed, according to the product to be manufactured, is passed through a dry-pan crusher, then washed, blunged and pressed through a press filter. The fire brick material passes through a pug-mill, a Giant auger, 12-brick wire cutter, and an Eagle represser. The sewer

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pipe material passes through a wet-pan crusher, and two presses, according to the dimensions of the pipes, one making those from 3″ to 16″ in diameter, and the other those from 18″ to 36″ in diameter. The pottery material goes to the pottery pug-mill, where it is brought to the required plasticity. The green products are dried in large rooms, slightly heated by the exhaust from the kilns. The time required for drying depends upon the weather; in summer from 8 to 10 days are sufficient.

California Clay Manufacturing Co. pit near Alberhill.

The plant has seven downdraft kilns, using oil as fuel: three of 30 ft. diameter; one of 25 ft. diameter; two of 20 ft. diameter; and one of 12 ft. diameter. Power is furnished by a 250 h.p. boiler, using oil as fuel, and a 200 h.p. engine.

No. 5. McKinley and Slauson avenues, Los Angeles. Formerly owned by the California Clay Manufacturing Company. Used for sewer pipe and vitrified conduits. The works are equipped with Brewer wet-mud brick machines, and a Berg press for dry-pressed brick, each with a daily capacity of about 20,000 bricks; a Barber pipe press, and 8 downdraft kilns, varying from 16′ to 30′ in diameter, using oil as fuel. About 30 men are employed.

No. 6. At Los Nietos. Used for sewer pipe and drain-tile.

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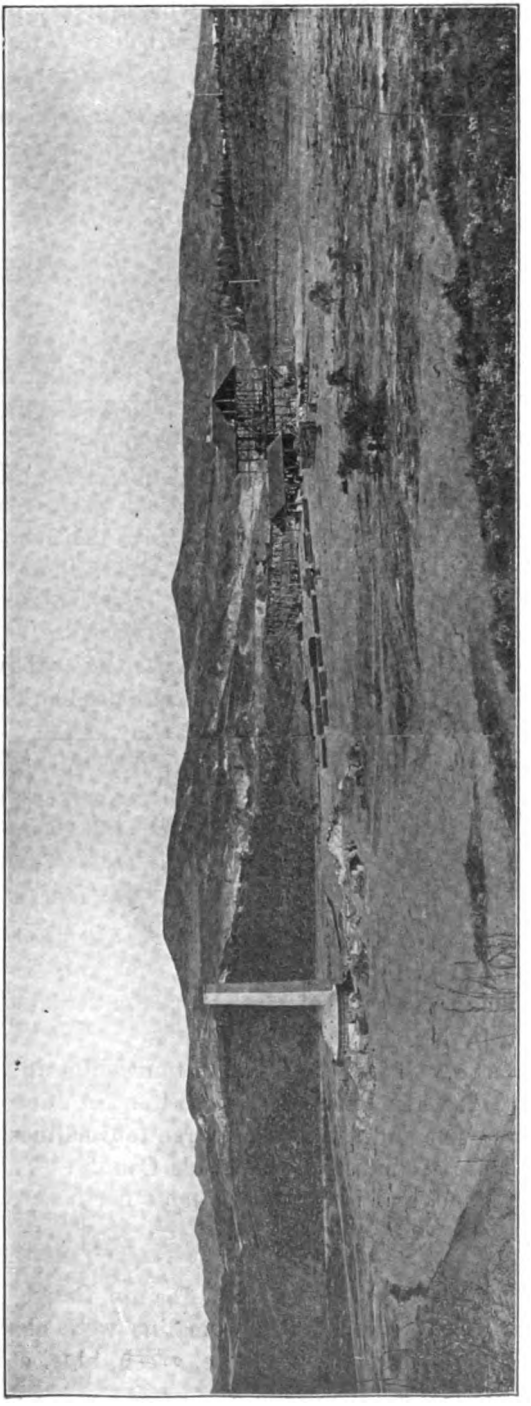

Panoramic view of new works of Los Angeles Pressed Brick Company, at Alberhill, RiversideCounty. Photo by Gerald A. Waring, July, 1916.

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California Clay Manufacturing Co. is working clay pits near Elsinore, analyses of their materials being given below. Alexander Caskey is manager, with offices at 235 South Los Angeles St., Los Angeles.

Analyses of Clays from the Mines of the California Clay Manufacturing Co.

Analysis	No. 20. Color, gray, fuller's earth, per cent	No. 23. Whitish, tile clay, per cent	No. 25. Color, gray, fire clay, per cent	No. 26. Color, white, China clay, per cent	No. 26. Color, white, pisolitic, per cent	Fire clay, hard and sandy, per cent	Red clay, pipe, per cent
Silica (SiO_2)	62.14	68.16	61.02	42.54	43.70	54.8	41.30
Alumina (Al_2O_2)	23.84	20.54	21.42	38.48	39.09	37.1	28.10
Iron Oxide (Fe_2O_2)	2.24	1.76	4.00	2.40	2.50	.7	15.00
Titanic Oxide (TiO_2)	1.00	.70	.20	1.12	----------	----------	---------
Lime (CaO)	.74	.46	1.68	.22	.40	.6	.60
Magnesia (MgO)	.22	.45	.76	.12	Trace	----------	.09
Alkalies ($K,No)_2O$	.82	.55	1.02	.70	----------	----------	---------
Sulphuric Anhydride (SO_3)	.11	----------	.25	----------	----------	----------	---------
Ignition loss	9.10	7.62	10.08	14.80	15.10	----------	13.90
	100.21	100.25	100.43	100.38	100.79	93.2	98.08

Analyses by Smith, Emery & Co.

The **Los Angeles Pressed Brick Co.** is (July, 1916) building a new plant for manufacture of clay products at Alberhill.

COAL.

Alberhill Coal and Clay Company shipped some coal from its holdings at Alberhill several years ago. No recent production of the coal. Work confined to the clay pits. See under Clay.

FULLER'S EARTH.

(See California Clay Mfg. Co., under Clays.)

GEMS.

TOURMALINE.

The tourmaline mines of this county were discussed in detail by Dr. Geo. F. Kunz in Bulletin No. 37, pp. 57-58, and from this publication the following descriptions are in part abstracted with added data contributed by Mr. Clarence A. Waring.

"The first discovery of the colored gem tourmaline in the state goes back as far as 1872, when Mr. Henry Hamilton, in June of that year, obtained some very fine and handsome colored tourmalines on the southeast slope of Thomas Mountain, in Riverside County. This was known as the Columbia Mine, and is one of the most northern occurrences in the state."

[17]Dr. Kunz also says:

"In 1893, near the crest of the San Jacinto Range, in Riverside County, loose or 'float' crystals of tourmaline were observed, chiefly black, but some finely colored—red, rose, green, blue, etc. [18]In some

[17]U. S. Geol. Survey, Min. Res. 1892, p. 12 (reprint).
[18]Bull. 37, p. 57.

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cases the green crystals were found to have red centers—a type long known from Brazil. Some large crystals were obtained and a number of gems were cut from them. The indications were promptly followed up, and several mining claims were located and worked. One of them, opened near the summit of the range by three prospectors, Messrs. Dwight Whiting, F. M. Speer, and F. H. Jackson, was called the San Jacinto Gem Mine. It was reported that more than a bushel of red and green crystals was found during the first season's operation, one of which measured 8 inches in length and several inches in diameter. This was purchased by Harvard University, with other crystals several inches long and two inches in diameter. One of this size had a dark green basal termination showing a red center on the fracture at the other end of the crystal."

Other very fine specimens are in the American Museum of Natural History in New York.

Dr. Kunz continues, Bull. 37, p. 21:

"Tourmalines have been mined in Riverside County, California, at the California Gem Mine, the San Jacinto Gem Mine, and the Columbia Gem Mine. These claims are situated at the foothills of the San Jacinto Range, overlooking Hemet Valley and the Coahuila Valley, and about 27 miles southeast from the San Jacinto branch of the Santa Fe railroad. The crystals occur in veins from 40′ to 50′ wide, running nearly north and south through the crystalline rocks of the mountain range. These veins in places consist of pure feldspar, or of feldspar with quartz; in others wholly of mica, and in others of rose quartz and smoky quartz. The tourmalines vary in size from almost micrograins to crystals 4 inches in diameter. They are most plentiful in feldspar, but are found in other portions of the vein, sometimes in pockets and sometimes isolated. The larger crystals generally have a green exterior and are red or pink in the center. Some crystals contain green, red, pink, black, and intermediate colors; others again are of uniform tint—red, pink, blue, or colorless. Associated with the tourmalines are rose-quartz, asteriated quartz, and fluorite, and some of the quartz is penetrated with fine, hair-like crystals of tourmaline, strikingly like the similar occurrence of rutile.

"Associated with the tourmaline from Coahuila have been found yellow beryls, closely resembling those from Sarapulka in the Ural mountains, also, others that are pale green, pink, and colorless. Some of the yellow crystals are finely formed and others show remarkable instances of etched faces, while others are almost as delicate as a darning-needle.

"Elegant specimens were made from some of the large crystals of this type by cutting and polishing sections across the prism, showing the rich green exterior, then a narrow zone of white, and within that

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the red central portion—a beautiful contrast of colors, suggesting a slice of watermelon. Some of these were as much as three inches in diameter. A few years later, remarkably fine crystals of colorless tourmaline (achroite) were reported from this locality by Mr. Dwight Whiting.

"There were, at one time, several mines in operation in the San Jacinto district, which gave a valuable output for several years. The one that has been most prominent of late is that known as the **Fano Mine** (formerly the Simmons), discovered and located in 1902, by Mr. Bert Simmons, but now owned by Mr. E. A. Fano, of San Diego. This was in the name of the Fano-Kunzite Tourmaline Mining Company, on the north side of Coahuila Mountain, at an altitude of some 4500 feet, about a mile south of Bautista Creek, 4 miles west of Ramona Indian Reservation, and 3 miles north of Coahuila Indian Reservation. This mine consisted of 4 claims. The nearest post office is Hemet. After some preliminary surface work a tunnel was driven 300 feet from the summit of the hill, to cross-cut the ledge, which was found about 20 feet from the surface. The parties then continued the tunnel until, at a distance of 176 feet, solid blue diorite was reached. The tunnel was then abandoned, and since that time work has been confined to the surface.

"The dike is about 5 feet wide, with a northwest and southeast strike, and dips southwest about 17°. The pegmatite is finely crystallized, and resembles that of the other tourmaline and kunzite mines in San Diego County.

"The output so far has been 25 pounds of kunzite, white; 1 pound of kunzite, pink; and 25 pounds of all classes of tourmaline, mostly blue and green; about 250 pounds of beryl have also been taken out, but only 5% of it available for gem purposes. Two hundred pounds of very fine quartz crystals also have been sold, and about a ton of lepidolite and 30 to 40 pounds of amblygonite; also flake mica has been discovered large enough for commercial purposes.

"There is a spring near the property, on land rented by the owners of the mine; also, plenty of oak timber for mining purposes. Considerable money has been expended here without much result, but for the work actually done on gem pockets, this mine has been a splendid producer.

"Several tourmaline mines were also located by **Mr. Bert Simmons,** north and east of Coahuila, from which some large gems have been obtained."

Columbia Gem Mine. "This, the oldest tourmaline mine in the state, is on the site of the original discovery of colored tourmaline in this county, made by Mr. Hamilton, in 1872, and was owned by Messrs.

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H. C. Gordon, P. E. Johnson, J. C. Connell, and William Dyche, but other parties have claimed it under the name of the April Fool Mine.

"It is on Thomas Mountain near Coahuila, at 5000 feet elevation, about ½ mile northwest of the road leading from Coahuila to the Hemet reservoir, and near the summit of the divide crossed by this road. The property has produced many beautiful gems, but nothing except assessment work has been done on it for many years. The pockets worked, at one time, seem to have been exhausted, and nothing important has recently been found. The pegmatite dikes are of very fine grain, and both sides of the pocket material seem to be of the same character, thus differing from the other gem-bearing dikes of California. There is no water or timber available."

Mr. C. A. Waring contributes the following additional matter on this property:

California Gem Mine: "It is located at the east end of Thomas Mountain, on Nigger Jimmy Hill. Yielded rose quartz and black and green tourmaline. It is said that $10,000 worth of gems were taken out about 1894. Some pink, green, and dark red tourmaline is said to have been taken out also. It is said that $300 worth of rose quartz has been taken out recently. The workings consisted of a cut 60′ long and 15′ deep, with, also, a few scattering prospect holes. The product is reported to have been sold to Messrs. F. A. Marcher, Whiton, Bradley, and Saxon, of Los Angeles."

In November 1914 no other tourmaline mine than this described by Mr. Waring was known in this region. The two others described by Dr. Kunz have been forgotten.

GYPSUM.

This material, the hydrous calcium sulphate, or sulphate of lime, is of much importance in construction since the calcined product, plaster of Paris, is the base of nearly all wall plasters for interior work. It also forms the base of the material known as staff which is so extensively used in the construction of temporary buildings for exposition purposes. Gypsum is also important as a fertilizer in supplying lime and in correcting alkaline soils. In small quantities, it is used in the manufacture of Portland cement to retard its setting.

The principal deposits of gypsum in this county are near Corona and in the eastern desert section. Mr. C. A. Waring reports on the latter as follows:

United States Gypsum Company, 200 Monroe St., Chicago, Ill.; president, S. L. Avery. The gypsum claims of this company are in the southwest corner of T. 3 S., R. 21 E., and the northwest and southeast corners of T. 4 S., R. 21 E., S. B. M. Most of the prospecting has been

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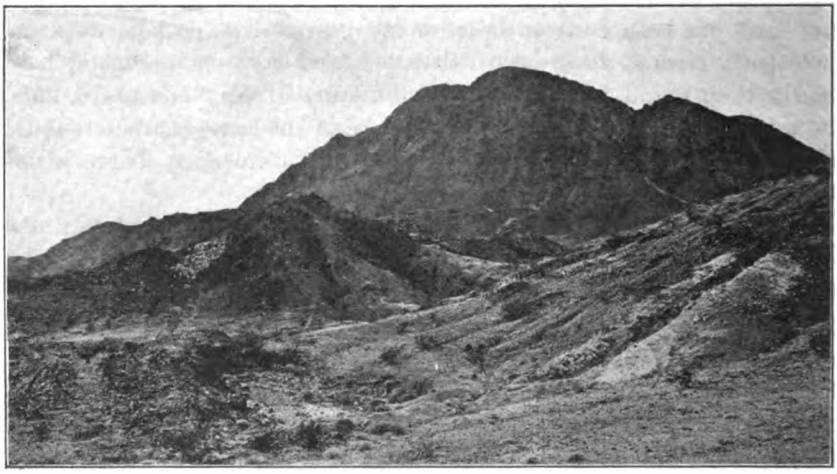
carried on in a cove on the south side of the Santa Maria Mountains, 2 miles west of the stage road from Blythe to Blythe Junction. (See upper photo.)

The gypsum beds on the north side of this cove strike N. 50° W., and dip 55° to the north. They are in places 150 ft. thick and consist



Looking N. 50° W., along strike of gypsum deposits, Santa Maria Mountains. Prospects of the United States Gypsum Co. Photo by C. A. Waring.

of fine, white, compact crystals of pure gypsum. The same gypsum beds occur on the south side of the cover with somewhat similar strike but with a southerly dip. The center of the anticline has been faulted and eroded away, leaving the gypsum exposed on either flank. The

Looking eastward along the strike of the gypsum beds, Santa Maria Mountains, from the United States Gypsum Co. prospects shown in view above. The intense folding and faulting of the schists is well exposed in the Big Maria Mountains in the distance. Photo by C. A. Waring.

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beds on the southern flank dip into the plains to the southeast. (See lower photo, p. 118.)

The gypsum strata are interbedded with a pale greenish amphibolitic quartzitic schist which weathers to a glossy brown in the desert climate. In places limestone occurs interbedded with the gypsum.

Only prospecting in the nature of cuts and trenches has so far been carried on. Water has been developed in a 585 ft. well on the north side of the mountains in Sec. 19, T. 3 S., R. 21 E.

These gypsum deposits are quite extensive and claims have also been located about 4 miles east of the main U. S. Gypsum deposits. Assessment work has been done on the claims of **Mr. Schellenger,** of the **Riverside Gypsum Company,** and of the **Consolidated Gypsum and Plaster Company,** on the west side of the Little Maria Mountains.

Gypsum is said to occur at the north end of the Palen Mountains, about three miles north of Packard's well.

CORONA DEPOSITS.

In the range of hills west and southwest of Corona are deposits of gypsum, which are somewhat unique, in that they contain besides the calcium sulphate, iron sulphate and some lime. This combination is stated by the orchardists of the district to be particularly valuable, not only as a fertilizer, but also for preventing disease and parasites. For the latter purpose, they dig around the trunk of the tree and put the gypsum near the roots.

Among the larger orchard properties which have their own gypsum deposits are:

El Cerrito Ranch, W. C. McCully, superintendent.

W. H. Jameson Company, J. G. Jameson, manager.

The Natural Fertilizer Co., near Corona, is quarrying gypsum on its property and has a grinding mill in which the mineral is prepared for fertilizing purposes. Ten men are employed.

The Soil Tone Co., W. L. Brown, manager, Corona National Bank Bldg., Corona, is working a gypsum deposit near Corona and shipping a considerable tonnage.

W. C. Barth, Corona, has a gypsum deposit near Corona on which some development work has been done.

George W. Lord, Corona, has been shipping small amounts of gypsum from his deposit near there. He also has ochre suitable for paint.

MAGNESITE.

The chief deposit of this material in Riverside County, is near Winchester, and is carefully described in the U. S. G. S., Bull. 355, pp. 38–39.

This deposit has been opened for commercial use, but without success, for the serpentine matrix dominates to such an extent that it is difficult to separate the magnesite in a state of sufficient purity

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from the enclosing rock. At present no use is made of the deposit. It is now controlled by **W. H. Daum,** Equitable Bank Bldg., Los Angeles[19].

Magnesite is important commercially as a source of carbon dioxide gas used in making soda water and similar aerated beverages. It is also used in refractory linings for metallurgical furnaces.

One of the chief uses is in cement for flooring bath-rooms, and similar purposes, for which tile and marble have long been employed.

There is also a limited use of magnesia as a medicine. A very thorough discussion of this subject will be found in Mineral Resources of the United States, 1913, Part II, pp. 445–449. See also our Bull. 71, pp. 47–53.

MINERAL SPRINGS.

Among the natural resources of Riverside County, which are of commercial importance, must be reckoned its mineral springs. Their importance lies in their curative properties which attract hundreds of persons to the hotels operated in connection with them. Many of these springs have been known and used for many decades, and their popularity is still noteworthy.[20] Some of the most noted of these are on the fault line of Temescal Valley. These are the well known springs of Glen Ivy, Elsinore, and Murrietta. At Elsinore, there were originally several thermal springs containing a small amount of sulphur. Some of these were absorbed in establishing water supply for the city of Elsinore, and there remain those used for their curative properties in connection with the Lakeview Inn and Bundy's Hotel. The analyses of these waters are as follows:

Analyses of Water From Lakeview Inn Hot Springs.

	Original Hot Springs, grains per gallon	White Sulphur Springs, grains per gallon
Total residue by evaporation	19.88	19.40
Soluble in water after evaporation	13.12	11.88
Insoluble in water after evaporation	3.79	5.24
Organic matter and chemically combined water	2.91	2.88
The soluble parts consist of—		
Sodium and potassium sulphates	7.07	4.09
Sodium chloride (common salt)	3.38	5.07
Sodium carbonate (sal soda)	2.67	2.67
The insoluble parts consist of—		
Calcium sulphate (gypsum)	1.92	2.33
Calcium and magnesium carbonates		
Silica	1.87	2.91

[19]Since the above was written, W. Wells & Company of New York have taken over the magnesite property between Hemet and Winchester, formerly operated by the Magnesco Refractory Products Co. Shipments of crude magnesite are being made, and construction of a calcining plant begun. E. G. Kleiner, Hemet, is superintendent. (Nov., 1916).

[20]The most elaborate discussion of this subject thus far issued will be found in U. S. G. S. Water Supply Paper No. 338, by Gerald A. Waring, 1915.

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A partial analysis of the waters of *Bundy Hot Springs*, made by the California State University, is as follows:

Partial Analysis of Water From Bundy Hot Springs.

	Grains per U. S. gallon
Sample clear, with taste of sulphuretted hydrogen.	
Sodium and potassium sulphates (Glauber's salt)	5.02
Sodium chloride (common salt)	1.64
Sodium carbonate (sal soda)	6.19
Calcium and magnesium carbonates and calcium sulphate	2.04
Silica	3.51
Organic matter and chemically combined water	.88

Temperature 112° F.

Murrietta Hot Springs. The largest and hottest spring is at Siloam. It will boil an egg in ten minutes. Its waters are 170° F. The analysis of the waters from this spring, by Prof. C. E. Wagner, a chemist of Saxony, Germany, shows the following:

Analysis of Water From Murrietta Hot Springs.

	Constituents per 100,000	Grains per gallon
Sulphate of lime	2.14	1.25
Carbonate of lime	.69	.40
Carbonate of magnesia	Trace	Trace
Iron	.52	.30
Soluble silicate	6.00	3.50
Chloride of sodium	60.10	35.00
Carbonate of sodium	2.83	1.65
Hydrogen sulphide and carbonic acid	5.15	3.00
	77.43	45.10

Some twelve miles northeast of **Elsinore,** along the western base of the San Jacinto Range, is another fault, along the line of which are several thermal springs, notably Eden Hot Springs, San Jacinto or Relief Hot Springs, and Richey or Soboba Hot Springs. On the eastern base of the same range occur the Palm Springs. All of these springs are well known locally and they are well described in the Water Supply Paper above mentioned, to which, for information about these and other springs in this county the reader is referred.

SALINE DEPOSITS.

Bibl.: Bull. 24, pp. 54, 69, 89, 102, 107, 122–126.

BORAX.

A large portion of the eastern end of Riverside County is occupied by the Colorado Desert, which was once the basin of the ancient lake

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which has been named Lake Coahuila.[21] Salton Sea, in the lowest portion of this basin, is crossed by the boundary line between Riverside and Imperial counties. While no borax is at present being worked in this county, its presence is known to prospectors at a number of places in the Colorado Desert.

Borate of lime has been found in the foothills of the San Bernardino Range northeast of Salton Sea in Riverside County. The borders of this old lake offer a promising field to the prospector for borates, and lime borates should be especially looked for.

Boric acid exists in a number of springs on San Felipe and Carizzo creeks in San Diego County. Dr. Veatch[22] in his search for borax in the early days, found boric acid in some quantity in the mud volcanoes and on Carizzo Creek. It has also been discovered in Agua Caliente Springs, on Warner's Ranch, San Diego County. Borax associated with salt and carbonates and sulphides of soda, are found in many of the playa lakes of the Colorado Desert. No locations for borates have been made in this district.

Borax: Native borax or biborate of soda. One of the main sources of borax in the state. Boric acid, 36.6%; soda, 16.2%; water, 47.2%. Color, white, sometimes grayish, bluish or greenish. Hardness, 2 to 2.5. Specific gravity, 1.69 to 1.72. Luster, vitreous to resinous, sometimes earthy. Translucent to opaque. Taste, sweetish alkaline, feeble. Soluble in water. In blowpipe fuses to "borax glass."

POTASH.

(See Riverside Portland Cement Co., under "Cement.")

SALT.

In 1884, the **New Liverpool Salt Company** began work on the salt beds of Salton Sea, producing some 1500 tons.[23] From that time progress was rapid until the submergence of the salt beds in 1903 by the inundation of the basin, when the company stopped work. Prior to the inundation, the basin was being constantly supplied by numerous springs in the adjacent foothills, the water from which flowed into the basin and quickly evaporated, leaving a deposit of pure salt varying from 10 to 20 inches in thickness.

Borings made at Salton give the following section:[24]

1.	Salt crust	10 to 20 inches
2.	Mud	6 inches
3.	Crust of chlorides of sodium and magnesium	7 inches
4.	Black ooze containing 50% of water and carrying chlorides and carbonates of sodium and magnesium	22 feet
5.	Hard clay with a few streaks of cement	275 feet 5 inches
	Total	300 feet

[21] See Wm. P. Blake, Pac. R. R. Reports, Vol. V.
[22] Bull. 24, p. 55.
[23] Bull. 24, "Saline Deposits of California," by Gilbert E. Bailey, pp. 122-126.
[24] Op. cit., p. 126.

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Published analyses of the natural crusts from Salton show that the salt was very pure, as follows:

Sodium chloride	91.68	97.76
Sodium sulphate	.68	.70
Calcium sulphate	.77	.38
Magnesium sulphate	3.12	
Water	.75	.96
Insoluble		.20
	100.00	100.00

This salt remained dry in any ordinary atmosphere, and was free from organic matter.

The salt was loosened by cable plows, that cut, in the salt, furrows 8 ft. wide and 6 inches deep, each plow harvesting over 700 tons of pure salt per day. On a moveable railroad track the salt was conveyed to the works.

The workmen were Indians of the Coahuila tribe, large, well developed men, not affected by the dazzling sunlight, and able to work 10 hours a day with the thermometer registering 150° in the sun. As solar heat alone was necessary at this locality, the mill plant consisted only of machinery for grinding and bagging the salt for shipment.

As described by Professor Bailey, the sight of the salt works was an interesting one, for thousands of tons were piled up in heaps like snow drifts, and a large force of men was busy preparing and packing for market, salt of the various grades.

One observer has said:[25] "As one approaches the Salton Sea, it looks like an immense crystal lake, and the houses and sheds of the salt works appear suspended in the air, in mirage. As far as the eye can see the white and dazzling field of salt extends towards the horizon."

STONE INDUSTRY.

BUILDING STONE.

That there is a great wealth of valuable stone in California has been known for years. It is equally well known that much of it is undeveloped, a considerable portion of the building and ornamental stone used in this state being imported from other states and from Europe.

Uses of Stone.

Stone is used in substructures very extensively. Wood, concrete, brick, and iron are frequently used as a substitute in superstructures, but where first cost can be subordinated to architectural effect, stone will, in most cases, be used.

For funeral monuments there is no satisfactory substitute for stone, and for this purpose it is often shipped long distances, in order to get

[25] Bull. 24, p. 124.

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one that has an established reputation. Many of the monuments in this state are of stone from New England, Indiana, Georgia, or Europe, and often a large part of the cost of the monument is in railroad and water freight.

Some other uses of stone are in the construction of breakwaters, bridge abutments, culverts, curbing, fences, flagstones, hitching posts, macadamizing, paving blocks, piers, retaining walls, reservoirs, sewers, sluiceways, etc.

Classification of Building Stones.

Rocks are commonly divided into two, sometimes three, great classes: the unstratified, or igneous; and the stratified, or sedimentary.

The first class may be subdivided into the granitic or crystalline rocks, and the volcanic or partially crystalline rocks. The granitic class includes granite, syenite, etc., the volcanic class includes basalt, trachyte, tuff, etc.

The sedimentary rocks include those formed in water, such as sandstone, limestone, etc.

The third class includes the metamorphosed forms of the other two classes. They may be formed from the igneous rocks, as gneiss, some of the schists, serpentine, and talc; or from the sedimentary rocks, such as marble, which is a metamorphosed limestone; quartzite, which is a metamorphosed sandstone; or slate, which is a metamorphosed clay or shale.

GRANITE.

This stone is widely distributed over Riverside County. It has been quarried on a large scale at Casa Blanca for rubble used in the San Pedro breakwater, and for building and ornamental purposes at Corona, Riverside, and Temecula. At Porphyry and Riverside it has been quarried for broken stone. The Casa Blanca quarries have long been idle.

Besides its use for paving, the Corona granite is used to some extent for building stone, and in considerable quantities for monuments in Los Angeles, Riverside and other places in southern California.

The monument dealers in southern California nearly all speak highly of the Corona granite for monuments, thus giving it a reputation in that field. Its nearness to Los Angeles and Riverside also favors the use of this stone for "Belgian" (paving) blocks.

Corona. East of Corona, one mile north of the Santa Fe Railway, in Sec. 16, T. 3 S., R. 6 W., are several productive granite quarries. A number of rounded hills or buttes occur at this place, over the tops and slopes of which the granite outcrops in rounded ledges in the midst of a multitude of large rounded boulders. Many of the boulders, as well as the projecting ledges, have a smooth, hard, firm surface. Some of them have been polished by wind carrying dust, which has worn away

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the disintegrated surface as fast as it has been formed. A large part of the granite has been quarried here from the boulders, as these are more easily worked into dimension stone than the massive bedrock. The boulders are especially available for making Belgian paving blocks, which are produced here in large numbers.

Sierra Grande Quarries. M. J. Mayer, lessee. Sec. 16, T. 3 S., R. 6 W., S. B. M. The quarry is in the low foothills, close to the track of the Santa Fe Railway, near Porphyry Station, about 2 miles east of Corona. Here are made large numbers of Belgian blocks for Los Angeles streets; also, considerable granite is shipped to monument dealers in different towns. Mr. Mayer in several places is working the outcropping granite boulders into paving blocks. Under the microscope the granite from Mayer's quarry at Corona is seen to consist of orthoclase feldspar, with a little microcline and albite, quartz, biotite, and muscovite.

The stone from all the quarries is hauled by wagon to the railroad at Hammer switch, about a mile east of Porphyry station.

Corona Rock Company, 516–17 Pacific Electric Building, Los Angeles. The quarry is in Secs. 8 and 17, T. 3 S., R. 6 W., S. B. M. This is a contracting company, using large quantities of building granite, as well as paving blocks, and broken stone for ballast and concrete. Besides the granite quarries north of Hammer switch, this company operates a large quarry at Porphyry Station. The stone is used for concrete, macadam, and railway ballast.

Bly Bros. & McGilliard Stone Co., 678 S. Utah street, Los Angeles. This firm operates two quarries: One in the NW. ¼ of Sec. 1, T. 2 S., R. 6 W.; the other in the SE. ¼ of the same section. These are in the Jurupa Mountains, which are formed by a granite intrusion.

These quarries produce a large quantity of fine granite used for building purposes in Los Angeles and vicinity. This firm has in Los Angeles one of the best equipped stone yards for handling and dressing stone that there is in southern California. There are saw gangs for sawing stone, as they handle consider sandstone and marble in their contracts. They have stone planers, steam drills, pneumatic drills, and surface tools. There is always a large force of stonecutters, as much of the cutting and finishing is necessarily done by hand. The annual production is 120 carloads (40 tons) dimension stone (5% of this is used for monuments), and 1200 carloads of riprap. Twenty men are employed at the quarry, and 20 men at the yard.

Lane Bros. Monument dealers, 833½ S. Figueroa St., Los Angeles, Cal. This firm formerly worked a granite quarry 3 miles east of Corona, loading at Alvord Station on the Santa Fe Railway. This quarry is now idle, and the stone used is purchased from various

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quarries. This firm operates a stone cutting yard on Santa Fe avenue, Los Angeles.

Elsinore. Near this town there are two granite quarries which have produced paving blocks in moderate quantities. One is operated by **P. H. Coogan** in Sec. 2, T. 5 S., R. 4 W. The product is chiefly derived from surface boulders; the rock is a gray diorite. The other quarry is controlled by **Connolly Bros.** and is now idle.

Temecula. Two granite quarries have long been worked about two miles south of this place. They have lately been operated by **M. Machado** and **Joseph Winkles,** but were formerly worked by other persons.[26]

Perris. Between this place and Elsinore are some quarries in diorite controlled by **La Borde Bros.** of Perris.

CRUSHED ROCK.

Temescal Rock Quarry. The quarry is owned by the Temescal Rock Company; office, 603 Central Building, Los Angeles; A. B. Filch, president; H. S. Cook, secretary. The company has about 200 acres of mountain land lying in Sec. 4, T. 4 S., R. 6 W., S. B. M. The quarry is located in Temescal Cañon, 4 miles southeast of Corona. The material that is being crushed is a rhyolitic porphyry and is very hard and sharp. The mountain side where the rock is being quarried slopes steeply and has an elevation of 1000 to 1200 feet above the cañon.

The company has nearly four miles of its own tracks which connect through the cañon with the main line of the Santa Fe Railroad. The plant has a capacity of 1500 to 2000 tons of crushed rock products per day. Besides crushed rock products, an incline tramway has been installed to load massive rock material up to 10 tons in weight, for riprap and sea wall construction.

The quarry extends along the mountain side south of the head of the crushing plant, this quarry floor being 180 feet above the floor of the cañon. It is so arranged that while one end of the quarry is being drilled and blasted, the broken rock on the other end is being loaded into cars and hauled to the crusher. A Marion steam shovel, model 100, loads the broken rock into all-steel dump quarry cars, which have a capacity of 8 tons. The drilling is done by two Star drills, by means of which a line of holes are drilled from a bench and then blasted at one round. Trojan powder is used in the blasting operations. The quarry dump cars are operated by electric motors, receiving the current from a third rail. By a system of levers in a tower over crusher in the crushing plant, operated by one man, an empty car is sent to the steam shovel, when loaded brought back and spotted at

[26] Bull. 38, pp. 42–47.

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chute before large crusher. By means of another lever controlled by the same operator, the load is dumped into a Blake Jaw type of crusher, size 84″x66″, and capable of handling a rock 5′x6′x10′. The crusher is driven by 300 h. p. motor. The capacity of this crusher is rated at 600 tons per hour.

The material from this crusher will pass through a 10″ ring. The product from the crusher passes through revolving screen (5′ in diameter by 12′ in length), where the fine dirt material is screened out. The over-size runs down into a No. 9 McCully gyratory crusher and is reduced to 3½″ maximum pieces. This crusher is driven by 150 h. p. motor. The material is then conveyed by belt conveyor to two revolving screens (size 5′ in diameter by 12′ in length) which take out all rock more than two inches in diameter. The over-size material is conveyed to two 48″ Symons Disk crushers, where it is reduced to 2″ or less. The finished product is carried by means of a belt conveyor from the scalping screens and disk crushers to a sizing screen over storage bins, where it is separated into five different sized products. Those sizes of smallest volume are conveyed by chutes direct into the bins nearest the screen, and those of larger volume are carried by shuttle belt conveyors to bins farther away.

The storage bins have a capacity of 5000 tons of crushed rock. Supplies and material are hoisted from the main railroad tracks over a standard gauge track to the quarry floor by means of 75 h. p. Lidgerwood electric hoist. Another 50 h. p. Lidgerwood electric hoist operates cars over incline to load riprap material.

The following new concern was beginning operations in May, 1915:

B. R. Davison Construction Co. of Monrovia, opening up a quarry near Banning to supply crushed rock for highway work between Banning and Palm Springs.

Riverside Portland Cement Co. (See also page 95), in addition to its output of limestone quarried for use in the cement plant, also offers for sale the crushed crystalline limestone for use in concrete and road work.

SAND.

Sand for building is necessarily in demand at every city, town and settlement, where building operations are conducted. The material occurs abundantly in all stream belts or washes, and needs only an inexpensive treatment by screening to prepare it for use. The only substantial plant observed in Riverside County was 1½ miles east of

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Whitewater Station on the Southern Pacific Railroad. From this point sand and gravel are shipped to El Centro and other cities.

This plant is controlled and operated by M. R. Kane of Snow Creek post office.

The following persons reported in 1914 the production of sand and gravel from local sources:

J. F. Atkins, 1393 W. 6th St., Riverside.

F. S. Ramsey, 1159 11th St., Riverside.

M. I. Wheeler, 245 Colton Ave., Riverside.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

Vol. 34 JANUARY, 1938 No. 1

CALIFORNIA JOURNAL

OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIV

STATE DIVISION OF MINES
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·DIVISION·OF·MINES·
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MEXICO

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District, on account of unfinished field work. A special report on gold dredging is in preparation.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field District are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

MINERAL DEVELOPMENT AND MINING ACTIVITY IN SOUTHERN CALIFORNIA DURING THE YEAR 1937

By W. B. Tucker, District Mining Engineer

The total value of the mineral production of California for the year 1937, is estimated by the Division of Mines, under the direction of Walter W. Bradley, State Mineralogist, to have been $351,487,000.

There were 50 different mineral substances produced during 1937.

The following southern California counties were producers of a great variety of these minerals:

County	Number of mineral products
Imperial	11
Inyo	18
Kern	18
Los Angeles	20
Mono	7
Orange	13
Riverside	14
San Bernardino	25
San Diego	13
Santa Barbara	10
Ventura	8

The salient feature of the 1937 mineral production was the increase in production and value of the metals: Gold, silver, quicksilver, lead, tungsten and iron.

Structural Materials: Of the structural group practically all materials showed an increased production and value with the exception of cement. They were as follows: Clay products, granite, lime, marble (onyx and travertine).

Industrial Minerals: There was a small increase in production and value of the following minerals: Bentonite, diatomite, pumice, volcanic ash, silica, sillimanite (andalusite and kyanite), sulphur, and talc.

Salines: There was an increase in production and value of borates, potash, soda, and salt.

Metals.

California continued to hold its position as the leading gold producing state of the United States; the quantity in 1937 was greater than in any year, since 1883, with the highest annual gold value since 1861, the production being 1,164,000 fine ozs. with a value of $40,740,000.

All other major metals showed an increase in output with the exception of zinc.

The silver and copper yield, each had a total value over the million dollar mark.

Mining Activity. There has been increased activity in all the gold districts in southern California during 1937. There has also been a considerable revival in the mining of tungsten ores in Kern, San Bernardino and Inyo counties. There was also some revival of mining in the silver-lead districts of Inyo and San Bernardino counties. There is some activity in the mining of iron ores in Inyo and San Bernardino counties. In Inyo County high-grade magnetite ore was being mined from the Hoot Owl Iron deposit situated in the Argus Range of mountains, 20 miles north of Trona, the ore being shipped to San Francisco. In San Bernardino County high-grade hematite was being mined from Cave Canyon Iron deposits near Baxter, a station on the Union Pacific Railroad, and shipped to cement plants.

There was a revival of quicksilver mining in Inyo, Kern, San Luis Obispo, and Santa Barbara counties.

Gold.

Mine development and the production of gold showed a considerable increase in the following counties in southern California:

Imperial County.

The most active mining district in the county was the Cargo Muchacho district, situated in the Cargo Muchacho Range of mountains, 4 miles northeast of Ogilby, and 18 miles northwest of Yuma.

There were four producing properties under operation during the year. The *American Girl Mine* was operated by the *Socorro Mining Company,* Mrs. J. J. O'Brien, president, A. T. Balmforth, secretary, W. B. McMillen, superintendent, Ogilby, California. Increased the capacity of flotation plant to 150 tons per 24 hours.

Forty-five men employed.

Cargo Muchacho, Madre and Padre Mines, being operated by *Holmes and Nicholson Mining and Milling Company;* Kenneth Holmes, president and manager. At present extracting ore from the Padre and Madre mines. Ore hauled by truck 12 miles for treatment in company's 50-ton cyanide plant at Winterhaven.

Twenty men employed.

Sovereign Mine. This property is operated by the Sovereign Development Company. Courtney Baylor, president; Thomas L. Woodruff, vice president and manager; M. Dick, secretary, 30 Bay State Road, Boston, Mass. Mine office, Ogilby, California.

Ore hauled by truck from mine a distanct of 2 miles for treatment in company's 30-ton cyanide plant.

Fifteen men employed.

Tumco Tailings. Riggs and Horgan operated 20-ton cyanide plant on tailings from Golden Queen, Golden Crown and Golden Cross mines, continuously during the year, employing six men.

Inyo County.

Gold mining was quite active throughout the county, and a number of new and old properties resumed operations during the year.

Bishop Creek District: The *Cardinal Mine* was operated continuously during 1937, and was the largest gold producer in the county.

The operating company was the Cardinal Gold Mines Company; Victor Bongard, superintendent.

Operating 150-ton flotation plant.

One hundred men employed.

Polita Mine near Bishop was operated by H. W. Van Loon, of Bishop. Ore was treated in a 25-ton amalgamation and flotation plant.

Keeler Gold Mines Inc., Roy Troeger, manager, 972 Fourth Ave., Los Angeles. Operated the *Kruger Mine* in Cerro Gordo Mining district. near Keeler. Also treated ore in 50-ton cyanide plant from *Tucki, Del Norte Mines* situated in the Wildrose Mining district in Panamint Range of mountains.

Twelve men employed.

In Wildrose mining district the *Cashier* and *Skidoo* mines were operated by Roy Journigan, the ore being treated in 20-ton cyanide plant of the *Journigan Mining and Milling Company.* Roy Journigan, manager.

Fifteen men employed.

In Argus Range of mountains, there was increased activity in gold mining. The *Ruth Mine*, situated 14 miles north of Trona, was taken over by *Burton Bros. Inc.*, George Wyman, and Nels Sweetzer of Mojave. Installed a 40-ton cyanide plant, which is to be increased to capacity of 70 tons per day. Also acquired the *Davenport Mine* which is being developed.

Twenty-five men employed.

Mohawk Mine was acquired under lease by L. E. Netherton, of Randsburg. Ore mined being treated in 20-ton cyanide plant.

Twelve men employed.

This property is 14 miles north of Trona in Argus Range of mountains.

There were eight producing gold mines in Inyo County during 1937.

Kern County.

Gold mining continued active during 1937, there being fifteen producing properties under operation. The most active districts were Mojave, Tropico, Randsburg, Kernville, Keyesville. In the Mojave district the following mines were under operation:

Golden Queen Mine operated by the Golden Queen Mining Company, William Browning, manager. Offices, Pacific Mutual Bldg., Los Angeles, California.

This company increased its cyanide plant to treat 400 tons per day. The mine is the largest producer of silver in the state.

Lode Star Mine was developed during the year to be one of the largest producers in the district. Ore mined is shipped to the Golden

Queen Mill for treatment at the rate of 150 to 200 tons per day. Installed new Imperial type of Ingersoll-Rand compressor and continued development on the Echo tunnel level. John Rogers, of Willow Springs, is general manager of the property.

Fifty men employed.

Other mines under production are *Soledad Extension*, *Standard Whitmore*, *Eureka* and *Pride of Mojave*.

At Tropico:

The Tropico Mines were operated by Burton Bros. Inc.; Clifford Burton, president and manager.

This company increased the capacity of the mill to 100 tons per day. Besides treating mine run of ore, the mill was operated as a custom mill, treating ores of other mines in the district.

At Middle Butte:

The Cactus Queen Mine was acquired by the *Cactus Mines, Inc.;* Harvey Mudd, president; Roy Moore, general manager; offices, Pacific Mutual Bldg., Los Angeles, California.

This company purchased the *Blue Eagle group* of mines, and has developed the property into one of the large gold producers in this district. Ore from the mine is treated in 100-ton cyanide plant.

Seventy-five men employed.

Middle Buttes Mine, was acquired under lease by George Holmes, of Mojave, and ore mined is hauled by truck to Golden Queen mill for treatment.

Twenty men employed.

Randsburg District:

The following mines are under operation: Yellow Aster, Big Butte, Operator, Buckboard, King Solomon and Black Hawk.

At the *Yellow Aster Mine*, the *Anglo-American Mining Corp.*, Walter Brown, president; H. W. Klipstein, vice president; A. W. Frolli, manager; Mills Bldg., San Francisco, California, plans to mine 2000 tons of ore from glory hole with steam shovels to deliver it to crushing and screening plant, where oversize material is eliminated, converting 4 tons into 1 ton of $\frac{1}{4}$-mesh size, delivering 500 tons of ore to amalgamation and concentration plant, tailings to cyanide plant. The 1200-ton cyanide plant operated to capacity.

Forty-five men employed.

Kernville District:

The Big Blue and Lady Belle mines at Kernville were operated continuously during the year by *Kern Mines Inc.* Eirind Knutsen, manager, 605 Market St., San Francisco, California.

Ore from above mentioned mines treated in 100-ton flotation plant.

Thirty men employed.

Keyesville District:

Mammoth Mine was being developed by G. W. Russell, Isabella, California.

Six men employed on development.

Keyes Mine was taken over under bond and lease by *Barlu Enterprise Mining Company;* Harry Lucas, manager.

Ore mined from winze from tunnel level is milled in 10-stamp mill. Ore being milled is reported to carry from $25 to $50 per ton in gold.

Pennsylvania Mine. Acquired by F. J. Roberts, of Los Angeles. After driving a tunnel 1400 feet in length, cut ore shoot 100 ft. in length, average width 8 in. reported to carry $100 per ton in gold. Ore being milled in Mammoth mill.

Four men employed.

In Piute Mining district, the following mines were under operation during 1937:

Burning Moscow Mine, operated by the *Piute Mining Company,* William Quackenbush, vice president and manager. This company also took over the *Skyline Mine* situated in Pine Tree Canyon, 15 miles northwest of Mojave. Development consists of four shafts with 4000 feet of underground workings. Ore treated in 25-ton amalgamation and concentration plant. Twenty men are employed.

Gwynne Mine was operated during the summer months by Otto and Jack Gerenger, of Mojave. The property is situated in Green Mountain Mining district in Piute Mountains, 25 miles north of Caliente. Mine developed by tunnel 1750 ft. in length with a shaft 300 ft. in depth. Mill has a capacity of 25 tons per day; ball mill, amalgamation plates and concentrator.

Seven men employed.

Los Angeles County.

The principal productive gold mines in the county were the Governor, Rogers-Gentry and Western Graphite Company's custom mill.

Governor Mine is owned and operated by Chas. H. McWilliams and J. F. Gage, 725 So. Figueroa St., Los Angeles. Development consists of tunnel 800 feet in length from which a vertical shaft is sunk to a depth of 430 ft., with over 1500 ft. of underground workings. Ore is hauled by truck from mine to mill a distance of 5 miles. Mill consists of amalgamation and flotation plant and has a capacity of 40 tons per day.

Fifteen men employed.

Rogers-Gentry Mine is situated 6 miles south of Neenach. Owners W. T. Rogers and R. J. Gentry, Neenach. Developed by three shafts, with depths of 300 ft. and a tunnel 150 ft. in length, with winze 200 ft. deep. Ore milled at mill of Burton Bros. Inc., Tropico, and Western Graphite Company's mill.

Western Graphite Company's custom mill operated by C. W. Jones, 337 West Avenue 26, Los Angeles. Capacity of plant is 50 tons per day. Treatment is by flotation and concentration.

Twelve men employed.

Mono County.

Activity in gold mining in this county showed a considerable increase, the most active districts being Bodie, Mono Lake and Chidago.

At Bodie, the *Standard Cons. Mines Company's* property, owned by J. S. Cain, of Bodie, operated under lease by the *Roseclip Mines Co.,* Henry W. Klipstein, president, Mills Bldg., San Francisco; K. E. Peters, manager. Installed 250-ton cyanide plant to treat 500,000 tons of dump material reported to have an average value of $4 per ton in gold and silver.

Fifty men are employed.

In the Mono Lake district, the *Simpson Mine,* west of Mono Lake, was operated by the *Mutual Gold Mining Company,* Spokane, Washington; J. A. Vance, general manager.

Development consists of a tunnel 1200 ft. in length and a shaft 300 ft. deep with 5000 ft. of drifts and crosscuts. Ore mined is treated in 10-stamp mill, with amalgamation plates and concentrators.

Thirty men are employed.

May Lundy Mine is situated in the Lundy Mining district. Owned by Thomas Hanna, Martinez, California. Installed 40-ton flotation plant for treatment of 60,000 tons of tailings said to carry $4.23 per ton in gold. Also rehabilitated power plant above Lake Lundy. Water to Pelton wheel drives 250 KVA generator, developing 180 h.p. at mill. Power line to mill from hydroelectric power plant is two miles in length.

Ten men employed.

In Chidago District, the *Casa Diablo, Sierra Vista* and *Last Chance* mines were operated on a small scale.

In Masonic District, the *Chemung Mine* was reopened by Johanson, of Los Angeles. A 25-ton amalgamation and concentration plant was installed to treat dump and mine run of ore.

Ten men employed.

In Silverado District, the *Silverado Mine* was acquired by the *Sierra Consolidated Mines Co., Inc.;* John J. Raskob, president; T. S. Davey, manager. Offices: Wellington, Nevada. Mine Office: Sweetwater, Nevada. Installed a 100-ton flotation plant.

Forty men are employed. The ore treated contains its main values in silver.

In Mammoth Lakes District, the *Mammoth Cons. Mines* property was taken over under lease and bond by the *Crystal Craig Mining Co.;* C. E. Wood, president, 5068 W. 20th St., Los Angeles.

Ten men employed on development.

Riverside County.

The most active mining districts were the Dale, Pinacate, and Vidal. In the Dale District, the *Gold Crown Mining Company,* George Novell, president and manager; offices, Petroleum Securities Bldg., Los Angeles, California, was the largest gold producer in Riverside Co.

The major tonnage of ore milled was mined from *Nightingale* and *Supply* mines in Dale District, San Bernardino County. Supply and Nightingale mines were equipped with electric-driven hoists and compressors. Ore hauled by trucks from above-mentioned mines.

Thirty men employed.

In the Pinto Mining District, the *Golden Bee* and *Ducky Boy* mines operated by E. Auclair, of Twenty-nine Palms, was a small producer of high-grade ore.

In the Pinacate District, the *Ida-Leona Mine* was operated by H. L. Nelson, of Perris. Development consists of two shafts 300 ft. deep, with several thousand feet of drifts and cross-cuts. Shipped high-grade ore to Midvale Smelter of United States Smelting, Refining and Mining Co., Midvale, Utah.

Fifteen men employed.

In the Vidal District, the *Mountaineer Mine* was operated by Mountaineer Mining Company, of Los Angeles; B. M. Stansbury, president; A. J. Bryant, superintendent; H. E. Olund, consulting engineer, 1117 Citizens National Bank Bldg., Los Angeles.

Development consists of two tunnels each 200 ft. in length. Shaft 200 ft. deep and several thousand feet of underground workings. Mine equipment consists of 100-h.p. Fairbanks-Morse diesel engine which drives a 75 KVA General Electric generator, Imperial Type No. 10 Ingersoll-Rand compressor and electric-driven hoist. High-grade ore mined is shipped to Magma Smelting Company, low-grade ore treated in 25-ton flotation plant.

Fifteen men employed.

In Chuckawalla Mountain Mining District, the *Red Cloud Mine* is owned by Red Cloud Mining Company, J. D. Huston, of Los Angeles, president.

The mine is situated in the Chuckawalla Mountains, 50 miles east of Mecca. Development consists of 3 shafts, with depths of 300 and 400 ft. Ore being mined from Red Head shaft which has been sunk to a depth of 400 ft. Several thousand feet of underground workings. Property recently acquired by Frank Ahlburg, 610 Vermont Ave., Los Angeles, California.

Ten men employed on development work.

In the Eagle Mountains Mining District, the *Black Eagle Mine* (copper, gold, lead and silver) owned by Black Eagle Mining Co., Sam Mosher, president, Signal Oil Bldg., Los Angeles, California, is being operated by *Imperial Smelting & Refining Co.*, Sam Mosher, president; C. LaV. Larzelere, secretary; H. E. Covey, superintendent. Development consists of tunnel 600 ft. in length and shaft 300 ft. deep with 2000 ft. of drifts. Recently completed the installation of 300-h.p. Fairbanks-Morse diesel engine. Electric-driven hoist and completed the construction of 150-ton concentration plant. Water for operations is secured from Cottonwood Springs, 23 miles southwest of the mine.

Thirty men employed.

San Bernardino County.

The most active mining districts were the Dale, Stedman (Ludlow), Imperial Lode, Barstow, and Atolia.

Carlyle Mine, operated by Carlyle Mining Corp., William A. Dorman, president; A. E. Cates, secretary; G. Gemmell, superintendent, Los Angeles.

Mine development consists of two tunnels, one 1500 ft. in length, the other 1200 ft. in length; with 2000 ft. of raises, winzes and cross-cuts. Mine equipment consists of compressors, aerial tram 2600 ft. in length from tunnel to mill.

Mill: Flotation plant with capacity of 60 tons per day. Power plant consists of 250-h.p. Fairbanks-Morse diesel engine direct connected to 150 KVA generator.

Twenty-four men are employed.

Jupiter Mine is in the Dale District, situated 7 miles NE. of New Dale. Operated by Frank H. Berger and Matt Gilbert, 619 N. Palm Ave., Los Angeles; Hugh Leonard, superintendent.

Development consists of a tunnel 200 ft. in length, also sinking shaft on the southwest end of the property. Ore mined is shipped to the Gold Crown mill for treatment.

Ten men employed.

In the Goldstone District the *Reward Mine* was operated by the Reward Mining Co.; Julian Itter, manager, Barstow, Calif.

Development consists of a tunnel 600 ft. in length on the vein, with raises and cross-cuts. The company installed a 20-ton amalgamation mill about 6 miles west of the mine.

Six men employed on development work.

In the Stedman District, 4 miles south of Ludlow, the *Bagdad Chase Mine* was under lease to *d'Aix Syndicate*, of Daggett; F. D. d'Aix, president and manager. Installed hoist and compressor; also retimbered shaft. Reported to be shipping 50 tons per week to Magma Smelting Co.

Six men employed.

American Mine. Owner Marcus Pluth, of Daggett. Under lease and bond to *American Mines, Inc.*, F. H. Merrill, president and manager. The property is situated in Sheep Hole Mts., 10 miles south of Amboy. Development consists of 3 tunnels each 300 ft. in length and shaft 115 ft. deep. Shipped a certain tonnage to the Gold Crown mill for treatment. Company installing a 25-ton mill on the property.

Ten men employed.

Imperial Lode Mines situated in the Lava Bed Mining District, 9 miles southwest of Lavic, a station on the Santa Fe Railroad. Owner, *Cave Springs Mining Corp.*, of Los Angeles. Under lease to F. M. Covey, Indio, California.

Property developed by tunnels and shafts. Installed a compressor, cars, track and screening and sorting equipment. The ore mined is lead-silver, with high values in silver. Shipped 500 tons of ore to Salt Lake smelters.

Ten men employed.

Telegraph Group of Mines. The property is situated in Solo Mining District, 17 miles east of Baker. Owner, Telegraph Mines, Inc., J. T. Hutton, president; Andrew Bauer, secretary, Long Baech, California. Under lease and bond to the *Solo Engineering Co.;* C. F.

Robbins, president and manager, Long Beach, Calif. Development consists of three shafts 100 ft. deep. Main working shaft 125 ft. deep with 1000 ft. of drifts. Mine equipment consists of hoist, compressor, cars and air drills. Mill consists of 25-ton amalgamation and flotation plant.

Ten men employed.

Lead-Silver Mines:

The principal activity in lead-silver mining was confined to the Cerro Gordo, Darwin, and Slate Range districts in Inyo County. The outstanding development being the reopening of the *Defiance, Independence,* and *Thompson mines* owned by the *Wagner Assets Realization Corp.* of Chicago. The property is under lease to the *Darwin Lead Company,* Col. Noble B. Judah, president; H. R. Montgomery, secretary; H. E. Olund, manager. Offices, 453 S. Spring St., Los Angeles. Was an active shipper of lead-silver ores and concentrates to Salt Lake smelters. Also installed 100-ton concentration plant for treatment of low grade ores from Defiance and Thompson mines. Development consists of a shaft on Defiance Mine 500 ft. deep on an inclination of 35° and 5000 ft. of drifts and cross-cuts. On the Thompson Mine there is a tunnel 1000 ft. in length. Ores mined are galena and lead carbonate with silver values.

Twenty-five men are employed.

Darwin-Keystone Mines, situated in the Darwin District, were operated by the Darwin-Keystone Mining Company, A. A. Rupel, president, Piru, Ventura Co., Calif.; A. Yoder, superintendent. Developed by tunnels and drifts totaling several thousand feet. Mine equipment consists of compressors, air drills and trucks. Shipped 800 tons of ore to United States smelter at Salt Lake City, Utah, carrying $1.75 in gold, 28 oz. in silver and 15% lead.

Twenty men employed.

In Cerro Gordo Mining District, the *Royal Mine,* owner, R. C. Spear Estate, of Lone Pine, Calif., was operated by *Cerro Gordo Extension Mining Co.,* J. P. Hart, president and manager, Keeler, California. Development consists of shaft 200 ft. deep and tunnel 1000 ft. in length. Mine equipment consists of hoist, compressor, air drills and truck. A number of shipments of ore were made to U. S. Smelting Co., Midvale, Utah. Average run of ore shipped, gold .115 oz.; silver 15.40 oz.; lead 20.20%.

Six men employed.

Santa Rosa Mine is situated in Cerro Gordo Mining District, 26 miles northeast of Keeler. Owner, Santa Rosa Mines Development Company, J. R. LeCyr, president; G. W. Dow, Lone Pine, trustee. Under lease to R. E. MacDonald and C. Grand, of Keeler. Development consists of incline shaft 340 ft. deep, with 5000 ft. of underground workings; also a number of tunnels 100 to 600 ft. in length. Mine equipment consists of hoist, compressors, air drills and cars. Galena and lead carbonate ore is being shipped to U. S. Smelting Co. smelter at Midvale, Utah. Ore shipped runs from 15 to 20% lead with 12 to 15 oz. in silver. About 700 tons of ore shipped in 1937.

Six men employed.

Sterling Mine (silver). Situated in Revenue Canyon in Argus Mountains, 30 miles north of Trona. Owner, Sterling Mining Co.; James Stevenson, president, Trona, Calif. Development consists of two incline shafts, one 100 ft. deep, the other 285 ft. and 500 ft. of drifts. Thirty-ton flotation plant.

Twelve men employed.

Slate Range Mine (Copper Queen) (copper, gold, lead, silver). Situated in the Slate Range of mountains, 9 miles northeast of Trona, Calif. Owner, Slate Range Consolidated Mining Co.; T. A. Wells, president, Bakersfield. Under lease and bond to *Gold Bottom Mines, Inc.;* Emil Bender, President; F. W. Handle, secretary; T. J. Nicely, manager, Bakersfield, Calif. Mine office, Trona, Calif.

Developed by tunnels and shafts; lower tunnel is 1000 ft. in length, with 6000 ft. of underground workings. Shipping selected ore to U. S. Smelting Company's smelter at Midvale, Utah. Ore shipped is galena and lead carbonate carrying gold and silver values. Reported to carry 0.63 oz. gold; 15 oz. silver; and 15% lead. Company has a 25-ton flotation plant located on east side of Searles Lake, 2 miles west of mine, in which second grade ore is concentrated to produce a shipping product.

The production during 1937 was $15,000. Property equipped with hoist, compressors and air drills.

Fifteen men employed.

Ubehebe Mine (lead-silver). It is situated in the Ubehebe District, 50 miles by road northwest of Death Valley Junction. Owner, A. Farrington Estate, Bishop, Calif.

Under lease to Grant Snyder and C. A. Rankin, Los Angeles. Ore is hauled by truck to Death Valley Junction for shipment to Salt Lake City smelters.

Ten men employed.

Carbonate Mine. Situated in the Panamint Range of mountains, 40 miles northeast of Zabriskie, a station on Tonopah & Tidewater Railroad. Operated by John P. Madison and H. L. Hellwig, 400 Post St., San Francisco, Calif. Mine address, Shoshone, Calif.

Developed by three tunnels with about 5000 ft. of underground workings. The ore is hauled by truck to Zabriskie for shipment to smelters at Salt Lake City, Utah. The ore is lead carbonate and galena with silver values. Ore shipped reported to carry 15% lead and 10 to 15 oz. in silver. Equipment consists of trucks, compressor, air drills and cars.

Ten men employed.

Iron:

Hoot Owl Iron Deposit. Situated in Argus Range of mountains, 14 miles north of Trona. Owner, Lloyd Helm, of Inyokern, Calif. Operated by Ekstrom & Bradley, 320 Market St., San Francisco. Iron ore hauled by truck to Trona, California, and shipped to San Francisco.

Titaniferous iron deposits of the San Gabriel Range of mountains in Los Angeles County: *The DuPont Co.,* of New Jersey, has acquired

a number of deposits located in Mill Creek and the Mount Gleason area. The company is making an active survey of the deposits to determine extent and available tonnage, also conducting experiments for treatment of the ores for the purpose of manufacturing titanium oxide.

Quicksilver:

Inyo County.

The Coso Quicksilver Mine situated near Coso Hot Springs in the Coso Range of mountains, 14 miles NE. of Little Lake, Inyo County. Owner, F. J. Sanders, Santa Barbara, California. The property has been acquired by A. W. Leege, of Santa Barbara, Calif., who has installed a 20-ton Herreshoff furnace.

Ten men employed.

Kern County.

Cuddeback Quicksilver Mine situated 13 miles northeast of Woodford, a station on S. P. Railroad. Owner, Cuddeback Cinnebar Corp., C. G. Cuddeback, Tehachapi, Calif. Under lease and bond to *Wallabu Mining Co.,* Bakersfield, Calif. Dan Murphy, president; Percy Blodgett, superintendent. Operating 50-ton Gould rotary furnace.

Twelve men employed.

Tungsten:

San Bernardino County.

Atolia Mining Co., Clifford Dennis, manager, Atolia, Calif. Installed a new 100-ton concentration plant. Some 250 leasers were employed on the company's property in mining ore and delivering it to the mill for treatment.

Inyo County.

There was a renewal of activity in the mining of tungsten ores in the Bishop district. The following companies installed mills on their several tungsten deposits.

Tungsten Milling Company. Raymond Stolle installed 120-ton concentration to treat tailings from *Tungsten City Mines.* (Developed a combination vacuum and electrostatic separator). Table concentrates 30% WO_3, separator cleaned concentrates to 70% WO_3.

El Diablo Mining Company. H. O. Johanson, Bishop—has a lease on *Tungsten City Mine;* 60-ton concentration plant with Stolle electrostatic separator.

Pacific Tungsten Co., O. T. Wilkerson and Ralph Moore, of Bishop —*Rossi Mine,* 3 miles south of Bishop; 50-ton concentrator mill. Table concentrates 30%. Product cleaned by Stolle electrostatic separator— to 70% WO_3 concentrate.

U. S. Vanadium Company reopened *Pine Creek Tungsten Mine.* Rebuilt 100 ton mill—and road from property via Rock Creek to mine. Treating 100 tons per day.

Thirty men employed.

Mono County.

Black Rock Tungsten Mine situated south of Benton, Mono County, acquired by *Tungsten Corporation of America;* Fay Wright, president, Signal Oil Bldg., Los Angeles, California. Installed 150-ton concentration plant, put in operation November, 1937.

Non-metallic Minerals:

SULPHUR: *Sulphur Diggers,* Inc.; Sidney Wood, Jr., president, 3923 6th St., Los Angeles, California. Operated *Crater Sulphur Deposits* in Last Chance Range Mts., 68 miles east of Zurick, Inyo County. Installed 60-ton retort at Zurick. Shipped approximately 8000 tons of sulphur, grade 96% to 98%. Suspended operations September 1 due to market conditions, and cost of hauling from property to Zurick.

TALC: The following properties operated continuously during the year. *Sierra Talc Co.,* operated Darwin and Saline Valley Talc mines with grinding plant at Keeler. *Pacific Coast Talc Co.* operated *Mt. Whitney Talc Mine* near Darwin; also mines near Riggs, San Bernardino County. *Acme Talc Mines* near Tecopa were operated by the *Western Talc Company.*

BARITE: Reopening of *Poso Barytes Mines,* Inyo County, by *Western Barium Company,* of San Francisco. Also construction of Barium Products plant at Rosamond, California. Development of Barium deposits near Earp, San Bernardino County, by *California Talc Co.,* of Los Angeles

BENTONITE: Development of extensive deposits of bentonite by *California Talc Company,* near Hector, San Bernardino County.

WOLLASTONITE: The development of a large deposit of this calcium metasilicate ($CaSiO_3$) in Radamacher District, near Randsburg by *Johns-Manville Co.,* is progressing; and they are mining material for use in a new plant under construction in Los Angeles for manufacture of mineral wool.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

In this issue

Three outstanding things in the State of California are ever before the geologist's attention: Earthquakes, Gold, and Petroleum. In this issue of the Journal some of the broader points of view are taken of these subjects and told in a simple manner by two eminent scientists:

(1) "Doing Something About Earthquakes," by Commander R. R. Lukens, United States Coast and Geodetic Survey.

(2) "Gold and Petroleum in California," by Waldemar Lindgren, the veteran Economic Geologist of America, well known especially in this state by his work in the Sierra Nevada.

From time to time the Geologic Branch expects to publish an occasional popular paper of this sort from the pen of some famous geologist or engineer. In an earlier issue (January-April, 1933) for example, "Lakes of California" was presented by America's outstanding physiographer and geologist, the late Dr. William Morris Davis.

In press

In a few months' time, the new colored geologic map of the state will be ready for distribution. So also will "Minerals of California" (Bulletin 113) and "Bibliography of the Geology and Mineral Resources of California for the years 1931 to 1936, inclusive" (Bulletin 115).

In preparation

A new book, "Geologic Formations and Economic Development of the California Oil and Gas Fields" is now in preparation by a large number of contributing geologists who are actively engaged in the petroleum industry. The preparation and editing of this book is under the direction of the Geologic Branch of the Division of Mines.

DOING SOMETHING ABOUT EARTHQUAKES

By R. R. Lukens, Commander, U. S. Coast and Geodetic Survey

Nearly everyone is familiar with Mark Twain's classic remark about the weather. He might have gone a little further and mentioned earthquakes as well as weather. However, since Mark Twain's time meteorologists have made great strides in their studies of weather predictions and seismologists and engineers are rapidly coming to grips with the earthquake problem.

Of course, even the most brilliant scientist never hopes to find a way of preventing earthquakes. He is also very reticent regarding the possibility of even predicting earthquakes, but he does know that

Fig. 1. What happened to a building not designed to resist earthquakes. Helena, Montana, 1935.

ever since the appearance of man on this planet, earthquakes have occurred. They are occurring today and there is no evidence of any diminution in the number or severity of such shocks. In fact, more than 20,000 earthquakes occur yearly; a widely recorded shock every fourteen hours; and a destructive earthquake every six and one-half days.

If earthquakes can not be prevented, the question naturally arises as to what can be done to lessen their destructive effects on human life and the works of man. Probably the most severe earthquake ever to occur in this country was the New Madrid, Missouri, shock in 1811. Great topographic changes resulted from this earthquake, but, as the country was only sparsely populated and the few buildings were mostly log cabins, there was but little property damage. On the other hand,

consider the Long Beach earthquake in 1933. As an earthquake, it did not rate very high. Although of considerable intensity at the epicenter, the area covered was relatively small. Unfortunately, this area included a section of dense population—and, from an earthquake standpoint, much inferior building construction. The result was a terrific property loss and a considerable loss of life. Had the Long Beach

FIG. 2. The front of this building was shaken down by the Helena, Montana, earthquake of 1935.

earthquake occurred out in the arid, unpopulated portions of Nevada or New Mexico, it would hardly have been worth a single paragraph in the newspapers.

In 1929 a strong earthquake occurred on the Grand Banks, in the Atlantic about 1000 miles east of Boston. This disturbance was under the waters of the Atlantic Ocean and ordinarily would not have caused much damage, except for the fact that most of the Atlantic cables converge at this point. Every one of those cables was snapped with consequent interruption in transatlantic communication.

For many years seismologists studied earthquakes from the purely scientific approach. They developed sensitive seismographs which recorded earthquakes thousands of miles away. They also studied the rates and paths of travel of the various types of waves through the core of the earth and through the surface areas. The net result of these studies was the ability to locate the epicenter of an earthquake with considerable accuracy and to obtain information as to the materials making up the core of the earth.

This was all right in its way, but it gave the structural engineer no information whatever as to what forces he must build against when designing a structure in an area of known seismic activity. For example, the sensitive seismographs around the San Francisco Bay area in 1906 were either knocked off their supports or the records went off the scale, so that they gave no information as to the actual earth movements during that earthquake.

For many years there has been a tendency to try to solve the earthquake problem by ignoring it. Easteners have poked much fun at San Franciscans for always referring to the 1906 disaster as "the fire." In recent years, however, there has been a great change in sentiment. Today the attitude is, "Yes, we have earthquakes. We have had them for hundreds of years and will probably have them for hundreds of years in the future. How can we design buildings and structures which will stand through the worst earthquake that may reasonably be expected?" That is the proper approach to earthquake problems.

The bureau of the federal government charged with earthquake investigations is the U. S. Coast and Geodetic Survey. In 1930 that bureau, assisted by the Bureau of Standards and other institutions and individuals interested in seismology, developed the so-called strong-motion seismograph. This instrument works automatically and is so designed that when a fairly strong earthquake occurs, the mechanism starts and continues recording for one minute and then stops. A subsequent shock will start it off again. The various earth motions are registered by beams of light shining on photographic paper on a revolving drum. The strong motion seismographs are small but neces-

Photo by Walter W. Bradley

FIG. 3. Brick-veneer front shaken off in Long Beach, Cal., earthquake of March 10, 1933. This apartment house was just across the avenue from the tall Class A hotel shown in Fig. 4.

sarily of rugged construction. When the news came of the severe earthquake at Helena, Montana, on October 18, 1935, two observers at San Francisco loaded a strong motion seismograph in a light truck and started for Helena, hoping to get the instrument set up in time to record any possible aftershocks. In going over the mountains the truck went into a skid and turned over. Neither observer was seriously

hurt and upon righting the truck, they found they could proceed on their way. Arriving at Helena, the instrument was set up and successfully recorded the subsequent shock of October 30. It had gone through the truck accident without injury.

The first record from a strong-motion seismograph in the United States was obtained at Long Beach on March 10, 1933. This was an

Photo by Walter W. Bradley

FIG. 4. Villa Riviera, a Class A structure at Long Beach, Cal., not damaged by the earthquake of March 10, 1933. See also Fig. 3.

historic event in seismology because for the first time in the United States, earth movements near the epicenter of a strong earthquake were actually measured. The Long Beach and Helena earthquakes are the strongest shocks recorded by strong-motion seismographs to date.

There are now twenty-six strong-motion seismographs located at strategic points in northern California and twenty-four in southern California.

With the study of the strong-motion records, more and more light is being thrown on the nature and extent of seismic forces, against which the structural engineers must build. Today the studies are only

in their initial stage. The final test will come when a major earthquake occurs. We have every reason to believe that at least a portion of the strong-motion seismographs will function and produce invaluable records of that earthquake which we all *hope* will never come.

The instrumental work is only one phase of the cooperative earthquake investigation now being carried on in the Pacific coast area. Throughout that section there are thousands of volunteer observers. These consist of postmasters, public utility employees, lighthouse keepers, and citizens in general. Each is supplied with a questionnaire in the form of a postcard. When an earthquake is felt, the observer fills out a card, the questions being carefully framed to give a complete picture of the strength and characteristic of the shock, and mails it to the U. S. Coast and Geodetic Survey, 75 Appraisers Building, San Francisco. A trained seismologist studies these cards and assigns the relative intensity on a scale of 1 to 10, according to the description on each card. The various intensities are plotted on a map and lines of equal intensity drawn. These lines, known as isoseismals are usually more or less circular in shape and at the center of the circles is the epicenter, or origin of the shock. A glance at one of these maps gives a clear picture as to the intensities of various areas and the total area over which the shock is felt.

Of course, many of the cards bear apparently conflicting information. It is well known that an earthquake is felt much more strongly on filled-in ground than on solid rock. In the 1906 earthquake there was a great difference in apparent intensity between lower Market

FIG. 5. A strong motion seismograph being installed.

Street and nearby Telegraph Hill. The former is on filled ground over deep mud and the latter is solid rock. All reports, therefore, require careful evaluation by the seismologist.

At the end of each quarter, a mimeographed publication is issued, giving all the information collected concerning each earthquake recorded during that period. This information is not only valuable

to seismologists but is equally sought by insurance underwriters to assist them in formulating earthquake insurance rates in different localities.

In this brief article it is impossible to give the complete setup in the current seismological program. Suffice it to say, it is a highly cooperative one in which valuable work is being done by the University of California, Stanford University, California Institute of Technology, the Seismological Research Laboratory at Pasadena, the Seis-

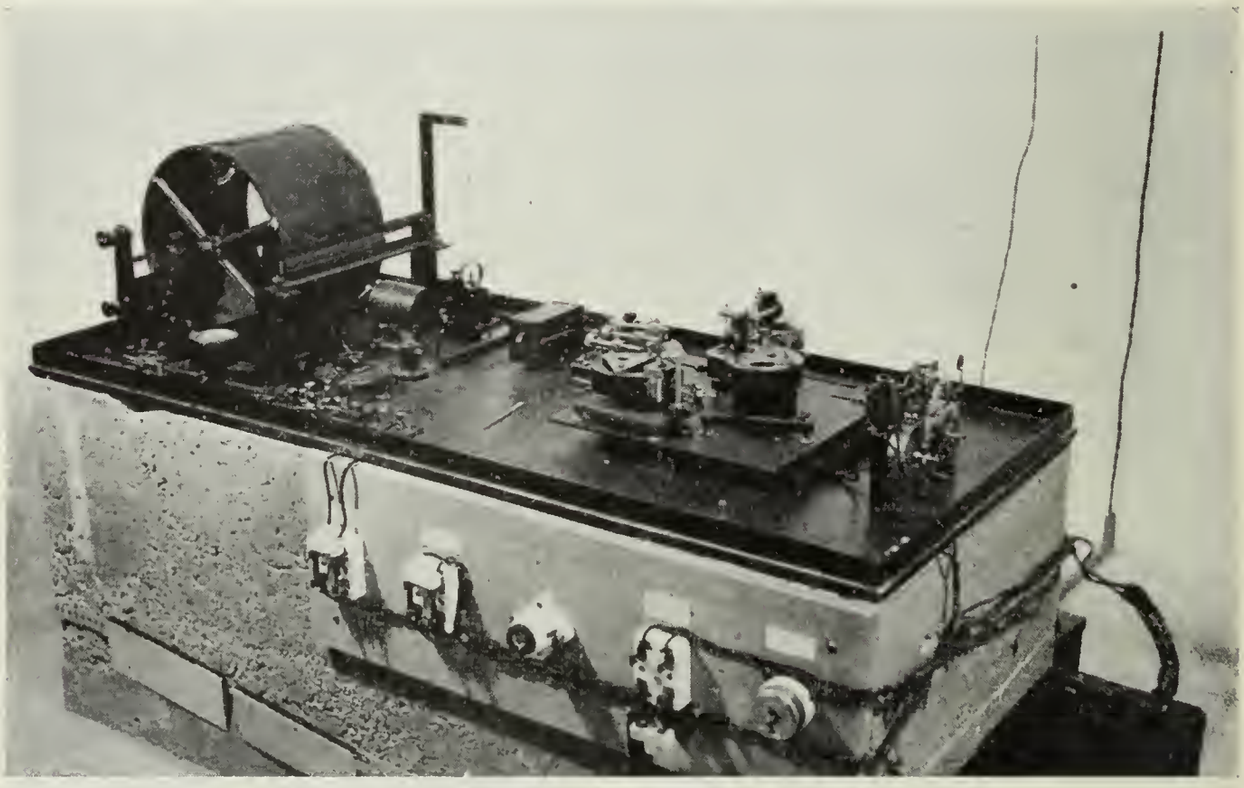

FIG. 6. A strong motion seismograph set up for operation. These instruments record the actual earth movements during a strong earthquake.

mological Society of America, and many individual public-spirited citizens. While the Pacific coast and California, in particular, is a region of considerable seismic activity, a study of earthquake history quickly reveals the fact that no point in the United States can be said to be immune from earth shocks. It is, in reality, a national problem and should be approached from that viewpoint. In the meantime, however, the Pacific coast area affords a natural laboratory for seismic research and it is only natural that the work should start in that locality.

GOLD AND PETROLEUM IN CALIFORNIA

By Waldemar Lindgren *

The following pages contain little that is new, but simply call attention to the geological factors that have influenced the resources and the production of the two most important mineral products of California.

The gold deposits of California were first discovered in 1848 at Coloma, El Dorado County, and the enormous production rapidly spread the fame of the State all over the world as the gold land *par excellence*. Throughout the years this proud position among the states has been maintained, except when temporarily eclipsed by those flashing meteors of epithermal deposits like Cripple Creek and Goldfield. Of late the Canadian gold production from the province of Ontario has exceeded that of California.[1]

Thirty years later, about 1876, the petroleum of California began to appear in the list of mineral products and its amount increased rapidly. At the present time its value entirely overshadows that of the gold. The lowest value of the gold production was in 1929 when it fell to about eight and one-half million dollars. But the present value of the annual petroleum production is rather on the order of two hundred million dollars. While the gold production mainly comes from the central Cierra region, the petroleum production is chiefly in southern California. The enormous value of the rock oil is scarcely yet generally realized.

Several things are likely to attract the attention of the observant reader as he looks over the data on the mineral resources of the state published by the State Division of Mines and by the U. S. Geological Survey and (since 1931) by the U. S. Bureau of Mines.

In the first place the variety of mineral products is greater in California than in any other state. Fifty-nine products are listed in 1936 and there are several more included under the "Miscellaneous" heading. In the case of many mineral products, such as clay and cement, the amounts are higher than in other states excepting very few, such as Pennsylvania. The same applies to such products as gravel, sand and stone.

In the production of quicksilver and borates California has always occupied the first place. On the other hand many mineral products are lacking or meager in quantity in California. Such are iron ores, coal, feldspar, bauxite, fluorite, sulphur, phosphates and gypsum. Ores

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[1] Colorado, 1902—$28,468,700.
Colorado, 1910—$20,526,500.
Nevada, 1910—$18,873,700.
California, 1910—$19,715,440.
U. S. A., 1936—3,769,000 ounces.
Canada, 1936—3,720,000 ounces.
Ontario, 1936—2,370,000 ounces.
California, 1936, 1,077,000 ounces.

carrying lead, zinc and silver, all prominent products of many states are not plentiful. This lack is intimately related to the geologic structure of the great block facing the Pacific and, more particularly (1) to the absence of large pre-Cambrian areas normally containing pegmatites and iron formations, (2) to the absence of Paleozoic and Mesozoic lowlands carrying abundant vegetation producing coal and siderite, (3) to the absence of deep tropical weathering producing bauxite, (4) to the lack of large Paleozoic and Mesozoic limestone areas carrying the elements for phosphates, sulphur, etc. For the same reason the lead, zinc and silver deposits are scarce except in the eastern and northern sections where intrusives generated these ores, as well as some iron deposits of contact metamorphic origin. The Paleozoic formations largely consist of shale and sandstone with no oölitic iron ores. Silver is, of course, a by-product of the gold deposits but some of the few epithermal, late Tertiary deposits on the east side carried considerable amounts of rich silver ores; these, however, are largely exhausted, being confined to a zone near the surface.

There were many periods of metallization in California. The earliest, the pre-Cambrian, has left few traces. The latest took place in the latter part of the Tertiary and even reached over into the Pleistocene. It is characterized by the quicksilver deposits connected with late basic igneous rocks in the Coast Range. There were also in that time scattered gold-silver veins, a few in the Coast Range but most of them in the eastern part of the state. Most of these were of economic importance only temporarily, like Bodie in Mono County and others in the southern region, and they have contributed but little to the great totals of gold and silver production. They appear to be connected with large intrusions of intermediate magmas of Tertiary age of which there are few in the Sierran region and in the Coast Range.

But the time of principal metallization took place between the end of the Jurassic and the beginning of the Cretaceous. That was the time of the great batholithic intrusions of granodiorite and allied rocks. A veritable revolution, it resulted in the development of the great Pacific Coast intrusive mass extending from Mexico to Alaska and represented in a wider sense by intrusions along the South American coast from Colombia to Patagonia. These intrusions appear to have begun on the east side of the Sierra Nevada and even in the Coast Range. The first products were basic granular rocks but toward the east the intrusions changed to quartz diorite and granodiorite. A little later minor intrusives of quartz monzonitic character began to spread eastward into the Cordilleran margin, as far east as Colorado, the intrusions probably continuing into early Tertiary time.

The important thing was that the batholithic intrusions were followed in the fractured mass by the rising of hot solutions carrying silica and various metals, such as gold, silver, copper, lead and zinc, and these solutions deposited metal veins, some of great value, particularly along the batholithic margins and in the smaller intrusions.

There were similar deposits formed northward as far as Alaska but the richest part seemed to be concentrated in the batholith of Central California. Thus were formed, for instance, the gold-quartz veins of Grass Valley, and the great Mother Lode veins. The deposits contain

as a rule only small amounts of sulphides and little silver. The principal value is metallic gold.

As far as can be judged by remnants of the batholithic cover, the surface was then 3000 to 4000 feet above the present surface and there is reason to believe that the upper parts of the gold-quartz veins were considerably richer than the lodes now worked in the mines.

The intrusion of the batholith was followed by a long period of erosion and degradation. The rich upper parts were destroyed and much of the gold was carried away. But in the central part of California special conditions developed; to these we owe the preservation of a large part of the gold. As erosion slowed down a more gentle surface was developed and this continued during early Tertiary time.

Rivers were established on this gentle slope and formed veritable sluiceboxes in which much of the coarse gold was caught. In the course of time these superficial deposits would have succumbed to the continued erosion. But just then, probably at the end of the Miocene, volcanic eruptions of rhyolite, andesite and basalt broke out covering the gold-bearing channels and forming a thick mantle of tuffs and igneous rocks over the treasures of the early Tertiary rivers. Almost contemporaneously with this, at the end of the Pliocene, occurred the great uplift of the Sierra as if along a hinge on its western front and the erosion quickened suddenly. The present imposing canyons were cut through the volcanic capping down into the buried channels and into the underlying rocks. A great part of the gold in the old channels, added to by newly exposed quartz veins, was concentrated in these sharply incised canyons. Some gold was carried out into the plains but an enormous mass of it was caught in these new and narrow sluice boxes. And then the miners of 1848 arrived upon the scene. Their first crop was scooped up in the present canyons. The second crop (not yet entirely harvested) came from the Tertiary channels and was mined by underground methods where the channels had been exposed on the canyon walls, or by hydraulic methods where exposed on the surface. The third crop began to be gathered after a few years as the more promising outcrops of the veins of the batholith were sampled. Thus started the deep lode mining which now in many places has attained a depth of 4000 to 5000 feet. No doubt the ores will decrease in quantity and value but they will not be exhausted in many decades.

So this is the source of the California gold production: veins with relatively coarse gold; two later concentrations by the action of water erosion. Much was lost by disintegration and dissipation but enough was left to yield the imposing gold production of the State.

There are few regions in which the preservation and concentration has been aided by processes similar to those in California. The most striking example that comes to mind is Victoria, Australia. There, too, were the rich veins; there, too, were the Tertiary volcanic flows which sealed and preserved the superficial river deposits. On the other hand, there is the Canadian shield in Ontario and adjacent provinces, where the gold metallization, older than that of California, has been subjected to erosion since pre-Cambrian times and so should yield an enormous wealth. But there erosion was not stopped by overlying lava flows. Erosion proceeded unchecked and what was left of the Ontario placer deposits was ruthlessly destroyed by the Pleistocene ice invasion.

The total value of the gold produced in California 1848-1936 is given as $1,967,929,252 which, however, includes a few million dollars from Tertiary veins and small amounts from copper and lead ores; the figures for 1934 to 1936 are calculated on the basis of $35 per ounce whereas the rest of the production data are on the basis of $20.67+.[2] During the first decade (1851-1860) gold was produced to the value of nearly half a billion dollars; during the second decade the output was less than half as much. It gradually diminished to $147,080,006 in the decade 1881-1890; and gradually increased in the decade 1911-1920 to $191,989,332. The percentage of placer gold has gradually diminished from 100 per cent 1848-50 to 20 or 25 per cent about 1900. The notable increase in the production of placer gold reported since 1900 is caused by the great development of the dredging industry working on gravel channels at the western base of the Sierra Nevada. In 1935 the output of placer gold in California was 346,000 ounces against a total gold production of 890,430 ounces, of which only a small part came from copper and lead ores. The output of California has at times been exceeded by that of Colorado, Nevada, and Alaska, and the output of South Dakota has at times approached it. But nevertheless California still maintains its proud position as the premier gold producing state, and is likely to retain it for many years to come.

In its appearance, in its origin and in its deposits, gold is one of the most conspicuous mineral products. Since the remotest historical times it has been sought for, treasured and accumulated by men for ornaments and as a medium of exchange. No greater contrast can be imagined than that between the bright yellow metal and the black, thick, viscous rock oil—petroleum—seeping from the sediments or bursting out from its accumulated reservoirs when released by the drill. The oil does not even have a definite chemical composition. It is a mixture of various hydrocarbons ranging from gaseous methane (CH_4) to liquid and solid compounds, with minor amounts of sulphur, oxygen and nitrogen. The crude oils are divided into the lighter, or paraffin series, and the heavier, or asphalt series. The California oils belong chiefly in the latter division. A great number of products are formed by partial natural evaporation and by distillation. Among these products are gasoline, naphtha, kerosene, lubricating oils, vaseline, wax, asphalt and petroleum coke. In its crude state petroleum is used very extensively for fuel. There are many other uses such as road dressing, building paper and roofing. Next to the use of petroleum as a direct fuel comes its importance for the distillation of gasoline, universally used for gas engines.

The occurrence of petroleum in seeps from the outcrops of the Tertiary strata has been known for many years, but production on an economic scale by tapping of the underground reservoirs is comparatively recent. I note that in 1876 the production was only 12,000 barrels. The first refinery was started in Ventura County. In 1895 this had increased to 1,208,482 barrels, in 1919 it was 101,183,000 and in 1936 to 214,773,000 barrels. The three greatest producing states are Texas, Oklahoma and California. Oklahoma's annual production is somewhat larger than that of California, but both are spectacularly exceeded by

[2] Hill, J. M., Historical summary of gold, silver, copper, lead and zinc produced in California, 1848 to 1926: U. S. Bureau of Mines, Economic Paper 3, pp. 22, 1929. Mineral Yearbook, U. S. Bureau of Mines, 1931-1936.

Texas whose output in 1936 was more than double that of California. The total production of California up to and including 1936 is given as 4,638,682,983 barrels. The value is a little difficult to ascertain correctly because of the fluctuating value of petroleum.

In 1936 according to the American Petroleum Institute the production as indicated above was 214,773,000 barrels divided in barrels as following:

San Joaquin Valley—97,627,000.

Coastal district including the Ventura and Santa Maria districts—22,901,000.

Los Angeles Basin including Long Beach, Santa Fe and other districts—94,245,000.

In the minor districts extending up to the vicinity of San Francisco in the Coast Range the output was insignificant.[3]

The total value may be set at something over $225,000,000. Adding to this the natural gas sold and the natural gasoline produced we obtain as a total about $277,000,000, an enormous amount compared to about $20,000,000 as the value of the gold production of 1936 (gold at $20.67+ per oz.).

The origin of the gold is spectacular: Hot solutions containing metals rise from the abyssal batholithic depths and deposit the metal in shining particles in brilliantly white quartz.

The origin of petroleum is inconspicuous in the highest degree: Vegetable and animal organisms, in part microscopical, accumulate on the surface at or near the shores of the oceans. Among these are diatoms, algae, jellyfish, small arthropods, etc., which sink to the bottom of the sedimentary basin after the death of the organism. This material, not yet petroleum, undergoes complex chemical changes even now imperfectly known, and in suitably porous beds petroleum develops by chemical and bacterial processes. It may migrate in these source beds and being light it has a tendency to rise above the water but below the gases; folding produces domes and anticlines in whose higher point the petroleum tends to collect; if released from gas and water pressure by the prospector's drill it may suddenly burst forth in large volumes. But the supply is limited and in time the yield of oil will decline. In California the petroleum is found almost entirely in the later Teritary beds ranging from Miocene to the Pliocene. As pointed out before, the great uplift which took place before or during the late Mesozoic intrusions was followed by a long period of erosion and degradation which extended far into the Tertiary.

The Coast Range existed only in part. The detritus from the Tertiary period of erosion accumulated along the foot of the Sierra Nevada in large quantities, reaching a maximum thickness of many thousands of feet in the southern end of the San Joaquin Valley and in the southern coastal region. Along the shores plankton developed and sank to the bottom making the source beds of petroleum. Covered again and again by later sediments, horizons rich in organic matter were, in this manner, repeatedly formed and entombed. Subsequent elevation folded and faulted these sediments resulting in the present

[3] A concise description of the oilfields of California may be found in W. H. Emmons, "Geology of Petroleum," New York, 1931, pp. 520-565.

complex structure of the Coast Ranges. Where these structures are not too badly crushed and eroded we now have great oil deposits accumulated in the domes and anticlines and other favorable traps. Thus we find in the southern oil fields numerous horizons where petroleum has been formed. Within 10,000 feet of sediment, there are in the region of Los Angeles as many as 10 to 15 oil zones.

The inorganic theory of the origin of oil is now generally abandoned. Likewise few geologists now believe that high temperatures prevailed during the development of oil. Probably 200°C. was rarely exceeded. Extensive migration of the oil across the beds probably rarely occurred. In the source beds, however, the oil could move until a suitable reservoir of fractured or porous bed was found and at the same time an impervious rock may have formed a barrier. The movement is most commonly upward on the dip as oil is lighter than water. Therefore a well drilled at the top of an anticline may yield only gas, while one drilled further down may develop oil or water or both. According to Trask [4] the amount of organic matter, not yet petroleum, in the source beds varies from one to seven or more per cent of the weight of the rock, the larger amounts occurring near the shore line. Of this (vegetable and animal) organic matter only about five per cent seems to be changed to oil by slow complex chemical and bacterial processes. It will be recognized that the formation of an oil pool is dependent upon many and complex conditions, and the prediction that oil may be found is always hazardous.

The great Mesozoic uplift of the western margin of the North American continent was initiated or followed by enormous batholithic intrusions. As a result of these the gold deposits were formed. The uplift was followed by a long continued Mesozoic and Cenozoic erosion and as a result tremendous masses of detritus accumulated in front of the rising coast. No doubt there were during this process innumerable pauses and oscillation. Plankton formed in abundance at the surface of the sea and sank to be covered by new sediments. From this animal and vegetable matter petroleum was gradually developed in numerous horizons. This oil migrated more or less freely in the source beds separating by gravity in suitable places which determined the locations of the future oil pools destined to become sources of wealth for coming generations.

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[4] Trask, Parker D., Origin and environment of source sediments of petroleum. Amer. Petr. Institute, 1932, p. 323.

One way of finding oil more cheaply. Oil and Gas Journal, Nov. 1937, pp. 120-129.

Nenitzescu, C. D., The present state of our knowledge on the origin of petroleum. J. Instit. Petrol. Technologists, 22, no. 166, 469-482.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology:

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

GEM MINERALS OF CALIFORNIA

Their History, Occurrence, Description, and Means of Identification; Also a Simple and Satisfactory Polishing Technique.

By Francis J. Sperisen[a]

INTRODUCTION

In number and diversity of mineral species as well as in economic value California is unique. Over 420 species have been recorded of which over 50 were either first described from California or are not found elsewhere. The widespread explorations and development which followed the gold rush of '49 and the '50's, revealed valuable economic resources in many other mineral substances. Of the other metals, quicksilver and copper were early sought after and worked. Of the fuels, coal mining was quite active in the '60's; petroleum coming in some years later. Building materials, salines, and various industrial mineral raw materials have added greatly to the total and importance of the list.

Among the last-named group are various minerals and 'stones' suitable for gem-cutting and jewelry purposes. The first list of California's minerals was published by W. P. Blake in 1866, showing 75 different varieties. The second list appeared in 1884 as part of the Fourth Annual Report of the State Mineralogist, Henry G. Hanks, indicating a 100% increase in the number of known minerals and gave detailed descriptions for some of the localities. The third list, Bulletin No. 67 of the State Mining Bureau, in 1914, was followed in 1922 by Bulletin No. 91, each adding to the total number of recorded species and to our store of knowledge concerning California's resources in minerals. While the foregoing reports listed all known mineral species occurring in the state, one bulletin in particular was devoted to description of the gem stones and their occurrences: Bulletin No. 37, "Gems, Jeweler's Materials and Ornamental Stones of California," by Dr. George F. Kunz, 1905.

The above-noted books have for some time been out of print and due to awakening interest in the collecting and study of minerals and gems in the past few years, the demand has been so great that a new issue is desirable. The matter contained herein is a compilation of all authoritative data contained in the previous bulletins and on file in the library of the State Division of Mines.

The various species of gem minerals have been grouped under a chemical classification, a departure from the custom followed in the usual works on gems, so as to be more instructive and to show to better advantage the relationship of the various species.

For more detailed descriptions of the physical, chemical and optical properties of these gem minerals, the reader is referred to the new edition of 'Minerals of California,' Bulletin 113, by Dr. Adolf Pabst, Associate Professor of Mineralogy, University of California.

Owing to the widespread interest in the cutting and polishing of gem minerals a short chapter on Lapidary Art is included giving

[a] Lapidary, San Francisco, Cal.

detailed information regarding the cutting and polishing of these stones. The technique is written as simply as possible and satisfactory results should be readily attained.

The author is indebted in particular to Walter W. Bradley, State Mineralogist of California, for help and assistance rendered, as well as to Henry Symons, Curator and Statistician of the State Division of Mines.

New minerals and localities are constantly being discovered in California and it is hoped this list may be the means of adding to the fund of knowledge already available, to increase interest in the minerals and mineral development of the State and to be of value to those who are seriously interested in the collection and study of the gem minerals.

The scope of this work includes all those minerals which have been used for jewelry purposes or for personal adornment.

THE GEM MINES OF CALIFORNIA

From the time of their discovery in the late 70's and early 80's the gem mines of the southern part of the state produced a notable quantity of valuable minerals, in a wide variety of types and colors. The production continued for several decades and extended into the present century.

The peak production since 1900 was recorded in 1906 with a total output for the State of $497,090. Since then the annual value of the gems produced has dwindled, the latest figures available (1936) being $2,878.

The all-time low since operations started was reached in 1918 when only $650 worth of gems was produced.

As will be noted from the table [1] herewith, the production of gem materials in California has been somewhat irregular and uncertain since 1911. The compilation of complete statistics is difficult owing to the widely scattered places at which stones are gathered and marketed, for the most part in a small way.

Total Production of Gem Materials in California.

The value of the gem output in California annually since the beginning of commercial production is as follows:

Year	*Value*	*Year*	*Value*
1900	$20,500	1919	$5,425
1901	40,000	1920	36,056
1902	162,100	1921	10,954
1903	110,500	1922	1,312
1904	136,000	1923	13,220
1905	148,500	1924	4,800
1906	497,090	1925	10,663
1907	232,642	1926	9,049
1908	208,950	1927	7,035
1909	193,700	1928	22,200
1910	237,475	1929	26,850
1911	51,824	1930	3,540
1912	23,050	1931	5,607
1913	13,740	1932	4,961
1914	3,970	1933	690
1915	3,565	1934	2,456
1916	4,752	1935	945
1917	3,049	1936	2,878
1918	650		
		Total	$2,260,698

[1] Symons, H. H., California Mineral Production for 1936, Bulletin 114, State Division of Mines, 1937.

The history and descriptions of the mines however, are of considerable interest. Greater activity existed in gem mining in California for a number of years than in any other State in the Union. Bulletin No. 37 of the State Mining Bureau, "Gems, Jewelers' Materials, and Ornamental Stones of California," by Dr. George F. Kunz, published 1905, was written during the height of activity in the tourmaline-kunzite-beryl-garnet area in San Diego and Riverside counties.

[2] "The first discovery of colored gem-tourmaline in the State goes back as far as 1872, when Mr. Henry Hamilton, in June of that year, obtained and recognized this mineral in Riverside County, on the southeast slope of Thomas Mountain. These colored tourmalines, now found at a number of points, were not encountered by Professor Goodyear,[3] who particularly noted the black tourmalines in the pegmatite veins, in his geological tour through San Diego County, in the same year, referred to above; but his reconnaissance was a little south of the gem-tourmaline belt. Some mining was done at this point, and fine gems were obtained. In the course of years three localities were opened and more or less worked in this vicinity, so that in the author's report on American gem-production for 1893, the following statement appeared:[4]

"Tourmalines are mined at the California gem mine, the San Jacinto gem mine, and the Columbian gem mine, near Riverside, California. These three mining claims cover the ground on which the tourmaline is found, and are situated in the San Jacinto range of mountains in Riverside County, California, at an altitude of 6500 feet, overlooking Hemet Valley and the Coahuila Valley, and 27 miles from the railroad. The formation in which the crystals are found is a vein from 40 to 50 feet wide running almost north and south through the old crystalline rocks which make up the mountain range. The vein in some places consists of pure feldspar, or else feldspar with quartz, in others all mica, and in others rose-quartz and smoky quartz. The tourmalines vary in size from almost micrograins to crystals 4 inches in diameter. They are most plentiful in the feldspar, but are found in other portions of the vein, sometimes in pockets and sometimes isolated. The larger crystals generally have a green exterior and are red or pink in the center. Some of the crystals contain green, red, pink, black, and intermediate colors; others again are all of uniform tint—red, pink, colorless, or blue. Associated with the tourmalines are rose-quartz, smoky quartz, asteriated quartz, and fluorite, and some of the quartz was penetrated with fine, hair-like crystals of tourmaline, strikingly like a similar occurrence of rutile.

"It may seem remarkable that this locality of gem-tourmalines should have been unrecorded in the earlier lists of California minerals given by such authorities as Professor Blake and Mr. Hanks in the reports of the State Mining Bureau for 1882 and 1884. But the parties who knew of the occurrence did not make it public for some years, and the earlier specimens were taken out quietly and their locality not divulged. The writer had positive knowledge as to the facts, however, and possesses a fine specimen obtained prior to 1873.

"The second important discovery in this region was made, or at least announced, twenty years later, in 1892, by Mr. C. R. Orcutt—the great locality of lithia minerals at Pala. Some illusions to red tourmaline from uncertain sources in this part of the State had appeared before; but nothing very specific. In the list of California minerals prepared by Prof. William P. Blake in 1880-82,[5] and also quoted in that of Mr. Henry G. Hanks, published in 1884,[6] references are made to the recent discovery of rubellite, for the first time in the State, associated with lepidolite, 'in the San Bernardino range, southern California.' The general description is precisely that of the Pala specimens, but the location is very indefinite. Mr. Hanks refers to the same association under lepidolite, and mentions a specimen in the State Mining Bureau, from San Diego County, and remarks that 'this may at some future time be found profitable to extract lithium from it'[7] a prediction abundantly verified now. Mr. Orcutt, however, was the first to make the locality known. It was noted by the author in his report for 1893, where the following account was given:[8]

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[2] Kunz, G. F., Gems, Jewelers' Materials and Ornamental Stones of California, State Mining Bureau, Bulletin 37, pages 21-25, 1905.

[3] Goodyear, W. A., San Diego County, State Mineralogist's Report, VIII, pages 516-522, 1888.

[4] Kunz, George F., Min. Res. U. S., Rept. U. S. Geol. Survey, 1893, p. 18 (reprint).

[5] State Mineralogist, 2d Rept., 1880-82, p. 207, Appendix.

[6] *Ibid.*, 4th Rept., 1884, p. 389.

[7] State Mineralogist, 4th Rept., 1884, p. 254.

[8] Rept. U. S. Geol. Survey, 1893, Min. Res. U. S., pp. 17, 18 (reprint).

"'Mr. Charles Russell Orcutt has announced a new and remarkable occurrence of pink tourmaline in lepidolite, similar to that of Rumford, Maine, 12 miles south of Temecula, near San Luis Rey River, in San Diego County, the southern county of California, and it has already become celebrated from the abundance and beauty of the specimens yielded, as much as twenty tons having been sent East for sale.'

* * * * *

"The next important discovery was made six years later, in 1898; this was the wonderful Mesa Grande locality, some 20 miles southeast of Pala. There are various stories about the Indians having known it for many years, and the most familiar account is that given further on under Tourmaline. But the fact that some of the highly colored crystals are found in Indian graves in the vicinity, suggests that they may have been known and valued perhaps for a very long time. The ledge in which they occur is exposed by erosion on the side of the mountain; and the natives had certainly learned where to find crystals, and had them in their possession for some years before the whites knew anything about them. It is even said and they had learned how to do a little rude blasting, and thus to reach the cavities in which the minerals occur. It was not until 1898, however, that this now famous locality was made known to the world.

* * * * *

"For several years, these above noted were the only gem mines of this region, and their product was highly esteemed. But in 1902 began a succession of new discoveries that have attracted great attention. On Pala Chief Mountain and on Heriart Mountain began to be found not only fine-colored tourmalines, but the novel and remarkable gem-spodumene, designated as kunzite. This last-named mineral was found by Mr. Frederick M. Sickler, at what is now known as the White Queen mine, on Heriart Mountain, east of Pala, early in 1902; it is claimed, indeed, that he had obtained one or two pieces some time before, but it was not identified. In July, 1902, Mr. Sickler visited San Diego and Los Angeles, and showed specimens to local jewelers and collectors, none of whom recognized it. The first determination was made by the writer, from specimens sent by Mr. Sickler early in 1903.

"The great Pala Chief mine, which has given its name to the middle one of the three ridges or mountains at Pala, and has yielded magnificent tourmalines and the largest and finest gem-spodumene crystals was located in May, 1903, by Frank A. Salmons, John Giddens, Pedro Peiletch, and Bernardo Heriart. The actual discoverers were probably the two last named, the Basque prospectors who had already been working and locating claims with the two Sicklers, father and son, on Heriart Mountain, the ridge a little to the east. Mr. Salmons has been the principal operator, however, of this very notable mine.

* * * * *

"Meanwhile, on September 8, 1902, gem-tourmaline had been discovered on Aguanga Mountain, some 5 miles south of Oak Grove, by Mr. Bert Simmons. This locality lies nearly east from Pala and south from that at Coahuila, next to be mentioned, and about equally distant from the two, some 15 miles. Kunzite has since been found on the same claim.

"On May 30, 1903, Mr. Simmons discovered both colored tourmalines and kunzite in Riverside County, some 10 miles west of the old Hamilton (first) discovery. The locality is on Coahuila Mountain, about 20 miles northeast of Pala. The mine was for some time known as the Simmons mine, but has been sold to Mr. E. A. Fano, of San Diego, and is now called by his name. This is one of the most promising and productive mines of the region.

"The discoveries at and around Ramona followed in rapid succession, in 1903. Some had been made several years earlier, but they had not attracted much notice. Essonite garnet was reported near Ramona in 1892, by D. C. Collier, and also fine epidote. Much of the essonite found hereabout is of rich color and fine gem quality.

"Several mines, with this 'hyacinth' variety of garnet and more or less of beryl and tourmaline, were located in May, July, and September, 1903.

"On October 3d of that year, topaz was discovered in the same vicinity, by James W. Booth and John D. Farley. This was a novel and important addition to the gem products of the State. The crystals are of various sizes, some of them large, often transparent, and range from colorless to pale shades of blue, much resembling those from the old and well-known locality at Sarapulka in the Ural Mountains."

NATIVE ELEMENTS

NON METALS

DIAMOND

Diamond, C

H. 10; Sp. Gr. 3.5±; Refractive index, n = 2.4175

The diamond besides being the gem stone of highest value and importance, is also indispensible for a number of industrial purposes.

Soon after the discovery of gold in California, diamonds were found as a constituent of the auriferous gravels. Lyman (1) reported seeing a pale-yellow crystal about the size of a pea which had been recovered from the river gravel. A few years later they were found in the gold-bearing gravels at Cherokee, Butte Co., which locality has yielded the largest number of diamonds found in the state. Placer deposits in other parts of the state have also yielded them from time to time as the diamonds are not restricted to any one locality. Although no systematic records have been kept, between four and five hundred stones have been found. Most of them were small, of a pale yellow or straw color, though a few have been found exceeding two carats in weight and of good quality and colorless.

The origin and source of these diamonds is still unknown. It is presumed that their genesis has been in the basic igneous rocks from which the serpentines of the gold regions have been derived and through continued search they may yet be found in place. The discovery near Oroville of an apparent pipe of serpentinized rock resembling the South Africa deposits led to some active operation by the U. S. Diamond Mining Co. A shaft was sunk but operations were not successful. The rock is a hard eclogite.

Hanks (1) gives an interesting account of the diamonds found in the early days of gold mining, and Storms (1) also contributed short articles on California diamonds.

In 1867 Prof. Benjamin Silliman, Jr., exhibited several diamonds before the California Acadamy of Sciences which were found in various districts, Cherokee in Butte Co., Fiddletown, Amador Co., one from El Dorado Co., and another from French Corral, Nevada Co.

Most of these were obtained from the ancient-river gravels. Prof. Josiah D. Whitney listed some fifteen localities here and states that the largest stone he had seen weighed 7.25 carats.

A total of eight counties have yielded diamonds, Del Norte, Trinity, Plumas, Butte, Nevada, El Dorado, Amador and Tulare. The greatest number however have been found in Butte, El Dorado and Amador counties, Nevada County having produced the largest stone as above mentioned.

The Volcano district in Amador Co., has yielded a number of stones, one of the largest, a pale straw-colored stone weighed 1.25 carats. Butte Co., is noted principally for the Cherokee district and diamonds have also been found at Yankee Hill and at Oroville.

El Dorado has several localities near Placerville. Turner (1) states most of the stones have been found south of Smiths Flat and at White Rock Canyon as well as Webber Hill.

In part the gold-bearing gravels which contain the diamonds is a conglomerate or cemented gravel, and in order to recover the gold the gravel is crushed and milled, so that whatever diamonds are contained therein are crushed also. The diamonds are so sparsely distributed that it is exceedingly doubtful if efforts to recover them would prove profitable.

In 1882 a beautiful stone weighing 1.57 carats was found at Volcano. This stone is a modified octahedron with curved faces and edges. This example of California diamond may be seen at the Museum of the State Division of Mines in the Ferry Building.

Photo by G. Dallas Hanna

FIG. 1. Diamond found, 1934, near Plymouth, Amador County. Enlarged 8X. Weight 0.53 grams (2.65 carats); maximum length 8.5 mm.; maximum width 6.1 mm.; minimum width 5.7 mm.

The Cherokee District in Butte County has long been famous for the number of diamonds found. A fine crystal found in the Spring Valley Hydraulic Mine was presented to the Museum by Mr. Williams, superintendent of the company. Two large stones were found which when cut yielded stones weighing 1.50 and 1.187 carats respectively.

In El Dorado County about three miles east of Placerville diamonds were found in the auriferous gravel. In 1871 an examination of the gravel was made by N. A. Goodyear, assistant State Geologist, who upon finding specimens of Itacolumite expressed an opinion that diamonds should be found in the gravel. A vigorous search disclosed a number in the possession of some of the miners, none of whom knew their true nature. In 1894 W. P. Carpenter of Placerville announced the acquisition of two crystals weighing six and seven troy grains respectively.

After the introduction of the stamp mill in place of the sluice box the recovery of diamond crystals decreased. From time to time

shattered fragments have been found in the tailings, mute evidence that the diamonds still exist.

In Nevada County diamonds have been found at French Corral, one yellowish stone weighing 1.60 carats being exhibited by Silliman. The largest stone found weighing 7.25 carats was from this district.

The black sands of Trinity River which drains through Trinity County in the northern part of the state has yielded microscopic diamonds.

METALS

GOLD, SILVER, PLATINUM, IRIDIUM, PALLADIUM, IRON

GOLD

Native Gold Au.

H. 2.5–3.0; Sp. Gr. 15.6–19.3.

Gold has always been the most important metal in the jewelry industry and its use is extensive. From earliest times in Egypt and Babylonia to the present this beautiful yellow metal has been wrought into exquisite works of art. The use of nuggets for jewelry purposes is extensive, small pieces are usually worked into chains, pins, rings and bracelets while the larger pieces are used as solitaire mountings or as pendants.

Gold Quartz has long been the most prominent gem mineral of the state. Most of the quartz found contains gold in such finely distributed particles as to be invisible. At times however it occurs in dense concentration in spots, flakes and moss-like markings throughout the quartz and when cut and polished makes handsome gems. Sometimes quite large water-worn boulders rich in gold are found. One large boulder found by the Nevada Hydraulic Co., weighed 160 pounds and contained about $2,500 worth of gold. Two small boulders weighing about one pound each, when cut yielded several dozen fine stones. While most of the quartz is white or nearly so, at the Sheep Ranch Mine in Calaveras County a black quartz is found. This when cut with the bright yellow gold showing forms beautiful gems.

The gold fineness varies considerably, the average of the better type being .875 fine or about 21 Kt. Gold quartz is extensively used for inlaying in boxes, frames, watch chains, pins and brooches and in cabochon sets for rings, clips, brooches, pendants and other classes of jewelry.

Gold has always been one of the most important mineral products of the state and has a wide distribution throughout it, being found in every county and produced in two-thirds of them.

Although gold is known to have been mined by the Indians in Los Angeles County as early as 1841, Symons (1), it was not until 1848 with its discovery at Coloma and the world-wide publicity given which led to its rapid development and production, in 1852 reaching an all-time high—record value of $81,294,700. This great quantity of precious metal was recovered principally from the gold-bearing gravels of the river streams and ancient-river channels throughout the state.

Many valuable nuggets and masses of large size were found. In 1854 at Carson Hill, Calaveras Co., one large specimen weighing

2,340 Troy ounces was found and in 1860 another weighing 1,596 Troy ounces was found at the Monumental mine, Sierra Buttes. Hanks (2) records many other nuggets which were found in the early days.

Gold is not confined to one class of rocks, although the gold-bearing quartz veins are principally in metamorphic schists and slates. The original source of the gold has been the igneous rocks and it is found in granites, syenites, monzonites, granodiorite, diorite, rhyolite, quartz-porphyries, andesites, porphyrites and diabases.

With quartz it has been deposited or impregnated in metamorphic rocks such as gneisses, amphibolites, chlorite schists, talc schists, mica schists, slates and quartzites and sedimentary conglomerate, sandstone and shales.

Gold in quartz is the usual association and although numerous localities have produced high-grade ore showing moss-like concentration of gold in quartz, the bulk of the regular production contains the gold in such finely divided particles as to be invisible. Gold in pyrite or 'auriferous pyrite' is widely distributed, and with it galena is frequently associated. From this type of ore the bulk of the gold is produced.

Gold is also associated with many other minerals. In arsenopyrite it is common throughout the Mother Lode, also in the Alleghany district, Sierra County. To a lesser degree, gold is found in calcite, and barite as gangue minerals and in a few localities it has been found with cinnabar. In addition it has also been observed in a wide variety of minerals, Eakle (1).

The leading gold-producing counties in the state are Amador, Butte, Calaveras, El Dorado, Kern, Mariposa, Nevada, Placer, Sacramento, Shasta, Siskiyou, Sierra, Trinity, Tuolumne and Yuba.

SILVER

Native Silver, Ag.

H. 2.5–3 ; Sp. Gr. 10.5±.

Silver is extensively used for jewelry purposes and for ornamental articles and has universally been used from the earliest times.

Native silver has not been found in any large masses in California, yet the element is universally present in the gold and copper-producing areas and occasionally arborescent masses, wires and thin sheets are found in the mines producing these metals. It is more common in the silver-lead districts, where it occurs often near the walls of veins or in the vicinity of intrusive dikes, as a reduction product.

The metal is produced in the following counties. Alpine, Calaveras, Inyo, Kern, Los Angeles, Mono, Nevada, Placer, Plumas, San Bernardino, and Shasta.

Although Inyo County is a typical silver producer having many celebrated mines and districts such as the Cerro Gordo and the Kearsarge, most of the silver produced in the state comes from the gold-producing districts and is recovered with the extraction of the gold. Of forty-three counties producing silver, five counties produced 86 per cent of the total, 66 per cent of which came from gold-bearing ores.

COPPER

Native Copper, Cu.

H. 2.5–3; Sp. Gr. 8.83.

From earliest times copper has been used for arts and for personal adornment. Today it is a popular medium for the design of art-craft jewelry and may be used in combination with silver or gold.

Shaku-do is an alloy extensively used by the Japanese for inlay work, being composed of 8% to 10% gold and the balance copper. With age it takes a beautiful purple-brown color which is most attractive.

While most of the copper mines in the state have produced native copper, no distinct deposits of the native metal are known. Where found in the mines it has been reduced from the ores through the intrusion of dikes and is also found as coatings along the walls of veins. Sometimes it is found together with malachite and cuprite.

From 1896 to 1932 copper was the most important metal produced next to gold, the maximum production was in 1909 with 65,727,736 pounds and in 1916 due to higher prices prevailing the value of the total output reached $13,729,017, Symons (1).

Copper has been produced in twenty-seven counties the more important occurrences of the native metal being:

El Dorado County. The Cosumnes mine near Fairplay, the Alabaster Cave mine near Newcastle, the Cambrian mine near Placerville, the Ford mine near Georgetown and the Oest mine near Auburn.

Mariposa County. The Copper Queen mine.

Placer County. At the Algol mine near Spenceville, Valley View mine near Lincoln and in the Ophir district.

Plumas County. With rhodonite at Mumford's Hill; and with cuprite, malachite and native silver in the Pocahontas mine, Indian Valley.

Shasta County. This was for some years the principal copper county and many of the mines have produced specimens of aborescent copper and occasionally compact masses. Some of the mines are, Bully Hill, Copper City, Shasta King, Greenhorn, Mountain Copper, Mammouth, Balaklala, and Kosk Creek.

PLATINUM

Native platinum, Pt.

H. 4–4.5; Sp. Gr. 14–19.

For several decades past platinum has become increasingly popular for jewelry purposes, and for the higher classes of jewelry it has completely supplanted gold. Occasionally the natural nuggets are mounted for stick pins or other jewelry.

Early in California's history gray metallic grains and small nuggets of platinum were observed in some of the gold-bearing black sands of the streams and beaches and also in the concentrates from gold washings. Little attempt was made to save this metal and it is only in recent years that records have been kept of production.

It is found throughout the gold-bearing districts and the bulk of the production is obtained as a by-product in the dredging for gold. Platinum is practically always found in combination with iridium, palladium, osmium, rhodium, and ruthenium. Nuggets up to an ounce or more have been found.

IRIDIUM

Native Iridium, Ir.

H. 6–7 ; Sp. Gr. 22.6–22.8.

Iridium is extensively used as a hardening agent in platinum for jewelry purposes. The best type of alloy contains 10 per cent iridium and 90 per cent platinum. In the Trinity River and New River districts in Trinity County, most of the 'platinum' nuggets are osmiridium (iridosmine).

PALLADIUM

Native palladium, Pd.

H. 4.5–5 ; Sp. Gr. 11.3–11.8.

Due to its lower cost an effort has been made to use this metal in place of platinum. It is found naturally alloyed with the other metals of the platinum group.

IRON

Native Iron, Fe.

H. 4–5 ; Sp. Gr. 7.3–7.8.

Iron has been used for centuries past for rings and there is a belief that it has curative properties, especially for rheumatism.

During the past decade many fine pieces of iron jewelry have been produced. These articles as fabricated by one manufacturer are cast and after finishing in the usual way are sand blasted and then oxidized to a beautiful velvety jet-black finish, the like of which is impossible to produce on any other metal. Set in combination with ox-blood coral, lapis lazuli, jade or pearls the effect is unusual and artistic.

Iron occurs native either as telluric iron or as meteoric iron. Meteoric iron has been found in at least four localities in California. Analyses show that nickel is always present and sometimes cobalt, phosphorous, graphite or diamond.

A meteorite weighing 85 pounds was found at Shingle Springs, El Dorado County in 1871. One found in the San Emigdio Mountains in Kern County in 1888 weighed about 80 pounds. In San Bernardino County near Ivanpah, in 1880, an irregular-shaped mass of meteoric iron was found which weighed 117 pounds and at Canyon City, Trinity County, a mass weighing about 19 pounds was found in 1875.

Small grains have been found in the gold-bearing sands of Smith River in Del Norte County.

SULPHIDES

PYRITE—'Iron Pyrites'

Sulphide of iron, FeS_2.

H. 6–6.5 ; Sp. Gr. 5.

Pyrite is extensively used as a gem stone in inexpensive jewelry. When cut into small round stones having a series of triangular facets evenly distributed over the crown and having a flat back, (Rose Cut) it is called 'Marcasite' and these are set in cheap jewelry of all kinds.

Pyrite is the commonest of the sulphide minerals and is found in all kinds of rock but is particularly prominent in the metamorphic

schists, slates and quartzites and in unaltered sandstones. Although it is found in combination with other minerals it sometimes is found in crystals up to several inches in diameter. Its occurrence in California is widespread.

HALOIDS

FLUORITE

Fluoride of calcium, CaF_2.

H. 4, Sp. Gr. 3.2; Refractive Index, $n = 1.434$.

Fluorite is a common mineral. It sometimes forms thick veins and plays an important commercial role as a flux. In the finer grades it is widely used as an ornamental object. The Chinese are masters of the art of carving and fluorite is a popular medium in which to express this artistry. Birds, statues, desk sets and objects of all kinds including dishes and bowls are made from it. It is also used in optical instruments.

Fine crystals of green and purple fluorite are found in the following counties: Los Angeles, Mono, Riverside, San Bernardino, and San Diego.

OXIDES

OXIDES OF SILICON

QUARTZ-Silica

Oxide of silicon, SiO_2.

H. 7; Sp. Gr. 2.65; Refractive Indices, $N_\gamma = 1.553$, $N_\alpha = 1.544$.

Silica is one of the most widely distributed minerals and constitutes about three-fifths of the earth's crust. The silica minerals are classified under two groups. Under *Quartz* are classed those forms which are phenocrystalline, that is those with a distinct crystal structure; and under *Chalcedony,* those which are cryptocrystalline, that is those so finely crystalline that they appear non-crystalline except under the microscope.

Common quartz is an essential constituent of granites, granodiorite quartz-porphyries, rhyolites, gneisses, schists, quartzites and sandstones. Veins, seams and masses of white quartz are common in volcanic and metamorphic areas and in California much of it is gold bearing.

QUARTZ—Crystalline

Rock Crystal (colorless)
Amethyst (all shades of purple)
Citrine (yellow)
Smoky Quartz (smoky brown)
Cairngorm (dark brown)
Spanish Topaz (deep yellow to brown)
Rose Quartz (rose)
Morion (black)
Asteriated Quartz (with star)
Aventurine (spangled)
Quartz Cat's Eye (fibrous)
Gold Quartz
Tourmalinated Quartz (tourmaline incl.)
Rutilated Quartz (rutile incl.)
Thetis Hairstone (rutile incl.)
Phantom Quartz

Clear transparent colorless quartz known as 'rock crystal,' although widely distributed throughout the state, is rarely found in large size; it is usually found in clusters and groups lining cavities and in seams and veins in igneous rocks and is recovered as an accessory mineral in the mines. From time to time unusual deposits have

been found and worked due to demand for the material. In 1891–92 an excellent deposit was found near Placerville, El Dorado County, in a decomposed vein material of reddish earth, fine rock-crystals varying in size and weight from a few ounces to over eighty pounds. Many were clear and limpid, some over fifty pounds in weight. Some contained inclusions of chlorite in successive stages forming beautiful phantom crystals.

The most extensive deposit of rock crystal in California was found in 1897 by John E. Burton of Milwaukee, Wisconsin, at the old Green Mountain Mine, Calaveras County, one and one-half miles south of Mokelumne Hill. Here in an ancient-river channel filled with auriferous gravel a quantity of enormous quartz crystals were found. A number of tons of crystals were removed, one attached to a group of 47 smaller pieces weighed over a ton. A number of the finest were sent to New York and crystal balls were cut from them by Tiffany & Company. One of the largest crystals measured 19x15x14 inches and one other 14x14x9 inches. A perfect sphere measuring five and one-half inches in diameter valued at $3,000 was cut from one of these crystals. Larger spheres have been cut from California crystals to over 7 inches in diameter, but none were perfect. Some of these crystals were the largest ever found.

In recent years this deposit has produced many tons of quartz although much of this is flawed and feathered and massive but a small amount being suitable for gem purposes. The widespread use of quartz for oscillators for radio apparatus has led to extensive search for commercial deposits. Prices range to $3.00 per pound for clear pieces two to five pounds each in weight.

Many counties produce fine specimens, a few important localities follow:

Calaveras County. Green Mountain Mine.

Amador County. Has produced fine large specimens from Volcano and Oleta.

El Dorado County. At Placerville and at White Rock Canyon near Georgetown.

Nevada County. Good specimens of rock crystal are found at Grass Valley and Nevada City. Large specimens have been found near Washington.

Placer County. Rock crystal occurs in the Ophir district.

Riverside County. Rock crystal in fine large crystals have been found at Coahuila.

San Diego County. Excellent specimens have been found in the tourmaline gem mines of the county.

AMETHYST

Amethyst is transparent crystalline quartz of various tones of purple varying from light to dark.

Few deposits are known in the state. Pale violet-colored amethyst has been found in Lake Co., the Clear Lake Gem Mining Company, Woodland, California, J. F. Garrette, Mgr., has operated a deposit near Howard Springs. This material shows remarkable metamorphism being found only in fragmentary pieces. Fragments showing

original crystal faces are rare. The material polishes into brilliant light-colored stones.

Mono County has produced amethyst from the Bodie district.

San Benito County. A few crystals of fair color were found in the San Carlos Mine of the New Idria Quicksilver Company.

CITRINE, SPANISH TOPAZ, CAIRNGORM, SMOKY QUARTZ, MORION

These transparent varieties of quartz, vary in color from light yellow through all of the tones of brown to black. Citrine and Spanish Topaz are the type commonly sold by the jeweler as 'topaz.' The darker shades of smoky quartz may be lightened by careful heating or the color may be removed altogether. Cairngorm is also known as 'scotch topaz,' and Smoky Quartz as 'smoky topaz' and 'smoky crystal.'

Yellow crystals have been found at the Newman mine on Cedar Mountain near Livermore, Alameda Co., and at Bald Mountain in Sierra County.

Smoky quartz is widespread and many fine specimens have been found in many localities. It occurs in the following counties:

Amador, in the Volcano and Oleta districts; Butte, on the North Fork of Feather River; El Dorado, near Placerville; Riverside, at Coahuila, Rincon and Mesa Grande; San Diego, in the various gem mines at Pala and Ramona.

ROSE QUARTZ

Rose quartz is practically always found massive, although crystals have been found. Several fine deposits exist in the state and it is found in the following counties:

Alpine County. In Hope Valley and in the Mogul and Monitor districts.

Amador County. At Volcano and Oleta.

Butte County. Near Forbestown.

Plumas County. Deep-colored rose quartz has been found in Meadow Valley.

Riverside County. At Coahuila.

San Diego County. Single crystals of a deep-rose color has been found in the pegmatites in which the other gem minerals are found as well. An opalescent rose-quartz occurs at Escondido.

Tulare County. Rose quartz is found at Bull Run Meadows and at Yokohol; beautiful specimens are found at the Summer Rose Quartz claim eight miles south east of California Hot Springs near Kern County line. It is also found on the west side of Bull Run Ridge; near Lemon Cove and at Badger. Excellent material is found in a pegmatite on the Gasenberger Ranch near Exeter.

Asteriated quartz, aventurine, tourmalinated quartz, rutilated quartz, and *thetis hairstone* as well as *gold quartz* are all varieties of quartz and with the exception of asteriated quartz, always contain inclusions which may be hematite, mica, chlorite, tourmaline, rutile, asbestos, actinolite or gold.

These varieties are associated with those above mentioned and are found in the following counties. Amador, thetis hairstone near Oleta; Butte County, tourmalinated quartz, the tourmaline being in brilliant-

black hair-like crystals. El Dorado County, phantoms at Placerville, with chlorite; rock crystal with actinolite inclusions are found near Fairplay.

Los Angeles County. Thetis hairstone near Los Angeles.

Placer County. Rock Crystal with green chlorite at Shady Run.

San Bernardino County. San Bernardino Range, quartz with rutile needles; also with specular hematite and epidote in the San Bernardino Mountains 30 miles northeast of San Bernardino.

San Diego County. Tourmalinated quartz found on the east side of Chihuahua Valley.

CHALCEDONY

Silicon dioxide SiO_2.

Refractive Indices, $n_\gamma = 1.543$, $\alpha = 1.532$.

The chalcedony forms of quartz are never transparent but occur in dense cryptocrystalline masses, translucent to opaque in a wide variety of colors and without crystal form. Hot solutions especially alkaline solutions acting upon silica in rocks dissolve some of the silica which is redeposited in layers, in seams or cavities in rocks completely or partly filling them, forming geodes and irregular-shaped masses, often with a banded structure. Chalcedony is a common secondary filling in cavities and fissures, in volcanic rocks and may form large geodes. In this manner often huge deposits of chalcedony and jasper are formed by deposition from springs whose waters contain soluble silica.

Chalcedony is more widely distributed than quartz and is found in large deposits. The various forms of chalcedony may differ slightly or markedly in color, pattern and texture. These include:

Chalcedony (white, blue, brown—pale tints)
Carnelian (flesh pink to red)
Sard (dark red to red brown)
Sardonyx (red and white layers)
Chrysoprase (green)
Agate (banded, various colors)
Onyx (black, or black and white striped)
Moss Agate (moss-like inclusions)
Jasper (opaque red, brown, green, etc.)
Bloodstone (dark green chalcedony with red jasper spots)
Agate Jasper (combined)
Basanite (black jasper)
Silicified Wood (Petrified Wood)
Myrickite (cinnabar in chalcedony)
Kinradite (spherulitic jasper)

Many fine specimens of all varieties have been found in the state. On the beaches along the Pacific Ocean, as well as in the stream beds or lake shores, chalcedony, agate or jasper pebbles are found in the greatest profusion. Notable deposits on the ocean beaches are: At Crescent City, Del Norte County in the northern part of the state. At Pescadero in the central part about 25 miles west of San Jose, chalcedony and agate pebbles are abundant. Occasionally hollow chalcedony pebbles containing liquid are found, (*hydrolite*). At Redondo, a beach resort 15 miles south of Los Angeles, fine pebbles are found. These are cut by the local lapidaries and are prized by the tourists. At Moonstone Beach, Santa Catalina Island, many chalcedony pebbles are found. On the shore of Lake Tahoe, agate, chalcedony and jasper pebbles are abundant, many of which are finely marked.

A sky-blue to deep-blue variety found near Kane Springs, Kern County is highly prized, this variety is sometimes called 'sapphirine'. In ancient times this type of chalcedony was highly prized by the

Babylonians and was extensively used for sealing purposes, the material being cut in the form of a cylinder and the engraving cut into the surface. The California deposit occurs in a reddish rhyolite which is sometimes cut with it. The chalcedony is usually in geodes or nodules and often fine picture effects are to be had by sawing these in half and polishing.

Chalcedony is also noted in Alameda County, as small geodes in the Berkeley Hills.

Imperial County. Fine agates are found as drift pebbles in the Colorado Desert near Canyon Springs.

Marin County. The beach pebbles at Bolinas are agate and chalcedony. Beautiful small carnelian pebbles, (amygdules) are found about two miles north of Point Bonita.

San Bernardino County. Moss agate has been found in the San Bernardino Mountains; bluish chalcedony occurs in the Black Mountains north of Barstow. White to creamy-white chalcedony with inclusions of hematite forming graphic markings (graphic chalcedony) occur near Barstow.

Myrickite occurs 45 miles northeast of Johannesburg and 15 miles northeast of Lead Pipe Springs; also in several of the quicksilver mines of the state, notably in the Rinconada Mine, San Luis Obispo County. Fine blue chalcedony is found two miles northeast of Lead Pipe Springs. Bloodstone is also found near here.

San Diego County. Red and white-banded chalcedony is found southeast of Dulzura and east of Donohoe Mine. Amethystine to pale-violet chalcedony found east of San Diego has been called 'violite.'

Tulare County. Fine moss-agate is found in Deer Creek. Chrysoprase is found in the hills east of Visalia on Deer Creek and at Yokohol. It was mined at Venice Hill, Stokes Mountain, Tule River, Deer Creek and one mile east of Lindsay.

Onyx

Very little true onyx is found in the state. Thick banded masses often of large size are found at the Knoxville quicksilver mine in Napa County.

The 'black onyx' sold by the jeweler is a chalcedony artificially colored by chemical means.

Bloodstone is green chalcedony having included spots and markings of red jasper. Fine bloodstone is rare, most of the material found and so termed is mottled or variegated green and red jasper.

Chrysoprase

Chrysoprase is a beautiful apple-green chalcedony, deriving its color from nickel compounds. It has been prized from ancient times and is sparsely distributed, few localities being known. Several localities exist in Tulare County, near Visalia. The first discovery was made in 1878 by a surveyor, George W. Smith. Mr. Max Braverman who was a collector of some note identified the mineral as chrysoprase. The original locality is at Venice Hill about 12 miles northeast of Visalia, where the material is found in thin veins. Much of it is flawed and cloudy but many fine dark apple-green colored stones were found.

Other deposits were found, five in all, one on Stokes Mountain, another on Tule River. The fourth on Deer Creek was found in 1897, thirty miles southeast of Visalia.

The following year another deposit was discovered at Lindsay. Associated with this material is a green opal which is called 'chrys-opal' or 'opal prase'. There was considerable activity in these mines after their discovery, over two thousand pounds being mined the first year. In the early part of the present century, a large New York company operated the mines and by 1902 the production had reached a value for that year of $15,000. For some time past the mines have been inoperative and only small quantities reach the market.

Jasper

Jasper is one of the most abundant varieties of cryptocrystalline quartz and it is widely distributed throughout the state. Many different types are found. These are characterized by solid or variegated colors of all kinds and patterns and is always opaque. The color is due to impurities, usually iron compounds which vary considerably in content. This jasper ranges in quality and texture from fine close-grained solid material differing little from chalcedony to coarse friable material commonly known as chert.

Jasper pebbles are found in practically all river streams, on the shores of lakes and along the ocean shore. It is common in the Franciscan series and is profusely distributed on both shores of the Golden Gate. An interesting variety called *Kinradite* is found here in the basalt and as loose pebbles and masses, being composed of spherulites, colored red by iron oxide. Sometimes the matrix is dark green and when cut with the red spots in contrast makes beautiful stones. The majority of the jasper found is in uniform and variegated colors of red, brown, yellow, green, and white.

Sometimes deposits of jasper reach large proportions. At Stone Canyon in Monterey County, 16 miles east of Bradley, a deposit of this type occurs. Here a fine-grained breccia is found. The deposit contains several thousand tons, many boulders lying about being individually several tons in weight. The dominant color of the jasper here is tan and brown and the breccia is cemented with chalcedony varying in color from white, through blue, purple, brown and black.

A beautiful orbicular jasper is found in Santa Clara County near Morgan Hill. The prevailing color is a brick-red having orbicular markings in yellow and maroon. Angular markings are also present and the stone is one of great beauty. Boulders over 100 pounds in weight have been extracted. Wm. B. Pitts of Sunnyvale, an ardent collector, has done much to popularize this material. His collection is both extensive and educational as well, many examples of orbicular jasper being included.

'Agate jasper' is a combination of chalcedony with particles of jasper and is found with the other quartz forms.

Basanite is a black variety. Fine specimens have been found along the Ocean Beach from San Francisco to Mussel Rock in San Mateo County. It is commonly called 'touchstone' and is used for testing gold by streak and acid reaction.

PETRIFIED WOOD—Silicified Wood

Petrified (silicified) wood is a most interesting mineral. This is a pseudomorph of silica replacing the wood. In fine specimens the entire wood structure may be clearly seen, the general form of the tree trunk, bark and concentric rings. Under the microscope the fine cellular structure which is perfectly preserved may be readily discerned and the type and class of wood determined. Some pieces of unusual academic interest are found showing a gradual change from wood right through to silica or opal. Petrified wood is found in one notable locality, the Petrified Forest, Sonoma County, west of Calistoga. Here large masses are found in place, tree trunks varying in diameter from one to five feet and up to 100 feet in length being embedded in the ground and have been uncovered. The color is usually tan or light-brown and the grain of the wood is quite distinct, chalcedony may be found filling seams and cracks. Most of the material is porous and is not capable of receiving a high polish like the silicified wood from other localities.

Fragmentary pieces of silicified wood are also found in the gravels of the hydraulic mines in northern California. The majority of the specimens found however are opalized.

Opalized wood is rather common and is found throughout the gold regions. The trees which grew along the banks of the ancient rivers were buried under rock, mud and lava and in the countless ages since, through the infiltration of siliceous waters, silica was deposited and replaced the wood fibers, retaining the original form and structure. Colors range from white through the shades of yellow and brown to black. Wood opal is capable of receiving and retaining a high polish and is extensively used for ornamental purposes.

OPAL

Hydrous oxide of silicon, $SiO_2.nH_2O$.

H. 5.5–6.5; Sp. Gr. 2.1–2.2; Refractive index, n = 1.406–1.460.

Opal differs from chalcedony in being amorphous and carrying varying amounts of water. It is silica which has solidified from a colloidal state. It commonly occurs in cavities and seams in many kinds of rocks.

Precious opal shows a beautiful play of colors.

Common opal is widely distributed and is found in a variety of colors.

Hyalite is a glassy transparent type and is found occasionally in the cavities of volcanic rocks.

Chrysopal, 'prase opal' or 'opal prase' is a green type closely resembling chrysoprase.

Moss opal is common opal showing moss-like markings or inclusions.

Wood opal is wood replaced by opal.

All of the types of opal are found in the state and are used for gem purposes. Precious opal and prase opal are rare while common opal is abundant. The latter material is found throughout the Mother Lode in large masses buried in the ancient-river channels. Opal of gem quality has been found in the following counties.

Napa County. Opal-prase occurs at the Knoxville mine.

San Bernardino County. Some good opal of gem quality occurs in the Black Mountains about 25 miles north of Barstow.

Siskiyou County. Fire opal has been found near Dunsmuir.

Sonoma County. Some opal of gem quality has been found near Glen Ellen. Fire opal has been found in a clay deposit on the Weise Ranch between Glen Ellen and Kenwood.

Tulare County. Opal-prase is found in the chrysoprase deposits in the hills east of Visalia and Porterville.

OXIDES OF THE METALS

ANHYDROUS OXIDES

Cuprite	Ilmenite
Corundum	Spinel
Hematite	Cassiterite

CUPRITE—Red Copper

Red oxide of copper, Cu_2O.

H. 3.5–4; Sp. Gr. 5.99; Refractive index, $n = 2.849_2$.

Cuprite is occasionally used for gem purposes and when pure and free from cracks is capable of receiving a high polish.

Cuprite occurs in most of the copper localities as a secondary mineral in the oxidized portions of the deposits. Massive specimens have been found in many counties but no large bodies of the mineral have been noted in California. Cuprite is found in the following counties, Eakle (1).

Alameda, Amador, Calaveras, Del Norte, Fresno, Glenn, Humboldt, Kern, Lassen, Modoc, Mono, Napa, Nevada, Placer, Plumas, Riverside, San Benito, San Bernardino, Shasta, Trinity, Tulare, and Tuolumne.

CORUNDUM

Oxide of aluminum, Al_2O_3.

H. 9; Sp. Gr. 3.95–4.10; Refractive indices, $n_\alpha = 1.760$, $n_\gamma = 1.768$.

Its great hardness and high specific gravity serve to distinguish corundum from other minerals. Transparent varieties as well as translucent to opaque asteriated corundum are important gem stones. *Ruby* is the name given red varieties and *sapphire* is applied to all the other colored varieties. Asteriated stones are those which exhibit a six-rayed star when cut cabochon and are called *Star Rubies* or *Star Sapphires* according to color.

Massive corundum is an important abrasive mineral. An impure form called 'emery' is extensively used for this purpose.

Corundum is a constituent of syenite rocks, a type which is not common in the state. In the few localities where it is found, it exists in limited quantities, consequently few corundum gem stones have been found.

Los Angeles County. First found in the state in the drift at San Francisquito Pass as small blue pebbles, W. P. Blake (1). Near Uplands red corundum crystals occur in a syenite in San Antonio Canyon.

Plumas County. Large crystals of a pale violet shade occur in the plumasite of Spanish Peak, Lawson (1).

San Bernardino County. Found in the Kingston Range. Rubies have been identified in limestone from the Baldy Mountains, but no stones of commercial size have as yet been taken out.

San Diego County. A constituent of the dumortierite schist of Dehesa, Schaller (1). Occurs in a vein with garnet in a mica schist on the north slope of San Miguel Mountains, 26 miles east of San Diego, in pink colors and opaque crystals.

HEMATITE—Red Ochre

Sesquioxide of iron, Fe_2O_3.

H. 5.5–6.5; Sp. Gr. 4.9–5.3; Refractive indices, $n_\alpha = 2.94$, $n_\gamma = 3.22$.

Hematite is the chief ore of iron and large deposits occur in California. Several distinct types are found, Eakle (1). Only the fine-grained material is capable of being highly polished. Hematite has been used as a gem from the earliest times. It was often used for intaglii in the early Roman days. When properly polished it possesses a brilliant luster and is often cut into the diamond form (brilliant cut) and sold as 'black diamonds,' the resemblance being quite marked. Intaglii in hematite are fashionable at the present time and make handsome ringstones.

Deposits occur in thirty-six counties. There are large deposits in Inyo, Madera, San Bernardino, and Shasta counties.

Other iron minerals found in the state and sometimes used for gem purposes are—

ILMENITE. Oxide of iron and titanium, $(FeTi)_2O_3$. Hexagonal rhombohedral. Plates, massive and in rounded pebbles and grains. Color black; streak dark-brown to black. Metallic luster. H. 5.6; Sp. Gr. 4.5–5.0.

CHROMITE. Oxide of iron and chromium, $FeCr_2O_4$. Isometric, generally massive; color black; streak grayish-brown. Metallic luster. Sp. Gr. 4.32–4.57. Refractive index, 2.16.

GÖTHITE. Hydrous oxide of iron, $Fe_2O_3.H_2O$. Orthorhombic; slender prisms, vertically striated; cleavage perfect brachypinacoidal. Color yellowish-brown; streak yellowish-brown; adamantine to submetallic luster H. 5–55; Sp. Gr. 4.37; Refractive indices, $n\alpha = 2.26$, $n\gamma = 2.40$.

LIMONITE. Hydrous oxide of iron, $2Fe_2O_3.3\ H_2O$; massive, compact stalactitic, botryoidal, columnar, fibrous, earthly; color yellow, brown to black. Streak yellow-brown. Submetallic to dull luster. H. 5–5.5; Sp. Gr. 3.6–4.0; Refractive index, 2.05.

SPINEL

Oxide of Aluminum and Magnesium, $MgO.Al_2O_3$.

H. 8; Sp. Gr. 3.5–4.1; Refractive index, $n = 1.723–1.75$.

Spinel in the fine red varieties commonly called 'ruby spinel' is a valuable gem mineral. Up to the present time its occurrence in the state is limited to small grains found in some of the gold-bearing

sands and gravels. Small crystals have been found in the rocks in Butte County near Oroville. *Picotite* a brown variety is found at Rocklin, Placer County, Hanks (1).

San Bernardino County. Black spinel occurs in basalt flows south of Pipe Canyon and in basalt near Quail Springs.

San Diego County. Deep green (*pleonaste*) in small octahedrons occurs at the Mack Mine, Rogers (1).

San Luis Obispo County. Ruby spinel has been observed near San Luis Obispo, Kunz (1).

Siskiyou County. Picotite occurs in the basalts of Mt. Shasta, Hanks (1).

CASSITERITE—Tin Stone

Oxide of Tin, SnO_2.

H. 6–7; Sp. Gr. 6.8–7.1; Refractive indices, $N_\alpha = 1.997$, $n_\gamma = 2.093$.

Cassiterite, wood tin or tin stone, as it is called, is rare in California. Fine material when cut and polished yields handsome lustrous gems.

It has been found at Michigan Bluff, Placer Co., and three miles above Big Bar in the Feather River, Plumas Co., Hanks (1).

Riverside County. At the Temescal tin mine, in a vein of tourmaline and quartz.

San Diego County. As a constituent in some of the gem mines.

Siskiyou County. At Sawyers Bar and on Hungary Creek.

Trinity County. Near Weaverville, Hanks (1).

CARBONATES

ANHYDROUS CARBONATES

CALCITE—Calc Spar—Limestone

Carbonate of Calcium, $CaCO_3$.

H. 3; Sp. Gr. 2.71; Refractive indices, $n_\alpha = 1.486$, $n_\gamma = E.658$.

Calcite is an exceedingly common mineral and though seldom used as a gem stone, varieties of it are important ornamental stones. Among these are marble, onyx or 'onyx marble', travertine, aragonite and limestone. The variety called 'oolite' contains black spherulitic calcite in a white matrix of the same material.

Calcite is found in practically every county, several of which are important commercial producers, Eakle (1).

Satin Spar is a fibrous crystalline variety showing when cut and polished a beautiful sheen. When cut cabochon shows a cat's-eye effect.

MAGNESITE

Carbonate of Magnesium, $MgCO_3$.

Magnesite is a very common mineral in the state being found with the serpentinized rock in veins and sometimes in deposits of considerable extent. It occurs in dense compact masses, the color is white to gray and the siliceous varieties possess considerable hardness.

As an ornamental stone magnesite possesses qualities which make it suitable for carved objects of all kinds; the harder varieties in par-

ticular are capable of receiving a glossy polish and where it is utilized for smokers' articles it has an appearance similar to meerschaum.

RHODOCHROSITE

Carbonate of manganese, $MnCO_3$.

H. 3.5–4.5; Sp. Gr. 3.45–3.60; Refractive indices, $n_\alpha = 1.597$, $n_\gamma = 1.817$.

A few specimens of a rose-red color have been found in the state. The mineral is usually found in the gold-silver regions where manganese is associated with the veins, Eakle (1).

SMITHSONITE

Carbonate of zinc, $ZnCO_3$.

H. 5; Sp. Gr. 4.45; Refractive indices, $n_\alpha = 1.618$, $n_\gamma = 1.818$.

Smithsonite in the fine green shades is often cut as a gem stone. Although like other carbonates it lacks sufficient hardness to be a durable gem stone, its soft green color is very pleasing and when worn as a pendant or brooch stone will give good service.

Found chiefly in Inyo County, at Cerro Gordo, Hanks (1), and various localities in San Bernardino County.

HYDROUS CARBONATES

MALACHITE—Green Copper

Basic carbonate of copper, $CuCO_3.Cu(OH)_2$.

H. 3.5–4; Sp. Gr. 4; Refractive indices, $n_\alpha = 1.655$, $n_\gamma = 1.909$.

Malachite is found in practically all localities where there is a trace of copper, being an alteration mineral of copper compounds. Although fine specimens are found, hard compact material suitable for cutting and polishing is scarce. As a general rule other copper minerals are associated with it—azurite, chalcocite, cuprite, chrysocolla.

A combination of several of these minerals called 'Mala-Cuprite' is composed essentially of malachite and cuprite with chalcocite and chrysocolla. This material cuts into fine and attractive gem stones. True malachite is extensively used for carvings and for ornamental purposes as well as inlay work.

AZURITE—Blue Malachite

Basic carbonate of copper, $2CuCO_3.Cu(Oh)_2$.

H. 3.5–4; Sp. Gr. 3.77–3.83; Refractive indices, n 1.739, n 1.836.

Azurite is usually found with malachite in the copper mines, though not so common. It generally occurs in aggregates of crystals but it is sometimes found compact with malachite, the two being cut together and the gem is then called 'azur-malachite.'

ANHYDROUS SILICATES

FELDSPARS

The name feldspar is given to a group of alumina silicates with potash, soda, and lime, whose members have the same general properties of hardness, cleavage, specific gravity and twinning order. They include; two potash feldspars, orthoclase and microline; a potash-soda feldspar, anorthoclase; a soda feldspar, albite; a lime feldspar, anorthite; and four soda-lime to lime-soda feldspars intermediate between albite and anorthite, namely oligoclase, andesine, labradorite and bytownite. The feldspars are the most abundant and most important of the rock-forming silicates, and the classification of an igneous rock is in general based upon the prevailing feldspar. The potash feldspars are characteristic of the acid group while the albite-anorthite feldspars belong to the basic group, the terms acid and basic meaning whether high or low in silica percentage. The albite-anorthite feldspars are commonly called the plagioclase feldspars.

ORTHOCLASE—Potash Feldspar

Silicate of potassium and aluminum, $KAlSi_3O_8$.

H. 6; Sp. Gr. 2.57; Refractive indices, $n_\alpha = 1.518$, $n_\gamma = 1.526$.

Orthoclase is an essential constituent of the acid igneous rocks, granites, syenites, quartz-porphyries, rhyolites and trachytes and is also found in other more basic rocks. The color of granites is mainly due to the orthoclase, red granite having the orthoclase colored by ferric oxide. Granites, syenites and diorites are often intersected by pegmatite veins and these veins vary greatly in width and some can be quarried for the feldspar. Orthoclase is sometimes found in transparent lemon-yellow crystals which may be cut into beautiful faceted gems.

The principal commercial deposits in California are in Monterey, Riverside, San Diego, and Tulare counties.

Adularia is a glassy variety and is sometimes found in large crystals.

Graphic Granite

Graphic Granite consisting essentially of orthoclase feldspar and quartz, derives its name from its peculiar markings, the orthoclase crystals being arranged in patterns resembling Hebrew writing.

This interesting rock is found in the pegmatites of San Diego and Riverside counties and is common at Soulsbyville in Tuolumne County. It also occurs in Mariposa County.

Graphic Granite is capable of receiving a high polish and is excellent for ornamental objects.

MICROCLINE—Potash Feldspar

Silicate of potassium and aluminum $KAlSi_3O_8$.

H. 6; Sp. Gr. 2.54–2.57; Refractive indices, $n_\alpha = 1.522$, $n_\gamma = 1.530$.

Microcline has the same composition as orthoclase but differs from it in its crystallization and twinning structure.

Amazonite, is the gem name given to the various tints of green and is extensively used for jewelry purposes the mineral being cut into all forms.

OLIGOCLASE—Soda-lime Feldspar

Silicate of sodium, calcium and aluminum, $mNaAlSi_3O_8$, with $nCaAl_2Si_2O_8$.

H. 6; Sp. Gr. 2.65–2.67; Refractive indices, $n_\alpha = 1.539$, $n_\gamma = 1.547$.

Occurs as a contituent of various igneous rocks.

Moonstone, in the gem trade called 'oriental moonstone' in order to distinguish it from the common chalcedony, is a semi-transparent to milky variety possessing white to bluish-white chatoyance.

Oligoclase is a constituent of the glaucophane rocks of Santa Clara County.

LABRADORITE—Lime-soda Feldspar

Silicate of calcium, sodium and aluminum, $CaAl_2Si_2O_8$, with $NaAlSi_3O_8$.

H. 6; Sp. Gr. 2.70–2.72; Refractive indices, $n_\alpha = 1.559$, $n_\gamma = 1.568$.

An essential constituent of most basic eruptive rocks. Sometimes it occurs in veins of large cleavable masses.

Los Angeles County. Labradorite is a constituent of the rocks on Mount Gleason; in the rocks of Yosemite Park, Mariposa County; and pebbles containing inclusions of native copper have been found in Modoc County.

Plumas County. Found in the rocks at Engels Copper mine.

Santa Barbara County. A constituent of the teschenites at Point Sal.

PYROXENE GROUP

ENSTATITE

Silicate of magnesium, $MgSiO_3$.

H. 5.5; Sp. Gr. 3.1–3.3; Refractive indices, $n_\alpha = 1.650$, $n_\gamma = 1.656$.

Enstatite is a rock-forming mineral characteristic of gabbroitic rocks and rocks that have been derived from gabbros, like much of the rocks of the Coast Range and of the Sierras which have become serpentinized.

Bronzite is a variety in which part of the magnesium has been replaced by iron. It occurs in bronze-brown reticulated masses.

HYPERSTHENE

Silicate of iron and magnesium $(Fe,Mg)SiO_3$.

H. 5–6; Sp. Gr. 3.4–3.5; Refractive indices, $n_\alpha = 1.692$, $n_\gamma = 1.705$.

Hypersthene is a constituent of basic eruptive rocks particularly gabbros and andesites.

Enstatite, bronzite and hypersthene are sometimes used for gem purposes. When properly cut, due to the fibrous structure they have a pleasing cat's-eye effect.

Cut by courtesy of Albert A. Sperisen.

Kunzite from Pala, California.

DIOPSIDE

Silicate of calcium, iron and magnesium, $Ca(MgFe)(SiO_3)_2$.

H. 4–6; Sp. Gr. 3.2; Refractive indices, $n_\alpha = 1.67$, $n_\gamma = 1.70$.

Diopside is found in crystalline limestones as a contact mineral associated with garnet. It also occurs in schists and other types of metamorphic rocks and is sometimes found in gabbros and peridotites.

Diopside is found in several counties in the state. This grass-green mineral affords gems of considerable beauty.

Contra Costa County. Common in the schists near San Pablo.

El Dorado County. Fine dark-green crystals occur near Mud Springs and in good crystals at the Cosumnes Copper Mine.

Los Angeles County. Large light-green crystals are found near San Pedro.

Riverside County. Crystals of pale-green diopside occur in the limestone at Crestmore.

SPODUMENE

Silicate of lithium and aluminum, $LiAl(SiO_3)_2$.

H. 7; Sp. Gr. 3.13–3.20; Refractive indices, $n_\alpha = 1.660$, $n_\gamma = 1.676$.

Spodumene is found in pegmatite veins where lithia is present. Sometimes the crystals are of exceptional size.

Hiddenite is the name given to the green varieties.

Kunzite is spodumene in the shades of lilac and violet.

The discovery of lilac-colored spodumene in the mineral deposits of southern California in the early part of the present century was of unusual interest and notable importance, being an entirely new mineral species, the first time lilac-colored spodumene was found. Although the mineral spodumene was known to mineralogists prior to this discovery it had never before been found in lilac or violet colors and with the exception of a few occurrences the transparent gem crystals were of small size.

When they were first found in San Diego County, being associated with tourmaline, they were at first thought to be a variety of that mineral. Specimens found by Frederick M. Sickler, were sent to George F. Kunz in Dec. 1902 for determination, who upon examination recognized the mineral as spodumene. In his honor this beautiful lilac gem mineral was named 'Kunzite' the name being proposed by Prof. Chas. Baskerville of the University of North Carolina, Baskerville (1).

Besides their unusual color and transparency many of the crystals found were of extraordinary size, some of the largest were recorded as follows:

No. 1.	528.7 gm	17 x 11 x 1 centimeters
No. 2.	528.7 gm	22 x 8 x 1.5 centimeters
No. 3.	297.0 gm	19 x 5.5 x 1.5 centimeters
No. 4.	258.6 gm	23 x 4 x 2 centimeters
No. 5.	340.5 gm	13 x 6 x 2.52 centimeters
No. 6.	239.5 gm	18 x 4 x 2 centimeters
No. 7.	1000.0 gm	18 x 8 x 3 centimeters

Soon after the discovery the locality was visited and examined by Dr. Waldemar T. Schaller then of the geological department of the University of California, who reported as follows, (1):

"The formation in which these fine crystals are found at the Pala locality consists of a pegmatite dike, dipping westerly at a low angle perhaps 20 degrees. It is more or less broken, and as a whole seems to form the surface of much of the slope of the hill on which it occurs. The dike is rather broad but irregular in its present shape, and has a thickness probably of not more than thirty feet. So far as the mining developments have shown, only a small portion of the dike is rich in lithia minerals.

"Ordinarily the dike is a coarse muscovite-granite, the orthoclase and quartz predominating containing many rounded prisms of black tourmaline with broken ends. Lepidolite, occasionally seems to replace the muscovite and when it does, red, blue and green tourmaline replace the black variety.

"It is with these gem-tourmalines that the spodumene occurs. While the tourmaline and lepidolite are frequently inclosed in the quartz and feldspar, no such inclusions of spodumene have been found. The latter mineral always occurs associated with the other minerals, but never penetrating them or penetrated by them. It occurs in pockets, and these facts seem to indicate that the formation of the spodumene is later and not coincident in time of formation with the tourmalines and with the dike. The dike cuts across the large intrusion of dark rock occurring at Pala and briefly mentioned by Dr. H. W. Fairbanks, (1).

"This large body of dark rock several miles across is surrounded on all sides by granite. The dark rock forming the foot-wall of the dike in which the spodumene occurs is a diorite, consisting of hornblende, a plagioclase and (surbordinate) orthoclase with accessory magnetite and apatite."

The original discovery made by Frederick M. Sickler was a product of the White Queen mine on the ridge east of the Pala Chief now known as Heriart Mountain. In 1902 and 1903 considerable exploration work was done which resulted in the discovery of the notable tourmaline and kunzite mine on Pala Chief Mountain.

Many outcrops and openings showed lepidolite and several showed kunzite at various points on the ends and on both sides of the ridge. Eleven claims in all were recorded and more or less developed. A peculiar reddish clayey mineral matter that occupies the cavities in which nearly all of the gem minerals are found is a form of halloysite.

Kunzite has also been found in Riverside County at the Fano mine near Coahuila, which was located in 1902 by Bert Simmons, and for some time bore his name. It occurs here both pink and colorless chiefly and is also found in yellow, green, and blue.

The colored varieties of spodumene show marked pleochroism, some specimens when viewed transversely may be gray or nearly colorless and when viewed longitudinally they present deep tones of lilac or amethyst, etc. All of the crystals show deeply etched faces.

Kunzite becomes strongly luminescent on exposure to a static charge of electricity. When a cut gem is suspended between the two poles it becomes an intense orange-pink color glowing with wonderful brilliance. On exposure to the rays of ultra-violet light the crystals phosphoresce for some moments.

The response to the Roentgen or X-Rays is most remarkable and many interesting experiments were conducted by Kunz, (1).

Many fine gems have been cut from this mineral. Numerous specimens of crystals and cut gems are in the Tiffany-Morgan collection in the American Museum of Natural History in New York.

PECTOLITE

Basic silicate of calcium and sodium, $HNaCa_2(SiO_3)_2$.

H. 5; Sp. Gr. 2.68–2.78; Refractive indices, $n_\alpha = 1.595$, $n_\gamma = 1.634$.

White pectolite occurs in veins and patches in altered basic dikes and flows and in serpentinized rocks.

As early as 1887 large masses of pectolite were found in the serpentine on Elder Creek, Tehama Co., Kunz (1). Here it occurs in a vein from two to three inches in thickness and in dense and compact masses. The fractured surfaces of the broken material exhibit characteristic silky luster. When cut and polished this mineral exhibits a beautiful sheen from the fibrous crystalline structure. Massive white fibrous pectolite also occurs in the serpentines at Fort Point in San Francisco County.

RHODONITE

Silicate of manganese, $MnSiO_4$.

H. 5.5–6.5; Sp. Gr. 3.4–3.68; Refractive indices, $n_\alpha = 1.726$, $n_\gamma = 1.737$.

Rhodonite, the rose-red manganese silicate is extensively used for gem purposes and ornamental objects of all types, dishes and trays, etc.

It is often present in copper and silver mines where oxide of manganese is abundant and it is usually associated with pyrolusite or psilomelane. It is generally developed as a contact mineral in veins.

Rhodonite of good gem quality occurs in the following counties:

Alameda County. At the Corral Hollow manganese deposit.

Butte County. Found on the North Fork of Feather River.

Madera County. Found near Coarse Gold.

Placer County. At Forest Hill.

Plumas County. Good red rhodonite is found in many of the valleys and canyons and in the Genessee Meadow.

Siskiyou County. Fine specimens of rhodonite occur at Sawyer's Bar. Rhodonite partly altered to the black manganese oxides occurs near Gazelle and on the South Fork of Salmon River. Specimens have come from Empire Creek, also Dutch Creek and Gottville. Massive material of good red color with black oxides occurs on Indian Creek near Happy Camp.

Tulare County. Some good gem rhodonite occurs about three miles north of Lemon Cove.

Tuolumne County. Found on Rose Creek near Columbia, also in veins two miles north of Sonora.

BERYL

Silicate of beryllium and aluminum, $Be_3Al_2Si_6O_{18}$.

H. 7.5–8; Sp. Gr. 2.63–2.80; Refractive indices, n_α 1.564, $= n_\gamma = 1.568$.

The mineral species beryl, includes several varieties varying greatly in color and value and known by different names:

Emerald is the deep to grass-green type.

Aquamarine is sea-green to sky-blue.

Golden beryl, yellow.

Morganite is the deep pink to rose-red.

Other names have been applied to varying color varieties, but generally these are called beryl. Beryl occurs in several parts of southern

California associated with the other gem minerals, and every color variety with the exception of emerald has been found there. This is one of the most important gem minerals, as at the present time fine quality emeralds are the most valuable of gem stones. Aquamarines are fashionable and in great demand.

The never-ending quest for new alloys has brought the metal beryllium into prominence. This metal, lighter than aluminum, with the strength of steel, and possessing great hardness is being rapidly developed for commercial use.

The chief localities are in Riverside County, and in particular San Diego County, at Pala, Mesa Grande, and Jacumba.

LAZURITE—Lapis-Lazuli

Silicate of sodium and aluminum with sodium sulphide, $Na_4(NaS_3Al)Al_2(SiO_4)_3$.

H. 5–5.5; Sp. Gr. 2.38–2.45; Refractive index, n = 1.50.

The blue ornamental mineral, lapis-lazuli, is rare and is only known in one locality in California. Fine quality specimens are highly prized, and by some authorities it is declared to be the only real blue gem-stone known.

Lapis-lazuli has been prized from the earliest times. It was the finest ornamental stone used in ancient Egypt, Assyria and Babylonia and the mines are still being worked today after a period of some 6,000 years.

Lapis-lazuli was the mineral used for making the beautiful blue ultramarine of the Egyptians. It is interesting to note that a number of artists today, have provided themselves with pigment made in a similar manner.

San Bernardino County. Small boulders of limestone containing lapis-lazuli with pyrite occur in the bed of San Antonio Creek, near Uplands. The boulders come from an old prospect which was thought to be a silver deposit. It occurs on the north slope of the south fork of Cascade Canyon, one and a half miles east of the 'Hogback', in San Antonio Canyon, twelve miles from Upland. The occurrence has been described as lapis-lazuli by Surr (1). (However, see Bulletin 113, p. 229).

GARNET

Silicate of Ca, Mg, Al, Fe, Cr, Mn, forming several varieties.

H. 6.5–7.5; Sp. Gr. 3.15–4.3.

Garnet is one of the common minerals of the state and a number of varieties are known to occur. It is generally a product of metamorphism and is common in metamorphic rocks such as gneiss, schist, quartzite and crystalline limestone. As a contact mineral formed by the intrusion of igneous rock into limestone and other rock, it is often found in fine large crystals. It is a common constituent of beach sands and of the concentrates of mining districts. There are several varieties based on composition.

Type	*Composition*	*Sp. Gr.*	*Refractive Index* $n =$
Grossularite—Lime-alumina garnet (essonite, hyacinth, cinnamon stone)	$CaAl_2(SiO_4)_3$	3.4–3.7	1.735–1.763
Pyrope—Magnesia-alumina garnet	$Mg_3Al_2(SiO_4)_3$	3.7	1.705–1.742
Almandite—Iron-alumina garnet	$Fe_3Al_2(SiO_4)_3$	3.9–4.2	1.778–1.830
Andradite—Lime-iron garnet (melanite, demantoid, topazolite)	$Ca_3Fe_2(SiO_4)_3$	3.75	1.865–1.895
Spessartite—Manganese-alumina garnet	$Mn_3Al_2(SiO_4)_3$	4–4.3	1.800–1.811
Uvarovite—Calcium-chrome garnet	$Ca_3Cr_2(SiO_4)_3$	3.4–3.5	1.838

Garnet is one of the most important gem minerals being extensively used in all types and classes of jewelry. Cabochon cuts in almandite or pyrope are called 'carbuncles'. Color varies greatly among the various types and even in the one species, thus grossularite when clear and light green is called 'gooseberry' stone, when translucent to opaque, 'African jade' and the brown variety, essonite, is the 'hyacinth' of the jeweler.

Andradite varies considerably also; melanite is black; demantoid, the beautiful yellow-green garnet, is the 'olivine' of the jeweler, and 'topazolite' is brown.

The majority of the garnets used are in the two classes: Almandite and Pyrope. While the garnets are extensively used as gems, they have many commercial uses, the most important of which is its utilization in the manufacture of garnet paper and cloth for the wood-working industry, approximately 8,000 tons of which is used annually.

With its high degree of luster (sub-adamantine) garnets make excellent gems. One variety of andradite, demantoid, has unusually high dispersion .057 and closely approaches the diamond in fire. When properly cut these stones exhibit a remarkable play of color.

In California garnets are extensively distributed throughout the state and are found in nearly all counties, the most important of which follow:

Calaveras County. Good crystals of andradite in schist at the Shenandoah mine. Andradite is found with idocrase and epidote at Garnet Hill above the confluence of Moore Creek and Mokelumne River.

El Dorado County. Large crystals of grossularite have been found at the old Cosumnes copper mine. Good crystals nine miles southeast of Placerville. Common near Georgetown.

Fresno County. Occurs at Grub Gulch and Fort Miller. The limestone near Trimmer contains much garnet. Brown garnet with green tourmaline on Spanish Peak in a ledge of white quartz. In calcite at San Ramon a white garnet occurs with the green californite on the south side of Watt Valley.

Inyo County. Fine large crystals of glossularite occur associated with white massive datolite and greenish-brown vesuvianite at the San Carlos mine. Andradite with epidote and scheelite in Deep Canyon.

Mariposa County. Andradite crystals are found on Mount Hoffman.

Monterey County. An unusual form of garnet being a combination of uvarovite and chromite is found in the county.

Nevada County. Fine green crystals of uvarovite are found at the Red Ledge mine associated with rhodochrome and kammererite.

Placer County. Fine uvarovite crystals have been found on chromite seven miles southeast of Newcastle at Farmer Swanton mine.

Riverside County. Occurs massive at the Santa Ana district. Essonite is found at Hemet. Abundance of grossularite and some andradite garnet occurs in the crystalline limestone at Crestmore. Essonite in fine crystals are found at Coahuila and near Mecca.

San Diego County. This is the most important garnet producing county and several types are found in the various gem mines. The finest essonite crystals were obtained from Ramona, associated with other gem minerals, beryl, tourmaline, white topaz, occasionally in perfect dodecahedrons and trapzohedrons, of rich honey-yellow to orange-red color. Essonite of very fine quality has been found in the Hercules, Lookout, Surprise and Prospect mines from some of which fine stones weighing from six to eight carats have been cut.

Sonoma County. Large masses of garnet occur near Petaluma. Almandite garnets occur abundantly in a chlorite schist on the Cox ranch three miles west of Healdsburg, with glaucophane and actinolite in schists at Camp Meeker and near Healdsburg. Almandite garnets occur in chlorite schist west of Healdsburg.

Trinity County. Uvarovite in emerald-green crystals occur on chromite near Carrville. Andradite occurs at Peanut. Colorless grossularite occurs associated with epidote, titanite and zircon in a soda granite-porphyry in the Iron Mountain district.

Tulare County. Several varieties occur at different points: essonite at Three Rivers, pyrope on Rattlesnake Creek, and topazolite near the chrysoprase locality 12 miles northeast of Visalia. Almandite is abundant between the North and Middle forks of Tule River. Massive white grossularite is found near Selma.

OLIVINE—Chrysolite-Peridot

Silicate of magnesia and iron, $(Mg,Fe)_2SiO_4$.

H. 6.5–7; Sp. Gr. 3.27–3.37; Refractive indices, $n_\alpha = 1.662$, $n_\gamma = 1.699$.

Olivine is a rock-forming mineral which is practically limited to basic igneous rocks such as basalt, andesite, gabbro and peridotite. When the mineral is found clear and limpid it constitutes a gem mineral of importance and considerable beauty.

Chrysolite is the name applied to the lighter varieties, in color ranging from lemon-yellow to yellow-green.

Peridot is applied to all of the darker olive-green shades.

Peridot was most highly prized by the ancient Greeks and Romans and in certain periods was in high favor as a seal stone.

Most of the olivine in the state is found in the form of grains as a sand constituent.

As a constituent of basalt it is found in the following counties:

San Bernardino County. Large bombs of granular olivine occur in the rock of the Morongo district. Common also in the lavas along the State Highway near Amboy.

Butte County. As a constituent of diabase at Mooreville Ridge.

Modoc County. Found in basalt near Cedarville.

WERNERITE—Scapolite

H. 5–6; Sp. Gr. 2.66–2.73; Refractive indices, $n_\alpha = 1.545$, $n_\gamma = 1.567$.

Wernerite, when found clear and transparent may be cut into gem stones of considerable beauty.

Scapolite is the name given a group of rock-forming silicates consisting of isomorphous mixtures of $Ca_4Al_6Si_6O_{25}$ with $Na_4Si_9O_{24}Cl$. Wernerite is the most common member of the group. The scapolites are in general formed by contact metamorphism.

Scapolite occurs in Nevada County at Nevada City and Grass Valley.

Riverside County. As an associate mineral at Crestmore and in small dikes on Eagle Mountain.

IDOCRASE—Vesuvianite

Basic silicate of calcium and aluminum, $H_4Ca_{12}(Al,Fe)_6Si_{10}O_{43}$.

H. 6–6.5; Sp. Gr. 3.35–3.45; Refractive indices, $n_\alpha = 1.722$, $n_\gamma = 1.723$.

Vesuvianite is a characteristic mineral formed in limestone near the contact with intrusive rocks. Small prismatic crystals suitable for cutting have been found near Georgetown, El Dorado County, on the property of W. L. Stifle. Some of the crystals found were of a fine grass-green color and were mistaken for emeralds.

A compact variety called 'californite' (california jade), was first found on the south fork of Indian Creek about 12 miles from Happy Camp and ninety miles from Yreka in Siskiyou County.

Californite varies in color from white and greenish-yellow to dark green. The outcrop at Happy Camp extends some 200 feet along the hillside and large boulders have fallen to the creek below. The country rock is serpentine. It was at first supposed to be jade and has been called California Jade. Analysis however proves it to be vesuvianite.

This mineral is hard and compact and is extremely tough and difficult to break with a hammer. It is capable of receiving and retaining a high polish and the clearer pieces make fine gems. A considerable quantity of this mineral has been sent to China where it is carved into ornamental objects of all kinds.

Butte County. Californite in translucent to opaque white and beautiful lemon-green color is found at the Jade Mountain Mine near Pulga on the North Fork of Feather River. It occurs in seams and as veins in serpentine.

El Dorado County. Brown crystals of vesuvianite at the Siegel Lode.

Fresno County. Californite occurs on the east side of Watts Valley about 32 miles east of Fresno.

Inyo County. Brownish-green crystals were associated with garnet and massive white datolite at the San Carlos Mine.

Riverside County. Green and brown vesuvianite are common in the crystalline limestones at Crestmore.

San Diego County. Brown vesuvianite is found about ten miles east of Jacumba.

Tulare County. Californite is found in the chrysoprase locality east of Porterville also found about 35 miles east of Selma.

ZIRCON

Silicate of zirconium, $ZrSiO_4$.

H. 7.5; Sp. Gr. 4.68–4.7; Refractive indices, $n_\alpha = 1.931$, $n_\gamma = 1.993$.

Zircon is invariably an associated mineral in acid eruptive rocks such as granites and syenites. The concentrates from the gold washings and the black sands usually carry some zircon grains and crystals.

There are no records showing zircons have been found in California in sizes large enough for gem cutting.

TOPAZ

Silicate of aluminum and flourine, $Al(O,F_2)AlSiO_4$.

H. 8; Sp. Gr. 3.4–3.65; Refractive indices, $n_\alpha = 1.619$, $n_\gamma = 1.627$.

Topaz occurs in veins in metamorphic and eruptive rocks, where fluorine has accompanied the formation of the vein. It is usually associated with tourmaline and other minerals whose formation has been due to the action of gases on the constituents of the rock.

Topaz is a durable and important gem mineral. Its hardness, brilliance and fine color all contribute to make a gem of great beauty.

Excellent topaz crystals, often of considerable size, have been found in San Diego County, near Ramona. Here the mineral is found in a pegmatite ledge. The crystals are not uniformly distributed throughout the rock but occur in zones or pockets.

The principal producers have been the mines known as the Surprise and The Little Three. These mines adjacent to each other are about four and a half miles northeast of Ramona. Associated with them are dark-green tourmaline crystals, albite and orthoclase feldspar. The topaz crystals found near the surface were colorless but at greater depth were of a sky-blue to deep aquamarine-blue. Over fifty pounds of them were taken from a cut 20 ft. long and 8 ft. wide. Fine crystals, light-green in color occur in the Aguanga Mountains.

ANDALUSITE—Chiastolite

Silicate of aluminum, Al_2SiO_3.

H. 7.5; Sp. Gr. 3.16–3.20; Refractive indices, $n_\alpha = 1.632$, $n = 1.643$.

Andalusite occurs as a constituent of gneisses and schists and is usually associated with kyanite, sillimanite and staurolite.

Chiastolite is a variety found in carbonaceous schists, in knotty and long prismatic crystals having black inclusions of carbon arranged axially and thus forming black crosses seen in transverse sections.

Mariposa County. Choice crystals of chiastolite are found in schist along Chowchilla River near the old road to Fort Miller.

KYANITE—Disthene

Silicate of aluminum, Al_2SiO_3.

H. 5–7; Sp. Gr. 3.56–3.67; Refractive indices, $n_\alpha = 1.712$, $n_\gamma = 1.728$.

Kyanite is a common metamorphic mineral found in schists and gneisses with andalusite, sillimanite and dumortierite.

When of a fine uniform blue color they are cut into gems of distinction.

ZOISITE

Basic silicate of calcium and aluminum, $HCa_2Al_3Si_3O_{13}$.

H. 6–6.5; Sp. Gr. 3.25–3.37; Refractive indices, $n_\alpha = 1.700$, $n_\gamma = 1.706$.

Zoisite belongs to the metamorphic class of minerals and is often developed by the metamorphism of gabbros and diorites.

Saussurite is a mixture of zoisite, calcite and plagioclase feldspar.

Thulite is a rose-red variety which makes attractive cut stones.

Found in Lake County at Sulphur Bank; Plumas County in the Diadem Lode, Meadow Valley; also in Riverside, Santa Clara and Shasta counties, Eakle (1).

EPIDOTE

Basic silicate of calcium, aluminum and iron, $HC_2(Al,Fe)_3Si_3O_{13}$.

H. 6–7; Sp. Gr. 3.25–3.5; Refractive indices, $n_\alpha = 1.729$, $n_\gamma = 1.768$.

Epidote is a common mineral in the state, especially as an alteration mineral in crystalline rocks. It is often found in aggregates of large crystals and columnar masses in veins with quartz and feldspar. The colors range from pistachio to dark green, dark brown, yellow.

Most of the epidote found is opaque or so badly fractured that it is impossible to cut good stones, however, clear transparent crystals are found at the McFall mine seven and one-half miles southeast of Ramona in San Diego County.

AXINITE

Borosilicate of aluminum and calcium with iron and manganese.

$H(Ca,Mn,Fe)_2BAl_2(SiO_4)_4$.

H. 6.5–7; Sp. Gr. 3.27; Refractive indices, $n_\alpha = 1.678$, $n_\gamma = 1.688$.

Crystals of axinite are sometimes developed in the veins and along the contact of intrusive rocks but the mineral is rare in its occurrence.

Fine crystals of exceptional beauty occur in the southern part of the State. A large crystal of axinite was found in the city quarry at Riverside, which measured 9 x 12 x $1\frac{1}{2}$ centimeters. The axinite of this quarry is a violet brown, Rogers (2).

Violet axinite occurs associated with cinnamon garnet in the pegmatite at Crestmore. Crystals of violet-colored axinite are also found in the Box Springs Mountains.

San Diego County. Smoky-pink crystals, a beautiful "ashes of roses" tone are found in an altered granite in Moosa Canyon, about 18 miles south of Pala near Bonsall, associated with quartz, epidote, and laumontite.

PREHNITE

Acid silicate of calcium and aluminum, $H_2Ca_2Al_2Si_2O_{12}$.

H. 6–6.5; Sp. Gr. 2.8–2.95; Refractive indices, $n_\alpha = 1.616$, $n_\gamma = 1.649$.

Green drusy coatings and veins of prehnite are sometimes present in altered diabase and lavas. Its soft green color makes it an attractive

gem stone or ornamental stone. Riverside County, a constituent of the pegmatite veins at Crestmore.

TOURMALINE

Borosilicate of aluminum with various bases.

H. 7–7.5; Sp. Gr. 2.98–3; Refractive indices, $n_{\alpha} = 1.631$, $n_{\gamma} = 1.653$.

Black tourmaline is a common mineral in the state and large areas of tourmaline granite exist in the Sierra Nevada. The common black tourmaline is characteristic of granites and quartz veins in granites. Brown tourmaline is found in crystalline limestone near the contact with intrusive igneous rocks. The transparent green and red shades occur in pegmatite veins which carry lithia and they are classed as lithia-tourmalines. The red tourmaline is known as *rubellite,* the blue as *indicolite* and the colorless as *achroite.*

The first discovery of colored gem tourmaline in the state goes back to 1872 when Henry Hamilton in June of that year obtained this mineral in Riverside County, the specimen having come from the southeast slope of Thomas Mountain. Some mining was done at this point and fine gems recovered. By 1893 several mines were in operation, the San Jacinto, and the Columbian being near Riverside. The vein varies from pure feldspar to feldspar with quartz and in others all mica, the vein being from 40 ft. to 50 ft. wide. The tourmalines varied from small size to crystals over four inches in diameter. The larger crystals found had a green exterior and red or pink inside. Some of the crystals contained green, red, pink, black and other colors.

Between 1890 and 1894 several other deposits of importance were found at Pala, in San Diego County. In Pala a little west of Smith's Mountain in the Peninsula range a ledge of lepidolite containing rubellite has been found which was traced for over half a mile. The rubellite was in clusters and radiations, several inches in diameter, also occasionally as single crystals and the specimens of deep-pink tourmaline in the pale-lilac mica made beautiful specimens. About eighteen tons were shipped during 1892.

The next important discovery was made in 1898 at the Mesa Grande locality some 20 miles southeast of Pala. This deposit was known to the Indians for many years, as tourmaline crystals were found in the burial grounds. The ledge in which they occur is exposed by erosion on the side of the mountain and the crystals were exposed.

The great Pala Chief mine which has given its name to the middle one of the three mountains at Pala, has produced magnificent tourmalines as well as the largest and finest gem spodumene (kunzite) in the world.

Subsequently through prospecting, other mines were opened in Riverside County at and around Ramona. One of these mines, called the San Jacinto gem mine, produced over a bushel of red and green crystals during the first year of operation. One of these measured eight inches in length and several inches in diameter. This was purchased by Harvard University, with other crystals several inches long and two inches in diameter. Other fine crystals were sent to the American Museum of Natural History, New York.

The Mesa Grande locality is remarkable for the great size and perfection of the tourmaline crystals, many of them being almost faultless, and doubly terminated ones being the rule rather than the exception. Bicolored crystals are quite common and often these are cut to show the two colors. Some of the crystals have circular tubelike hollows and when cut into cabochon forms, exhibit Cat's Eye effect and are called 'tourmaline cat's eye.'

This locality has been worked more thoroughly and has been more productive than any other locality in the United States. The mineralogical specimens alone were valued at $30,000 and up to 1905 the total gem value reached $200,000.

At the Pala Chief mine tourmalines a foot long and three inches in diameter were found. Many of these crystals were of a rich rubellite center with a blue coating of indicolite on the exterior.

Tourmaline is prized the world over as a gem. Its hardness, and great variety of bright colors make it a very attractive stone.

DUMORTIERITE

Basic silicate of aluminum with boron, $HAl_8BSi_3O_{20}$.

H. 7; Sp. Gr. 3.22–3.43; Refractive indices, $n_\alpha = 1.678$, $n_\gamma = 1.689$.

Dumortierite is a metamorphic mineral found in certain gneisses and schists; rare in its occurrence.

Dumortierite is somewhat difficult to polish particularly in the darker shades but attractive stones and ornamental objects may be cut from it.

Boulders of dark-blue dumortierite have been found in Imperial County twenty-five miles from Ogilby; also in Riverside County on the plains of Big Four mines, Pinacate district.

San Diego County. A violet-red variety of considerable beauty when polished, occurs near Dehesa, Schaller (2).

Tuolumne County. Boulders have been found in various parts.

HYDROUS SILICATES

MARIPOSITE

H. 2.5–3; Sp. Gr. 2.78–2.81; Refractive indices, $n_\alpha = 1.60$, $n_\gamma = 1.63$.

Mariposite is essentially a muscovite with its characteristic green color due to the presence of chromic oxide. It is characteristic of the gold belt of the Sierra Nevada.

It is common in the Mother Lode schists of Mariposa County whence it derives its name; and common also in Tuolumne County.

Mariposite in the finer grades, massive, is an excellent ornamental stone.

THOMSONITE

Hydrous silicate of aluminium, sodium and calcium, $(Na_2Ca)Al_2Si_2O_8.2\frac{1}{2}H_2O$.

H. 5–5.5; Sp. Gr. 2.3–2.4; Refractive indices, $n_\alpha = 1.497$, $n_\gamma = 1.525$.

Thomsonite is found in cavities of vesicular lava with other zeolites.

When there is contrasting color in the mineral, beautiful gem stones may be cut from it, the fibrous nature and concentric rings and bands forming a pattern of unusual interest.

Plumas County. Thomsonite is one of the zeolites occurring in the Engels copper mine.

SERPENTINE

Hydrous silicate of magnesium, $H_4Mg_3Si_2O_9$.

H. 2.5–4; Sp. Gr. 2.5–2.65; Refractive indices, $n_\alpha = 1.490$, $n_\gamma = 1.511$.

Serpentine is one of the commonest minerals and also rocks in the state. It is found in every county. It is a common alteration product of basic igneous rocks rich in magnesium silicates and it has all been formed by alteration and metamorphism of such rocks. Serpentine as a massive metamorphic rock, consists essentially of the mineral antigorite. Chrysotile, another form of serpentine is distinguished from antigorite by its fibrous structure and in differing optical properties.

Serpentine is used as an ornamental stone. Large quantities of it are carved in the Orient and often sold under different forms of 'jade' names.

TALC—Steatite—Soapstone

Hydrous silicate of magnesium, $H_2Mg_3Si_4O_{12}$.

H. 1–1.5; Sp. Gr. 2.7–2.8; Refractive indices, n_α 1.539, $n_\gamma = 1.589$.

Talc is a common mineral in the metamorphic areas of the state forming talc schists and talc gouge in mines. It is often associated with serpentine and actinolite.

Hard compact varieties are extensively used at the present time for ornamental objects.

CHRYSOCOLLA

Hydrous silicate of copper, $CuSiO_32H_2O$.

H. 2–4; Sp. Gr. 2–2.24; Refractive indices, $n_\alpha = 1.46$, $n_\gamma = 1.57$.

Small amounts of chrysocolla occur in most of the copper districts of the state where it is always found as an oxidation product of copper minerals. No deposits in quantity of the silicate have been found.

Inyo County. It occurs in numerous deposits in the various copper mines, being associated with azurite, cuprite, malachite and melaconite. The gem stone known as 'Mala-cuprite' contains a small percentage of chrysocolla. This mixture of copper minerals is very attractive and yields excellent gem stones, when cut.

CHLOROPAL

Hydrous silicate of iron, $H_6Fe_2Si_3O_{12}.2H_2O$.

H. 2.5–4.5; Sp. Gr. 1.72–2.01; Refractive indices, $n_\alpha = 1.625$, $n_\gamma = 1.655$.

Chloropal is a green, opal-like mineral of rare occurrence.

Nontronite is a yellowish variety.

This mineral is sometimes used as a gem, having unusual color and markings. Found in El Dorado, Kern, Mariposa, and Placer counties.

TITANO-SILICATES

TITANITE—Sphene

Titano-silicate of calcium, $CaTiSiO_5$.

H. 5–5.5; Sp. Gr. 3.4–3.56; Refractive indices, $n_\alpha = 1.900$, $n_\gamma = 2.034$.

Titanite is a common accessory mineral in the granites and gneisses and schists in the state. It is invariably found in microscopic size and large crystals are rare.

When found in sizes sufficiently large to be cut, titanite is a remarkable gem. Exceeding the diamond in dispersion, when properly cut, it is a gem of great beauty.

BENITOITE

Titano-silicate of barium, $BaTiSi_3O_6$.

H. 6.5; Sp. Gr. 3.64–3.65; Refractive indices, $n_\alpha = 1.757$, $n_\gamma = 1.804$.

Beautiful violet-blue, sapphire-blue and colorless crystals were found in San Benito County in 1907. These were at first thought to be sapphires; but they were subsequently determined to be a new mineral and named Benitoite, Louderback (1, 2). Of unusual interest is the

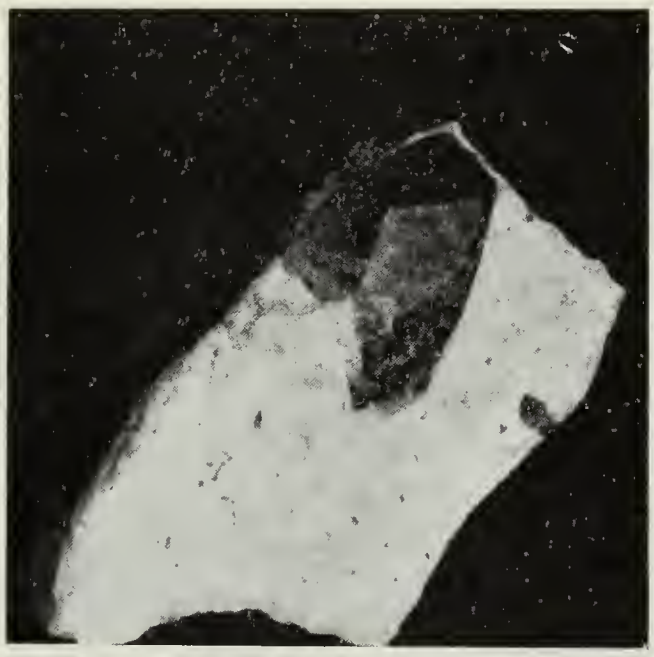

Photo by Walter W. Bradley

FIG. 2. Benitoite Crystal in Natrolite Matrix. Two-thirds natural size.

fact that this mineral was not only new but that it is the lone representative of the ditrigonal bipyramidal class of the hexagonal system. Prior to its discovery this class was projected by mathematics in accordance with the laws of symmetry.

The benitoite crystals occur in narrow veins of natrolite in serpentine near the headwaters of San Benito River; associated with it are neptunite, chalcocite, chrysocolla, actinolite, crossite, albite, aegyrite, calcite, aragonite, Joaquinite, and psilomelane.

The strong pleochroism of benitoite, requires placing the front of the cut stone parallel to the vertical axis of the crystal. A number of fine large stones are known. The largest weighing 7.65 carats, for a

Photo by Walter W. Bradley

FIG. 3. Crystals of Benitoite and Neptunite in Natrolite Matrix.

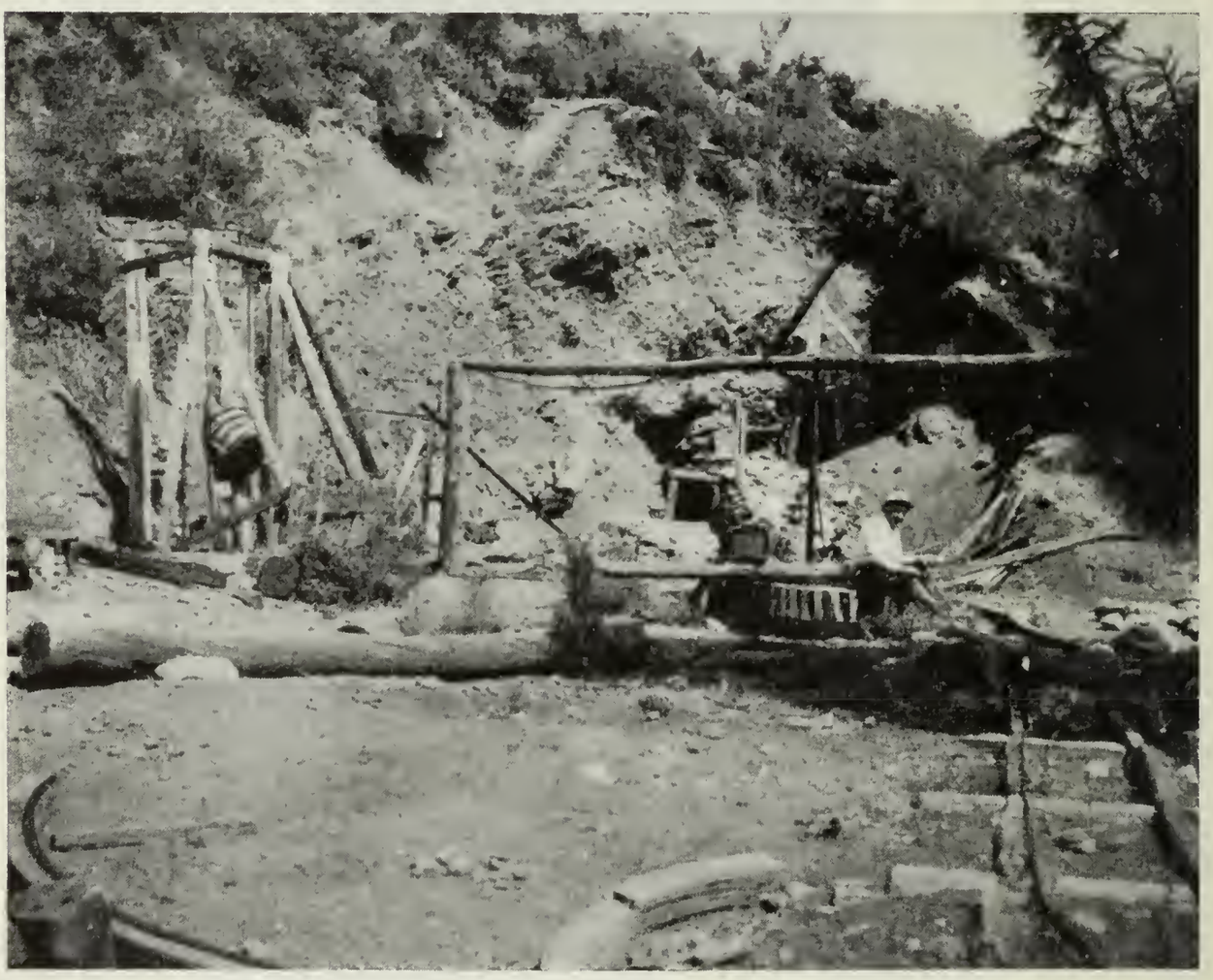

Photo by Walter W. Bradley, 1914

FIG. 4. Dallas Benitoite Mine, San Benito County.

long time the possession of a San Francisco jeweler, is now in the Smithsonian Institution, Washington, D. C. Production of benitoite has been limited to the Dallas mine, covered by two patented claims.

PHOSPHATES

APATITE

Phosphate of calcium with chlorine or flourine, $(CaCl)Ca_4(PO_4)_3$ or $(CaF)Ca_4(PO_4)_3$.

H. 5 ; Sp. Gr. 3.17–3.23 ; Refractive indices, $n_\alpha = 1.631$, $n_\gamma = 1.634$.

Apatite has been observed as small crystals in many of the rocks of the state but no deposits of the mineral are known. A small percentage of calcium phosphate is found in many of the limestones of the state.

When transparent and clear apatite is sometimes used for gem purposes.

LAZULITE

Basic phosphate of aluminum, iron and magnesium $(Fe,Mg)Al_2(OH)_2P_2O_8$.

H. 5–6 ; Sp. Gr. 3.05 ; Refractive indices, $n_\alpha = 1.603$, $n_\gamma = 1.639$.

Lazulite is a rare phosphate, azure-blue in color, found in quartzites and metamorphic rocks.

Inyo County. Lazulite occurs in a white quartz vein in schist in Breyfogle Canyon, Death Valley.

Mono County. In a white quartzite associated with rutile near Mono Lake. Found in a quartz vein in Green Creek Canyon, near Bodie. Lazulite occurs with andalusite and pyrophyllite at the mine of Champion Sillimanite, Inc., on the western slope of the White Mountains, east of Mocalno.

TURQUOISE

Hydrous phosphate of aluminum, $AlPo_4Al(OH)_3.H_2O$.

H. 5.5–6 ; Sp. Gr. 2.6–2.83 ; Refractive indices, $n_\alpha = 1.61$, $n_\gamma = 1.65$.

Turquoise is a gem mineral of importance and has been used for such purposes for thousands of years. In some parts of the world, it is a medium of exchange.

A most notable deposit of turquoise was found in San Bernardino County, which is of historical interest, Kunz (1).

[1] "In the extreme northeastern part of this county there have been discovered old and abandoned mines of turquoise covering an area of many square miles. Associated with these mines were found the relics of an early race ; and it is supposed that this is the original source of much of the turquoise found in the hands of the Indians of the southwestern United States and Mexico. The turquoise occurs in small veins and also in kidney-shaped masses about the size of a bean. Much of it is of good quality.

"The first published announcement of turquoise discoveries in this region was made through the writer in 1897, in his report to the U. S. Geological Survey.[2] The locality was given as near Manvel. Mr. T. C. Bassett had observed in this neighborhood a small hillock where the float rock was seamed and stained with blue. On digging down a few feet, he found a vein of turquoise—a white talcose material inclosing nodules and small masses of the mineral, which at a depth of 20 feet showed fine gem color. Two aboriginal stone hammers were met with, as usual at

[1] Kunz, G. F., Gems, jewelers' materials and ornamental stones of California : Bull. 37, Cal. State Min. Bur., pp. 107–110, 1905.

[2] Min. Res. U. S., 1897, p. 504.

all the turquoise localities in the southwest, and from this circumstance the location was named the Stone Hammer mine.

"The State Mining Bureau reported at about the same time that turquoise had been found in the desert region between Death Valley and Goff's Mining District, nearer the former, and that good samples were in the museum of the Bureau.

"In the spring of 1898, many reports of extensive discoveries were announced, and much attention was given by the press to the accounts of the region, both for the turquoise itself, and for the remarkable archaeological remains associated with the ancient workings. The district was seen to cover quite a large area in northeastern San Bernardino County, near the Arizona and Nevada lines.

"On the reports of prospectors reaching San Francisco as to a great group of ancient turquoise mines with cave dwellings, stone implements, and rocks covered with inscriptions, an exploring party was organized by the San Francisco 'Call,' and Mr. Gustav Eisen, of the California Academy of Sciences, became attached to it as archaeological expert.[3] The party set out early in March, 1898, going first to Blake Station on the Santa Fe Railroad, thence north to Manvel, and onward some sixty miles, across the Ivanpah Sink, and up into the mountains to an altitude of over 6000 feet, through an exceedingly rugged country, to reach the region reported. The turquoise district, as described by Mr. Eisen and others of the party, occupies an area of 30 or 40 miles in extent, but the best mines are in a smaller section, about 15 miles long by 3 or 4 in width. The region is conspicuously volcanic in aspect, being largely covered with outflows of trap or basaltic rock reaching outward from a central group of extinct craters. These flows extend for many miles in all directions, and appear as long, low ridges, separated by valleys and cañons of the wildest character. Among these basaltic rocks and in the valleys are found smaller areas of low, rounded hills of decomposed sandstones and porphyries, traversed at times by ledges of harder crystalline rocks, quartzites, and schists. In the cañons and on the sides of these hills are the old turquoise mines, appearing as saucer-like pits, from 15 to 30 feet across and of half that depth, but generally much filled up with debris. They are scattered about everywhere. Around them the ground consists of disintegrated quartz rock, like sand or gravel, full of fragments and little nodules of turquoise. Whenever the quartzite ledges outcrop distinctly they show the blue veins of turquoise, sometimes in narrow seams, sometimes in nodules or in pockets. The mode of occurrence appears closely to resemble that at Turquoise Mountain, Arizona. A few prospectors have dug into the old, half-filled depressions and found stones of good color and quality, and ordinary ones may be picked up almost anywhere out of the decomposed quartz. Stone tools are abundant in the old workings, and the indications are plain that this locality was exploited on a great scale and probably for a long period, and must have been an important source of the turquoise used among the ancient Mexicans. From an archaeological point of view this locality possesses remarkable interest. The cañon walls are full of caverns, now filled up to a depth of several feet with apparently wind-blown sand and dust, but whose blackened roofs and rudely sculptured walls indicate that they were occupied for a long time by the people who worked the mines. In the blown sand were found stone implements and pottery fragments of rude type, incised but not painted. The openings to these caves are partially closed by roughly built walls composed of trap blocks piles upon one another with no attempt at fitting and no cement, but evidently made as a mere rude protection against weather and wild beasts. The tools, found partly in the caves and largely in the mine pits, are carefully wrought and polished from hard basalt or trap, chiefly hammers and adzes or axes, generally grooved for a handle and often of large size. Some are beautifully perfect, others much worn and battered by use.

"The most impressive feature, however, is the abundance of rock carvings in the whole region. These are very varied, conspicuous, and peculiar, while elsewhere they are very rare. Some are recognizable as 'Aztec water signs,' pointing the way to springs; but most of them are unlike any others known, and furnish a most interesting problem to American archaeologists. They are numbered by many thousands, carved in the hard basalt of the cliffs, or, more frequently, on large blocks of the same rock that have fallen and lie on the sides of the valleys. Some are combinations of lines, dots, and curves into various devices; others represent animals and men; a third and very peculiar type is that of the 'shield figures', in which complex patterns of lines, circles, cross hatchings, etc., are inscribed within a shield-like outline perhaps 3 or 4 feet high.

"One curious legend still exists among the neighboring Indians that is in no way improbable or inconsistent with the facts. The story was told Mr. Eisen by 'Indian Johnny', son of the Piute chief, Tecopah, who died recently at a great age, and who in turn had received it from his father. Thousands of years ago, says the tale, this region was the home of the Desert Mojaves. Among them suddenly appeared, from the west or south, a strange tribe searching for precious stones among the rocks, who made friends with the Mojaves, learned about these mines, and worked them and got great quantities of stones. These people were unlike any other Indians, with lighter complexions and hair, very peaceable and industrious, and possessed of many curious arts. They made these rock carvings and taught the Mojaves the same things. This alarmed and excited the Piutes, who distrusted such strange novelties, and thought them some form of insanity or 'bad medicine', and resolved on a war of extermination. After a long and desperate conflict, most of the strangers and Mojaves were slain, since which time, perhaps a thousand years ago, the mines have been abandoned. Mr. Eisen connects this account with the existence of a fair and reddish-haired tribe, the Mayos (not Mayas), in parts of Sinaloa and Sonora, some of whom may have reached these mines and carried on a turquoise trade with Mexico.

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[3] See 20th Rept. U. S. Geol. Surv., Min. Res., 1898, pp. 582–584; and San Francisco "Call," March 18, 1898.

"This region has since been opened at several points, and at least a dozen mines are now being worked by various parties, mostly with Eastern capital. The principal work is being done by the Himalaya and the Toltec mining companies. The turquoise obtained, when pure and of good color, is cut into fine gems; also the white and blue combination known as turquoise matrix, when small portions and veins of turquoise are distributed through the rock, and the whole is cut and polished as an ornamental stone. The paler varieties of turquoise are cut into beads, etc., long strings of which are sold. Most of the material produced is sent to New York. The yield in 1900 was estimated at a value of $20,000."

HYDROUS-SULPHATES

GYPSUM—Gypsite

H. 1.5–2; Sp. Gr. 2.31–2.32; Refractive indices, $n_\alpha = 1.520$, $n_\gamma = 1.530$.

Gypsum is a common mineral in the state, but large deposits of the mineral are exceptional. The mineral is easily formed by the action of sulphated waters on limestone.

Satin-spar and *alabaster* are two varieties which are extensively used for ornamental purposes, particularly statuary and utility boxes of various types.

Found in numerous counties throughout the state, Eakle (1), Pabst (1).

OBSIDIAN

Composition variable, contains SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O and K_2O

H. 5-5.5 Sp. Gr. 2.2-2.7

Color, black, grey, brown or red, sometimes green, transparent to opaque. $n = 1.48$ to 1.67

Although due to its indefinite composition obsidian is classed as a rock or mineraloid, it is frequently cut for gem purposes. It occurs in large masses and in deposits of great extent and sometimes of considerable beauty. Small pebbles of obsidian are widely distributed and are often erroneously called 'black diamonds'.

Beautiful examples of iridescent obsidian have been found recently near Davis Creek in Modoc County; and on the east slope of Volcanic Mountain in Inyo County. This material shows fine iridescent colors on fractured surfaces and when cut and polished exhibits a pleasing chatoyance.

Glass Mountain in eastern Siskiyou County, elevation about 7,000 feet is composed almost entirely of obsidian.

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LAPIDARY ART

A simple and practical method for the cutting and polishing of gem minerals for the collection or for personal adornment

LAPIDARY ART

The widespread interest in mineral collecting has been largely responsible for the interest in the collecting and polishing of those varieties commonly called gems.

The polishing of gem minerals can be a never-ending source of pleasure due to the wide variety of species and types available. For the polishing of small specimens the apparatus required may be of the simplest nature and while excellent results can be obtained by hand methods only, the use of power-driven laps is recommended.

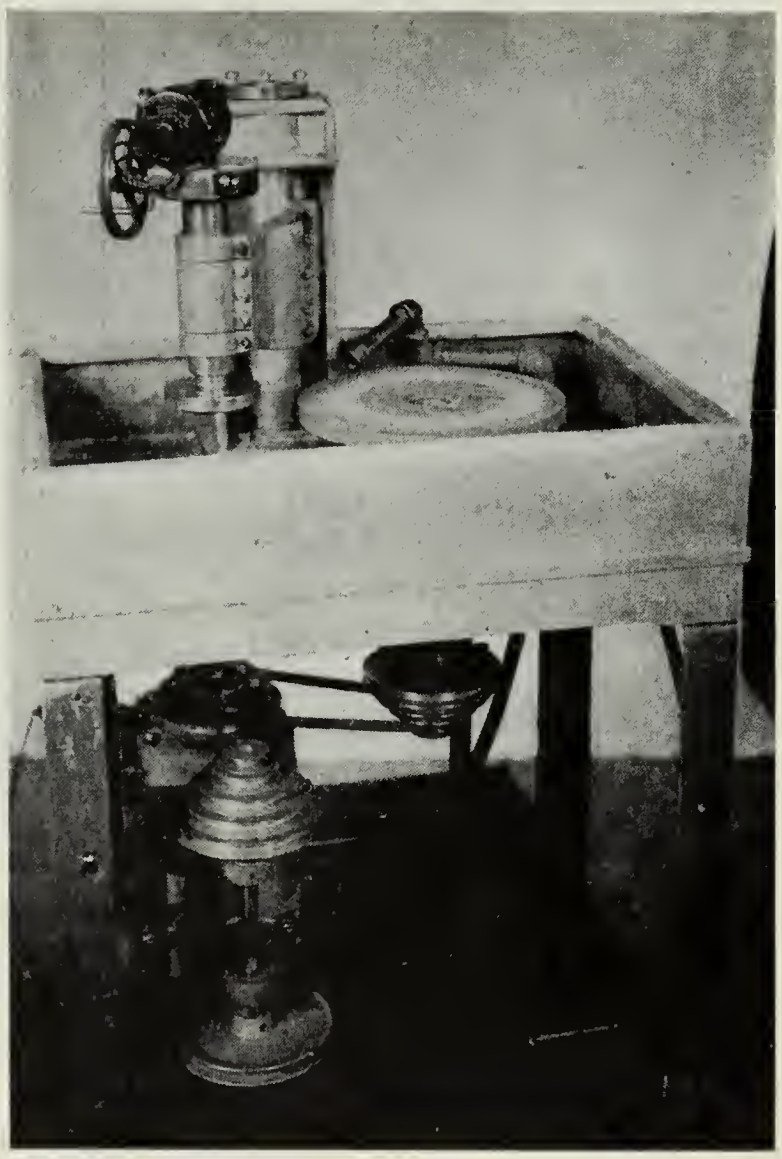

FIG. 5. Sperisen Universal Lapping and Grinding Machine.

The polishing process consists of grinding, smoothing and polishing a surface by successively finer steps with suitable abrasive materials and proper medii. The technique herein described is suitable for all stones ranging in hardness to and including beryl and tourmaline and has been used by lapidaries for decades.

The equipment required and used in the order listed follow:

Suitable grinder head with $\frac{1}{4}$ h.p. motor.

Grinding wheels, 60 K. Crystolon. Operate at 5,000 S. F. P. M.

Grinding wheels, 180 K. Crystolon. Operate at 5,000 S. F. P. M.

Abrasive cloth, 240 Crystolon. Operate at 500 S. F. P. M.

Polishing wheels, leather-covered wood drum. Operate at 1,000 S. F. P. M.

The polishing wheel consists of a depression turned in the flat side of a wooden wheel over which calfskin is stretched tightly and fastened securely. The hair or grain side being out is used as the polishing surface. The polishing medium is stannic oxide which is applied wet in the form of a wet, thin paste.

The grinding wheels are 'coarse', 60, being composed of 60-mesh abrasive, and the 'fine', 180, graded in a similar manner. The letter K designates the wheel hardness and in this case is of a medium grade. S. F. P. M. or surface feet per minute is the peripheral speed at which it has been found most economical to operate and should be maintained.

The quartz minerals are most suitable for polishing. They are abundant, being found in a great variety of colors and types and in the majority of cases of uniform texture so that results obtained by careful polishing are most pleasing and satisfactory.

Chalcedony, agate and jasper should be tried first.

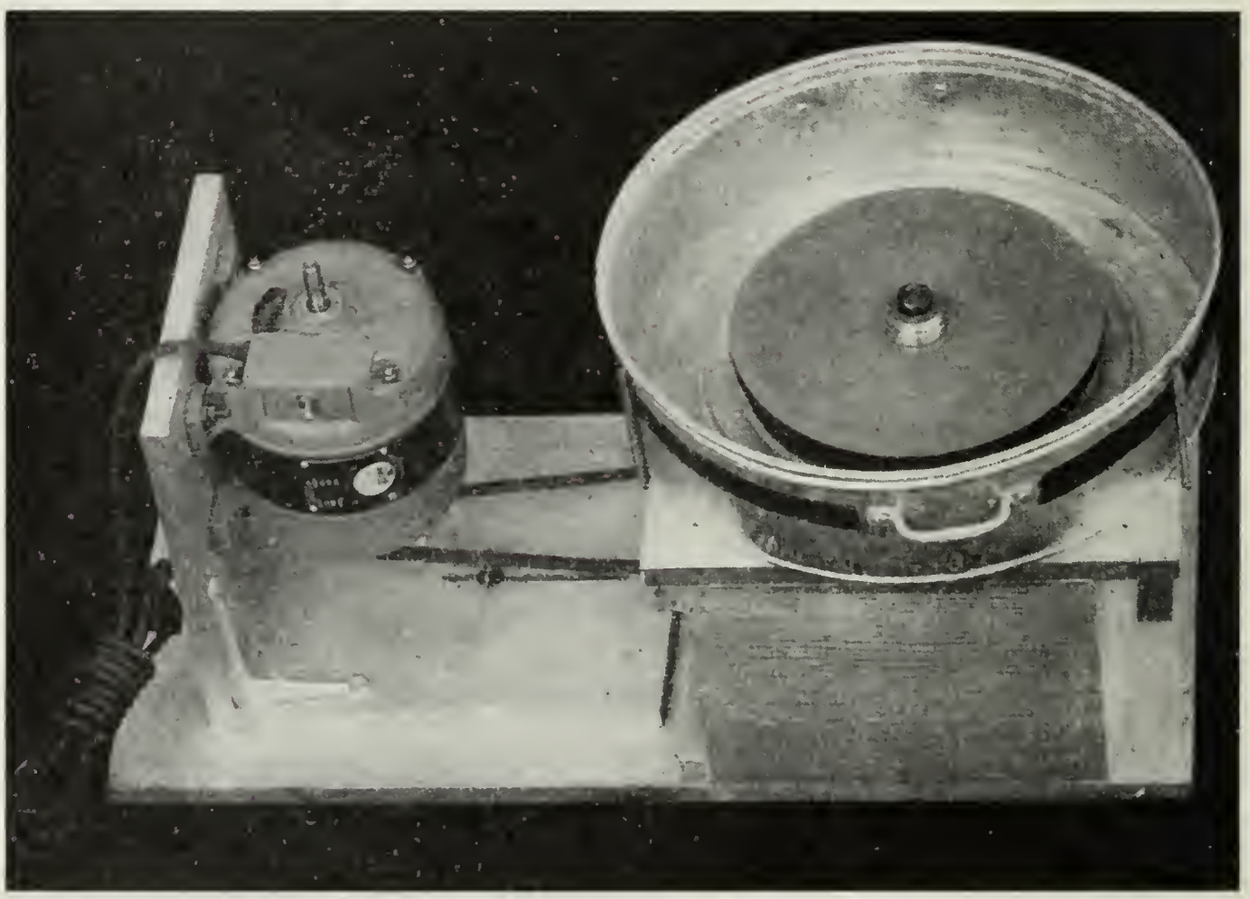

Photo by courtesy of C. W. Marwedel

FIG. 6. The Pretherick Lap.

A simple form of polished stone is known as a faced or spotted stone. This consists of polishing a face or spot on a specimen in order to bring out the color and marking.

The majority of specimens found have rough and irregular surfaces and assuming that it is desired to polish a face, the stone is first ground on the 60 K. Crystolon wheel, until a uniform surface is produced, care being exercised to remove all deep pits or fissures which may exist. The stone should be rotated so as to produce a convex surface, this being easier to polish. Flat surfaces may also be produced but these are more difficult to polish and should not be tried first.

During grinding, a copious supply of water is directed on the wheel and work. When all of the rough surface is uniformly ground the stone is ready for the second step which is similar.

Using the finer wheel, 180 K. Crystolon, the surface is further ground and it will be noticed that after grinding a minute or two, that the surface has been greatly improved, being smoother and brighter.

A magnifying glass or loupe of about 3X should be used so as to be certain that all of the deep scratches previously made by the coarser wheel have been removed. The proper preparation of a surface for polishing is of the greatest importance if best results are to be obtained.

As the following stages of smoothing and polishing remove the material very slowly, it is obvious that if deep grinding scratches exist and have not been removed, they will be plainly seen. Having produced a uniform surface with the smoother grinding wheel, the stone is next smoothed with No. 240 Crystolon cloth by briskly rubbing the face to be polished, using the cloth dry. This operation may be done equally well with the use of a wheel of wood to which the abrasive cloth has been fastened with glue. *In either case the stone is pressed against the abrasive cloth with moderate pressure.* Too great a pressure may cause overheating with the possibility of cracking. In some cases hand smoothing is preferable as it eliminates the possibility of burning, always present with the wheel method.

The surface is again examined with the 3X glass and if smooth and free of deep scratches it is ready for the final polishing.

At this stage the specimen is thoroughly scrubbed with soap and water to remove all traces of grit, a most important step. The slightest trace of grit in the polishing material will quickly ruin an excellent finish. The stone having been suitably prepared, will show a glossy surface of uniform nature and texture.

The final stage in polishing is done on the leather wheel using Tin Oxide in a paste condition *made with water and applied to the polishing* wheel with a brush, the best type being an inch-and-a-half flat varnish brush.

The stone is applied to the surface and in a few moments the wheel will be sufficiently charged to commence polishing. The time required for polishing depends on the size and type of specimen. A specimen of quartz one inch square may be completely faced and polished from the rough in 10 to 15 minutes without difficulty, the polishing time alone not exceeding five minutes.

Care should be exercised to obtain the highest degree of polish. By reflected light the high light may be examined and the dull surfaces, if any, noted. Flat surfaces may also be polished in the same manner but require a little more skill in handling.

CABOCHON CUTTING

Having mastered the art of grinding and polishing specimens, it is a natural desire to cut and polish these beautiful gem minerals into pieces suitable for personal adornment. The simplest form of gem is the Cabochon.

This is a domed shape with convex surface, the stone may have any type of geometrical outline, although it is customary to cut the stone into regular forms such as the round, ellipse, oval, rectangular, oblong, square, etc. The stone is roughed out to the desired form and size and subsequently smoothed and polished in the usual manner.

Due to the fact that the stones are usually small, they are somewhat more difficult to handle and to facilitate handling they are cemented to sticks for proper manipulation. Penholders with the top part cut off are ideal for this purpose and are inexpensive, although if preferred any round stick of equivalent size will suffice. Common red sealing-wax is used to attach the stone in place on the end of the stick, the wax is obtained in bar form and heated in a bunsen flame and a sufficient quantity is rolled on the end of the stick. The stone is heated slightly and when placed on the wax the wax is moulded about the stone until the cement has set.

Proper procedure in normal cabochon work is to finish the back of the stone first and the front of the stone finally. In reversing the stone on the stick the wax is gently heated in the flame and scraped from the stone with the aid of a knife.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

There have been no changes of personnel in the Division of Mines to be noted the past three months.

New Publications.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, July, 1937, being Chapter 3 of the State Mineralogist's Report XXXIII. This chapter contains: "Mineral Resources of Los Angeles County," accompanied by a map showing locations of the principal mines and the oil fields; also "Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County," accompanied by a geological map.

Commercial Mineral Notes (Nos. 175-177, inc.), November, December, 1937, January, 1938, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'CALIFORNIA JOURNAL OF MINES AND GEOLOGY.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

SUMMARY OF WORK ACCOMPLISHED

Under WPA Projects in the Division of Mines

Unpublished Material.

In the fifty-eight years since the creation by legislative statute of the State Mining Bureau (now Division of Mines of the Department of Natural Resources), there has been accumulating a library of several thousand volumes of books, magazines, and pamphlets devoted to geology, mining, chemistry, and metallurgy. Particularly in such magazines as the Mining and Scientific Press (1861-1922) and the Engineering and Mining Journal (1872-1937), there is a wealth of contemporaneous and chronological data on Californian mines, their development and operations. Lacking sufficient clerical personnel it had not been possible for the Division of Mines to index these reports so that interested engineers and others could find the data on individual mines or districts without taking up much time in searching through many volumes.

During the past two and half years, under Works Progress Administration projects sponsored by the Division of Mines, clerical and technical help has been provided, through which card-file indexes have been made for all California's mines noted or described in the above-noted magazines, listing volume number and page for each entry. These two files constitute a total of approximately 75,000 cards, and are daily consulted, being open to public use.

Similar indexes are being made of California's mines described in the bulletins and reports published by the United States Geological Survey and the United States Bureau of Mines. A total of 10,000 cards have been typed thus far, the job being now about one-half completed. A consolidated card-file index of the publications of the Division of Mines and its predecessor the State Mining Bureau is nearing completion and comprises some 45,000 cards. They cover the contents of a total of 33 annual (or biennial) reports of the State Mineralogist and 112 bulletins.

An index and revision of the bureau's bulletin on American Mining Law is being prepared, 40 chapters now being in manuscript form out of total of 60. In the book-binding section of our project, about 800 maps have been mounted on cloth, 1250 volumes repaired, and approximately 1,000 books bound in cloth and board. Mounting of the maps preserves them as they are subject to severe service in the library through frequent handling and reference use.

About 30,000 cards have been typed, indexing and cross-indexing the specimens in the mineral exhibit. This exhibit is the largest and most important of its kind west of the Mississippi River, ranking probably fifth or sixth in the entire United States. In the gold-statistics section a card index, about 6,000 cards, has been made of the names of persons who sold gold to licensed gold-buyers in 1934-1936; also over 20,000 sales receipts have been checked, arranged, and filed.

Scattered through the long list of State Mineralogist's reports and bulletins issued during the fifty-eight years of the bureau's life, are descriptions of not only the mines and deposits of the various metals but likewise of California's diversified resources of structural, industrial, and saline commercial minerals. Under our WPA project these reports have been annotated, and typewritten manuscripts prepared on the following list of commercial minerals, 24 in all thus far. These are for office reference use and copies have been supplied to the branch offices of the Division at Los Angeles, Sacramento, and Redding.

Antimony
Asbestos
Bituminous rock
Bentonite (Fuller's Earth)
Coal
Diatomite
Dolomite
Granite
Gypsum
Iron ore
Lead
Lime-Limestone
Lithia
Marble-Marl
Mica
Molybdenum
Pumice-Volcanic Ash
Pyrite
Soapstone-Talc
Slate
Sulphur
Tungsten
Wollastonite

Systematic card files are being prepared by WPA workers under the direction of the Geologic Branch of the Division of Mines. Although these files will not be published as such, they represent accumulated information, systematically arranged, to be used as working data for the Division of Mines.

In cooperation with Stanford University, sponsored by the Division of Mines, a WPA project has been preparing card files as follows:

(1) *Geographical Index.*

This index has been prepared from various maps covering the State of California. Each card represents a geographic feature, its definition and location.

(2) *Index of Fossil Localities in California.*

Each card gives information regarding the location of fossil-collecting grounds and other pertinent geologic information, together with bibliographic reference.

(3) *Annotated Bibliography of the Paleontology of California.*

(4) *General Bibliography of the Geology and Mineral Resources of California.*

In the Ferry Building, San Francisco, the following card files are being prepared under the direction of the Geologic Branch:

(1) *Mineral Deposits File.*

Each card in this file gives pertinent information abstracted from literature on the individual mineral deposits and mining claims described in publications; accurate location, dates of production, associated mineral products, types of mineralization, geological formations, significance, and bibliographic references. Of the last mentioned, duplicate cards have been made, one set arranged by county and mine, the other by mineral product and location.

(2) *Economic Mineral Deposits*

This file is developed through the evaluation of those mineral deposits which have been responsible, at some time in their history, for contributing to the State's mineral production record.

(3) *Mining Claim Index.*

The cards making up this file have been sent to the Ferry Building from our individual WPA projects sponsored by the Division of Mines and located in various County Recorder's offices throughout the State. The cards are made in triplicate form, one being left with the Division's District Engineer and the other two filed in the main office in San Francisco. Accompanying them are maps and township plats showing graphic information secured in the county recorder's offices. Tracings of patented mining claims, which are actually surveyed are being provided the Division of Mines through WPA projects located in the U. S. Land Offices in Sacramento and Los Angeles and in the office of the U. S. Cadastral Engineer at Glendale. The final drafting work is being done in San Francisco and also in the Division's Los Angeles district office.

Besides the foregoing files, other useful work has been done by WPA workers:

Map Making.

Draftsmen, provided by WPA have succeeded in preparing a large number of mining claim plats, and township plats showing the location of mining claims and also a number of maps and charts of geological interest.

Preparation of Lantern Slides.

Many hundreds of lantern slides of salient geological and mineralogical features of California have been prepared through help provided by WPA.

The foregoing indexes, files, maps, etc., all represent work accomplished or in part yet to be completed which of themselves will not be put in published form for sale or distribution. They are all available, however, for reference use of the interested public and the Division's technical staff, and for the preparation of future geological or mineral resources reports.

Publications.

Three outstanding publications are the result of the work done under the direction of the Geologic Branch of the Division of Mines which could not have been done without the clerical and drafting assistance provided by the Federal Public Works Administration and the Works Progress Administration. One of these is the new State Geologic Map of California, on a scale of 1:500,000 (8 miles per inch), issued in 6 sections, showing geologic formations, so far as they are known, throughout the entire State. A grant of $5,000 was first issued by the Federal Public Works Administration and dispensed through the U. S. Geological Survey. With this money competent geological draftsmen were employed to work under the special direction of the Chief Geologist of the State Division of Mines. Before this map went to the lithographer, however, many marginal maps, charts, legends, etc., were prepared for it by WPA draftsmen.

A new book, "Minerals of California," is now in press and will soon be ready for distribution as Bulletin No. 113 of the Division of Mines. Preparation of this book by Dr. Adolf Pabst, Associate Professor of Mineralogy at the University of California, was made possible by the clerical assistance provided by the WPA.

Another new book, the "Bibliography of the Geology and Mineral Resources of California," by Dr. Solon Shedd, of Stanford University, is now in press and will be issued as Bulletin No. 115 by the State Division of Mines. The preparation of this book was made possible by the clerical assistance provided by the federal WPA.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

CALIFORNIA MINERAL PRODUCTION FOR 1937 SHOWS INCREASE

The total value of the mineral production of California for the year 1937, just closed, is conservatively estimated by the Statistical Section as $351,487,000. This is partly detailed in the tabulation below, but as there are more than 50 mineral substances on California's commercial list, figures on the most important items only are available at this early date. The production report forms are being mailed to the operators in all mineral lines, and the detailed and complete report will be compiled and published later.

The estimated total of $351,487,000 is an increase of approximately $23,683,000 over the 1936 production total value, and is the largest since 1929. The principal increases in value of output over those of the previous year were shown by petroleum, gold, natural gas, brick and hollow building tile, silver, copper, lead, and quicksilver. The only important mineral substances to register decreased values were miscellaneous stone and cement.

The value and amount of the petroleum output showed an increase over that of 1936, with a total quantity of about 237,666,000 bbls., an increase of about 11 per cent over that of 1936. There was little or no change in the price paid to producers by the refineries, although production increased in the lighter-gravity crude oils which bring higher prices. There was an increase in the amount of natural gas utilized thereby increasing its total value over that of the previous year.

Receipts of bullion at the mint and smelters showed an increased output of gold of some 87,000 fine ozs. Thus 1937 had the highest annual gold value since 1861, and the largest in fine ounces since 1862 with the exception of 1883. All other major metals on the California commercial list showed an increase in output with the exception of zinc. The silver and copper yield each had a total value over the million dollar mark.

Of the structural group practically all materials showed an increased production and value, with the exception of cement and miscellaneous stone. These declines brought the total value of this group to show a net decline from that of 1936. Building permits in 51 principal cities of the state increased $7\frac{1}{2}$ per cent over the previous year. Both the miscellaneous industrial and the saline groups showed small changes in their total values.

The estimated values and quantities for 1937 are as follows:

$40,740,000	(1,164,000 fine ozs.) gold.
2,209,000	(2,865,000 fine ozs.) silver.
1,268,000	(10,480,000 lbs.) copper.
152,000	(2,500,000 lbs.) lead.
791,000	(9,200 flasks) quicksilver.
350,000	other metals including chromite, iron ore, platinum, tungsten ore, etc.
240,000,000	(237,666,000 bbls.) petroleum.
18,724,000	(302,000,000 M. cu. ft.) natural gas.
17,023,000	(12,073,000 bbls.) cement.
9,980,000	crushed rock, sand, and gravel.
2,300,000	brick and hollow building tile.
1,450,000	other structural materials, including bituminous rock, granite, magnesite, marble, sandstone, slate, etc.
5,000,000	miscellaneous industrial materials.
11,500,000	salines, including borates, potash, iodine, salt, soda, etc.
$351,487,000	total value.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20816 DAKEITE, a hydrous carbonate and sulphate of calcium and uranium. From the desert of Wyoming.
Donor: Minnie McCormick, Wamsutter, Wyoming. October, 1937.

20817 BARITE ($BaSO_4$), Barium sulphate.
From 16 miles from Battle Mountain, Nevada.
Donor: H. C. Auston. November, 1937.

20818 CINNABAR (HgS) with CALCITE ($CaCO_3$) and PYRITE (FeS_2), deposited either as replacement of organic roots or stems, or the filling of tubes in sandstone.
From Oceanic Quicksilver Mine, near Cambria, San Luis Obispo County, California.
Donor: Mr. O'Boyle. October, 1937.

20819 SCHEELITE ($CaWO_4$), calcium tungstate.
From Rossi Tungsten Mine near Bishop, Inyo County, California.
Donor: B. W. Holeman. August, 1937.

20820 CHROMITE ($FeCr_2O_4$)—a very good grade ore.
From Bear Chrome Mine, Rock Creek, Plumas County, California.
Donor: Louie Eddelbethel. November, 1937.

20821 ELLESTADITE (pale rose-pink). A complex lime-silicate similar to Wilkeite. From Crestmore, Riverside County, California.
Donor: John Melhase. November, 1937.

20822 BARITE 'Roses'—barium sulphate ($BaSO_4$).
From Norman, Oklahoma.
Donor: Charlie Hansen. November, 1937.

20823 BARITE ($BaSO_4$)—barium sulphate. Mined at a depth of 200 feet below surface.
From Devil's Gulch, Mariposa County, California. November, 1937.

20824 STIBNITE (Sb_2S_3)—well crystallized.
Found in cache about 13 miles from Alleghany, Sierra County, California.
Donor: William H. Cogley. December, 1937.

20825 AXINITE—a borosilicate of aluminum and calcium, with iron and manganese. From the Humbug Mining District, Siskiyou County, California.
Donor: C. B. Kay. December, 1937.

20826 STIBNITE (Sb_2S_3), antimony ore. From Prathier Mine, Reese River Mine District, Lander County, Nevada.
Donor: E. B. Hodges. December, 1937.

20827 ALTAITE (PbTe), lead telluride.
From Hill Top Mining Co., 18 miles northeast of Las Cruces, New Mexico.
Donor: F. W. Meneray. January, 1938.

20828 STIBNITE (Sb_2S_3) both crystalline and fine; granular massive.
From Stayton Mine, San Benito County, California.
Donor: Ross Kesser. January, 1938.

20829 CHROMITE—about 65 per cent CrO_2. Crystallized.
From New Caladonia, a French Colony in the Antipodes.
Donor: Al Leschot. January, 1938.

20830 CHROMITE. This will grind up to a fine powder.
From New Caladonia, a French colony in the Antipodes.
Donor: Al Leschot. January, 1938.

20831 STELLERITE ($CaAl_2Si_7O_{18}.7H_2O$), a rare Zeolite.
From San Diego County, California.
Donor: J. D. Nichols. January, 1938.

20832 Muscovite MICA. From near Council, Idaho.
Donors: A. H. Huntington and L. H. Albee. January, 1938.

20833 ALUNITE, a hydrous sulphate of aluminum and potassium.
From Cactus Range, Inyo County, California.
Donor: Death Valley Curly. January, 1938.

LABORATORY

FRANK SANBORN, Mineral Technologist

Prospecting for and development of California's mineral wealth appears to increase rather than decrease as the state grows in population. During the year, 1937, approximately 7200 samples were received and identified at this laboratory. Also, additional information and help was given to more than a hundred miners and prospectors who sought information on recovering gold and platinum from sluice box concentrates, on detecting tungsten in an ore, and many other problems.

The detection of the calcium tungstate, scheelite, by its fluorescence is very interesting and practical, and we have already given instructions and demonstrations on this method of prospecting to a number of miners. Anyone desiring information on the detection of scheelite by the ultra-violet ray may call at our laboratory where it will be given by a practical test.

Assistance in finding a market for minerals is given to those who make such a request. Those who desire to sell a mineral should submit a small sample of it to this department when help is wanted in finding buyers.

LIBRARY

J. C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

Water Supply Papers:

679 B Thermal Springs in the U. S.
796 C Flood in La Canada Valley, Calif.. January 1, 1934.
797 Selected Bibliography on Erosion and Silt Movement.
809 Part 9, Colorado River Basin.
811 Part 11, Pacific Slope Basins in California.
812 Part 12, Pacific Slope Basins in Washington and Upper Columbia River Basins.
817 Water Levels and Artesian Pressure in Observation Wells in the U. S. in 1936.

Bulletins:

895 A Geophysical Abstracts, 88, January-March, 1937.

Topographic Sheets:

Banner Hill, Quadrangle, Nevada County.
Bouldin, Quadrangle, Nevada County.
Chatswood, Quadrangle, Los Angeles County.
Fairmont, Quadrangle, Los Angeles County.

Isleton, Quadrangle, Los Angeles County.
Ivanpah, Quadrangle, California-Nevada.
Little Tujunga, Quadrangle, Los Angeles County.
Manzana, Quadrangle, Los Angeles County.
Mount Baden-Powell, Quadrangle, Los Angeles County.
Palo Alto, Quadrangle, Los Angeles County.
Red Rover, Quadrangle, Los Angeles County.
Reef Ridge, Quadrangle, Los Angeles County.
San Francisquito, Quadrangle, Los Angeles County.
Sunland, Quadrangle, Los Angeles County.
Swarthout, Quadrangle, Los Angeles County.
Waterman Mountain, Quadrangle, Los Angeles County.

U. S. Department of Agriculture, Forest Service:

Los Padre National Forest (Except the Monterey Division).
West Half, Mt. Diablo and San Bernardino Meridians.
Los Padre National Forest, East Half, Mount Diablo and San Bernardino Meridians.

162 A Vegetation Types of California, Tujunga Quadrangle.
163 B Vegetation Types of California, Rock Creek Quadrangle.

U. S. Bureau of Mines:

Information Circulars:

6948 Aerial Tramways in the Metal-Mining Industry, Part 1. By O. H. Metzger.
6949 Shaft- and Slope-Bottom Lay-Outs at Coal Mines. By Robert L. Anderson.
6950 Mining and Reduction Methods and Costs at the Oceanic Quicksilver Mine, Cambria, San Luis Obispo County, California. By A. W. Frolli.
6955 Smelting Ores in the Electric Furnace. By R. S. Dean and M. W. von Bernewitz.
6957 Some Results of First-Aid Training of All of the Employees of a Mine or Plant. By J. J. Forbes.
6958 What's Wrong With Mine Safety Programs. By D. Harrington.
6959 Some Aspects of Strip Mining of Bituminous Coal in Central and South Central States. By Albert L. Toenges and Robert L. Anderson.
6960 Sampling and Testing of a Gold-Scheelite Placer Deposit in the Mojave Desert, Kern and San Bernardino Counties, California. By H. W. C. Prommel.
6961 Placer Operations of Humphreys Gold Corporation, Clear Creek, Colo. By E. D. Gardner and Jos. R. Guiteras.
6962 Mining and Grinding Methods and Costs at the Malvern Clay Co. Mine, Malvern, Ohio. By E. J. Lintner.
6963 Mining Methods and Costs of the Quartz Hill Mining Co., Dewey, Mont. By S. H. Lorain.
6964 Reconnaissance of Mining Districts in Clark County, Nevada. By Wm. O. Vanderburg.
6965 Ventilation at the Anthracite Collieries of the Northern Pennsylvania Field. By G. E. McElroy.
6966 Occurrence and Treatment of Mercury Ore at Small Mines. By M. W. von Bernewitz.
6967 Methods and Costs of Mining & Crushing Gypsum at the Mine of the Victor Plaster, Inc., Victor, N. Y. By E. J. Lintner.
6968 Pebble-Phosphate Mine Accident Experience. By Frank E. Cash and Claud P. Dempsey.
6969 Some Suggestions on Safety in Coal-Mine Haulage. By C. A. Herbert.
6970 Liquid Carbon Dioxide Used to Extinguish a Gob Fire in a German Coal Mine. By Geo. S. Rice and Irving Hartmann.
6971 Methods and Costs of Mining and Crushing Gypsum at the Mine of the Ebsary Gypsum Co., Inc., Wheatland, N. Y. By E. J. Lintner.
6972 Gold Lode Mining in the Tobacco Root Mountains, Madison County, Montana. By S. H. Lorain.
6973 Annual Report of the Mining Division for the Fiscal Year 1937. By Chas. F. Jackson.
6974 Annual Report of the NonMetals Division, Fiscal Year 1937. By Oliver C. Ralston.

6975 Milling Methods and Costs at the Mill of the Tom Reed Gold Mines Co., Oatman, Ariz. By Paris V. Brough.
6976 Operations and Costs at the St. Joe Mining & Milling Co., Boulder, Colorado. By Jos. R. Guiteras.
6977 Petroleum Refineries, Including Cracking Plants in the U. S. By G. R. Hopkins and E. W. Cochrane.
6978 Mining Methods and Costs at the Mount Isa Mines, Ltd., Mount Isa, Queensland, Australia. By J. Kruttschnitt and V. I. Mann.
6979 Electric Signaling System, Ross Shaft, Homestake Mining Co. By John F. Wiggert.
6980 Use of Reflector Buttons for Danger, Warning, Direction and Safety Signs in Mines. By F. E. Griffith and H. J. Van Der Veer.
6981 Coal-Mine Fires of Electrical Origin; Their Cause and Prevention. By E. J. Gleim.
6982 Pumping Operations in the Cripple Creek District, Colo. By Jos. R. Guiteras.

Report of Investigations:

3352 A Method of Determining Porosity: A List of Porosities of Oil Sands. By D. B. Taliaferro Jr., T. W. Johnson and E. J. Dewees.
3353 Earth Vibrations Caused by Quarry Blasting, Progress Report I. By J. R. Thoenen and Stephen L. Windes.
3354 Hardening of Mud Sheaths in Contact with Oil, and a Suggested Method for Minimizing Their Sealing Effect in Oil Wells. By C. P. Bowie.
3356 Sulphuric Acid Extraction Methods for Determining Olefins and Aromatics in Hydrocarbon Oils. Optimum Conditions and Concentrations of Acid. By C. H. Fisher and Abner Eisner.
3357 Progress Reports—Metallurgical Division. 20. Annual Report of the Metallurgical Division, Fiscal Year 1936-37. By R. S. Dean and Others.
3360 Bureau of Mines Midget Impinger for Dust Sampling. By J. B. Littlefield, Florence L. Feicht and H. H. Schrenk.
3361 Active List of Permissible Explosives and Blasting Devices Approved Prior to June 30, 1937. By J. E. Tiffany, Explosives Division, Bureau of Mines Experiment Station, Pittsburgh, Pa.
3362 Properties of California Crude Oils, V—Additional Analyses. By E. C. Lane and E. L. Garton.
3364 Progress Reports—Metallurgical Division.
21: Studies in Nonferrous Metallurgy.
Collection of Gold by Iron Abraded in Grinding. By S. R. Zimmerley.
Flotation of Oxidized Silver-Lead Ores As Influenced by Modified Grinding. By S. R. Zimmerley.
3366 Mineral Economics Series: 2. Consumption of Ferrous Scrap and Pig Iron in the United States in 1936. By Robert H. Ridgway, H. W. Davis, and M. E. Trought.
3374 Cooperative Fuel Research Motor-Gasoline Survey, Summer, 1937. Compiled by E. C. Lane.

U. S. Bureau of Mines:

Technical Paper 577, Chemistry of the Anhydrous Chlorides of Chromium. A Thermodynamic Investigation. By H. A. Doerner.

Books:

Annual Report of Director of the Mint, 1937.
Annual Report of the Smithsonian Institute, 1936.
Colorado School of Mines, quarterly, January, 1937.
Engineering Index.
General Alphabetical and Analytical Index, American Institute of Mining and Metallurgical Engineers.
Geophysical Studies, 1932-1936.
Handbook for Prospectors, 3d Edition, M. W. Von Bernewitz.
The Hoover Policies. By Ray Lyman Wilbur and Arthur M. Hyde.
Metal Quarry Catalogs, including Directory of Manufacturers, 1938, McGraw-Hill Catalog Service.
Mines Register, Successor to The Mines Handbook, 1937 Edition.
The Mineral Industry during 1936, Vol. 45.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon Bureau of Mines and Geology, Corvallis.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemmologist, London.
Gold, Toronto, Canada.

Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nickel Cast Iron News, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Moscow, Idaho.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.

San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California
Western Mineral Survey, Salt Lake City, Utah
Western Sentinel, Etna Mills, California.

Books.

Land Use Programs of Public Agencies in California Organization Personnel, History and Objectives.
Gold Deposits of the World. By Wm. Harvey Emmons.
Minerals Yearbook, 1937, U. S. Dept. of the Interior.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of California Journal of Mines and Geology, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of California Journal of Mines and Geology.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.70
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.70
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	---- 1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	1.25
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.60
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.00
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.55
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	$0.75
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.90
Mines and Mineral Resources of Plumas County, 188 pp., paper	.60
Mines and Mineral Resources of Sierra County, 144 pp., paper	.60
Seventeenth Report of the State Mineralogist, 1920. 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.00
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.30
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.30
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.30
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.30
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.30
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.30
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.30
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California', Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.30
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.35
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.30
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.35
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.30
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.30
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.30

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
April, 1928, Mines and Mineral Resources of Mariposa County	$0.30
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.30
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.30
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.35
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.35
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.35
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.35
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.30
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.35
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.35
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradlley. Published quarterly:	"
January, 1931. Preliminary Report of Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.35
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.35
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.30
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.35
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.35
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.65

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

Price Postpaid

Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:

January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties ---------- $0.90

July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543 ---------- .90

Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits ---- .50

April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores ---------- .90

October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas ---------- .50

Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties, Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation ---------- .50

April. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits ---------- .50

July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights ---------- .50

October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County ---------- .50

Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Gold Mines of Placer County, including Drag-line Dredges. Geologic Report on Borax Lake, California ---------- .50

April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum -- .50

July. Mines and Mineral Resources of Calaveras County. Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization	$0.50
October. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco. Biennial Report of the State Mineralogist, Properties and Industrial Applications of Opaline Silica	.50
Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold	.50
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Map No. 53—Greeley and Ten Section, Kern County	.75

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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QUARTERLY CHAPTER

OF

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STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
CALIFORNIA

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OREGON
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·DEPARTMENT·OF·NATURAL·RESOURCES·
·GEORGE D. NORDENHOLT - DIRECTOR·
·DIVISION·OF·MINES·
·WALTER W. BRADLEY·
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OUTLINE MAP
OF
CALIFORNIA
SCALE
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SHASTA
LASSEN
TRINITY
TEHAMA
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YOLO
EL DORADO
SONOMA
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CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
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SANTA CLARA
MERCED
MADERA
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MONTEREY
TULARE
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SAN LUIS OBISPO
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SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
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PACIFIC OCEAN
NEVADA
MEXICO
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).
3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

SACRAMENTO FIELD DISTRICT

C. A. Logan, Mining Engineer.

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. Laizure, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field district are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. Tucker and R. J. Sampson, Mining Engineers

Reports covering the mines and mineral resources of most of the counties in the Los Angeles field district are now available, and field work at present is confined to investigations for special reports upon Inyo, and Mono counties.

REDDING FIELD DISTRICT

GOLD DREDGING IN SHASTA, SISKIYOU AND TRINITY COUNTIES

CHAS. VOLNEY AVERILL, Mining Engineer

Introduction.

The price of $35 per fine ounce for gold, which has now been in effect for four years, has stimulated all types of gold-dredging. In northern California, during those same years, the development of the dragline dredge into an efficient machine for the recovery of placer gold has been an important factor in the growth of the industry. The dragline dredge has been called a 'doodlebug' by many persons, but this is not considered an appropriate name by the writer, and it is not used here.

The name dragline dredge is used in this article to denote a placer mining outfit composed of two separate and distinct units. The digging is done by a standard make of dragline shovel, which travels on the ground by means of caterpillar tracks under its own power. The heavy bucket, which picks up from one cubic yard to three cubic yards of gravel at one time, is suspended by a steel cable from a structural-steel boom roughly 50 ft. in length. Washing of the gravel is accomplished on the second unit, which is a barge floating in a pond. For washing out the gold, the barge carries a revolving screen and riffle-tables similar to the standardized units used on the larger dredges. The dragline shovel digs away at the edge of the pond, which thus advances. To cause the barge to follow, a pull on cables anchored on the shore is all that is needed. The tailing discharged from a belt-conveyor and sand-sluices fills up the pond behind the barge.

The standard type of dredge, on which the digging is done by means of a bucket-elevator comprising a chain of heavy buckets, each of which is connected by a round pin to the next one, will be called here a bucket-ladder dredge. The ladder is the heavy structural steel member that supports the bucket-chain.

It is not the purpose of this article to indicate that the dragline dredge is in any way superior to the bucket-ladder dredge. The writer believes that the dragline dredge has opened up a new field to dredging, namely those deposits that are too small to justify the construction of a bucket-ladder dredge. If a deposit is large enough and contains enough gold to amortize the capital investment in a bucket-ladder dredge, and return a suitable profit, probably a dragline dredge should not be considered. Bucket-ladder dredges have been made portable to a certain extent, and may be used on more than one deposit, but the dragline has the advantage in this regard. The operating cost per cubic yard is roughly the same on the smallest bucket-ladder dredges as it is on the largest draglines.

The dragline dredge has the following disadvantages:

1. The maximum depth to which they have worked in this district is

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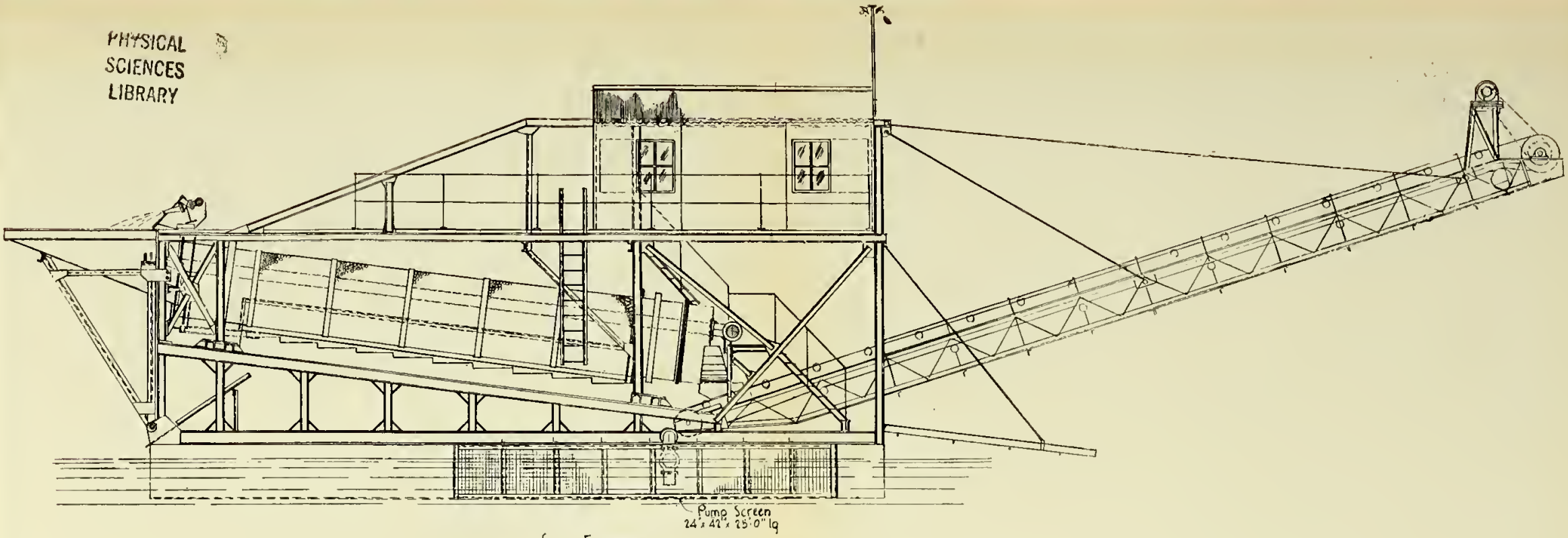
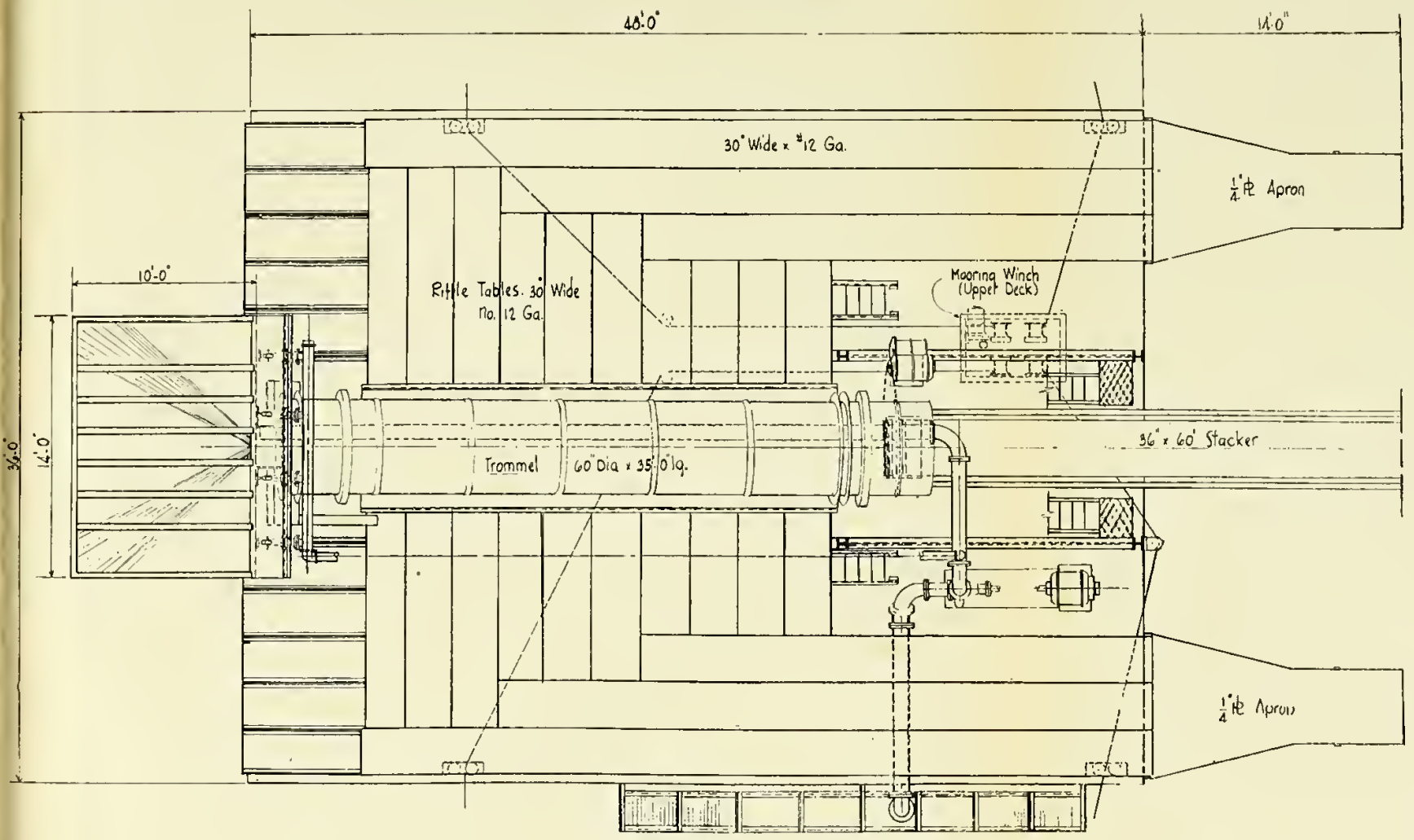


SIDE ELEVATION



PLAN VIEW

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FIG. 1. Dragline dredge. (Cut by courtesy Bodinson Mfg. Co.)

roughly 20 ft. Possibly this can be extended somewhat with the largest shovels with very long booms.

2. They will not dig gravel that is hard and compact or partly cemented as well as a bucket-ladder dredge.
3. Bedrock must be soft. No dredge is successful where bedrock is very hard and irregular, but a bucket-ladder dredge will dig harder rock than a dragline.

Subject to favorable conditions regarding depth, ease of digging, and soft bedrock, dragline dredges are successful on deposits too small for bucket-ladder dredges for the following reasons:

1. Less capital is needed to purchase the dragline shovel and washing-plant.
2. The dragline dredges are smaller and float in very shallow ponds because the heavy digging-machinery is not on the barge.
3. The dragline shovel and the tractor with 'bulldozer' blade, which is now practically a standard item of equipment, can quickly throw up small dams so that the barge can be placed on various terraces and in small tributaries higher than the main channel. If necessary, water for the pond is pumped.
4. When one small deposit has been worked out, the modern outfit with barge of steel-pontoon construction can be quickly moved to another deposit. Such a move involving dismantling and re-erection has actually been made in a week's time with the regular crew.

Logan[1] and Magee[2] have written articles on dragline dredges. Since those articles were written, washing plants have been much improved, larger units have been put in service, and cost per cubic yard has been much reduced.

'Dry Land' Dredges.

At least a dozen dredging outfits of the so-called 'dry-land' type have been built in northern California in recent years. Most of them were so poorly designed and constructed that they had no chance to succeed, and were used for very short periods. Even the best of them have been built on timber skids to be pulled forward by the power shovel. Gravel accumulates under the skids, irregular bedrock interferes, and much time is lost in moving. Another common fault is tailing-sluices on trestles, which must be rebuilt every time a move is made. Lack of head-room often results in the tailing backing up against the rear end of the washing plant. Most of these outfits are built of second-hand material including second-hand gasoline engines. Contrast this with the latest dragline dredges, which are built of new material of excellent quality, and which are powered by diesel engines or electric motors. Gasoline engines may be considered obsolete for dragline dredging. Diesel engines soon pay for themselves in fuel savings.

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[1] Logan, C. A., Placer mining in California with power shovels; Calif. State Mineralogist's Report XXXII, pp. 373-377, 1936.

[2] Magee, J. F., A successful drag-line dredge: Amer. Inst. Min. Met. Eng. Technical Publication No. 757, pp. 1-16, 1936.

A few outfits of the 'dry-land' type have been operated successfully in other states. One of these in which the washing-plant is on special steel wheels running on rails has been described by Ross and Gardner.[1] Another in which gravel is screened in a plant mounted on a caterpillar track, which moves under its own power alongside two dragline shovels, and in which fines are pumped to a separate gold-saving plant through 8-inch pipe and hose, has been described by Gardner and Guiteras.[2] Even with good design and good management, costs per cubic yard at these plants are higher than for the latest dragline dredges described below. The dragline dredge has the advantage that the floating plant follows the shovel with a minimum of lost time.

In another type of operation, gravel is loaded on trucks and hauled to a stationary washing plant. Cost per cubic yard is higher (20 cents to 25 cents per cubic yard and up) than for any other type mentioned here. The washing plant is soon practically buried in its own tailing. A successful operation of this type is described briefly in State Mineralogist's Report XXXI.[3]

Acknowledgments.

The writer wishes to acknowledge the cooperation of all operators of dredges named on the following pages; also of E. J. Quinn, Bodinson Manufacturing Co., San Francisco; H. A. Sawin and C. M. Romanowitz, Yuba Manufacturing Co., San Francisco; Walter W. Johnson Co., San Francisco.

Areas Being Dredged.

A word about the old cry that dredging renders land useless for agriculture may not be out of place. In general it may be said that lands now being dredged in northern California are worthless for agriculture before being dredged as well as after. Suppose that the owner of any typical piece of dredging land receives 10% of the gross value of the precious metals recovered from the tract as his share or royalty. If he will invest this money even at present low interest rates of 2% and 3%, he will have a greater annual income than he could have obtained from the land in any other way.

One large dredging company invested a part of its profits from dredging in reclaiming a tract of land elsewhere for agricultural use. The tract so developed was much better suited to agriculture than the tract that was dredged. This scheme can be followed if a shortage of agricultural lands exists, but such a shortage does not exist at present.

Dragline dredging has been very active in the vicinity of Redding, especially to the southwest at distances ranging from a few miles to 35 miles by road. In Trinity County draglines are working on tributaries of Trinity River near Douglas City and Weaverville, and at Hayfork. Bucket-ladder dredges are located as follows: three on Trinity River near Junction City and Lewiston, two just outside of Yreka, one

[1] Ross, C. L., and Gardner, E. D., Placer-mining methods of E. T. Fisher Co, Atlantic City, Wyo.: U. S. Bur. Mines Inf. Circ. 6846, pp. 1-11, 1935.

[2] Gardner, E. D., and Guiteras, J. R., Placer operations of Humphreys Gold Corporation, Clear Creek, Colo.: U. S. Bur. Mines Inf. Circ. 6961, pp. 1-16, 1937.

[3] Averill, C. V., Mines and Mineral Resources of Siskiyou County, Klamath Placer Mining Co.: Calif. State Mineralogist's Report XXXI, pp. 294-296, 1935.

on Scott River at Callahan, and one on Roaring River southwest of Redding.

Geology

A few details of the geology of the dragline field southwest of Redding will be given because conditions are nearly ideal for this type of dredging. Gravels being dredged are in the channels of present streams and on low terraces adjacent to the present channels. The gravel is seldom more than 10 ft. in depth, and most of it is loose enough so that it is not difficult to dig.

Beneath the gravels of the present streams are sediments of Tertiary and Cretaceous age, all of which form soft bedrock that the dragline buckets can dig. Several inches to a foot of it are usually taken up to recover gold lying on bedrock. To the west of the Pacific Highway for a distance of 10 to 15 miles, the Tertiary bedrock is a clay-like volcanic tuff dipping below horizontal at small angles to the east. Gravels of the Pleistocene Red Bluff formation overlie the tuff in large areas, and they should not be confused with gravels of present streams. Apparently no concentration of gold occurs in these widespread Red Bluff gravels. In the vicinity of Gas Point, the bedrock changes from Tertiary on the east to Cretaceous formations toward the west. The Cretaceous dips east at a steeper angle, roughly 20°. It comprises shales, sandstones and conglomerates in general harder than the Tertiary tuff, but a layer near the top is decomposed and is soft enough for easy digging.

The gold has no doubt been carried over these sedimentary formations from an origin in the igneous rocks, schists, and older sediments to the north and west. Clear Creek is one of the principal streams and it passes through the French Gulch [1] district, well known for its rich quartz veins. Erosion of these has unquestionably contributed gold to the placer deposits. In the vicinity of Igo is a deposit of gravel covering many acres to depths reaching 100 ft. It is apparently an old terrace of Clear Creek, now high above the present stream. Part of it has been mined by drifting and hydraulicking. Part of it has not yet been mined. Dry Creek and its tributaries, now being extensively dredged with draglines, dissect the old Clear Creek terrace, and gold has been carried out by Dry Creek and over Cretaceous and Tertiary bedrock. Hence the placer gold of Dry Creek is derived largely from an older placer deposit.

Some persons have thought of the Cretaceous conglomerates as a possible source of the gold, and it is possible that some of the beds of Cretaceous conglomerate contain gold. However, an examination of the boulders in the placer deposits shows that many are larger than those found in the conglomerates, and that they have apparently been washed in by streams originating in the igneous rocks and schists, and in the older Bragdon conglomerate (Carboniferous). The bulk of the gold must have been washed along with them. Quartz veins in the Bragdon conglomerate are gold-bearing at French Gulch.

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[1] Averill, C. V., Gold deposits of the Redding and Weaverville quadrangles (including map): Calif. State Mineralogist's Report XXIX, pp. 3-73, 1933. Hinds, N. E. A., Geologic formations of the Redding-Weaverville districts, northern California (including map): Calif. State Mineralogist's Report XXIX, pp. 77-122, 1933.

Platinum-group metals are produced as a byproduct from Roaring River near Gas Point and from other properties between there and Cottonwood; also from Hayfork. The metal carries roughly 30% iridium, which gives it a high value per ounce. The osmiridium grains are a bright silvery-white in color, and are inclined to be flat in shape because of a natural cleavage. Some of them show sharp angles instead of the rounded forms of softer metals. They are hard enough to scratch glass readily. This metal has no doubt been derived from bodies of serpentine. One large dike of serpentine is known on Cottonwood Creek west of Ono. Others probably exist farther west in areas of which the geology has not yet been mapped in detail.

Prospecting.

Nothing is more important to the success of a dredging operation than to determine in advance that the tract in question contains enough gold, and possibly platinum, to return a profit. The usual way of proceeding is to put down a few holes at widely spaced intervals, and determine the gold content per cubic yard. If the results are encouraging, a line of holes across the channel at wider than normal spacing is put down. If the results are still good, intermediate holes are put down in this line, and other lines of holes are sampled at regular intervals along the channel.

In general, holes put down by a drill of the Keystone type are most widely used. Casing is driven a foot or two at a time, the gravel inside the casing is cut with the bit, and is then bailed out into a bucket or tub for panning. Gold from panning should be weighed on an assay-balance, and an occasional fire assay should be made to determine the fineness of the gold. If necessary, a drop of quicksilver can be used in the pan to collect fine gold. The quicksilver is dissolved in nitric acid, then the gold is washed and dried, and weighed as usual. Volume of the gravel is calculated as a cylinder of the depth drilled and diameter equal to the outside diameter of the cutting shoe on the casing. A variation of this method is described by Ross and Gardner in Information Circular 6846 of the U. S. Bureau of Mines, previously cited. Details on the latest types of drills suitable for this work may be obtained from Keystone Driller Co., Beaver Falls, Pennsylvania, and from C. Kirk Hillman Co., 111 Sutter Street, San Francisco, California.

In shallow deposits such as are suitable for dragline dredging, it is often possible to dig shafts or pits by hand at low cost. The choice between this method and drilling is affected by the depth at which water flows into the hole. Some operators recover the gold from all of the gravel removed from such a shaft or pit by washing the gravel twice in a rocker. Others cut a channel a foot long and a foot wide for the depth of the hole, and wash the gravel removed from the cut twice in a rocker. Gravel from different depths is treated separately to determine which strata contain the gold. To a limited extent tracts have been prospected for dragline dredging by digging pits with a dragline shovel. The sample is cut from the side of the pit, a vertical channel one foot square in plan.

The spacing and the number of holes depend on how uniformly the gold is distributed through the gravel. It is likely to occur in

streaks as the deposit is viewed both in plan and in vertical section. Unless the distribution has been proved to be more uniform by several rows of closely spaced holes, this erratic occurrence of the gold should be assumed, and the prospecting should be planned accordingly.

DRAGLINE SHOVELS

Dragline shovels of such standard makes as Bucyrus-Erie, Lima, Link Belt, Koehring, Marion Northwest, P. & H. and Thew-Lorain are in use for dragline dredging. Details of various sizes, speeds and horsepower may be obtained from the manufacturers. Thoenen[1] has tabulated some of these data in Information Circular 6798 of the U. S. Bureau of Mines. Fairly high digging and swinging speeds are desirable for this type of work, and hence fairly high horsepower. Most of the shovels in northern California are equipped with $1\frac{1}{4}$-cu. yd. and $1\frac{1}{2}$-cu. yd. buckets, but those of 3-cu. yd. capacity more recently put in service give a lower operating cost per cubic yard. The $1\frac{1}{2}$-cu. yd. shovels have 50-ft. booms, and the 3-cu. yd. shovels have 60-ft. booms. Different lengths are obtainable if they are needed to fit different conditions.

Buckets.

Both Page and Esco buckets are in use. The Esco with five teeth will dig harder gravel than the Page, but it dumps more slowly. A set of teeth is usually dulled each shift, and must be built up by welding.

Power.

The shovels with $1\frac{1}{2}$-cu. yd. buckets for which cost-data are given below are powered by D-13000 Caterpillar diesel engines rated at a maximum of 130 horsepower. The 3-cu. yd. shovel is powered with a 200-hp. electric motor.

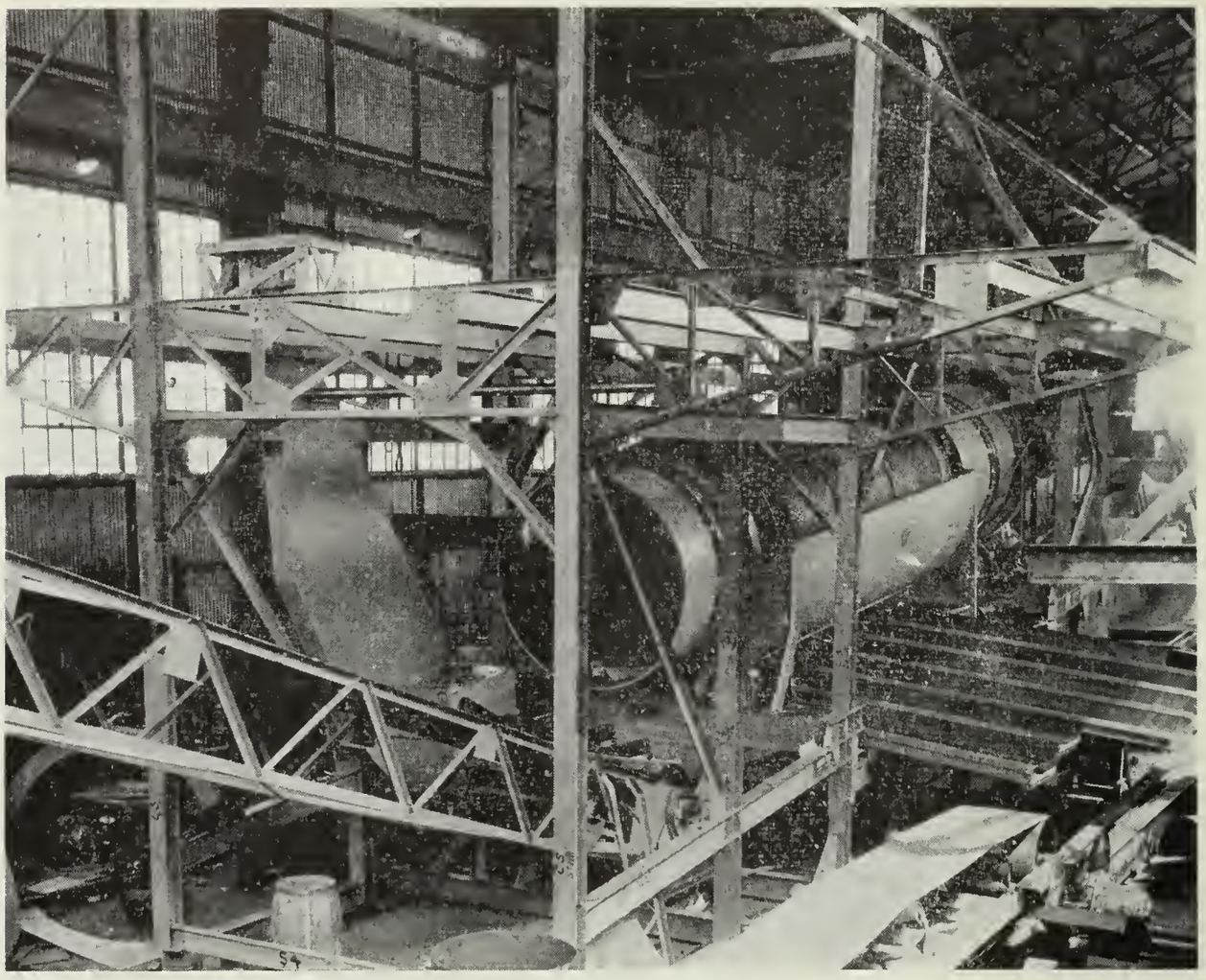
Digging Methods.

Two general methods of digging are in use. The common method is to move the shovel in the direction of the channel, and reach to each side as far as possible with the boom. Each cut is twice as wide as the boom is long, roughly 100 ft. By utilizing the momentum of the swing, the operator can cast the bucket a little beyond the end of the boom. The other method is to move the shovel across the channel, thus placing the caterpillar tracks at right angles to the direction of the digging-cable. Wider cuts are possible with this method, and its advocates state that bedrock is cleaned better. This seems reasonable, because in the method mentioned first the arc through which the bucket moves causes a strip of bedrock to remain uncleaned toward the extreme reach of the boom. This can be avoided to a certain extent by overlapping the cuts, but the digging is done under muddy water, and accuracy of this overlap is difficult to attain.

Mats.

While the shovel can usually travel on the ground in dry weather, when the ground is muddy or very sandy, mats are needed. These are made by bolting together timbers, about 8 by 10 inches, in sections four

[1] Thoenen, J. R., Sand and Gravel Excavation, Part I: U. S. Bur. Mines Inf. Circ. 6798, pp. 23-39, 1934.



PHOTOGRAPH 1. Dragline dredge under construction in shop, showing trommel and parts of riffle-sluices and stacker-ladder. (Photo by courtesy Bodinson Mfg. Co.)

feet wide and somewhat longer than the width of the tread of the shovel. The boom is used as a crane to pick these up behind the caterpillar tracks and put them down in front.

TRACTORS

A tractor of the caterpillar type powered by a diesel engine is now practically a standard item of equipment in both dragline dredging and bucket-ladder dredging. It is usually equipped with a scraper or bulldozer blade in front and often has a winch mounted in back. The principal use is for clearing the land of brush and trees. These are either pushed or pulled to one side or piled for burning. Many jobs of handling heavy parts are possible with the tractor, and it is useful in building dams for some locations of the dredge-pond. In dragline dredging, the tractor and bulldozer are particularly useful for smoothing the way ahead of the shovel, so that the latter can be moved ahead with a minimum of lost time. The tractor and a Le Tourneau carryall have been used in a few places to remove several feet of soil overburden containing no gold.

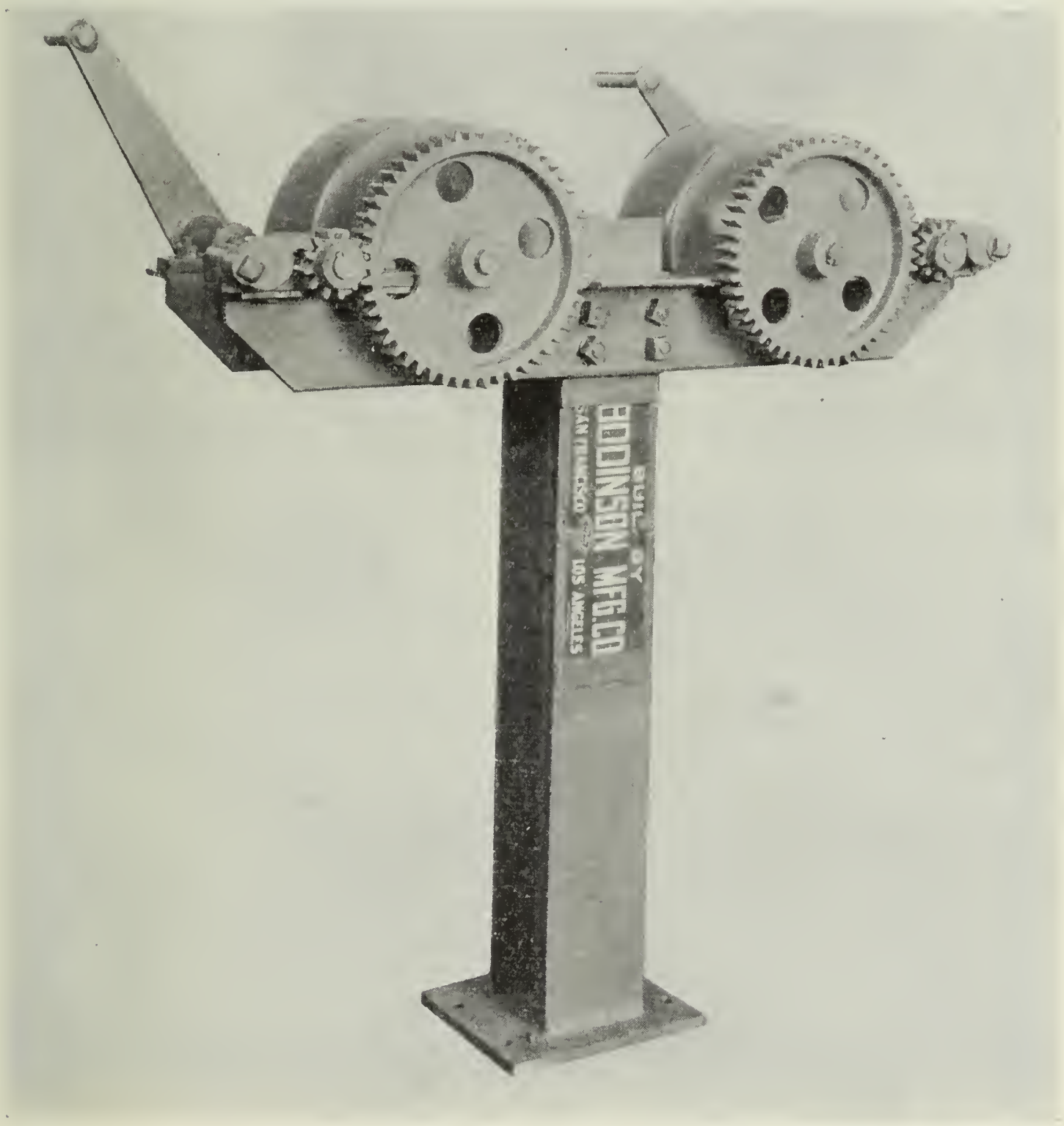
WASHING PLANTS

The washing-plant for a dragline dredge is mounted on a barge, and consists of a hopper into which the gravel is dumped by the shovel, a revolving screen or trommel, and a belt-conveyor to stack the coarse tailing behind the barge. Large streams of water are pumped from the

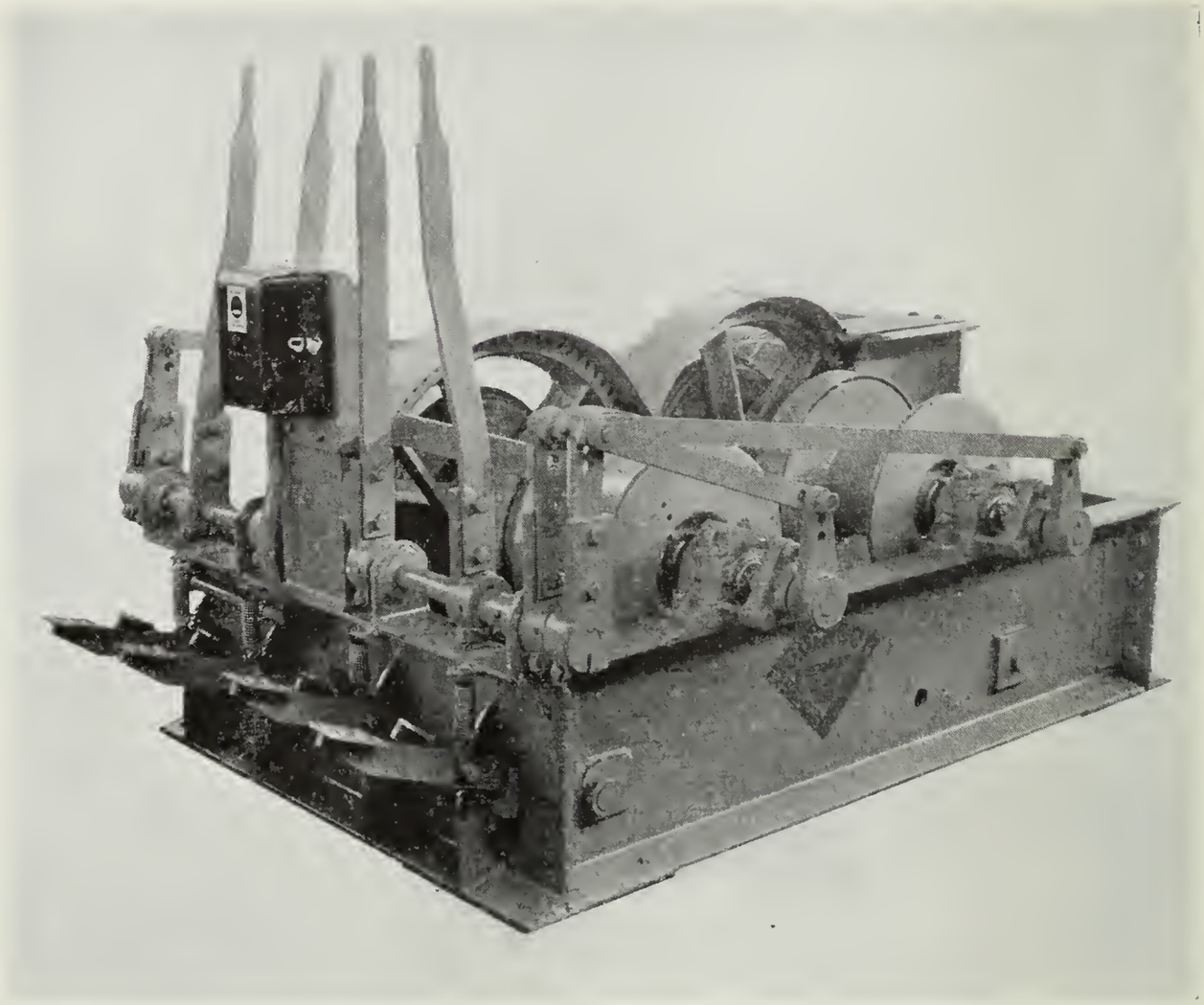
pond into both the hopper and the trommel. The sands that pass through the screen are washed on inclined tables, which are divided by partitions into a number of sluices containing riffles to retain the gold. The washed sand flows into the pond behind the barge. The following descriptions of details have been generalized somewhat to cover practice in the district, but they are given with the particular plants in mind for which cost-data are tabulated below. The all-steel plants are made by Bodinson Manufacturing Co., 2401 Bayshore Boulevard, San Francisco. Welded joints are used throughout. Even the corrugated iron housing is tack-welded to the steel frame.

Hulls.

The barge for a 1½-cu. yd. outfit is 30 ft. by 40 ft. and is made of five pontoons, each 8 ft. by 30 ft. by 42 inches deep. For the 3-cu. yd. outfit, it is 35 ft. by 48 ft. by 42 inches deep, and comprises six pontoons, each 8 ft. by 35 ft. Steel is $\frac{3}{16}$-inch thick, and all seams are electric-welded. Well braced frames for pontoons are made of 2½-inch by



PHOTOGRAPH 2. Hand-winch for dragline dredge. (Photo by courtesy Bodinson Mfg. Co.)



PHOTOGRAPH 3. Power-winch for dragline dredge. (Photo by courtesy Bodinson Mfg. Co.)

$2\frac{1}{2}$-inch by $\frac{3}{16}$-inch angles. The earlier barges were made of timber frames covered with 3-inch planks, and a number of these are still in use.

Winches.

The barge is pulled ahead and swung to distribute tailing by means of cables anchored ashore and attached to winches on the barge. Hand winches are used on the smaller outfits and power-winches on the larger ones. On a plant serving a 3-cu. yd. electric shovel the winch is driven by a 3-hp. electric motor.

Hopper.

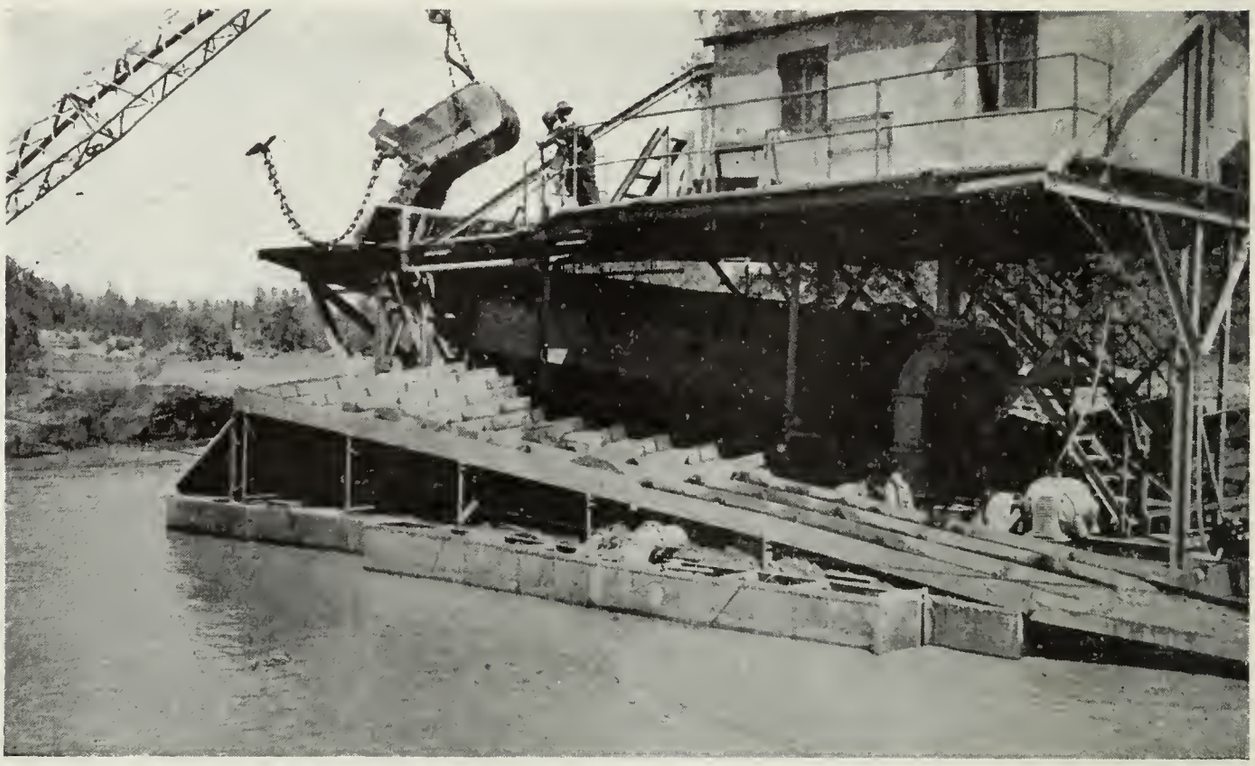
A heavy hopper usually made of $\frac{1}{2}$-inch steel plates welded together receives the gravel dumped from the dragline bucket. A grizzley of 90-lb. steel rails spaced at 16-inch centers prevents large boulders from entering the trommel. An effort is made to lay aside with the shovel any boulders that will not pass through this grizzley because on plants operated in this district facilities for handling boulders on the barge are not good. A new design to be mentioned later overcomes the difficulty. Water is discharged from nozzles into the hopper. On the 3-cu. yd. outfit, the hopper is 14 ft. by 10 ft. and is 13 ft. $11\frac{1}{2}$ inches above the deck.

Trommels.

Details given here are for the plants on which cost-data are given below. Different sizes of holes and different spacing can be used as required by the particular deposit being worked. For the $1\frac{1}{2}$-cu. yd. outfits, trommels are 24 ft. long by 54 inches in diameter. Two end sections of 4 ft. each are not perforated. Other sections of 4 ft. each are perforated as follows: first, $\frac{3}{8}$-inch holes with $1\frac{1}{4}$ inches metal between; second, $\frac{3}{8}$-inch holes with $\frac{3}{4}$-inch metal between; last two, $\frac{1}{2}$-inch holes and $\frac{1}{2}$-inch metal between. They turn at 14 revolutions per minute. On the 3-cu. yd. outfit, the trommel is 35 ft. long by 5 ft. in diameter. End sections of 5 ft. each are not perforated. The balance of 25 ft. is perforated with $\frac{3}{8}$-inch holes, but the spacing varies in the 5-ft. sections as follows: on the first section $1\frac{1}{4}$ inches of metal is left between holes; second section, $\frac{3}{4}$-inch; last three sections, $\frac{3}{8}$-inch. The speed of rotation is 12 rpm. A pipe drilled with $\frac{5}{8}$-inch holes extends through the trommel, and water is sprayed from it to wash the gravel.

On the older outfits, the metal housing around the lower half of the trommel ended a few inches above the riffle sluices, and water and sand dropped directly on the riffles. On the Bodinson washing plants, the trommel housing is carried several inches below the level of the riffles into a narrow, depressed steel box running the full length of the trommel. This is provided with baffles or weirs to regulate the flow to the different sluices. It serves also as an effective trap to retain coarse gold. To recover this at cleanup time, large pipe-plugs in the bottom are unscrewed.

PHOTOGRAPH 4. Trommel for dragline dredge on truck and trailer.



PHOTOGRAPH 5. Dragline dredge showing trommel, riffle-sluices, pump and pump-screen.

Riffle-Tables.

On the 3-cu. yd. outfit are 10 sluices with riffles on each side of the trommel. They are all 30 inches wide, 12 are 14 ft. long, and 8 are $11\frac{1}{2}$ ft. long. They discharge into a pair of sluices of the same width on each side of the barge, running lengthwise of the barge to discharge at the stern. The lower portions of these sluices are provided with riffles also. In the upper portions, where the sluices running crosswise of the barge discharge into them, too much turbulence exists for riffles to be effective. The trommel and all sluices are set at a grade of $1\frac{1}{2}$ inches to a foot. Some designers use $1\frac{1}{4}$ inches to a foot. On the smaller barges for $1\frac{1}{2}$-cu. yd. shovels, the arrangement is the same, except that dimensions are reduced to correspond with those of the barge.

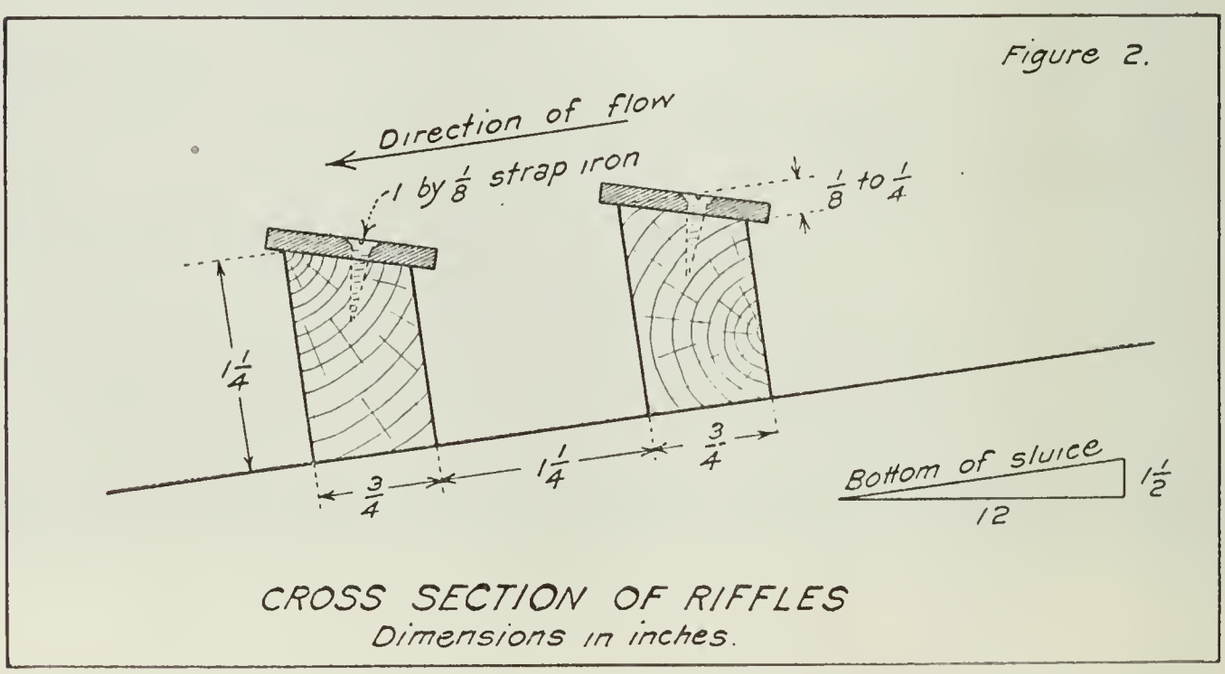


FIG. 2. Cross section of dredge-riffles.

Riffles are of the Hungarian dredge-type of wood, $1\frac{1}{4}$ inches deep, $\frac{3}{4}$-inch wide, spaced at $1\frac{1}{4}$ inches. They are made up in sections of a length equal to the width of the sluice, and about a foot along the direction of flow. These small sections are easily handled during the cleanup. The top of the wood is beveled off for $\frac{1}{8}$ inch to $\frac{1}{4}$ inch, so that the top is nearly level when the riffle is in the sluice. It is shod on top with strap iron, 1 inch by $\frac{1}{8}$-inch, held in place with countersunk wood screws. On the Roaring River dredge described on a later page, rubber is substituted for iron. Both the rubber and the iron are wider than the wood beneath, and overlap the wood a little on both edges.

Most operators use expanded metal lath of one-inch mesh over burlap, coconut matting or English corduroy in the upper half of the sluices running crosswise of the barge, that is just beneath the trommel.

PHOTOGRAPH 6. Dragline dredge under construction in field.

The metal lath is raised with tongue-and-groove flooring so that the top is even with the top of the riffles in the lower part of the sluice. Quicksilver is sprinkled on this at the start of each shift, and the metal lath holds the quicksilver close to the under side of the flow of sand and water, where it is more effective in amalgamating the gold than in the deeper riffles.

Stackers.

For stacking the coarse tailing behind the barge, the $1\frac{1}{2}$-cu. yd. plant is equipped with a belt-conveyor system, 50 ft. long between pulleys, with a 30-inch belt. The stacker for the 3-cu. yd. plant is 50 ft. long with a 36-inch belt. Some of the boats with diesel power have an electric generator and motor so that the stacker can be driven by the upper pulley. One plant has the upper pulley driven by a shaft running the full length of the stacker.

Power.

On one of the 1½-cu. yd. outfits for which cost-data are given below, power is furnished by a D-7700 Caterpillar diesel engine rated at 50 hp. on continuous sustained loads or 63 hp. maximum; on the other by a D-8800 Caterpillar diesel engine rated at 64 hp. and 80 hp. respectively. Electric lights are furnished by 2000-watt Koehler plants.

Power on the 3-cu. yd. outfit is furnished by the following electric motors: 50 hp. on pump, 30 hp. on trommel, 10 hp. on stacker, 3 hp. on winch and 5 hp. on auxiliary pump.

Water.

During the first half of the year, for which cost figures are given below, practically all water needed was obtained from the natural flow of the streams. During the dry season, impounded water bought from a company which furnishes water primarily for irrigation may cost $500 per month total for all three outfits.

Water for washing the gravel on the barges is pumped from the pond on the 1½-cu. yd. outfits with a 7-inch centrifugal pump. The 3-cu. yd. plant has a 10-inch pump discharging into the hopper and trommel; also a 4-inch auxiliary pump to supply additional water to the sluices. The 4-inch pump is used to furnished water for cleaning up the riffles. The proportion of water and sand is variable according to the character of the ground being mined. The mixture of sand and water discharged at the stern of the barge is roughly 10% to 15% solids.

Delays.

The plants are kept in operation 24 hours per day. "Operating hours" listed below include only that time in which the shovel was digging gravel and delivering it to the hopper on the barge. All other time is counted as delays. These include time for moving, for lubricating and servicing the shovel and other machinery, repairs and cleanups.

For a move to a new location involving dismantling of equipment, seven days are required for the 1½-cu. yd. outfit, and eight days for the 3-cu. yd. outfit. The regular crew of roughly 14 men is used in either case. As extensive replacements of worn parts are usually made at this time, an accurate estimate of the cost of such a move is not available. Parts and cost of installing them should be charged to maintenance and not to moving. In such a move, the shovel is used as a crane to pick up a pontoon or other heavy part and load it on a truck and trailer. It is interesting to note that $1,000 should be ample to cover the cost of dismantling and re-erection when the length of the truck-haul is moderate.

Cleanups.

Cleanups probably average about once a week. Some operators could no doubt improve their recovery by watching the condition of the riffles more closely and cleaning up when the riffles are loaded instead of at regular intervals. One operator who uses expanded metal lath over burlap near the trommel cleans up the lath after every 80 hours of running time, and makes 80% to 90% of his total recovery

in this way. The metal lath is taken up, then the concentrate on the burlap is hosed off into a tub. To clean it thoroughly, it is finally held in a vertical position over the tub and hosed again. When the Hungarian riffles are cleaned up, the sections about one foot in length are taken up one at a time, and lighter sands are washed overboard with a hose. Amalgam and several tubs full of the heavier sands are saved for further treatment. This treatment varies with different operators, and long toms, tables of the Wilfley type, and amalgamation-barrels are all in use. Amalgam is squeezed and retorted, and the resulting sponge-gold is ready for the mint.

One operator who recovers platinum makes the final concentration by panning, dries the concentrate, and blows away the last of the sand. The metal is then treated with nitric acid, washed and dried, and sold to platinum-buyers.

Experiments are under way to treat the entire sand content of the riffles from each cleanup. One of these contemplates table-concentration followed by passing the concentrate through molten lead. Another method is to dry the sand and use dry concentration with mechanical blowers.

Crew.

The crew employed on the three outfits for which cost-data are given below comprises the following: 18 men on barges, 9 on shovels, 3 oilers, 3 tractor-drivers, 3 mechanic-welders, 3 extras used as truck-drivers, etc., one cleanup man, and one superintendent. This crew of 41 men operates the three plants for 24 hours per day.

Capital Investment.

The following figures are intended to give a rough idea of the principal items of equipment of high quality and bought new.

	1½-cu. yd. diesel	3-cu. yd. electric
Shovel	$22,000	$30,000
Barge and washing plant	20,000	28,000
RD7 Caterpillar tractor, diesel	6,500	
RD8 Caterpillar tractor, diesel	------	8,000
Attachments for tractor (bulldozer, winch)	------	3,300
Miscellaneous welding, etc.	1,500	1,700
	$50,000	$71,000

In addition to these main items, the following may or may not be needed depending on the location and other variable conditions: truck, shop, camp, stock of spare parts, electric power line and transformers, storage for diesel fuel. A shop of some kind is usually provided. It may contain a part or all of the following: welding equipment, machine tools, retort for amalgam, machinery for cleaning sands, and possibly for recovery of platinum.

Operating Costs.

The following figures on operating costs, covering the first six months of 1937, were furnished by the auditor of an experienced operator who had been in the business for some time. All of the equipment was bought new for the purpose of dragline dredging and had been in

operation for an average of about a year before January 1, 1937, when the period covered below starts. Depreciation of $1,000 per month on each outfit is charged by the operator with the idea in mind that the machinery runs continuously, as near 24 hours per day as possible, not intermittently like equipment used by a contractor. The figures are believed to be accurate, but with less accuracy in the figure for cubic yards than in the others. Yardage was calculated on the basis of an actual survey for area, but depths were estimated. The costs per cubic yard are representative of those being claimed by a number of operators with considerable experience, and using high-class equipment.

The lower cost per cubic yard for the 3-cu. yd. electric is due chiefly to the fact that a much larger yardage is handled by the same size of crew as is used on the smaller outfits. The cost per cubic yard for power is a fraction of a cent lower on the electric.

	1½-cu. yd. diesel	1½-cu. yd. diesel	3-cu. yd. electric
Gravel handled, cubic yards	394,050	330,900	696,000
Cost of Operation.			
Shovel, payroll	$4,659.10	$4,003.38	$4,269.20
Fuel oil, lubricating oil, gasoline	1,500.00	1,471.38	57.03
Maintenance	1,405.58	1,264.15	889.96
Cable	592.73	777.03	1,394.97
Direct expense	8,157.41	7,515.94	6,611.16
Washing-plant, payroll	5,283.11	4,489.94	6,307.50
Fuel oil, gasoline	1,255.00	1,278.68	160.39
Maintenance	877.22	825.73	949.48
Direct expense	7,415.33	6,594.35	7,417.37
General operation			
Power	--------	--------	3,599.13
Water	--------	--------	159.00
Repair, labor and materials, including clearing of land with tractors	8,282.11	7,658.11	8,301.89
Compensation insurance	586.70	593.26	585.62
	8,868.81	8,251.37	12,645.64
Office, taxes, general	1,001.00	875.39	948.80
Depreciation	6,000.00	6,000.00	6,000.00
Total operating expense, 6 months	$31,442.55	$29,237.05	$33,622.97
Cost per cubic yard	0.08	0.088	0.048
Operating hours	2,175	2,489	2,686

No land-costs and no royalties are included in these figures.

New Designs.

Bodinson Manufacturing Co., San Francisco, is now building washing plants for dragline dredging which include newly designed equipment of two kinds. On one of these is special equipment for handling boulders. Means of transporting these from the grizzley lengthwise of the top of the superstructure on the barge are provided. The boulders are discharged through either of two chutes at the stern, arranged to drop them in the pond just clear of the stacker.

In another new design of an outfit of 3000 cu. yd. rated daily capacity, jigs will be substituted for riffle-sluices. Four rougher jigs

will be carried on each side of the barge, and their concentrate will be treated in two cleaner-jigs. Overflow from the cleaners will go back to the roughers. Discharge launders running lengthwise of the barge will be equipped with riffles only as a check on jig operation. Ahead of the jigs will be nugget-traps consisting of a depressed trough containing a perforated pipe for its entire length. Water discharged from the perforations will keep the sand in motion. One consideration in the installation of these jigs is the recovery of platinum.

Jigs are each 3 ft. 6 inches square. They are of a special design called the Bodinson-Heath, and are actuated by oil-cylinders working on a diaphragm. One advantage of this design is a saving of head room.

BUCKET-LADDER DREDGES

Bucket-ladder dredges, called also bucket-line dredges, bucket-elevator dredges, and bucket-chain dredges, on which the heavy digging machinery forms a part of the floating equipment, had already reached a high degree of perfection 20 years ago when Janin [1] described them in a 226-page bulletin of the U. S. Bureau of Mines. This bulletin is still useful but it is out of print. It may be consulted in many large libraries. However, designers of dredges have not been idle during the past 20 years; and Janin's bulletin could be considerably revised and extended to cover recent improvements. Only short descriptions of the most important of these will be attempted here. A few additional new developments are mentioned in connection with individual dredges recently built in northern California. They are described on later pages under the names: Junction City Mining Co., Roaring River Gold Dredging Co., Yreka Gold Dredging Co., and Yuba Consolidated Gold Fields.

So much has been learned about special methods of taking care of the great strains to which a dredge is subjected, and of combating excessive wear caused by the abrasive material handled, that the design of a dredge is a matter for experts. Dredges designed by others are likely to break down so often, and lose so much time in which production of gold should be taking place, that the losses in just a few months will exceed the cost of expert design. The use of manganese steel for buckets and other parts subject to abrasion and the use of chrome-nickel steels for parts subject to great strains are notable. Many dredges have been built of second-hand parts, and in a large number of these cases, the cost has exceeded the cost of a new dredge.

Pontoon-Hulls.

Bucket-ladder dredges were built with hulls of steel pontoons of a size suitable for easy transportation long before that design was adopted for dragline dredges. The first of these was No. 96 of Yuba Manufacturing Co. built originally in Montana in 1933. It was later dismantled and shipped in 19 days, and then re-assembled in California in 38 days. The crew was about the same size as that required for regular dredge operation on three shifts. In moving the dredge they all worked on one shift. The hull of this dredge is 90 ft. 6 inches long by 37 ft. 4½ inches wide by 8 ft. 1 inch deep. Buckets are of 6-cu.-ft. capacity and the dredge digs 150,000 cubic yards per month to a depth

[1] Janin, Charles, Gold Dredging in the United States: U. S. Bur. Mines Bull. 127, 1918. (Out of print.)

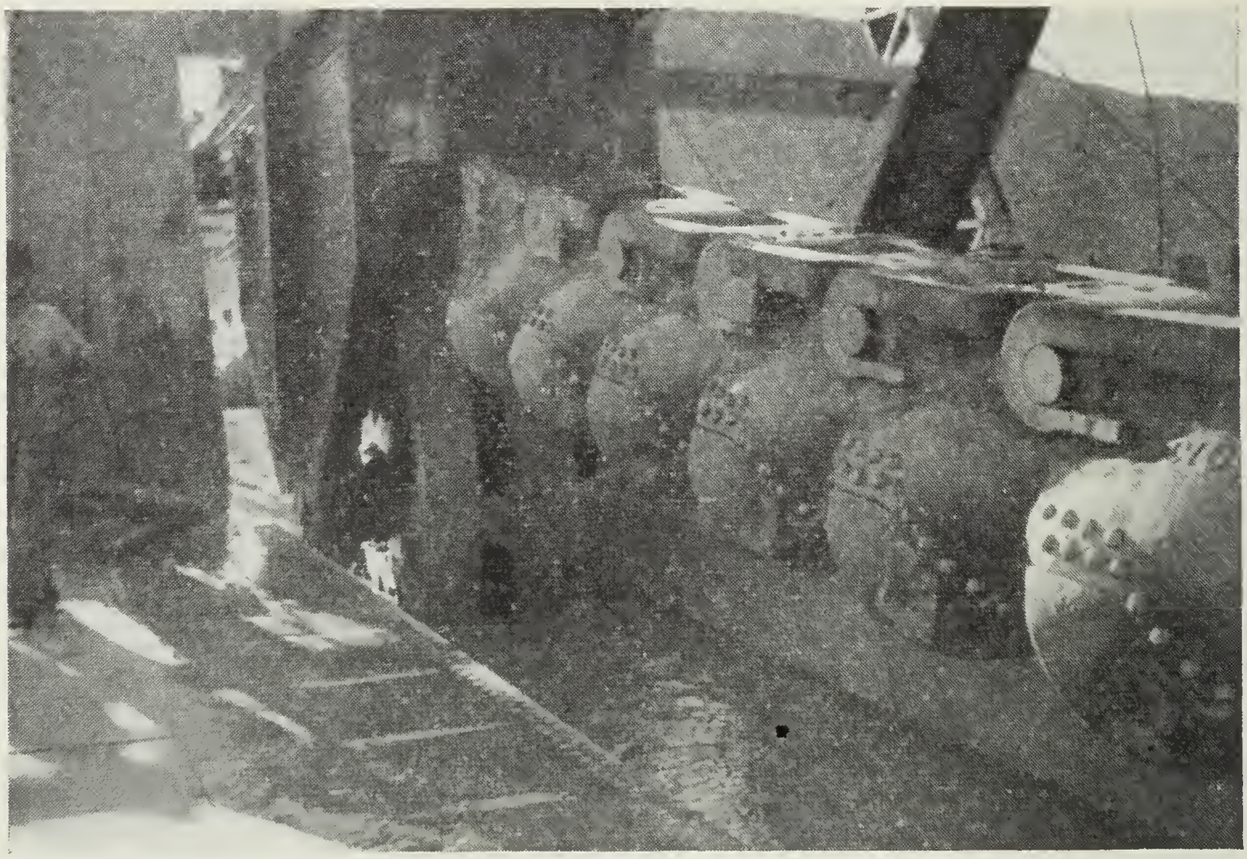


Photo by Walter W. Bradley

PHOTOGRAPH 6a. Perry idler on Yuba No. 17 dredge.

of 26 ft. in gravel of an ordinary degree of compaction. Pontoons are practically cubic in shape and all of the same size. Later dredges have been designed in such a way that partitions are more favorably placed to strengthen the hull. In this design pontoons are of various sizes and shapes. The dredge of Junction City Mining Co., built by Yuba Manufacturing Co., and the dredge of Yreka Gold Dredging Co., built by the Walter W. Johnson Co., are of this general type. Further details on these two dredges are given under the above headings arranged alphabetically on later pages. Yuba Manufacturing Co. has built 12 or more dredges of this type, and their experience is that when the pontoons are properly designed and arranged a hull built of pontoons is equal in strength and service to the more common type of hull braced with structural steel. These multiple compartments in a pontoon-hull afford a great protection against sinking.

New Bucket-Designs.

Buckets of new designs are now in use in which the replaceable wearing-edge of the lip is held by only two bolts instead of the large number of rivets formerly used. The lips can be changed quickly and lost time from this source is reduced. Such buckets are made by Taylor-Wharton Iron & Steel Co., Balfour Building, San Francisco, and by American Manganese Steel Co., 956 Ferry Street, Oakland.

Perry Idler.

In 1933, Yuba Manufacturing Co.[1] rebuilt dredge No. 17 at Hammonton to dig to a depth of 150 ft. The rebuilt all-steel hull is 233 ft.

[1] Romanowitz, C. M., and Young, G. J., $35 Gold stimulates the dredge designer's ingenuity: Eng. and Min. Jour., vol. 135, pp. 338-341, 1934.

9 inches long by 68 ft. wide by 11 ft. 6 inches deep. The total weight of the entire dredge is 3220 tons. The digging system weighs 740 tons, of which the ladder weighs 315 tons. It is 200 ft. in length between tumbler centers. The bucket line comprises 126 buckets, each of 18 cu. ft. capacity. To help support this great weight a Perry idler was installed on the under side of the bucket-line near the midpoint of the ladder, to divide the catenary into two parts. The idler is 10 ft. in diameter and weighs 40 tons.

Digging-depth below water line for No. 17 is 112 ft., the balance of the depth being carried as bank. At about the same time, in 1934, that No. 17 started, Yuba [1] No. 18, another 18-cu. ft. dredge, was equipped with a new bucket line but no idler. It digs to a depth of 81 ft. below water level, and performs in about the same way as a number of other Yuba dredges of the same size. A comparison of these dredges, made in 1935, shows that on No. 17 the heel plates on the upper tumbler have a life 2 to 2.4 times the life of the same parts on No. 18. The bucket pins and bushings on No. 17 last 1.8 times as long as those on No. 18. The idler showed practically no wear. Hence engineers of Yuba Manufacturing Co. believe that the installation of this idler would be economical on all dredges digging to a depth of 60 ft. or more.

Jigs.

The use of jigs on dredges has recently been described by P. Malozemoff,[2] Metallurgical Engineer, Pan-American Engineering Corporation, Berkeley, California. Jigs are being used by Bulolo Gold Dredging Company in New Guinea, and by several dredges in Colombia. A number of experiments have been made with jigs on dredges in California, starting in 1914, but they are not yet used to any extent. Yuba

PHOTOGRAPH 7. A. C. Mining Co. dredge under construction.

[1] Romanowitz, C. M., New digging-ladder bucket idler: Eng. and Min. Jour., vol. 137, p. 49, 1936.

[2] Malozemoff, P., Jigging applied to gold dredging: Eng. and Min. Jour., vol. 138, No. 9, pp. 34-37, 1937.

dredge No. 19 at Hammonton is now being operated entirely with jigs as an experiment. No riffles are used. Dredges in northern California, described in this article, all use riffles.

DREDGES OPERATING IN SHASTA, SISKIYOU AND TRINITY COUNTIES

A. C. Mining Co. (Collins), 1617 S. W. 19th Avenue, Portland, Oregon, operated a dragline dredge during the early part of 1937 in Sec. 2, T. 32 N., R. 5 W., at Buckeye, seven miles north of Redding. The location is the same as that mined first by Pioneer Dredging Co. for a period of a few months. Water is available during winter and spring only, and no dredging has been done during the dry season.

The washing plant is built on a barge of steel-pontoon construction, 48 ft. by 32 ft., made in Redding by Gerlinger Foundry and Machine Works, Inc. The tailing stacker is shorter than those commonly used, and is supplemented by a sand-pump with 8-inch discharge pipe mounted above the belt-stacker.

Baker Dry-Land Dredge. M. D. Baker of Redding has recently completed the installation of a 'dry-land dredge' in Sec. 34, T. 32 N., R. 6 W., on Clear Creek four miles southwest of the old town of Shasta. Gravel is mined with a P. & H. gasoline shovel of the dipper-stick type with bucket of one cubic yard capacity. The washing-plant is of timber construction built on heavy timber skids, and is designed to be pulled by a cable attached to the shovel. It consists of a hopper at a low elevation into which gravel is dumped by the shovel. From the hopper the gravel is raised to a trommel at a higher elevation by a belt conveyor. Oversize is stacked by a second belt conveyor, and undersize is washed in riffle sluices. Sands are discharged by a sluice mounted on trestles resting on the ground. One gasoline engine drives the first belt-conveyor and the trommel; a second gasoline engine drives the stacker; while water is pumped from Clear Creek with a third gasoline engine (Hudson automobile). Some damage was done to the equipment by high water in Clear Creek in December, 1937. This same outfit was in operation near Igo for a short time.

Cal-Oro Dredging Co., L. Gardella, 681 Market Street, San Francisco, has operated a bucket-ladder dredge with 6-cu. ft. buckets from time to time in Sec. 27, T. 45 N., R. 7 W., just south of Yreka. It has been idle recently, but reports indicate that a new tract of land has been acquired for further operation.

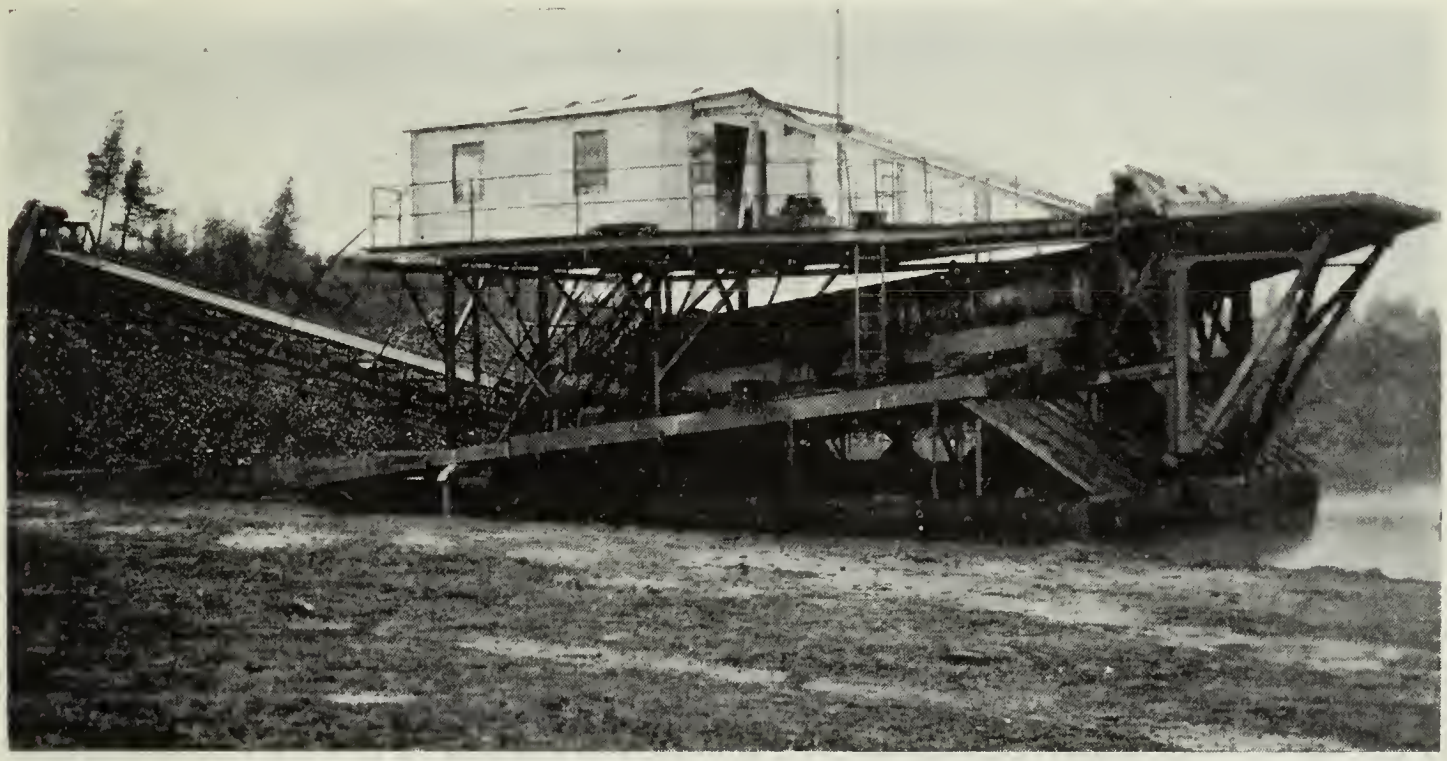
Carlson & Sandburg, L. D. Carlson and John Sandburg of Redding, operated three dragline outfits including a 3-cu. yd. electric on land between Sec. 23 and Sec. 31, T. 31 N., R. 5 W., five miles southwest of Redding, during 1937. This land is on the Olney Creek and the Clear Creek drainages. On the latter, some stripping of overburden was done with a Caterpillar tractor and a Le Tourneau carryall. Late in 1937, one of the outfits was moved to Indian Creek, Sec. 5, T. 32 N., R. 9 W., in Trinity County near Douglas City. Another was moved to Sulphur Creek just north of Redding, Sec. 23, T. 32 N., R. 5 W. Washing plants are of Bodinson make.

Cascade Dredging Co., a limited partnership of B. M. Stites, Cottonwood, and others, operated a dragline dredge during a part of 1937

in Sec. 7, T. 29 N., R. 5 W., 10 miles west of Cottonwood. The work was done along Cottonwood Creek and up a small tributary to a point close to the Cottonwood-Gas Point road, in an area a quarter of a mile in length, 250 ft. in width, and to a depth of 5 ft. to 15 ft. A compact clay bedrock caused some difficulty in digging. Both gold and platinum were produced.

A dragline shovel with a 1¼-cu. yd. bucket was used, and a washing plant built on a wooden barge. Diesel engines furnished the power. The outfit was idle in the fall of 1937.

El Oro Dredging Co., a California corporation, Verne H. Carter, Managing Director, Cottonwood, operated a dragline dredge during part of 1937 in Sec. 3 (?), T. 29 N., R. 5 W., nine miles west of Cottonwood. The company leased 158 acres of land on a tributary of Dry Creek east of the main stream. A Northwest dragline shovel with a



PHOTOGRAPH 8. Carlson and Sandburg dragline dredge for 3-cubic yard shovel. (Photo by courtesy Bodinson Mfg. Co.)

1½-cu. yd. bucket was used and a washing plant on a wooden barge equipped with Bodinson machinery. A Caterpillar gasoline tractor of 50 hp. with bulldozer attachment was used for clearing the land and leveling ahead of the shovel. Including the manager, a crew of 12 men operated the machinery for 24 hours per day. In addition to gold, some platinum-group metal was sold, containing roughly 35% iridium, and netting the company $55 per ounce according to Carter. The outfit was idle late in 1937, and apparently was to be moved to a new tract of land.

Gold Acres Dredging Co., controlled by P. G. Flummerfelt and Miss Helen Ardelle, 658 Haddon Road, Oakland, California, is operating a dragline dredge in Sec. 2, T. 29 N., R. 6 W., 14 miles west of Cottonwood. The shovel is of 1½-cu. yd. size and the washing plant is on a wooden barge, 30 ft. by 40 ft. Diesel engines furnish the power. Brush and oak and pine timber are cleared from the land ahead of the dredge with a Caterpillar tractor.

The property contains 400 acres and 30 acres of it have recently been dredged just south of the Cottonwood-Gas Point road. The outfit moves back and forth taking a cut 90 ft. wide each time. Depth is 6 ft. to 12 ft., and bedrock is volcanic tuff. The land is a flat roughly 25 ft. higher than Cottonwood Creek, and probably contains an upper terrace of this creek. Water is pumped from the creek with a Caterpillar diesel engine. Some platinum is produced as a byproduct.

Gold Bar Dredging Co. See Lewiston Gold Dredging Co.

Hayfork Gold Dredging Co., Charles C. Stearns, Manager, Hayfork, California, is operating a dragline dredge in the channel and on the benches of the Hay Fork of Trinity River, just outside of the town of Hayfork, in Sec. 11, T. 31 N., R. 12 W. The property contains 260 acres of dredgable land leased from Van B. Young, Emma C. Young, George English, Dan Gordon and others.

The channel of the Hay Fork of Trinity River has recently been dredged for a width of 150 ft. and a depth of 10 ft. This present channel runs west, while the channels on the benches run north and south, and hence must belong to an earlier system of drainage. Bedrock is soft and dark green in color, and has the appearance of serpentine. It is probably derived from a basic lava or tuff of Tertiary age. Wells are said to have been driven through it into gravel lying beneath. No gold or platinum are found more than two feet above bedrock, and as much as two feet of the bedrock are taken up by the shovel to recover gold and platinum in the crevices. Top soil is stripped to a depth of several feet with a No. 75 Caterpillar tractor (Diesel) and a Le Tourneau carryall. One of 8-cu. yd. capacity has been in use, and cost of stripping has been 3 cents per cubic yard. A 12-cu.-yd. carryall has recently been substituted, and is expected to reduce this cost to 2 cents per cubic yard.

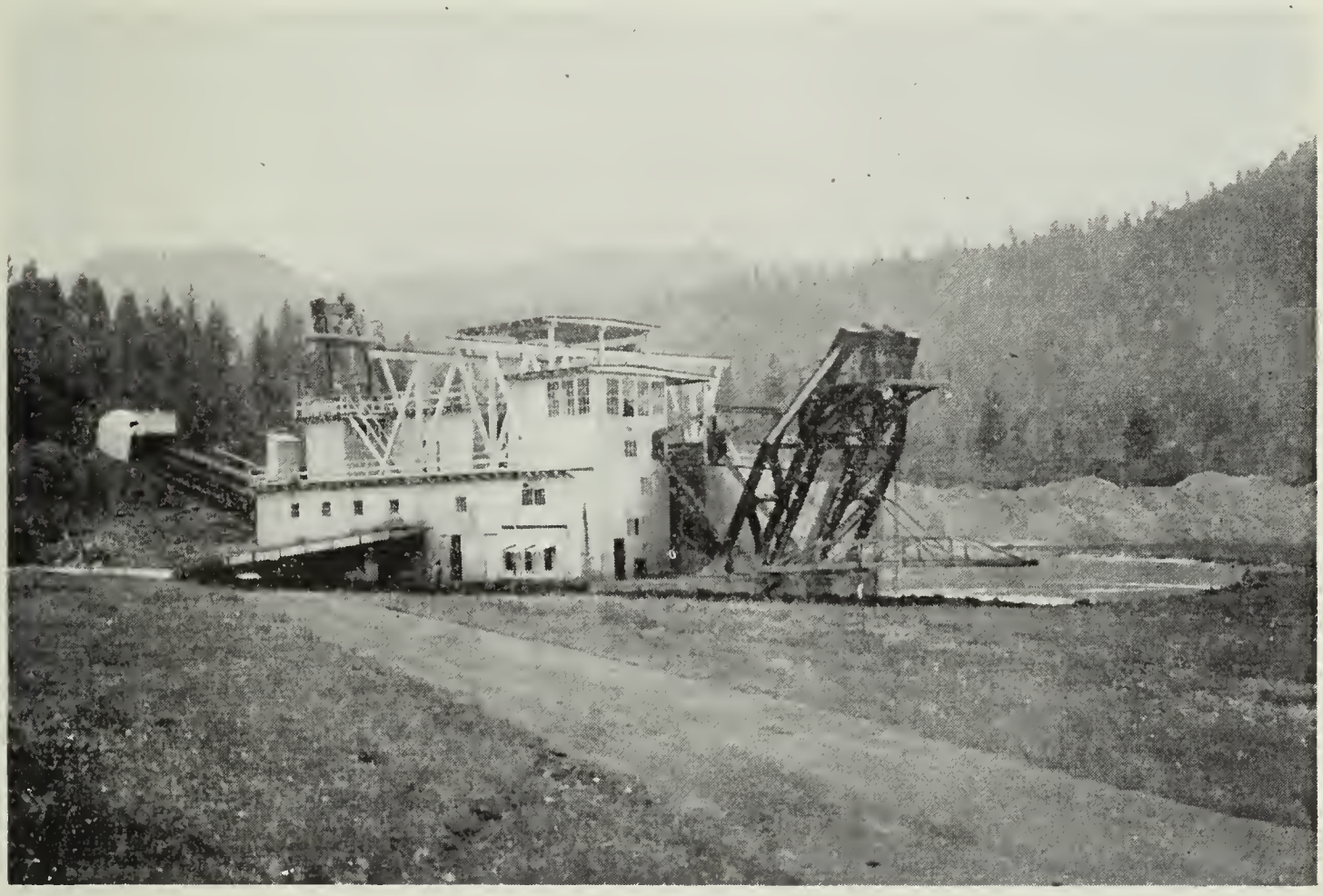
Excavating is done with a 1½-cu. yd. Lima dragline shovel with a 45-ft. boom, which will reach to a depth of 15 ft. The side-cut method is in use, in which the shovel travels back and forth at a right angle to the channel. This allows the bucket to travel parallel to the channel in all parts of the cut, and the bedrock is said to be cleaned much better than when the shovel travels along the channel and reaches to the sides with the boom. A wooden barge carries the usual hopper, trommel, riffle-tables and stacker. Diesel engines furnish the power. Some large boulders are found in the gravel, and they are laid aside by the shovel whenever possible to avoid handling them on the barge.

The equipment is kept in operation 24 hours per day by a crew of 17 men. The capacity varies from 1500 cu. yd. to 2500 cu. yd. per day. The lower capacity is usually caused by an excess of sand in the riffle-sluices. Actual digging time is said to average 19 hours per day. According to Stearns, when 2500 cu. yd. are handled per day, the cost per yard is 7 cents including 1½ cents per yard for depreciation. This is for the gravel handled by the shovel; stripping is not included. The machinery was originally installed by Wyandotte Dredging Co., and was bought from that company. Stearns states that the total investment is $50,000. When work is done on the benches, water is pumped from the creek with a 100-h.p. diesel engine at a

cost of $300 per month. Enough platinum (35% iridum) is produced to pay the wages of all shovel-operators.

Junction City Mining Co. started a modern steel bucket-ladder dredge in Sec. 18 and adjoining sections, T. 33 N., R. 10 W., near Junction City, on January 10, 1936, and has been operating continuously since. Harvey Sorensen, 685 6th Street, San Francisco, is president; C. M. Derby, Mills Tower, San Francisco, is consulting engineer; and L. T. Roberts is superintendent at Junction City. Some of the machinery from the old Madrona dredge was used.

The hull is new and of the latest pontoon design, being No. 113 of Yuba Manufacturing Co. Transportation over mountain roads was one reason for adopting this design. The hull is 120 ft. by 52 ft. by 8 ft. 1 inch deep, and is made of 31 pontoons. These are designed and



PHOTOGRAPH 9. Dredge of Junction City Mining Co.

arranged so that the inside walls strengthen the hull at critical points. The largest pontoon weighs 24,000 lb. and the smallest 4800 lb. Most of them weigh from 10,000 lb. to 16,000 lb. When assembled they form a rigid structure due to the beam-effect of the side-walls.

The bucket-chain contains 79 buckets of 9½-cu.-ft. capacity each, and the dredge is capable of digging to a depth of 45 ft. below waterline, although the actual depth of the gravel averages 30 ft. Bedrock varies from soft to hard but is decomposed enough so that a few inches can be taken up. The dredge is held in digging position by a single spud of 32 tons. The trommel is 7 ft. in diameter and is perforated with ⅜-inch to ½-inch holes, but one section of 2-inch mesh is provided for recovery of nuggets. Riffles are of the Hungarian dredge type described in the general section on dragline dredging, and are shod on top with ⅛-inch strap iron. The stacker for coarse tailing is 135

ft. long and carries a 36-inch belt. The operating crew averages 24 men.

Electric motors are as follows: 50 hp. on a high-pressure 10-inch pump, 50 hp. on a low-pressure 10-inch pump, 50 hp. on an auxiliary 10-inch pump, 25 hp. on a 4-inch pump, 35 hp. on the winch, 35 hp. on the screen, 50 hp. on the stacker, and a 200-hp. digging motor.

The following figures on operation are furnished through the courtesy of C. M. Derby, consulting engineer. For the fiscal year ending in June, 1937, the operating cost under rather severe conditions averaged 4.98 cents per cubic yard. This includes labor, materials, power, ordinary taxes, and general expense. No land-cost, no royalty and no depreciation are included. The average monthly yardage was 240,000 cu. yd. The approximate cost of the dredge was $250,000.

Lewiston Gold Dredging Co. is a new company formed to take over the Gold Bar dredge at Lewiston. It should not be confused with Lewiston[1] Dredging Co., which formerly operated a dredge farther up Trinity River at Minersville. The new company is a partnership of 13 persons, of whom three are general partners, Elwyn W. Stebbins, F. J. Estep, and C. H. Thurman, Manager, 420 Market Street, San Francisco. W. J. Harvey is superintendent at Lewiston.

The location is Sec. 18, 19, T. 33 N., R. 8 W. The present operators started in June, 1937, and expect to work from Lewiston down the river for two miles. Their work is on an upper terrace. A new revolving screen and other new parts have been installed on the dredge, and steel pontoons for extending the hull have been delivered.

The Gold Bar dredge was described in State Mineralogist's Report XXIX. The hull is 79 ft. by 44 ft. by 7 ft., and it carries a chain of 45 buckets of 8 cu. ft. capacity each, digging to a depth of 31 ft. below water line. It is held in position by headlines of 1½-inch steel cable. No spuds are used. Electric motors are as follows: 150-hp. digging motor, 30 hp. on 8-inch pump, 50 hp. on 10-inch pressure pump, 40 hp. on seven-drum winch.

Midland Company, a California corporation, 4th and Dwight Way, Berkeley, California, has been operating a dragline dredge in Sec. 4, T. 29 N., R. 5 W., 10 miles west of Cottonwood. Dry Creek has been dredged from its confluence with Cottonwood Creek for a distance of nearly two miles to a width of several hundred feet and a depth of 7½ ft. F. A. Hoyer was superintendent at Cottonwood, and Ben Howard was dredge-master. In January, 1938, this property had been worked out, and the outfit was to be moved to a new location near Red Bluff.

The shovel is a 1¼-cu. yd. Thew-Lorain dragline powered with a 109-hp. Caterpillar Diesel engine. The washing plant is on a wooden barge 30 ft. by 40 ft. by 36 inches, covered with 3-inch planks. From the hopper the gravel goes to a revolving screen 30 ft. by 4 ft. made by Thew-Lorain. Holes are ⅜-inch and the metal between varies from 1 inch to ⅜-inch in the six sections. The riffle system has an area of 552 square feet, and a combination of expanded metal lath over

[1] Averill, C. V., Gold deposits of the Redding and Weaverville quadrangles, Lewiston Dredge: Calif. State Mineralogist's Report XXIX,, pp. 65-66, 1933. Requa, L. K., Description of the property and operations at the Lewiston dredge, Lewiston, Calif.: U. S. Bureau Mines Inf. Circ. 6660, pp. 1-15, 1932.

burlap and dredge-type Hungarian riffles is used as described in more detail in the general section on riffles above. Water is pumped from the pond with a Fairbanks-Morse pump of a capacity of 4000 gallons per minute when running at 1200 rpm. Power on the barge is furnished by an 85-hp. Fairbanks-Morse Diesel engine. Two eight-hour shifts were worked per day with a total crew of 10 men, and cleanups were made between regular shifts.

Olson Dredge. Roy S. Olson of Redding dredged 100 acres of gravel along China Gulch in 1937. The location is Sec. 36, T. 31 N., R. 5 W. and adjoining sections, five miles south of Redding. Bedrock is a volcanic tuff apparently laid down in water. The 1½-cu. yd. dragline outfit was later sold to Pioneer Dredging Co.

PHOTOGRAPH 10. Dragline dredge of Midland Co.

Oro Trinity Dredger Co. controlled by R. G. Stapleton and C. E. Cummings of Oroville installed a 1½-cu. yd. dragline outfit on the Arbuckle property at Weaverville, Trinity Co., late in 1937. D. A. McQueen is manager.

Pioneer Dredging Co. started as a partnership of four persons, but is now owned by R. W. Baker, Box 700, Redding, California. Three dragline dredges are operated including a 3-cu. yd. electric. The first was installed at Buckeye, Sec. 2, T. 32 N., R. 5 W., where water is available during winter and spring only. After one season's operation here, it was moved to Dry Creek near Igo. The three dredges are now operating near Igo and Olinda, about 15 miles southwest of Redding, Sec. 11, 18, 19, 28, 29, 32, 33, T. 30 N., R. 5 W.

PHOTOGRAPH 11. Dragline dredge of Pioneer Dredging Co.

On Dry Creek, where 2880 acres of patented land are held, the channel and first terraces will be dredged for a length of 4 miles, width of 1000 ft., and depth of 5 ft. to 10 ft. On Spanish Gulch, where 195 acres are held, the channel will be dredged for a length of 4 miles, width of 400 ft. and depth of 3 ft. to 9 ft. On Spring Gulch, where 75 acres are held, the entire area will be dredged to a depth of 3 ft. to 9 ft. Shovels are all of Lima make, and washing plants are Bodinson. Bedrock is volcanic tuff.

Roaring River Gold Dredging Co. is dredging on Roaring River, a tributary of Cottonwood Creek, in Sec. 4, 5, T. 29 N., R. 6 W., 15 miles west of Cottonwood, with a new dredge of the bucket-ladder type. Norman Cleaveland, 351 California Street, San Francisco, is manager, and J. Ellery Sanders, Cottonwood, California, is superintendent. The company controls two miles along the channel, which will be dredged to an average width of about 800 ft. and depth of 10 ft.

The dredge is of the steel pontoon type with hull 75 ft. by 36 ft. by 6 ft. deep and draft of 4 ft. Machinery was built by Joshua Hendy Iron Works, San Francisco. A single spud of roughly 10 tons is provided to hold the dredge in digging position. The rated capacity is 60,000 cubic yards per month, but the actual capacity has been greater, reaching as much as 2700 cu. yd. per day when bucket-line speed is 36 buckets per minute. It is operated 24 hours per day with a crew of 18 men including those clearing land and tending pump.

From the bucket-line, which carries 72 buckets of 3 cu. ft. capacity each, gravel is dumped into a trommel-screen $4\frac{1}{2}$ ft. in diameter by 23 ft. long, where it is washed with water discharged from nozzles. Oversize goes to a 56-ft. tailing-stacker, on which runs a 24-inch belt. The trommel-screen contains four drilled and countersunk high-carbon steel or cast manganese steel sections, each 4 ft. in length, one section

with $\frac{1}{4}$-inch to $\frac{3}{8}$-inch holes, two sections with $\frac{3}{8}$-inch to $\frac{1}{2}$-inch holes, and one section with $\frac{1}{2}$-inch to $\frac{5}{8}$-inch holes. Sand and water passing through the screen drop to the usual riffle-sluices running crosswise of the boat, thence to sluices running lengthwise of the boat, which discharge on both sides of the stacker at the stern. Riffles are of the standard Hungarian type used on dredges (see above). Instead of being shod on top with the usual strap-iron, they are shod with rubber strips $1\frac{1}{4}$-inches wide and $\frac{3}{16}$-inch thick, supplied by American Rubber Manufacturing Co., Oakland, California. They are said to wear better than iron. Quicksilver is used in these riffles; also in some solid rubber blocks in which shallow grooves are cut parallel to the riffles. The shallow grooves hold the quicksilver close to the lower surface of the sand and water flowing over them, so that particles of gold are amalgamated. Wooden riffles are beveled for about $\frac{1}{4}$-inch on the upper edge so that the rubber top has a slope opposite to that of the sluice. This together with the excess width of rubber over that of the wood beneath tends to cause turbulence in the space between riffles.

Power on the dredge is furnished by two D-13000 Caterpillar Diesel engines, which are rated at 95 hp. each on sustained load or 130 hp. maximum. One of these drives the bucket-line, the winch for swinging the dredge, and the trommel-screen. The other drives the two pumps, the stacker, and the welding and lighting equipment. A Ford V-8 engine is provided as a stand-by for lights. The two Byron Jackson 8-inch pumps of the dredge type on the boat operate against 40-ft. and 60-ft. heads of water respectively. During the summer a supply of water for the dredge-pond is pumped from the Middle Fork of Cottonwood Creek with a 5-inch pump driven by a 40-hp. Caterpillar Diesel engine. This water is pumped over the ridge

PHOTOGRAPH 12. Roaring River Gold Dredging Co.

between the two streams through a quarter mile of 8-inch pipe against a head of 100 ft.

Each of the large engines burns 4½ gallons of oil per hour, while the smaller pumping engine burns 2½ gallons per hour. Consumption of lubricating oil amounts to 200 gal. per month. Fuel-oil costs 7½ cents per gallon and lubricating oil costs 52 cents per gallon delivered at the dredge.

This dredge recovers platinum-group metals as well as gold, the proportion of platinum-group metals being one of the highest for Californian dredges. The ratio of gold to platinum-group metals varies roughly between 20 to 1 and 30 to 1.

Savage & Dodson, Red Bluff, California, have recently made some repairs to the *Gas Point Dredge* formerly owned by *Ogden & Wilson* in Sec. 3, T. 29 N., R. 6 W. on Roaring River, near Gas Point, which is 15 miles west of Cottonwood. The land is leased from Trautz and Green, Cottonwood. They plan to dredge 21 acres on Crow Creek, a tributary of Roaring River.

A new trommel, 4 ft. by 20 ft., with ⅜-inch holes, new 70-ft. stacker with a 24-inch belt, a new 10-inch pump have been installed. The wooden hull of the dredge is 80 ft. by 30 ft by 6 ft. Power is furnished by a 70-hp. oil-engine, burning stove oil. Buckets are of 3-cu. ft. capacity.

Bibl: State Mineralogist's Report XXIX, p. 61.

Trinity Dredging Company has operated a dredge for many years in Sec. 5, 6, 7, and others, T. 33 and 34 N., R. 8 W., four miles north of Lewiston, Trinity County. Miss Mary Smith of Lewiston is president and Chas. R. Harris is dredge master. The bucket-line of this dredge carries 42 buckets of 11-cu. ft. capacity and 42 links of the same length as a bucket. When the bucket-line is heavily loaded, these links carry about 2 cu. ft. each. Nine buckets are dumped per minute. Gravel is washed in a trommel with 6-inch and 8-inch holes. Oversize, up to 4 ft. in diameter, is dumped over the side through chutes. Undersize goes through the holes in the trommel to a sluice 125 ft. long, 4 ft. wide and 2 ft. deep. The lower part of the sluice, 110 ft. long, is carried on a scow behind the dredge. Separate drums are provided on the winch to swing the sluice for proper distribution of tailing, which is deposited so that the surface is left nearly level. Riffles are made of 2-inch by 3-inch steel angles with 2-inch face up and 3-inch face vertical. Spacing between angles is 2 inches. The tops are protected with manganese-steel castings, one inch thick, made with bars two inches wide alternating with two-inch openings. The castings are in sections 4 ft. square. Some of these assembled riffle sections, 4 ft. square, are placed with the bars lengthwise of the sluice, but most of them are placed crosswise. The hull of the dredge is 110 ft. long, 50 ft. wide and 7 ft. deep, and draws about 5½ ft. of water. It is provided with two steel spuds of 25 tons each.

List of motors, all taking power from lines of the Pacific Gas and Electric Co. at 2200 volts, follows: 150-hp. digging motor geared to line with herringbone gears, no belt; 52-hp. winch motor driving 10-drum winch; 100-hp. on 16-inch centrifugal pump; 35 hp. on 6-inch centrifugal pump; 25-hp. on trommel; 25-hp. on compressor and other

shop tools; 50-hp. on shore pump needed at times to keep the pond full of water.

Bibl: State Mineralogist's Reports XIV, p. 919; XVIII, pp. 601, 734-35; XXII, pp. 59, 62; Prelim Rep. No. 8, p. 18; Bull. 36, p. 104; Bull. 92, p. 95; XXIX, pp. 70-71. U. S. G. S. Bull. 540, p. 20.

Viking Dredging Co. was incorporated late in 1937 by Irving N. Benson, David W. Hinds, Carl V. Needham, all of Redding; and E. B. Noble of Red Bluff. A dragline dredge was to be installed at the confluence of Redding Creek and Trinity River, Sec. 12, T. 32 N., R. 10 W., near Douglas City.

Weaver Dredging Co., R. C. Dempster, Redding, and Oscar R. Batham, Weaverville, is mining a part of Weaver Creek just above Douglas City, Sec. 1, T. 32 N., R. 10 W. A dragline shovel of $2\frac{1}{2}$-cu. yd. size is used and a Bodinson washing plant with diesel power. The main channel of Weaver Creek was worked by early-day placer miners by hand. Later considerable tailing from hydraulic mines was deposited in the channel. This material is being reworked by the dragline dredge together with some virgin bars along the sides. Bedrock is schist, and varies from a soft, decomposed variety to hard rock that stands up in ribs, adding to the difficulty of digging.

Wyandotte Gold Dredging Company, which pioneered dragline dredging in the Oroville district, Butte County, also built the first outfit to serve an electric shovel with a 3-cu. yd. bucket in the Redding district. The washing plant was of Bodinson make built on steel pontoons. It was installed on Churn Creek near Enterprise, Sec. 17, T. 31 N., R. 4 W. Operations were conducted here for only a short time, then the outfit was sold to Carlson & Sandburg, who moved it to Clear Creek, Sec. 31, T. 31 N., R. 5 W. Persons associated with Wyandotte also installed the outfit now operated by Hayfork Gold Dredging Company.

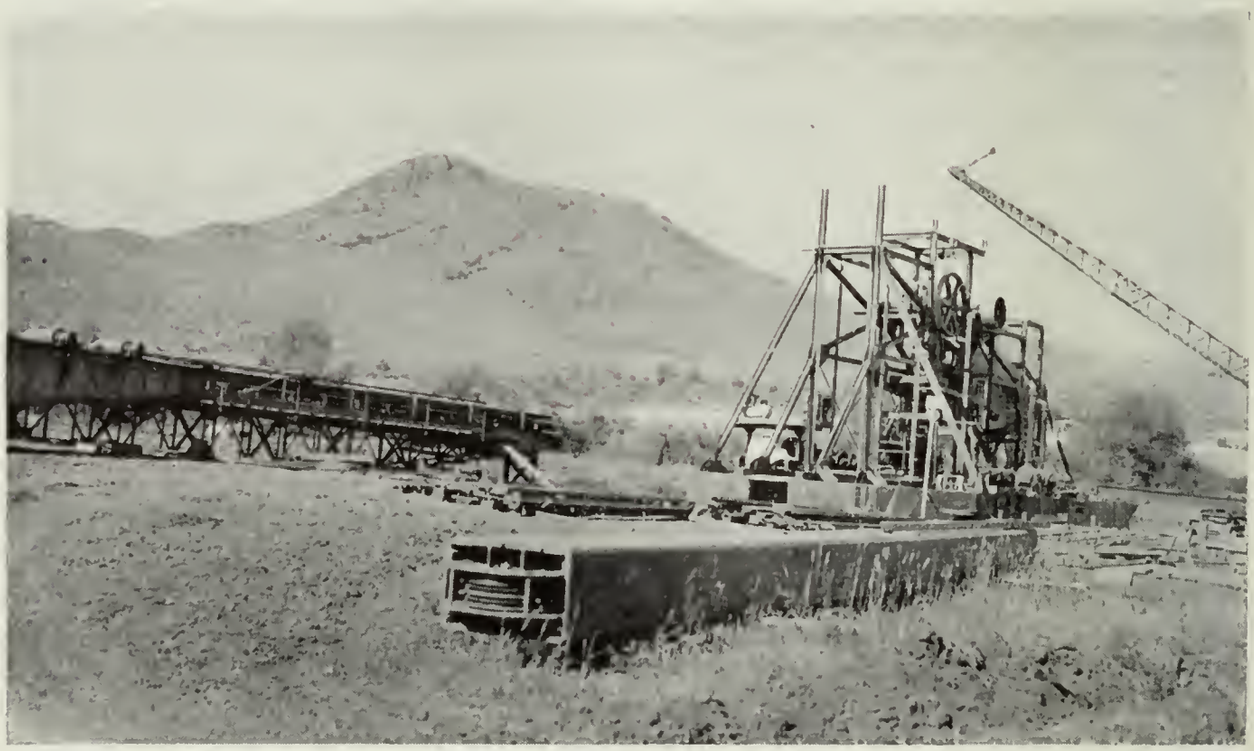
Bibl: State Mineralogist's Report XXXII, pp. 374-375.

Yreka Gold Dredging Company built a new dredge in 1937 to work in Sec. 14, T. 45 N., R. 7 W., and adjoining sections along two miles of Yreka Creek just north of Yreka. Ethredge Walker is president and Albert Schubach is secretary, Balfour Building, San Francisco. Eric Peterson is dredge-master at Yreka. The dredge was built by Walter W. Johnson Co., Balfour Building, San Francisco, and the following details are furnished through the courtesy of that company.

The hull is approximately 82 ft. by 42 ft. by 7 ft., and is made of 19 pontoons about 20 ft. by 10 ft. by 7 ft., weighing 6 tons to 7 tons each. Exposed walls are made of $\frac{9}{16}$-inch steel and inside walls adjacent to other pontoons are of $\frac{3}{16}$-inch steel. The pontoons and all structural parts, the digging and stacking ladders, frame for revolving screen, distributors, and 10-ton spud are of electric-welded construction, which has proved very satisfactory.

The bucket-line carries buckets of 6 cu. ft. capacity each, to dig to a depth of 25 ft. Buckets are of the new rivetless-lip, bowl-shaped design, and are made of manganese steel by American Manganese Steel Co., Oakland. Lower tumbler is made of manganese steel and

PHOTOGRAPH 13. Steel hull of dredge of Yreka Gold Dredging Co.



PHOTOGRAPH 14. Dredge under construction. Yreka Gold Dredging Co.

is round; upper tumbler is of high-carbon steel, six-sided, and cast integral with shaft. The hopper-chute is lined with manganese steel bars. A special feature of this is a removable back plate for discharging boulders too large for the revolving screen. The boulders are dumped, without stopping the bucket-line, on a fork made of heavy bars. These are swung by a heavy shaft operated by a compressed-air cylinder to dump the boulder into a steel-lined chute which discharges into the pond. Dumping is regulated by a gate in the chute, so that the boulder can be placed in some part of the pond where it will be out of the way.

The revolving screen is 34 ft. long by 6 ft. in diameter, and is lined with manganese steel plates. Perforations are $\frac{3}{8}$-inch to $\frac{1}{2}$-inch and $\frac{5}{8}$-inch to $\frac{3}{4}$-inch in the sections of screen except the last, which has $\frac{3}{4}$-inch by $\frac{1}{2}$-inch slots for recovery of nuggets. Several feet at each end of the screen are not perforated. Undersize from the screen is treated on 1600 sq. ft. of riffle-tables. Riffles are of angle-iron, $1\frac{3}{16}$ inches by $1\frac{3}{16}$ inches spaced at 1 inch; also of wood, some shod with steel, some with rubber. They are $1\frac{3}{16}$ inches deep spaced at 1 inch. Oversize from the screen is stacked by a stacker 90 ft. long carrying a 36-inch American Rubber Co. rib-stacker belt.

Water is pumped from the pond by Byron Jackson pumps of 82% efficiency. The 10-inch high-pressure pump furnishes 3200 gallons per minute at 65-ft. head to the revolving screen. The 8-inch low-pressure pump furnishes 1800 gpm. to the riffle-tables. A 4-inch pump is provided for cleanups, washing decks, and fire-protection.

The winch is a combination ladder-hoist, swing-line and spud-line winch controlled entirely by compressed air. This method of control adds to the efficiency of the dredge. A two-speed, specially designed motor delivers 55 hp. at 1200 rpm. or 35 hp. at 600 rpm. At the higher speed, it provides ample power for raising the digging-ladder, raising the spud, and swinging the dredge when stepping ahead. The low speed is used for swinging during regular digging.

Other electric motors are as follows: 100-hp. variable-speed on the bucket-line, 60-hp. on the high-pressure pump, 15-hp. on the low-pressure pump, 40-hp. with reduction gearing on the revolving screen, 25-hp. with reduction gearing on the stacker, and 3-hp. on the fire-pump. Power is transmitted by the bucket-line and winch motors to the driven pulleys with multiple V-belt drives.

Power is taken on the dredge at 2400 volts and is stepped down by three 100-kva. transformers to 440 volts. A 5-kva. transformer is provided for lights.

The dredge is operated 24 hours per day by one dredge-master, three winchmen, three oilers, two shore-men, one tractor driver, and one cleanup man. The direct operating cost is 4.3 cents per cubic yard to which should be added $\frac{1}{2}$ cent per yard for management and shipment of bullion. No depreciation, no land-cost and no royalty are included. The capacity at Yreka is 140,000 cu. yd. to 150,000 cu. yd. per month. The same dredge would handle 210,000 cu. yd. in easier ground. It cost approximately $160,000 including some miscellaneous pumping equipment for pumping muddy water out of the pond, but not including the 55-hp. Caterpillar tractor with diesel engine and bulldozer.

PHOTOGRAPH 15. Yuba Consolidated Gold Fields, Callahan, Siskiyou County.

Yuba Consolidated Gold Fields built a new dredge near Callahan, Siskiyou County, in 1936, in Sec. 8, T. 40 N., R. 8 W. From a point near the confluence of Wildcat Creek and Scott River, it will work for several miles up the river. F. C. Van Deinse, 351 California Street, San Francisco, is vice-president and general manager. H. C. Perring is field-superintendent.

The dredge is No. 116 of Yuba Manufacturing Co., and is built on a steel hull not of the pontoon type, 122 ft. 8 inches by 56 ft. by 10 ft. It will now dig to a depth of 35 ft. below water line, but is designed so that extensions can be put on both the hull and the digging-ladder; and it will then dig to a depth of 50 ft. or 60 ft. To cope with very difficult digging, this dredge was equipped with machinery of sizes ordinarily used on dredges with 18-cu. ft. buckets, while its buckets are of 9-cu. ft. size. Concentric ladder suspension is used, that is the ladder and the bucket-chain turn on the same axis.

Gravel is screened in a trommel 8 ft. in diameter by 48 ft. long, of which 34 ft. are perforated with $\frac{1}{2}$-inch to $\frac{5}{8}$-inch and $\frac{3}{8}$-inch to $\frac{1}{2}$-inch holes. It turns at 7 rpm. The trommel is lined with $\frac{3}{4}$-inch plates of "abrasion resisting steel," a high-carbon, high-manganese steel supplied by United States Steel Corporation. It costs more per pound than ordinary steels but less per cubic yard dredged. Undersize from the trommel is treated on 3500 square feet of riffle-tables in a double-deck arrangement. They are provided with wooden riffles shod with steel. For washing, 10,000 gallons per minute of water are pumped from the pond. The total connected load is 750 hp., which includes an extra-heavy digging motor about midway in size between those customarily used in 18-cu. ft. dredges and 9-cu. ft. dredges.

The dredge is operated for 24 hours per day by a total crew of 24 men including a man in the office. The actual capacity is 210,000 cu. yd. per month in ground that is hard to dig.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

NEW STATE GEOLOGIC MAP—METHOD OF MOUNTING

The new State Geologic Map of California is now being printed, and will soon be ready for distribution. The colored proof has already been received in the office of the Division of Mines, and has been inspected by many persons interested, all of whom seem highly pleased with results.

The map consists of six sheets arranged according to the accompanying diagram. Each sheet is about 32″ x 42″, and overlaps by a few inches its adjoining sheets. Although Sheet IV contains the complete master legend with explanations of the different patterns and symbols illustrating the geologic formations, a more condensed legend is repeated along the outside margin of each of the other separate sheets. In mounting the group, condensed marginal legends would be cut off.

The six sheets of the geologic map are so printed that they may be mounted all together as a wall map. When thus assembled, they form a map $6\frac{1}{2}'$ wide by $7\frac{1}{2}'$ long. To those who wish to mount the map in such a manner, the procedure followed recently by the Division of Mines is recommended:

A piece of smooth, inexpensive congoleum rug, large enough to accommodate the entire map, was mounted on a broad table made for the purpose. and waxed. Inexpensive, 81-inch sheeting was soaked in water overnight, then stretched tightly over this table top and tacked around the edge. Ordinary boiled paste such as that employed for wall-paper was applied to the cloth. To insure evenness and absence of lumps, the whole paste-covered, stretched cloth was scraped with a straight-edge. Before mounting the map, the six sheets were immersed in water for a few minutes. It was found advisable to mount Sheet II and V before adding Sheets I and IV, III and VI. Since the edges of the sheets overlap, the one overlapping was cut in such a manner that lettering and crowded drafting was avoided. Thus, where the paper was plain, a straight line was cut; but where the map was intricately colored, a curved line was cut and better registration was made of the upper sheet on the one underlying it. In pressing the map down to the cloth, a rubber roller or squeegee, such as used by photographers, was employed; although a dry soft cloth rubbed by hand would have been satisfactory. The drying of this mounted map required several days. The upper and lower edges of the map were fastened on sticks or rollers to hang on the wall. The roller was made by slipping the edge of the map between two half-round mouldings and nailing the two together.

For use in travel, it is recommended that the six sheets be cut, each into 16 rectangles, and each set pasted on cloth in the same manner as above described, excepting that a space of at least $\frac{1}{4}''$ should be left between the cut pieces. It is not advisable to assemble the whole map when mounting in this manner for field use. The map thus prepared may be folded so that the part in use is left exposed for reference.

Since the principal roads, both highways and by-ways, are shown on this geologic map in addition to the geologic formations, the traveler will find that the map, mounted-to-fold for field use will be his constant companion.

The geologic formations, which are shown in many varied colors and patterns grouped in some 80 units, are outlined in black and each outlined formation also contains a significant letter-symbol corresponding to that shown in the geologic legend. There is a more or less standardized system of colors and symbols used by the U. S. Geological Survey and other organizations in the publication of geologic maps, and the Geologic Map of California has digressed very little from those standards. In the margins of the map, which are quite ample in size, various explanatory and index maps are shown.

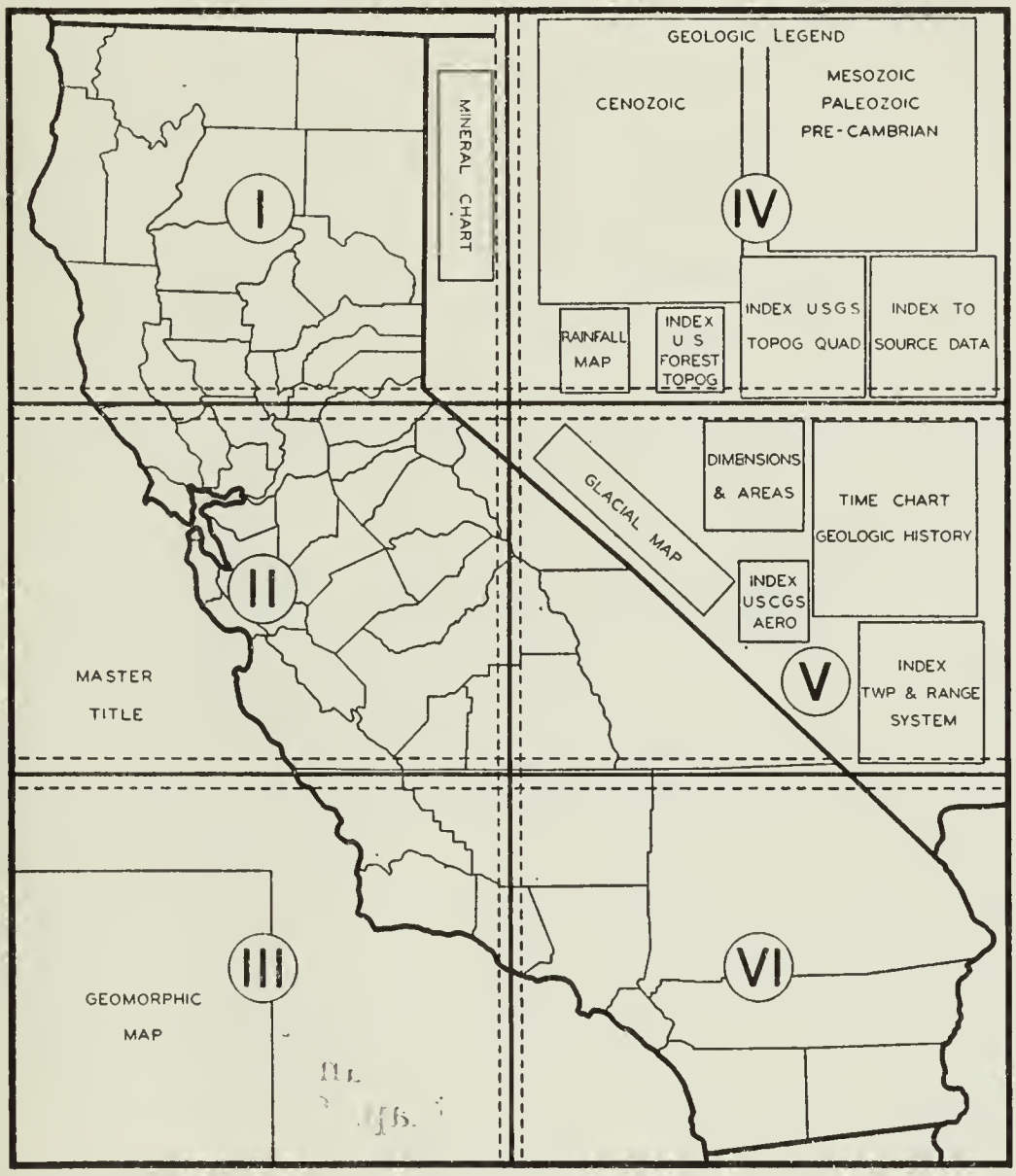
The index map showing the principal sources of geologic data with a list of names of contributors and an index to the areas they have mapped, is especially valuable as a guide to one who wishes to know the original source on which the compilation is based. Index maps to various topographic sheets, a chart showing mineral products of California by counties, a map showing the township and range system of California, another indicating the dimensions of the state and the size of its counties, all serve as useful guides.

In addition to these things, there is an outline map of the Sierra Nevada showing the distribution of the vanished Pleistocene glaciers. On Sheet III there is a Geomorphic Map, 20″ x 21″, which shows by brown contour lines the surface relief and by blue contour lines the submarine configuration; it is interesting to note that deeper canyons are to be found in the bottom of the sea than on the surface of the land.

The great earthquake fault lines which are shown in black on the body of the map are repeated in red on this little geomorphic map. Eleven major natural divisions or *geomorphic provinces* of the state are outlined by colored dotted lines. These provinces are: the Great Valley of California; the Sierra Nevada; the Cascade Range; the Modoc Plateau; the Klamath Mountains; the Coast Ranges; the Transverse Ranges; the Peninsular Ranges; the Colorado Desert; the Mojave Desert; and the Basin-Ranges. Descriptive material concerning each of these distinctive provinces is printed in the border of this geomorphic map.

Another chart which is placed on Sheet V is entitled "Looking Back in Geologic Time." It is a block diagram, drawn to indicate that one is looking far into the distance, as down a railroad track. The major geologic periods are scaled off in terms of hundreds of millions of years, but diminishing in the distance as by perspective. In this chart, opposite each geologic period, is briefly summarized the salient geologic events which are known from geologic evidence to have happened in California during that period.

The map not only serves as a guide to travel, but is in itself a condensed text to the geology of the state. It is by no means complete nor the last word in accuracy of detail, but it represents much careful study and hard work and should form a background for regional investigation and for further research.



Index to arrangement of the six sheets of the new Geologic Map of California.

Scale 1:500,000.

GEOLOGY OF THE CENTRAL SANTA MONICA MOUNTAINS, LOS ANGELES COUNTY

By E. K. Soper *

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ABSTRACT

The central part of the Santa Monica Mountains described herein lies just west of the area described in Professional Paper 165-C of the United States Geological Survey, and includes all of the Las Flores and Dry Canyon quadrangles, and the western part of the Topanga Canyon quadrangle. The topographic relief of this area is considerably higher than in the eastern half of the Santa Monica Mountains, although the

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highest points in the range are found still farther west. The elevations of the central area vary from about 1000 feet to about 3000 feet. Remnants of at least two well-marked elevated marine terraces occur along the coastal belt. The larger canyons on the south or seaward slope of the mountains show a steepening and narrowing of the lower canyon walls. This suggests fairly recent rejuvenation which possibly may be related to the terrace development.

The rock formations exposed in the area include the following: Chico and Martinez formations undivided (Upper Cretaceous and Paleocene) 4900-7500 feet thick; Sespe formation (non-marine; Eocene to lower Miocene), 1600-3275 feet thick; Vaqueros and Topanga formations undivided (lower and middle Miocene), 12000 ± feet thick; Modelo formation (upper Miocene), 4600 feet thick; Pleistocene terrace deposits (marine and non-marine), 25-50 feet thick; and Recent alluvium. The Topanga formation of middle Miocene age contains about 4000 feet of intrusive and extrusive basalt and volcanic breccia or agglomerate with some intercalated sandstone and shale beds. All pre-Topanga sediments contain numerous basalt dikes and intrusive sheets, and irregular intrusive masses. The post Topanga formations do not contain igneous rocks in this area. No Santa Monica slate or granite, so prominent in the eastern end of the Santa Monica Mountains, outcrops in the central or western parts of the range.

Fossils were collected in all formations except the Sespe. The best preserved and most numerous fossil fauna occur in the lower part of the Topanga formation. Although a careful search was made, no vertebrate fossils were found in the non-marine Sespe beds.

A noteworthy feature of the stratigraphy of the western and central part of the Santa Monica Mountains is the rapid thinning eastward (shoreward) of the marine Vaqueros formation in marked contrast with the non-marine Sespe formation which becomes thinner toward the west, or basinward.

The anticlinal structure clearly apparent in the eastern part of the Santa Monica range becomes less evident in the central and western parts, where faulting, cross-folding, and igneous intrusions and extrusions have largely obscured all evidence of a major fold. The structure in the central area is essentially a north-dipping monocline upon which a north-plunging anticline and two north-plunging synclines have been superimposed. The apparent monoclinal structure of the central part of the range may represent the north flank of the westward continuation of the large anticline which forms the eastern end of the range, the axial line of which may be submerged beneath the Pacific Ocean toward the west. Along the coast an important east-west trending fault (Malibu Coast fault) separates the older formations on the north from a down-dropped block of Modelo formation on the south. This feature suggests that the central and western parts of the Santa Monica Mountains may represent only the north flank of an intricately faulted and invaded anticlinal structure, the faulted axis of which is now submerged off-shore. There is some evidence that the Modelo formation once covered the entire area, although only remnants now remain.

The earliest deformation of which there is a definite record in the central part of the range occurred in pre-Topanga time, and is represented by the total absence of any marine Eocene and Oligocene strata. In post-Topanga and pre-Modelo time the area was again affected by

important diastrophic deformations recorded in the sharp angular unconformity between the Topanga and Modelo formations. This deformation was preceded or accompanied by a sequence of basalt flows on the sea floor, and also by much faulting of the Topanga and pre-Topanga formations. In post-Miocene time and again in post Pliocene time the area was affected by folding, faulting, and uplift. These disturbances continued intermittently until late Pleistocene time as evidenced by the elevated wave-cut platforms covered with marine Pleistocene debris.

Four test wells have been drilled for oil within the area of the Dry Canyon quadrangle but without success. Several additional test-wells have been drilled for oil short distances beyond the borders of the area, all without success. The only closed structure in the area is the Topanga anticline in the southeast part of the Dry Canyon quadrangle, where a domed closure on the fold brings the Sespe formation to the surface. However, the oil possibilities of this structure are not regarded as promising since the drilling of a well on the crest of the dome by the Standard Oil Company of California. This test-well was drilled through the Sespe into the Martinez beds without finding oil. There is a slight possibility of the existence of a closed structure in the Modelo formation along the narrow coastal belt at Malibu Beach near the mouth of Malibu Creek.

INTRODUCTION

LOCATION AND SIZE OF AREA

The area described in this report is located in the central part of the Santa Monica Mountains, Los Angeles County, California, about 30 miles northwest of the central part of the City of Los Angeles, and includes about 60 square miles of mountainous terrane embracing all of the Las Flores and Dry Canyon quadrangles and the southwestern part of the Topanga Canyon quadrangle of the United States Geological Survey. The area lies immediately west of the Topanga Canyon and Reseda quadrangles, the geology of which is described in U. S. Geological Survey Professional Paper 165-C by H. W. Hoots,[1] published in 1931. The Las Flores quadrangle is located along the coast in the southern part of the area; and the Dry Canyon quadrangle, which lies to the north, includes a small area in the extreme western end of the San Fernando Valley. These two quadrangles comprise a north-south strip of country about five and three-quarters miles wide, extending from the Pacific Ocean on the south to San Fernando Valley on the north. Together, they give a cross-section more or less typical of the central part of the Santa Monica Range.

Several wells have been drilled in this area in an attempt to discover oil, but without success. Notwithstanding the unfavorable results of drilling, it is hoped that the data concerning the structure and stratigraphy of the region may be of some value in future geological studies of neighboring areas in which oil possibilities may be more promising.

PREVIOUS GEOLOGIC INVESTIGATIONS

The earliest published records of the geology of the Santa Monica Mountains were those of W. P. Blake,[2] Thomas Antisell,[3] J. D. Whitney,[4] and Jules Marcou.[5] These brief descriptions all referred to areas far to the east of the portion of the Santa Monica Range herein described.

In 1914 the California State Mining Bureau [6] published a report and geologic atlas on the petroleum industry of California, in which a geologic map of the eastern portion of the Santa Monica Mountains was included. This map, however, did not extend as far west as the region described in the present paper.

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[1] Hoots, H. W., Geology of the eastern part of the Santa Monica Mountains, Los Angeles County, California: U. S. Geol. Survey Prof. Paper 165-C, 1931.

[2] Blake, W. P., U. S. Pacific R. R. explorations, vol. 5, pp. 73-76, 1856.

[3] Antisell, Thomas, U. S. Pacific R. R. explorations, vol. 7, pp. 76-73, 1857.

[4] Whitney, J. D., Geological survey of California, Geol., vol. 1, pp. 168-171, 1865.

[5] Marcou, Jules, Report on the geology of southern California: U. S. Geog. Surveys, W. 100th meridian, Ann. Rept. for 1876, pp. 157-160, 1876.

[6] McLaughlin, R. P., and Waring, C. A., Petroleum industry of California: Cal. St. Min. Bur. Bull. 69, Atlas, Pl. 11, 1914.

In 1917, C. A. Waring[7] published a paper with a small-scale geological reconnaissance map showing a portion of the central Santa Monica Mountains east and west of Topanga Canyon.

The United States Geological Survey published a report in 1924, by W. S. W. Kew,[8] on the geology and oil resources of parts of Los Angeles and Ventura Counties. This report, which contains a large geologic map showing a part of the Santa Monica Mountains, was the first detailed description of this region to be published.

The most detailed geologic report and map of the eastern part of the Santa Monica Mountains that has been published is the one by H. W. Hoots,[9] issued in 1931 as a part of Professional Paper 165 of the U. S. Geological Survey. Hoots' report and map (W. S. W. Kew collaborated in the geological mapping) include all of the range lying to the east of the Las Flores and Dry Canyon quadrangles except a narrow strip along the west edge of the Topanga Canyon quadrangle.

In 1932 the International Geological Congress (XVI Session) issued a guide-book to the geology of southern California, prepared under the direction of Hoyt S. Gale.[10] One of the small-scale geologic maps accompanying this publication includes the extreme western end of the Santa Monica Mountains, but the geology of the area described in the present report is not shown on the guide-book maps.

R. D. Reed [11] and J. S. Hollister published a generalized tectonic map of southern California that shows in a generalized way the distribution of the rock series present in the Santa Monica Mountains, as well as some of the larger tectonic features of the range. In 1934 the writer, with U. S. Grant,[12] prepared a short paper containing a summary of the stratigraphy and structure of the Las Flores and Dry Canyon quadrangles.

Other references to the geology of the Santa Monica Mountains could be cited, but none of them include the central portion of the range described in the present paper.

FIELD WORK AND ACKNOWLEDGMENTS

The geology of a large part of the area now included in the Dry Canyon quadrangle was mapped in 1917-1922 was W. S. W. Kew, C. M. Wagner, W. A. English, and J. P. Buwalda. This geologic map, drawn to a scale 1/62500 (approximately one mile to the inch) and the accompanying report by W. S. W. Kew [13] were published by the U. S. Geological Survey in 1924 as Bulletin 753.

The rocks along the north edge of the Santa Monica Mountains, mapped at that time as belonging to the Pico formation (Pliocene), are now considered to represent the upper part of the Modelo forma-

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[7] Waring, C. A., Stratigraphic and faunal relations of the Martinez to the Chico and the Tejon of southern California: Cal. Acad. Sci., Proc., 4th ser., vol. 7, No. 4, pp. 51-57, fig. 3, 1917.

[8] Kew, W. S. W., Geology and oil resources of a part of Los Angeles and Ventura Counties, California: U. S. Geol. Survey Bull. 753, 1924.

[9] Hoots, H. W., *op. cit.*

[10] Gale, Hoyt S., Guidebook 15, Excursion C-1, Internat. Geol. Cong. (XVI Session), Pl. 11, 1932.

[11] Reed, R. D., and Hollister, J. S., Structural evolution of southern California: Bull. Amer. Assoc. Pet. Geol., vol. 20, No. 12, Pl. 1, Dec., 1935.

[12] Soper, E. K., and Grant, U. S., Stratigraphy of a part of the western Santa Monica Mountains, California: Proc. Geol. Soc. of Am. for 1934, pp. 310-311 (Abst.).

[13] Kew, W. S. W., *op. cit.*

tion (upper Miocene). East of Calabasas Peak, at the southern edge of the area shown on the geologic map accompanying Kew's report, there is shown the northern end of an important anticlinal structure (Topanga anticline) which is of special interest, and the full extent of which until now has not been shown on any published map.

In 1927-29 the United States Geological Survey, in cooperation with the County of Los Angeles, re-surveyed the topography of that part of the Santa Monica Mountains lying within Los Angeles County, and new topographic maps of the area were published in 1932 on a scale of 1/24000 (2000 ft. to the inch). Because of the revisions in the age determinations of the rocks originally mapped as Pliocene, and in order to show clearly the structure of the Topanga anticline which in the past had been considered to possess some oil possibilities, it was thought desirable to map the geology of the entire Dry Canyon quadrangle on the larger scale base maps now available, rather than to show only the geology of the southern part of the quadrangle south of the area described by Kew.[14]

The paleontologic work on the identification of the fossils collected in the area was done by Dr. U. S. Grant, Associate Professor of Geology at the University of California at Los Angeles, who has given his conclusions in the following pages. Dr. Grant was assisted by Ernest H. Quayle in the identification of the fossils. Dr. Grant also collaborated in part of the geological mapping. Mr. W. D. Rankin contributed several determinations of foraminifera from samples collected by the writer from the Modelo formation. The following former students in the geology department at the University of California at Los Angeles assisted at various times in the field work: Messrs. C. E. Abel, L. A. Braden, Roland Olson, H. B. Page, and E. S. Pickett. Credit should be given to Russel R. Simonson for pebble counts and mechanical analyses of Sespe and Topanga conglomerates and sandstones, and for data concerning the various rock types represented in these formations.

The writer also wishes to express his appreciation to Mr. T. R. Cadwalader, Trustee for the Marblehead Land Company, for permission to enter the lands of the Malibu Ranch, and to Mr. Wayne Loel for the loan of aerial photographs.

PHYSIOGRAPHY

The Santa Monica Mountains form an east-west range about 45 miles long extending from the Oxnard alluvial plain in Ventura County on the west to the Los Angeles River in Los Angeles County on the east. The chain of islands which lie to the south of the Santa Barbara Channel occur as summits along a westward continuation of the same uplift, much of which is now submerged. The width of the mountain mass varies from 10 to 15 miles. The elevations vary from about 1000 feet to about 3000 feet.

The central part of the Santa Monica Mountains exhibits greater topographic relief than the eastern end of the range, described by Hoots,[15] although the highest elevations in the range are found still

[14] Kew, W. S. W., *op. cit.*

[15] Hoots, H. W., *op. cit.*, pp. 129-130.

ILLUSTRATIONS AND TABLES TO ACCOMPANY REPORT BY E. K. SOPER ON SANTA MONICA MOUNTAINS

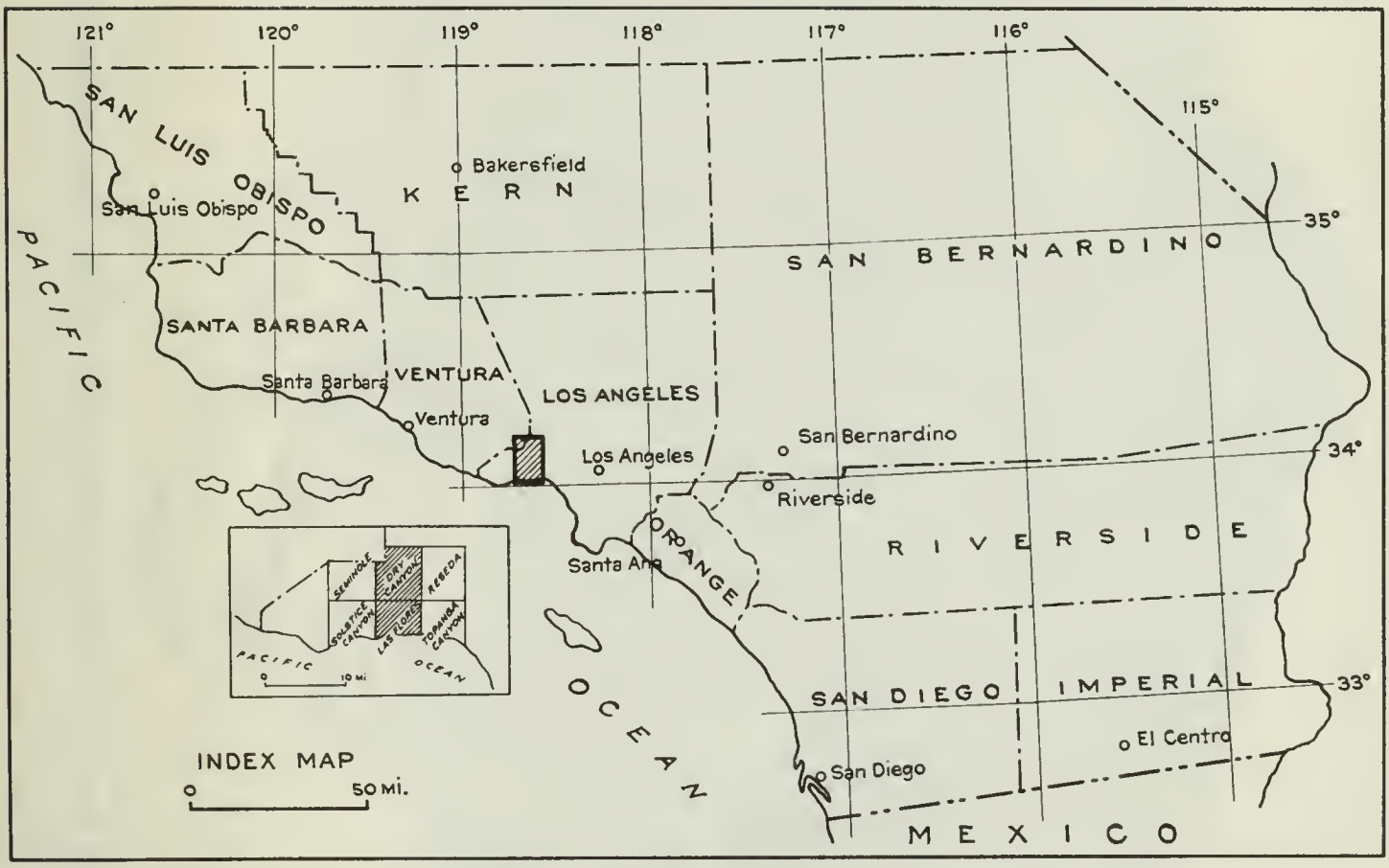

FIG. 1. Index map showing location of the Las Flores, Dry Canyon and Topanga Canyon quadrangles.

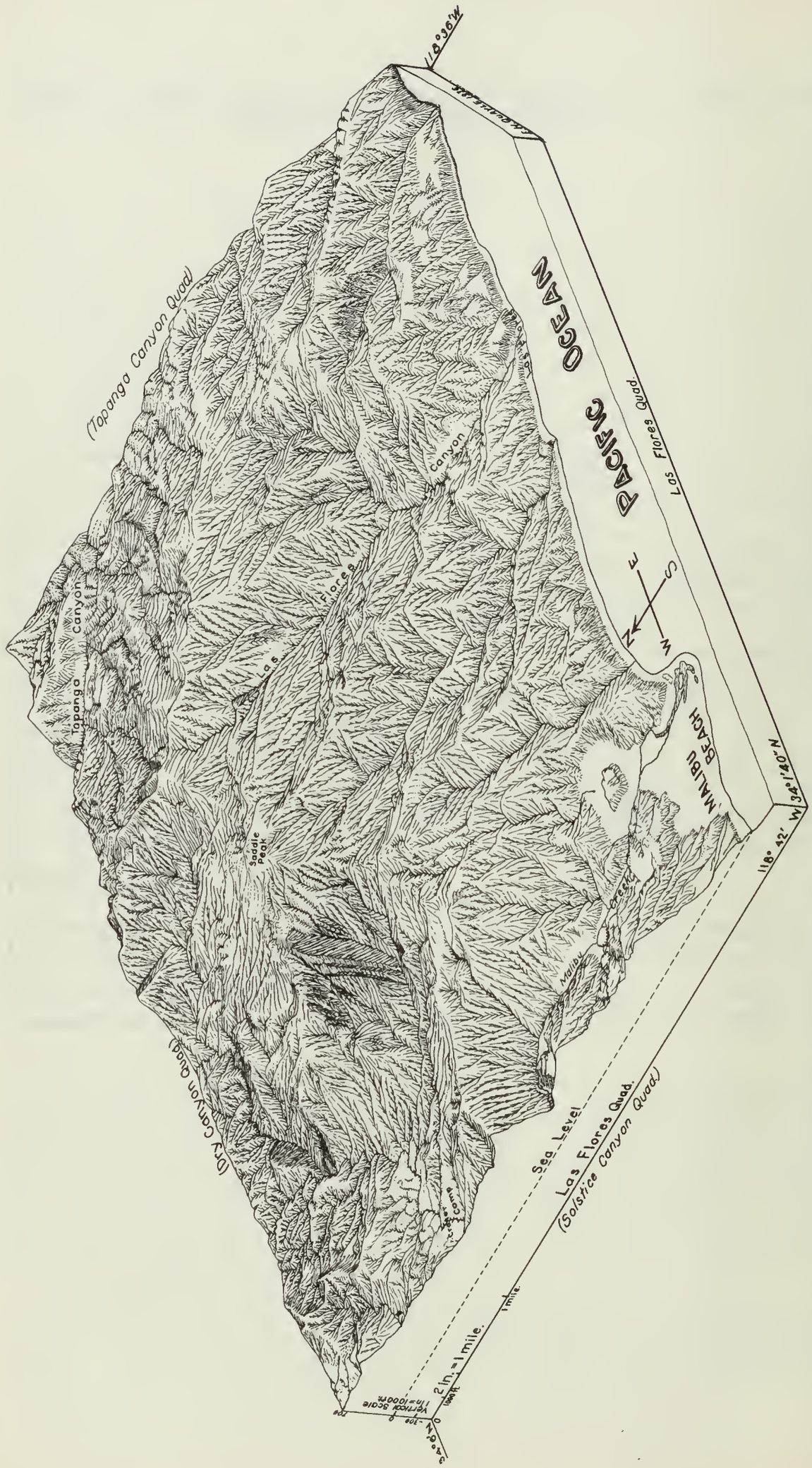

FIG. 2. Block diagram showing topography of the Las Flores quadrangle.

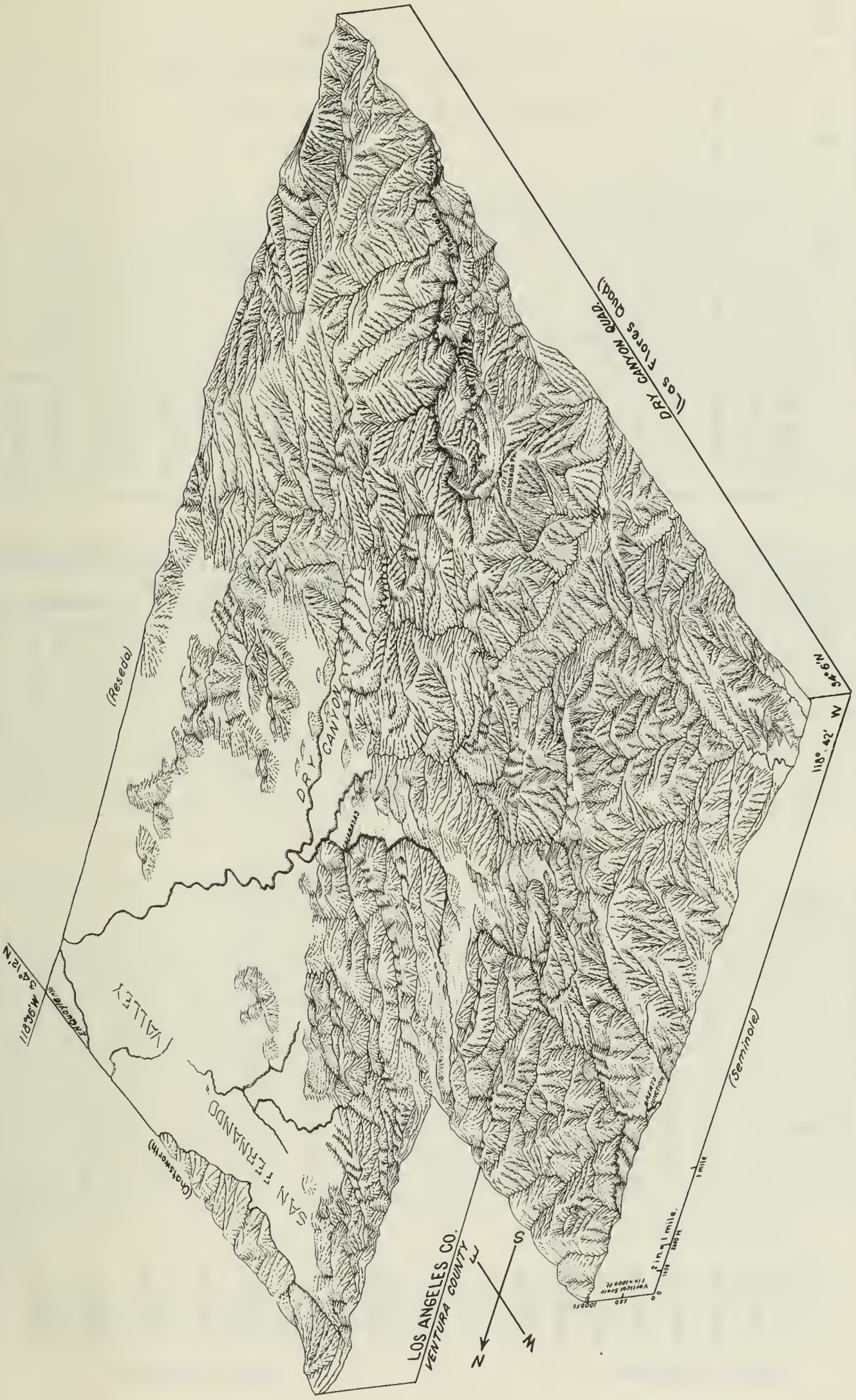

FIG. 3. Block diagram showing topography of the Dry Canyon quadrangle.

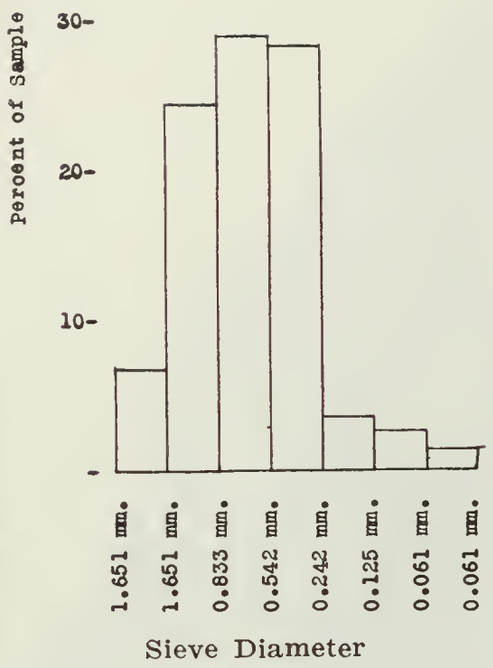

FIG. 4. Mechanical analysis of lower red Sespe sandstone from Red Rock Canyon, Dry Canyon quadrangle. (*Analysis by Russell R. Simonson.*)

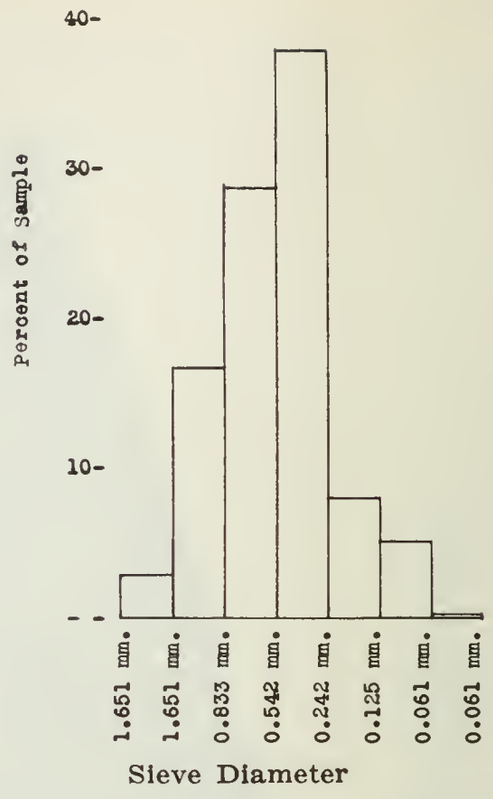

FIG. 5. Mechanical analysis of middle gray Sespe sandstone from Dry Canyon quadrangle. (*Analysis by Russell R. Simonson.*)

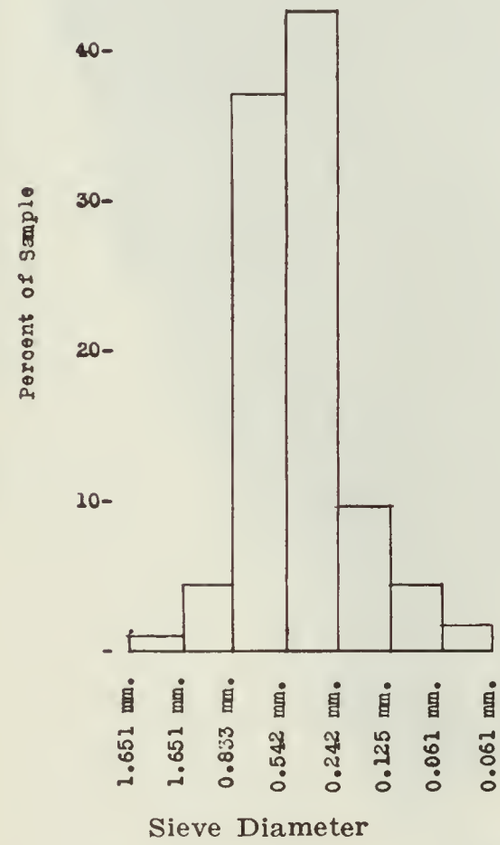

FIG. 6. Mechanical analysis of upper variegated Sespe sandstone from Dry Canyon quadrangle. (*Analysis by Russell R. Simonson.*)

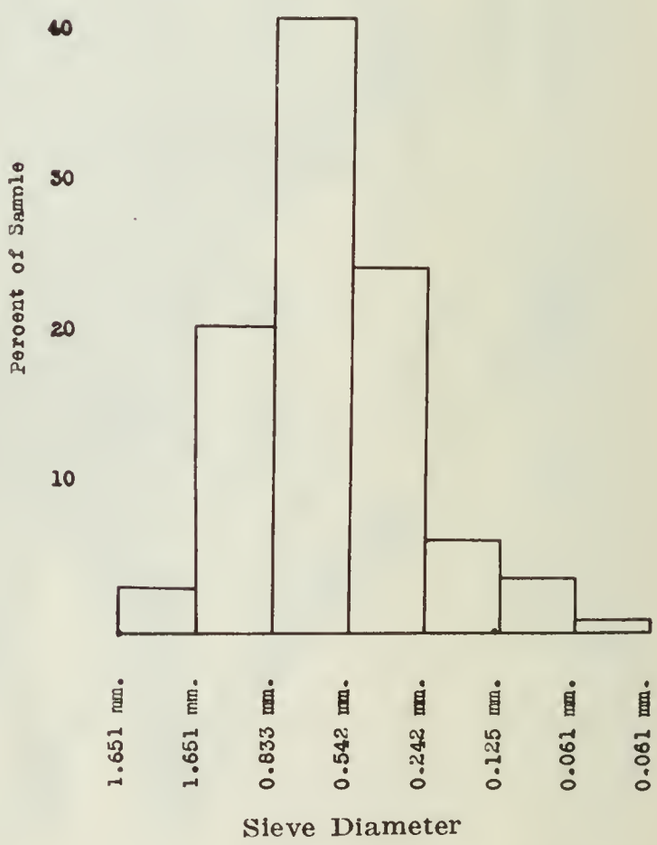

FIG. 7. Mechanical analysis of lower Topanga sandstone just above upper Sespe variegated member. (*Analysis by Russell R. Simonson.*)

Table I

Pebble Count of Lower Sespe Conglomerate

(Made by Russell R. Simonson)

	1-2	2-3	3-4	4-5	5-6	over 6	size	Total
VOLCANIC ROCKS								
MG 6 Dacite porphyry	2	2	1					5
SP 2 Meta-dacite porphyry	1	4		1	1			7
MG 1 Diabase porphyry	1	2		1				4
MG 4 Porphyrite								
SP 4 Meta-dacite	4	2	1		1	1		9
SP 5 Dacite	4	2	2	2				10
SP 6 Meta-dacite	3	3	2	1	2	1	7"	12
SP 7 Meta-rhyolite breccia	2	1		2				5
SP 8 Meta-rhyolite porphyry	2	3	2	2		1		10
LR 1 Meta-quartz latite	4	3	2	1	1			11
MG 3 Rhyolite porphyry	3		1					4
Andesites	2	2	2					6
Basic lavas	3	3	2		1	1	8"	10
								96
"GRANITES"								
SP 3 Epidote granite	3	2	2					7
MG 5 Quartz diorite	2	4	2			3	7"-9"-8"	11
SP 9 Tourmaline-quartz monzonite		1	1					2
SP 10 Gneissoid granite	4	6	4	3	1	3	7"-8"-8"	21
SP 11 Tourmaline-quartz diorite	1	2	1	1				5
MG 8 Quartz diorite	4	3		2		6	9"-1"	15
Garnetiferous granite gneiss				1				1
Diorite gneiss	3	3	2	1				9
Pegmatite	1	2						3
Aplite		2						2
								76
SEDIMENTS AND META-SEDIMENTS								
LR 3 Tourmaline quartzite		2				1	10"	3
SP 12 Quartzite	1	4	3	2				10
LR 2 Arkosic sandstone	2	2				2	9"-9"	6
MG 2 Quartzite	4	4	2	1				11
LR 4 Brecciated chert	1							1
LR 5 Serpentine quartzite		1	1	1				3
MG 7 Schistose quartzite	3	4	1					8
LR 9 Quartzite	1	1		1				3
LR 6 Organic chert		1	1					2
LR 8 Quartzite		2						2
SP g Mica schist			2					2
Tourmaline chert		1						1
Green schist	1							1
	62	73	38	23	7	19		53

(The numbers and letters at the left refer to the labels on the specimens and thin-sections now in the collection at the University of California at Los Angeles)

Table 2

Pebble Count of Upper Topanga Conglomerate

	Size of cobbles				TOTAL
	0-1	1-2	2-3	3-4	
VOLCANIC AND META-VOLCANIC					
MG 6 Dacite porphyry	4	4			8
SP 2 Meta-dacite porphyry	3	2	1		6
MG 1 Diabase porphyry		2			2
MG 4 Porphyrite		1	1		2
SP 4 Meta-dacite	1				1
SP 5 Dacite	4	3			7
SP 6 Meta-dacite	1	3			4
SP 7 Meta-rhyolite breccia	2	2			4
SP 8 Meta-rhyolite porphyry	2	2			4
LR 1 Meta-quartz latite	5	3		1	9
MG 3 Rhyolite porphyry	2	1			3
SP c Meta-quartz latite			1		1
Greenstone	4	4	3		11
					53
PLUTONICS					
SP 3 Epidote granite					
MG 5 Quartz diorite	4	1			5
SP 9 Tourmaline-quartz monzonite		1			1
SP 10 Gneissoid granite	4	3	2		9
SP 11 Tourmaline-quartz diorite	1				1
MG 8 Quartz diorite	2	1	1	1	5
Aplite			1		1
Pegmatite			1		1
					23
SEDIMENTS AND META-SEDIMENTS					
LR 3 Tourmaline quartzite	1				1
SP 12 Quartzite	4	1	1	1	7
LR 2 Arkosic sandstone					
MG 2 Quartzite	2	1	1		4
LR 4 Brecciated chert		1			1
LR 5 Serpentine quartzite	3	2			5
MG 7 Schistose quartzite	1	2			3
LR 9 Quartzite	2				2
LR 6 Organic chert	1	1			2
LR 8 Quartzite	1				1
Greenstone	2	1			3
(Muscovite) Mica schist		1			1
SP g Mica schist	1				1
	56	41	13	3	31

(The numbers and letters on the left refer to specimens that are now in the collection at the University of California at Los Angeles)

FOSSIL LOCALITIES IN THE LAS FLORES AND DRY CANYON QUADRANGLES, SANTA MONICA MOUNTAINS (1933-1935)

Macroscopic Fossils

U C L A Number	Number on Map (Plate I)	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L966	1	Hard gray sandstone at edge of hills 1600 ft. north of coast highway and due north of "M" in Malibu Beach, Las Flores quadrangle				X	
L967	2	Dark gray hard calcareous sandstone, weathering red-brown, 900 ft. east of west edge of Las Flores quadrangle and about 3800 ft. north of coast highway				X	
L968	3	Soft gray sandstone on point of ridge about 500 ft. west of Malibu Creek and about 3000 ft. north of coast highway, Las Flores quadrangle				X	
L969	4	Top of 687 ft. hill about 1000 ft. east of center of Sec. 29, Las Flores quadrangle					
L970	5	Near top of hill (triangulation station 636) about 1800 ft. north of coast highway and 1200 ft. west of longitude 118° 40'; Las Flores quadrangle. Hard brown to gray sandstone surrounded by basalt				X?	
L971	6	Hard dark-gray shale about 1100 ft. northeast of locality 5; Las Flores quadrangle				X?	
L972	7	About 1600 ft. west of the center of Sec. 29, Las Flores quadrangle			X?		
L973	8	About 1400 ft. northeast of the center of Sec. 29, Las Flores quadrangle					X
L974	9	Sandy shale and sandstone on west side of Malibu Canyon about 250 ft. east and 900 ft. south of the north west corner of Sec. 29, Las Flores quadrangle			X		
L975	10	Hard, gray to purplish colored sandstone on east edge of Malibu Creek about 650 ft. east and 350 ft. north of the southwest corner of Sec. 20, Las Flores quadrangle			X?		
L976	11	Gray to brown sandstone on west side of Malibu Canyon about on section line 1200 ft. north of the southwest corner of Sec. 20, Las Flores quadrangle			X		
L929	13	On ridge about 1500 ft. north of the north end of Malibu dam at Malibu Reservoir; Las Flores quadrangle					X
L927	14	At north side of trail about 1000 ft. southeast of the center of Sec. 20, Las Flores quadrangle					X

U C L A Locality No	Number on map	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L978	15	Sandstone on ridge at 2003 ft. hill about 300 ft. west and 1650 ft. north of the southeast corner of Sec. 20, Las Flores quadrangle				X	
L926	16	Coquina bed in pebbly sandstone on ridge about 500 ft. east of locality 15, Las Flores quadrangle				X	
L935	17	About 1300 ft. east and 1000 ft. south of the northwest corner of Sec. 21, Las Flores quadrangle				X	
L936	18	About 200 ft. south and 2700 ft. east of the northwest corner of Sec. 21, Las Flores quadrangle				X	
L934	19	About 500 ft. east and 2250 ft. north of the southwest corner of Sec. 16, Las Flores quadrangle				X	
L921	20	In embankment on south side of road about 2000 ft. east of Crater Camp, in Sec. 17, Las Flores quadrangle. Fragments of large oyster shells in lens of calcareous shale included in extrusive basalt				X?	
L922	21	Dark gray, hard shale in embankment on east side of road north of Monte Nido, about 1400 ft. west and 1800 ft. south of the northeast corner of Sec. 17, Las Flores quadrangle				X?	
L937	22	About 450 ft. north and 1800 ft. east of the southwest corner of Sec. 9, Las Flores quadrangle				X	
L928	23	On trail about 1700 ft. west and 2800 ft. south of the northeast corner of Sec. 20, Las Flores quadrangle				X	
L979	24	On ridge about 800 ft. south and 1300 ft. east of the southeast corner of Sec. 30				X?	
L924	25	Sandstone and sandy shale on ridge about 100 ft. north and 650 ft. west of the southeast corner of Sec. 16, Las Flores quadrangle				X	
L980	26	Sandstone at head of Carbon Canyon, about 800 ft. south and 700 ft. east of the northwest corner of Sec. 22, Las Flores canyon				X?	
L981	27	Sandstone on Saddle Peak road about 2350 ft. south and 550 ft. east of the northwest corner of Sec. 14, Las Flores quadrangle				X?	
L982	28	Sandstone on trail about 500 ft. north of Saddle Peak road and about 1650 ft. south and 1050 ft. east of the northwest corner of Sec. 14, Las Flores quadrangle				X?	
L983	29	Sandstone about 1750 ft. north and 2200 ft. east of the southwest corner of Sec. 11, and about 650 ft. southwest up the hillside from an old cabin, Las Flores quadrangle				X?	

U C L A Locality No	Number on map	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L984	30	Conglomerate and pebbly sandstone on point of ridge about 1100 ft. south of the north edge of Las Flores quadrangle and 1350 ft. east of the line between Secs. 11 and 12				X	
L985	31	Hard sandstone in bed of creek in Hondo Canyon about 900 ft. S 72° E from locality 30				X	
L344	32	Yellow-brown, fine-grained silty sandstone and sandy shale on private road about 300 ft. south and 1800 ft. east of the northwest corner of Sec. 13, Las Flores quadrangle				X	
L986	33	Sandstone on trail leading southward up ridge from road near locality 32, Sec. 13, Las Flores quadrangle				X	
L987	34	Sandstone at end of private road southeast of locality 32				X	
L988	35	Sandstone on ridge west of Fernwood about 1250 ft. north and 2200 ft. west of the southeast corner of Sec. 13, Las Flores quadrangle				X	
L989	36?						
L990	37	Brown sandstone, north of Tuna Canyon road, about 2600 ft. south and 2800 ft. west of the northeast corner of Sec. 24, Las Flores quadrangle				X	
L991	38	Light-brown sandstone on secondary road about 2300 ft. south and 1000 ft. east of the northwest corner of Sec. 19, Las Flores quadrangle				X	
L992	39	Soft, buff sandstone in road-cut at east edge of Las Flores quadrangle, about 1650 ft. south and 1600 ft. east of the northwest corner of Sec. 19				X	
L993	40	Hard brown sandstone and conglomerate in canyon at end of trail leading northeast from end of Las Flores Canyon road, N.E.$\frac{1}{4}$ Sec. 22, Las Flores quadrangle		X?			
L948	41	Fine-grained, yellowish to gray sandstone in embankment on west side of Las Flores Canyon road about 1900 ft. north and 1900 ft. west of the southeast corner of Sec. 22, Las Flores quadrangle		X			
L994	43	Brown, pebbly sandstone on point of ridge about 500 ft. north and 2150 ft. west of the southeast corner of Sec. 28, Las Flores quadrangle				X?	
L995	44	Hard brown calcareous sandstone with some limestone beds about 3000 ft. south and 2150 ft. east of the northwest corner of Sec. 27, Las Flores quadrangle		X			

U C L A Locality No	Number on map	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L993	45	Hard, brown, calcareous sandstone with some limestone beds a short distance west of private road about 500 ft. northeast of locality 44, Las Flores quadrangle		X			
L954	46	Hard, brown, calcareous sandstone with some limestone beds about 350 ft. southeast of center of Sec. 27, Las Flores quadrangle; between private road and trail leading up hillside to the north of road		X			
L996	47	Hard, brown, sandstone on private road about 3000 ft. south and 600 ft. west of the northeast corner of Sec. 27, Las Flores quadrangle		X?			
L997	48	On trail on east side of Las Flores Canyon about 2000 ft. south and 1500 ft. east of the northwest corner of Sec. 26, Las Flores quadrangle		X?			
L998	50	In small canyon about 350 ft. north of coast highway about 2300 ft. west of the mouth of Carbon Canyon, Las Flores quadrangle					X
L999	52	Calcareous shale and sandstone on trail up first small canyon east of mouth of Las Flores Canyon about 1450 ft. north of coast highway			X		
L1000	54	Sandstone and sandy shale on hillside about 200 ft. north of coast highway, about 2500 ft. west of curve in highway at "Big Rock", Las Flores quadrangle			X		
L1001	55	Sandstone and shale about 300 ft. east of locality 54, Las Flores quadrangle			X		
L1002	56	Brown, pebbly sandstone 900 ft. north of coast highway about 1500 ft. south and 500 ft. east of the southeast corner of Sec. 25, Las Flores quadrangle		X?			
L1003	57	Sandstone on trail about 900 ft. north and 500 ft. west of the southeast corner of Sec. 26, Las Flores quadrangle		X?			
L1004	58	Brown, silty sandstone on Tuna Canyon road embankment about 350 ft. north and 1250 ft. west of the southeast corner of Sec. 24, Las Flores quadrangle		X?			
L1005	59	Brown sandstone about 1000 ft. north of coast highway and about 2000 ft. south and 1100 ft. west of the northeast corner of Sec. 35, Las Flores quadrangle			X?		
L1006	60	Gray calcareous sandstone on old road about 1500 ft. north of coast highway and about 1500 ft. south and 2000 ft. east of the northwest corner of Sec. 36, Las Flores quadrangle		X?			

U C L A Locality No	Number on map	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L1007	61	Sandstone bed between two basalt flows about 400 ft. south and 2350 ft. east of the northwest corner of Sec. 8, Dry Canyon quadrangle, and about 850 ft. north of the south edge of the quadrangle				X	
L1008	62	Thin bed of hard, calcareous, sandstone associated with basalt, about 150 ft. north and 1550 ft. west of the southeast corner of Sec. 5, Dry Canyon quadrangle				X	
L1009	64	Sandstone about 200 ft. north and 2800 ft. east of the southwest corner of Sec. 3, Dry Canyon quadrangle				X	
L941	65	Sandstone bed between two basalt flows about 2000 ft. north and 100 ft. west of the southeast corner of Sec. 4, Dry Canyon quadrangle				X	
L942	66	Sandstone about 1800 ft. north and 2200 ft. west of the southeast corner of Sec. 3, Dry Canyon quadrangle				X	
L1010	68	Sandstone on section line about 1650 ft. west of the southeast corner of Sec. 34, Dry Canyon quadrangle				X	
L1011	69	Sandstone about 1500 ft. north and 2100 ft. east of the southwest corner of Sec. 34, Dry Canyon quadrangle				X	
L1012	70	Sandstone about 1300 ft. south of the center of Sec. 34, Dry Canyon quadrangle				X	
L1013	71	Sandstone about 100 ft. north and 700 ft. east of the southwest corner of Sec. 35, Dry Canyon quadrangle				X	
L1014	72	Sandstone about 150 ft. south and 1900 ft. east of the northwest corner of Sec. 2, Dry Canyon quadrangle				X	
L1015	73	Sandstone and sandy shale about 1250 ft. north and 650 ft. east of the southwest corner of Sec. 3, Dry Canyon quadrangle				X	
L1016	74	Sandstone on hill near edge of basalt about 1300 ft. south and 1100 ft. west of the northeast corner of Sec. 2, Dry Canyon quadrangle				X-	
L1017	75	Sandstone about 350 ft. southeast of locality 74				X	
L1018	76	Sandstone about 2350 ft. south and 350 ft. west of the northeast corner of Sec. 2, Dry Canyon quadrangle				X	
L1019	77	Sandstone on ridge about 500 ft. south and 1100 ft. west of the northeast corner of Sec. 6, Dry Canyon quadrangle				X	
L1020	78	Hard sandstone on hill about 800 ft. north and 100 ft. west of the southeast corner of Sec. 31, Dry Canyon quadrangle				X	

U C L A Locality No	Number on map	Description	Upper Cretaceous	Eocene (Martinez)	Vaqueros	Topanga	Modelo
L1021	79	Sandstone on hill about 400 ft. north and 2000 ft. east of the southwest corner of Sec. 32, Dry Canyon quadrangle				X	
L1022	80	Sandstone on ridge about 2400 ft. north and 1800 ft. west of the southeast corner of Sec. 32, on hill 1322, Dry Canyon quadrangle				X	
L1023	81	Hard sandstone about 2250 ft. north and 750 ft. east of the southwest corner of Sec. 33, Dry Canyon quadrangle				X	
L167	82	Greenish-brown, medium to fine-grained sandstone with interbedded gray shale cut by basalt intrusions; about 2200 ft. east and 250 ft. north of the southwest corner of Sec. 35, Dry Canyon quadrangle				X	
L168	83	Greenish-brown medium-grained to fine-grained sandstone with basalt intrusions, about 2000 ft. south and 900 ft. east of the northwest corner of Sec. 35, Dry Canyon quadrangle				X	
	84	Dark gray sandy shale in road embankment on east side of Tuna Canyon road in Sec. 31 about 1750 ft. north of Coast highway, Topanga Canyon quadrangle	X				
		Foraminifera					
	85	Light gray to white punky diatomaceous shale in road embankment on Coast highway on point of hill at east edge of Malibu lagoon near mouth of Malibu Creek, Las Flores quadrangle					X
	86	Light gray to brown punky diatomaceous shale in road embankment, Coast highway on point of hill at west edge of flood plain at mouth of Malibu Canyon, Las Flores quadrangle					X

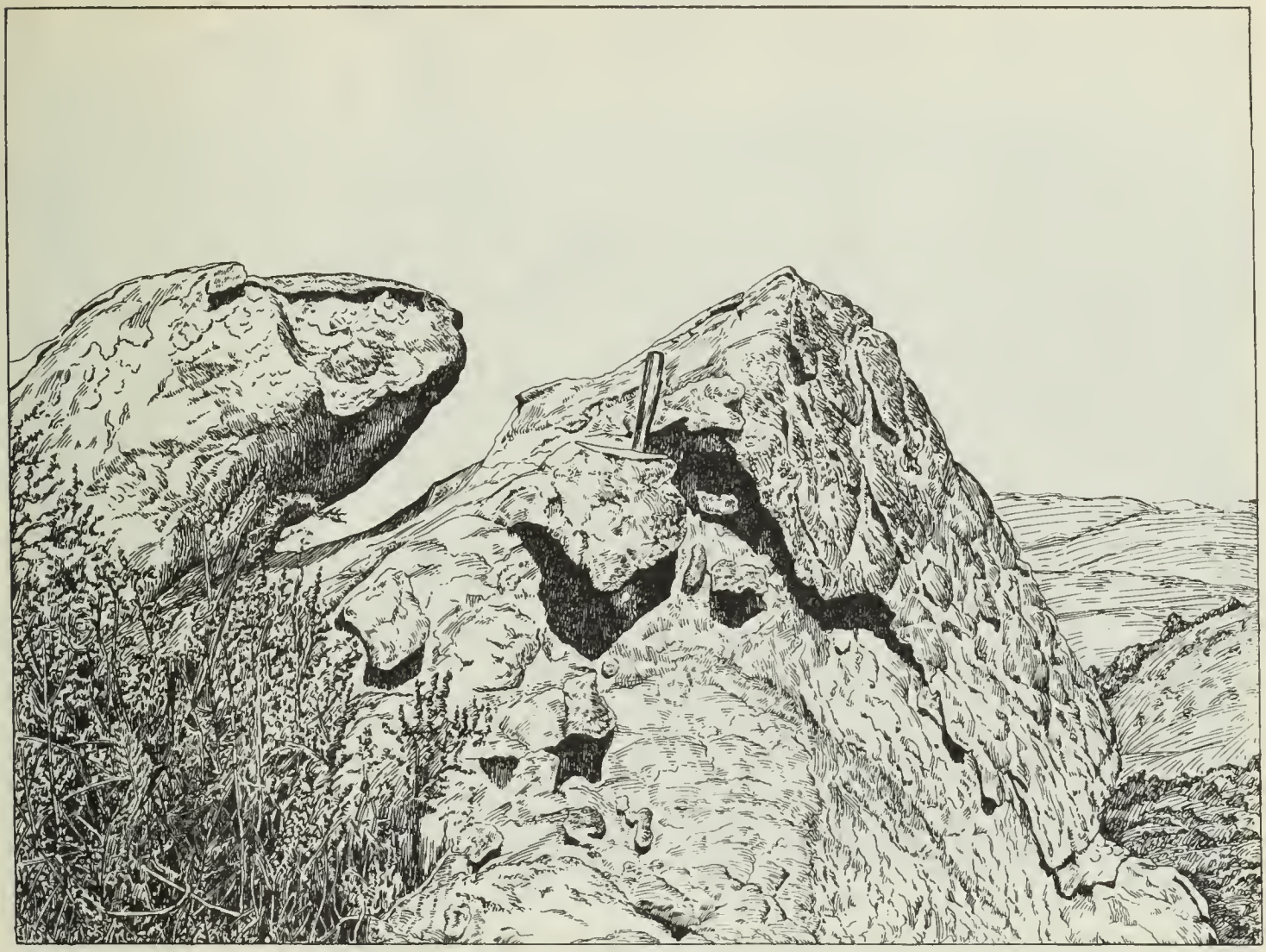

FIG. 8. Typical incrusted and weathered surface of Topanga sandstone, Las Flores quadrangle.

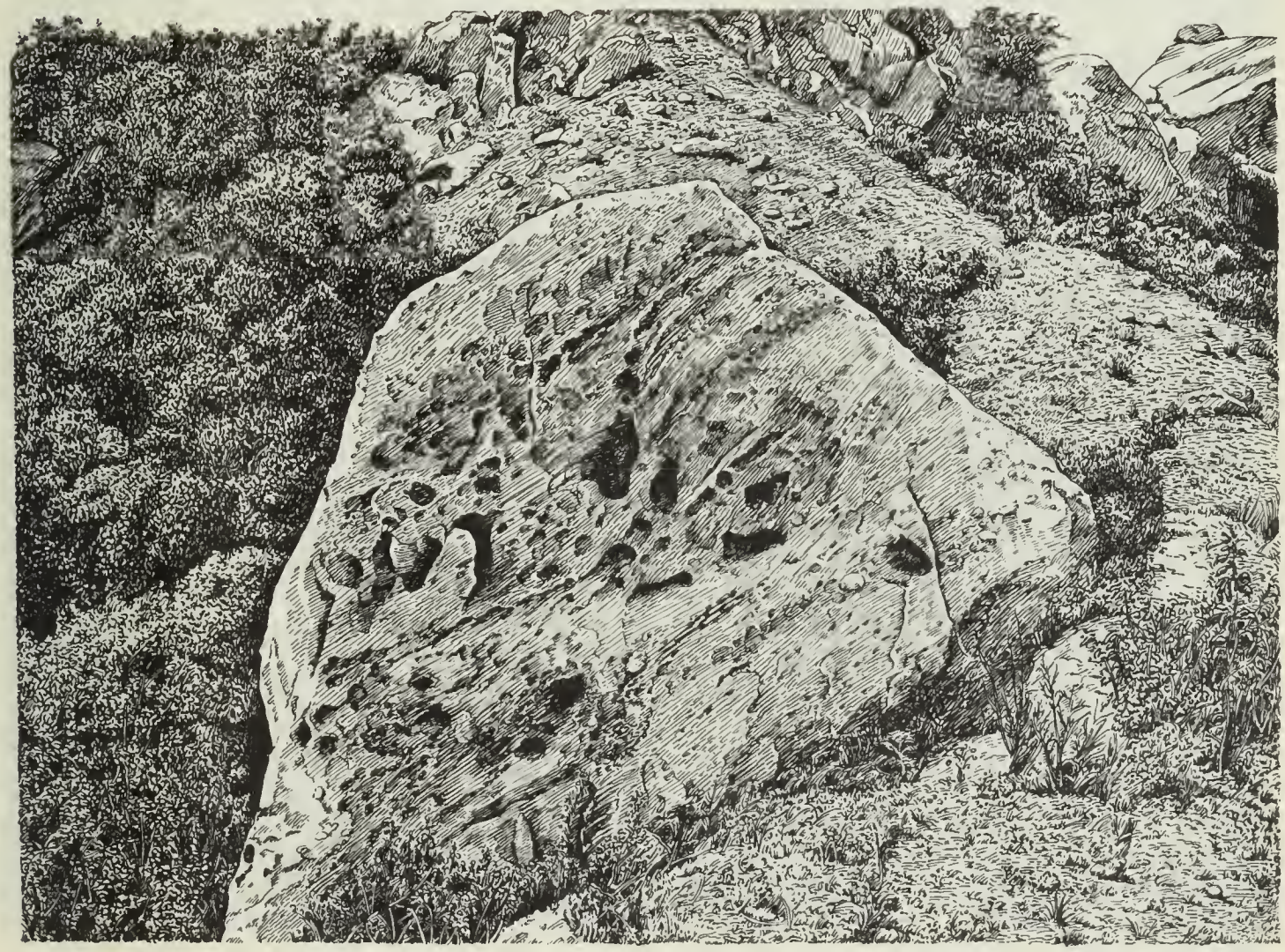

FIG. 9. Pitted surface of Topanga conglomeratic sandstone due to chemical weathering and wind erosion, Las Flores quadrangle.

FIG. 10. Concentric weathering of Topanga basalt, near Saddle Peak, Las Flores quadrangle.

FIG. 11. View eastward from ridge northeast of Saddle Peak, showing gently arched summit line beyond upper Topanga Canyon. Outline of San Gabriel Mountains is faintly visible in distance.

FIG. 12. Upper Topanga sandstone and shale showing soil 'creep' parallel to surface of hillside. Dry Canyon quadrangle.

FIG. 13. Unconformity at Topanga-Modelo contact, near Mohn Springs, east edge of Dry Canyon quadrangle.

FIG. 15. Lower Sespe conglomerate in Red Rock Canyon, Dry Canyon quadrangle.

FIG. 14. Steeply-dipping Topanga sandstone showing erosional effects upon alternating hard and soft strata. Las Flores quadrangle.

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DEPARTMENT OF NATURAL RESOURCES
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PLATE I.

GEOLOGIC MAP OF LAS FLORES AND DRY CANYON QUADRANGLES AND WESTERN PART OF TOPANGA CANYON QUADRANGLE SANTA MONICA MOUNTAINS, CALIF.

GEOLOGY BY E. K. SOPER 1937.

SCALE

0 1/2 1 Mile

0 1000 2000 3000 4000 5000 Ft

Base from U.S. Geological Survey in cooperation with Los Angeles County

Contour interval 100 feet
Datum is mean sea level

LEGEND

RECENT — Qal — Alluvium

Coarse to fine unconsolidated valley and terrace deposits; marine beach sands

PLEISTOCENE — Qt — Marine terrace deposits

Unconsolidated coarse to fine alluvial deposits on elevated marine terraces.

QUATERNARY

UNCONFORMITY

Tmush / Tms / Tmlsh — Modelo formation

Marine. Mostly shale, upper part (Tmush) soft, white to light gray shale; diatomaceous in places with a few thin lenticular beds of sandstone; lower part (Tmlsh) hard, platy, siliceous shale with chert, alternating with soft, brown, foraminiferal shale; with thick lenticular beds of coarse to fine sandstone (Tms) separating it from the upper siliceous member.

UNCONFORMITY

Ttp — Topanga formation

Marine. Soft to hard, brown and dark-gray, fossiliferous shale and siltstone, interbedded with brown sandstone, overlying thick volcanic series in Dry Canyon quadrangle; represents upper part of the Topanga formation

Tv-Ttp — Vaqueros-Topanga formations (undivided)

Marine. Where recognizable the Vaqueros (Tv) consists of fossiliferous soft to hard, gray to brown sandstone and shale with some calcareous beds. Topanga (Ttp) consists of fossiliferous, hard, brown to gray sandstone and conglomerate in the lower part; soft brown shale with interbedded sandstone in the upper part, intercalated with intrusive and extrusive basalt and flow breccias

MIOCENE - TERTIARY

EOCENE (?) / OLIGOCENE (?) / L. MIOCENE (?) — Tsp — Sespe (?) formation

Non-marine, soft, red, maroon, gray to white conglomerate and sandstone with thin beds of red, green, and purplish shale at the top. Unfossiliferous

UNCONFORMITY

U. CRET. & PALEOCENE — Kc-Tmz — Chico-Martinez formations (undivided)

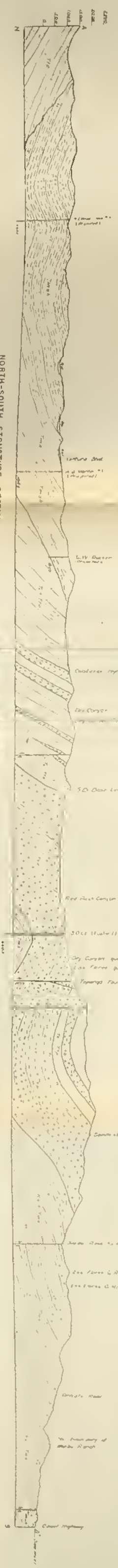
Marine. Martinez formation (Tms) where recognizable consists of soft, gray to brown, fossiliferous shale with some sandy and calcareous beds; Chico formation (Kc) consists of hard, dark-gray, coarse, massive conglomerate and sandstone with subordinate amounts of hard, gray shale

CRETACEOUS

IGNEOUS ROCKS

MIOCENE — Tb — Basalt and agglomerate

Soft to hard basalt, intrusive and extrusive, diabase sills and dikes; volcanic breccias and agglomerates; mostly Middle to Upper Topanga in age. In many places sub-marine in origin and interbedded with Topanga fossiliferous shale. Numerous areas of basalt too small to show on map, occur throughout all formations represented in area from Chico to Middle Topanga inclusive.



NORTH-SOUTH STRUCTURE SECTION ACROSS LAS FLORES AND DRY CANYON QUADRANGLES ALONG LINE A-A' SHOWN ON MAP (PLATE I) LOOKING EAST

Vertical and horizontal scale 1" = 2000'

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further west on Bony Mountain. The elevations in the two quadrangles under discussion vary from sea level on the south to 2828 feet, the highest point in the area, on the summit of Saddle Peak, in Sec. 15, in the central part of the Las Flores quadrangle. The highest point in the Dry Canyon quadrangle is 2161 feet on Calabasas Peak, in section 3, in the south-central part of the quadrangle. The lowest point in the Dry Canyon quadrangle is about 790 feet, on the floor of the San Fernando Valley, in the extreme northeast corner of the area. These elevations compare with 2125 feet and 2000 feet, the highest points respectively in the Reseda and Topanga Canyon quadrangles adjoining the area on the east.

A noteworthy feature of the physiography is the crest line, or divide, located far to the north of the highest peaks, nearly all of which occur as prominent elevations on spur ridges which extend southward from the watershed. This feature probably is the result of the northward shifting of the divide resulting from the more rapid rate of erosion on the south flank of the range.

Another noteworthy feature of the physiography of this area is the fact that the divide, which has a general east-west trend in the east half of the Santa Monica Range, turns abruptly to the north in the south-west part of the Dry Canyon quadrangle and trends northward to the Simi Hills, whence it turns westward along the summit of the Simi Hills to a point west of Simi Peak, near the head of Lindero Canyon. At this locality the divide makes an abrupt bend to the south near the head of Russell Valley, where it again turns westward and follows a general west-southwest trend to Mugu Point on the coast. The Simi Hills, which form a northeast-southwest trending link, join the Santa Monica Mountains with the Santa Susana Mountains to the north. Because of this relationship, the Simi Hills shed the drainage in four directions; eastward into the San Fernando Valley; southward through the Santa Monica Mountains to the Pacific Ocean; westward to Pleasant Valley, and the Oxnard Plain; and northward to Simi Valley.

The area under discussion exhibits several structural features which may have influenced the development of the abrupt northward swing of the topographic divide described in the preceding paragraph. Among these structural features are the following: (1) The definite anticlinal character of the eastern part of the range becomes obscure toward the west and is no longer apparent in the area of the Las Flores and Dry Canyon quadrangles. Here the dominating east-west structural trend of the mountains has superimposed upon it a strong north-south belt of folding, especially in the Dry Canyon quadrangle; (2) no comparable north-south trending folds have been observed elsewhere in the range; (3) west of the Las Flores and Dry Canyon area the east-west strike of the formation again predominates. Field work by the writer and others [16] indicates that this east-west structural trend continues, without important north-south flexures, to the extreme western end of the range at Mugu Point. It is believed that the strong belt of north-south folding influenced, if it did not control, the abrupt northward bend in the topographic divide which is such a conspicuous feature

[16] Kelley, Vincent C., Geology of the westernmost Santa Monica Mountains, California: Proc. Geol. Soc. of Am. for 1934, p. 311 (Abst.); *also* Geological map of the western end of the Santa Monica Mountains between Sycamore Canyon and Mugu Point (Unpub.); *also* Unpublished data supplied by Wayne Loel.

of the topography of this area, and which connects the Santa Monica Mountains with the Simi Hills.

The crest of the range in the area herein described is fairly even, although less so than farther east. The larger canyons on both the north and south flanks of the mountains are steep-sided and rugged. Those on the south side of the divide show a marked steepening and narrowing of the canyon walls about one-third of the distance above the canyon floors, which suggests important rejuvenation of the streams at a fairly late stage in canyon development.

The even character of the summit areas and the flat-topped ridges indicate that they are remnants of an older surface which had been reduced by erosion to low, rolling hills or to a gently undulating plain prior to the uplift which produced the present mountains. The area was probably undergoing erosion throughout Pliocene and Pleistocene time. There is no evidence to suggest that the pre-Pliocene formations which comprise the rocks of the area were ever covered by Pliocene or Pleistocene sediments. During mid-Pleistocene time, or later, this old erosion surface was elevated by the uplifts which are known to have affected much of the California region at that time. The present topography of the Santa Monica Mountains has been developed by the erosion and dissection of the uplifted area since this uplift or succession of uplifts occurred.

Along the coast at the southern base of the mountains within the area under discussion there are remnants of two distinct, elevated, cliff-backed, wave-cut terraces which slope gradually seaward, above the present beach-level terrace now in course of active production. These terraces have been described by the late Dr. W. M. Davis,[17] who applied the names *Malibu* to the higher terrace, and *Dume* to the lower terrace. In the Las Flores quadrangle only small remnants of the Malibu terrace remain; but remnants of the Dume terrace are still distinctly recognizable at elevations of about 300 feet above sea level. Both elevated terraces became tilted toward the west as a result of uplifts which have affected the Santa Monica Mountains so that the lower, or Dume terrace, which lies at an elevation of about 300 feet above sea level in the eastern part of the range, stands at an elevation of about 100 feet on Dume Point, and disappears at sea level to the west of Dume Point. The higher, or Malibu terrace, was also involved in this tilting.

Davis has related the changes of sea level which were responsible for the cutting of these platforms to the formation and melting of great continental ice sheets. He believed that the subaerial deposits stripped from the adjacent highlands and deposited upon the lower and upper elevated platforms represent the local work of two glacial epochs, while the abrasion of the three platforms (including the one now being cut by the sea) represents two interglacial epochs and the present postglacial epoch.

STRATIGRAPHY

The accompanying table gives a list of the rock formations exposed in the area in their stratigraphic sequence, together with data concerning their lithologic characteristics and thicknesses.

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[17] Davis, W. M., Glacial epochs of the Santa Monica Mountains, California: Bull. Geol. Soc. of Am., vol. 44, No. 5, pp. 1041-1133, Oct., 1933; *also* Shorelines of the Santa Monica Mountains, California: Bull. Geol. Soc. of Am., vol. 43, No. 1, p. 227, March, 1932 (Abst.); *also* Glacial epochs in the Santa Monica Mountains: Proc. Natl. Acad. of Sci. vol. 18, No. 11, pp. 659-665, Nov., 1932.

Rock Formations Exposed in the Las Flores and Dry Canyon Quadrangles, Western Santa Monica Mountains

Geologic Age	Formation	Approximate thickness (feet)	Description
Recent	Marine sands,	0–15	Beach sands along coast.
	Alluvium.	0–100	Sands, gravels, silts, soils. Stream channel deposits and valley fill.
Pleistocene	Alluvial deposits on raised marine platforms.	0–50	Breccia, conglomerates, sands, silts.
	Marine terrace deposits	0–25	Fossiliferous sands and gravels.
Unconformity			
Upper Miocene	Modelo formation	4600 (max.)	Marine. Mostly shale. Upper part soft, white to light gray shale; diatomaceous in places; with few thin, lenticular beds of sandstone. Lower part hard, platy, siliceous shale, with chert, alternating with soft, brown, formaminiferal shale, with thick, lenticular beds of coarse to fine sandstone separating it from upper siliceous member.
Unconformity			
Middle Miocene Lower Miocene undivided	Topanga formation and Vaqueros formation	12000 (max.)	Marine. Where recognizable, Vaqueros consists of fossiliferous, soft to hard, gray to brown, sandstone and shale with some thin calcareous beds. Topanga consists of fossiliferous, hard, brown to gray sandstone and conglomerate in lower part; soft, brown shale with interbedded sandstone in upper part; intercalated with intrusive and extrusive basalt, and flow breccias.
Lower Miocene (?) Oligocene (?) Eocene (?) undivided	Sespe formation	1600–3275	Non-marine. Soft, red, maroon, gray to white, unfossiliferous conglomerate and sandstone, and sandstone with thin beds of red, green and purplish shale at top.
Unconformity			
Paleocene and Upper Cretaceous undivided	Martinez formation and Chico formation undivided	4900–7500	Marine. Where recognizable, Martinez formation consists of soft, gray to brown, fossiliferous shale with some sandstone. Chico formation consists of hard, dark-gray, coarse, massive conglomerate and sandstone, with subordinate amounts of hard, gray shale. Very few fossils.

UPPER CRETACEOUS AND PALEOCENE ROCKS

Chico and Martinez Formations

In the southeastern part of the Las Flores quadrangle and in the adjacent part of the Topanga Canyon quadrangle there is a considerable area occupied by rocks of upper Cretaceous age (Chico (?) formation) and of Paleocene age (Martinez formation). These rocks do not crop out in the northern part of the Las Flores quadrangle nor at any place in the Dry Canyon quadrangle. Because of their general lithologic similarity, the scarcity of fossils, the complications due to faulting, and the heavy cover of vegetation, it has been possible at only a few localities to separate these rocks in the field.

The upper Cretaceous rocks of the area are referred to in this report and shown on the accompanying map as "Chico," although no fossils have been found in the area which would definitely establish the age of the formation as equivalent to the type Chico. Previous investigators have found numerous upper Cretaceous fossils in what is apparently a continuation of this formation in adjoining areas,

and have mapped the formation as Chico. Therefore the present writer has designated as Chico the rocks below the Martinez, to indicate their correlation with the same formation elsewhere in the Santa Monica Mountains. The rocks of the Chico formation, where recognizable, are similar to those in the Topanga Canyon quadrangle described by Hoots.[18] They consist of conglomerates, sandstones, and shales, and form a westward continuation of the area of Chico-Martinez rocks mapped by Hoots in the vicinity of Topanga Canyon. The only Cretaceous fossil found in the area described in the present report was an *Inoceramus* which occurred in hard, dark-gray, sandy shale in the embankment on the east side of Tuna Canyon road in the Topanga Canyon quadrangle about 1800 feet north of the coast highway (fossil locality 84). The lowermost strata found in the area consist of dark-gray shales near the coast. Overlying these shales, coarse, massive, dark-gray conglomerate occurs with subordinate amounts of hard, gray shale and sandstone, which are considered to be of probable Chico age because of their stratigraphic relation to the overlying fossiliferous Martinez beds. The massive Chico (?) conglomerate is made up of very smooth, well-rounded cobbles, both spherical and ellipsoidal in shape, of an average size of from four inches to six inches on the long axes, but occasionally up to one foot in diameter. The cobbles consist mainly of fine-grained, dense, gray-colored, highly quartzose to flinty rocks including much quartzite. It is noteworthy that almost no schist or gneisses were observed among the cobbles. The matrix of this conglomerate consists of fairly clean, brownish sandstone, quite different in appearance from the matrix in the various conglomerate members of the Miocene formations.

Although it has been impossible to separate the Chico formation from the Martinez formation in the field with sufficient accuracy to justify mapping the boundaries between them, it is believed that the approximate distribution of the two formations may be determined from fossil collections identified as Martinez in age, and from the stratigraphic relation of these fossiliferous beds to the underlying rocks in which the only identifiable fossil which could be found was the *Inoceramus* of upper Cretaceous age (fossil locality 84).

Fossils of definite or probable Martinez age have been found at eleven localities: (locality numbers 40(?), 41, 44, 45, 46, 47, 48, 56(?), 57(?), 58(?), 60(?). At several of these localities the material was so poorly preserved that definite indentification was impossible. Dr. U. S. Grant has identified the following fossils from this formation: *Cucullaea mathewsonii* Gabb; *Crassatillites* (?) *branneri* Waring; and a poorly preserved *Turritella* which resembles *T. pachecoensis* Stanton. In general, the Chico rocks are confined to a narrow strip along the coast in the southeastern part of the Las Flores quadrangle and in the southwest corner of the Topanga Canyon quadrangle. The rocks of the Martinez formation occur immediately north of the Chico, and extend northward about one and one-half miles to the central part of the Las Flores quadrangle. The best Martinez fossil collections from which definite age determinations could be made were found in sections 22 and 27 in the south-central part of the Las Flores quadrangle.

[18] Hoots, H. W., *op cit.*, pp. 90-93.

The rocks containing Martinez fossils consist of fine-grained, buff or light-brown sandstone, overlain by brown conglomeratic sandstone which grades upward into brown conglomerate. Thin beds of soft-brown to gray shale, and buff, calcareous beds are numerous in the sandstone members of the sequence. It is noteworthy that the algal limestone reefs which form a conspicuous feature of the Martinez in the Santa Ynez Canyon and Temescal Canyon region to the northeast, described by Hoots,[19] do not occur in this area.

The unseparated Chico-Martinez formations are in fault contact with all other formations in this area except in the central part of the Las Flores quadrangle, where the Martinez is overlain by the Sespe beds. Although there is no change in the strike of the formations above and below this contact, there is a definite break in the sequence of sedimentation at this horizon, for the entire marine Eocene seems to be missing. No fossil evidence suggesting the presence of these formations has been found in the area. It is possible, as will be explained later, that the basal Sespe beds may represent a nonmarine phase of upper Eocene sedimentation; but even if this is the case, the lower and middle Eocene section seems to be missing.

No accurate measurements of the thickness of the undifferentiated Chico-Martinez formations can be made in this area because of complex faulting which has broken the Chico-Martinez rocks into several discontinuous blocks. Measurements indicate a combined thickness of from 4900-7500 feet for the Chico-Martinez formations in the Las Flores quadrangle, as compared with about 8000 feet in the region a few miles to the east.

EOCENE (?) AND OLIGOCENE (?) ROCKS

Sespe Formation

The most distinctive mappable sedimentary formation found in the Las Flores-Dry Canyon area consists of a rather narrow belt of soft, unfossiliferous conglomerates, conglomeratic sandstone, and coarse to medium-grained sandstones, of non-marine origin, which exhibit a prevailing red or maroon color. The color of these beds, however, is not always a safe criterion for their recognition, since it may change abruptly from red to light gray or nearly white along the strike. These prevailingly red beds occupy the same stratigraphic position as the red beds to the east, mapped and described by Hoots,[20] as of questionable Sespe age. The red beds of the Las Flores quadrangle have been traced by the writer into the area of red beds to the north and west, mapped and described by Kew[21] as Sespe. Because of the lack of fossils in these red beds, and the fact that throughout the Santa Monica Mountains they underlie fossiliferous middle or lower Miocene strata and rest upon Paleocene or Cretaceous beds, they are believed to belong to the Sespe formation. This does not necessarily imply that they represent the same stratigraphic horizon as the type locality in Sespe Canyon, about 18 miles to the northwest.

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[19] Hoots, H. W., *op cit.*, pp. 91-93.

[20] Hoots, H. W., *op cit.*, p. 93.

[21] Kew, W. S. W., U. S. Geol. Survey Bull. 753, Pl. I, 1924.

Stock[22] has shown from studies of the mammalian fauna that the age of the lower part of the Sespe formation, as represented in the Simi Hills in Ventura County, is upper Eocene. Stock has also shown that the middle part of the Sespe formation as represented in the Las Posas Hills in Ventura County is either upper Oligocene or lower Miocene. Sespe beds elsewhere have been considered as equivalent to marine strata correlated with the lower Miocene. The "Sespe formation" represents a series of non-marine deposits, the accumulation of which began in late Eocene time and continued through the Oligocene and into early Miocene time. The lower portions of the Sespe formation may therefore be the time equivalent of the marine upper Eocene, and the upper portion of the Sespe may be of the same age as part of the marine Vaqueros formation of lower Miocene age. In fact, there is evidence that Sespe red beds may grade laterally into marine strata.[23] The stratigraphic relationships of the Sespe beds in the central and western parts of the Santa Monica Mountains are entirely consistent with the field evidence found elsewhere, which indicates a considerable variation in age between different parts of the formation.

In the extreme western end of the Santa Monica Mountains, where no Sespe beds are exposed, a fairly thick section of marine fossiliferous strata of lower Miocene age is found (Vaqueros formation). In the central part of the range some marine fossiliferous Vaqueros beds are present but these are only a few hundred feet thick, whereas the Sespe red beds are represented by more than 3200 feet of strata showing marked characteristics of non-marine origin. Unfortunately no fossils have been found in the Sespe beds of the Santa Monica Mountains. To the west of the Las Flores quadrangle a considerable part of the geology of the Solstice Canyon, Seminole, and Dume Point quadrangles has been mapped by the writer and the westward continuation of the Sespe formation into the Solstice Canyon and Dume Point quadrangles has been demonstrated; but as yet no fossils have been found in these red beds. Since vertebrate faunas which indicate a range in age from upper Eocene to lower Miocene have been found in the Sespe beds in various localities to the west and northwest of the Santa Monica Mountains, it is possible that more careful search may result in the discovery of a mammalian fauna in the Santa Monica Sespe beds.

The greatest thickness of Sespe represented in the area under discussion occurs in the southern part of the Dry Canyon quadrangle, where the surface exposures together with records obtained from a well drilled on the Topanga anticline (Standard Oil Company Austin No. 1) indicate a total thickness of about 3275 feet. East and south of Saddle Peak in the north-central part of the Las Flores quadrangle the thickness of the Sespe varies from 1600 feet to 2500 feet, indicating a rapid thinning to the southwest.

The best exposures of the Sespe beds in this area are to be seen in Red Rock Canyon which cuts across the Topanga anticline in the south-central part of the Dry Canyon quadrangle. On the sides of this

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[22] Stock, Chester, Eocene land mammals in the Pacific Coast: Proc. Nat. Acad. Sci., vol. 18, no. 7, pp. 518-529, 1932.

Upper Oligocene mammalian fauna from southern California: Proc. Nat. Acad. Sci., vol. 18, no. 8, pp. 550-559, 1932.

[23] Reed, R. D., Geology of California, p. 148; *also* Sespe formation: Bull. Am. Assoc. Pet. Geol., vol. 13, pp. 489-507, 1929.

canyon the greater part of the Sespe formation is exposed to view. At this locality the formation may be divided into three members as follows: (1) A lower member, the base of which is not exposed, consisting of about equal amounts of red and red brown conglomerate and red arkose sandstone; (2) a middle member, consisting of about 800 feet of coarse to fine light-gray to nearly white, medium-hard arkose sandstone, with small lenses of conglomerate; (3) an upper member consisting of about 1000 feet of soft, coarse to fine, red, yellow, green, and brown variegated sandstone and conglomerate with thin, variegated, red, purple, and green shales at the top at some localities. The variegated shale at some places grades upward into Miocene marine strata; at other places there is about 100 feet of red sandstone above the shale.

The red color of the Sespe in this area is due to the presence of dehydrated iron oxides, especially hematite, turgite, and goethite, which are present around the sand grains, in the cleavages of the minerals and in the finer, silty matrix. The high percentage of grains of fresh-appearing, slightly oxidized, orthoclase feldspar, often of a pinkish color, probably contributes to the general reddish color of the formation. Until recently it was generally believed that the "Sespe red beds" represented continental deposits which accumulated under arid conditions. Stock's [24] discovery of Sespe vertebrate fossils, which represent forms that lived in areas of fairly humid climatic conditions, at various localities and horizons in the Sespe, has cast grave doubt about the arguments for aridity in this region during Sespe time. If the red color of the Sespe is due to the degree of dehydration of the iron compounds rather than to their degree of oxidation, the color may no longer be regarded as inconsistent with the idea of accumulation in a fairly humid region.

Lower Sespe Member.

In the lower member of the Sespe, the boulders in the conglomerate average between three inches and six inches in diameter, with a maximum of about twelve inches. A noteworthy feature is the high degree of rounding exhibited by the majority of these boulders. Many varieties of rocks are represented. Table 1 shows the results of a pebble count made by Russell R. Simonson [25] in the lower Sespe typical red conglomerates from this area. This table shows that out of a total of 225 cobbles and boulders varying in size from one inch to ten inches, collected from a given plot where they were 'in place' in the matrix, 30 different rock types were identified. Quartz diorite and quartzite were commonest (26 specimens of each). Other rock types present in greatest numbers were dacite, meta-dacite, meta-rhyolite porphyry, meta-quartz latite, basic lavas, and gneissoid granite. A predominance of volcanic and meta-volcanic rocks is shown by the count and the 'granites' predominate over the sedimentary and meta-sedimentary rocks. A second count taken in the same region also showed the volcanics to predominate, but at this

[24] Stock, Chester, *op cit.*

[25] Simonson, Russell R., Conglomerates of the Sespe and Topanga formations of Dry Canyon quadrangle, Santa Monica Mountains, California: Proc. Geol. Soc. of Am., pp. 304-305 (Abst.); *also* Unpublished manuscript submitted to the Department of Geology, University of California at Los Angeles, in partial fulfillment of the requirements for the degree of Master of Arts, June 1936.

second locality the 'granites' and sediments were present in nearly equal number. The scarcity of typical schists and foliated metamorphics is of special interest, and the total absence of Franciscan rock types is noteworthy. The rock types shown to compose the lower Sespe of this area strongly indicate an eastern source. The tourmalinized suite, a unique feature of the group, are especially significant as indicating a source to the east.

A mechanical analysis of a typical sample of red sandstone of the lower member of the Sespe (Fig. 4) shows that about 80 per cent of the sandstone consists of grains varying in size from 1.651 mm. to 0.242 mm. The analysis indicates a poorly sorted sediment. Among the heavy minerals identified in the samples, hematite, magnetite, garnet, and zircon were common, with tourmaline and rutile present. Of the light minerals in the samples, quartz and feldspar comprise the bulk. Orthoclase is most common, but acid plagioclase is fairly abundant. Biotite is also a common constituent.

Middle Sespe Member.

The middle member of the Sespe formation is somewhat harder than the lower and upper members, and for this reason the outcrops stand out as conspicuous hog-backs. About 85 per cent of the beds comprising this middle member consist of light gray sandstone, the remaining 15 per cent being conglomerate. The cementing material of this member does not contain the dehydrated iron oxides which prevail in the sandstone of the lower Sespe member. This may account for the lack of red color in this and other parts of the Sespe, since the more hydrated iron compounds are yellowish in color, and tend to become red upon loss of water.

A pebble count by R. R. Simonson in the conglomerate of this middle member of the Sespe gave quite different results from the count made in the lower Sespe conglomerate. The cobbles of the middle member are much smaller than those of the lower member. In both members round to sub-round forms prevail over angular and sub-angular forms.

The commonest rock type found in the middle Sespe member is quartz porphyrite. The other most common rock types are meta-quartz latite, basic lavas, gneissoid granite, quartz diorite and quartzite. Out of a total of 155 cobbles collected from a unit area, where they were embedded in the matrix, 67 specimens were of volcanic and meta-volcanic rocks, 43 specimens represented granitoid or plutonic rocks; and 45 specimens represented sedimentary and meta-sedimentary rocks. A total of 29 different rock types were identified in the count.

One interesting point brought out by a comparison of the pebbles and cobbles in the middle and lower Sespe conglomerates is the absence in the lower member of rocks typical of the San Gabriel Mountains, and the prevalence of such types in the middle member. The quartz porphyrite, mentioned above as predominating in the middle Sespe member, has been found in place chiefly in the San Gabriel Mountains.[26] The fact that San Gabriel rock types pre-

[26] Miller, W. J., Geology of the western San Gabriel Mountains: Univ. of Calif. at Los Angeles Publications in Math. and Phys. Sci., vol. 1, no. 1, 1934.

dominate throughout the "Sespe" of the Mint Canyon region, whereas they are absent from the lower Sespe member in the Santa Monica Mountains, and first appear in the middle Sespe member, suggests that the Mint Canyon Sespe might have been deposited at about the same time as the middle part of the Santa Monica Sespe.

A mechanical analysis of the middle gray Sespe sandstone (Fig. 5) shows a much better sorting than in the sands of the lower member. An examination of the heavy minerals from the middle sandstone shows that they consist chiefly of magnetite, garnet (pink and brown), epidote, and zircon, in that order of abundance. Tourmaline, rutile, piedmontite, and topaz were present but rare. As in the lower sandstone, quartz and feldspar, which prevail among the light minerals, are present in about equal quantities. The feldspars show more alteration than they do in the lower sandstone; which, in conjunction with the better sorting of the middle member, indicates a slower rate of accumulation.

Upper Sespe Member

The upper member of the Sespe formation, which is about 1000 feet thick in the Dry Canyon quadrangle, contains only about 200 feet of conglomerate and pebbly sandstone which is near the base of the member. The conglomerate resembles that of the lower Sespe member.

A pebble count of the red conglomerate of the upper Sespe member by R. R. Simonson shows that the rock types which are present are like those in the two lower Sespe members previously described, but the proportions of the various rock types are different. A noteworthy feature is the decrease in the amount of porphyrite. A total of 127 cobbles were collected in the unit area, all 'in place' in the matrix. From this total, 22 distinct rock types were identified. The greatest variety was found among the volcanics and meta-volcanics, of which meta-dacite predominated. The sediments and meta-sediments were next in order of variety of rock types, among which quartzites of various colors and textures greatly predominated. The plutonic rocks were found to be present in largest quantity but they showed the least variety of rock types, of which quartz diorite was much the commonest, with gneissoid granite second in abundance.

A mechanical analysis of a typical sample of the thick variegated sandstone of the upper Sespe member (Fig. 6) shows that about 80 per cent of the material of which it is composed consists of grains between 0.833 mm. and 0.242 mm. in size. This indicates a higher degree of sorting than in the sandstones of the middle and lower Sespe members. although it is not so well sorted as the overlying Topanga sandstone (Fig. 7). There is but little cementing material present in the upper sandstone which is soft and friable. The heavy minerals identified in a sample of this sandstone, taken about 300 feet below the Topanga contact, showed magnetite abundant; garnet, epidote and zircon common; titanite and tourmaline present; and rutile rare. Feldspar, quartz, and biotite were very abundant. The quartz-feldspar ratio was estimated to be 2:1.

Since the three-fold division of the Sespe in this area is based upon color and lithology, neither of which features are constant for

any horizon within the formation, it was not found practicable to map the three members separately throughout the area.

Southeast of Saddle Peak, in the Las Flores quadrangle, the lowermost part of the Sespe consists of a white or light gray sandstone similar to that in Topanga Canyon described by Hoots.[27] This white sandstone is overlain by red or maroon conglomerate and coarse sandstone, which, in turn, is overlain by reddish and variegated sandstone, with thin variegated shales at or near the top. The red or maroon sandstone of this middle Sespe member southeast of Saddle Peak is composed largely of fairly coarse grains of quartz and feldspar, with much biotite mica. The heavy minerals are about the same as those observed in the samples from the Dry Canyon quadrangle. The matrix is argillaceous. Interbedded with the sandstone at this locality are thin beds of variegated shale showing distinct ripple marks and mud cracks.

The petrology and probable sources of the Sespe of the Las Flores and Dry Canyon quadrangles may be summarized as follows: In the *lower member,* which is largely conglomerate, volcanic and metavolcanic rocks are abundant; gneisses, quartzites, and cherts are common; plutonic rocks are common; true schists are rare, piedmontite schist and a tourmaline suite of rocks are present. In the *middle member,* in which sandstone predominates, the conglomerates are composed of rock types similar to those in the lower member except that San Gabriel rock types, absent in the lower Sespe, are abundant. In the *upper member* in which sandstone predominates, the conglomerates are composed of rock types similar to those in the lower and middle members except that the percentages vary and the San Gabriel (?) porphyrite decreases. The sandstones show progressively better sorting from the lower member toward the top. Many of the rock types found in the Sespe, especially those showing all phases of tourmalinization, are now found '*in place*' in the Riverside region (Corona quadrangle).[28] Other rock types found in the Sespe of the Santa Monica Mountains are known to exist in place in the San Gabriel Mountains. No typical Franciscan types were found in the Sespe conglomerates nor were distinctive Franciscan minerals found in the sandstones. This, together with the other facts above stated, strongly suggests an eastern source for the material comprising the Sespe beds of the Santa Monica Mountains.

LOWER AND MIDDLE MIOCENE ROCKS

The rocks of lower and middle Miocene age represented in the Las Flores and Dry Canyon quadrangles comprise the Vaqueros and Topanga formations. Possibly the upper part of the Sespe formation may be of lower Miocene age as previously explained. At first an attempt was made to separate the Vaqueros from the lower Topanga in the mapping of the Las Flores and Dry Canyon quadrangles, but this was found to be possible at only a few localities where recognizable lower Miocene fossils could be found. Overlying the Sespe in a few places, Vaqueros fossils (*Turritella inezana*) were found overlain by strata containing abundant Topanga fossils (*Turritella ocoyana* and *Pecten nevadanus*). At most localities throughout the area under dis-

[27] Hoots, H. W., *op. cit.*, p. 94.

[28] Irving, Earl M., Unpublished manuscript submitted to the Dept. of Geology, University of California at Los Angeles in partial fulfillment of the requirement for the degree of Master of Arts, 1935.

cussion the lowermost Topanga formation could not be distinguished from the marine Vaqueros formation on purely lithologic field evidence. Therefore, the two formations have been mapped together, with the exception of the upper part of the sequence which overlies a thick series of volcanics, where the strata are of definite Topanga age. These volcanics occur mostly in the Dry Canyon quadrangle and therefore the rocks which lie above the volcanics and below the upper Miocene Modelo formation in the Dry Canyon quadrangle have been mapped separately, and represent the upper part of the Topanga formation.

Vaqueros Formation.

Strata containing abundant *Turritella inezana*, indicating the Vaqueros age of the beds (although there is doubt whether the Vaqueros is lower Miocene or Oligocene) were found in only two restricted areas in the quadrangles under discussion. One of the areas is along the coast highway between the mouth of Las Flores Canyon and Big Rock (immediately west of the mouth of Piedra Gorda Canyon) in the southeast part of the Las Flores quadrangle. Along the coast between these points there is a narrow belt of red Sespe sandstone 200 to 400 feet wide. Immediately north of this belt of Sespe sandstone there is a belt of sandy and calcareous shales and sandstones in which Vaqueros fossils were found at several places (localities 52, 54, 55 and 59). This belt of Vaqueros rocks, which trends east-west for almost 6500 feet varies in width from about 700 to 1200 feet and is in fault contact on all sides with older formations, suggesting a small down-dropped block. The thickness of this faulted belt of Vaqueros varies from 200 to 600 feet.

The other area in which well-preserved Vaqueros fossils were found at several localities (7, 9, 10 and 11) is along the bottom and lower slopes of Malibu Canyon, between the dam at the lower end of the Malibu reservoir and a point about one and one-half miles downstream. The strata at these localities, in which Vaqueros fossils were found, consist of hard, gray, brown, and red-brown sandstones and sandy shales, overlain conformably by a great thickness of sandstone of Topanga age.

No fossils which could be definitely identified as Vaqueros in age were found in the Dry Canyon quadrangle where the red beds, mapped as Sespe, are overlain with apparent conformity by sandstones and sandy shales containing a typical Topanga fauna. A noteworthy feature of the contact between the Sespe red sandstone and the overlying marine Topanga formation in the Dry Canyon quadrangle is the occurrence at this horizon of flows, sills, and dikes of basalt, which are especially prominent along the east flank of the Topanga anticline. Except for a large basalt sill near the base of the Topanga formation on the high ridge east of Stunts Ranch, volcanic rocks were not observed at this horizon in the Las Flores quadrangle.

Hoots[29] reported that marine strata which could be definitely identified as Vaqueros from their fossil fauna were not well represented in the eastern Santa Monica Mountains, although in the upper drainage area of Santa Ynez Canyon in the Topanga and Reseda quadrangles, he mapped a thick unfossiliferous series of soft, red and light gray to

[29] Hoots, H. W., *op. cit.*, pp. 93-94.

white, arkosic sandstones and conglomerates, the upper part of which he considered to be of possible Vaqueros age. At the extreme western end of the Santa Monica Range, Kelly[30] found a fairly thick series of marine sandstones and shales containing a typical Vaqueros fauna. Loel reported scarce Vaqueros fossils west of the Malibu dam and reservoir.[31] Thus, it appears that the marine Vaqueros formation in the Santa Monica Mountains thins rapidly toward the east or shoreward, in marked contrast with the non-marine Sespe formation, which thins toward the west or basinward. This again suggests that at least a part of the upper Sespe beds in the Santa Monica Mountains may represent a continental phase of deposition that may be correlated with marine beds of the Vaqueros formation, which generally have been considered to be lower Miocene in age. Schenck[32] has recently suggested that the Vaqueros formation may actually represent marine Oligocene, the apparent absence of which has long been a puzzling problem in California stratigraphy.

Topanga Formation

The Topanga formation in the Las Flores and Dry Canyon quadrangles rests conformably upon either the Sespe or Vaqueros formation, with gradational contact. In the Dry Canyon quadrangle the marine Vaqueros is either absent or unrecognizable because of lack of fossils, and the Topanga formation rests directly upon unfossiliferous red colored sandstones or variegated shales which have been mapped as Sespe. There is a prominent series of intrusive sheets and dikes of basalt with some basalt flows at this contact horizon on the flanks of the Topanga anticline, but the contact elsewhere is not characterized by volcanic intrusives. In the Las Flores quadrangle fossiliferous marine Vaqueros is represented at some places between the Sespe and Topanga formations by a thin series of sandstones and sandy shales from 200 feet to 600 feet thick. At other localities in the Las Flores quadrangle marine Vaqueros beds seem to be missing, and the Topanga rests directly upon red Sespe sandstone.

The Topanga formation in the Las Flores and Dry Canyon quadrangles consists of over 12,000 feet of sandstones, conglomerates, shales, intrusive and extrusive basalts, and volcanic breccias (agglomerates). The formation may be divided into three distinctive members: (1) a lower member consisting of about 3500 feet (maximum) of fossiliferous sandstones, conglomerates, and sandy shales; (2) a middle member, consisting of about 4600 feet (maximum) mostly of intrusive and extrusive basalts, but with some volcanic breccias (agglomerates) and also some interbedded, fossiliferous shales and sandstones; (3) an upper member, consisting of about 4800 feet (maximum) of softer sandstones, conglomerates, and shales, with few fossils.

Lower Topanga Member

The lower Topanga member, which rests conformably upon either the Sespe or Vaqueros formation, consists of about 3500 feet of hard

[30] Kelley, Vincent C., *op. cit.*

[31] Loel, Wayne, Oral communication.

[32] Schenck, H. G. What is the Vaqueros formation of California and is it Oligocene?: Bull. Amer. Assoc. Pet. Geol., vol. 19, pp. 521-536, 1935.

massive brown and gray sandstones, conglomerates, and sandy shales. The sandstones of the lower Topanga member comprise the hardest rocks to be found in the Las Flores and Dry Canyon quadrangles, and for that reason form the highest and most rugged ridges in this part of the Santa Monica Mountains. The sandstones of this member are characterized in the outcrops by the presence of a hard surface crust of a dark brown color, developed by chemical weathering. The crust is always darker in color than the freshly broken surface of the rock.

In the coarse sandstone near the base of this member, about 50 feet stratigraphically above the Sespe formation, is a fossil horizon that can be traced for several miles. This faunal zone is especially well exposed on the east and north flanks of the Topanga anticline in the Dry Canyon quadrangle (fossil localities 30, 31, 64, 66, 68, 71, 72, 74, 75, 76, and 82). At other localities in both quadrangles this faunal zone is marked by a reef containing giant pectens and fragments of oysters. Other fossil reefs, containing oysters and other brackish water forms occur at intervals between 1700 feet to 2500 feet above the base of the member. The upper 1000 feet of this lower member consists of finer-grained brown sandstones, alternating with sandy shales which are overlain by the thick volcanic series of the middle Topanga member. The sandy shales and argillaceous sandstones near the top of the lower member carry the largest and most varied fauna of the entire Topanga formation of this area.

A mechanical analysis of the lower hard, massive Topanga sandstone showed a higher degree of sorting than in any of the sandstone members of the Sespe formation. (Fig. 7.) About 85 per cent of the grains are between 1.651 mm. and 0.242 mm. in diameter. Of the heavy minerals which are present in this lower sandstone, magnetite and garnet are by far the commonest. Other heavy minerals present but not abundant include epidote, tourmaline, hornblende, zircon, hematite, and titanite. Among the light minerals, quartz and feldspar predominate. Biotite, a very common constituent of the Sespe sandstones, is much less abundant in the lower Topanga sandstone.

Middle Topanga Sandstone and Basalt Member.

The middle Topanga member consists of a maximum of about 4600 feet of intrusive and extrusive basalt and volcanic breccia or agglomerate with associated sandstone and shale. The intrusives include dikes and sills and irregular masses, many of which are too small to be shown on the accompanying geologic map. Many basalt flows, especially near the base of the volcanic series, show unmistakable evidence of a submarine or sea-bottom origin. The lower 600 or 800 feet of basalt exhibits a well-developed pillow-structure, and the flows are interstratified with thin-bedded, fissile, black, fossiliferous shales. At numerous localities, especially in the Crater Camp and Monte Nido regions in the northwest part of the Las Flores quadrangle, layers of hard, platy, dark-gray to black shale not more than a few inches thick, containing numerous fish scales and other organic remains, were observed interbedded with thick basalt flows. At other localities in the same region calcareous shale lenses four to six feet thick, containing numerous oyster shell fragments, may be seen between thicker basalt flows. It is noteworthy that all of the occurrences of fossiliferous sedi-

ments just mentioned are confined to the lower 600 to 800 feet of the middle Topanga volcanic series and indicate the gradual advent of the submarine volcanic disturbances, which at first were intermittent and separated by brief periods of sedimentation, but which gradually increased in violence and duration, culminating in a great series approximately 4000 feet thick, made up mostly of basalt flows with some agglomeratic breccias, in which no true sedimentary material was found. In the Seminole and Solstice Canyon quadrangles to the west of this area, volcanic breccias predominate over the basalts of this volcanic sequence. Throughout the greater part of these volcanic extrusives there is less evidence of pillow structure or other sub-marine features so conspicuous in the lower part. The middle and upper parts of the volcanic flows exhibit typical vesicular and amygdaloidal textures. Some tuffaceous material is present. The amygdules are filled, in many places, with white zeolites up to one inch in diameter. At one locality in the southwest corner of the Dry Canyon quadrangle the ground is dotted white with round pieces of natrolite which have weathered out of the amygdaloidal basalt. The basalt flows occur in distinct layers in many places, which conform in strike and dip to the north-dipping monoclinal structure of the sedimentary rocks.

One of the most interesting features of the geology of the Las Flores and Dry Canyon quadrangles is the fact that this area includes the eastern limits of the great mass of volcanic extrusive rocks which make up a large part of the western half of the Santa Monica Mountains. The above-mentioned basalts lense out rapidly northeast of Crater Camp and Monte Nido. North of Stunts Ranch the volcanics are less than 2500 feet thick. Farther east where they lap around the north-pitching nose of the Topanga anticline the volcanics lense out entirely, grading into conglomeratic sandstone and shale, thus indicating the eastward limits of the middle Topanga submarine volcanic flows. There are several isolated Topanga basalt beds of probable sub-marine origin in the area mapped by Hoots, but these do not compare in extent with the basalt and agglomerate flows of the western half of the range. In the Seminole quadrangle to the west, the Topanga volcanic sequence is very much thicker than in the Dry Canyon quadrangle, so that the upper Topanga sedimentary member is represented there chiefly by volcanic extrusives. Only a few hundred feet of marine sediments separate these volcanics from the overlying Modelo formation.

The fact that the basalts in this area offer little resistance to weathering and erosion has resulted in a conspicuous topographic depression or 'bowl' which marks the area occupied by the volcanic rocks. This topographic feature is suggested by the name "Crater Camp" which has been given to the small settlement at this locality. The basalts show many conspicuous examples of concentric, or spheroidal weathering. The sandstone and shale members interbedded with the basalt in the lower part of the series, because of their greater resistance to erosion, form conspicuous 'hog-back' or cuesta ridges in the steeply-dipping monoclinal beds.

Upper Topanga Member

The upper Topanga member, which overlies the volcanic member, is found only in the Dry Canyon quadrangle and consists of about 4800 feet of poorly consolidated sandstones and coarse conglomerates. The sandstones form the lower and upper portions of the member, the conglomerate the middle portion. The upper Topanga is overlain by the Modelo formation (upper Miocene) with a well-marked angular unconformity, the differences in dip being from 20 to 40 degrees, thus making the separation of the two formations comparatively easy. This angular unconformity is more pronounced in the eastern part of the Dry Canyon quadrangle, in the vicinity of Mohn Springs, where it has been described by Hoots.[33] Near this locality an angular discordance of as much as 40 degrees has been observed.

The upper Topanga strata are overlapped by the Modelo formation so that the exposed thickness of the Topanga is extremely variable. For example, in the Dry Canyon quadrangle, the maximum thickness (about 4800 feet) occurs in the Stokes Canyon area, west of the Topanga anticline. On the northward pitching nose of the Topanga anticline, the upper Topanga (above the volcanics) is only about 3000 feet thick. On the east flank of the Topanga anticline beyond the eastern limits of the middle Topanga volcanics, the Topanga formation is almost entirely covered by the overlapping Modelo formation. A pebble count of the conglomerate of the upper Topanga member was made by Simonson[34] (Table 2). A comparison of these results with pebble counts in the Sespe conglomerates shows that in the upper Topanga conglomerate, cobbles of volcanic and meta-volcanic rocks predominate just as in the lower and middle Sespe conglomerates, and in contrast with the prevalence of plutonic types in the upper Sespe conglomerates. In the upper Topanga conglomerate, volcanic and meta-volcanic types predominate not only in quantity of material but also in variety of rock types. Quartzite is very common and pebbles of white vein quartz are numerous. One pebble of white quartz collected by the writer showed minute flakes of free gold.

Foliates and porphyrites are rare in the upper Topanga conglomerate, as are also the tourmaline-quartz monzonite, tourmaline diorite, and tourmaline quartzite, which are rather abundant throughout the Sespe conglomerates. In general the pebbles and cobbles of the Topanga conglomerate are much smaller in size than those in the Sespe conglomerates, and there is a distinct preponderance of the more resistant rock types.

A list of the fossils collected from the Topanga in the two quadrangles under discussion and identified by Dr. U. S. Grant and Ernest H. Quayle is given in the accompanying table.

Partial List of Fossils from the Topanga Formation, Las Flores and Dry Canyon Quadrangles, Santa Monica Mountains

(Numbers refer to localities indicated on the accompanying map)

Pelecypoda	Localities as Mapped
Amiantis cf. *stalderi* Clark;	*73*, 82, 83.
Arca *(Anadara) osmonti* n. subsp., Reinhart ms,	*32*, 82.
Arca *(Anadara) trilineata* Conrad,	*32*.
Clementia (Egesta) pertenuis (Gabb),	*32*, *66*, *71*, 82.

[33] Hoots, H. W., *op. cit.*, p. 102.

[34] Simonson, Russell R., *op. cit.*, p. 52.

Pelecypoda **Localities as Mapped**

Dosinia arnoldi Clark, 82.
Lucina (Here) excavata Carpenter, 82.
Lucina (Myrtea) acutilineata Conrad, *32*, 82.
Macoma nasuta Conrad, *22, 32*, 82.
Mytilus mathewsoni Gabb var. *expansus* Arnold, *32*, 82, 83.
Ostrea eldridgei Arnold, *32*.
Panope generosa Gould, 83.
Pecten (Lyropecten) cf. *magnolia* Conrad, 82.
Pecten (Vertipecten) navadanus Conrad, *5, 17, 18, 22, 26, 30, 66, 68, 71, 72*.
Pholadidea penita (Conrad), 82.
Pholas (Zirfaea) deutatus (Gabb), 82.
Pinna (Pinna) n. sp., *32*.
Pteria peruviana Reeve var. *rositae* Hertlein, *32*.
Saxidomus nuttalli Conrad, *32*, 82.
"Tivela" gabbi, Clark, 82.

Gastropoda

Calyptraea (Calyptraea) inornata Gabb, *32*, 82.
Calyptraea (Trochita) trochiformis (Chemnitz), *32*, 82.
Cancellaria (Calcarata) condoni Anderson, 82.
Cancellaria (Calcarata) dalliana Anderson, 82.
Cancellaria (Euclia) simplex Anderson, 82.
Crepidula praerupta Conrad, *32*.
Crepidula princeps Conrad, 25. (L. 106. W. 63 H 40 mm.)
"Drillia" antiselli Anderson, 82.
"Drillia" cf. *buwaldana* Anderson, 82.
"Drillia" ocoyana, Anderson & Martyn, 82.
Fissurella rixfordi Hertlein, *32*.
"Ocinebra" topangensis Arnold, *32*, 82.
Polinices (Neverita) reclusianus callosus (Gabb), *78*, 82, 83, *32*.
Terebra cooperi Anderson, 82.
Thais trophonoides Anderson & Martyn, 82.
Turbo topengensis Arnold, 82.
Turritella ocoyana Conrad, ss., *32*, *78*.
Turritella ocoyana bosei Hertlein & Jordan, *22, 66, 75, 78, 82*.
Turritella temblorensis Wiedey, *18, 22, 32, 44, 73, 75*, 79, 82.
Turritella inezana Conrad var., 54, 55, 59, 79.
Turritella inezana bicarina Loel & Corey, 59.
"Echinarachnius" norrisi (Park).

Dr. Grant offers the following comments on these fossils:

"Most of the collections appear to indicate the Transition zone or lowest Temblor as those terms are customarily used in defining the subdivisions of the Miocene of the California coast ranges. However, the occurrence of what appears to be *Turritella inezana bicarina* Loel and Corey at Locality 59 suggests a zone well down in the Vaqueros. *Turritella temblorensis* Wiedey is the most abundant *Turritella* in the collections. Its growth lines indicate it may belong to the *T. terebralis* group. It appears to be entirely distinct from the *T. ocoyana* clan which is well represented in the collections by the variety bösei Hertlein and Jordan and Conrad's typical variety. Several well-preserved specimens of *Turbo topangensis* Arnold, including opercula, were obtained from Locality 82. One of these has the operculum wedged inside the aperture. The pustulose operculum of this little *Turbo* places it with the *Callopoma* group which is represented in the recent faunas of the eastern Pacific by *T. (Callopoma) fluctuosus* Wood, *Saxosus* Wood, *Magnificus* Jonas, *Niger* Wood, and *mazatlanica* Pilsbry and Lowe. *Turbo topangensis* has a superficial resemblance to some species of *Tectarius* Valenciennes which, however, has a horny operculum and belongs to the Littorinidae.

"As a whole the pectens appear to be poorly preserved but *Vertipecten nevadamus* (Conrad) (which is probably an older name for *Pecten bowersi* Arnold and *Pecten Kernensis* Hertlein) is rather abundant. *Clementia (Egesta) pertennis* (Gabb) is common. Its variability here as well as in the Caliente Mountain Miocene of eastern San Luis Obispo County suggests that *Clementia conradiana* (Anderson) probably represents only an individual variation.

"The correlation of these Santa Monica Mountain fossil beds with the zones in the Kern River-Poso Creek area is difficult on account of differences in ecology. It is possible that some of the Transition faunas of the Santa Monica Mountains in the area just west of Topanga Canyon may be equivalent in age to the Jewett-Freeman silts, but the latter appear to represent deeper water. Locality 82 contains a number of species which are also found at Barker's Ranch (Zone "B" of F. M. Anderson) and if this represents identical or similar ages, then the beds in the Dry Canyon quadrangle (Loc. 82) may be equivalent to the base of the Round Mountain Silt or upper part of the Olcese sand. Such a correlation would place the lower few hundred feet of the Topanga formation in the

Dry Canyon quadrangle well up in the Temblor subdivision of the Miocene as applied to the Kern River area. This suggests that the basal Topanga beds rapidly attain lower horizons westward. This seems to be true in the areas west of the quadrangles considered in the present report.

"Echini are remarkably rare in the collections. Occasional unidentifiable fragments occur but only *"Scutella" norrisi* Pack has been identified. This species is not a typical *Scutella* but has customarily been referred to that genus.

"As a whole the faunas indicate that the marine temperature during the deposition of the fossiliferous beds was considerably higher than that of the present seas in this latitude. Similar temperatures might be encountered in shallow water south of Scammons Lagoon on the west coast of Lower California."

UPPER MIOCENE ROCKS—MODELO FORMATION

The diatomaceous shales along the north edge of the Santa Monica Mountains, described and mapped by Kew,[35] as Pliocene (Pico formation), are now considered to represent the upper part of the Modelo formation. In his report on the eastern Santa Monica Mountains, Hoots[36] mapped these diatomaceous shales as upper Modelo. He divided the Modelo into four mappable units: a lower shale and lower sandstone, and an upper shale and upper lenticular sandstone.

The present writer at first attempted to divide the Modelo formation in the Dry Canyon quadrangle into the same four units as was done by Hoots, but this was found to be impracticable because of the rapid lensing out of the upper sandstone members towards the west. Consequently only a three-fold division of the Modelo is shown on the accompanying geologic map.

Except for a few shell fragments, no mega-fossils were found in the Modelo formation in this area. Fish scales and marine plant remains are numerous. A few whale bone fragments and small pieces of petrified wood were found. Samples of brown foraminiferal and diatomaceous shale collected by the author from the highway cut on the east side of Malibu lagoon (fossil locality 85) were submitted to Wilbur D. Rankin who identified the foraminifera as belonging to the upper part of the lower Modelo shale, not higher than zone 12 nor lower than zone 8, and probably correlating with zone 9 described in Hoots' report on the eastern Santa Monica Mountains.[37]

Area in Dry Canyon Quadrangle.

In the Dry Canyon quadrangle all three members of the Modelo are present, as follows: (1) a lower member, consisting of hard, platy, siliceous shale containing abundant foraminifera, radiolaria, and diatoms; cherty at many localities; alternating with thin beds of soft, brown, foraminiferal shale; (2) a middle member consisting of soft brown to gray lenticular beds of coarse sandstone, separating the lower platy shale from (3) an upper member of soft, white to light gray, diatomaceous and foraminiferal shale, and gray, punky diatomite, containing a few thin lenses of yellowish sandstone. The Modelo rests upon the Topanga with pronounced angular unconformity. The thickness of the various members of the Modelo are variable due to the lenticular nature of the formation. The maximum total thickness of the Modelo formation as represented in the area is

[35] Kew, W. S. W., *op. cit.*, p. 64; *also* Pl. I.
[36] Hoots, H. W., *op. cit.*, pp. 101-115; *also* Pl. 16.
[37] Hoots, H. W., *op. cit.*, Pl. 27.

about 4600 feet in the north-central part of the Dry Canyon quadrangle.

Area Along Coast—Las Flores Quadrangle.

The only Modelo found in the Las Flores quadrangle occurs as a narrow east-west strip along the coast south of the Malibu Coast fault, and west of Las Flores Canyon. It is believed, however, that the Modelo formation originally was deposited throughout the area and that it has been eroded from most of the area since the post-Modelo diastrophism which elevated the region. The best Modelo exposures along the coastal belt may be seen along the coast highway on the southern ends of the spur ridges on both the east and west sides of the mouth of Malibu Canyon, north of Malibu Beach. Another good exposure of Modelo diatomaceous shale may be seen on the north side of the coast highway about opposite the tile factory east of Malibu Canyon.

PLEISTOCENE ROCKS

Marine Pleistocene.

The only marine Pleistocene deposits in the area occur as small discontinuous remnants on portions of the elevated wave-cut platforms along the coast in the Las Flores quadrangle. These marine deposits rest upon the truncated edges of steeply-dipping older strata, and are mostly covered by recent deposits stripped from the steep slopes to the north. The Pleistocene marine deposit consists of thin beds of cobbles and sands, in some of which numerous fragments of marine fossils were found. A short distance east of the mouth of Las Flores Canyon a small area of red-colored sandstone, containing marine Pleistocene fossils may be seen. This deposit was probably derived from the adjacent red Sespe sandstone cliffs against which it lies. The Pleistocene sands which dip gently to the south lie upon sandstone strata of probable Sespe age which dip steeply to the north. Between Carbon Canyon and Las Flores Canyon, on a remnant of an elevated marine platform is found a coarse, semi-consolidated dark-gray sandstone, containing many Pleistocene fossil fragments along the surfaces of stratification.

Non-Marine Pleistocene.

Non-marine sands, gravels and soils believed to be of late Pleistocene age occur as thin, discontinuous patches on the elevated marine platforms along the coast. They cover marine Pleistocene sands and gravel beds in a few places, and are, in turn, mostly covered by Recent soils and sands. The material of which the non-marine Pleistocene deposits is composed consists of poorly sorted angular rock fragments, sands and muds made up of the same rock types which occur in place on the adjacent slopes. They were deposited by streams which flowed south from the Santa Monica Mountains across the marine platform at a time when the shore was considerably farther out from its present position. The gradual shifting of the shore line landward is the result of late Pleistocene and Recent marine erosion.

RECENT ALLUVIUM

Coarse to fine unconsolidated valley and stream channel deposits cover the floor of the San Fernando Valley in the northeast part of the Dry Canyon quadrangle. Along the coast in the Las Flores quadrangle Recent sands, gravels and soils are found on the surfaces of the elevated marine terraces and along the canyon bottoms and especially along the bottom of the lower part of Malibu Canyon. Beach sands of Recent age extend continuously along the shore. Opposite the mouth of Malibu Canyon, the muds and sands which have filled the lagoon behind the sandbar of Malibu Beach are largely of post-Pleistocene age.

LIST OF FOSSIL LOCALITIES

The following table describes the localities where fossils were collected in the area. The map numbers correspond with those shown on the accompanying geological map. The U. C. L. A. locality numbers correspond with those on the specimens in the collections of the Geology department at the University of California at Los Angeles.

STRUCTURE

Without some knowledge of the geology of the area to the east, the six-mile-wide strip across the Santa Monica Mountains under discussion would give a very misleading idea of the geological structure of the range. The area embraced within the Dry Canyon and Las Flores quadrangles is of particular geological interest because it occupies approximately the middle portion of the range; to the east and west the geological structure is very different. The anticlinal structure clearly apparent in the eastern end of the Santa Monica Mountains becomes less evident toward the west. In the Topanga Canyon and Reseda quadrangles, near the western end of the area mapped by Hoots[38] and Kew, block-faulting and igneous extrusion and intrusion have obscured any anticlinal structure which once may have existed here.

Still farther west, in the Dry Canyon and Las Flores quadrangles, the structure appears to be a north-dipping monocline upon which a north-plunging anticline and two north-plunging synclines have been superimposed. (See map and structure section.) The axes of these secondary folds trend in a direction nearly normal to the east-west regional strike and topographic trend of the mountains. Along the coast in this area, at the southern edge of the range, an important east-west fault (Malibu Coast fault) separates the older formations on the north from a down-dropped narrow belt of Modelo rocks on the south. Although these Modelo rocks dip steeply to the north into the fault, it is possible that the range represents only the north flank of an intricately broken and invaded anticlinal structure, the faulted axial portion of which is now partially submerged. If the Modelo formation was originally deposited over the entire area with great angular unconformity similar to the Modelo overlap now visible in the eastern part of the range, the presence of the belt of Modelo rocks along the coast would not necessitate the assumption of any great amount of vertical displacement along the Malibu coast fault.

[38] Hoots, H. W., *op. cit.*, Pl. 16.

The Santa Monica slate (Triassic?) and the granite intrusives (Jurassic?) associated with it, which form the axial core of the domed uplift midway between Topanga Canyon and the eastern end of the range, are not exposed in the Dry Canyon and Las Flores quadrangles, nor, in fact, in any part of the western Santa Monica Mountains. The Jurassic (?) granite intrusion and diastrophism which effected the domed area of the eastern part of the range, apparently did not produce comparable effects in the western portion. In the eastern part of the range, the middle Miocene Topanga formation in many places rests upon the upturned and truncated Santa Monica slate, and both are overlapped by the upper Miocene Modelo formation with great angular unconformity. In the western part of the range the Topanga rests upon the Vaqueros and Sespe with gradational contact, and the uncomformity between the Topanga and the Modelo is less pronounced than it is farther east. The Modelo formation, if it were originally deposited over the entire area, has been eroded from the pre-Topanga formations with which it is now in fault contact.

PRE-TOPANGA DEFORMATION

The earliest deformation of which there is a record in the western Santa Monica Mountains occurred in post-Martinez and pre-Vaqueros time. It is represented by the total absence of marine Eocene and Oligocene strata, unless, as suggested by Schenck,[39] the Vaqueros formation of California is Oligocene in age, in which case the deformation would be limited to Eocene time. In the area under discussion the non-marine Sespe beds (Eocene ? and Oligocene ?) rest unconformably upon marine Martinez strata (Paleocene) and grade upward and interwedge into marine Vaqueros beds, thus recording changes of level resulting in the withdrawal and subsequent advance of a shallow sea. There is no convincing evidence that these changes of level were accompanied by any important folding or faulting in this region. The unconformity between the Sespe and the Martinez is not very conspicuous, and the change from non-marine Sespe to marine Vaqueros and Topanga strata is gradational. In the eastern Santa Monica Mountains, as pointed out by Hoots,[40] there appears to have been relatively large-scale uplift in the block of slate and granite, between Martinez and Sespe (?) or Vaqueros (?) time.

POST-TOPANGA AND PRE-MODELO DEFORMATION

One of the most important disatrophic deformations recorded in the area is that which occurred subsequent to the deposition of the Topanga (middle Miocene) marine strata. This deformation was preceded by the extrusion of large masses of lava upon the sea floor. That this interval was one of sharp uplift and folding followed by rapid erosion, is recorded in the angular unconformity of from 20 to 40 degrees which separates the Topanga and Modelo formations throughout the area. From a study limited to the area under discussion, it can not be definitely determined whether the diastrophism which occurred at this time produced anticlinal folding, as it is known to have done in the eastern Santa Monica Mountains. The deformation involved not only

[39] Schenck, H. G., *op. cit.*

[40] Hoots, H. W., *op. cit.*, p. 126.

the extrusion on the sea floor of a thick sequence of basalt flows, but many faults were formed at this time. The magmas, which in middle Topanga time began to be extruded irregularly as submarine flows, permeated the older Chico, Martinez, Sespe, Vaqueros and lower Topanga formations through which they had to rise to the surface, and formed innumerable intrusive basalt masses, many of which are dikes, but the majority of which are small and extremely irregular in shape. Many of the dikes occur along faults producing a field relationship useful in mapping the faults. The use of such a large volume of magma in late Topanga time may have helped to develop the forces of uplift which deformed all the existing formations in the area in post-Topanga-pre-Modelo time.

It is noteworthy that only one or two very small patches of volcanic rock were found within the Modelo formation. These are both intrusive, and occur adjacent to the post-Modelo Malibu Coast fault in the southern edge of the Las Flores quadrangle. To the west in the Solstice Canyon and Dume Point quadrangles and elsewhere, the writer has seen several fairly large masses of basalt in the Modelo. The evidence is clear, however, that the great majority of the volcanic extrusions and intrusions in the Santa Monica Mountains occurred during middle and upper Topanga time.

The accompanying geologic map shows the most noteworthy feature bearing upon the age of faulting in the area. In the Las Flores quadrangle, where the rocks are mostly pre-Modelo in age, faults are numerous throughout the area. In the Dry Canyon quadrangle the faults are confined to the pre-Modelo rocks in the south part of the area. The only important fault which from the field evidence in this area is definitely of post-Modelo age, is the Malibu Coast fault. This does not preclude the possibility that movements along some of the faults in the older rocks may have occurred in post-Modelo or even in post-Pliocene time.

POST-MIOCENE DEFORMATION

That post-Miocene folding and post-Pliocene uplift accompanied by faulting affected the eastern part of the Santa Monica Mountains is clearly indicated by the folded and faulted condition of the Modelo formation in that area, and by the presence there of faulted and tilted Pliocene strata. In the area described in the present report, no Pliocene rocks are known to occur. This fact, together with the very scanty distribution of the small remnants of Pleistocene deposits, make it difficult to date definitely post-Miocene deformation which affected the western Santa Monica Mountains. The faulted condition of the Modelo formation along the coast and its folded structure on the north side of the range make it certain that important post-Miocene deformation, of an orogenic aspect did affect the region. The elevated and tilted marine terraces along the coast, carrying remnants of marine Pleistocene deposits, prove that late Pleistocene or post-Pleistocene uplift occurred. Additional evidence of such late uplift is seen in the narrow, V-shaped profiles of the lower parts of most of the canyons along the coast, indicating fairly recent rejuvenation.

The post-Miocene folding which involved the Modelo formation in the Dry Canyon quadrangle produced alternating anticlines and synclines trending approximately north-south at right angles to the direc-

tion of the axes of folding farther east. While it seems probable that these folds were formed at the same time that the Modelo in the eastern part of the range was folded to form a part of the Santa Monica anticline, nevertheless such a conclusion must remain uncertain. The marked divergence of the structural trend of the post-Modelo folds in the Dry Canyon region from the regional trend of folding elsewhere in the Santa Monica Mountains, and the fact that these north-south folds do not extend south of the Calabasas fault into the Las Flores quadrangle, suggests that they may not be contemporaneous in origin with the post-Modelo folding along the Santa Monica anticline east of the Topanga Canyon quadrangle.

FAULTS

The principal faults in the area are shown on the accompanying geologic map. There are numerous small faults, especially in the Las Flores quadrangle, which are too small, or the tracing of which was too uncertain to justify showing them on the map. All of the large faults and the great majority of the smaller ones are high-angle faults. Along the extreme eastern edge of the area in Topanga Canyon several low-angle faults were observed, but these could not be traced westward beyond the canyon walls. Some of these small low-angle faults are of the thrust variety, but the great majority of the faults of the area, including all of the larger ones, are either high-angle normal faults or vertical faults.

The fault pattern shows four distinct groups based upon directional trends; (1) a northwest-southeast group represented by the Calabasas, Red Rock, Saddle Peak, Dark Canyon, Pena Canyon, and several smaller faults; (2) a northeast-southwest group, represented by several relatively short faults in the Las Flores quadrangle; (3) a north-south group, represented by the Las Flores, Malibu Canyon, Fernwood, and several smaller faults all in the Las Flores quadrangle; (4) an east-west group; represented principally by the Malibu Coast fault. It is not intended to imply from the foregoing classification that the faults in the four groups were formed at different times. However, the east-west group shows evidence of being the most recent (post-Modelo) in age. The north-south Las Flores fault appears to offset or terminate faults of both remaining groups, but does not displace Modelo rocks. Upon that evidence, the north-south faults represent the second youngest group and are pre-Modelo in age. There seems to be no convincing evidence as to the relative age of the northwest-southeast and northeast-southwest groups. Faults of each of these two groups terminate against faults of the other group; and it is of course possible that they are of the same age.

The basalt flows of the middle Topanga member are cut and displaced by four large faults of the northwest-southeast group, i.e., the Calabasas Peak, Red Rock, Saddle Peak, and Dark Canyon faults. None of these four fault lines are marked by basalt intrusives. None of these four faults could be traced across the upper Topanga member, and none of them cut the Modelo formation. Their age is thus fixed as later than the volcanic member of the Topanga and younger than Modelo. They may have developed during the Topanga volcanic out-

burst, and in that case may have served as conduits for the rising lavas which formed the middle Topanga sub-marine flows.

Many basaltic intrusions occur along certain pre-middle Topanga faults in the Las Flores quadrangle. Most of these intrusions appear to have risen along the fault fractures subsequent to the last major movements on the faults. It is noteworthy that the numerous areas of basalt which occur in the pre-middle Topanga rocks throughout the Las Flores quadrangle are mostly intrusive in nature, whereas in the Dry Canyon quadrangle, the basalts are mostly extrusive and confined to the Topanga formation. This relationship supports the theory that some of the intrusive basalts in the pre-Topanga and lower Topanga rocks represent conduits up which magmas rose in the middle Topanga time to form sub-marine flows. The principal source or center of extrusion of the great basalt and agglomerate flows of the western Santa Monica Mountains was probably to the west of this area. The vents up which the lavas rose may now be buried beneath the flows. These vents may well have been faults in pre-Topanga rocks.

The topographic reflection of the faults is in general not impressive. There are certain important exceptions to this, particularly along the Malibu Coast fault, which exhibits an eroded fault-line scarp in some places near the upper margin of marine terraces, and the Las Flores and Pena Canyon faults, along parts of which canyons have been eroded.

The Malibu Coast fault is not very conspicuous in this area; but westward along the coast, in the Solstice Canyon and Dume Point quadrangles, pronounced topographic features mark the fault zone. The bringing of the upper Miocene Modelo formation into contact with the Chico-Martinez and Sespe formations along the Malibu Coast fault in the Las Flores and Solstice Canyon quadrangles at first suggests to the observer the existence of a very large vertical displacement. However, no unusual displacement is necessary because of the probable overlapping of the Modelo onto all older formations. Because of the angular unconformity at the base of the Modelo and its overlap onto older formations, it is impossible to estimate the throw of the Malibu Coast fault.

In his report on the eastern Santa Monica Mountains, Hoots (pp. 126-127) pointed out that in the region mapped by him, "the coastal area northwest of the city of Santa Monica is one of complex structural conditions and is composed of a series of small fault blocks now largely concealed beneath Pleistocene alluvium. The faulting involved the rocks of all ages from Cretaceous to Pliocene, and it appears that this belt is an integral part of the fault zone which parallels the southern base of the range . . ." It is the present writer's opinion that the Malibu Coast fault, the trace of which has been mapped westward across the Solstice Canyon and Dume Point quadrangles and eastward to the mouth of Las Flores Canyon where it becomes submerged beneath the sea, represents the westward continuation of the same fault zone which parallels the southern base of the range to the east. The complex structural conditions mentioned by Hoots as characterizing the coastal area in the Topanga Canyon quadrangle are practically duplicated along the coast in the Las Flores quadrangle, adjacent to the Malibu Coast fault, and become even more conspicuous further west.

FOLDS

The Topanga anticline, named and mapped in part by Kew,[41] is the largest and most important fold in the area. This fold, the axis of which trends slightly west of north, plunges to the north and south from the apex of a domed area in the vicinity of Red Rock Canyon southeast of Calabasas Peak. The fold is cut off abruptly on the south by the Red Rock fault, but to the north it can be traced across the Topanga and Modelo formations for more than four miles. To the east and west of the Topanga anticline there are parallel synclinal folds which the writer has called the Topanga syncline and the Stokes Canyon syncline respectively. These synclines both plunge to the north or northwest. They may be traced northward for approximately the same distance as the Topanga anticline. At their northern extremities these north-south folds all curve slightly westward and die out or merge into east-west folds which constitute the prevailing structural trend elsewhere throughout the Santa Monica Mountains.

It is noteworthy that the north-south folding above described has been developed only in that part of the Santa Monica Mountains which lies opposite (south of) the Simi Hills, which form a north-south topographic link connecting the Santa Susana Mountains on the north with the Santa Monica Mountains on the south. The structure of the Simi Hills is essentially anticlinal with an axial trend from northeast to southwest. Thus, the folding in the rocks which border the west end of the San Fernando Valley is approximately parallel with the curving topographic margin of the valley. The folds in the enclosing hills "wrap around" the western head of the valley; this condition is typical of a structural basin.

The Red Rock fault, which terminates the Topanga anticline and Topanga syncline on the south, does not cut off the Stokes Canyon syncline, the head of which extends southward into the Las Flores quadrangle in the vicinity of Stunts Ranch.

No folds of importance occur within the Las Flores quadrangle, except the head of the Stokes Canyon syncline and the head of another north-pitching syncline southwest of Monte Nido. The structure throughout most of the Las Flores quadrangle is essentially that of a steep north-dipping monocline intricately broken by many faults. The prevalence of faulting in the pre-middle Miocene rocks of the Las Flores quadrangle and the prevalence of folding in the post-middle Miocene rocks of the Dry Canyon quadrangle is the most conspicuous structural feature of the entire area. Most of the faults are pre-Modelo in age, whereas all of the larger folds are post-Modelo. It is quite possible that the small, discontinuous folds observed on the various fault blocks in the Las Flores quadrangle are also post-Modelo in age. However, because of the absence of Modelo and post-Modelo rocks throughout most of the Las Flores quadrangle it is uncertain whether these folds were formed along with the faulting, or whether they belong to a later period of deformation.

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[41] Kew, W. S. S., *op. cit.*, p. 107; *also* Pl. I.

GEOLOGIC HISTORY

The geologic history of the region is summarized in the following table:

Summary of geologic history of Las Flores and Dry Canyon Quadrangles, Western Santa Monica Mountains, during late Mesozoic and Cenozoic time

Sedimentation	Uplift folding faulting	Igneous Activity	Results	Known Area Affected
Upper Cretaceous and Paleocene undivided (Chico-Martinez)			4900-7500 feet of marine conglomerate, sandstone and shale with some thin limestone beds; (Chico-Martinez formations undivided).	Probably entire area
Eocene, Oligocene and possibly early Miocene (Sespe?)	Post-Paleocene		Erosion— Unconformity with angular discordance. Omission of marine Eocene and Oligocene strata. Deposition of more than 3200 feet of non-marine conglomerates and sandstones of prevailing red color (Sespe formation)	Probably entire area
Early and middle Miocene (Vaqueros-Topanga undivided)		Yes	Several hundred feet of marine sandstone and shale containing *Turritella inezina*, interfingering with non-marine Sespe red beds, and overlain with gradational contact by over 12,000 feet of conglomerates, sandstones, shales with included extrusive basalts and volcanic breccias.	Entire area
	Late middle Miocene	Yes	Uplift, tilting and probably folding, accompanied by much normal faulting and basalt intrusions, and subsequent erosion, resulting in pronounced angular unconformity.	Entire area
Late Miocene (Modelo)		Very little	Erosion— 4600 feet of platy, siliceous, cherty shales, diatomaceous shales, clay shales, and sandstone; a few thin beds of volcanic ash.	Probably entire area
	End of Miocene to Pleistocene		Erosion— Absence of Pliocene rocks from area indicates important post-Miocene uplift but makes exact date of uplift uncertain. Except for narrow strip along coast area probably undergoing erosion throughout Pliocene and Pleistocene time.	Entire area
	Pleistocene		Oscillations of coastal strip resulting in series of elevated wave-cut terraces, tilted toward west.	Southern part along coast
Pleistocene			Deposition of thin beds of marine Pleistocene sands and gravels on terrace surfaces, now mostly covered by non-marine wash from the mountains.	Southern part along coast
	Late Pleistocene		Uplift, accompanied by faulting along coast. Erosion.	Probably entire area uplifted

ECONOMIC GEOLOGY

Petroleum

Wells Drilled for Oil.

Four wells have been drilled for oil within the area of the Dry Canyon quadrangle, none of which were successful. The well locations are all shown on the accompanying map and section.

The Standard Oil Company of California in 1926 drilled a well known as Austin No. 1, located in the north-central part of Sec. 11, T. 1 S., R. 17 W., to a depth of 2503 feet. This well was located on the crest of the Topanga anticline, where the Sespe formation is exposed at the surface. Gas seepages in water wells had been reported in the district. Hard, dark-gray shale, believed to represent the top of the Martinez formation, was encountered at a depth of 1250 feet.[42] The well was drilled 1253 feet into the Martinez shale below the Sespe. Gas showings were reported from the formation (Martinez) in the lower part of the hole but no oil was encountered. This well location, on the very top of the Topanga anticline, which is a faulted dome with several hundred feet of closure, is regarded as structurally favorable. However, the Sespe sandstone is deeply eroded along the axis of the anticline and lacks a cap-rock or impervious cover. In the underlying Martinez shales, where small amounts of gas were present, no sandstone or porous reservoir rock was found.

At a point 1000 feet south and 1200 feet east of the west quarter corner of Sec. 26, T. 1 N., R. 17 W., a well known as Lyle W. Rucker No. 1, was drilled in 1931 to a depth of 802 feet. This test was started in the lower Modelo formation and reached the top of the Topanga formation. The bottom was in hard, gray sandstone. The location is not regarded as favorable as it is on the west flank of the Topanga syncline.

A well known as W. C. Price (Hale No. 1) located near the southwest corner of Sec. 10, T. 1 N., R. 17 W., was drilled in 1920 to a depth of 2930 feet. It is located in an east-west trending syncline to the north of the north-south folds of the Dry Canyon quadrangle. The well started in the upper Modelo formation and bottomed in Modelo sandstone (see structure section A-A'). Slight gas showings were reported at 2310 feet but no oil was encountered. The well was abandoned in 1921.

In the southeast quarter of Sec. 22, T. 1 N., R. 17 W., a well known as W. J. Martin No. 1 was drilled in 1929 to a depth of 1825 feet. The surface formation at this locality is sandstone which represents the upper part of the lower Modelo. The well bottomed in the lower Modelo formation. Fossil fish remains, commonly found in the Modelo formation, were found in the well cores. No oil or gas was encountered and the well was abandoned in 1931.

In addition to the four wells described in the foregoing paragraphs, several test wells were drilled for oil short distances beyond the borders of the Dry Canyon quadrangle. About one and one-half miles north of Ventura Boulevard and west of the west border of the area, two wells were drilled in Las Virgenes Canyon: Olympic

[42] Data supplied by geological department of Standard Oil Company of California, Los Angeles.

Petroleum Company (Hearst 1) 5935 feet deep; and Sinol Oil Company (Hearst 2) 4900 feet deep. No oil was found. Another well, Easton and Smith No. 1, was drilled to a depth of 2954 feet, a short distance northwest of Brents Junction, near the west edge of the Dry Canyon quadrangle. A fourth unsuccessful well, Pugh-Miller (Colyear No. 1) was drilled to a depth of 2527 feet at a location about one mile north of Stokes Canyon and a short distance west of the southwest edge of the Dry Canyon quadrangle.

A short distance north of the coast highway and just west of the extreme southwest corner of the Las Flores quadrangle, in Sec. 31, T. 1 S., R. 17 W., a well known as Ferguson-Francisco Petroleum Company No. 1 was drilled in 1922 to a depth of 1185 feet. No oil was found and the hole was abandoned in November, 1925. No record of the formations encountered is available.

Oil Possibilities.

The most promising structure in the area for possible oil accumulation is in the Topanga anticline with a closure of several hundred feet in Red Rock Canyon in the southeastern part of the Dry Canyon quadrangle. This is the only closed fold in the area. The dark-colored Martinez shale, which underlies the Sespe sandstone and conglomerate at this locality, has been regarded as a potential source rock for oil elsewhere in southern California. In the Simi oil field, on the north side of the Simi Valley, about 15 miles to the northwest, commercial oil is found in Sespe sandstone overlying shales of Eocene age, and oil is also obtained there in limited quantity from strata in the Eocene. Failure to find oil in the Standard Oil Company Austin well on the crest of the Topanga anticline must be regarded as highly unfavorable for the oil possibilities of the entire area. None of the folds involving the Modelo formation in the two quadrangles here under discussion show any closure, although it is possible that there may be a closed structure involving the Modelo a short distance off-shore in the vicinity of the mouth of Malibu Creek at the extreme south edge of the Las Flores quadrangle.

Throughout the Las Flores quadrangle the formations are broken into small blocks by numerous faults, and no anticlinal folds of significance exist. Along the south side of the Malibu Coast fault, the Modelo formation dips northward into the fault so that the off-shore submerged area is structurally higher than the exposed Modelo adjacent to the fault north of the coast highway. If these north dips in the Modelo represent the north flank of a faulted anticline, the axis of which is submerged a short distance off shore, there would be the possibility of a structural closure in the coastal belt of Modelo. This condition is suggested by the occurrence of a conglomerate reef exposed at low tide off Malibu beach which shows a reverse dip to the south.

No surface indications of oil were seen by the writer anywhere in the area other than slight impregnations in upper Modelo shale in the Dry Canyon quadrangle. A questionable oil seepage has been reported from the marshy flat near the lagoon at the mouth of Malibu Creek, but this was not seen by the writer.

BUILDING AND ORNAMENTAL STONE

Shale.

The lower Modelo siliceous and cherty shale is quarried in a small way at many localities for slabs which are widely used in Los Angeles for paving blocks in garden walks and residential yards, as well as for ornamental masonry walls.

In the northwest corner of the Dry Canyon quadrangle there are three small areas within the upper Modelo diatomaceous shale, where the shale has been burned to a cream, red, or maroon color, producing a rock of texture and appearance similar to brick in a kiln. The heat which produced this alteration of the shale was probably derived from the underground combustion of petroleum or asphalt originally present in the rock. The combustion is somewhat similar to the subterranean burning of coal. Oil or asphalt impregnations are commonly present in the upper Modelo shales in southern California and occurrences of such shales in the process of combustion have been recorded where the shale shows "burned" effects similar to those in this area. Near the Olympic Petroleum Company (Hearst No. 1) test well, previously mentioned, there is an area of burned Modelo shale which extends into the west edge of the Dry Canyon quadrangle. Here the shale is not only burned to bright red and variegated colors but it is hard and brittle. In places the shale has been fused so that it resembles basic lava. The rock at this locality is quarried and sold for ornamental purposes under the trade name of "volcanic rock."

Sandstone and Basalt.

At a few localities in both quadrangles the harder sandstones have been utilized locally for building. Their principal use is in foundations, chimneys, and stone walls. A small amount of basalt has been quarried and used for road metal.

UNDERGROUND WATER

Adequate supplies of good water are obtained from wells in the alluvial fill of the San Fernando Valley, the west end of which extends into the Dry Canyon quadrangle. Smaller supplies of water, sufficient for domestic supply of ranchers, are available from wells in the alluvial fills of the narrow flat-bottomed arroyos which drain the north flank of the mountains in the Dry Canyon quadrangle; also in the Valley of Malibu Creek; and in the Valley of the tributary of Malibu Creek which flows westward through the Monte Nido and Crater Camp districts in the northwest part of the Las Flores quadrangle.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

MARKETING MICA[1]

By Paul M. Tyler[2]

The value of mica depends chiefly upon the size of the flat sheets into which it can be split and also upon whether it is clear or stained. Muscovite (white mica) and phlogopite (amber mica) are the micas of commerce. Biotite (black mica) and other varieties are virtually unsalable. Vermiculite, an altered mica having the extraordinary property of expanding greatly when heated, preferably should not be classed commercially as mica. Mica is marketed as (1) cut or uncut block, (2) sheet, (3) splittings, and (4) wet or dry ground mica.

In the United States, mica that will not yield flat films over about $1\frac{1}{2}$ inches square, or that is ruled, rumpled, or flawed in any way, can be sold only as scrap, its sole use being for making ground mica. Only sizes that will yield rectangles $1\frac{1}{2}$ by 2 inches or larger can be classed as sheet quality; slightly smaller sizes may be classed as punch, and under certain circumstances still smaller sizes, down to about 1 inch square, may be used for splittings, which are mostly a thousandth of an inch thick or even thinner. Splittings, however, are produced in large quantities only in British India, where labor costs very little. Even there the work is done mostly by children, who not only work cheaper but have a delicacy of touch that enables them to do the splitting faster and better. No mechanical process yet devised will permit ordinary splittings to be made economically in the United States.

A great deal of apparently good, large mica is ruined by rumpling and distortion of the crystals or "books." Tangle-sheet mica splits imperfectly; ruled mica splits in ribbons across the regular cleavage planes; and wedge mica yields films that are thicker at one end than at the other. Spotted or stained mica contains thin scales or streaks of dark minerals, such as iron oxides, and is worth less than clear, transparent mica, even though for some purposes its usefulness is not greatly impaired. Clay-staining usually occurs only near the surface, the mica books being opened slightly by weathering, thereby admitting soil between the laminae, which often renders the mica useless even as scrap. Air-bells may ruin mica for use as sheets, unless the air can be removed by careful splitting.

Grading.—The small mica miner can scarcely hope to know how to appraise the value of his product, and ordinarily his appraisal would not be accepted by large buyers, who know exactly what they want. The product of any mine is mixed and contains many grades (sizes) and classes (qualities) in ever varying proportions. Even if universally accepted standards did exist with respect to certain grades and classes (which is not the case), there would still be opportunity for a difference of opinion as to the value of a mixed lot, some portions of which would yield sizes that were in active demand while other portions would not be wanted at the moment. Ordinarily, the better pre-

[1] "Reprinted from Bureau of Mines Information Circular 6997."

[2] Chief engineer, Nonmetal Economics Division, Bureau of Mines.

pared the product, the better the price that will be paid, partly for the reason that the product can be appraised more readily. On the other hand, much good mica can be spoiled by improper trimming or rifting, an experienced worker often being able to salvage a great deal of punch or even sheet sizes from material that others would classify only as waste. Trained judgment is essential, particularly when it comes to trimming out defects in rifted material; irregular pieces are likely to be worth more than the largest rectangle that could be obtained from them by close trimming. The complexity of the grading and classifying is indicated by the fact that there are fully 100 distinct products; A.S.T.M. designation D 351-33T recognizes six different qualities for each size—namely, clear, clear and slightly stained, fair stained, good stained, stained, and black stained or spotted—and intermediate classifications can be distinguished.

The following operations are performed in preparing mica for sale: (1) Cobbing and cleaning the books; (2) rifting or splitting into sheets thin enough to be cut by hand with a blade, say 0.01 to 0.04 inches thick; (3) trimming (Bengal mica is "sickle-trimmed", resulting in an irregular outline and beveled edge. Maderas mica is trimmed with a knife or guillotine, and mica from other countries is trimmed with knife, shears, or thumb); (4) grading by size; (5) classifying each size by quality; and (6) splitting to the desired final thickness, usually one mil (0.001 inch).

Production and consumption.—Although the United States is the world's largest consumer of mica, it produces normally only 15 to 35 per cent of its requirements of sheet mica and less than 5 per cent of its requirements of splittings. Domestic mines furnish almost enough punch and circle sizes, but the bulk of their yield is scrap. A good deal of finely divided mica is recovered as a byproduct of clay washing, further quantities are obtained from schists, and some scrap or waste mica is imported for grinding. Our principal importation is splittings, of which we consumed 3,500,000 pounds in 1936, about 90 per cent coming from British India and the balance from Madagascar and Canada. Domestic production of sheet mica in 1936 was 1,319,233 pounds, but only 300,773 pounds was larger than punch or circle. Imports of sheet mica aggregated less than 1,000,000 pounds, but consisted principally of larger sizes. Production of ground mica in the United States in 1936 reached an all-time record, amounting to 23,418 short tons. At present domestic mica is mined principally in North Carolina, New Hampshire, and Connecticut, but supplies are obtained from Alabama, Georgia, South Carolina, New Mexico, South Dakota, Virginia, and other States.

Uses.—The electrical industry is the principal consumer of sheet mica and splittings. However, the quantities used for stove windows, lantern chimneys, furnace peepholes, and nonbreakable goggles and sundry decorative uses are not insignificant. Ground mica is used mainly in roll roofing, although substantial quantities are consumed in making wall paper, paint, and rubber goods; miscellaneous uses include surfacing asphalt shingles, Christmas-tree snow, lubricants, annealing, concrete surfacing, foundry facings, pipeline enamels, plastic specialties, and others.

Prices.—The Engineering and Mining Journal (New York) regularly quotes various classes of mica, but any trade-journal quotations for domestic mica must necessarily be nominal inasmuch as prices must be determined chiefly by negotiation between buyer and seller on a given lot of material. Even with respect to well-standardized Indian mica, there is some latitude for price variation with respect to nominally similar grades. Reports of producers to the Bureau of Mines indicate that in 1936 waste or scrap mica was worth, on the average, $12.44 per short ton at the mines, and waste from some mines has sold as low as $6. Ground mica has sold for from about $12 a ton for byproduct or low-grade dry-ground material to over $100 for better qualities of clean, wet-ground mica, the average in 1936 for dry-ground mica being $21.97 and for wet-ground, $55.46 per ton. Punch and circle mica averaged 5 cents a pound, and for the larger sheet mica the average was 52 cents. For uncut sheet mica 2 by 2 inches, the price was from 30 to 50 cents; for 3- by 3-inch it was around 50 to 65 cents; and so on up to $3.50 to $5 a pound for 8- by 10-inch size. The effect of staining on price is illustrated in respect to high-grade Indian ruby #5 (3 to 6 square inches in area), which in 1935 was listed by dealers in the United States as worth $2.14 per pound for clear or slightly stained, $1.69 for fair stained, $1.47 for good stained, $0.54 for stained, and $0.33 for black-spotted. A similar grade of New England clear mica was listed at $1.20, and larger or smaller discounts were placed on mica from other sources, such as Brazil or Rhodesia. Generally speaking, Indian ruby mica, grade for grade and class for class, sells for higher prices per pound than other kinds of foreign or domestic mica. During 1936 Indian splittings brought from 10 cents to $1.20 a pound.

Buyers.—The following firms have indicated to the Bureau of Mines that they are buyers of mica of the kinds specified:

BUYERS OF MICA

Waste or Scrap

California.
Pacific Minerals Co., Ltd., Richmond.

Georgia.
Frank Smith, Cartersville.

Illinois.
Amalgamated Roofing Co., 6600 Central Ave., Clearing.
United States Gypsum Co., Chicago.

Massachusetts.
Huse-Liberty Mica Co., 171 Camden St., Boston.

New Hampshire.
New Hampshire Mica & Mining Co., Keene.

New York, New York City.
Barclay Chemical Co., Inc., 75 "A" Varick St.
English Mica Co., 220 East 42d St.
General Mineral Co., 96-104 Spring St.
Minerals & Insulation Corporation, 135 Prince St.
Eugene Munsell & Co., 200 Varick St.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Soeldner-Heyman Co., Inc., 149 Church St.
Varlacoid Chemical Co., 116 Broad St.

North Carolina.
Asheville Mica Co., Biltmore.
Franklin Mineral Products Co., Franklin.

Carolina China Clay Co., Penland.
General Mica Co., Penland.
Penland Feldspar & Kaolin Co., Penland.
D. T. Vance, Plumtree.

Ohio.

Gilbert H. Downey, The Westlake, Cleveland.

Virginia.

F. G. Hoffman, Claremont.
Richmond Mica Co., Richmond.

Wisconsin.

W. E. Krause Co., 8136 Milwaukee Ave., Wauwatosa.

Punch or Circle

Illinois.

American Mica Products Co., 313 W. Chestnut St., Chicago.
United States Gypsum Co., Chicago.

Massachusetts.

Huse-Liberty Mica Co., 171 Camden St., Boston.

New Hampshire.

New Hampshire Mica & Mining Co,, Keene.

New York.

Brooklyn

Ford Radio & Mica Corporation, 832 4th Ave.
Industrial Mica Corporation, 730 64th St.
Reliance Mica Co., 342 39th St.

New York City

William Brand & Co., 276 4th Ave.
General Mineral Co., 96-104 Spring St.
Otto Gerdau Co., 533 Canal St.
Gillespie Rogers Pyatt Co., Inc., 80 John St.
Mica Insulator Co., 200 Varick St.
Minerals & Insulation Corporation, 135 Prince St.
Eugene Munsell & Co., 200 Varick St.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Soeldner-Heyman Co., Inc., 149 Church St.
Varlacoid Chemical Co., 116 Broad St.

North Carolina.

Asheville Mica Co., Biltmore.
Carolina China Clay Co., Penland.
Penland Feldspar & Kaolin Co., Penland.
Spruce Pine Mica Co., Inc., Spruce Pine.

Ohio.

Gilbert H. Downey, The Westlake, Cleveland.

Uncut Sheet or Block

Georgia.

Frank Smith, Cartersville.

Illinois.

American Mica Products Co., 313 W. Chestnut St., Chicago.
Robert K. Preston Mica Co., 53 W. Jackson St., Chicago.

Massachusetts.

Huse-Liberty Mica Co., 171 Camden St., Boston.
The Macallen Co., 61 Macallen St., Boston.

New Hampshire.

New Hampshire Mica & Mining Co., Keene.

New Jersey.

Colonial Mica Co., 26 Exchange Place, Jersey City.

New York.

Ford Radio & Mica Corporation, 832 4th Ave., Brooklyn.
Industrial Mica Corporation, 730 64th St., Brooklyn.

New York City

American Mica Works, 49 West St.
William Brand & Co., 276 4th Ave.
Brazilian Trading Co,, Inc., 377 4th Ave.

General Mineral Co., 96-104 Spring St.
Otto Gerdau Co., 533 Canal St.
Mica Insulator Co., 200 Varick St.
Minerals & Insulation Corporation, 135 Prince St.
Mitchell-Rand Manufacturing Co., 51 Murray St.
Eugene Munsell & Co., 200 Varick St.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Soeldner-Heyman Co., Inc., 149 Church St.
Varlacoid Chemical Co., 116 Broad St.

North Carolina.

Asheville Mica Co., Biltmore
Carolina China Clay Co., Penland.
Penland Feldspar & Kaolin Co., Penland.
Spruce Pine Mica Co., Inc., Spruce Pine.

Ohio.

Gilbert H. Downey, The Westlake, Cleveland.

Pennsylvania.

Rodale Manufacturing Co., Emaus.

Virginia.

F. G. Hoffman, Claremont.

Cut

Illinois.

Robert K. Preston Mica Co., 53 West Jackson St., Chicago.
United States Gypsum Co., Chicago.

New Hampshire.

New Hampshire Mica & Mining Co., Keene.

New Jersey.

Colonial Mica Co., 26 Exchange Place, Jersey City.

New York.

Brooklyn

Industrial Mica Corporation, 730 64th St.
Reliance Mica Co., 342 39th St.

New York City

American Mica Works, 49 West St.
William Brand & Co., 276 4th Ave.
Brazilian Trading Co., Inc., 377 4th Ave.
General Mineral Co., 96-104 Spring St.
Otto Gerdau Co., 533 Canal St.
Gillespie Rogers Pyatt Co., Inc., 80 John St.
Mica Insulator Co., 200 Varick St.
Minerals & Insulation Corporation, 135 Prince St.
Mitchell-Rand Manufacturing Co., 51 Murray St.
Eugene Munsell & Co., 200 Varick St.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Soeldner-Heyman Co., Inc., 149 Church St.
Varlacoid Chemical Co., 116 Broad St.

North Carolina.

Asheville Mica Co., Biltmore.

Ohio.

Gilbert H. Downey, The Westlake, Cleveland.

Pennsylvania.

Rodale Manufacturing Co., Emaus.

Virginia.

F. G. Hoffman, Claremont.

Wisconsin.

W. E. Krause Co., 8136 Milwaukee Ave., Wauwatosa.

Ground

Georgia.

Frank Smith, Cartersville.

Illinois.

A. Daigger & Co., 161 West Kinzie St., Chicago.
United States Gypsum Co., Chicago.
Amalgamated Roofing Co., 6600 Central Ave., Clearing.

Massachusetts.

Fisk Rubber Co., Chicopee Falls.

New York.

John A. Wiener, 81 West 7th St., Oswego.

New York City

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza.
Barclay Chemical Co., Inc., 75 "A" Varick St.
Stanley Doggett, Inc., 473 Canal St.
General Mineral Co., 96-104 Spring St.
Mica Insulator Co., 200 Varick St.
Minerals & Insulation Corporation, 135 Prince St.
William H. Scheel, Inc., Water & John Sts.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Wishnick-Tumpeer, Inc., 295 Madison Ave.,

North Carolina.

Asheville Mica Co., Biltmore.
Carolina China Clay Co., Penland.
General Mica Co., Penland.
Penland Feldspar & Kaolin Co., Penland.

Ohio.

Natl. Sales Corporation, 31-35 East 13th St., Cincinnati.
Gilbert H. Downey, The Westlake, Cleveland.
Harshaw Chemical Co., 1933 East 97th St., Cleveland.
Weaver Wall Co., Brookpark & State Roads, Cleveland.

Wisconsin.

W. E. Krause Co., 8136 Milwaukee Ave., Wauwatosa.

Splittings

Georgia.

Frank Smith, Cartersville.

Illinois.

Robert K. Preston Mica Co., 53 West Jackson St., Chicago.
United States Gypsum Co., Chicago.

Indiana.

Continental-Diamond Fibre Co., Valparaiso.

Massachusetts.

The Macallen Co., 61 Macallen St., Boston.
New England Mica Co., Waltham.

New Hampshire.

New Hampshire Mica & Mining Co., Keene.

New York.

Mica Company of Canada, Inc., Massena.

Brooklyn

Industrial Mica Corporation, 730 64th St.
Reliance Mica Co., 342 39th St.
American Mica Works, 49 West St.

New York City

William Brand & Co., 276 4th Ave.
General Mineral Co., 96-104 Spring St.
Otto Gerdau Co., 533 Canal St.
Gillespie Rogers Pyatt Co., Inc., 80 John St.
Mica Insulator Co., 200 Varick St.
Minerals & Insulation Corporation, 135 Prince St.
Eugene Munsell & Co., 200 Varick St.
A. O. Schoonmaker Insulation Co., Inc., 345 Hudson St.
Soeldner-Heyman Co., Inc., 149 Church St.
Varlacoid Chemical Co., 116 Broad St.

North Carolina.

Asheville Mica Co., Biltmore.
Penland Feldspar & Kaolin Co., Penland.
Tar Heel Mica Co., Plumtree.
D. T. Vance, Penland.

Ohio.

Gilbert H. Downey, The Westlake, Cleveland.

Wisconsin.

Allis-Chalmers Manufacturing Co., Milwaukee.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

There have been no changes of personnel in the Division of Mines to be noted in the past three months.

New Publications.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, October, 1937, being Chapter 4 of State Mineralogist's Report XXXIII. This Chapter contains: "Mineral Resources of the Resting Springs Region, Inyo Couty." "Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County." "Native Arsenic from Grass Valley, California"; also the complete Index for Volume XXXIII.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, January, 1938, being Chapter 1 of State Mineralogist's Report XXXIV. This Chapter contains: "Mineral Development and Mining Activity in Southern California during the year 1937." "Doing something about Earthquakes." "Gold and Petroleum in California." "Gem Minerals of California," and "Lapidary Art."

Commercial Mineral Notes (Nos. 178-180, inc.). February, March and April, 1938, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

The counties of California have produced for some years past more than 50 different mineral substances, the total value of which was estimated at $351,487,000 for 1937. See January, 1938, issue of the CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

At present (April, 1938) reports for most of the producers are in hand. Data for several substances are now complete and have been compiled, being presented herein. Information at hand indicates that there was no commercial production during 1937 of the following: antimony, asbestos, bismuth, graphite, lithia, manganese ore, molybdenum ore, serpentine, shale oil, strontium, titanium, or tin.

There was a single producer of each of the following: bromine, fluorspar, magnesite, potash, pyrite, and wollastonite.

For the first time in this State, zircon sands appeared on the list of commercial producers. This came from a dragline dredge near Lincoln in Placer County, and was shipped for sand-blasting and experimenting in the manufacture of refractories.

BORATES

During 1937 there was produced in California a total of 346,487 tons of borate materials compared with 319,658 tons for the year 1936. The material shipped during the year included the new sodium borates, kernite (rasorite), Kramerite from Kern County; also crystallized borax prepared by evaporation of brines at Searles Lake in San Bernardino County and Owens Lake in Inyo County.

As the crude ore is not sold as such, but is almost entirely calcined before shipping to the refinery for conversion into the borax of commerce, and because of the fact that the material varied widely in boric acid content, we have recalculated the tonnage to a basis of 40 per cent A. B. A. This is approximately the average A. B. A. content of colemanite material after calcining, and also of the crystallized borax obtained from evaporation of the lake brines.

Recalculated as above, the 1937 production totaled 326,099 tons valued at $6,206,619. This was an increase both in quantity and value over the 1936 output, which was 313,389 tons worth $5,911,093.

The total amount of borates exported from the United States [1] during the year 1937 was 153,772 tons valued at $4,708,691, as compared with 102,021 tons worth $3,119,850 in 1936.

[1] Monthly Summary of Foreign Commerce of the United States, Department of Commerce, Dec., 1937.

CEMENT

During 1937 there was a production of 12,072,062 barrels of cement in California, valued at $16,546,229 f.o.b. plant, of which 4,339,320 barrels came from northern California plants, and 7,732,742 barrels came from southern California plants. The 1937 output was a decrease from that of 1936, which was 13,300,188 barrels worth $18,314,589.

Shipments during 1937 were made from ten plants in nine counties to the extent of 11,721,818 barrels valued at $16,868,379, as compared with 12,994,393 barrels worth $18,090,256. There were five plants in operation in northern California—one each in Calaveras, Contra Costa, Merced, San Mateo, Santa Cruz counties, which shipped 4,284,965 barrels of cement; and five plants in southern California, two in San Bernardino County, and one each in Kern, Los Angeles and Riverside counties, which shipped 7,436,853 barrels of cement. There were 2,157 men employed in the above plants during the year 1937.

CHROMITE

During the year 1937 there were shipments of chromite or chromic iron ore in California amounting to 1,918 short tons, recalculated to a basis of 45% Cr_2O_3, valued at $20,830 f.o.b. shipping point, and came from two properties in Del Norte County and one each in El Dorado, Fresno, Placer, Santa Barbara, and Tulare counties. The total shipments for 1937 were the largest since 1919. The 1936 output amounted to 221 tons worth $3,314.

Occurrence.

Chromite is widely distributed in California, the principal production, thus far, having come from El Dorado, San Luis Obispo, Del Norte, Shasta, Siskiyou, Placer, Fresno, and Tuolumne counties. In 1918 a total of 29 counties contributed to the State's output. There are two main belts in California yielding this mineral, one along the Coast Ranges from San Luis Obispo County to the Oregon line, including the Klamath Mountains at the north end, and the other in the Sierra Nevada from Tulare County to Plumas County. Chromite occurs as lenses in basic igneous rocks such as peridotite and pyroxenite, and in serpentines which have been derived by alteration of such basic rocks.

Imports.

Imports of foreign chromite[1] to the United States duty free during 1937, came mainly from Southern Rhodesia, Union of South Africa, New Caledonia, Philippine Islands, Turkey, Greece, and India. The total was 553,916 long tons, valued at $7,324,488 for 1937, compared with 324,258 long tons worth $4,431,898 for 1936.

DOLOMITE

The 1937 output of dolomite in California amounted to 12,371 short tons valued at $24,603. This came from four properties—one each in Inyo, Los Angeles, Monterey, and San Benito counties.

[1] Monthly Summary of Foreign Commerce of the United States. Department of Commerce, Dec., 1937.

The 1937 production showed a decrease in amount and value as compared with that of 1936, which was 25,807 tons, worth $63,122.

The material shipped was utilized for steel-furnace flux and refractories, plaster, stucco, dash-coat, terrazzo, art stone, for the manufacture of CO_2, and mineral wool.

FELDSPAR

The output of feldspar in California during 1937 amounted to 2686 short tons valued at $10,930 and came from two properties in San Diego County, and one in Fresno County.

The 1937 production was a decrease in quantity and value as compared with that of 1936 which was 3430 tons worth $24,959.

GYPSUM

During 1937 there were shipments of gypsum in California amounting to 186,160 tons valued at $384,431. This came from three properties in Fresno County, and one each in Imperial and Riverside counties. Shipments showed an increase in both amount and value over the 1936 output which was 143,549 tons worth $282,703.

IRON ORE

During 1937 shipments of iron ore were made in California coming from two properties each in Inyo and San Bernardino counties. These amounted to 5490 short tons valued at $29,340, as compared with 31,084 tons worth $155,434 for 1936.

The 1936 output came from two properties in San Bernardino County and one in Santa Cruz County. The material mined during the year was magnetite and hematite from Inyo County, and hematite from San Bernardino County. The hematite was used mostly in high iron cement with some going to foundries as a flux. The use to which the magnetite was put was not disclosed.

There was also some high grade limonite mined in Yuba County, but as it was used in the manufacture of pigments, it has been classed under Mineral Paints.

There are considerable deposits of iron ore known in California, notably in Shasta, Madera, Placer, Riverside, San Bernardino, and Los Angeles counties, but production has so far been limited for lack of an economic supply of coking coal. Some pig iron has been made, utilizing charcoal for fuel, both in blast furnaces and by electrical reduction; also, ferrochrome, ferromanganese, and ferrosilicon have been made in California.

MAGNESIUM SALTS

During 1937 there was an output of magnesium salts in California coming from one plant in San Diego County, and two in San Mateo County. This amounted to 3867 short tons valued at $316,669, and consisted of the chloride and carbonate. The 1936 output amounted to 3798 tons worth $347,838, which was also the chloride and the carbonate. The chloride was nearly all sold for use in magnesite stucco and cement mixtures (Sorel cement), also some for road liquor. The carbonate, a bulky white powder, was used as a heat-insulating material, as a filler for rubber, paper, paint, etc., and in medicines, in tooth paste,

in face powder and as a polish for metal and glass. The sulphate marketed in past years was utilized for medicinal and bath purposes. The material coming from San Diego County was residual bitterns from the salt plants and was in part marketed in the liquid form carrying from 35% to 67% $MgCl_2$ and in part as dry crystals, while that from San Mateo County was magnesium carbonate.

The average value reported for the chloride produced in California in 1937 was approximately $29.69 per ton, f. o. b. plant.

PUMICE and VOLCANIC ASH

The production of pumice and volcanic ash in California during the year 1937 amounted to 10,392 short tons, valued at $79,005. This came from five properties in Siskiyou County, four in Inyo County, two each in Madera and Napa counties; and one each in Imperial, Kern, Mariposa, Mono, and San Luis Obispo counties.

The 1937 figures showed a decrease in amount and value as compared with those of 1936 which were 17,132 tons worth $143,709.

The material from three deposits in Inyo County, part from Madera, and that from Imperial, Mariposa, Mono, Napa, and Siskiyou counties, was 6387 tons of lump pumpice, which was used in acoustic plaster, light-weight aggregate in concrete, for abrasive purposes, and for chicken-house litter. The production part of one property in Madera County, one property in Inyo, and that in Kern and San Luis Obispo counties was 4005 tons of volcanic ash, or tuff variety, and was employed in making soap, cleanser compounds, a large tonnage being utilized as a concrete filler in cement displacement, and in asphalt and as a carrier for dry agricultural sprays. The Kern County ash is going into the preparation of one of our popular and nationally advertised brands of cleanser compounds.

SILICA (Sand and Quartz)

We combine these materials because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

We do not include under this heading such forms of silica as: quartzite, sandstone, flint, tripoli, diatomaceous earth, nor the gem forms of 'rock crystal,' amethyst, and opal. Each of these has various industrial uses, which are treated under their own designations.

The production of silica in California during 1937 amounted to 84,313 short tons valued at $348,987 f.o.b. rail shipping point, and came from two properties in Contra Costa County and one each in Monterey, Riverside, and San Diego counties. The above was an increase in both amount and value over the output of 1936 which was 77,830 tons worth $310,278. The 1937 output consisted of 83,567 tons of glass sand and 746 tons of vein or boulder quartz.

The glass sand came from Contra Costa, Monterey, and Riverside counties. For making the higher grades of glass, deposits in Contra Costa County are replacing the sand imported from Belgium. Belgium sand has displaced local material in the manufacture of sodium silicate ('water glass'). There are various deposits of quartz in California

which could be utilized for glass making, but to date they have not been so used owing to the cost of grinding and the difficulty of preventing contamination by iron while grinding.

Silica sand has been produced in the following counties of the State: Alameda, Amador, Contra Costa, El Dorado, Imperial, Inyo, Los Angeles, Mariposa, Mono, Monterey, Orange, Placer, Riverside, San Diego, San Joaquin, and Tulare, the chief centers being Contra Costa, Amador, Monterey, and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class colorless glass; for such, it must be essentially iron-free. Even a fractional per cent of iron imparts a green color to the glass.

The Tariff Act of June 21, 1930, placed a duty on sand, containing 95 per cent or more of *Silica* and not more than six-tenths of 1 per cent of oxide of iron and suitable for use in the manufacture of glass, of $2 per ton.

SLATE

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, but since then it has been irregular. Large deposits of excellent quality are known in the State, especially in El Dorado, Calaveras, and Mariposa counties, but the demand has been light owing principally to competition of cheaper roofing materials.

The production of slate in California during 1937 amounted to 5036 short tons and 440 squares, having a total value of $32,572 f. o. b. quarry and came from properties in Calaveras, El Dorado, Los Angeles, Inyo, and Tuolumne counties.

The 1937 figures showed a decrease in both amount and value from those of 1936 which were 12,252 and 65 squares having a total value of $49,818. Practically all the slate was crushed and used for roofing granules. The slate shingles came from Calaveras County, and that from Los Angeles County and a small amount from El Dorado and Inyo counties was sold as flagstone.

SOAPSTONE and TALC

The total output of talc and soapstone in California during 1937 amounted to 29,657 short tons valued at $347,772. This was an increase in both quantity and value over the 1936 figures, which were 25,643 tons valued at $309,287. Of the 1937 production, 28,202 tons were high-grade talc from Inyo and San Bernardino counties, which material was utilized mainly in toilet powders, paint, paper, for rubber manufacture, and some in ceramics. The remainder of 1455 tons was soapstone and came from Butte, El Dorado, and Los Angeles counties.

The 'soapstone' grades were used mainly for ceramics and as a filler in roofing paper, part also in magnesite cement and foundry facing.

It is reported that California talc has replaced to some extent imported talc in the toilet trade on the basis of quality. The largest production of talc in the United States comes from Vermont and New York and of massive soapstone from Virginia.

During 1937 imports of talc steatite, etc., totaled 26,876 short tons valued at $472,819, as compared with 24,520 tons worth $456,667 during 1936, according to the United States Bureau of Foreign and Domestic Commerce.

The Tariff Act of 1930 places a duty on talc, steatite or soapstone and French chalk, crude or unground, of one-fourth of one cent per pound.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20834 ALTAITE (PbTe) with GALENA (PbS) and SPHALERITE (ZnS). From Hill Top Mining Co. property, 18 miles northeast of Las Cruces, New Mexico.

Donor: F. W. Meneray. February, 1938.

20835 JAMESONITE (Pb_2Sb_2S) on SPHALERITE (ZnS). From Chuisbaia, Roumania.

Donor: Hatfield Goudey. February, 1938.

20836 MASSICOT (PbO) Lead Oxide. From Rescue Mine, El Dorado County, California. Old specimen not numbered: donor not known.

20837 ALUNITE ($K_2Al_6(OH)_{12}(SO_4)_4$). A hydrous sulphate of aluminum and potash. From the Alunite Mine of the Mineral Products Corp., in the Marysvale Mining District, Piute County, Utah.

Donor: Jacob W. Young.

20838 GARNETS (Almandite). From Wrangell, Alaska. Old specimen not previously numbered: donor not known.

20839 LIMONITE ($2Fe_2O_3.3H_2O$). From extensive deposit. Assay, 48.44% Fe, 12.26% SiO_2, 0.012% S.
From Johe Ranch, near San Luis Obispo, California.

Donor: E. L. Raymond. March, 1938.

20840 Wire GOLD in quartz. From Green Ledge Mine, Genesee, Plumas County, California.

Donor: Louie Eddelbuttel. March, 1938.

20841 MANGANESE ORE, assays 57.57% Mn, and 4.30% SiO_2.
From Staneuch Mine on Prefumo County Road, San Luis Obispo County, California.
Donor: Edward L. Raymond. March, 1938.

20842 CHROMITE, from Baker Chrome Mine, Quincy, Plumas County, California.
Donor: Louie Eddelbuttel. March, 1938.

20843 MANGANESE ORE. From Mt. Huff Mine, Quincy, Plumas County, California.
Donor: Louie Eddelbuttel. March, 1938.

20844 FLUORITE (CaF). Probably from Cumberland, England. Old specimen not numbered: donor not known.

20845 VANADINITE ($3Pb_3V_2O_8PbCb_2$). Large crystals.
From Yuma Mine in Pima County, Arizona.
Donor: Herbert Salinger. March, 1938.

20846 VANADINITE Crystals on WULFENITE Crystal. From Yuma Mine in Pima County, Arizona.
Donor: Herbert Salinger. March, 1938.

20847 FLUORITE (CaF_2), calcium fluoride and CELESTITE ($SrSO_4$), strontium sulphate. From Clay Center, Ohio.
Donor: R. A. McMullen. March, 1938.

20848 SILVER ORE. From Easley Vein, 280-ft. level of Palisades Mine near Calistoga, Napa County, California. Mined in 1929.
Donor: Walter W. Bradley. March, 1938.

20849 SILVER ORE (Argentite Pyrargyrite and chalcopyrite). From 380-ft. level, Palisades Mine, near Calistoga, Napa County, California. Mined in 1929.
Donor: Walter W. Bradley. March, 1938.

20850 ALMANDITE, (iron aluminum Garnet) in mica schist.
From Garnet Mt., on extreme lower left limit of Stikine River. near Wrangell, Alaska.
Donor: Walter G. Culver. April, 1938.

20851 Green TOURMALINE. This was associated with topaz, beryl topaz, quartz, epidote, and some lithia mica.
From near Ramona, San Diego County, California.
Loaned by Mr. McIntosh.

20852 GOLD ORE. From Monumental Mine, Del Norte County. California.
Donor: H. C. Kirkpatrick. April, 1938.

20853 Blue CALCITE on Idocrase. From North Fork of Shepard Canyon, Inyo County, California; one-half mile north of Crystal Dome Mine.
Donor: E. A. Bacchi. April, 1938.

LABORATORY

FRANK SANBORN, Mineral Technologist

An interesting mineral was recently received and identified as troilite by the laboratory of the Division of Mines. The mineral was brought in for determination by H. W. Gooch of Crescent City, Del Norte County, who has done considerable prospecting in that locality.

Troilite is a ferrous sulphide, FeS. It has the following properties: Hexagonal. Compact granular. Metallic luster. Color, light grayish-brown. Speedily tarnishes to bronze-brown. Streak black. H–3½–4½. G–4.67–4.82. It was first noted from this locality and analyzed in 1922.

	Fe	S
1	58.78	33.62
2	62.70	35.40

This is its only known terrestrial occurrence. It had been observed previously only in meteorites. It was found in serpentine and contained inclusions of magnetite from which it has probably been derived.

This mineral has no commercial value outside of its specimen value to mineral collectors, who are invited to communicate with Mr. Gooch who can supply specimens at reasonable prices.

It is our policy to give assistance to prospectors in identifying and finding a market for minerals found in California, and to have the operators and prospectors of the state make use of the laboratory for that purpose.

LIBRARY

J. C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Bureau of Mines:
Technical Paper No. 581, Ball Mill Grinding.
Bulletin No. 410, Metal—Mine Accidents in the U. S. 1935.

Information Circulars:

6983 Some Pertinent Information about Mine Gases.
6984 Mineral Wool. By J. R. Thoenen.
6985 Gold Mining & Milling Methods and Costs at The Gold Hill Mine of Talache Mines, Inc., Quartzburg, Idaho. By Joe H. Skidmore.
6987 Gold Mining in New Mexico. By O. H. Metzger.
6988 Trends in Sales of Memorial Stone. By Oliver Bowles and Mabel Schauble.
6989 Methods for Protection Against Silicosis and When They are Justified. By D. Harrington.
6991 Gold Mining and Milling in the Wickenburg Area, Maricopa and Yavapai Counties, Arizona. By O. H. Metzger.
6993 Technique for Routine Use of the Konimeter. By J. B. Littlefield, C. E. Brown and H. H. Schrenk.
6994 Some of the Results of Recent Research on the Control or Prevention of Silicosis. By D. Harrington.
6995 Reconnaissance of Mining Districts in Humboldt Co., Nevada. By William O. Vanderburg

6996 The Bureau of Mines and Mineral Utilization. By John W. Finch.
6997 Marketing Mica. By Paul M. Tyler.
6998 Marketing Clay. By Paul M. Tyler.
6999 Laboratories that make assays, analyses and tests on ores, minerals, and other substances. By C. W. Davis and M. W. Von Bernewitz.
7000 Treatment and Sale of Black Sands. By M. W. Von Bernewitz.
7001 Review of Literature on Conditioning Air for Advancement of Health and Safety in Mines. By D. Harrington and Sara J. Davenport.
7002 Mine Safety Board Decision 28; Safety Catches and Arresting Devices for Cages, Skips, and Cars in Mine Shafts and Slopes. By Mine Safety Board.
7003 Mining Methods and Costs at the Judge Mine, Park City, Utah. By Geo. S. Krueger and E. A. Hewitt.
6611R Federal Placer-Mining Laws and Regulations. By Fred W. Johnson, Commissioner of General Land Office.
Small-Scale Placer Mining and Methods. By Chas. J. Jackson.

Report of Investigations:

3367 Survey of Fuel Consumption at Refineries in 1936. By U. S. Bureau of Mines.
3368 Petrographic Identification of Atmospheric Dust Particles. By Wilder D. Foster and H. H. Schrenk.
3369 Relation of Dust Concentration to Depth of Hole During Wet Drilling. By J. B. Littlefield and H. H. Schrenk.
3370 Progress Reports—Metallurgical Division 22: Ore-testing Studies, 1936-1937 (Special Methods of Analysis and Testing and Details of Tests on Various Ores. The Staff of the Ore-Testing Section.
3371 Performance of a Baum-Type Coal-Washing Jig. By H. F. Yancey and M. R. Geer.
3372 Performance of a Pulsator-Type Coal-Washing Jig. By H. F. Yancey, M. R. Geer, and R. E. Shinkoskey.
3376 Concentration of Southern Barite Ores. By G. O'Meara and G. D. Coe.
3377 Primary Crushing, Progress Report No. 1. By Mark Sheppard and C. N. Witherow.
3380 Primary Crushing Progress Report No. 2. By Mark Sheppard.
3381 Effect of Angle of Drilling on Dust Dissemination. By Carlton E. Brown and H. H. Schrenk.
3383 Annual Report of the Explosives Division Fiscal Year 1937. By Wilbert J. Huff.
3387 Dust Sampling With the Bureau of Mines Midget Impinger, Using a New Hand Operated Pump. By J. B. Littlefield and H. H. Schrenk.
3388 Control of Dust from Blasting by a Spray of Water Mist. By Carlton E. Brown and H. H. Schrenk.
3390 Primary Crushing Progress Report No. 3. By. Mark Sheppard.
3392 Resumé of Problems Relating to Edgewater Encroachment in Oil Sands. By F. G. Miller and H. C. Miller.
3393 Relation of Dust Dissemination to Water Flow Through Rock Drills. By Carlton E. Brown and H. H. Schrenk.
3394 Disposal of Petroleum Wastes on Oil-Producing Properties. With a Chapter on Soils and Water Resources of Kansas Oil Areas. By Ogden S. Jones. By Ludwig Schmidt and C. J. Wilhelm.
3396 Calibration of Positive-Displacement Oil Meters. By R. E. Heithecker and W. B. Berwald.

U. S. Geological Survey:

Bulletin 892 Bibliography of North American Geology, 1935 and 1936.
Topographic Maps
Bidwell Bar Quadrangle.
Black Mountain Quadrangle ----------Los Angeles County
Kettleman City Quadrangle ----------Kings County
Manzana Quadrangle ----------Los Angeles County
Medford Quadrangle ----------Oregon-California
San Francisquito Quadrangle----------Los Angeles County
Ventura Quadrangle
Yosemite Quadrangle

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California, Magazine of the Pacific, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.

Gemmologist, London.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Moscow, Idaho.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Industry, Los Angeles.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.

Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

Oil Field Maps, published by Pacific Coast Edition of the Wall Street Journal:

Los Angeles Basin Oil Fields Map "E."
Master Map of California Oil Fields.
Northern Coastal District Oil Fields Map "B."
San Joaquin Valley Oil Fields Map "A."
Ventura County Oil Fields, Map "D."

Books:

Annual Report of the Chief of Engineers, U. S. Army, Part 1, 1937.
Annual Report of the Chief of Engineers, U. S. Army, Part 2, 1937.
Industrial Minerals and Rocks, Seeley W. Mudd Series, A. I. M. E., 1937.
Theory and Practice of Mine Ventilation, by W. J. Montgomery.
The Condensed Chemical Dictionary, 2d Edition.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of California Journal of Mines and Geology, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of California Journal of Mines and Geology.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

PRICES SUBJECT TO CHANGE. WRITE FOR LATEST PRICE LIST

	Price Postpaid
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	$0.75
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	.75
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	1.15
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	1.50
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report XIV, Biennial Period, 1913-1914, Fletcher Hamilton:	
Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	.60
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.75
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	.35
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.50
Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	.60
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:	
A General report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	3.25
Chapters of the State Mineralogist's Report XV, Biennial Period, 1915-1916 Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.75
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.75
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	.75

REPORTS—Continued

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	Price Postpaid
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	$0.75
Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	.60
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.75
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917:	
A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	1.00
Mines and Mineral Resources of Plumas County, 188 pp., paper	.75
Mines and Mineral Resources of Sierra County, 144 pp., paper	.75
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.50
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, November, December, 1922	.40
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.40
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California.' Lloyd L. Root. Published quarterly. January, April, October, 1924, per copy, 30¢; July, per copy	.40
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.40
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.40
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.40
October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	.40
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California', Lloyd L. Root. Published quarterly:	
January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	.40
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.40
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.40
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.40
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.40
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	----
October, 1927, Mines and Mineral Resources of Mono County	.40
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County	.40

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April, 1928, Mines and Mineral Resources of Mariposa County	$0.40
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.40
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.40
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	.40
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	.40
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.40
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.40
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.40
**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.40
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.40
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradlley. Published quarterly:	
January, 1931, Preliminary Report of Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.40
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.40
**July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	----
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.40
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.40
April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	.40
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.75

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Chapters of Report XXIX, 1933 (quarterly: titled 'California Journal of Mines and Geology,' containing the following:

January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties---------- $1.00

July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543---------- 1.00

Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits---- .60

April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores---------- 1.00

October. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle. Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas---------- .60

Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Review of Gold Mining in East-Central, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties, Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation---------- .60

April. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstake Permits ---------- .60

July. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights---------- .60

October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County ---------- .60

Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:

January. Gold Mines of Placer County, including Drag-line Dredges. Geologic Report on Borax Lake, California---------- .60

April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum-- .60

July. Mines and Mineral Resources of Calaveras County. Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost

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of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization	$0.60
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Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold	.60
April. Mineral Resources of Plumas County (with Geologic Map). List of preferred mineral names. New Placer Mining Debris Law	.60
July. Mineral Resources of Los Angeles County (with map showing principal Mines and Oil Fields.) Geology and mineral deposits of the Western San Gabriel Mountains, Los Angeles County	.60
October. Mineral Resources of the Resting Springs Region, Inyo County. Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California. Native Arsenic from Grass Valley, California	.60
Chapters of Report XXXIV, 1938 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
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Subscription, $2.00 postpaid in advance (by calendar year only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----
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Summary of Operations—California Oil Fields—Continued

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BULLETINS

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**Bulletin No. 1. A description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
**Bulletin No. 4. Catalogue of California Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----
Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	$0.75
**Bulletin No. 10. A Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----
**Bulletin No. 12. Mineral Production of California, by Counties, for 1896, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 13. Mineral Production of California, by Counties, for 1897, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms, 1900, 154 pp., 49 illustrations	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, 9 maps	.75
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 26. Mineral Production of California for the Past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet	----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----

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**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	----
**Bulletin No. 30. Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905. 120 pp., 66 illustrations, 3 maps	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet	----
**Bulletin No. 41. Mines and Minerals of California for 1904, by Charles G. Yale. 1905. 54 pp., 20 county maps	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.	----
**Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.	----
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 48. Mineral Production of California for Twenty Years, by Charles G. Yale. 1906	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorn and J. A. Edman, 366 pp., 74 illustrations. (Revised edition)	$1.50
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, by D. H. Walker, 1907. Tabulated sheet	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker. 62 pp.	----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet	----
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**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations, 10 maps	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker. 1909. Tabulated sheet	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker. 1909. Tabulated sheet	----
**Bulletin No. 60. Mineral Production for 1909, with County Maps and Mining Laws of California, by D. H. Walker. 94 pp.	----
**Bulletin No. 61. Mineral Production of California, by Counties, for 1910, by D. H. Walker. Tabulated sheet	----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker. 1910. Tabulated sheet	----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps	----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.	----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.	----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp.	----
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp.	----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.	----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]	----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.	----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp. 4 illustrations	----
**Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.	----
**Reconnaissance Geologic Map (of which Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch = 12 miles. Mounted	----
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California for the fiscal year 1915-16, by R. P. McLaughlin. 278 pp., 26 illustrations	----
**Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations	----
**Bulletin No. 75. United States and California Mining Laws. 1917, 115 pp., paper	----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring. 1918, 248 pp., 51 illustrations, 5 maps, paper	$0.75
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880-1917, by E. S. Boalich. 44 pp., paper	Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley. 1919, 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth	2.00
Bulletin No. 79. Magnesite in California, by Walter W. Bradley. 1925, 147 pp., 62 photographs, 11 line cuts and maps, cloth	1.25
†Bulletin No. 80. Tungsten. Molybdenum and Vanadium in California. (In preparation.)	
†Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)	
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† Not yet published.

BULLETINS—Continued

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**Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley. 1919, 212 pp., paper	----
Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello. 1920, 124 pp., paper	$0.75
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**Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley. 1921, 218 pp., paper	----
**Bulletin No. 91. Minerals of California, by Arthur S. Eakle. 1923, 328 pp., cloth	----
**Bulletin No. 92. Gold Placers of California, by Chas. S. Haley. 1923, 167 pp., 36 photographs and 7 plates (colored and line cuts, also geological map), cloth	----
**Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley. 1923, 188 pp., paper	----
**Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley. 1924, 162 pp., paper	----
**Bulletin No. 95. Geology and Ore Deposits of the Randsburg Quadrangle, by Carlton D. Hulin. 1925, 152 pp., 49 photographs, 13 line cuts, 1 colored geologic map, cloth	----
**Bulletin No. 96. California Mineral Production for 1924, by Walter W. Bradley. 1925, 173 pp., paper	----
**Bulletin No. 97. California Mineral Production for 1925, by Walter W. Bradley. 1926, 172 pp., paper	----
Bulletin No. 98. American Mining Law, by A. H. Ricketts. 1931, 811 pp., flexible leather	3.50
Bulletin No. 99. Clay Resources and Ceramic Industry of California, by Waldemar Fenn Deitrich. 1928, 383 pp., 70 photographs, 12 line cuts including maps, cloth	2.00
**Bulletin No. 100. California Mineral Production for 1926, by Walter W. Bradley. 1927, 174 pp., paper	----
**Bulletin No. 101. California Mineral Production for 1927, by Henry H. Symons. 1928, 311 pp., paper	----
**Bulletin No. 102. California Mineral Production for 1928, by Henry H. Symons. 1929, 210 pp., paper	----
**Bulletin No. 103. California Mineral Production for 1929, by Henry H. Symons. 1930, 231 pp., paper	----
Bulletin No. 104. Bibliography of the Geology and Mineral Resources of California, to the end of 1930, by Solon Shedd	2.50
**Bulletin No. 105. Mineral Production in California for 1930 and Directory of Producers	----
Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25
**Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	----
Bulletin No. 108. Mother Lode Gold Belt of California, by Clarence A. Logan. 1934, 240 pp., with geologic and claim maps, cloth	2.25
**Bulletin No. 109. California Mineral Production and Directory of Mineral Producers for 1932, by Henry H. Symons. 200 pp., paper	----
**Bulletin No. 110. California Mineral Production and Directory of Mineral Producers for 1933, by Henry H. Symons. 214 pp., paper	----

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**Bulletin No. 111. California Mineral Production and Directory of Mineral Producers for 1934, by Henry H. Symons. 334 pp., paper	----
**Bulletin No. 112. California Mineral Production and Directory of Mineral Producers for 1935, by Henry H. Symons. 205 pp., paper	----
Bulletin No. 113. Minerals of California, by Adolf Pabst. 1938, 338 pp., cloth	$1.75
Bulletin No. 114. California Mineral Production and Directory of Mineral Producers for 1936, by Henry H. Symons. 199 pp., paper	.80
Bulletin No. 115. Bibliography of the Geology and Mineral Resources of California for the years 1931 to 1936, inclusive, by Solon Shedd. 125 pp., cloth	1.25

PRELIMINARY REPORTS

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin. 4 pp.	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp.	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.	----
**Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello. 1918. 34 pp. Paper	----
**Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello. 1918. 44 pp. Paper	----
**Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton. 1920. 43 pp. Paper	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker. 1920, 102 pp. 24 illustrations. Paper	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton. 1922, 68 pp. Paper	----

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper	----
Bulletin. Reconnaisance of the Colorado Desert Mining District. By Stephen Bowers. 1901, 19 pp. 2 illustrations. Paper	.25
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 (15¢ annually)	----

MAPS

Register of Mines with Maps

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Register of Mines, with Map, Amador County	----
Register of Mines, with Map, Butte County	$0.30
**Register of Mines, with Map, Calaveras County	----
**Register of Mines, with Map, El Dorado County	----
**Register of Mines, with Map, Inyo County	----
**Register of Mines, with Map, Kern County	----
**Register of Mines, with Map, Lake County	----
**Register of Mines, with Map, Mariposa County	----
Register of Mines, with Map, Nevada County	.30
**Register of Mines, with Map, Placer County	----
**Register of Mines, with Map, Plumas County	----
**Register of Mines, with Map, San Bernardino County	----
Register of Mines, with Map, San Diego County	.30
Register of Mines, with Map, Santa Barbara County (1906)	.30
**Register of Mines, with Map, Shasta County	----
**Register of Mines, with Map, Sierra County	----
**Register of Mines, with Map, Siskiyou County	----
**Register of Mines, with Map, Trinity County	----
**Register of Mines, with Map, Tuolumne County	----
Register of Mines, with Map, Yuba County (1905)	.30
Register of Oil Wells, with Map, Los Angeles City (1906)	----

OTHER MAPS

**Map of California, Showing Mineral Deposits (50x60 in.)	----
**Map of Forest Reserves in California	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
**Map of Madera County, Showing Boundaries, National Forests	----
**Map of Placer County, Showing Boundaries, National Fortsts	----
**Map of Shasta County, Showing Boundaries, National Forests	----
**Map of Sierra County, Showing Boundaries, National Forests	----
**Map of Siskiyou County, Showing Boundaries, National Forests	----
**Map of Tuolumne County, Showing Boundaries, National Forests	----
**Map of Mother Lode Region	----
**Map of Desert Region of Southern California	----
Map of Minaret District, Madera County	.25
Map of Copper Deposits in California	----
**Map of Calaveras County	----
**Map of Plumas County	----
**Map of Trinity County	----
**Map of Tuolumne County	----
**Geographical Map of Inyo County. Scale 1 inch equals 4 miles	----
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	----
Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted	2.75
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92. In 4 colors (also sold singly)	----
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt accompanying July-October Chapter of Report XXVIII of the State Mineralogist. (Sold singly)	.40
Map of Northern California, showing rivers and creeks which produced placer gold in 1932	.25

OTHER MAPS—Continued

	Price Postpaid
Mother Lode Geologic and claim maps in 5 county sections: El Dorado, Amador, Calaveras, Tuolumne and Mariposa. Single sections 25¢. Set of 5	$1.00
Map of Mariposa County, showing principal gold mines	.25
Geologic Map of Elizabeth Lake Quadrangle, Los Angeles and Kern Counties (accompanying October Chapter of Report XXX), sold separately	.25
Map of Western Portion of Siskiyou County Showing Location of Principal Gold Mines (accompanying July Chapter of Report XXXI), sold separately	.25
Geologic Map of Redding and Weaverville Quadrangles Showing Location of Gold Mines	.25
Map of Ancient Channel System, Calaveras County	.25
Map of Ancient Channels Between San Andreas and Mokelumne Hill	.25

OIL FIELD MAPS

The maps are revised from time to time as development work advances and ownerships change.

	Price (including postage and tax)
Map No. 1—Sargent, Santa Clara County	$0.75
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	1.25
Map No. 3—Santa Maria, including Casmalia and Lompoc	1.25
Map No. 4—Brea Olinda and (East Portion) Coyote Hills, Los Angeles and Orange Counties	1.25
Map No. 6—Salt Lake-Beverly Hills, Los Angeles County	1.25
Map No. 7—Sunset and San Emidio, Kern County	1.25
Map No. 8—South Midway and Buena Vista Hills, Kern County	1.25
Map No. 9—North Midway and McKittrick, Kern County	1.25
Map No. 10—Belridge and McKittrick Front, Kern County	1.25
Map No. 11—Lost Hills and North Belridge, Kern County	1.25
Map No. 12—Devils Den, Kern County	1.00
Map No. 13—Kern River, Kern County	1.00
Map No. 14—Coalinga, Fresno County	1.50
Map No. 15—Elk Hills, Kern County	1.25
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Map No. 17—Santa Paula-Sespe, including Bardsdale, South Mountain and Camarillo, Ventura County	1.25
Map No. 18—Piru-Simi-Newhall, Ventura County	1.25
Map No. 19—Arroyo Grande, San Luis Obispo County	1.00
Map No. 20—Long Beach, Los Angeles County	1.75
Map No. 21-B—Portion of District No. 5, showing boundaries of oil fields—Fresno, Kings and Kern Counties	1.00
Map No. 21-C—Portion of District No. 4, showing boundaries of oil fields—Kern, Kings and Tulare Counties	1.25
Map No. 22—Portion of District No. 3, showing boundaries of oil fields—Santa Barbara County	.75
Map No. 23—Portion of District No. 2, showing boundaries of oil fields—Ventura County	1.00
Map No. 24—Portion of District No. 1, showing boundaries of oil fields—Los Angeles and Orange Counties	1.00
Map No. 26—Huntington Beach, Orange County	1.50
Map No. 27—Santa Fe Springs, Los Angeles County	1.25
Map No. 28—Torrance, Los Angeles County	1.25
Map No. 29—Dominguez, Los Angeles County	1.00
Map No. 30—Rosecrans, Los Angeles County	1.25
Map No. 31—Inglewood, Los Angeles County	1.25
Map No. 32—Seal Beach, Los Angeles and Orange Counties	1.25
Map No. 33—Rincon, Ventura County	1.50

OIL FIELD MAPS—Continued

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Map No. 34—Mt. Poso, Kern County	$1.00
Map No. 35—Round Mountain, Kern County	1.00
Map No. 36—Kettleman Hills, Fresno, Kings and Kern Counties	1.50
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Map No. 41—Potrero, Los Angeles County	1.00
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Map No. 45—Buttonwillow gas, Kern County	1.00
Map No. 46—Richfield, Orange County	1.25
Map No. 48—Mountain View and Edison, Kern County	1.25
Map No. 49—Fruitvale, Kern County	1.00
Map No. 50—Wilmington, Los Angeles County	1.25
Map No. 51—Santa Maria Valley, Santa Barbara County	1.00
Map No. 52—El Segundo and Lawndale, Los Angeles County	1.50
Map No. 53—Rio Bravo, Greeley, Ten Section and Canal, Kern County	1.25

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

Vol. 34 JULY, 1938 No. 3

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXIV

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
CALIFORNIA

62700

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OREGON
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·DEPARTMENT·OF·NATURAL·RESOURCES·
·GEORGE D. NORDENHOLT - DIRECTOR·
·DIVISION·OF·MINES·
·WALTER W. BRADLEY·
·STATE MINERALOGIST·
OUTLINE MAP
OF
CALIFORNIA
SCALE
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SHASTA
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TEHAMA
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BUTTE
SIERRA
MENDOCINO
LAKE
COLUSA
YUBA
NEVADA
SUTTER
PLACER
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EL DORADO
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SOLANO
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SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
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SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
PACIFIC OCEAN
NEVADA
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.
MEXICO

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geological Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to California Journal of Mines and Geology, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).
3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

A slate worker making roofing slate. El Dorado County has several good deposits suitable for roofing.

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District, on account of unfinished field work.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field District are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

Reports covering the mines and mineral resources of most of the counties in the Los Angeles field district are now available, and field work at present is confined to investigations for special reports upon Inyo and Mono counties.

SACRAMENTO FIELD DISTRICT

C. A. Logan, Mining Engineer

MINERAL RESOURCES OF EL DORADO COUNTY [1]

History.

Coloma, scene of James W. Marshall's epochal gold discovery January 24, 1848, is on the South Fork of American River eight miles northwest of Placerville. Spreading out in all directions from this focal point to which they had been drawn by the exciting news, thousands of miners occupied the shallow placers in this and nearby counties on the western slopes of the Sierra Nevada. In El Dorado they found gold in nearly every stream as far east as Grizzly Flat. Quartz mining began on the Mother Lode in this county in 1851 at the Havilah Mine, Nashville, and for years many arrastres were used at that camp and at the Union Mine at Aurum City farther north on the lode, to crush rich ore found on and near the surface. In 1851 also, the Mt. Pleasant and Sierra Nevada Mines were opened at Grizzly Flat. The county was the most populous in the state up to 1853. It enjoyed great prosperity during the Comstock boom because of the traffic with the Nevada mines over the Placerville wagon road, extending for 82 miles from the railroad terminus at Shingle Springs, over the Sierra Nevada to Carson Valley.

The county was particularly noted for its placers and pocket mines. The seam mines, which are not peculiar to the county, but which have been worked there more extensively than elsewhere, also contributed heavily in gold production. However, the quartz mines did not share in the extensive and deep development carried on in other counties and it is only since the revival of the industry in the past four years that work has gone to depths of over 1200 ft.

Plant of Pacific Minerals Co., Limited, at Chili Bar on South Fork of American River. Roofing granules are made here from Mariposa slate taken from a deposit adjoining the plant.

[1] See pp. 363, *et seq.*, for additional data on El Dorado County mines.

From the early 1860's, El Dorado County was famous for its fruit industry, and specializes at present in pear-raising. Lumbering has been an important business since pioneer days. The population of the county in 1930 numbered 8300, living mostly in the vicinity of the county-seat and in or near the small towns extending from Georgetown on the north, along the Mother Lode to Nashville. This number represented an increase of nearly 2000 since 1920, and there has probably been at least as great an increase due to the revival of gold mining since 1932.

Ranging in elevation from 500 feet above sea-level where it joins Sacramento County on the west, to 10,000 feet on the higher peaks of the Sierra Nevada, the county shares a great variation of climate and scenery with its neighbors. Rainfall increases with elevation, averaging 43 inches annually over a period of about 50 years at Placerville, the county-seat, (elevation 1860 ft.). Usually little snow falls below this elevation, and the dry season extends from May to November.

The Mother Lode and western sections of the county are supplied with electric power and good roads, and water may generally be purchased for mine use. The eastern section supplies an abundance of good pine timber, with sawmills at several convenient points.

ASBESTOS

Between 1904 and 1906, a total production of 142 tons of asbestos was reported from this county. Part of this came from the El Dorado Copper Company's property in sec. 24, T. 12 N., R. 10 E., and the French Hill claim in sec. 36, T. 13 N., R. 9 E., was also listed as an asbestos property, but there are no details of its output available. There is no record of any later activity in prospecting for asbestos.

Serpentine areas, in which chrysotile asbestos might occur extend north and south for 6 miles in the region 2 miles east of Georgetown. The rock is also found in a line of disconnected outcrops extending from Cosumnes River northwest past Latrobe, thence east of Clarkville and west of Salmon Falls to the Middle Fork of American River. Practically all of this land is patented and is used for cattle range. Chromite has been mined on most of it, but no asbestos has been reported from it.

CHROMITE

During the world war this county was one of the principal producers of chromite ore and concentrate. Several mills had been erected and were in operation in the district south of Rattlesnake Bridge between the forks of American River, when the war ended. Only one producer, Placer Chrome Company, continued work after the price collapsed. They operated near Rattlesnake Bar until the end of 1920. Except for the shipment in 1931 of a little ore mined previously, there has been no record of activity until the past few years. From what can be learned, a promoter named Bedford had sold shares in England several years ago in a company which was to use chromite from El Dorado County in the plant of Darlington Rustless Iron Company, in County Durham. Bedford's options on the local chromite deposits expired without any ore having been produced. Late in 1935, A. H. Wild, an Englishman who represented himself as

EL DORADO

Year	Gold, value	Silver, value	Copper		Lime	
			Pounds	Value	Barrels	Value
1880	$389,383	$208				
1881	550,000	900				
1882	600,000					
1883	530,000					
1884	575,000	16,000				
1885	35,000					
1886	619,992	1,822				
1887	706,871	365				
1888	650,000	500				
1889	427,638	408				
1890	204,583	275				
1891	173,279	359				
1892	198,321					
1893	294,610	1,220				
1894	366,707	356			10,000	$8,000
1895	700,101	448			28,500	28,500
1896	812,289	534			4,413	4,158
1897	674,626	886			13,500	6,750
1898	501,966	4,174			3,360	3,360
1899	404,497	8,414			7,935	7,935
1900	368,541	25,129	3,125	$500	7,500	6,000
1901	292,036	5,977			11,000	11,000
1902	335,031	52	2,128	319	24,599	16,176
1903	277,304				5,600	7,000
1904	474,994				12,864	7,075
1905	384,735	2,525	160,000	24,960	9,260	6,946
1906	431,746	2,690			19,217	21,138
1907	319,177	2,301		122		16,198
1908	342,033	5,504	603	83	15,921	20,192
1909	238,284	1,299			13,828	14,591
1910	171,304	967			11,300	9,944
1911	133,967	1,010			15,086	12,309
1912	105,565	843			14,023	11,218
1913	62,688	250	693	107		
1914	133,886	654			14,000	12,082
1915	401,288	1,353	417	73	15,911	12,872
1916	361,821	1,496	[3]		[3]	
1917	24,758	85	18,982	5,182	[3]	
1918	28,352	722	22,259	5,498		
1919	30,121	279				
1920	13,379	155				
1921	34,109	301				
1922	47,340	376				
1923	30,264	185				
1924	28,207	153				
1925	40,212	238				
1926	91,789	472			[3]	
1927	82,254	383	[3]			
1928	122,017	697	1,074	155		
1929	57,680	236	[3]		[3]	
1930	78,019	250			[3]	
1931	85,322	283	[3]		[3]	
1932	182,043	438	850	54	[3]	

COUNTY, 1880-1937.

Limestone		Slate		Miscellaneous stone[2], value	Miscellaneous and unapportioned		
Tons	Value	Squares	Value		Amount	Value	Substance
[1]							
		1,800	$11,700				
		1,350	9,450				
		500	2,500				
500	$250	400	2,800				
		400	2,800				
		600	4,500				
		3,500	26,250			$251,820	Unapportioned, 1900-09.
		5,100	38,250				
		4,000	30,000				
		6,000	50,000		10 tons	162	Asbestos.
1,050	5,775	4,000	40,000		112 tons	2,625	Asbestos.
		10,000	100,000		20 tons	1,000	Asbestos.
	15,318	7,000	60,000				
		6,000	50,000	$1,600	200 M	8,000	Paving blocks.
		6,961	45,660	530	3,763 tons	5,645	Sand (glass)
		1,000	8,000	2,616	1,200 tons	1,800	Sand (glass)
1,000	1,000			5,465	3,701 lbs.	167	Lead.
				4,375			
				4,678			
				2,600	90 lbs.	4	Lead.
		[3]		7,500		5,250	Slate and soapstone.
					5,260 tons	72,560	Chromite.
						19,613	Lime and limestone.
[3]				12,000	886 tons	1,717	Silica.
						1,480	Copper and soapstone.
					8,319 tons	167,950	Chromite.
						104,851	Lime and limestone.
[3]				6,200	2,684 tons	4,506	Silica.
						70	Other minerals.
96,673	218,120			20,500	11,936 tons	674,856	Chromite.
						11,236	Pyrites, silica, soapstone.
					378 tons	6,510	Chromite.
41,025	112,423			1,700	1,600 tons	13,950	Soapstone and talc.
						1,169	Other minerals.
41,109	139,873			5,500	2,640 tons	18,200	Soapstone.
						9,325	Other minerals.
15,296	66,143			2,750	1,652 tons	9,453	Talc.
42,200	113,700			4,250		18,850	Slate and soapstone.
95,274	163,987			5,900	2,670 tons	15,729	Soapstone.
112,156	322,995			2,538	1,498 tons	8,988	Talc.
						32,691	Copper and lime.
228,293	297,127			10,305		4,946	Lime and silica.
59,386	186,702	[3]		17,510		5,613	Lime, silica, slate.
96,733	146,506	[3]		500		15,792	Copper, gems, silica, soapstone, slate.
57,012	158,252	[3]		17,455	365 tons	8,855 21,995	Soapstone, lead, silica, slate.
71,033	199,989	[3]		25,665		83,930	Copper, lime, silica, slate, soapstone.
88,869	205,225	[3]		96,599		113,105	Lead, lime, silica, slate, soapstone.
79,798	207,594	[3]		37,494		107,242	Chromite, copper, lead, lime, silica, slate, soapstone.
105,094	207,241	[3]				97,126	Lead, lime, platinum, silica, slate, miscellaneous stone, soapstone, tungsten ore.

EL DORADO COUNTY,

Year	Gold, value	Silver, value	Copper		Lime	
			Pounds	Value	Barrels	Value
1933	$540,939	$1,458	2,755	$176	[3]	
1934	1,380,710	6,035	4,312	345	8,250	$85,938
1935	1,803,368	5,943	12,391	1,028	[3]	
1936	1,988,735	9,063	21,661	1,993	[3]	
1937	1,719,795	8,238	65,353	7,908	[3]	[3]
Totals						

1880-1937—Continued

Limestone		Slate		Miscellaneous stone[2], value	Miscellaneous and unapportioned		
Tons	Value	Squares	Value		Amount	Value	Substance
120,026	$208,049	[3]	----------	$7,551	----------	$90,586	Lead, lime, slate, soapstone.
112,237	152,422	[3]	----------	7,400	----------	18,405	Lead, silica (quartz), soapstone, slate.
151,814	298,867	[3]	----------	46,886	----------	232,907	Lead, lime, mineral water, silica (quartz), slate, soapstone.
159,134	348,055	[3]	----------	77,778	----------	371,356	Chromite, lead, lime, mineral water, platinum, slate, soapstone.
227,721	448,130	[3]	----------	20,784	[3]	402,762	Chromite, lime, mineral water, platinum, slate, soapstone.
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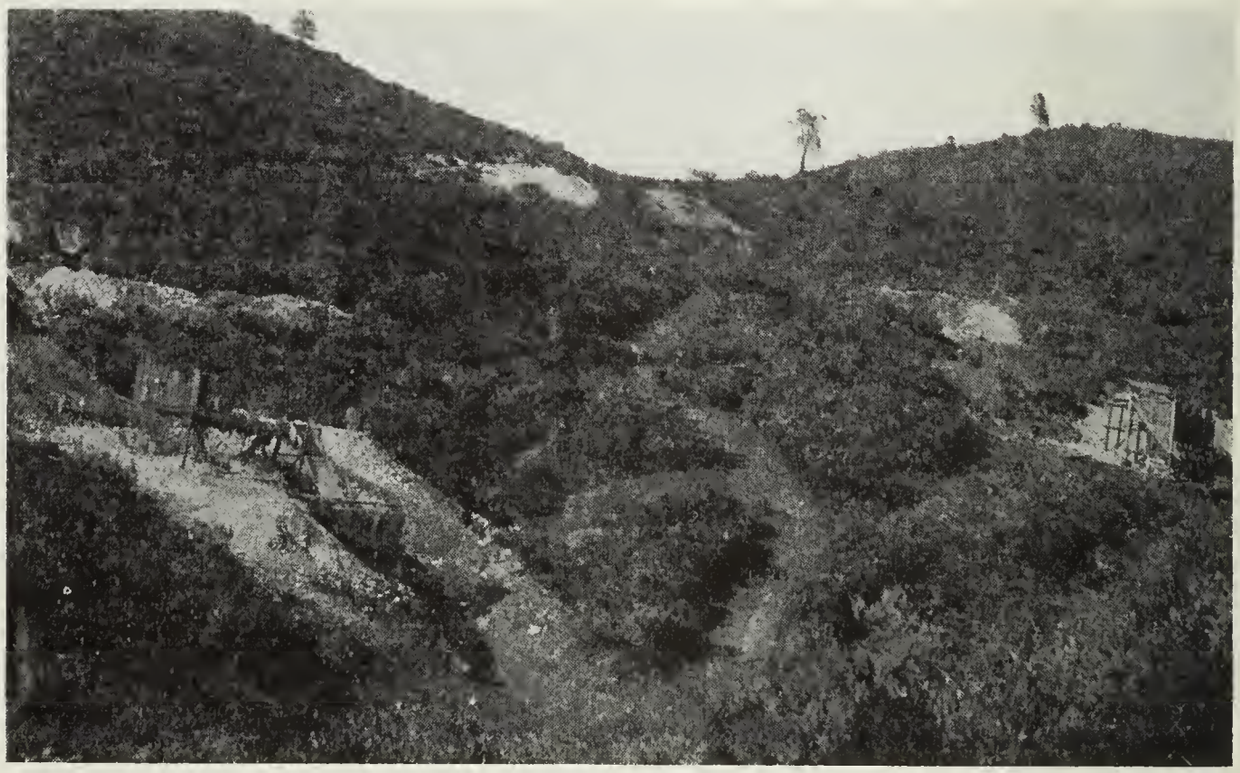
a stockholder in the above venture and a principal owner of the old Darlington plant, took options on many of the old chromite mines, including the Pilliken, Steele, Placer Chrome, and others. During 1936 and 1937, under the name of United States Chrome Mines, Inc., a small experimental plant for concentrating chromite was operated intermittently, and Wild reported a shipment of concentrate by water to the eastern seaboard early in 1937. When visited August 13, 1937, the equipment, which was 3½ miles south of the Auburn Chemical Lime Company's plant, had been mostly dismantled and was scattered over the hillside. No one was on the ground. Work has been resumed recently.



Old chromite workings on the Pilliken property showing how good ore occurred in scattered bodies. Mining has recently been resumed in this district.
(Photo by C. A. Waring)

The chromite mining operations of past years in this county were described in our Bulletin 76, pages 131-144, to which the reader should refer for further details.

COPPER

The western belt of copper prospects extends from Latrobe and Cothrin to the vicinity of Cool. Most of these deposits are either sulphide impregnations or replacements of the amphibolite schist country rock, or quartz veins carrying sulphides. East of the Mother Lode, copper ore occurs in places near the contact of granodiorite and limestone and other rocks of the Calaveras formation, as at the Cosumnes Copper Mine, five miles southwest of Grizzly Flat. It has also been found in similar associations around the peripheries of granodiorite areas west of the Mother Lode. Prospects have been noticed also near or in serpentine areas east of Georgetown. Although some small mines were productive along the west belt between 1860 and 1870, no record of their output remains. In 1905, about 160,000 lbs. of copper was produced in the county and in 1917 and 1918 a total output of 41,000

lbs. was reported. Since then, only a few hundred to a few thousand pounds of copper has been produced annually as a by-product of gold quartz mining.

The following table gives the location of copper prospects and references to our reports which the reader may consult for further details.

Table of Copper Prospects in El Dorado County

	Location			
Name	*Section*	*Twp.*	*Range*	*Latest report*
Agara	19	8 N.	9 E.	Bull. 50, p. 216
Alabaster Cave	10, 15	11 N.	8 E.	Bull. 50, p. 211; XV, p. 276
Arizona	24	12 N.	10 E.	Bull. 50, p. 214
Big Buzzard	29	11 N.	8 E.	R. XIX, p. 141, R. XXII, p. 406
Bob	13	12 N.	10 E.	Bull. 50, p. 219
Boston	22	9 N.	9 E.	Bull. 50, p. 216
Breala	2	8 N.	9 E.	R. XXII, p. 407
Bunker Hill	14	12 N.	9 E.	Bull. 50, p. 219
Cambrian	23	11 N.	9 E.	Bull. 50, p. 213
Camel Back	11	11 N.	8 E.	R. XVII, p. 430, R. XXII, p. 407
Contraband	24	12 N.	10 E.	Bull. 50, p. 214
Copper Chief	--	12 N.	10 E.	Bull. 50, p. 216
Costa Ranch	12	11 N.	8 E.	Bull. 50, p. 218
Cothrin	29	9 N.	9 E.	R. XXII, p. 407
Cosumnes	24, 25	9 N.	12 E.	Bull. 50, p. 218
Dr. Wren	7	9 N.	11 E.	Bull. 50, p. 216
E. E.	18	9 N.	11 E.	R. XV, p. 277
Hale	25	9 N.	12 E.	R. XV, p. 217
Irland	15	10 N.	10 E.	R. XV, p. 218
Larkin	29	10 N.	11 E.	R. XV, p. 277
Little Emma	3	11 N.	9 E.	Bull. 50, p. 212, R. XXII, p. 408
Noonday	18	9 N.	11 E.	R. XV, p. 278
Pioneer	3	11 N.	9 E.	Bull. 50, p. 213
Revoir	12	9 N.	12 E.	Bull. 50, p. 217
Rip and Tear	3	8 N.	9 E.	R. XXII, p. 408
Robert	13	9 N.	11 E.	Bull. 50, p. 216
Seven Bells or Sporting Boy	4 miles west of Placerville			R. XXII, p. 408
Voss	See Camel Back			

Gems, Jewelers Materials and Ornamental Stones

The occurrences of precious, semi-precious and ornamental minerals so far reported from the county are briefly alluded to, principally for the convenience of the increasing number of amateur mineral collectors.

Adularia—reported in the county, but no localities are given. This is a clear variety of orthoclase, to be found in granitic rocks, and large crystals are to be expected only occasionally where conditions were favorable.

Agalmatolite—(also called Pagodite or figure-stone because it has been used by the Chinese for carving miniature pagodas and other ornaments) is a name applied to some compact varieties of mica, pyrophyllite and steatite, according to Kunz. Reported 2 miles west of Greenwood.

Axinite, a borosilicate of aluminum and calcium, with iron and manganese. The color varies from white or yellow to dark brown or blue. Reported at the old Cosumnes copper mine on the Middle Fork of Cosumnes River 3 miles northeast of Fairplay, in small brown crystals on epidote.

Azurite—blue carbonate of copper. It has been found in the copper mines (which see) near the surface, but good specimens are becoming scarce.

Bornite—"horse-flesh copper ore" or "peacock ore." A sulphide of copper and iron usually occurring with chalcopyrite. A polished specimen of purple bornite and brassy-yellow chalcopyrite is showy. Found at several of the idle copper prospects. (See Copper, *ante*).

Brookite and *Octahedrite* have been found on quartz crystals at Placerville, and *octahedrite* has been taken from a locality 1 mile northeast of American Flat.

Californite—(See Idocrase)

Chalcedony—None of the colored varieties of this cryptocrystalline form of silica have been reported from the county. The white, translucent mammilary phase may be found occasionally in thin layers in the serpentine areas.

Chloropal (Nontronite)—Only an alteration of this mineral to limonite has been found, near Georgetown.

Diamond—A number of discoveries of diamonds were reported during the early period of placer mining around Placerville. Some of these discoveries prior to 1880 were mentioned by Goodyear [1] as quoted by Whitney. Two placer mining claims on the south side of Webber Hill, and one at Dirty Flat, both near Placerville, and mines at and near White Rock Canyon, $2\frac{1}{2}$ to 3 miles northeast of that town, had yielded diamonds, one probably weighing "not far from one and a half carats." Smiths Flat was also said to have produced them. In all, about 60 diamonds are credited to the gold placer gravels of the county. All have been chance finds and probably a much greater number have been lost, as no one appears to have taken any special pains to use apparatus suited to saving them. No authentic discovery of a diamond in place, or of a rock matrix identical with that in which diamonds occur elsewhere, has yet been made in California. Many of the California diamonds are slightly 'off-color.'

Diopside, $CaMg(SiO_3)_2$ varies from white to deep grass green in color. Green crystals are found at the old Cosumnes copper mine and have also been reported "near Mud Springs."

Good crystals of *epidote* and *grossularite* have been found at the Cosumnes copper mine.

Gold in crystalized form suitable for jewelry or for collections, is often found in the 'seam diggings' and 'pocket' mines between Placerville and Georgetown. Crystallized specimens have been sold for more than the bullion value. A very fine specimen, 101.4 oz. troy weight, came from the Grit claim at Spanish Dry Diggins in 1865.

Idocrase (Vesuvianite). The green variety called *Californite* is found on Traverse Creek $2\frac{1}{2}$ miles south of Georgetown in crystal form. White idocrase is also reported in the same locality.

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[1] Whitney, J. D. The Auriferous Gravels of the Sierra Nevada of California. 1880. University Press, Cambridge, Mass.

Malachite (see Azurite).

Rock Crystal in large sizes, some weighing as much as 90 pounds was found in a vein at Placerville in 1891. Crystals have also been found in White Rock Canyon 4½ miles by road northeast of Placerville.

GOLD

There is probably no area in the state similar in size to western El Dorado County which contains such a number or variety of gold 'prospects.' While the scale of operations has not generally equalled that in some other counties, there have been numerous mines in operation lately that have yielded good ore. Adding to this the gold from many pocket, seam and small placer mines, the total output has been increased in recent years until the county has resumed its position as an important gold producer. From the low figure of only $13,379 production recorded for 1920, gold yield increased to $182,043 in 1932, and reached $1,988,735 in 1936. The Big Canyon, Montezuma, Beebe and Sliger mines have been the most important producers and the Gold Reserve and Black Oak, the last named a rich small mine, have added very materially to the total.

The Mother Lode traverses the entire length of the county and the deposits along its course vary greatly in character. In the southern part from the Amador County line to and including the Church Union mine, the veins occur in the Mariposa slate area and share many geologic features with the mines in this slate in Amador County. The slate belt is comparitively narrow and is flanked on the west, and for some distance on the east, by greenstones. Topographically the lode here occupies the narrow stream valley of the North Fork of Cosumnes River.

Near the Church Union, a granitic intrusive has entered the footwall of the slate, which changes its course to northeast and becomes much wider. From there north, gold is found not only in the slate but also in the intruded or interbedded igneous rocks. These rocks vary in character from granitic to ultra-basic, the latter having yielded serpentine. There are quartz veins in slate and schist, impregnations, dolomitic veins, pockets and seam deposits.

The 'seam diggings' extend from Placerville into Placer County. The gold in them occurs in quartz veinlets and seams in the decomposed schist of the greenstone rocks and in the slate. The soft, rotten upper parts of these deposits were worked extensively years ago by hydraulicking. Beginning near Garden Valley, a large body of amphibolite separates the Mariposa slate into two branches, one of which extends north through Georgetown and the once highly productive 'seam diggings' of Georgia Slide; the other striking northwest through Greenwood and Spanish Dry Diggins. The Alpine and Rozecrans mines are in the amphibolite schist mentioned and the Black Oak is at its extreme southern tip.

Among miners, the region east of the Mother Lode from Mariposa through El Dorado is called the East Belt. The metamorphic rocks of the Calaveras (Carboniferous) and exposed sections of the Sierra Nevada grantitic batholith occupy that section. They carry veins

which are generally narrower and may be richer in gold than the veins of the Mother Lode. The ore shoots are also likely to be smaller and the ores more complex, containing several sulphides such as galena, zincblende, chalcopyrite, pyrrhotite and arsenopyrite in considerable amount. The mines at Grizzly Flat in the granodiorite, and the Grand Victory mine in the Calaveras formation are examples of such mines.

Several good mines lie on the west side of the Mother Lode in the areas mapped as amphibolite schist, or near the outer boundaries of bodies of granitic rocks. In the former, feldspar and quartz are gangue minerals, and pyrite often carries most of the gold. The percentage of pyrite is rather high in these ores and the gold is so fine and so intimately associated with the pyrite that little of it can be amalgamated. Concentration by gravity or flotation processes, followed by smelting or cyanidation, are required. The Big Canyon, Gold Reserve and Crystal are examples of these mines.

Alhambra Mine. In S½ sec. 6 and N½ sec. 7, T. 11 N., R. 11 E., 2 miles by road northeast of Poor's Store. It was located in 1883 and a shaft was sunk 29 ft. A block of ground 23 ft. long is said to have yielded $27,600. Again in 1886 work was resumed and a depth of 64½ ft. was reached, with good ore reported. In 1934, Jensen and Schneider took a lease on the claim and at a depth of 90 ft. struck 'high grade' ore in a drift only a few feet from the old shaft. The initial 'strike,' made after 79 days' work, yielded over $10,000 in bullion which brought $30.50 an ounce at the mint. This was recovered by mortaring the rock and roasting some of the gold-bearing arsenopyrite. Later a similar amount was found. The claim passed into other hands and at present is being prospected by Alhambra Shumway Mining Company, Helm Building, Fresno, Calif. No substantial production has been made recently.

The gold occurs free and associated with arsenopyrite in lenses or nodules of quartz and calcite. These nodules are between layers of a very slippery, talc schist which forms the hanging wall. The footwall is gneiss. The strike is S.40°E. and the dip varies from nearly flat to 37° NE.

The present company has sunk a new shaft 130 ft. deep alongside the last of the older shafts. The 90-ft. level has been run 95 ft. southeast and 30 ft. west; the drift on the 130-ft. level extends 95 ft. southeast and 65 ft. northwest.

The equipment includes a single-drum hoist, air compressor and blower, all operated by electric motors and housed in a new building. There has never been any mill on this property. Three men are employed. Besides the Alhambra patented claim, 3 unpatented locations are owned.

Avansino Mine. Mineral rights under NE¼ sec. 29, T. 10 N., R. 12 E., in Pleasant Valley district. Gold-bearing gravel was found in 1893 under the Avansino and Fink ranches. If any production was made, it was not mentioned in available records. There is a shaft 107 ft. deep from which drifts have been run 57 ft. north on the 90-ft level, and 307 ft. south on 107-ft. level. The shaft is reported to pass through alternate layers of lava ash, sand and gravel. On the

90-ft. level a layer of gravel 42 ft. wide lies on a bench sloping toward the shaft, and a winze 20 ft. deep from the south end of the 107-ft. level is claimed to give prospects.

The workings were unwatered a few years ago but no new discoveries were reported.

Ball Brothers Drift Mine. About 3½ miles south and east of Omo P. O. An adit was run 1250 ft. to reach gravel, on which a drift was run south 600 ft. Work was then turned eastward to follow what is thought to be the main channel. This consists of tight gravel about 80 ft. wide in which some pay is reported. Late in 1935, Rio Escondido Mines, Incorporated, Seattle, Washington, was incorporated in Delaware and announced plans to work this deposit.

Barnes-Eureka Mine (formerly *Barnes and Greenstone*) contains two patented claims, 3½ miles north of east of Shingle Springs. Here a narrow body of serpentine extends for several miles north and south as a dike in greenstone, and these claims are among those which have produced small amounts of gold, so far as recorded statistics are concerned. Arsenopyrite and gold tellurides are reported to occur. The last known production, amounting to a few tons of ore that yielded about $10 a ton, was in 1912. Numerous shallow openings were made along the vicinity of the contact, and two shafts were sunk, one reported 350 ft. deep with 60 ft. of drifting on the 200-ft. level and a small stope to the 100-ft. level. The other shaft, 77 ft. deep and south of the first, was being reopened April 28, 1936, by five partners, including A. Swinburne and W. R. Woock of Auburn. A small pump, gasoline engine and single-drum hoist were in use. Although little quartz shows on the surface on these two claims, there is, said to be a vein averaging 2 ft. wide in some of the workings, but these were inaccessible at time of visit.

Beebe Mine. Beebe Gold Mining Company, Crocker Bldg., San Francisco, has continued operation of this mine since the publication of Bulletin 108, in which it was described. The holdings include the Beebe, Eureka, Woodside and Eureka mill-site.

A new shaft on the vein was raised from the 500-ft. level to the surface about 190 ft. from the old one. A winze has been sunk 200 ft. from the 500-ft. level at a point 520 ft. northeast of the main shaft and in July, 1938, ore was being stoped from the 600-ft. level in the Eureka ground. A length of from 500 ft. to 600 ft. along the strike was worked from the surface to a depth of 250 ft. On the 370-ft. level, a length of about 700 ft. was drifted in ore, of which 65% was mined, the balance being left in pillars. The width stoped varied from 5 ft. to 50 ft. and averaged from 12 ft. to 15 ft. The orebody is a silicified and mineralized zone dipping about 80°E. in amphibolite schist. Narrow basic dikes occur in the fissure but there is only a 'commercial' hanging wall. Ore is mined by shrinkage stoping.

The Hadsell mills formerly used have been replaced by two 7 ft. by 36 in. Hardinge conical ball mills. Otherwise the flow sheet remains about the same as shown in Bulletin 108. The overflow from the classifiers below the ball mills passes to 24 Kraut flotation cells. The concentrate from these is thickened to 50% solids, ground in a 5 ft.

Open cut, Beebe Mine, Georgetown.

by 8 ft. Marcy mill and treated with cyanide in two 30 ft. by 8 ft. Devereaux agitators. After passing through 3 thickeners the pregnant solution is filtered and gold is precipitated by zinc dust. About 6 lb. lime per ton of concentrate is used for conditioning and cresylic acid and Zanthate Z5 are used in flotation.

The daily tonnage handled has lately been reduced from 250 to 100 tons as a result of selective mining at the Beebe and the closing of the Alpine mine in June, 1938.

Bella Vista Gravel Mine. Near the Gambling Mine on south. George Busse and John Heckenleitner, owners. Edgar F. Maylone

and Al Larsen were mining and washing a few cubic yards daily in July, 1936.

The adit workings have revealed two narrow gravel deposits, one of which is probably a bench of the other, and only 14 ft. vertically above it. The gravel lies on granodiorite bedrock and is capped by rhyolite. The upper run of gravel was found in a raise 17 ft. high from the adit at a point about 325 ft. from the portal. Gravel was mined here for a length of 200 ft. and a width of 30 to 35 ft. About 400 ft. from the adit portal, and 3 ft. above it, a drift was run on the west side of adit for a reported length of 200 ft. but this drift was caved and unsafe. Good gravel is reported in the face of it. The gravel trends south of west.

Small lots of gravel are trammed to a bin and washed in a concrete mixer carrying 200 to 300 lb. of iron balls, to clean the boulders which are then discharged through a trommel, and the fine material passes into a short sluice only six inches wide fitted with screen and carpet. Two small gasoline engines furnish power. The gold content of gravel is said to be $1 to $1.50 a cubic yard.

Steel headframe at Big Canyon Mine of Mountain Copper Co.

Conveyor and mill at Big Canyon Mine of Mountain Copper Co.

Big Canyon (Oro Fino) Mine is 4½ miles south of Shingle Springs by road. It had a 20-stamp mill before 1888 but the complete record of output is not available. The most productive of the early operations were carried on by Hayward, Hobart and Lane between 1893 and 1901. They produced $720,000 from 180,000 tons of ore. The ore shoot, which had a maximum length of 450 ft., was mined for a length of 400 ft. and an actual thickness of 60 ft. on the old 150-ft. level, but the apparent width is about 100 ft. because of the flat dip. Old reports indicate 20% of the gold was saved by amalgamation by former operators, but this is not true of recent work. The balance was saved by chlorination of concentrate. Since 1901 the mine has been sampled several times, but was idle until 1934 when Mountain Copper Company took it over for operation after extensive sampling. The old shaft was 800 ft. long on the incline or about 500 ft. deep vertically. Ore had been stoped out to the 500-ft. level.

The present company sank a new 3-compartment inclined shaft 620 ft. on 45° incline, 400 ft. north of the old shaft. No. 1 level, 315 ft. deep on the incline, has been opened 1400 ft. No. 2 level, 525 ft. deep on 45° incline, has been run a total of 1970 ft. On the north the ore split up. On the south, another lens of low grade, believed to be a replacement of quartzite, was found. The vein strikes S. 25° W., turning to the west on the south end. The average dip is not over 40° and generally about 35° east.

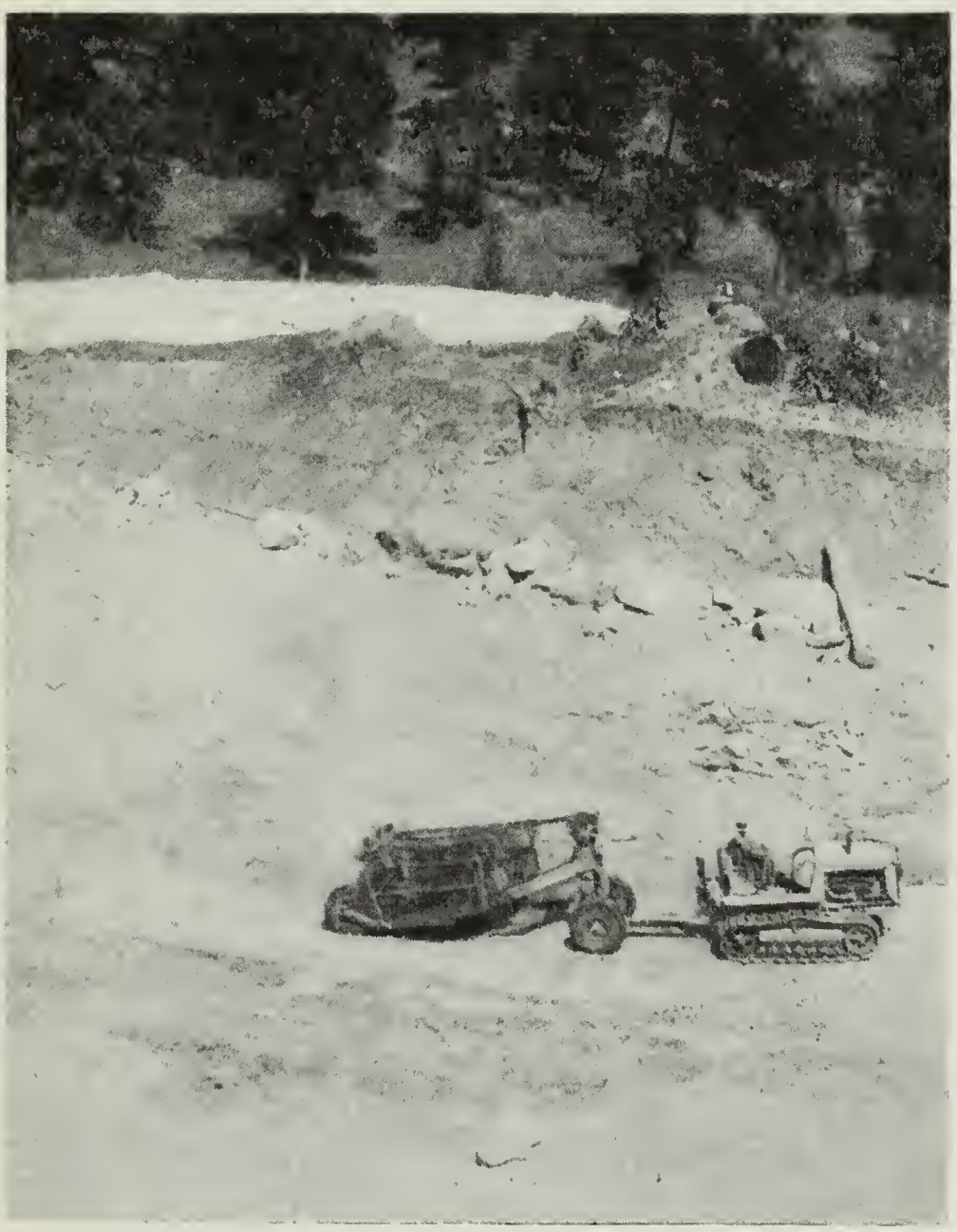
The ore, often described as altered meta-andesite breccia, has a dike of serpentine between it and the Calaveras (Carboniferous) hanging-wall rocks. On the west it merges into amphibolite schist. The work of the present company has brought out many interesting points concerning the ore and its parent rock. The good ore has been found to consist of about equal parts of albite, ankerite and quartz, of which albite appears to be necessary, or at least highly favorable, for gold deposition. Rock of very similar appearance superficially, and provisionally termed quartzite, but lacking the albite, does not make ore. J. M. Basham, superintendent, reports three periods of

sulphide mineralization. The first is of arsenopyrite, the second of barren pyrite and the third of auriferous pyrite. Only 4% of the gold is recovered by amalgamation. Microscopic examinations have shown that the balance of gold is in quartz which in turn is locked up inside of pyrite crystals not coarser than 60 mesh. With 54% of the gold in pulp of —325 mesh, and in view of the fact that grinding below —60 mesh was considered uneconomical, Basham advised a flotation plant instead of cyanidation, in spite of favorable cyanide tests on oxidized ore. Flotation has proven very successful.

Mention of quartzite, and the occurrence of what appear to be water-worn pebbles, suggest that the igneous rock picked up and engulfed some of the sandstone and shore-line conglomerate of the adjacent Calaveras beds.

The orebody has been found to wedge out in depth. Because of the serpentine, former operators left a layer of ore on the hanging wall. The present company has found the walls stand well but has been filling. The ore is so hard that 60% gelatin is used for blasting, which is all done electrically.

On February 26, 1937, water from Big Canyon Creek, which flowed directly above the mine, began to enter the workings. The few men in the mine at the time were safely removed and steps were taken

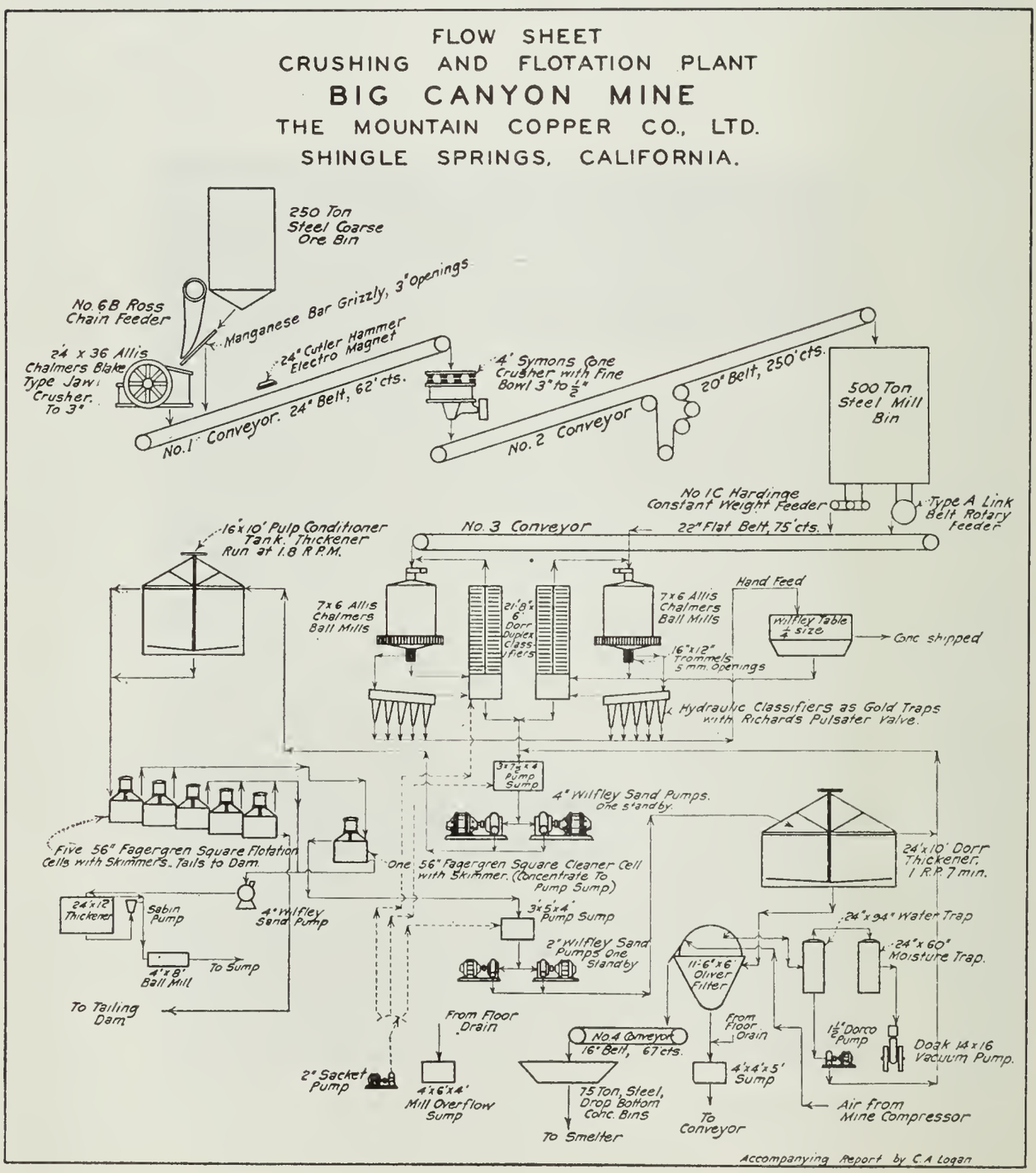


Stripping vein at Big Canyon Mine to facilitate mining ore in upper levels.

to facilitate the dewatering later. Within 52 hours 30,000 gallons of water had poured into the mine, and then a pond of water several hundred feet long formed on the surface. Work was started first on a 78-inch corrugated galvanized iron pipe-line on the east side of the creek to divert the water and carry it past the mine workings.

Later a contract was let to strip rock to below the old 100-ft. level to make available the remnants of ore in the upper part of the mine. This work was finished by July 1, 1937, and mine operations were resumed.

The mining and milling plant are substantial and up-to-date. Ore is hoisted in 4-ton skips operated by a Nordberg double-drum hoist with 165-h.p. electric motor. In the third compartment a 1-ton skip is used for tools and material. Compressed air is supplied by 2 compressors, one of 1300 cu. ft. f. a. capacity run by a 200-h.p. motor and one of 1500 cu. ft. capacity with a 290-h.p. motor. Hoists and compressors are housed in one building. The 75-ft. steel head-



frame has a built-in receiving bin from which oversize over a grizzley goes to an Allis-Chalmers 24 in. by 36 in. jaw crusher which crushes it to 3-inch size and it is then reduced to $\frac{5}{8}$-inch to $\frac{3}{8}$-inch by a Symons cone crusher. The crushers and conveyors are interlocked electrically so that no unit can run when the one next in line has been stopped.

Fine grinding is done by a 2 Allis-Chalmers 7 ft. by 6 ft. ball mills in closed circuit with 2 Dorr double rake classifiers. The classifier overflow (minus 60 mesh) is pumped from 2 steel sumps to a conditioning tank under the mill roof, where it may be held 2 hours before passing to the 5 Fagergren flotation cells and 1 cleaner cell. After the plant had been operating some time, a higher grade ore was found, and the insoluble content of the concentrate increased with this. A 4-ft. by 6-ft. ball mill was put in to regrind the middling product and reduce the insolubles. Concentrate is run through a Dorr thickener and an Oliver filter and then hauled by trucks to Stockton where it is shipped by steamer to Tacoma smelter. Ore yielding $5 a ton or more is considered satisfactory. The ratio of concentration is $13\frac{1}{2}$ to 1. A crew of 150 men produced about 300 tons daily when in full operation.

The surface plant at this mine was described in detail by John B. Huttl, in Engineering and Mining Journal for May, 1935.

Black Gold Mine. This small drift mine in the NW$\frac{1}{4}$ sec. 29, T. 10 N., R. 12 E., adjoins the Hinds Mine in Pleasant Valley district. It included the western part of the original Hinds location, and a lease on other land, a total of 153 acres.

The same bench deposit of fine, loose quartz gravel found first by Hinds was worked through a 60-ft. shaft sunk $19\frac{1}{2}$ ft. from the east property line. Drifts were run west 100 ft., north 280 ft., and east 127 ft., and a few thousand dollars in gold was produced. In a report to stockholders in July, 1930, an average recovery of $3.23 a ton was claimed from gravel breasted up to that time. For milling gravel, two 10-stamp Straub mills with plates and a concentrator were used. Gravel through $1\frac{1}{4}$-inch screen was crushed to 15 mesh. The gravel was sticky but not cemented.

In January, 1931, Black Gold Mining Company quit. Later, Flavel Atkinson had a short lease and is reported to have mined some gravel 50 ft. wide which yielded up to $5 a cu. yd. In 1936, *Ventura Mine Associates, Incorporated,* had a lease on the property, which they plan to prospect through an adit being run southward from the Ventura Placer Mine in sec. 20, on the north side of the lava-covered ridge.

Black Oak Mine is in the NW$\frac{1}{4}$ of SW$\frac{1}{4}$ of SE$\frac{1}{4}$, sec. 27, T. 12 N., R. 10 E., near Garden Valley school. Since the last report (in Bulletin 108) this mine has been in steady operation and has been one of the more important producers of the county. It lies near the narrow southern end of a long body of amphibolite schist which for several miles separates the Mariposa slates into two branches. Although nearly 2 miles wide at the maximum, it has a width of only a few hundred feet in the vicinity of the Black Oak. The mine is part of a placer patent.

It has been opened by a vertical shaft 400 ft. deep (Oct., 1937) and has been stoped from the 400-ft. to 50-ft. level, with levels at 120, 150, 220, 300 and 400 ft. deep. A series of small faults with a horizontal throw of from 4 ft. to 6 ft. was encountered. The widest portion of the vein was between the 220-ft. and 300-ft. levels where specimen ore was found scattered through a width of 22 ft. Nearly all of the work has been done south of the shaft. Going south on the vein, it feathers out. On the 400-ft. level south, the footwall is sheared greenstone (amphibolite schist) in which chlorite schist has been developed. The hanging wall is claimed to be blacker and is locally called 'slate'; an inspection of hand specimens in full daylight shows they appear identical. Here the vein consists of a quartz and calcite stringer lead, with calcite seams making out into the hanging wall. The gold is claimed to be practically all in the calcite. To the north the vein is reported to be solid quartz and calcite from 10 ft. to 12 ft. wide. In the ore zone, the average thickness mined is said to be 8 ft. and the stope length 100 ft.

Although the operator is now inclined to minimize the effect of the small faults (the uppermost of which was mentioned in Bulletin 108 as having apparently been instrumental in localizing the accumulation of gold near the 50-ft. level) these were probably a favorable factor. At least one was encountered in stoping from each level.

The total recorded production of the property up to October 7, 1937, has been $417,303 in gold. Losses through theft have been rather high. Although the total stolen can only be guessed, $16,000 in gold stolen from the mine has recently been recovered in a round-up of 'high-graders.' The term "average grade of ore" is not applicable to such a property where so much of the pay is in 'high grade.' During the latter operations a milling plant with a capacity of 35 tons a day has been operated. It contains large and small crushers, Williamson ball mill, a Dorr classifier, hydraulic trap and 3 Fagergren flotation cells. It was planned to put a Denver jig in place of the hydraulic trap.

For some time, *Dayton Cons. Mines,* a Nevada corporation, has been prospecting the land on three sides of the Black Oak mine in the effort to pick up a part of the rich ore zone on the dip or strike. The properties involved in this development project were the *Davey,* adjoining the Black Oak on the north, the *Clark* land on the east and the *Davenport* claim adjoining the Black Oak southeast on the strike. Of immediate interest in connection with the Black Oak was the work on the Davey land where a shaft was sunk. This work was started in 1934 by M. J. Kelly and Geo. P. Morgan, who took out a little ore which was crushed at the Hart mill. In 1936 the Dayton Consolidated took the property and sank the shaft to the 500-ft. level. Work was carried on until January, 1938, when a 'strike' was reported on the 500-ft. level on the dip below the Black Oak workings and east of the side-line. A few days later it was announced that the Dayton Consolidated was turning over its leases and options on these three holdings to the owners of the Black Oak mine.

Blue Gouge and Berg Mines. The Blue Gouge is on Camp Creek about two miles northwest of Baltic Peak Lookout and may be reached by roundabout roads from Pleasant Valley. In 1895-1896, when it

was being extensively prospected by Mackay, Flood and associates, it was described in Report XIII of the State Mineralogist. It was abandoned shortly afterward and little has been done upon the claims since. Seven unpatented claims, covering most of these old prospects were leased in 1936 to D. A. Raybould with an option to purchase.

The deposit, revealed by erosion in the canyon of Camp Creek, is a zone 400 ft. wide exposed for a reported length of 3500 ft. along the canyon side, and rising several hundred feet above the creek. Several veins of quartz traverse this zone of slate and schist which also carries seams and small lenses of quartz. The footwall is Calaveras formation (Carboniferous) and the hanging wall, eroded and oxidized, is diorite or granodiorite. The strike of the zone is N. 30° W. and dip is 78° NE.

Seven crosscuts at different levels have been run across the central part of deposit from the canyon slope. These vary in length from 121 ft. to 316 ft, and total over 2000 ft., the deepest giving 235 ft of backs. These are claimed to indicate two blocks of low-grade material 1000 ft. and 1500 ft. long containing several million tons. Assay values are reported from $1.60 to $1.98 a ton (old gold price) for several hundred samples.

The Berg ground lying north of the Blue Gouge, and with an apex 100 ft. higher is claimed to contain a block of similar material about 1000 ft. long. Very low mining costs are possible because of the topography. The oxidized zone is underlain by fresh rock carrying $2\frac{1}{2}\%$ of auriferous iron sulphide which is claimed to assay $85 a ton (old gold price).

Camp Creek carries sufficient water for milling a large daily tonnage, but it is not known how much of this water belongs to the claims. There is plenty of good timber nearby.

Bollhalter quartz prospect. One mile north of Weber Creek east of Lotus road, on an agricultural patent. Besides this 147-acre patent, Mrs. Mary Bollhalter has 70 acres in placer locations on a small stream nearby.

A large outcrop has been uncovered for a length of 75 feet on top of a hill, where it strikes east. Reported assays of $1.40 and $3.80 a ton are claimed by the owner from random pieces of quartz. Near the north property-line a stringer lead of quartz in manganese-stained greenish amphibolite schist is said to have yielded pockets from a pit 10 by 10 by 20 ft. The country-rock forms a narrow peninsula extending southward for one-half mile into serpentine. No late work has been done here.

Bret Harte Mine. Frank Dean, owner. In $NW\frac{1}{4}$ sec. 6, T. 11 N., R. 12 E. Three claims, on the north slope of Slate Mountain $\frac{3}{4}$ mile by trail from the road.

An adit 240 ft. long has been run on the Bret Harte claim, and one 140 ft. long on the Safeguard No. 1 claim. During and prior to 1934, a few hundred tons of ore was milled in a Tetrault mill. This came from the surface, and was not in place. The 240-ft. adit gives about 150 ft. of backs on a vein which has been followed 60 ft. and is from 2 inches to 14 inches thick. The other adit shows from 18 inches to 36 inches of quartz which has been followed 50 ft. Idle in 1936.

Briarcliffe Mines, Ltd. (*Baldwin or Nashville Mine*). The adjacent *Maginess* and *Last Chance* claims are also held under option by the company. These claims are two miles east of Nashville and are reached by three miles of road from the Mother Lode highway.

Shallow shafts and adits were run years ago on these claims but apparently the total output was small. About 1914, O. N. Hirst reopened the Baldwin shaft, then 225 ft. deep, and did some work on the 100-ft. and 170-ft. levels. The vein had been previously stoped from the 100-ft. level to the surface. On the Last Chance a 10-stamp mill was operated a short time in 1909 on low-grade rock by *Monarch Consolidated Mines Company.* On the Inez Central (Maginess) there is an old shaft 250 ft. deep from which some ore was produced and hauled to Nashville for milling.

The present company began work in January, 1932 and began milling with 10 stamps a few months later. This mill was run part of the time until March, 1935 when a 100-ton flotation plant was put in commission. This was in steady operation from October, 1935 until July 3, 1936, when the mine and mill were closed down and have been idle since. The late manager, Ray Morrow, stated that labor troubles were chiefly responsible for the suspension, which is hoped to be only temporary. Over 30,000 tons of ore was milled.

The Baldwin claim is 3000 ft. long by 300 ft. wide, and the Last Chance (or Nome) group adjoining it on the east cover the same length. On the Baldwin, where work has been concentrated, the hanging wall is amphibolite schist and footwall slate. This land lies a mile east of the recognized course of the Mother Lode but the character and value of ores found are similar in both, though the best pay at the Baldwin is said to be in the quartz and schist on the hanging wall side. The strike of vein is N. 10° E. and dip 72° NE.

The company ran the main tunnel 895 ft. north to the old Baldwin shaft and 100 ft. beyond it, reaching a depth of 290 ft. below the apex. The shaft was connected with the tunnel. At a point 500 ft. from the tunnel portal, a winze was sunk on an angle of 72° to a depth of 500 ft. (with 25-ft. sump). Levels were turned from winze at depths of 125, 275 and 500 ft. Ore was mined from all three of these levels, with stopes reported of a maximum width of 60 ft. to 70 ft. No. 7 level was drifted about 100 ft. each way on vein and is claimed to be all in ore, in what is called the south or Morrow shoot. Besides this there is the old Baldwin shoot at the old shaft, from which this company mined over 10,000 tons. The average reported yield was $3 to $4 a ton in 1934 to 1936 though some ore stoped on the hanging wall in the deeper levels is claimed to have been much better.

After passing through a Symons cone crusher and being ground to —200-mesh in a 4-ft. by 5-ft. Hendy ball mill, ore was put through a Morse Brothers unit flotation cell and 16 M. S. cells. Water for milling was pumped from Middle Fork of Cosumnes River through 4300 ft. of pipe-line with 475 ft. lift. Electric power is used. When mining and milling 100 tons daily, 48 men were employed.

The company is stated to have been financed entirely with Canadian capital. The main office is in the Supertest Building, London, Ontario. J. G. Thompson, president.

Buckeye Hill Placer Mine (*Flora Mine*), nine miles northeast of Georgetown was worked extensively in the 1890's by J. J. Flora. It contains an ancient channel deposit 1000 ft. wide carrying layers of gravel alternating with "cement," the total thickness being 127 ft. where it was hydraulicked on the west side. A good deal of drift mining was also carried on through adits, breasts being 100 ft. wide in the bottom gravel, where coarse gold was found. Timber was pulled out after working this ground so that the old 600-ft. adit caved. Later work was done on a bench above.. A few years ago, Oscar Jacobson and associates, the present owners, did some work on the north rim through an adit 125 ft. long, dropping gravel to a 400-ft. bedrock adit. Water for washing is scarce and has to be lifted 500 ft. by pumping and then piped 1300 ft. to a Beers mill. The gravel is loose and is reported to yield $1 (old price) gold per 1500-lb. carload. The gold is coated black.

Bucks Bar Placer. On North Fork of Cosumnes River two miles north of Youngs P. O. The Hutton property lying on both banks of the river just upstream from the highway bridge contains a gravel deposit from 8 ft. to 16 ft. deep and claimed to carry about 800,000 cu. yds. on decomposed granitic bedrock. Bradford, Cross and Prior of Sacramento are reported to have been interested in a drag-line outfit which operated here a short time without success. Lately (July, 1936) the land was taken on lease by Los Angeles interests who planned to install another placer mining plant.

Buena Vista Mine. This is an old claim six miles south of El Dorado by road passing the Union and Martinez mines. According to Storms[1]

> "The veins are found in Calaveras formation—mica-schist at this place. A small vein running parallel with the strike and dip of the schists has been followed for some distance in search of pockets with satisfactory results. A former operator who prospected this mine, in some way was misled as to the value contained in a schistose zone impregnated with iron sulphides, and expended nearly $50,000 on the property doing considerable development work, erecting numerous buildings and a mill. The rock proved almost valueless, and the mine was closed. The present owners, however, are doing well."

The mine's name does not appear as a producer in records of that period. It lay idle many years until 1936 when John J. Schuster obtained an option and later formed Buena Vista Mining Company to reopen and prospect the workings which include a shaft reported to be 208 ft. deep, an adit, and drifts 400 ft. or more in length. Work had been suspended early in May, 1937. It was said the company did not completely unwater the workings.

California Consolidated Group comprises three claims south of Mt. Pleasant Mine and covering 4500 ft. along the strike of veins supposed to be extensions of some of those in the latter mine.

An adit 468 ft. long has been run and it is estimated by the owner that 225 ft. more work will be required to strike what he believes is the Mt. Pleasant vein. This adit would give 300 ft. of backs. Some ore mined from shallow workings years ago on the Tapioca vein, was hauled to the Morey mill and is claimed to have yielded $11.30 a ton. Other samples varied from $6 to $11 a ton. The claims lay idle

[1] Storms, W. H., Calif. State Min. Bur. Bull. 18, p. 91, 1900.

a long time, until work was resumed recently by Marie H. Johnson and others.

Crystal Mine. In sec. 18, T. 9 N., R. 10 E., 3 miles south of Shingle Springs. It is being prospected by Oakleigh Thorne with Ben Lockwood, superintendent. In June, 1937, 25 men were employed. This is an old mine, once equipped with a 10-stamp-mill but idle many years. There is one claim 1220 ft. long.

The present work is being done through an adit level run 1028 ft. north through the hill, with the north section in broken and muddy ground. At 328 ft. from the portal, a winze has been sunk 480 ft. on 45° angle, following the dip of ore. Levels 2, 3 and 4 have been turned at depths of 200, 326 and 456 ft. respectively on the incline. Most of the work below the adit level has been done on No. 3 where a drift of 240 ft. north and 40 ft. south is claimed to be all in ore, reported as varying from 8 ft. to 24 ft. in width. The writer noted a width of 12 ft. at one place on this level where the vein strikes north and dips 42° E. In No. 2 raise crosscut, and in other parts of the mine, the vein material is frozen tight to both walls, which appear to be identical. A sample of the wall rock has been classified by Frank Sanborn as amphibolite-chlorite schist. It is dark green, fine grained and appears black under ground. On No. 4 level, drifting had extended 30 ft. south and 50 ft. north at time of visit.

From inspection underground, it appears that the vein material was deposited in the irregular cracks and occasional cavities in the schist resulting from the smashing and crushing which occurred when the gabbrodiorite entered the country to the west. In places in the mine small open cavities were formed, and in these growths of quartz crystals are found. The whole effect has been the formation of a very irregular vein. An examination of a thin section of typical vein mate-

Surface plant at Crystal Mine, south of Shingle Springs. Steel cyanide tanks in right foreground.

rial from the third level was made by Frank Sanborn and Charles V. Averill. This was stated by the superintendent to be good ore. It was found to consist of quartz, feldspar, calcite and pyrite. Some albite twinning was noted, but the feldspar, although apparently more plentiful than the quartz, was mostly in crystals too small to permit telling whether it was albite or adularia.

Hoisting is done with a 20 h.p. Box Iron Works Denver electric hoist. Near the portal of adit there is a 600-cu. ft. Worthington air compressor run by a 100-h.p. motor; a drill sharpener and smaller tools all housed in new buildings. About 5000 gallons of water is raised daily with a duplex piston pump on No. 3 level and pneumatic sponges in the sump.

Assays are claimed to indicate ore ranging up to $11 a ton in gold.

In July, 1938 a reduction plant with a capacity of 100 tons to 125 tons a day was completed and put in operation. Ball milling and cyanidation are employed. Dams have been built for conserving water and restraining tailing in French Creek. It is expected about 45 men will be employed when in full operation.

Expansion Mine. In SE$\frac{1}{4}$ of SW$\frac{1}{4}$ sec. 17, T. 10 N., R. 10 E., about seven miles by road north of Shingle Springs. This prospect is on one of the deposits of disseminated pyrite in silicified amphibolite schist so common in the western foothills. Serpentine lies on the footwall. The lower adit, 150 ft. long, is a crosscut which for 40 ft. crosses a mineralized belt which gives gold assays, all the gold being reported in the sulphide. This work, done years ago, just entered fresh rock showing unoxidized sulphide with some bluish quartz.

Although claimed to have been a producer between 1900 and 1904, no record of output is available.

Ferriera Claim. Contains 20 acres in sec. 29, T. 10 N., R. 12 E., on the east end of Newtown ridge. In 1930 A. Neistrum sank a shaft 135$\frac{1}{2}$ ft. deep to slate bedrock in search of gravel. No pay was found, although 13 g.p.m. of water had to be pumped.

Fort Yuma claim is lot 49 in Secs. 29 and 32, T. 9 N., R. 10 E., 1$\frac{3}{4}$ miles by road southeast of Big Canyon Mine. Under lease to George Phillips, Sacramento and George Wilson, in August, 1938.

Between 1890 and 1902 this property was worked by Hale and Baughman but there is no record of any ore having been milled, although a stamp-mill was taken to the claim. There is an old shaft reported to be 175 ft. deep from which some drifting was done, and to the south is a second shaft 40 ft. deep. The vein filling on the surface varies from 2 ft. to 4 ft. wide, including from 2 ft. to 2$\frac{1}{2}$ ft. of solid quartz. The strike is nearly north and dip is steeply east. Both walls are Calaveras slate.

With 8 men employed in August, the lessees have cleared the shaft to the 100-ft. level and have opened the drift on that level 132 ft. south and 119 ft. north. A Lane mill and 4 Fagergren flotation cells have been installed and a test run of 100 tons of ore gave satisfactory returns. An electric power line a mile and a half long has been built. Water is taken from Big Canyon Creek through 1500 ft. of pipe and 2000 ft. of ditch.

Fossati Drift Mine (*Tunnel claim*). It is about 1½ miles south of Camino, on Goose Nest Ravine east of Sailor Jack Mine. Old workings, besides surface placer mining, included the adit now called Green Tunnel running west from the ravine, and a shaft through which some gravel was taken out. About 1930, Charles Croft drove another adit 500 ft, north of and 50 ft. above the Green tunnel. From this a raise 200 ft. in struck gravel 14 ft. above the adit, and some production was made from it. The main adit was advanced 50 ft. further where it passed through a channel rim which was followed down for 50 ft. on an incline. Over 400 ft. of drifting was done from the foot of this incline, when the lease was transferred to J. S. Green. The latter did considerable prospecting through the Green tunnel which was advanced northwest toward the channel that had been worked by Croft. At about 620 ft. from the portal in the right branch of this tunnel No. 3 raise was put up, striking good gravel 26 ft. above the tunnel. Some small breasts were opened in this, but in June, 1934, the property was turned back to the owner. In September, 1934, R. W. Waterman began work for another group of lessees, *El Dorado Channel Mines, Inc.*, and did some additional work which showed the channel varied greatly in width and gold content. Funds were exhausted before much new ground was opened, and work was stopped in September, 1935.

The deeper channel in the different workings ranges from 25 to 200 ft. wide and the gold content varies from 50 cents to several dollars a yard, mostly in coarse sizes, up to an ounce each. The gravel is tight and lumpy enough to require a trommel.

The gravel found in No. 1 raise and other shallow workings is of a different run, with gold the size of bran.

In May, 1936, this claim was reported under lease to Charles Woods and sons.

Frog Pond Mine. It is ½ mile northwest of Garden Valley, in decomposed igneous rocks enclosed in Mariposa slate. Work has not reached sufficient depth to expose fresh rock, but it is probably amphibolite schist found commonly in the region.

The surface of the claim was worked extensively for the gold released by weathering, and later Samuel W. Collins sank a shaft 60 ft, from which a drift and incline has been run south between 80 ft. and 100 ft. Coarse gold was found both in quartz and in lumps of arsenopyrite, in a series of seams. No work is going on at present.

There is a 2-stamp mill which was used at intervals between 1914 and 1927 to crush small tonages of ore and has been used also at times as a custom mill for ore from other nearby mines. Water for milling must be purchased from a public utility company.

Gambling Mine. Joe Lopez, Plymouth and Tony Levaggi, owners. It covers 2800 ft. in length along the strike of vein, and 40 acres of additional mineral rights, in sec. 5, T. 8 N., R. 12 E., south of Aukum-Fairplay road.

The vein strikes east and dips 80° south with an average width reported to be 18 inches, but 30 inches wide in the bottom according to Joe Lopez. It has been idle since late in 1934 and the workings could not be visited. Both walls are granodiorite with a narrow gouge on each.

The shaft is 500 ft. deep on an incline of 80°. The upper 350 ft. was sunk between 1915 and 1918, when the 350-ft. level was also run 700 ft. east and 240 ft. west. The later work in 1933 and 1934 included 150 ft. of shaft sinking, with drifts 150 ft. each way on the vein on 225-ft. level and 180 ft. each way on 450-ft. level. There is also an adit called 90-ft. level on which considerable drifting was done. The only stoping reported was a little on the 350-ft. level, besides which part of the ore from the drifts was milled.

The plant includes a good galvanized-iron mill-building, with 10 stamps, a jaw crusher, four 12-ft. Frue vanners, plates, clean-up barrel and 4-cylinder tractor engine; a single-drum steam hoist, Bury compressor, and Pomona pump. The shop contains a drill sharpener and oil-fired forge. Three cords of wood was required daily at a cost of $10 to furnish steam, and power was scarcely adequate for all requirements.

Gilt Edge (Revenge) and Consolidated claims are in the NE¼ sec. 10, T. 12 N., R. 10 E., 1½ miles southeast of Greenwood. It is one of the mines on the Greenwood seam belt, formerly worked by hydraulicking. Only a little pocket-hunting on the stringers exposed in the old pit has been done in late years. Some specimen ore was exposed by this work but production has been nominal and has not been separately recorded. Properties of this kind are difficult to sample except on a large scale, because of the capricious distribution of the gold throughout a large volume of rock. The geology of the 'seam mines' has been discussed elsewhere.

Grand Victory Mine is in secs. 33 and 34, T. 10 N., R. 11 E., 4 miles by road southeast of Diamond Springs. It is an old mine, which was found in 1857, but little was done until 1879 when a 5-stamp mill was built. This was increased to 50 stamps in the latter part of 1880, and in 1883 the mine was reported to have produced a total of $150,000 in free gold from open cuts at an operating cost of 65 cents a ton. There was little sulphide in this oxidized ore, but soon after the work reached unaltered sulphides. Concentrators were installed and a reverberatory furnace was erected, but little success appears to have been had for several years. The ore was said to carry antimony and arsenic and recovery was said to be poor at that time, leading to the suspension of work before 1890. About 1894, a cyanide plant was installed and was operated to treat oxidized ore until late in 1901. The total production during this period was over $85,000. The record of production between 1883 and 1890 is not available. In 1885 the mill was reported to be crushing 225 tons a day with an average yield of $2 a ton.

After being closed in 1901, the mine lay idle until July 1, 1933, when work was resumed and prospecting and sampling was carried on for nearly two years. Although the former operators had sunk a winze giving a depth of 385 ft. below the outcrop, practically no stoping had been done below the 100-ft. level except a little at 200 ft. Most of the ore milled came from three open cuts, which are from 100 to 135 ft. wide at the surface and extend for a total length of 530 ft.

The new work consisted of cleaning out the winze and running several thousand feet of crosscuts and drifts on the 200-ft. and 300-ft. levels. The winze giving access to the deeper workings had previously been sunk from the main adit 450 ft. from the portal. The workings on the 300-ft. level consist of a drift about 970 ft. long running from the shaft northeast and north, with a number of crosscuts from it. The limestone bodies, alongside of which the ore lies, strike N. 70° E. on this level. Five such bodies, from 12 ft. to 33 ft. thick, have been cut. The ore is a dense, heavy silicified member of the Calaveras series which here includes principally silicified schist, quartzite and limestone. The mine is within one-half mile of surface exposures of a granodiorite batholith. Acid dikes run about parallel to the ore bodies and diorite dikes strike N. 51° E., N. 58° E., and S. 77° E. In places the limestone is faulted with a horizontal throw of a few feet, but this faulting does not seem to be definitely associated with the dikes. On this level ore was crosscut 22 ft. wide and 270 ft. of drift was run in ore, and a raise was put up in ore. Four diamond drill holes from 150 to 250 ft. long were run. On the 200-ft. level, the longest crosscut was run N. 15° W. 372 ft., besides which about 1080 ft. of shorter ones were driven. The strike of ore on this level is N. 40° E., diagonally across the strike of schistosity of the wall rocks, which is N. 80° E. This variation from the normal northwest strike of the Calaveras rocks is no doubt due to the effect of the granodiorite invasion. About 180,000 tons of sulphide ore is claimed to be reasonably indicated, though not blocked out.

There are four good galvanized iron buildings and some old wooden dwellings on the mine. Mine equipment includes a sinking pump of 170 g.p.m. capacity, with 25-h.p. electric motor, Sullivan compressor with 125-h.p. motor, Clyde single-drum hoist with 35-h.p. motor, and shop tools.

The workings are reported to make an average of 60 to 65 g.p.m. of water, but sudden and heavy flows are likely to occur whenever a cavern is opened in the limestone.

Greenwood Quartz Mine at Greenwood was leased in 1935 to T. W. Carpenter and sons, who erected a plant containing two 4-ft. by 8-ft. ball mills and cyanide equipment for treating the material from the seam deposit which they believed carried enough gold over a width of 200 ft. to pay for working. After a short period of operation during which a gasoline shovel was used to mine surface material, work was suspended.

Hart Mine in N½ sec. 27, T. 12 N.; R. 10 E.; on the 'seam belt' between Manhattan and Empire canyons 1 mile north of Garden Valley, was described in bulletin 108. In early days it was hydraulicked for a length of 175 ft., a width of 50 ft. and a depth of 40 ft. Later it was prospected to learn if the ore would pay for milling. Four separate stringer systems or veins were found. Drifts called Rymal and Hart adits were run on two of these, a shaft 200 ft. deep was sunk connecting with the former, and a 30-ft. shaft from the Hart adit. A raise was also put up 65 ft. to the bottom of the old hydraulic

pit. A large part of this work was done by J. A. Flink and J. B. McAuley since 1930, when they erected an 8-stamp mill. Some ore has been milled nearly every year since. The average recovery per ton over a period of 4 years (using a value of $35 an ounce for gold), was nearly $5 a ton. At the time of the last two visits, however, the mine was idle and deserted and nothing could be learned of the width and length of ore bodies.

The deposit is a stringer lead in amphibolite schist, being in the same long, narrow body which contains the Black Oak Mine. The geology of these 'seam belts' has been described in Bulletin 108. It is claimed to have a length of 600 ft. and an average width of 12 ft.

The equipment includes 8 light stamps, a concentrator, electrically operated hoist and 225-cu. ft. air compressor, with assay office, etc.

Havilah (Nashville) Mine. This adjoins the Montezuma mine on the south, and the last operations, which terminated about July, 1936, were carried on by *Montezuma Apex Mining Co.* Since then, the mine has been turned back to the owners.

When the Havilah was reopened in 1934 it was found that former operators had stoped out a short ore shoot, from 60 ft. to 75 ft. long so far as could be judged, on the north side of the shaft from the 1000-ft level to the surface. This old mine is claimed to have been the first quartz mine worked in the county. Its production had been between $350,000 and $400,000.

The last operators opened a length of 160 ft. of good ore up to 10 ft. thick on the 200-ft. level south of shaft by advancing the drift beyond the old face. It proved to be only a small ore shoot. The 1000-ft. level was cleared and 450 ft. of drift was run on the Montezuma footwall vein (the main vein of both mines). An ore shoot 80 ft. long and from 6 ft. to 15 ft. thick was found, with an average value of about $5 a ton, but it gave out before the Montezuma 700-ft. level was reached. The Montezuma 1200-ft. level was also run into the Havilah ground and a raise was put up to the 1000-ft. level 300 ft. north of Havilah shaft. On the 1500-ft. level run from the Montezuma shaft, some indications of ore were found near the Havilah line, but this extended only 20 ft. high and 40 ft. long.

Hinds (Los Angeles) Mine. In NW$\frac{1}{4}$ sec. 29, T. 10 N., R. 12 E., in Pleasant Valley district nine miles east of Diamond Springs. W. A. Hinds discovered a gold-bearing deposit of bench gravel here in 1927. After producing a few thousand dollars from a short drift at a depth of 20 to 24 ft., he turned the property over to others who called it the Los Angeles mine. They sank a shaft 48 ft. deep and ran a drift about 200 ft. northwest with a branch east 70 ft.

The gravel seen in Hinds' workings was mostly fine, loose quartz gravel but with some quartz boulders two feet thick. It lay on soft, clayey rhyolite ash and had a white sand covering. In a distance of 60 ft. drifted eastward, the bedrock dropped about three ft. This gravel was dry. The gold is all coated black and mostly coarse. A deeper and later channel, known to exist on the next property east, probably drains the section and may have eroded much of the earlier gravel.

No work has been done here for several years, the last mining having been done by lessees who made good wages.

Headframe used in prospecting a shallow gravel deposit at Hinds Mine, Pleasant Valley.

Kaeser (Boulder) Mine. This old mine, 2½ miles northwest of Deer Valley school, was active over 40 years ago, but had lain idle some time when seven claims were relocated in 1931 by F. J. Kaeser and associates. The work in the past consisted of driving adits and stoping out ore at successively lower levels on the north slope of the hill. This was followed by sinking a winze 200 ft. deep on the vein from the lowest adit. There was a lapse of 30 years between the last production reported by the old company in 1901 and the first output under the new owners in 1931. Since that year less than 1000 tons has been milled, yielding from 0.1 oz. to 0.25 oz. gold per ton.

The vein lies in gabbrodiorite near the north border of a batholith. The strike is N. 45° to N. 50° E., dip about 45° NW., and average width reported 8 ft. though where seen it showed from 1 ft. to 14 ft. of quartz, in the lower adit. This adit, the scene of the limited amount of recent work, is a crosscut south 600 ft. to the vein, which it follows as a drift 300 ft. For 60 ft. on the strike and 30 ft. above the level in a raise, the vein averages 8 ft. thick. On the strike it pinches to one foot. In the top of the raise, the fissure is completely filled with

mineralized country rock, which F. J. Kaeser claims assays high enough over a width of six feet to make good ore.

In the winze workings below this adit, which were inaccessible at time of visit, the former operators are beleived to have stoped a block of ore 100 ft. deep, and for a length of 100 ft. north of the winze, but definite details are lacking. It is claimed there is ore left in these workings, but this has not been verified by any recent examination.

The four older adits, higher on the slope, still contain low-grade quartz left after the selective mining done by former operators.

The mill contains ten 350-lb. stamps, rock breaker and small concentrator and is run by an automobile engine.

In April, 1938, the claims were under option to H. Fulmer and J. Torney, Seattle. A new adit was being run to connect with No. 4 adit (caved) and furnished ventilation for No. 5, the lowest level.

Kelsey Gold and Silver Mine. The claims of this group extend for nearly a mile along the contacts of narrow dikes of amphibolite schist and serpentine with the enclosing Mariposa slates, on the steep slope on the north side of South Fork of American River, starting $\frac{1}{2}$ mile south of Kelsey. The work done up to June, 1934, was described in our Bulletin 108.

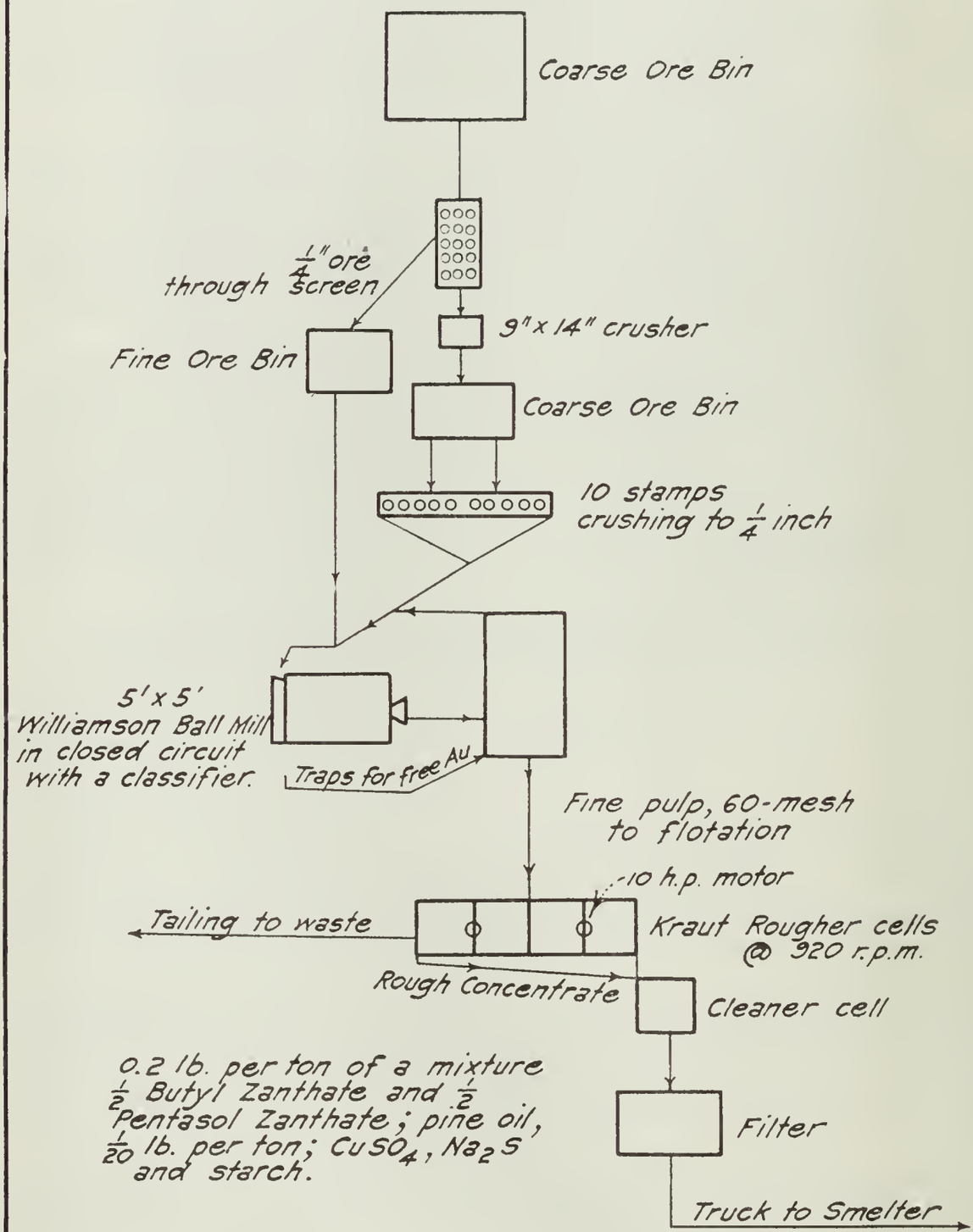
Since that time an upper adit, 300 ft. above the main adit, has been run 700 ft. north. The main adit, 1700 ft. long, has not been extended. Stoping is going on above the lower adit. An electric locomotive hauls trains of loaded cars to the mill which is crushing 40 to 45 tons a day. A shaft has been sunk 42 ft. at the mouth of main adit, and the 2 adits have been connected by a manway. The upper one is being advanced. The Lady claim on the hanging-wall side has been acquired.

The mill has been rebuilt, dispensing with the 10 stamps. A Telsmith gyratory crusher and Aurora jaw crusher furnish $\frac{3}{4}$-inch feed to a 5-ft. by 5-ft. Williamson ball mill crushing to 60 mesh, in closed circuit with a double classifier. A Pan-American jig takes pulp from the mill. The classifier overflow passes to 4 Kraut flotation cells run in pairs by 10-h.p. electric motors. Concentrate then is cleaned in 1 cell which returns its tailing to the 4 rougher cells. Pine oil, reagent 301 and zanthates Z 6 and Z 8 are used for flotation. A recovery of 90% is claimed with tailings running from 13¢ to 26¢ a ton. About 30% of gold is recovered free and the balance by smelting concentrate at Selby smelter.

About 15 men are employed, working 1 shift in the mine and 3 in the mill. Electric power is used throughout. So far a large sum raised from the sale of stock has been spent, but the average grade of material milled has not been high enough to permit calling it ore.

Lotus Bar Placer. This is on the South Fork of American River at Lotus, where a deposit of gravel accumulated on the south side of the stream. Several companies have been formed in the past few years to work here. The first was *Great Bend Mining Company, Limited,* which built a stationary washing plant using a trommel, sluices and a belt conveyor similar to those on bucket dredgers and employing a steam shovel for digging with trucks to haul gravel to the

FLOW SHEET, KELSEY MINING COMPANY
EL DORADO COUNTY
June, 1934.



Accompanying Bulletin 108, by C. A. Logan.

washer. This plant was operated only a short time and apparently not at a profit. The company was succeeded by *Placers, Incorporated,* a Los Angeles concern, which at first brought in an elaborate screening and washing plant mounted on a heavy auto truck chassis. In April, 1935 they had given up the use of this. A Le Tourneau 'bulldozer' was then employed to strip the overburden, and the gravel was dug with a 1-cu. yd. gasoline shovel feeding directly to a small portable washing plant, which limited the capacity of operations. Later trucks were used to haul gravel. The washing plant was placed on a worked out piece of land where tailing storage space was available, and the plant could be moved by a tractor.

The deposit is about 15 ft. deep, consisting of up to 12 ft. of sandy overburden and 3 to 4 ft. of loose gravel with medium to coarse boulders, lying on rotten granodiorite bedrock.

Mammoth Mine. Between Weber Creek and American River about one mile east of their junction and eight miles northwest of Shingle Springs. It was worked in early days by Jasper Jurgens who is reported to have taken out a $10,000 'pocket' in 1860. The 'porphyry vein', 5 ft. wide and striking west, runs at nearly a right angle to the 'pocket' vein, which strikes northeast and dips west in gabbro-diorite. The 'porphyry vein' has been prospected by a crosscut 75 ft. long and a drift of 120 ft.

Lester F. Skinner, who leased the property in 1934, reported milling some of the dump material from the 'porphyry vein' with encouraging results. He used three 350-lb. stamps, run by a small gasoline engine.

Martinez Gold Mines Company (formerly *Hillside Group,* and later locations). West of Martinez Creek 4½ miles east of south of El Dorado, on road past the Union Mine. The claims cover 4500 ft. on the strike.

Since Bulletin 108 was published, work has been resumed and in May, 1937 when visited, 4 men were working of whom 2 were driving the lower adit south. This adit enters from the east and the various branching crosscuts and drifts partly prospect the Gold Reef, Martinez and Hillside No. 3 claims, the south face being about on the side-line between the 2 latter claims, south of the Gold Reef. These claims are on the east side of the Mariposa slate carrying the Mother Lode veins, near and upon the contact with the Calaveras formation. Rock coming from the face at time of visit was in part altered to carbonate showing mariposite and indicating interbedded igneous layers in the contact zone, but Mariposa slate is the most prominent in the exposures to the west and north. The south face is about 1400 ft. from the portal. On Gold Reef claim 600 ft. from the portal, a typical lens of slate-quartz ore 38 ft. long was opened in previous work. Grant Busick, president of the company, reports mining here 115 carloads of ore that yielded $4.12 a ton (old gold price). A winze was sunk 22 ft. below the adit here and is claimed to show 9 ft. of ore. About 90 ft. of backs remain above the adit, the rest of this ore having been mined from above, and is said to have yielded $10,000.

These adit workings, aggregating probably 2000 ft., are east of the 'bull quartz' vein and the slate above this adit level appears to be disturbed, with dip to the west. The ore was followed down from the hilltop along a series of breaks which faulted it northeast from 16 ft. to 30 ft.

The old 5-stamp mill has been sold and moved to the Crusader mine. There are several small buildings, one housing a Holt 4-cylinder engine which runs a 9 inch by 8 inch air compressor.

Melton Mine on Cosumnes River 2½ miles north of Grizzly Flat, had already been extensively worked in 1888, when it was described in Report VIII of the State Mineralogist. At that time it had 3 adits, the longest and lowest being 3000 ft. long and having a reported vertical depth of 500 ft. below the surface. Nine ore shoots had been found in the vein which strikes north and dips steeply west and which was stated to have an average width of about 3 ft. Evidently it lay idle for a long time after 1888 as it does not appear among the list of producers again until 10 years ago. Since that time, a number of companies have each worked at the property for a short time, and there has been an annual production of a few hundred tons of ore. The total reported for 7 years was less than 2500 tons, of an average gold content of nearly one-half ounce a ton.

The vein strikes nearly north and dips west in granodiorite. The ore carries sulphides of iron, lead, zinc, copper, antimony and arsenic and the bullion produced in the early work contained considerable silver. The concentrate amounted to 2% or more and yielded from $100 to $200 a ton in gold. In late years, the ore bodies found have been small.

The milling plant includes an Emco ball-mill, Dorr Duplex classifier, Denver unit flotation cell, 4 Fahrenwald and 4 Kraut flotation cells. The name of the operating company has lately (Feb. 15, 1938) been changed from *Miller Gold Mining Company* to *Cosumnes Mines, Inc.*

Mitchell Prospect. In SE¼ sec. 7, T. 10 N., R. 9 E., two miles northwest of Pine Hill Lookout. A quartz vein from 4 ft. to 10 ft. wide has been prospected on this and adjoining land owned by W. C. Wulff in sec. 8. A length of 200 ft. on the Mitchell land, where the vein is widest, is claimed to give encouraging assays in surface openings.

On the Wulff land, an old shallow adit about 150 ft. long was lagged up at time of visit, but the vein is stated to carry a fair gold content for a length of 110 ft., judging by assays and other tests mentioned by Wulff.

Montezuma Mine. This mine is now owned by *National Tunnel and Mines Co.* which is controlled jointly by *Utah-Apex Mining Co.* and *Anaconda Copper Mining Co.* The property is at Nashville on the Mother Lode highway 2 miles north of the Amador County line.

Since the publication of Bulletin 108, which described operations up to June, 1934, the Montezuma shaft has been sunk to 1540 ft. The 1300 ft. level was run 700 ft. and the 1500 ft. level 1275 ft. on the Montezuma vein. Although the vein appeared unchanged and was of

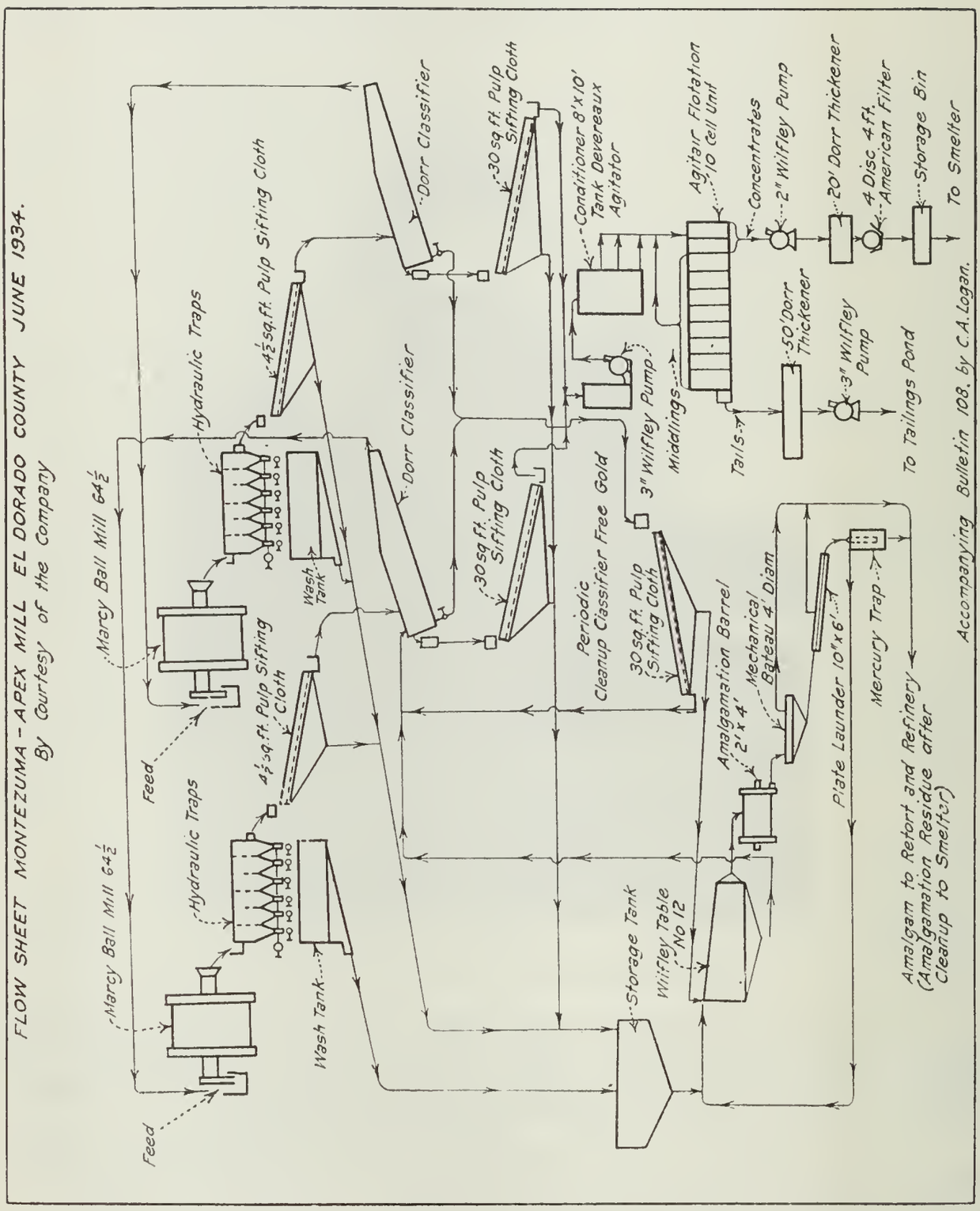
good width in these deeper levels, with no faults reported, it did not carry sufficient gold to make ore below a depth of 1225 ft. The 1500 level south drift was run 1050 ft. and besides prospecting the Montezuma vein, some 250 ft. of work was run looking for the Nashville (Havilah) vein below the bottom of the Havilah shaft.

Headframe at Montezuma Mine, Nashville.

Milling of ore from the Montezuma was stopped July 10, 1936, but the mill was used until April, 1937, to crush ore from the Union Mine. Since the latter date, operations have been suspended pending a decision as to the advisability of further prospecting.

The occurrence of such lean zones is not at all unusual in Mother Lode mines and most of the successful ones have sunk through such zones into deeper ore bodies.

The Montezuma spur vein, entering the main footwall vein from the east side near the shaft, with a northwest strike, produced good ore between 900- and 1100-ft. levels. Below the latter level it became poorer, and was not found on the 1300- and 1500-ft. levels.


FLOW SHEET MONTEZUMA - APEX MILL EL DORADO COUNTY JUNE 1934.
By Courtesy of the Company
Marcy Ball Mill 64½
Marcy Ball Mill 64½
Feed
Feed
Hydraulic Traps
Hydraulic Traps
4½ sq.ft. Pulp Sifting Cloth
4½ sq.ft. Pulp Sifting Cloth
Wash Tank
Wash Tank
Dorr Classifier
Dorr Classifier
30 sq.ft. Pulp Sifting Cloth
30 sq.ft. Pulp Sifting Cloth
Conditioner 8'x10' Tank Devereaux Agitator
Agitair Flotation 10 Cell Unit
Concentrates
2" Wilfley Pump
20' Dorr Thickener
4 Disc 4 ft. American Filter
Storage Bin
To Smelter
50' Dorr Thickener
3" Wilfley Pump
To Tailings Pond
Middlings
Tails
3" Wilfley Pump
Periodic Cleanup Classifier Free Gold
30 sq.ft. Pulp Sifting Cloth
Amalgamation Barrel 2'x4'
Mechanical Bateau 4' Diam
Plate Launder 10"x6'
Mercury Trap
Storage Tank
Wilfley Table No 12
Amalgam to Retort and Refinery (Amalgamation Residue after Cleanup to Smelter)
Accompanying Bulletin 108. by C.A. Logan.

Morey Mine adjoins Mt. Pleasant Mine on the north. A dozen or more shafts from 60 to 70 ft. deep have been sunk on 10 different small veins. Bunches of ore of good grade, six inches in average width and about 15 ft. long, have been extracted. The owner has a small mill nearby to which ore has been hauled.

Mormon Hill Mine. In sec. 3, T. 10 N., R. 9 E., 1⅓ miles north of Deer Valley road, and contains 80 acres. Dr. C. C. Long, R. 2, Box 24, Placerville, was in charge at time of last visit.

An incline was sunk in 1934 to an inclined depth of 110 ft. on a vein from 24 to 30 inches wide, striking N. 40° E. and dipping west. Drifts were run 40 ft. each way on the vein at 100-ft. level. Some low-grade ore from the workings and from an old dump was crushed in a 5-stamp mill with no concentrators. Later the small gasoline hoist was removed from this shaft to the site of some old Mexican workings, about 500 ft. southeast. Here a new incline was being sunk but had not yet bottomed the old workings at time of visit. In early days Mexican arrastres had been operated here on quartz outcrops near a branch of Weber Creek. Three men were employed at the time.

Power for the mill is supplied by a 15-h.p. semi-Diesel engine burning stove oil, and the hoist is run by an automobile engine.

Mount Pleasant Mine, a mile from the old town of Grizzly Flat, was the principal producer of the district. It covers 5156 ft. along the strike of a series of parallel veins in granodiorite near the contact with mica schist.

This mine is said to have been opened in 1851 but no record of its output before 1874 is available. From Oct. 20, 1874, to 1914, the output is claimed to have been $1,046,748 from 75,000 tons, but no statistics are available for many of the years when the mine was reported active. Details quoted by James D. Hague indicate that from July, 1881, to Sept. 30, 1887, a total of 46,000 tons yielded $643,348 gross, from which a profit of $170,603 was realized and $150,000 in dividends, equal to the entire capital stock, was paid. During the past 10 years very little work has been done and the reported production has been only a few hundred dollars a year. The old surface plant has been burned.

The veins dip vertically and strike from N. 15° E. to N. 39° E., a few degrees east of the zone in which they lie. The principal veins, their sizes and the extent of the development work done upon them, are as follows:

Name of vein	*Width*	*Length developed*	*Depth reached*
Earle	1 ft. to 18 ft.	400–800 ft.	1000 ft.
Mt. Pleasant	6 ft. to 18 ft.	225 ft.	260 ft.
McKane	1 ft. to 14 ft.	120 ft.	500 ft.
Charles	6 in. to 4 ft.	200 ft.	240 ft.

Most of the production came from the Earle vein, of which one-half the width is said to have been ore, and the balance filling and 'horses.' Stoping on this vein reached a depth of 850 ft.

Three shafts, 300, 600 and 1040 ft. deep respectively, were sunk, the deepest being 1220 ft. from the north end-line. Most of the prospecting was north of this shaft, the north drifts on the 10 levels varying from 300 to 1300 ft. long. Stopes were extended 180 ft. north and

from 100 ft. to 180 ft. south of this shaft. The veins pinch and swell and consist of banded or ribbon quartz with pyrite, galena and zinc-blende, and with some copper reported in the bottom level.

The mine formerly had a water-right and 4½ miles of ditch for taking water from a branch of Cosumnes River. A 10-stamp mill was used and power was furnished by steam.

No. 2 (Edmunds) Claim adjoins the Paul Friedman ranch, 1.2 miles north of Rescue. A ledge so far found to be broken up has produced some small 'pockets' in years past. At present being prospected by Cary Edmunds who has an adit 200 ft. long and has started another. He has mined possibly 100 tons of quartz. Width of vein averages two ft.

One Spot (Sailor Jack) Drift Mine. Spot Mining Company has been working the ground since early in 1933 under lease from El Dorado Irrigation District. The holding contains 90 acres in NE¼ sec. 18 and NW¼ sec. 17, T. 10 N., R. 12 E. between Camino and Newtown. Years ago about $40,000 is said to have been taken out of 160 ft. of buried channel, through an old adit 500 ft. long.

The present company began work 300 ft. from the portal of the old adit and ran 492 ft. mostly N. 12° W., diagonally and upstream in a secondary flow which had cut off the earlier productive channel worked by Sailor Jack and partners. They have also cut back across the later channel in search of the first, a total of 600 ft. more; and breasted out an area 15 ft. wide by 125 ft. long and 4 ft. deep of cemented mixed gravel and soft bedrock. Several raises have been put up, in one of which in May, 1936 white rhyolite ash was reported. This ash is known to be the capping of the earlier channel they are seeking. Two men are working.

In the past two years enough gold has been produced to pay running expenses. An average of $8 a cubic yard is claimed, the largest nugget weighing 3.42 oz. Troy. The gold ranges from 910 to 919 fine.

On the west side of the land another channel is reported, 21 ft. lower than the earliest one.

Pendelco (Funny Bug) Mine is in SE¼ sec. 5; T 10 N; R 10 E; 1200 ft. north of Weber Creek and 7½ miles by road west of Placerville. For several years, different lessees attempted to open this property and the production of a few ounces of gold has been reported annually since 1928 by H. H. Smith. When visited in 1929, two shafts were 50 ft. deep and another, caved, was 35 ft. Two veins had been prospected, one for nearly 170 ft. striking N. 15° E. and dipping 80° E; and showing a streak from 6 inches to 9 inches wide heavily charged with pyrite, chalcopyrite, specular hamatite, a little malachite and much iron oxide, at the bottom of one of the 50-ft. shafts. A shipment of 4 tons taken out between the surface and 35 ft. in depth in 1929 showed gold, copper, iron, antimony and arsenic. Zinc, lead and traces of molybdenum have since been reported.

The last operator, Pendelco Company (Ralph Penn) had a shaft 200 feet deep in October, 1937. This is on an angle of 73°-20′ and reported in ore to a depth of 117 ft. Below there the vein and

shaft are steeper, the latter being inclined at 83°-20′. No. 1 level is reported in ore for 117 ft. From this a crosscut was run 210 ft. to the second vein and a drift of 117 ft. was driven on this. On No. 2 level, a drift had been run 307 ft. north, of which about 266 ft. was on the hanging-wall side of the main vein and not exposing the full width of ore, but a width of 2 ft. to 50 ft. of vein material was claimed, with the best assays on the footwall.

The deposit is in fractures in augite diorite, which has granodiorite on both walls. Assays of gold and copper content of the main vein vary considerably, showing from a few dollars to over an ounce of gold in places, and from 1% to 10% or more of copper.

The equipment includes an air compressor with 50 h.p. motor and single-drum hoist with 25 h.p. motor, run by electric power from P. G. & E. Co. Eleven men were employed in October, 1937, but work has since been stopped. The owner was planning in August, 1938 to install milling machinery.

Pilot Hill Mining Company (Boulder Placer Mine). The company was working this old mine at Pilot Hill in May, 1936 but is reported to have suspended work since. Thirty acres of land, traversed by a remnant of old channel, was under lease. It had not been sufficiently prospected to give an accurate estimate of yardage. An average depth of 22 ft. was being worked in May but farther south the depth increased to 40 ft. The bank shows little washed gravel but much angular greenstone and rotten slate, with a few large quartz boulders.

At the time of visit, the plant was working two 8-hour shifts, handling about 400 cu. yd. in place each shift. A Diesel-operated shovel with 1¼-cu. yd. dipper was used for digging. Gravel was hauled under contract in four 2-cu. yd. auto trucks a short distance to the stationary washing plant, dumping from a ramp. The grizzley, with bars spaced 7½ inches apart, rejected 10% of the total in the form of heavy rock which was trucked away. The remainder, of which only 33% was fines, was handled by 115 ft. of 30-inch conveyor belt, a 25-ft. trommel (of which 8 ft. was screen and the balance scrubbing sections) and 240 sq. ft. of riffles. Sixty miners inches of water was purchased and brought to the plant in 3000 ft. of 8-inch pipe. A Kohler lighting plant was used.

The pay was spotted and was reported to vary from 13 cents to 60 cents a cubic yard. N. M. Gibson and J. C. Fay formed the company and had active charge of work.

Pleasant Valley Mine. An old mine about four miles northeast of Pleasant Valley between the forks of Clear Creek. It was last worked in the 1880's. In an old report (1896) a tunnel 480 ft. long is mentioned. The discovery shaft joins this tunnel at a depth of 110 ft. about 400 ft. from the tunnel portal. Thence a drift runs about 100 ft. on the vein to a winze 80 ft. deep from which some drifting was done. An air shaft 110 ft. deep also connects with the tunnel. The vein, reported to be 2½ ft. to 6 ft. wide, yielded some good ore in the early 1880's.

In 1935 several partners spent $7000 cleaning out the tunnel and prospecting the upper workings. They planned to buy the mill

building and equipment on the Black Gold and move it to the Pleasant Valley, but after hauling a little ore from the mine to the mill, the work on the mine was discontinued.

Poor Prospect. Wm. Poor, owner. In SW¼ sec. 12, T. 11 N., R. 10 E. A shaft has been sunk 60 ft. on a stringer lead in amphibolite schist surrounded by Mariposa slate. The open cut from the floor of which the shaft was sunk is 37 ft. wide and is said to assay well for a width of 28 ft. Quartz stringers dipping and striking with the schistosity of the schist are said to carry most of the gold. In the bottom of the shaft, which was nearly full of water, it is claimed there is 2 ft. of solid quartz on the hanging wall side and 1½ ft. of it on the footwall side with 'stratified slate' between. The hanging-wall section there is said to prospect well. The quartz stringers at the surface strike N. 15° W. and dip east nearly vertically. Gold concentration may have been localized by cross stringers and small flat-dipping slips from the west, though this could not be checked. Thirty feet west of the shaft one of the typical 'bull quartz' veins of the Mother Lode strikes N. 30° W. The shaft is in a section of vein about 150 ft. long between two transverse gullies. It makes 80 g.p.m. of water.

Between 200 and 300 tons of ore from this prospect is reported to have been milled at the Veerkamp property during the time Gilbert Chisholm had a lease (early 1938). The owner has no definite record of what this yielded. Idle July 8, 1938. The only equipment at that time was a small gasoline engine and pump. An electric power line now being built will pass close to the shaft. Water is available in the Georgetown ditch 2000 ft. distant.

Pyramid Mine is 4.4 miles west of north of Shingle Springs by road. The Pyramid claim covers about 3500 ft. in length on the strike and contains 23.65 acres, and mineral rights on surrounding land have also been under option by the operators. Several companies in succession have had the property in late years. The last of these, *Gold Reserve Mine,* for over 30 months mined and milled ore, a large part of which had been developed by their predecessors. The mill was shut down late in 1936 and since then prospecting has been going on, but this work was stopped early in 1937.

The mine was opened through an inclined shaft on the vein at an angle of 63° for 525 ft. then at 58° to the 700-ft. level. On No. 2 level (165 ft. deep on dip) where former operators had drifted 62 ft. south and 225 ft. north, a length of 185 ft. was claimed to be ore. On the third level, 100 ft. of drifting was done and on the fourth drifts were run 100 ft. each way. Level No. 5 was run about 140 ft. south and 300 ft. north from the shaft crosscut, but on the north the vein was low grade. In March, 1936, the last operators completed sinking the shaft to 818 ft. The last work was done on the 5th, 7th, and 8th levels, on the '49' vein, about 70 ft. from the main vein which had supplied ore above. In these lower workings an ore shoot 140 ft. long was claimed and the average width stoped was 6 ft., although from 12 ft. to 15 ft. was mined in places. This was low-grade sulphide ore. The main vein in the upper levels was also wide.

The mine is in an area of amphibolite schist, with gabbrodiorite on the west. Considerable of the carbonate-silica mixture stained by mariposite, a rock commonly called ankerite, has been developed by alteration of the amphibolite, and this forms one wall in places. The vein strikes west of north and dips east, and the width varies from a few feet to over 20 ft. with a maximum width of 30 ft. in the massive outcrop of quartz from which the mine was named. The main vein does not run far south of this outcrop, but is broken and irregular in the south drifts from the present shaft, which is some distance from the old workings. The early operators claimed an ore shoot 500 ft. long existed at their old workings. The second vein is thought to join the Pyramid near the north end of claim. Because of the gold being associated with sulphides, and the ore being of only medium or low grade, the early work was not successful.

Headframe and mill building at Pyramid (Gold Reserve) Mine, north of Shingle Springs.

The cyanide process as applied here by Vandercook proved a success and the increase in the price of gold was an added inducement to work the mine. A recovery of from 96½% to 97.2% was claimed during the last work.

Primary crushing was done with a Traylor gyratory crusher which reduced ore to 1 inch. The 6-ft. by 6-ft. ball mill in circuit with a Dorr duplex drag classifier ground 98% of ore to pass 65 mesh. The pulp passed to two agitators, 14 ft. by 16 ft. Eight hours elapsed from the time ore entered the ball mill to the completion of agitation. It is claimed that most of the gold was in the precipitate bags within two hours after contact with solution. A special feature of the Vandercook process is the mercuric generator, a tank in which aerated cyanide solution is passed over mercury, forming, according to the inventor, mercuric cyanide which is claimed to shorten the time of treatment and to make possible the treatment of complex ores containing sulphides which would foul ordinary cyanide solution.

The cyanide plant (not including mill building and crushing equipment) is stated to have cost $15,000. It consisted of the following items:

2 thickener tanks, each 50,000 gal. capacity.

2 agitator tanks, each 25,000 gal. capacity.

1 clarifier, sump and stock tanks of 10,000 gal. capacity each.

2 generator tanks of 2000 gal. capacity each.

Oregon pine lumber was used in making all tanks.

3 diaphragm pumps, 3 small pumps, 3 five-h.p. motors, main shaft drive and one 25-h.p. motor. A Merrill-Crowe precipitating unit of 3 iron tanks 4 ft. by 4 ft. by 15 ft. with bag collectors was used. Tank foundations, pipe and connections were included in the above reported cost.

In treating 112 tons of ore daily, about 75 lb. of sodium cyanide and 24 lb. of zinc dust were used. About 20 lb. of mercury was used every 3 months in the mercuric generators. Fresh water consumption was 8000 gallons daily. An operating cost of 70 cents a ton of ore crushed, exclusive of interest and depreciation, was claimed for the cyanide plant.

Since the above was written, F. J. Kaeser, Rhoads Grimshaw, and associates, who held the first lease, have completed the purchase of the mine and have resumed possession. The cyanide plant and part of the mining equipment have been sold and were being removed at the time of last visit, March 25, 1938. Ten stamps and a concentrating table have been erected in the mill-building, and crushing of ore from the 200-ft. level north of the shaft has been started. Three lessees are working underground and the owners are operating the mill. They claim there is considerable oxidized ore between the surface and 200-ft. level that they think is amenable to stamp-milling.

The lower levels are under water and the owners have no plans now for resuming work in that part of the mine. For the present, the 200-ft. level will be advanced on the Pyramid vein northward in search of 2 intersections which are believed to exist where cross veins from the east and west meet the main vein. The 800-ft. level was run 234 ft. south in the last work done by the Gold Reserve management. This level is said to have encountered a fault crossing the vein and dipping N. 70°.

The mine is equipped with a 125-h.p. single-drum hoist of 800 ft. depth capacity, and an Ingersoll Rand air compressor run by a 75-h.p. motor. There are a shop building, boarding house, and smaller buildings on the land.

Richelieu Prospect is the next claim north of Golden Fleece claim of the Church Mine, and is on Martinez Creek. There is an old shaft of unknown depth on the slope west of the creek, and on the same side an adit was run from near the creek level. This work was done while the Church mine was active, and a small lot of low-grade ore is said to have been crushed at the Church mill. In 1932 W. A. McCoy and associates began work in the adit and extended it to 275 ft. in length. For 180 ft. the adit crosses Mariposa slate with quartz stringers, and gold in small quantities is reported all through this width. On the

west of this there is a soft gouge 3 ft. thick which runs badly when wet. For 40 ft. west of gouge, the adit is in diorite porphyry and work stopped in this. Idle in May, 1937.

Robert Veerkamp Mine is in the NW¼ sec. 33, T. 12 N., R. 10 E., about 1 mile west of Garden Valley. It was mentioned in Bulletin 108 as a prospect before any work except shallow pocket-hunting had been done upon it, and the writer expressed the belief that the gold found in the loose, red soil probably came from stringers or disseminated sulphides in the upper, decomposed part of a long, narrow basic dike which here runs northwest along the west side of the Mother Lode, about a mile west of the main vein system. This has been confirmed by work done on the property during the past few years, although the quartz veins which formerly outcropped have been partly removed in mining and probably contributed some gold. One of these veins at the surface was wide and of low-grade white quartz. It strikes N. 25° W., dips east and is faulted to the west, looking north, by a smaller vein of bluish quartz striking N. 15° E. The decomposed dike forming the red soil on the east side of the junction of the two veins gave way at the shallow depth reached to oxidized ore.

The Bradley interests took the property early in 1933. Some ore was mined from an open cut and hauled to the Beebe mill at Georgetown. They also ran an adit about 400 ft. into the hillside, but evidently did not reach the ore mined later. When they gave up their option, the *Spanish Gold Quartz Syndicate* (a Canadian company) was formed to operate the prospect. This company was soon succeeded by *The Gold Company, Limited,* also Canadian, under the same management.

They ran an adit from the north side of the hill which showed the best prospect. Near the portal, a pocket containing about $5,000 was found in October, 1935. The adit was run nearly south through the hill at a depth of only 37 ft. A shaft was sunk to a depth of 180 ft. and levels were turned at depths of 60 ft. and 97 ft. The 60-ft. level is reported to have been run 1200 ft. and the 97-ft. level 1000 ft. but the mine was closed at the time of last visit and this could not be checked. Oxidized ore was mined out above the 60-ft. level. This ore is reported to have been worked for a width of 27 ft. in places and assays of some of it are claimed to have indicated $12 a ton. Various methods of treatment, including the use of Huntington, Hadsell and Ellis mills, ball mill and flotation, and cyanidation were tried but it was stated that satisfactory recovery could not be made. The company quit early in 1937 and much of the equipment has since been removed. About $33,000 production was reported in 1936, and a little ore was milled early in 1937. Some small equipment, 3 buildings and cyanide tanks remain.

Along the strike of the dike, several hundred feet N. 25° W. from the shaft, an open pit was dug in the dike and considerable oxidized material was milled. Assays up to $4 a ton are reported here, the gold occurring in seams which occasionally show some quartz.

Rose Kimberly Mine. In secs. 10 and 11, T. 10 N., R. 9 E., 1¾ miles north of Rescue. The only recorded production was made in 1895. So

far as can be learned, little work has been done since until the present lessees, H. Marsh, Henry Snyder and Alfredo Rodriguez started reopening and unwatering on Apr. 12, 1938. When visited July 7, water had been removed to the 120 ft. level, which was open, and the shaft had been retimbered to that depth. It is reported to extend to an inclined depth of 220 ft. Levels were turned at 60 ft., 120 ft. and 220 ft. The 60-ft. level is caved, and 120-ft. level is open on the northwest its entire length, about 300 ft. Here the vein takes the form of lenses one 40 ft. long by 20 inches in average thickness; the other separated from the first by 120 ft. is 55 ft. long with a thickness of 2 ft. at the face. So far as could be judged, both walls are gabbro. The quartz shows some galena, pyrite and chalcopyrite with some brecciated fragments of country rock included. In places, a narrow band of iron sulphide occurs in the adjacent wall rock. Two samples stated to come from this level gave assays of $5 and $1 a ton in gold, respectively. No stoping was done from the 120-ft. level and part of the rock broken in drifting still lay on the floor. The drift on the 60-ft. level was caved; the small amount of rock crushed in 1895 probably came from there.

Another vein a little west of the above, strikes N. 83° E. A shallow shaft on it was being cleaned out at time of visit and this was claimed to show a width of 1½ ft. to 2 ft. of more promising quartz than the first vein.

Equipment included a small pump, hoist and 2 gasoline engines.

Rozecrans Mine is 1½ miles northwest of Garden Valley, adjoining the Taylor Mine on the southeast. *Lode Development Co.,* Box N, Auburn, is the lessee. This old claim was worked previous to 1888, and the operations then were described in the 8th Report of the State Mineralogist. The work done was in the same shaft lately reopened by the present lessee. This is nearly midway of the claim. Another shaft was sunk near the north end-line but details of this are lacking. A 10-stamp mill was operated for a short time about 1888 on ore reported as yielding over $10 a ton, with an estimated output of $21,000.

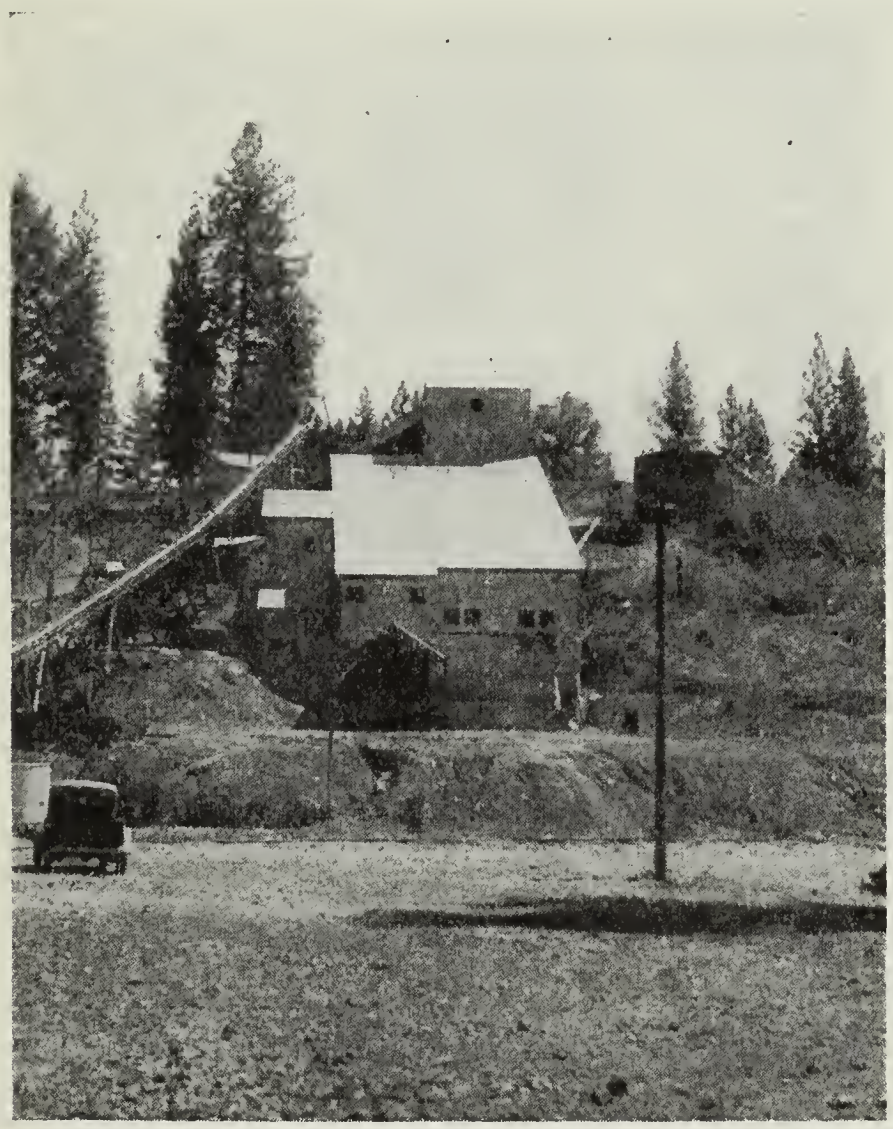
The shaft now in use is 350 ft. deep, the first 100 ft. being vertical and balance on an incline of 60°. The vein occurs in amphibolite schist which has a width at the surface of about 250 ft. and Mariposa slates lie on both sides. The vein is for the most part frozen or has little gouge, and its average width is reported to be 3½ ft. It dips west and is west of the Taylor vein. The quartz occurs in irregular shaped bodies. The hard walls permit mining without timber. The old work included the shaft to a depth of 200 ft. and levels at 100, 130, and 200 ft. with several hundred feet of drifts. The present company, besides deepening the shaft and reclaiming the upper levels ran the 250-ft. level 415 ft. north and 160 ft. south; and ran the 350-ft. level 130 ft. north and 180 ft. south. On the 130-ft. level, a lens of ore has been mined on each side of the shaft. On the 200-ft. level, one lens was mined on the south side and two on the north, while on the 250-ft. level two ore bodies both north of the shaft are being worked. These are reported to be 125 ft. to 150 ft. long each. This work on the west vein is near the west contact of the amphibolite schist and slate.

A crosscut was run 165 ft. east from the shaft on the 100-ft. level through the slate stringer lead of the Taylor vein. On the 130-ft. level,

100 ft. of work was done also on the Taylor vein, but neither of these revealed ore.

The ore is ground in a 6 ft. by 6 ft. grid-type ball mill which discharges to a Bendelari diaphragm jig and a double rake classifier. The jig is said to catch nearly all pyrite and 80% of the gold. Overflow from classifier then goes to a conditioning tank where reagents are added, and to 5 Fagergren flotation cells, a Dorr thickener and Oliver filter. The jig product is ground in 500-lb. batches for 24 hours, then 25 lb. mercury is added and grinding is continued 2 hours longer. Soda ash, Zanthate 301 and cresylic acid are used in flotation. Pyrite is practically the only sulphide found and 80% of the gold is free. The mill has a capacity of 100 tons in 24 hours but is being operated only 8 hours daily at present (July 20, 1938).

Electricity is used throughout. Two compressors are run by 125-h.p. and 50-h.p. motors and the hoist by a 50-h.p. motor. Thirty men are employed. Work began in August, 1936 and the mill has been running 11 months.



Mill at Rozecrans Mine near Garden Valley.

Shumway Prospect is about $\frac{3}{4}$ mile south of Alhambra Mine, and is also being prospected by *Alhambra-Shumway Mining Company.* There is a shaft 100 ft. deep, and at present 2 men are advancing a crosscut adit which is now (July, 1938) 300 ft. long, and will be 150 ft. below the outcrop at the shaft. No discovery of ore has been reported here yet by the present company. A portable compressor and air drill are the only equipment.

Sliger Mine, a mile west of Spanish Dry Diggings, was found in 1864 and is claimed to have made a production of about $225,000 to a depth of 300 ft., though no definite record of this remains.

It had been lying idle a long time when it was reopened in 1922 by *Sliger Gold Mining Company.* The operations from then until July, 1934, by this company and its successor, *Middle Fork Gold Mining Company,* were described in Bulletin 108. The latter company continued work until May 10, 1937, when the mine was closed pending financing of further development work. Over 80,000 tons of good ore was produced and milled in four years, 1932 to 1935 inclusive.

On August 31, 1937, *Mountain Copper Company, Ltd.,* took over the lease on the mine. They sank the shaft 350 ft., reaching a depth of 1350 ft. About 500 ft. of drifting and 1500 ft. of diamond drilling was done. Early in 1938 this company gave up its option.

In June, 1938, *Middle Fork Gold Mining Company* resumed work with a crew of 40 men. C. W. Plumb is superintendent. Electric power has since been supplied, the crew has been increased to 65 men and production at the rate of 100 tons a day has been reported.

The mine is at a fault contact with black slate on the footwall and ankerite and serpentine, followed by a gabbro dike on the hanging wall, all enclosed in amphibolite schist. On the 350-ft. and 500-ft. levels, the only ones examined by the writer, crosscuts were run through ankerite or similar mixed carbonate rock. The principal orebody seen was on the footwall side and is highly silicified, with some carbonates, and is thickly impregnated with fine disseminated crystals of sulphide, mostly pyrite. It had no definite wall but merged into low grade rock. Two classes of ore, called black slate or schist ore and grey schist ore were distinguished. Superficially the appearance was that of a replacement of a fine-grained rock. The width of ore here varied from 14 inches to 19 ft. Most of the gold is in the sulphides which make up 3.7% of the ore. On the 600-ft. level the ore was reported to be 32 ft. wide.

L. C. Raymond, geologist for Mountain Copper Company, believes that the ore-forming solutions rose along different favorable bands in the slate series to the thrust fault zone, where they spread out forming orebodies. The occurrence of several ore shoots at different levels along the fault zone in such a case would give the appearance of post-mineral faulting, although actually the only post-mineral faults were small horizontal offsets.

The stamp-mill first used was replaced by 2 ball-mills, flotation and gravity concentration. Two-stage crushing with Blake and Symonds crushers is used ahead of the ball-mills, which work in closed circuit with Dorr rake classifiers. From the mill, pulp passes over a Deister Overstrom concentrator which saves 75% to 80% of the gold in a high grade concentrator. The table tailing is sent to a conditioner and is treated by flotation in 6 Kraut rougher cells and 2 cleaner cells. Concentrate hauled by truck to Selby smelter.

Solari Tunnel Mine. First located as part of the Ventura Mine in Sec. 20, T. 10 N., R. 12 E., but in 1935 leased to Paul Alexander and Flavel Atkinsen, who were extending an adit then 351 ft. long. They were prospecting for the extension of the bench gravel found in the Black Gold.

Tiedemann, Kenna et al. Mines (*Two Channel Mine*) lie eight miles northeast of Georgetown. They were worked both by drift mining and hydraulicking in the 1890's and were described in Report XIII of the State Mineralogist, 1895-1896. Under the name of Two Channel Mine, production was reported until 1902. The holdings extend 3¼ miles southeast from Mount Gregory to and including the Tiedemann Mine in sec. 34, T. 13 N., R. 11 E. Two channels were found, called white and blue channels which were believed to be upstream portions of similar channels on the Forest Hill divide in Placer County. The former operators worked hydraulic pits on the Tiedemann, where the bank was 20 ft. high, with 10 ft. of gravel, and they also ran adits for drift mining. On the Kentucky Flat, a hydraulic pit was opened on the white channel, with a bank 25 ft. high of which from two ft. to six ft. was gravel, and drift mining was also carried on through an adit. On the Kenna and Morgan both channels were worked—the white channel by hydraulicking and blue channel by drift mining through an adit with breasts 60 ft. wide and 3½ ft. high. This blue gravel was cemented and was crushed in a 10-stamp mill.

In 1902, the following workings were reported at the various mines then held by *Two Channel Mining Company:*

Amelia, sec. 9, T. 13 N., R. 11 E. Adit 600 ft.
Kenna & Morgan, sec. 15, T. 13 N., R. 11 E. Adit 1500 ft. Breast 100 to 200 ft.
Kentucky Flat, sec. 22, T. 13 N., R. 11 E. Adit 625 ft. Shaft 80 ft. Breast 100 ft.
Novis, sec. 9, T. 13 N., R. 11 E. Adit 600 ft.
Tiedemann, sec. 34, T. 13 N., R. 11 E. Adit 1000 ft.

There were also hydraulic pits with areas of two acres or more each on the Tiedemann and Kentucky Flat, and some smaller ones. No reports appeared on the properties after 1902 and they had been idle for years when work was started on the *Tiedemann Mine* by *Century Mining Company* in 1932, under lease covering most of the holdings of the old company. The south end of the Tiedemann has since been prospected and mined through two main adits each 300 ft. long, with side drifts. They report a white quartz channel 1000 ft. wide, with gravel up to 14 ft. thick. Substantial production was made, judging by a suit brought against the company early in 1934 for royalties and rent alleged due.

The *Kentucky Flat* mine was worked in 1933 by C. B. Wooster.

Union (*Springfield*) *Mine.* Since Bulletin 108 of this division was published, the work started by *Gold Fields American Development Company* has been suspended, the mine was turned over to *Montezuma Apex Mining Company,* and turned back to the owners in April, 1937. During their lease, the latter company mined some ore which was hauled to their mill on the Montezuma mine and gave good returns.

The Springfield property lies in the Mariposa slates of the Mother Lode 2½ miles south of east of El Dorado. It was the center of a rich and populous placer-mining district of early days called Aurum City. Prof. Silliman, a noted mining authority of that time, was attracted by the rich ore first worked in arrastres here and induced friends to finance quartz mining. A pay-shoot north of the Union shaft is said to have yielded $450,000 from 15,000 tons of ore mined before 1868, but in spite of this the project failed and the property

lay idle until Hayward and Hobart purchased it. They operated it as the Springfield Mine until about 1887. They had a mill of fifteen 600-lb. stamps with a capacity of 26 tons a day. After an idleness of about 10 years, *Union Gold Mining Company* began work and a 30-stamp mill was built. In 1897, a production of $36,000 was reported, but thereafter only estimates of production were made public. These indicated that from 20,000 to 40,000 tons of ore was crushed annually, yielding from $5 to $7 a ton. In 1909, the last year for which any figures are at hand, 12,000 tons yielded a little over $5 a ton. The total production, although often claimed to be greater than from any other mine in the county is not definitely known.

Some of the old stopes partially checked by the last operators were found to be much smaller than indicated on a map which purported to show tonnages and gold content. It appears that both tonnages and gold production were less than claimed. For example, the Poundstone stopes, shown on the map as having a combined length of 400 ft. between the 500-ft. and 1300-ft. levels mostly north of the Springfield shaft, and claimed to have yielded $2,200,000 from 85,000 tons of ore, were found to have a length of only 100 ft.

The main veins, of which the Poundstone (East Gouge) vein has been the most important, follow the strike of the Mother Lode, north of northeast. They are linked by a series of lesser veins striking northeast. Of the latter, the Klondyke vein system is typical. This vein was found in 1898 by W. A. McCoy during the first forenoon after his employment by Harpending (then manager) to prospect for more ore. McCoy states this vein was only from 4 inches to 5 inches wide at the outcrop but of very good grade. It contained two ore shoots.

The Springfield 2-compartment vertical shaft had been sunk 1640 ft. by Hayward and Hobart. It was sunk to 1986 ft. vertical depth, with 3 compartments below 1600 ft., by Gold Fields American Development Co. This shaft is 320 ft. east of the East Gouge (Poundstone or hanging wall) vein, passing through it at 1200 ft. depth and cutting the west gouge (McCosmic) vein about 60 ft. above the 1600-ft. level. The veins steepen in the lowest workings and are claimed to join in the bottom. The shaft left the "hard slate" at 1975 ft. entering softer slate. The only work done on the deepest level, called 2000-ft. level, was a crosscut 28 ft. which showed 18 ft. of vein material with 4 in. to 6 in. of gouge on the footwall.

Only three small ore shoots were found in the recent work. On the 1800-ft. level, a crosscut 56 ft. west to the McCosmic vein struck ore which proved to be 35 ft. long, 6 ft. thick and 120 ft. high. Two other smaller bodies, called the 810 and 1210 ore shoots were also stoped, and the ore was hauled by truck to the Montezuma Apex mill. A total of about 35,000 tons was crushed in 1936 and 1937. Some of this, from the small ore-shoots mentioned, was of satisfactory grade; the average yield in 1936 was sufficient to have permitted operation at a profit if enough ore had been found. Concentrate formed 2% to 3% of ore, and carried about 35% of the gold saved. A typical lot carried about 3 oz. gold and 1 oz. silver a ton. Bullion carried 822 parts gold and 178 parts silver in 1000.

Besides the 21,000 feet of workings run by previous operators, the last two companies did the following work:

On the 1600-ft. level, 275 ft. north, 600 ft. east and 50 ft. north (mostly by Montezuma Apex Mg. Co.), 75 ft. south. On 1800-ft. level a crosscut 56 ft. to McCosmic vein and some drifting and stoping on it. On 2000-ft. level, a crosscut 28 ft.

On the 1200-ft. level, a total of 1575 ft. of old workings was reclaimed. The old 1000-ft. level was opened for 175 ft. from Springfield shaft and a new 1000-ft. sub-level was run 125 ft. The 800-ft. level was re-opened for 1000 ft. north of Springfield shaft to a raise and thence to a connection with the North Shoot shaft.

The number of veins exploited in the old workings is indicated by the following list of stopes:

Poundstone stopes from 500 ft. to 1300 ft. in depth, mostly north of Springfield shaft. (See ante.)

Union Gold Mg. Co. stopes between 1000-ft. and 1300-ft. levels, south of Springfield shaft, from shaft on East Gouge vein; claimed output, 17,500 tons of $8 ore.

Big Cut and Mexican stopes, from veins of the same names, between 800-ft. level and surface; mostly near surface. North shoot shaft workings are 1150 ft. N. 15° E. of Springfield shaft. The Klondyke north shoot was worked from this.

Clement shaft is about 950 ft. north of Springfield shaft and here McCosmic stopes were claimed to have yielded 50,000 tons of $25 ore.

The Klondyke shaft on Klondyke vein about 375 ft. east of Clement shaft, opened the original Klondyke ore shoot which was worked 400 ft. deep, 60 ft. to 100 ft. long and 3 ft. thick. It is claimed to have yielded 10,000 tons of $20 ore.

The Poundstone vein has been explored for 1400 ft. on the strike; Clement vein 1000 ft. on strike and Klondyke vein 550 ft.

All equipment except the hoist has been removed from the Springfield shaft.

U. S. Grant (New Deal) Mine is on an agricultural patent owned by John Sellick and J. A. Sackett, lying north of Mt. Danaher Ranger Station, nine miles east of Placerville. It is leased to Sackett and W. B. Nicholls.

This old mine is said to have had a 10-stamp mill in the 1870's, but no record remains of the production, if any. There is an old shaft, depth unknown, but probably not over 100 ft. A crosscut adit reaches the vein in 100 ft. and from there drifts had been run northeast and northwest 400 ft. and south 200 ft. on the vein. Two ore shoots are claimed. The vein varies from 8 inches to 44 inches wide. Some recent mill tests yielded $7 a ton. The country rock is of the Calaveras formation.

A Brunius muller-mill was being used for crushing. It has two shoes of $2\frac{1}{2}$-inch steel, 2 ft. by $2\frac{1}{2}$ ft. and weighing 1200 lb. each. They are run at 27 strokes a minute through an eccentric with 30-inch stroke. These mullers work in a wooden box 6 ft. by 6 ft. and 4 ft. high, paved with thick blocks of Rocklin granite. It is claimed the mill will crush 6 tons in 8 hours to 32 mesh, discharging pulp at a height of three inches upon amalgamated plates. A small concentrator saves sulphides. An auto engine is used for power. There is a 6 in.

by 6 in. compressor run by a 12-h.p. gasoline engine. Two or three men were working in May, 1936.

Vandalia Mine. This old mine, 4½ miles southwest of Shingle Springs between the Crystal and Big Canyon mines, is said to have been located in 1885. In 1888 it had a 5-stamp mill which was crushing 14 tons of ore a day. The ore was described as "partly honeycombed quartz and partly very heavily sulphuretted rock." Sulphide formed 5% of the ore and was saved on Frue vanners. After 1888, when most of the early work was done, the mine was reported idle in 1890 and 1894. In 1900, John Rosenfelds Sons produced about $10,000 with a cyanide plant. Since then, many attempts have been made to operate it. The extent of openings and amount of tailing indicate that considerable rock was mined and milled, but there are no available records of output except for about 50 tons of $5 ore milled in 1926.

The geology in general is similar to that of numerous sulphide deposits in the county in which amphibolite schist and the rocks interbedded with it have been silicified and impregnated with pyrite which is more or less auriferous. The oxidized, upper parts of the bodies rich in sulphide yielded the ore of early days. Two ore shoots 20 ft. thick and 50 ft. and 100 ft. long respectively, were reported. The lowest of the old adits reached the fresh sulphide at the bottom of the oxidized zone, and this has evidently not yielded enough gold, so far as opened, to pay a profit.

In 1937, Page Consolidated Mining Company completed the erection of a milling and cyanide plant of 150 tons capacity. It included a Hardinge conical mill, agitators, thickeners, clarifier, etc. Evidently insufficient underground work was done to learn whether or not such a plant was justified, before building. Only a few short runs were made when work was stopped. When visited in March 1938, the mine and plant were idle.

Ventura Mine. In sec. 20, T. 10 N., R. 12 E., in Newtown district, on the north side of a lava-covered ridge running west between Pleasant Valley and Webber Creek. Surface workings in early days on this side of the ridge were extensive and profitable. The recent work has consisted of driving an adit south through the ridge in search of a channel, and also to reach the unworked part of the bench deposit believed to remain on the Black Gold. At the time of visit, the adit was 935 ft. long and it was thought that the Black Gold ground would be entered in a short time.

This adit was in volcanic ash and no bedrock was seen. There was some fine, tight gravel at the face which was dipping at an angle that would soon carry it below the adit level. No pay was reported to have been found up to that point in the adit, and there was no water in evidence. The ground required blasting. Drift sets and tight lagging were used. Three men were employed.

White Owl Claim is in the SW¼ of the SE¼ sec. 23, T. 11 N., R. 11 E., near Red Bird Creek and about 1 mile south of Mosquito.

An inclined shaft has been sunk 65 ft. on a fissure from 18 inches to 3 ft. wide in which an average of 2 inches of quartz has been yielding

a reported average of $65 a ton. The walls are granodiorite and the vein strikes northeast.

There is a 2-ton Gibson mill on the claim. Mrs. Ethel Sperry and D. Chalmers, Box 342, Placerville, have been operating the claim recently.

Winton and Threlkel Prospect. This adjoins the Zantgraf Mine on the northwest and is believed to be on the same vein. It is on land patented for agriculture and belonging to Olivia Smythe and M. L. Winton et al.; in SE¼ of SE¼ sec. 17, T. 11 N., R. 8 E.

The fissure (in which a width of about 1 ft. of solid quartz and several small quartz stringers occur) has a width of 52 inches. It strikes N. 35° W. and dips 48° SW. near the surface, in granodiorite. The recently started shaft is 1500 ft. northwest of the present Longan shaft on the Zantgraf vein.

A mill of two 650-lb. stamps and a small concentrator has recently (April, 1937) been erected to mill ore taken out in sinking the shaft. This shaft was about 10 ft. deep at time of visit. Besides pyrite and free gold, a part of the vein near the footwall carries a silver-bearing sulphide containing a little copper and lead. Not enough of this has been taken out yet to give a conclusive test, but it resembles stromeyerite, not previously reported in this district.

Wulff Placer. On the W. C. Wulff ranch, in sec. 8, T. 10 N., R. 9 E., five miles northwest of Rescue.

A small placer deposit apparently formed by erosion from the nearby hillsides into a small basin, was being worked by two men at time of visit. About 2½ ft. of soil and clay overburden has to be removed from the 'pay dirt' which consists of broken rock debris 1 ft. to 1½ ft. thick on gabbrodiorite bedrock. Only a few cubic yards of material is hauled daily one-half mile to a small washing plant where a 1½-inch pump supplies 32 g.p.m. of water from a small creek for sluicing. A good profit was being realized.

Zantgraf (Montauk Cons.) Mine is eight miles southeast of Newcastle on the east side of American River near Rattlesnake bridge.

The mine was discovered in 1880 by Jacob Zantgraf, on land which had been patented years before by the Central Pacific Railroad Company, as agricultural land, because the veins do not outcrop conspicuously. About 1883 Zantgraf put up the first mill, of five stamps which was operated about seven months each year by water power, and worked the vein through two adits. In 1886 five stamps were added to the mill. The main vein was worked down to the 300 level adit, and was stoped for a length of about 900 ft. During the time it was worked by Zantgraf & Company the mine produced $438,000. In 1895, because of family disagreements, lack of money for sinking, and probably also because they thought the mine was nearly worked out, it was sold to Senator Chapman for $65,000. He renamed it the Montauk Consolidated, sank the shaft to the 800 level, put up a new 20-stamp mill and produced over $200,000 before January, 1898, when the mine was sold to *Montauk Consolidated Mining Company* for about $100,000. The property was then supplied with electric power from its own hydroelectric plant near by on American

River and 5 stamps were added to the mill. From May, 1898, to May, 1901, they produced over $351,000, the shaft meanwhile having been sunk to 1130 feet. The company became involved in lawsuits for damages and were hard pressed by creditors seeking pay for surface equipment and machinery, much of which should not have been bought. During a temporary shutdown in October, 1901, a fire burned the hoist, shops and mill and the mine has been idle since.

The Zantgraf, Montauk and other nearly parallel veins occupy fissures in granodiorite and amphibolite schist and are accompanied by diorite dikes. They strike northwest and dip southwest from 38° to 50°. Near the main shaft the Zantgraf and Montauk veins are 180 feet apart, diverging to the northwest. Most of the mine workings are in the granodiorite and all the production has been from the Zantgraf vein, only small test lots having been milled from the Montauk and Porterfield veins on this property. On the adjacent land some work has been done and some ore crushed on a vein which appears to be the Montauk. The main vein pinches and swells both vertically and horizontally and the value of ore varies widely, but there was usually from two to six feet of good ore with a gouge up to a foot wide. The ore averaged about $8 a ton, although considerable specimen ore occurred, and the bullion ranged in value from $11 to $14 an ounce. High-grade pyrite and galena formed 1% to 1½% of ore from the 600 level downward. The concentrate contained at times as high as $90 gold and 90 to 100 ounces silver per ton besides which considerable pay was lost in the slimes, as a slime plant added in 1898 gave slimes assaying 128 ounces silver and 1.3 ounces gold per ton.

The later operations were through an inclined shaft on the Zantgraf vein to a depth of 1130 ft. (715 ft. vertical). Two ore shoots were developed; above the 300 adit level they were stoped as one for a length of 900 ft. Below that level most of the ore came from the south ore-shoot, which pitched away from the shaft and was about 600 ft. long to the 10th level. Levels were run every 100 ft. to 1100 level, where the ore shoot was entered 309 ft. from the shaft and followed for over 300 ft. just previous to closing the mine. The assay values on this level varied from $2 to over $100 a ton but apparently averaged about $7 to $8 a ton. The vein has been explored for a maximum of 1600 ft. in length.

Since 1933, W. B. Longan has been prospecting the property and has sunk two shafts, with considerable drifting. On the Montauk vein a few hundred feet north of the old main shaft, he sank a shaft 190 ft. deep and drifted southeast 470 ft. and northwest 35 ft. Though the vein is of good width, it did not show in this distance any commercial orebody.

Later he sank a shaft on the Zantgraf vein 900 ft. northwest of the old shaft. This at present (April, 1938) is 200 ft. deep on the vein which dips 56° 50′ SW. to a depth of 125 ft. and flattens to 51° below there. Drifts were turned at 80 and 180 ft. deep. The upper level was run 140 ft. NW. and 95 ft. SE. and from the latter a crosscut was run to connect with the old 300-ft. adit level. On the 180-ft. level, drifts have so far been run 142 ft. SE. and 108 ft. NW. The vein in these drifts is reported to be from 1 ft. to 1½ ft. wide. The 180 ft. level is under water but some mining has been done

lately from the 80-ft. level and small lots of ore have been hauled to custom mills with encouraging returns. Longan claims that ore extends the entire length of this level so far as opened and that the northwest face is still in ore. He thinks this is a part of the original long ore shoot worked on the southeast above the 300-ft. level by J. Zantgraf, whose work did not extend this far north. If this is true, it would be one of the longest ore shoots in the state. The quartz and walls are "picking ground" so far, and the gold is free, but unoxidized ore with galena and pyrite is beginning to show in the 180-ft. level.

On April 14, 1937 a Beer mill (modified Chilian mill) with a capacity of 50 tons a day, was being installed. Four men were employed. This mill was later replaced by a ball mill which was being operated late in the spring of 1938.

TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Adams Gulch & Sullivan	25, 26	9 N.	10 E.	Camilla D. Heald and Virginia McDouall, Nashville	41	XII, p. 101; XIII, p. 132; XV, p. 279; Bull. 108, p. 15
Adjuster	12	9 N.	10 E.	Mrs. Cecilia Simpson	21	XV, p. 280; Bull. 108, p. 15
Adjuster and Hustler	12	9 N.	10 E.	R. B. Seward, Diamond Springs	40	XV, p. 279
Alabama	12, 13	9 N.	10 E.	El Dorado Mining Company	5	
Albright	17	10 N.	11 E.	Placerville Gold Mng. Co.	70	See Pacific
Alhambra	6, 7	11 N.	11 E.	Pearl McKee, et al., Placerville	10	X, p. 178; XXXI, p. 22
Alpine	15, 16	12 N.	10 E.	Lucero Gold Mng. Co., Inc., 530 Wilcox Bldg., Los Angeles	180	VIII, pp. 167-68; XIII, p. 132; XV, p. 280; Bull. 108, pp. 15-17
	15, 22	12 N.	10 E.	Alpine Gold Mng. Co.	8	
American Seam						Bull. 108, p. 45
Arctic	20	9 N.	13 E.	Mary J. Irwin, et al.	27	
Argonaut	17	12 N.	10 E.	Gold Unit Mng. Co., c/o Ralph E. Fry, R.F.D. 2, Box 1736, Sacramento	25	VIII, p. 176; X, p. 176; XII, pp. 101-102; XIII, pp. 132, 133; XV, p. 280; XVIII, p. 209; Pre. Rep. 8, p. 29; Bull. 108, p. 17; XXII, pp. 413-414.
Armstrong & Roberts	38	9 N.	13 E.	Armstrong Mng. Co., 9th and Broadway, Oakland	30	XII, pp. 101-102; XV, p. 301; XVII, pp. 425-26
Atlanta	7	11 N.	11 E.	Atlanta Gold & Silver Mining Co., c/o Pearl McKee, Placerville	21	
Atlantic	17	10 N.	11 E.	Estate of John F. Limpinsel, Placerville, et al.		
Aultman						See Argonaut
Baldwin	1, 2	8 N.	10 E.	Estate of E. J. Baldwin, San Francisco	20	XII, p. 102; XIII, p. 133; XV, p. 280
Balmaceda	35	9 N.	10 E.	Estate of J. C. Heald, Nashville	20	XV, p. 280
Baltic	23	10 N.	13 E.	Reed & Sciarossi, Placerville	80	XIII, p. 133; XV, p. 280
Barbara	32	11 N.	10 E.	Sarah Veerkamp; Leland W. Veerkamp, Placerville	14	
Barnes-Eureka	28, 33	10 N.	10 E.	Edward H. Polk	40	XII, pp. 102, 112; XIII, p. 144; XV, p. 281
Barney	15, 22	12 N.	10 E.	Hattie C. Schneider	20	
Bathurst						See Coe Hill
Beattie and Parsons	3	12 N.	10 E.	Ida B. Ackley, Georgetown; Emma B. Shutz, Arbuckle; et al.	60	XI, p. 203; XII, p. 102; XIII, p. 133; XV, p. 281; (see Georgia Slide also).
	34	13 N.	10 E.			
Beebe				Pacific Mining Co., Crocker Bldg., San Francisco		Bull. 108, pp. 17-19; 207-211
Bell	36	11 N.	10 E.	Laura B. Clark and Guilford Gold Mining Co., Placerville	10	See River Hill
	6	10 N.	11 E.			
Bidstrup	11	9 N.	10 E.	Walter I. Bidstrup, El Dorado	8	XII, p. 103-104; XIII, p. 133; XV, p. 281
Big Buzzard or Hercules	29	11 N.	8 E.	George Darrington, Mabel Scott et al.	20	XVII, p. 430; XVIII, p. 209; XIX, pp. 141-42; XXII, p. 406, 412
Big Canyon (Oro Fino)	29	9 N.	10 E.	Mountain Copper Co., 112 Market St., San Francisco	59	VIII, pp. 174-75; XVIII, p. 209; XXII, p. 412; XV, p. 293; XXXI, p. 22; XIII, p. 133; XII, pp. 103-104
Big Chunk	24	11 N.	10 E.	Margaret E. Smith, et al., Placerville	13	XV, p. 281; Bull. 108, p. 19

Big Four	34	12 N.	10 E.	B. O. Curry, P. D. Burtt, James O'Brien, Kelsey	16	XV, p. 281; Bull. 108, p. 19
Big Kennebec	32, 33	13 N.	9 E.	Howard W. Davis	12	
Big Sandy	24	11 N.	10 E.	Big Sandy Mining Co., c/o James Kelley, Kelsey	109	X, p. 173; XII, p. 104; XIII, p. 134; XV, p. 281; Bull. 108, pp. 19-20
Bird	20	10 N.	11 E.	Arthur H. S. Bird	6	
Black Hawk	24	11 N.	10 E.	Oscar Reeg, Placerville and Estate of Blair, Placerville	20	XV, p. 281
Black Oak	34	12 N.	10 E.	R. J. Wilson, Garden Valley		Bull. 108, pp. 20-21
Blair	9	10 N.	12 E.	Ruth S. Soule and W. A. Richardson	40	X, p. 179; XII, p. 104
Blasdel						Bull. 108, p. 44
Blue Bank					20	XIII, p. 134; XV, p. 281
Blue Gouge	21	10 N.	13 E.			XIII, p. 135
Blue Ledger	6	11 N.	11 E.	William Hodge	21	
Blue Lead	3	11 N.	10 E.	Mrs. M. P. Bennett, Placerville		Bull. 108, p. 21; see also Isabell
Blue Rock	34	13 N.	10 E.	James E. Flynn, Georgetown, et al.	24	XI, p. 203; XII, p. 104; XV, p. 282; see Georgia Slide Mines also
Blue Point						XI, p. 203
Board						XII, p. 104; XIII, p. 135
Bobby Burns	4, 5	10 N.	12 E.	J. & J. Blair Land & Lumber Co., et al.	11	
Bona Forsa						X, p. 177
Bonanza	11	8 N.	10 E.	C. E. Padilla		XVIII, p. 44
Bon Sorte	6	10 N.	11 E.	Laura B. Clark, Placerville	14	
Boneset	3	10 N.	9 E.	M. & S. Dev. Co., 2811 G St., Sacramento, c/o Z. Smith, president		XII, p. 104; XIII, p. 135; XV, p. 282
Bordt	7	12 N.	10 E.	W. Bordt, Greenwood	20	XV, p. 282
Boston	18	11 N.	9 E.	Gue M. Allen	20	
Boulder	33	11 N.	9 E.	F. J. and G. R. Kaeser, A. Benedetti, et al.	20	XIII, pp. 135-136; XV, p. 282; XXXI, p. 22
Bower	7	12 N.	10 E.		20	XI, p. 204; XIII, p. 136; XV, p. 282
Briarcliffe Mines, Ltd.	2, 11	8 N.	10 E.	Supertest Bldg., London, Ontario, operators		See Baldwin Mine
	12	8 N.	10 E.			
Bright Hope	2	12 N.	10 E.	Maude A. Horn and Lucy L. Shine, 1525 20th Ave., Oakland		X, p. 177; XII, p. 105; XIII, p. 136; XV, p. 282
Brooklyn, Iowa and East Lode	2, 3	12 N.	10 E.		36	See Woodside-Eureka
Brown Bear	36	11 N.	10 E.			VIII, p. 182
Brust	6	11 N.	11 E.	Chas. N. & Frank P. Brust, Kelsey	37	XVIII, p. 44; XXII, p. 412
Buena Vista	13, 24	9 N.	10 E.	W. C. R. Hoover, El Dorado Lease and option: John J. Schuster, R.F.D. 7, Box 2901, Sacramento	20	Bull. 18, p. 91
Bullion	31	10 N.	11 E.			
Calaveras	4 mi.	E. Latrobe				XIII, p. 136
Caldonia	15	11 N.	10 E.	Wayne Huckaby, 457 El Camino Ave., Sacramento		
California Cons.	21, 16	9 N.	13 E.	Wm. Brown, Oleta	60	XI, p. 201; XII, p. 113; XIII, pp. 145, 159; XXII, pp. 412-13
California Jack	22	12 N.	10 E.	Mrs. E. M. Potts and A. L. Jeffrey, 527 Citizens National Bank Bldg., Los Angeles	40	XIII, p. 136; XV, p. 282
Carrol Seam						Bull. 108, p. 45
Castillo	33, 34	12 N.	9 E.	Fred Castillo	21	
Castile Seam						Bull. 108, p. 45

* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Cedarberg	1 36	12 N. 13 N.	9 E. 9 E.	New El Dorado Gold Mining Co., c/o Grace E. Jennings	21	XII, p. 106; XIII, p. 137; XV, p. 282; Bull. 108, p. 45; MMR West of Rocky Mtns., 1873, p. 47; XXII, p. 413
Chaparral	26	11 N.	10 E.	Philip Stingle, Boston & Margaret Kelly, Kelsey	20	XV, p. 283; Bull. 108, p. 21
Cherokee Flat	24, 25	13 N.	9 E.	Chas. B. Davis & John Federwitz, Greenwood	18	
Chester	18	10 N.	11 E.			VIII, pp. 182-183; X, p. 173; XII, p. 106
China Hill	16	9 N.	10 E.	J. E. Fox, et al.	21	XII, p. 106; XIII, p. 137; XV, p. 283
Choller, Manzanita Queen & King	30, 31	10 N.	11 E.		62	See Griffith Cons.
Christian	28, 29	9 N.	13 E.	Cole Brothers	56	
Church	12	9 N.	10 E.	Seymour Hill, El Dorado; El Dorado Mining Company	80	VIII, pp. 191-193; X, p. 171; XII, p. 106; XIII, pp. 137-138; XV, p. 283; XVIII, p. 209; Bull. 18, p. 92; Bull. 108, pp. 21-22; XXII, p. 413
Cincinnati	3	11 N.	10 E.	W. J. and J. T. Davey, Garden Valley, et al.		XII, p. 106; XIII, p. 138; Bull. 108, p. 22
Cinnamon Bear	36	11 N.	10 E.			XI, p. 201; XII, p. 106
Climax	13	9 N.	10 E.	W. G. Busick & C. L. Pinney, E. H. Althoff	19	
Climax & Independence	14	11 N.	10 E.	W. A. Bell, c/o W. F. I. Bell, Kelsey	34	
Clyde	28	11 N.	9 E.	V. C. Sheehan, et al.	10	
Coe Hill	33	12 N.	10 E.	Ed Bathurst, Folsom		Bull. 108, pp. 22-23; XXII, p. 417
Collins & Bacchi	28	12 N.	10 E.		126	XV, p. 283
Columbia	18	10 N.	11 E.	Placerville Gold Mng. Co., c/o L. Weatherwax		
Conner Seam						Bull. 108, p. 45
Cousin Jack	29	9 N.	13 E.		20	XII, p. 107; XIII, p. 138; XV, p. 283
Cranes Gulch	15	12 N.	10 E.	Chas. E. Jerrett, et al., Georgetown	80	Bull. 108, p. 45
Crown Point Cons.	31	10 N.	11 E.	Charles T. Richards, et al., Placerville	40	XII, p. 107; XIII, p. 138; XV, p. 283; XX, p. 8; Bull. 108, p. 23
Crusader	12	9 N.	10 E.	Seymour Hill, El Dorado	60	XV, p. 284
Crystal	32, 33	9 N.	13 E.	Arthur S. Morey, et al.	31	XII, p. 107; XIII, p. 138; XV, p. 284
Crystal	18	9 N.	10 E.	Crystal Gold Mng. Co., c/o Wm. E. Kleinsorge, Sacramento	12	X, p. 178; XII, pp. 107-108; XIII, p. 138; XV, p. 284
Crystal	18	12 N.	9 E.	E. Terry, C. Ashley and C. Schulz, Cool	20	XIII, p. 138; XV, p. 284
Daily & Bishop	27	9 N.	13 E.	Bishop, et al., Grizzly Flat	40	XII, p. 108; XIII, p. 138; XIV, p. 284
Dalmatia	13	11 N.	10 E.	W. A. Bell, c/o W. F. I. Bell, Kelsey	102	VIII, p. 177; X, p. 174; XI, pp. 201-202; XII, p. 108; XIII, p. 139; XV, p. 284; Bull. 108, p. 23
Darling	33	12 N.	11 E.	P. G. Gilpin, 45 Crocker Bldg., San Francisco	20	XI, p. 202; XII, p. 108; XIII, p. 139; XV, p. 284
Davenport	34	12 N.	10 E.		320	Bull. 108, p. 21
Davidson	22, 27	10 N.	10 E.	Jerome Strickland, El Dorado, et al.	19	XII, p. 108; XIII, p. 139; XV, pp. 284-285
Day & Taylor	9	9 N.	13 E.	Grizzly Flat Mng. & Milling Company	20	
Defiance						XII, p. 108
Doncaster & Cleveland	11	11 N.	10 E.	E. E., A. C. and Jos. R. Maynard	7	
Donozo						XII, p. 108; XIII, p. 139
Drury						See Cedarberg

Dunlap	11	12 N.	12 E.	Boutwell Dunlap Estate, San Francisco	160	
Dunn-Vandenburg	20	10 N.	11 E.	Thos. E. Dunn and W. W. Vandenburg	17	
Dyer	9, 16	9 N.	13 E.	Maggie Dyer, et al	5	
Eagle	7	12 N.	10 E.	A. B. Craig and wife	20	
Eagle	9	9 N.	13 E.	L. J. Kendrick, 3012 Shattuck Ave., Berkeley	48	VIII, p. 178; XIII, p. 139; XV, p. 285
Eagle King	4, 9	9 N.	13 E.	Mary Witmer, Ernest L. McAfee, et al	10	VIII, p. 178; XII, pp. 108-109; XIII, p. 139; XV, p. 285
East Mother Lode	31	10 N.	11 E.	E. E. Twitchell	16	
East Nashville	2	8 N.	10 E.	Joshua Hendy Iron Works, San Francisco	17	
Edner					160	XII, p. 109; XIII, pp. 139-140; XV, p. 285
El Dorado & McKinley	25, 26	13 N.	9 E.	Kesington Gold Mng. Co., c/o Cleveland Forbes, 809 Merchants Exchange Bldg., San Francisco	36	
Elf	33	11 N.	11 E.	Pioneer Hardware Store, Placerville	40	
Elliott						See Sir Raleigh Mine
Emma	21, 28	12 N.	10 E.	Chas. E. Hand, Placerville	19	X, p. 176; XIII, p. 140
Empress	12, 13	9 N.	10 E.	El Dorado Mining Company	20	
Epley & Mammoth	20	10 N.	11 E.	Placerville Gold Mng. Co., c/o L. Weatherwax, Placerville	26	VIII, pp. 186-87; X, p. 173; XIII, p. 109; See also Pacific
Equator		10 N.	11 E.			VIII, p. 190;, X. p. 172; XII, p. 109
Esperanza	28	12 N.	10 E.	Garden Valley Gold Mining Co., c/o Haswell Bros., St. Johns Chambers, Chester, England	43	X, p. 175; XII, p. 109; XIII, p. 140;, XV, p. 285; Bull. 108, pp. 23-24
Esperanza	7	12 N.	10 E.		20	
Estelle	6	10 N.	11 E.	Mary E. McLaren (trustee)	14	
	36	11 N.	10 E.			
Eureka	6	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville	13	X, p. 178; XI, p. 203; XII, p. 109; XV, p.285
	36	11 N.	10 E.			
Eureka	4	9 N.	13 E.	H. S. Treat, c/o D. C. Treat, Mission Savings Bank, S. F.	10	
Eureka	2, 11	12 N.	10 E.		16	See Woodside Eureka
Fairweather and Fairweather No. Extension	12	12 N.	9 E.			See Spanish Group
Falls	1	9 N.	10 E.	Joseph Drechsler, Diamond Springs	16	XV, p. 285; Bull, 108, p. 24
Faraday	20	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville		VIII, p. 186; X, p. 173; XII, p. 110; See also Pacific
Fiane	36	9 N.	10 E.	Philip A. and Laura C. Fiane	77	
Fisk						See Joseph Skinner Mine
Fine Gold	19	9 N.	12 E.	Alex J. Gray	40	
Frances Adams	25	11 N.	10 E.	Frank A. Losh	17	
Fort Yuma	29, 32	9 N.	10 E.	Jacob Baughman	29	XII, p. 110; XIII, p. 140
French	13	12 N.	9 E.	California Water & Mining Co.	18	XI, p. 204; XII, p. 110; XIII, p. 141; XV, p. 286, Bull. 108, p. 45
French Hill	36	13 N.	9 E.	Mrs. A. J. Johnson, Santa Monica and Mrs. E. S. Hadley, Sacramento	160	XII, p. 110; XIII, p. 141; Bull. 108, p. 47; XV, p. 286
Frog Pond & Marigold Cons.	28	12 N.	10 E.	S. W. Collins and Mary Norris, Garden Valley	17	XV, p. 286
Gallagher	5	12 N.	10 E.	F. G. Johnson and Jesse P. Hinck	21	
Gamblin						XXXI, p. 23
Gardner Cons.	6	10 N.	11 E.	Wm. H. and Emma L. Myers, Placerville	27	XV, p. 286
Garfield & Excelsior	5, 6	12 N.	10 E.		40	XII, p. 111; XIII, p. 141; XV, p. 286
Garibaldi Cons.						XII, p. 111; XIII, p. 141

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TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
General Lee, Sunday, Bosquit & Golden Age	19	10 N.	10 E.	Red Raven Cons. Mng. Co., c/o F. C. Hunter	71	
Gentle Annie	6	10 N.	11 E.	Laura B. Clark, Placerville	20	X, p. 177; XII, p. 111; XIII, pp. 141-143; See River Hill also Bull. 108, p. 45
Georgia Slide	3 34	12 N. 13 N.	10 E. 10 E.	Ida Barklage Ackley, Georgetown; Emma B. Schutz, Arbuckle et al.	86	XV, pp. 281, 282, 292; XX, p. 8, Bull. 108, pp. 45, 49; USGS PP 157, pp. 48-49
German & Richards	14	9 N.	10 E.	Seymour Hill, El Dorado	34	XIII, p. 142; XV, p. 286; Bull, 18, p. 90
Gibralter and Alta	1 6	9 N. 9 N.	10 E. 11 E.	Starlight Mining Co., c/o W. P. Frick	38	
Gillespie	17	10 N.	10 E.	Chas. E. Pine and Thos. G. Patton, El Dorado		
Gold Bug	20	12 N.	12 E.	Estate of John I. Martin, Placerville	20	
Gold Dust	12, 13	9 N.	10 E.	El Dorado Mining Company	20	
Golden Gate	14, 23	9 N.	10 E.	Charles T. Richards, et al., Placerville	21	X, p. 171; XII, p. 117; XIII, p. 150; XV. p. 286
Golden Rod	12, 13	9 N.	10 E.	El Dorado Mining Company	20	
Golden State	29, 32	13 N.	10 E.	Victor Forni	18	XI, p. 204; XII, pp. 111-12; XIII, p. 143; XV, p. 287
Golden Trace						See Flagstaff
Gold Mountain	11	8 N.	10 E.	Mrs. B. E. Carter, 811 E St., Sacramento, and Mrs. L. S. Sa[illegible]in, Nashville	40	XV, p. 286; Bull. 108, p. 50
Gold Note	4, 9	8 N.	13 E.	Walter L. L[illegible] and Helen Dean	95	
Gold Top	12	9 N.	10 E.	Chas. F. Loo[illegible]arrow	21	
Good Hope	24	8 N.	9 E.	George B. Ryma[illegible]	19	
Gopher-Boulder	11, 14	11 N.	10 E.	W. A. Bell, c/o W. F. I. Bell, Kelsey	40	VIII, pp. 175-77; XIII, p. 143; XV, p. 287; Bull. 18, p. 98; Bull. 108, pp. 24-25
Grand Victory	33, 34	10 N.	11 E.	Grand Victory Gold Mng. Co., c/o Geo. M. Clark, Placerville	72	VIII, p. 194; X, p. 178; XII, p. 112; XIII, p. 143; XV, p. 287; XXXI, p. 23
Gray		10 N.	9 E.			XII, p. 119; XIII, p. 143
Green Valley	22	10 N.	9 E.	John Meder, Folsom, et al.	8	
Griffith Cons.	30, 31	10 N.	11 E.	Charles T. Richards et al., Placerville	41	VIII, p. 189; X, p. 172; XII, p. 112; XIII, p. 144; XV, p. 287; Bull. 18, p. 92; Bull. 108, pp. 50, 25-26
Grit Cons. & Spanish Dry Diggings	30	13 N.	10 E.	Fred Husler, J. M. Dawson, Roy Croxen, C. Wachter	24	XVII, p. 426; XVIII, p. 44; XX, p. 8; Pre. Rep. 8, p. 29; Bull. 108, pp. 44, 46; XXII, p. 414
Grizzly Bear	36	11 N.	10 E.			XI, p. 201
Gross Cons. & Van Hooker	6	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville	21	VIII, p. 181; X, p. 173; XIII, p. 161; XII, p. 113; See also Pacific, and Harmon Group
Grouse Gulch	16	9 N.	13 E.		20	VIII, p. 178; XII, p. 113; XIII, p. 144; XV, p. 288
Guadalupe	11	11 N.	10 E.	Pioneer Hardware Store, Bernard Mierson et al., Placerville	10	

Guilford	25, 36 6	11 N. 10 N.	10 E. 11 E.	Guilford Gold Mining Co., Placerville	447	XV, pp. 287-288; Bull. 108, pp. 36-37; USGS PP 157, p. 49; XXII, p. 414
Hall Cons.						See River Hill
Harmon Group	6 36	10 N. 11 N.	11 E. 10 E.	Placerville Gold Mining Co., Placerville		VIII, pp. 181-182; X, pp. 173, 178; XI, p. 203; XII, p. 109; 113; XIII, p. 161; XV, p. 285; Bull. 108, p. 26
Harrison	7	10 N.	11 E.	Max Mierson, Placerville	21	
Hart				J. A. Flink, Garden Valley		Bull. 108, p. 47
Havilah						See Nashville
Henrietta	20	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville	14	VIII, p. 186; X, p. 173; XII, p. 113
Hidden Treasure	8	8 N.	13 E.	J. C. Baughmann, Indian Diggings	28	
Hines-Gilbert	24	13 N.	9 E.	Hines-Gilbert Gold Mining Co., 313 Capital National Bank Building, Sacramento. Lessee: Gold Fields Amer. Dev. Co.	14	XVII, p. 427; XVIII, p. 209; XX, pp. 178-179; Bull. 108, pp. 27-28, 46; XXII, p. 414
Hodge & Lemon						Bull. 108, p. 47
Holly	7	10 N.	11 E.	Holly Quartz Mining Company	16	
Homestead	26	13 N.	10 E.		40	
Hope	12	11 N.	10 E.			XII, p. 113
Humphrey						XIII, p. 145
Hustler	12	9 N.	10 E.	Mrs. Cecilla S[illegible]son	21	
I Bid	21	9 N.	13 E.	William Brow[illegible], Oleta	20	See Calif. Cons. also; XII, p. 113; XIII, p. 145
Ida	18	10 N.	11 E.			VIII, pp. 182-183
Ida & Edith	34, 35	12 N.	11 E.	R. W. Brooke, Placerville	40	
Idaho	14, 23	9 N.	10 E.	Sidney Pringle, c/o E. C. Pringle, 354 Russ Bldg., San Francisco	20	XV, p. 288
Ida Livingstone	12, 13	11 N.	10 E.	Ida Livingston Mining Co., c/o Kenneth McLeod	15	XV, p. 288; Bull. 108, p. 28
Independence	14	11 N.	10 E.	W. A. Bell, c/o W. F. I. Bell, Kelsey	18	See also Climax & Independence
Independence	10	9 N.	10 E.		20	XV, p. 288
Indian Hill	5	10 N.	11 E.	Warren Crocker, John J. Dimon and Mrs. Leo Hamilton	80	
Indicator, S. W. H. and Martha L.	4	12 N.	9 E.	Eugene E. Howland		
Inez	1	8 N.	10 W.	Estate of S. H. Maginess, Placerville	184	X, p. 171; XII, p. 114; XIII, p. 147; XV, pp. 282-283
Isabell Group	3	11 N.	10 E.	Mrs. M. P. Bennett, Placerville	40	XV, pp. 288-289; Bull. 108, p. 28
Ivanhoe	28	12 N.	10 E.	Warren T. Russell	10	X, pp. 175-176; XII, p. 114; XV, p. 289
Jennings	22	11 N.	10 E.	Dalmatia Mining Co., c/o W. F. I. Bell, Kelsey	20	
Jones	6	9 N.	11 E.	J. M. Brown, Mrs. Allie Lange, Bakersfield, et al.	20	XV, p. 287; XVIII, p. 45; XIX, p. 142
Josephine or Shield	5, 6 7, 8	13 N. 13 N.	11 E. 11 E.	J. A. Shields, Auburn		VIII, pp. 165-66; X, p. 178; XI, p. 206; XII, p. 114; XIII, p. 147; XV, p. 289; XVII, p. 427
Joseph Skinner	7	10 N.	11 E.	J. H. Skinner, Placerville	17	XIII, p. 140; XV, pp. 285-86; Bull. 108, pp. 28, 45
Josh Billings	21	12 N.	10 E.	A. Siesnop, Garden Valley, James Johns, Auburn, Charles E. Hand, Placerville	20	
Kelly	13	11 N.	10 E.	Miss Margaret Kelly, Kelsey		Bull. 108, p. 29
Kelsey	24, 25	11 N.	10 E.	Kelsey Mining Co., Ltd., 519 California St., San Francisco	42	XV, p. 289; Bull. 108, p. 29, 211
Lady						See Kelsey
Lady Blanche	36	9 N.	12 E.	J. E. Stratton, San Francisco	60	XIII, p. 147; XV, p. 289

* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Lady Emma	13	11 N.	10 E.	Mary A. Peters, et al.	7	XIII, pp. 147-148; XV, p. 289
La Moille	11	9 N.	10 E.	Walter I. Bidstrup, El Dorado	11	XII, p 115; XIII, p. 148
Larkin	29	10 N.	11 E.	James Nickless, Sr.	28	XIII, p. 148; XV, p. 289; Bull. 18, p. 93; Bull 108, p. 30
Last Chance	15	10 N.	11 E.	Estate of G. Varozza, Placerville	54	XIII, p. 148; XV, p. 289
Last Chance	8, 17	11 N.	10 E.	Martha D. Franz, et al., 2818 O St., Sacramento; B. R. Heikens, c/o Mrs. Marie Von Buelow, et al., Coloma		
Levitt Cons.	30	11 N.	10 E.	Arthur W. Richardson, c/o Eunice R. Levitt	40	
Lincoln	3	12 N.	10 E.	Mrs. Melvin Groves, 681 Eileen St., Oakland	20	XIII, pp. 148-149; XV, p. 289
Lincoln	34	13 N.	10 E.	P. F. and James L. Morgan, Georgetown		XXII, p. 414
Live Oak	3	10 N.	11 E.	Live Oak Mining Company		
	33	11 N.	11 E.			
Live Oak						XII, p. 116; XIII, p. 149
Log Cabin	30	9 N.	10 E.	N. H. Cook and E. T. Cook		XII, p. 116; XIII, p. 149; XV. p. 289
Lone Jack	28	12 N.	10 E.	Campbell & Metson, San Francisco	20	X, p. 176; XII, p. 116; XIII, p. 149; XV, p. 290
Lone Star	11	8 N.	10 E.	Camilla D. Heald and Virginia H. McDouall, Nashville	20	X, p. 178; XII, p. 116; XIII, p. 149; XV, p. 290
Lone Star	31	10 N.	11 E.	E. E. Twitchell	21	XII, p. 116; XIII, p. 149; XV, p. 290
Lookout	11	9 N.	10 E.	Seymour Hill, El Dorado, and Estate of Lillie E. Hill	20	XII, p. 116; XV, p. 290; XVIII, p. 45; Bull. 108, p. 30
Lookout & K. K.	19	13 N.	11 E.	Wilson Cary, Georgetown	53	XIII, p. 149; XV, p. 290
Loveless	11, 14	9 N.	10 E.	L. T. Loveless & Bros., El Dorado	14	XV, p. 290
Lucinda				D. Gallagher, et al., Grizzly Flat	18	XIII, p. 149; XV, p. 290
Lucky Jack	11	9 N.	10 E.	Thomas Murphy, Logtown	18	XV, p. 290
Lucky Marion	12	12 N.	9 E.	Lucky Marion Mng. Co., 619 St. Charles St., St. Louis	20	XIII, p. 150; XV, p. 290; Bull. 108, p. 30
Lucky Star	6	10 N.	11 E.	Laura Clark	15	See River Hill
Lukens	25	12 N.	8 E.	Estate of G. E. Lukens, J. E. Lukens, Auburn		XIX, pp. 142-43; XXII, pp. 414-415
Lyon	6	10 N.	11 E.	Laura B. Clark	12	See River Hill
Lyon	21	10 N.	11 E.	Arthur S. Lyon, et al.	12	
Madrona	29	12 N.	10 E.			XII, p. 117
Maltby	17	12 N.	10 E.	A. C. Bequette	20	
Mameluke	3	12 N.	10 E.	P. F. and James L. Morgan, Georgetown	130	XI, p. 203; XV, p. 290
Mammoth	3, 4	10 N.	9 E.	Annie G. Jurgens and Dorothy Kipp, Rescue	9	XIII, p. 150; XV, p. 290
Manhattan Cons.	36	9 N.	10 E.	Nellie A. White, et al., Box 695, Coalinga	77	XV, p. 291
Manzaneta	24	11 N.	10 E.	Mrs. G. C. Baum	17	Field Report
Margareth	25	9 N.	10 E.	Arthur Lambrecht and Fritz C. Schneiber	20	
Marguerite	20, 29	10 N.	11 E.	Fannie S. Larkin and Chas. W. Ball	19	XV, p. 291
Marigold						See Frog Pond & Marigold
James Marshall						See Big Sandy Mine
Martinez Mines	12, 13	9 N.	10 E.	Martinez Gold Mng. Co., El Dorado	96	XV, p. 288; Bull. 108, pp. 30-31; XXII, p. 415
Maryland	17, 18	10 N.	11 E.	Placerville Gold Mng. Co.		See Pacific
Mathenas Creek	31	10 N.	11 E.	Sophia Schainman	21	VIII, p. 190; X, p. 172; XII, p. 117; XIII, p. 150; XV, p. 291

Mauley Seam Mine						Bull. 108, p. 45
McCurdy	12	8 N.	10 E.	Edith P. McCurdy	20	
McDowell	36	9 N.	10 E.	Estate of W. B. Hammell, c/o Mrs. Ruth H. Graeber, Lillie E. Hill and Seymour Hill, El Dorado	12	
McNulty	14, 23	9 N.	10 E.	Charles T. Richards, et al.	21	See Golden Gate
Melton	4	9 N.	13 E.	Melton Gold Mines, Ltd., R. O. Camozzi, Mgr., Grizzly Flat	54	VIII, pp. 177, 180; XII, p. 117; XIII, p. 150; XV. p. 291
Middle Fork	1, 12	13 N.	10 E.	Middle Fork Qtz. Mining Co.		XXII, p. 418
Middle End				Sciaroni Brothers		
Miller	20	10 N.	11 E.	Mary E. Goyan, Placerville	20	VIII, p. 189; X, p. 172; XII, p. 122; XIII, p. 150; XV, p. 291; Bull. 18, p. 94; Bull 108, p. 31
Miller	30, 31	13 N.	10 E.	C. O. Miller, 2214 M St., Sacramento	19	
Minerva	12	9 N.	10 E.	El Dorado Mining Co.	9	
Minnehaha	11	9 N.	10 E.	Walter I. Bidstrup, El Dorado	8	
Montana	19	13 N.	11 E.	J. Helmers, Georgetown, et al.	20	XIII, p. 151; XV, p. 291
Montezuma	1	11 N.	10 E.	Mary Witmer		
Montezuma & Montezuma Ext.	35	9 N.	10 E.	Camilla D. Heald and Virginia McDouall, Nashville. Operators: Montezuma-Apex Mining Co.	27	XII, p. 118; XIII, p. 151; XV, p. 291; Bull. 18, p. 91; Bull. 108, pp. 31-34; 205-207; XXII, pp. 415-416
	2	8 N.	10 E.			
Morey	16	9 N.	13 E.	E. R. Morey, Grizzly Flat	40	VIII, p. 178; X, p. 178; XII, p. 118; XIII, p. 151; XV, p. 291; XXII, p. 415
Morning Star, et al.	2	12 N.	10 E.	Estate of E. F. Porter, Georgetown	58	XXII, p. 415
Mother Lode	17	9 N.	10 E.	Michael B. Ryan		
Mountain Boy, Mountain Girl, Mountain Slide & Eastern Star	33	12 N.	10 E.	Jessie L. Whittle, 1716 Webster St., Oakland	20	Bull. 108, p. 51
Mount Hope	34	10 N.	13 E.	Sierran Mng. Co., c/o Judge Wildman, Norwalk, Ohio	40	VIII, p. 178; XII, p. 114; XIII, p. 151; XV, p. 292
Mount Pleasant	16	9 N.	13 E.	W. S. Kirk, Placerville	259	VIII, p. 178; X, p. 178; XII, p. 118; XIII, p. 151; XV, p. 292; XVIII, pp. 301, 209; XXII, pp. 416-417
Mulvy Point	35	13 N.	10 E.	Emma B. Shutz, Ida Ackley, et al.	80	XV, p. 292; See also Georgia Slide
Murray	17	8 N.	13 E.	Henry J. Garibaldi	51	
Nashville	2	8 N.	10 E.	F. J. Behnemau. Lessee: Montezuma-Apex Mining Co.	60	XII, p. 119; XIII, p. 151: XV, pp. 292-293; XVIII, pp. 45, 209; Pre. Rep. 8, p. 30; Bull. 18, p. 91; Bull. 108, p. 27
Nashville So. Ext.	2	8 N.	10 E.	Gladys M. Shores	20	
New Eldorado	36	13 N.	9 E.	New Eldorado Mng. Co., c/o E. Jennings, Box 1547, R.F.D. 4, Napa		XII, p. 119; XIII, p. 152; XV, p. 293
New Era	6	10 N.	11 E.	Laura B. Clark	12	See River Hill
	36	11 N.	10 E.			
New Garibaldi	12	12 N.	9 E.	J. B. Hayes, San Francisco	20	XIII, p. 152; XV, p. 293
North St. Lawrence	2, 3	11 N.	10 E.	Pioneer Hardware Store, Placerville and Bernard Mierson, et al.		See St. Lawrence Mine
North Star	32	10 N.	10 E.	Senf Draying Company	20	
Ohio & Eagle	7	12 N.	10 E.		18	XII, p. 119; XIII, p. 152, 157; XV, p. 293
Oak	32	9 N.	13 E.	J. Ryan, Grizzly Flat	35	XII, p. 119; XIII, p. 152; XV, p. 293
Old Hickory	25	11 N.	10 E.	Kelsey Mining Company, 519 Calif. St., San Francisco	17	
Old Jasper					80	XIII, p. 152

* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Old Quartz	12	9 N.	10 E.	E. H. Pearce Estate, c/o Carrie C. Pearce	11	
Olive	7, 18	12 N.	10 E.	Sarah J. Dorn, 812 Phelan Bldg., San Francisco	20	
Omo	32	9 N.	13 E.	G. W. Mock, Ono Ranch	60	XIII, pp. 152-153; XV, p. 293
One to Sixteen and Vulture Mines	6, 7	10 N.	11 E.	W. A. Craddock, Placerville	25	XV, p. 293
Ophir	11	9 N.	10 E.	Walter I. Bidstrup, El Dorado	14	Bull. 108, pp. 34-35
Oregon	18	10 N.	11 E.	Pardi Litizia, Placerville		VIII, pp. 182-183; X, p. 173; XII, p. 119; XIII, p. 153
Oregon Hill						See Pacific
Oro Flam (Oriflamme)	31	10 N.	11 E.	Mill B. Maginess et ux, 1607 9th Ave., San Francisco	20	VIII, pp. 189-190; X, p. 172; XV, p. 293
Oro Fino	33	12 N.	10 E.	Sam W. Collins, Garden Valley	40	Bull. 108, p. 35; XXII, p. 417
Orum	12	9 N.	10 E.	Orum Mining & Development Co., O. A. Ingraham, Placerville	45	XV, p. 300; Bull. 108, p. 35
Pacific	34	13 N.	10 E.	Emma B. Shutz, Ida B. Ackley, et al.	6	XV, p. 292; See Georgia Slide also
Pacific	17, 18	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville	13	VIII, pp. 183-186; X, p. 173; XII, p. 120; XIII, p. 163; XV, pp. 293-295; XVIII, p. 209; Bull. 108, pp. 35-36; XXII, pp. 417-418
Padre						XII, p. 120; XIII, p. 153
Paulson	29	9 N.	13 E.	P. A. Paulson	34	
Peterson	24, 25	11 N.	10 E.	Kelsey Mining Co., Ltd., San Francisco	18	
Philadelphia and Gold Note	21, 22	8 N.	13 E.	J. B. Polk and Parker Brothers, Omo Ranch	70	XII, pp. 120-21; XIII, p. 153; XV, p. 295
Philip Joiner & Black Hawk	3, 4	9 N.	13 E.	Agostino Sciaroni, Jr., et al.	20	
Pocahontas	10, 11 14, 15	9 N. 9 N.	10 E. 10 E.	Geo. Q. Bell and Helen C. Chase; Seymour Hill, El Dorado	37	XII, p. 121; XIII, p. 154; XV, p. 295; Bull. 18, p. 95; Bull. 108, p. 36
Polar Bear, White Bear, Empire Gr.	29, 32	9 N.	13 E.	J. T. and J. Q. Wrenn, Placerville	404	XV, p. 295
Potossi	30	10 N.	11 E.	Chas. T. Richards, et al.	40	
Poverty Point						See Guilford
Pyramid	12, 13	10 N.	9 E.	F. J. Kaeser, Rhoads Grimshaw, et al.	24	XII, p. 121; XIII, p. 154; XV, p. 295; XXXI, p. 23
Quiggle	12	11 N.	10 E.	John Quiggle	30	
Rainbow	21	12 N.	10 E.	J. Ramsdell and C. M. Root, Garden Valley	20	XIII, p. 155; XV, p. 295
Rattler	20	10 N.	11 E.			XII, p. 122; XIII, p. 155
Red Hill	11	11 N.	10 E.	E. E., A. C. and Jos. R. Maynard	21	
Red Rover		10 N.	9 E.			XII, p. 122; XIII, p. 155; XVII, pp. 427-28
Red Top	12, 13	9 N.	10 E.	Martinez Gold Mines Co., El Dorado	6	
Red Wing	14, 23	9 N.	10 E.	W. H. Jones, J. E. Sawyer, P. J. Loveless, El Dorado	20	XV, p. 296; XVIII, p. 301
Reed and Keyser	7	10 N.	11 E.	Mary Limpinsel, Placerville		
Revenge		13 N.	9 E.			XII, p. 122
Richilieu	1, 12	9 N.	10 E.	Richilieu Mining Company	20	
Richmond & Syracuse	4 33	8 N. 9 N.	13 E. 13 E.	Mary Witmer, et al., Placerville	38	XV, p. 296
Ringgold Lode & Keystone	20, 29	10 N.	11 E.	Fannie S. Larkin	36	

Rising Sun	14	11 N.	10 E.	Nettie L. Forni and Josephine Simpers, San Francisco	15	XV, p. 296
River Hill	6	10 N.	11 E.	Laura B. Clark, Placerville & Guilford Gold Mining Co., Placerville	178	X, p. 177; XII, p. 111; XIII, pp. 141-143; XV, p. 296; Bull. 18, p. 94; Bull. 108, p. 37
Rose	18	10 N.	11 E.	Placerville Gold Mining Co., Placerville	----------	VIII, pp. 182-183; XII, p. 122; XIII, p. 155
Rose	6	11 N.	9 E.	Henry H. Rose, Auburn	14	
Rosecranz	21	12 N.	10 E.	Geo. Steppe, Placerville; Chas. R. Young, Bijou, Lillie M., Eva, Wm. Crook, c/o Arthur S. Morey, 630 11th Ave., San Francisco; Mrs. Sallie Mitchell, Placerville; A. Siesnop, Garden Valley; Josephine F. Simpers, 1559 Sacramento St., San Francisco	20	VIII, p. 171; X, p. 176; XIII, p. 155; XV, p. 296
Rose Kimberly No. 1, Rose Kimberly No. 2	10, 11	10 N.	9 E.	Estate of Fredman	150	
Rubicon & Alhambra	15	13 N.	11 E.	Ida Barklage Ackley, Georgetown; Emma B. Shutz, Arbuckle; Flora Barklage Laine, Hotel Sacramento, Sacramento	35	X, p. 178; XIII, p. 156
Ruxford	7	12 N.	10 E.	E. H. Ruxford, Title Ins. Bldg., 275 Bush St., San Francisco	20	
Ryan	24	11 N.	10 E.	M. B. Ryan, Placerville and Barrett Bros., Shingle Springs	20	XV, p. 296
Salisbury	----------	----------	----------	----------	----------	XIII, p. 156
Sam Martin	6, 7	12 N.	10 E.	Ella S. Graves, c/o W. L. Thompson, East Liverpool, Ohio	----------	XII, p. 122; XIII, p. 156
Santa Claus	7	12 N.	10 E.	B. Rainy, Greenwood, et al.	20	
Schneider	----------	----------	----------	----------	----------	See Mathenas Creek
School Girl & Union	12	9 N.	10 E.	El Dorado Mining Company	37	
Sebastopol	30, 31	13 N.	10 E.	Charles O. Miller, 625 36th St., Sacramento	19	
Selby	29	10 N.	11 E.	Warren Larkin, Placerville	60	XV, p. 296; Bull. 18, p. 93
Shan Tsz	21	10 N.	10 E.	----------	20	VIII, p. 193; X, p. 181; XII, p. 481; XV, pp. 296-297
Sharp	----------	----------	----------	----------	----------	VIII, p. 194; XII, p. 123; XIII, p. 156
Sherman	8	10 N.	11 E.	Sherman Mine & Milling Co., Placerville	80	XV, pp. 297-298
Sir Raleigh	31	10 N.	11 E.	----------	----------	XII, p. 109; XIII, p. 140
Sleeping Beauty	12	8 N.	10 E.	Mary C. Ruiz, et al.	10	
S. L. Hunt	30	12 N.	9 E.	Henry G. Meyer	11	
Sliger	36	13 N.	9 E.	Sliger Gold Mining Co., c/o W. H. Simpers, 3628 Fulton St., San Francisco	47	XII, p. 123; XIII, p. 157; XV, p. 297; XIX, p. 143; Bull. 108, pp. 38-40; XXII, p. 418
Smith	----------	----------	----------	----------	----------	Bull. 108, p. 45
Snow Flake	12	12 N.	9 E.	Mrs. Lovenia E. Pease, Sacramento	13	See Spanish Group
Spanish Group	12, 13	12 N.	9 E.	Mrs. Lovenia E. Pease, 1621 16th St., Sacramento	----------	Bull. 108, p. 47
Standard	----------	----------	----------	----------	----------	XII, p. 123; XIII, p. 157
Starlight	10	9 N.	10 E.	Starlight Mining Company, c/o W. P. Frick	20	XII, p. 123; XIII, p. 157; XV, p. 298
St. Clair	14	11 N.	10 E.	Mary E. Peters, et vire, Kelsey	20	XV, p. 298
St. Lawrence	2, 11	11 N.	10 E.	St. Lawrence Gold Mining Co.	10	XI, p. 202; XIII, p. 156; XV, p. 298; Bull. 108, pp. 40-41, 47
St. Louis	13, 14 23, 24	9 N.	10 E.	Charles T. Richards, et al.	19	

* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
St. John	34	13 N.	11 E.	Hattie M. Wilson, 858 S. Philadelphia St., Anaheim, John Boggs, 130 N. Calif. St., Stockton, et al.	30	
Stillwagon Group	32,33	9 N.	13 E.	Mary K. Pond and A. A. Helmke and wife		X, p. 178; XII, pp. 123-124; XV, p. 298
Strucklager	24	11 N.	9 E.	Beryl and E. J. McKenney, et al.	50	VI, p. 43: X, p. 178; XII, p. 124; XIII, p. 158; XV, p. 298
Sugar Loaf	1, 12	8 N.	9 E.	Justus C. Smith and Guy Atkinson	9	XII, p. 124; XIII, p. 158; MMR. West of Rocky Mountains, 1868, p. 88
Sunday	4, 9	9 N.	13 E.		20	XII, p. 124; XIII, p. 158; XV, p. 298
Sun Rise	24	11 N.	10 E.	Mary E. Barrette, Shingle Springs, and John F. Meder	10	XIII, pp. 158-159; XV, p. 299
Sunrise & Shadyside	19	12 N.	10 E.	W. H. Tuhrman, Travelers Hotel, Sacramento	40	
Superior	20, 29	10 N.	11 E.	Emma Rose, c/o Garrett W. McEnerny, 2002		
	30	10 N.	11 E.	Hobart Bldg., San Francisco	27	VIII, pp. 187-189; X, p. 172; XII, p. 124; XIII, p. 159; XV, p. 299; Bull. 18, p. 94; Bull. 108, p. 41
Superior No. Ext.	20	10 N.	11 E.	Annie J. Darlington	21	
Swansae & Rocky Bend	10, 15	11 N.	10 E.	W. E. and H. E. Kleinsorge, Sacramento		
Swift & Bennett	11	12 N.	10 E.			Bull. 108, p. 47
Sylvester	32	11 N.	10 E.	Albert C. Wellington and wife	20	
Taylor	21, 30	12 N.	10 E.	Walter L. and Helen Dean, San Francisco	17	VIII, pp. 168-171; X, p. 176; XI, p. 205; XII, p. 113; XIII, p. 145; XV, p. 299; XVIII, pp. 209, 210; Bull. 108, pp. 41-42
Threlkel	16	11 N.	8 E.	L. L. and Margaret Threlkel, Newcastle	120	XXII, p. 418
Tong	7	9 N.	9 E.	Fred H. Jenssen	10	
	12	9 N.	8 E.			
Treat	4	9 N.	13 E.		40	VIII, p. 178; XIII, p. 159; XV, p. 299
Treat Extension	4	9 N.	13 E.	Agostino Sciaroni, Jr., et al.	10	
Trench						See Yellow Jacket
True Cons.	6, 7	10 N.	11 E.	Placerville Gold Mining Co., Placerville		VIII, pp. 180-181; XII, p. 125; XIII, p. 144; See also Pacific
Tullis	1	9 N.	10 E.	Seymour Hill, El Dorado	16	XIII, pp. 159-160; XV, p. 299
Uncle Sam	2	12 N.	10 E.	W. R. Beattie and C. R. Benjamin, et al.	19	XIII, p. 160
	35	13 N.	10 E.			
Union	12	9 N.	10 E.	El Dorado Mining Company, c/o Chas. Hussey, 507 Empire State Bldg., Spokane, Wash.	61	VI, p. 43; VIII, p. 167; XV, p. 299; XVIII, pp. 209, 210; Bull. 18, p. 92; XXII, pp. 418-419; XXVIII, pp. 215-216; Bull. 108, pp. 42-43
Utah Apex						See Montezuma
Valdora				F. H. McAfee, Grizzly Flat		VIII, p. 178; XIII, p. 161
Van	2	12 N.	10 E.	W. L. Dickerson, San Francisco	20	XI, p. 203; XII, p. 126; XIII, p. 161; XV, p. 300
Vandalia	19	9 N.	10 E.	Vandalia Mining Co., c/o C. N. Busby		VIII, pp. 172-173, X, p. 178; XII, p. 126; Bull. 18, pp. 96-98; XVIII, p. 301; XXII, p. 419

Vandergreft	26	9 N.	10 E.		40	XV, p. 300
Van Hooker	6	10 N.	11 E.	Placerville Gold Mining Co., Placerville		VIII, p. 181; X, p. 173; XIII, p. 161; See also Pacific
	36	11 N.	10 E.			
Veerkamp	33	12 N.	10 E.			Bull. 108, pp. 37-38
Victoria				Grimshaw, Ferris & Cornelius, Rescue		XX, p. 178; XXII, p. 419
Wagner	11	8 N.	10 E.	Geo. E. and John Waggoner and F. B. McKevitt, et al	92	XXII, p. 419
War Eagle	24	11 N.	10 E.			Bull. 108, p. 43
Waun	24	13 N.	9 E.			Bull. 108, p. 47
Webster	31	13 N.	11 E.	D. C. Webster, Georgetown	24	XII, p. 126; XIII, p. 161; XV, p. 300
Welch	7	12 N.	10 E.	J. A. Sisler, Visalia and Bryant Moore, Exeter	21	XII, p. 126; XIII, p. 161; XV, p. 300
Weske	3	12 N.	10 E.	Adolph Weske, c/o L. L. Clark, 501 S. Seville Ave., Huntington Beach	38	
White Bear	36	11 N.	10 E.	Part of Pacific		VIII, p. 182; XIII, p. 161
Wiedebush	20	13 N.	11 E.	A. E. Wiedbush		XVII, p. 428; XXII, p. 419
Wild Cat	20, 21	12 N.	10 E.	Adelia A. Angier	20	
	28, 29	12 N.	10 E.			
Wild Rose Cons.	13	9 N.	10 E.	Estate of F. H. Maginess, Placerville, c/o M. B. Maginess, 1607 9th Ave., San Francisco	67	Field Report
Wilhelm & Last Chance	25	12 N.	8 E.	Estate of G. E. Lukens, Auburn	40	XV, p. 300
Willimantic						XII, p. 126
Wiltshire	36	9 N.	10 E.	Elizabeth M. Green, 1723 K St., Sacramento and Joseph H. Woolford, Plymouth	11	XXII, p. 419
Woodside-Eureka	2, 3	12 N.	10 E.	Woodside-Eureka Mng. Co., c/o R. B. Myers, 204 Bacon Block, Oakland	115	XI, p. 200; XII, p. 126; XIII, p. 161; XV, p. 300
	11	12 N.	10 E.			
Yellow Jacket	18	13 N.	11 E.	Ruby E. Bryan, et al	22	XII, p. 125; XIII, p. 159; XIV, p. 299
Young Harmon	7	10 N.	11 E.		28	See Pacific
Zentgraf & Homestead	16	11 N.	8 E.	H. B. Drescher and Louise Kleinsorge, Sacramento	9	VIII, pp. 200-202; X, p. 178; XIII, pp. 161-162; XV, p. 300; XVIII, pp. 209, 210; XX, p. 8;; XXII, pp. 419-420

* To save space, frequently only one of several names is shown in this column.

TABLE OF PLACER MINES AND PROSPECTS, EL DORADO COUNTY

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Alveoro	3, 10	10 N.	11 E.	Estate of S. H. Maginess, Placerville	184	XV, pp. 300-301
American Bar, Winifred Shirley & Willow Bar	4	13 N.	11 E.	American Bar Qtz. Mining Co., 859 Mills Bldg., San Francisco	25	
	33	14 N.	11 E.			
Badger Hill	28	11 N.	12 E.		40	XV, p. 301
Bell	8, 17	8 N.	13 E.	Henry J. Garibaldi	155	
	18	8 N.	13 E.			
Benfelt	10	10 N.	11 E.		160	VIII, pp. 197-198; X, p. 179; XIII, p. 133; XV, p. 301
Bitters						See Two Channel
Blacklock	8, 17	10 N.	11 E.	Estate of S. H. Maginess, Placerville	25	XIII, p. 134; XV, p. 301
Black Rock	33, 34	12 N.	9 E.		26	XI, p. 203; XIII, p. 134
Brown's Bar	5	12 N.	9 E.	Howard W. Davis	34	
	32	13 N.	9 E.			
Brown & Thompson	34	13 N.	10 E.	George Brown and J. Thompson	4	
Buckeye	21	10 N.	11 E.	Mamie G. and G. W. Hinckley	24	Field Report
Buckeye Hill	7, 8	12 N.	10 E.	Henry A. Arvidson; Ellen Soderjelm and Oscar Jacobson	32	XII, p. 105; XIII, p. 136; XV, p. 301
	17, 18	13 N.	10 E.			
Buckeye Hill No. Extension		13 N.	10 E.	Henry A. Arvidson and Oscar Jacobson	20	
Burt Alley						XII, p. 105; XIII, p. 136
California Mohawk						See Fairplay
California & Virginia	32	14 N.	11 E.	Melvin T. Duffy and Walter W. Stevens	4	
Carrie Hale						XII, pp. 105-106; XIII, p. 136
Channel Bend	5, 7	13 N.	11 E.		40	XII, pp. 116-117; XIII, p. 137; XV, p. 301
Chili Ravine						XII, p. 106; X, p. 180; VIII, pp. 194-196
Clark	30	8 N.	10 E.	Mrs. L. M. Clark, Paul H. Clark, et al.	160	
Confederate	8	8 N.	12 E.		40	XIII, p. 138; XV, p. 301
Confidence Mng. Co.						XXXI, p. 23
Connor	33	10 N.	10 E.	F. M. McComas, R.F.D. L, Placerville		
Cooley	17	13 N.	11 E.	Wm. Ogle, Volcanoville	160	
Cow Bell	18	12 N.	12 E.	E. D. Butts		
Cox	16	10 N.	11 E.	John I. Martin, c/o Elsie Martin, Placerville	26	Field Report
DeLaney	2	8 N.	10 E.	Joe De Laney and Tom Kloezko	8	
Dividend	3	10 N.	9 E.		31	XII, p. 108; XIII, p. 139; XV, p. 301
Dorsey	17	8 N.	13 E.	Henry J. Garibaldi & Mary Weston	217	
Eagle	31	9 N.	13 E.	Frank E. Abbey and Edward J. King	112	
Edenborough	18	13 N.	11 E.	Elmer C. Ogle, Volcanoville	144	
Edner	8	8 N.	13 E.	J. C. Baughman, et al.		
Excelsior	18	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville		
Fairplay	34	9 N.	12 E.	Calif. Mohawk Mining Co.	60	XV, p. 301
Fine Gold	19	9 N.	12 E.	Alex J. Gray	40	
Franklin	6	10 N.	11 E.	Placerville Gold Mining Co., c/o L. Weatherwax, Placerville	80	XIII, pp. 140-141; XV, p. 301

Gignac	16	10 N.	11 E.	Olivene A. Stone	36	X, p. 180; XV, p. 301
Giltedge	9	8 N.	12 E.		160	XIII, p. 142; XV, p. 302
Gold Bug	32, 33	13 N.	10 E.		101	XII, p. 105; XIII, pp. 142-143; XV, p. 301; XVIII, p. 301; XXII, pp. 438-439
	34	13 N.	10 E.			
Gray Eagle	8	12 N.	11 E.		100	XII, p. 112; XIII, p. 143; XIV, p. 302
Grizzly Flat	15	9 N.	13 E.	William Voss, Grizzly Flat, et al.	90	XII, pp. 112-113; XIII, p. 144; XV, p. 302; XXII, p. 439
Harnish					40	XIII, p. 144
Hayward	18	8 N.	13 E.	Hayward, Hobart & Lane Estates, 1128 Merchants Exchange Bldg., San Francisco	358	XIII, pp. 145, 147; XV, p. 302
Hewitt Extension	25	9 N.	12 E.	Thomas A. Murray Estate, et al.		XXII, p. 439
High Tunnel						
Hines Slope	24	13 N.	9 E.	F. I. Green, et al.	150	
Hook & Ladder	10, 11	10 N.	11 E.	Toll House Mine, c/o S. Chamberlain, Mills Bldg., San Francisco	66	XVII, p. 428; XVIII, p. 45; XXII, p. 439
Horseshoe Bar & Boston Bar	32	14 N.	11 E.	American Bar Quartz Mining Company, 859 Mills Bldg., San Francisco	56	
	4, 5	13 N.	11 E.			
Horseshoe Flat	15	10 N.	12 E	Estate of S H Maginess, Placerville, c/o M. B. Maginess, 1607 9th Ave., San Francisco	400	XV, p. 302
Horswill	9, 10	4 N.	11 E.		160	XIII, pp. 108-109; Field Report
Hutchinson & Woodburn				Andrew Hutchinson & Charles Woodburn		XXII, p. 439
Jinkerson & Arditto				W. A. Jinkerson & J. Arditto		XXII, p. 439
Jones Hill Diggings	29	13 N.	10 E.		120	XI, p. 204
Jupiter	19	9 N.	12 E.	Ernest A. Gray, Mabel E. Gray	40	
Kentucky Flat	22	13 N.	11 E.	Andrew Chase & Wm. H. White, e/o Wm. S. Eaton, Rm. 87, 27 State St., Boston	403	XII, p. 115; XIII, p. 147; See also Norris & Kentucky Flat
Kum Fa	9, 10	10 N.	11 E.	Oscar O. Reeg, et al., Placerville	140	XV, p. 302
	15, 16	10 N.	11 E.			
Lady Bug	22	10 N.	10 E.	E. M. Fields	11	
Landecker Group	21	10 N.	11 E.	Hope Mining Co., c/o E. A. Gabriel, 917 H St., Modesto	400	Field Report
Lava Capped	1	8 N.	12 E.	Earl W., Bulah and Mary E. Frey	80	
Linden	16, 17	10 N.	11 E.		150	VIII, pp. 196-197; XII, pp. 115-116; XIII, p. 148; X, p. 179; XV, p. 302
Little Big Hole	30	9 N.	13 E.	George H. Wood, Placerville	20	XXII, p. 440
Little Chief	26, 35	13 N.	10 E.	W. R. Beattie and C. E. Benjamin, et al.	65	XII, p. 116
Little Flower	18	8 N.	13 E.	Edith M. Canvin, T. M. Canvin, S. C. Harrell, et al.	108	
Middle End						XXII, p. 418
Mississippi						See Norris
Mount Gregory	9	13 N.	11 E.		160	XIII, p. 151; XV, p. 302
Mooney	15	10 N.	12 E.		40	XII, p. 118; XIII, p. 151; XV p. 302
Murzo						XII, p. 119; XIII, p. 151
Nashville	2	8 N.	10 E.	Daisy Hayward	14	
Norris & Kentucky Flat	9	13 N.	11 E.	William S. Eaton, Rm. 87, 27 State St., Boston	893	XII, pp. 114-115; 117-119; XIII, p. 147, 150
	22	13 N.	11 E.			
Nutmeg	25	9 N.	12 E.	Wm. H. Stinson	20	
Old Empire	29	9 N.	13 E.	Alex Oliver, e/o Dorthy M. Oliver	34	
Pacific	34	13 N.	10 E.	Emma B. Shutz, Arbuckle; Ida B. Ackley, Georgetown, et al.	6	XV, p. 292; See also Georgia Slide Mines

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TABLE OF PLACER MINES AND PROSPECTS, EL DORADO COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Pacific Channel	34	11 N.	13 E.	John E. Sexton, Palisade, Nevada. Local agent: T. G. Patton, Placerville		Pre. Rep. 8, p. 30; XVII, pp. 428-429; XXII, p. 440
Payne	28	9 N.	13 E.	Cole Brothers, Pleasant Valley	40	XII, p. 120; XIII, p. 153; XV, p. 302
Pebble Hill	13	10 N.	11 E.	Nicola Fossati, Smith's Flat & Placerville Gold Mng. Co., Placerville	57	
Pioneer	6	10 N.	12 E.	Charles Schaeppi	31	
Plattsburg					22	XIII, p. 154
Potts & Maginess	21	10 N.	12 E.	Estate of S. H. Maginess, Mrs. W. E. Beck, et al., Placerville	100	XV, p. 302
Quail	9	8 N.	13 E.	John R. Labor	40	
Rau & Patterson	34	13 N.	10 E.	M. F., D. M., J. D. and P. C. Flynn; Mrs. Kate Smith; Geo. C. Rau c/o J. Wesley Rau, et al.	60	
Rising Hope	15	10 N.	11 E.	Schuyler N. Warren, 51 Exchange Place, New York	228	XV, p. 303; XVII, p. 429; XXII, p. 440
Rivera	16	10 N.	11 E.	J. Q. Wrenn Estate, c/o L. J. Anderson, Placerville	63	XV, p. 303
Rocky Bar	25	9 N.	12 E.	Thomas A. Murray Estate, et al., Cole Station		XXII, p. 440
Rocky Point	6	12 N.	9 E.	Howard W. Davis	43	
Roundout				Richards and Fairchild		XVII, pp. 429-430; XXII, p. 438
Sailor Slide	3	12 N.	10 E.	Charles F. Hickman, Swift Bldg., Columbus, Ohio	35	
	34	13 N.	10 E.			
Santa Rosa		18 N.	11 E.		300	XII, p. 122; XIII, p. 156
Slug Gulch	26	9 N.	12 E.	John L. Schenck and John R. McKee		
Stewart	20	10 N.	11 E.	Stanley F. Triplett	92	X, p. 180; XII, p. 123; XIII, p. 157; XV, p. 303
Table Rock	30	11 N.	11 E.	Mary Witmer	11	
Texas Hill						XII, pp. 124-125; XIII, p. 159
Toll House	10	10 N.	11 E.	Toll House Mine, c/o S. Chamerlain, 846 Mills Bldg., San Francisco	134	X, p. 179; XIII, p. 159; XV, p. 303; See also Hook & Ladder
Try Again	15	10 N.	11 E.		40	XIII, p. 159; XV, p. 303
Two Channel	15, 22	13 N.	11 E.	Century Mining Co., 43 N. First St., San Jose	1955	XIII, p. 160
	34	13 N.	11 E.			
	8, 9	13 N.	11 E.			
	10	13 N.	11 E.			
Union	3	10 N.	11 E.		78	XV, p. 303
	33	11 N.	11 E.			
Union Wisconsin River	20	10 N.	8 E.	Nellie Miller and Agnes Gray, c/o V. Gray		
Unity	3, 4	10 N.	11 E.		178	XII, pp. 125-126; XIII, p. 161
Uno		8 N.	12 E.		40	XIII, p. 161
Volcanoville	5, 8	8 N.	13 E.	Leslie C. Baughman, et al.	67	
Wabash Deep Channel	26	13 N.	10 E.	E. W. Claresse, Georgetown	160	XVII, p. 430
W. W.						XII, pp. 126-127; XIII, p. 161
Zimmerman						See Pacific Channel Mine

* To save space, frequently only one of several names is shown in this column.

CA. STATE MINERALOGIST. #34, 1938

LIMESTONE AND LIME

Next to gold, the most important mineral product of the county is limestone. The deposits are mostly in the form of upright lenses and have been classified as part of the Calaveras (Carboniferous) formation. They are usually enclosed in amphibolite schist which shows schistosity striking northwest to north, and dipping 70° to 85° northeast. The bodies of limestone conform in greatest length and depth with these directions. The largest outcrops extend north from near Cool into Placer County. Other deposits already opened are found at intervals going southward. Development has been confined to those lying within reasonable distance of the main-line of the Southern Pacific (Ogden Route) or its Placerville branch. Farther east are found other deposits, notably the marble at Indian Diggings, which remain undeveloped because of their distance from the railroad.

Four companies mentioned hereunder produced 159,134 tons of 'industrial' limestone in 1936, which was over ½ of all that produced in the state; besides which, two of the plants burned considerable lime.

Auburn Chemical Lime Co. Since 1930 this company has been operating the quarry, crushing plant and lime-kilns formerly worked by *Newcastle Lime Company* and *Farmer Lime Company,* and many years ago by *Holmes Lime Company.* T. L. Chamberlain, Auburn, is president of the company.

The property is in the NW¼ sec. 15, T. 11 N., R. 8 E., 7 miles by road southeast of Newcastle. The limestone deposit was in the form of a large, upright lens of good grade, colored gray. It is

Plant of Auburn Chemical Lime Co., near Rattlesnake Bar.

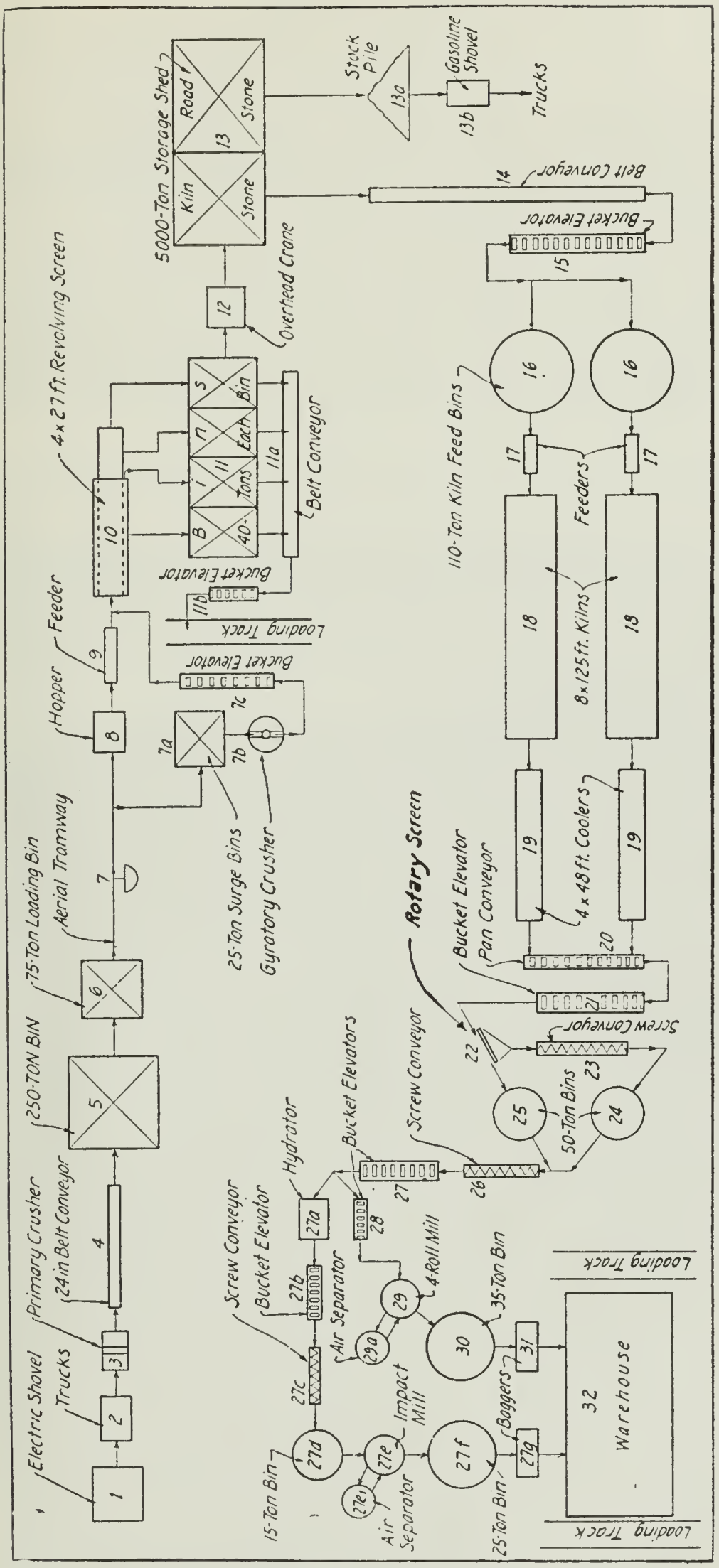
of the Calaveras (Carboniferous) formation and enclosed in amphibolite schist. The strike is nearly north, and dip steeply east, nearly vertical. A pit from 100 ft. to 120 ft. deep and 80 ft. wide has been opened on a level a little above the mill and kilns. After drilling and blasting the south face, 6 men break the rock to 1-ft. size or less, with sledges and tram it several hundred feet to the plant. A Dixie mill with a capacity of 8 tons an hour is operated by a 40-h.p. electric motor. It reduces the coarse rock to about 20-mesh for glass factories. Two lime kilns in commission burn about 10 tons of rock each day. They use oil brought to the plant in tank trucks from Stockton for fuel.

There is a small plant for preparing hydrated lime, and prepared lime is also sold. Sales are made to mine cyanide plants and to farmers for use in fruit-tree spray and as a soil corrective. From 14 to 18 men are employed.

Diamond Springs Lime Company is an Ohio corporation, operating a large modern lime plant at Diamond Springs. The supply of limestone comes partly from their own quarry, 3 miles east of the plant and in part is purchased from *El Dorado Limestone Company* (which see). Homer P. Brown is general manager. R. J. Finchley is the general superintendent and R. V. Whigham is assistant superintendent. The main office is at Diamond Springs. The plant was established in June, 1927.

Limestone from the company's own quarry carries considerable magnesium carbonate. The deposit is covered by a soil and clay overburden about 8 ft. deep, which is stripped during the off-season with the Link-Belt electric shovel used for digging and loading limestone. The total amount of limestone in the deposit is not known, though it is said to have been drilled to a depth of 600 ft. It has been stripped 200 ft. wide by 500 ft. long. A face 36 ft. high is broken by drilling with Jackhammers using 36-ft. steel in vertical holes. With a higher face, these are supplemented by flat holes drilled from near the bottom. The vertical holes are spaced 10 ft. apart in two staggered rows, and are shot with 40% Trojan bag powder, which is said to give $4\frac{1}{2}$ tons of broken stone to 1 lb. of powder. Stone is loaded into trucks and hauled to the primary crusher, going thence by belt conveyor to bins. An aerial tramway 3 miles long, with 149 buckets of 800 lb. capacity delivers about 250 tons of limestone to the plant in an 8-hour shift.

The tabular analysis and flow-sheet, taken from an excellent article published in "Pit and Quarry" April 6, 1932, gives details of the principal operations as carried on now, except that the vibrating screen for sizing quicklime has been replaced by a rotary screen. The plant is one of only three in the country using rotary kilns for burning limestone. Each of the 8-ft. by 125-ft. kilns requires from 3 to $3\frac{1}{2}$ hours to turn out 12 tons of finished lime. In all, 13 grades of lime and 3 of hydrated lime are produced. Kilns are inclined $\frac{1}{2}$ inch to 1 ft. and are driven at a speed of from $\frac{1}{6}$ r.p.m. to $\frac{1}{2}$ r.p.m. Oil fuel is fed at 225 lb. pressure and 280° F. The kiln temperature varies from 1800° F to 2200° F at the firing end, and is about 1300° F at the feed end. The oil feed is controlled by valves with micrometer adjust-



Flow sheet, Diamond Springs Lime Company's plant, El Dorado County.

ment. About 50 gallons of fuel oil is required per ton of lime. Each kiln is operated by a 25-h.p. electric motor.

Electric power is supplied by Pacific Gas and Electric Co. through a special automatic sub-station adjoining the works, which is fed by two 60,000-volt lines. This steps down power to 11,000 volts and is transformed to 440 volts for plant and quarry use. Oil for fuel is brought in tank cars over the Southern Pacific tracks serving the plant, and the high-calcium limestone supplied by El Dorado Limestone Co. also comes in by rail.

From the kilns, the lime passes through rotary coolers, over a pan conveyor to a bucket elevator and to the top of the hydrator building. The oversize (over $\frac{1}{2}$ inch to $1\frac{1}{2}$ inch) is used for quicklime and the fines for hydrated lime. A large part of the quicklime is ground in a Raymond 4-roller mill, which yields a product nearly all passing 100 mesh.

An important market for high-calcium quicklime is for steel fluxing, while lime made from magnesian limestone can be used in building; but other uses are numerous, including the cyanide process of gold extraction, water purification and the making of paper and strawboard.

An interesting side-line, utilizing waste products, is the manufacture of targets (clay pigeons) at this plant. A subsidiary, *El Dorado Chemical Company,* manufactures a heat-resisting aluminum paint.

In all, 72 men are employed, of whom 55 work in the plant and 7 in the quarry.

El Dorado Limestone Company has 465 acres $4\frac{1}{2}$ miles by road southwest of Shingle Springs where limestone mining has been going on for 25 years. In earlier days, stone from the deposit was used to make lime for building purposes. *El Dorado Lime and Minerals Company* was the immediate predecessor of the present company, and their operations were described in our Report XXII for 1926. The present company was formed in 1931. J. H. Bell, general manager, has been in charge of operations for many years for this and the preceding companies. The company has a right-of-way with 1.9 miles of standard gauge spur track connecting with the Placerville branch of the Southern Pacific Railroad.

The deposit occurs in a series of lenses of white, high-quality limestone dipping 85° east in a belt of Calaveras (Carboniferous) rocks from $\frac{1}{4}$ mile to $\frac{1}{2}$ mile wide. The lenses are separated by strips of the country rock and in places small dikes cut across the limestone. For many years two lenses have been mined by shrinkage stoping and by using benches or slicing and underhand stoping. Drifts 20 ft. wide by $8\frac{1}{2}$ ft. high have been run. Widths worked have ranged generally from 20 ft. to 70 ft. The object has been to make as much lump rock as possible. Coarse rock is drilled and blasted in the stopes and is broken again by hand with sledges on the grizzleys over the loading pockets at the shaft.

The mine has been opened through a 3-compartment vertical shaft 500 ft. deep with levels at 150, 300 and 470 ft. This shaft is lined with concrete to the first level.

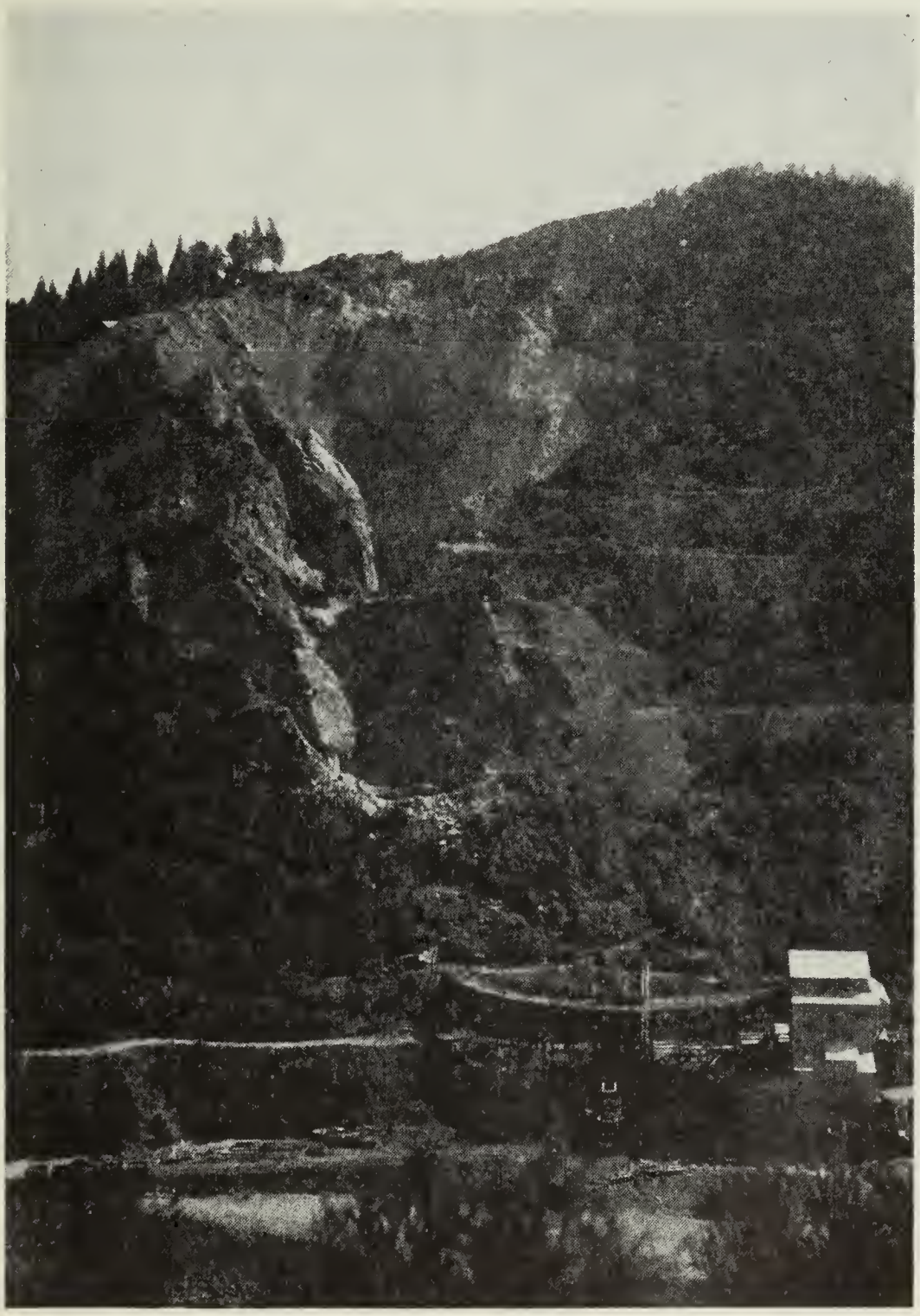
The limestone is solid, without gouges on the walls, and stands well without timber. A length of 300 ft. on the strike and a total

width of up to 120 ft. has been opened, but the total extent of deposit has not been revealed. Dynamite of 25% strength has been used. After hoisting, rock is screened to different sizes, some being crushed as fine as 20-mesh. Electric power is used throughout.

Because of its purity the limestone is put to various uses. Lump stone is sold to the steel mills and smaller sizes go into paint, kalsomine, glass-making, the sugar industry, etc.

About 40 men have been employed lately and the property has been the largest producer of 'industrial' limestone in the state with an output of around 100,000 tons a year.

Henry Cowell Lime and Cement Company, 2 Market Street, San Francisco, owns 885 acres of land in secs. 7, 8, 18, and 30 T. 12 N., R. 9 E., on which there is a large deposit of limestone. This is from ½ to 2 miles north of Cool, on and near the road to Auburn, and was mentioned in old reports as the Cave Valley Limestone Quarry or Blue Marble Quarry.



Mountain quarries (limestone) of Pacific Portland Cement Co., near Cool.

TABULAR ANALYSIS OF THE OPERATIONS AND EQUIPMENT OF DIAMOND SPRINGS LIME CO. PLANT AT DIAMOND SPRINGS, CALIFORNIA

(The key numbers refer to the equipment shown on the accompanying flow-sheet)

Operation	Key	Equipment	Make	Model No., size, capacity or type	Power source	Power transmission
Raw-material recovery and transportation	1	Shovel	Link-Belt	1¼-cu. yd. electric	60-hp. G. E.	Link-Belt silent-chain
	2	Trucks (2)	International	5-ton		
Primary crushing	3	Primary crusher	Allis-Chalmers	40-in. by 42-in. jaw	150-hp. G. E. slip-ring	Belt
	4	Belt-conveyor	Stearns	24-in. by 180-ft.	15-hp. G. E.	Belt
	5	Bin		250-ton		
	6	Loading bin		75-ton		
Transportation	7	Aerial tramway (Optional to 7a)	Am. Steel & Wire Co.	50-ton per hr.	40-hp. Westinghouse induction	Belt
	8	Hopper				
	9	Feeder	Link-Belt	Reciprocating type	5-hp. Westinghouse	Link-Belt silent-chain
Screening and storage	10	Revolving screen	Link-Belt	4-ft. by 27-ft.	15-hp. Westinghouse	Link-Belt silent-chain
	11	Bins (4) (Optional to car-loading 11a)		40-ton each		
Recrushing	7a	Surge-bin		25-ton		
	7b	Reduction crusher	Telsmith	8-in. gyratory	50-hp. Westinghouse	Belt
	7c	Bucket-elevator (To screening and storage 10)	Link-Belt			
Car-loading	11a	Belt-conveyor	Link-Belt	36-in. by 250-ft.	10-hp. Westinghouse	Link-Belt silent-chain
	11b	Bucket-elevator	Link-Belt			
Storage	12	Overhead crane	Judson Pacific Co.	1½-cu. yd.	2 50-hp., 1 15-hp., 1 5-hp.	Gears
	13	Open storage (Optional to stock-piling 13a)		5,000-ton		
Stock-piling	13a	Stock-piles				
	13b	Shovel	Northwest	¾-cu. yd. gasoline		

Reclaiming	14	Belt-conveyor	Link-Belt	24-in. by 40-ft.		
	15	Bucket-elevator	Link-Belt	67-ft.	10-hp.	Link-Belt silent-chain
	16	Kiln-feed bins (2)	Link-Belt	110-ton circular		
	17	Feeders (2)	Link-Belt	Belt-type	Kiln drive	Chain and reeves variable speed transmission
Calcining	18	Kilns (2)	Vulcan	8-ft. by 125-ft.	25-hp. variable-speed	Link-Belt reducer and gears
	19	Coolers (2)	Vulcan	4-ft. by 48-ft.	15-hp. Westinghouse	Belt and gear
	20	Pan-conveyor	Link-Belt		5-hp. Westinghouse	Chain and gear reducer
	21	Bucket-elevator (Optional to quicklime screening and storage 23)	Link-Belt	60-ft.	7½-hp. Westinghouse	Link-Belt silent-chain
Quicklime screening and storage	22	Rotary screen (Oversize to 25, throughs to 23)	Link-Belt	3-ft. by 6-ft. single-deck	2-hp. Westinghouse	Belt
	23	Screw-conveyor	Link-Belt		5-hp. Westinghouse	Link-Belt reducer and silent chain
	24	Bin	Link-Belt	50-ton capacity		
	25	Bin	Link-Belt	50-ton capacity		
	26	Screw-conveyor	Link-Belt			
	27	Bucket-elevator (Optional to hydrating 27a)	Link-Belt			
	28	Bucket-elevator	Link-Belt	40-ft.	5-hp. Westinghouse	Link-Belt silent-chain
Quicklime pulverizing and packing	29	4-roll mill	Raymond	4-roller	50-hp. Westinghouse	Belt
	29a	Air-separator	Raymond	No. 11 Exhauster	40-hp. Westinghouse	Belt
	30	Bin	Link-Belt	35-ton capacity		Belt
	31	Bagger (To storage for shipment 32)	Valve Bag Co.	4-bag	7½-hp. Westinghouse	
Hydrating	27a	Hydrator	McGann-Schulthess	6-t.p.h. capacity	15-hp. G. E.	Famous worm reducer and gear
	27b	Bucket-elevator	Link-Belt	40-ft.	7½-hp. Westinghouse	
	27c	Screw-conveyor	Link-Belt			
	27d	Bin	Link-Belt	15-ton capacity		
Hydrated-lime grinding and packing	27e	Impact mill	Raymond		20-hp. Westinghouse	
	27e	Air-separator	Raymond	No. 12 Exhauster	50-hp. Westinghouse	Direct-connected
	27f	Bin	Link-Belt	25-ton capacity		
	27g	Bagger (To storage for shipment 32)	Valve Bag Co.	4-bag	7½-hp. Westinghouse	Belt
Storage for shipment	32	Warehouse		50-ft. by 90-ft.		

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Many years ago lime kilns were operated here but nothing has been done recently. Superficially the deposit appears as large as the one being worked by Pacific Portland Cement Company on the north. A quarry face perhaps 200 ft. high could be opened from the north.

The same company owns another limstone deposit near Marble Creek, 3 miles east of Clarksville, and limestone was burnt there years ago. This also is idle.

Mountain Quarries, Pacific Portland Cement Co., owner. At the north boundary of the county, on the south slope of the canyon of Middle Fork of American River 4½ miles from Auburn. The company has its own broad-gauge railroad 7 miles long connecting with the Central Pacific old main-line a mile west of Auburn.

This, the largest limestone producer in northern California, has been in operation intermittently but for a part at least of nearly every year since 1910. It has been frequently described. The deposit is the southern part of a large lens of limestone divided and partly eroded away by the river. The outcrop was about 1 mile long north to south, and about two-thirds of the deposit was on the El Dorado County side. The lens stands nearly upright with a width of from 300 ft. to 400 ft. and was proved to a depth of 800 ft. The series of limestone lenses extending across the county, of which this is one, have been classified as being in the Calaveras formation (Carboniferous).

This deposit has been worked through an adit 10 ft. by 14 ft. in cross-section, 70 ft. above the river. After clearing the overburden with a steam shovel, raises were put up from the adit level and glory holes were opened. The broken stone is dropped down the raises to 6-ton cars on the adit level from which it is hauled to the crushers and sizing plant. Most of the stone in years past went to the company's cement plant at Cement, Solano County, at the rate of from 1200 tons to 1500 tons a day. Lately the cement plant has been idle and sugar companies have been the principal customers. A sugar refinery requires a large tonnage of limestone during a short working season, so the deposit is worked only part of the time.

The operations were described in detail by Geo. J. Young in 'Engineering and Mining Journal Press' July 4, 1925.

ADDENDA

See pp. 363, *et seq.,* for additional data on El Dorado County mines.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

The Geologic Branch endeavors to secure from outstanding and authoritative scientists and engineers, articles of a more general or popular nature so that the general reader may benefit by this broader point of view than may be acquired by perusing only the intensive technical accounts and inventories of facts.

IN THIS ISSUE

Strategic Minerals:

The possibility of war interfering with the importation of much-needed raw materials which are not now produced domestically in sufficient quantity, has brought up again the subject of strategic minerals. At the request of the Geologic Branch, Mr. Charles White Merrill, engineer of the U. S. Bureau of Mines as well as of the U. S. Army Reserve, has prepared and generously contributed for our publication the following timely paper—"Strategic Minerals in California"—explaining what conditions the country would be facing and how California can help in the case of another international disturbance.

Mineral Highlights:

In a period of over 30 years, our State Mineralogist, Mr. Walter W. Bradley, has had the opportunity of following with close interest the discovery and utilization of a long list of minerals and mineral products of California. It seemed in order, therefore, since we have finally published an up-to-date, detailed account of all the mineral species known in the state through Bulletin No. 113 ("Minerals of California" prepared by Professor Adolf Pabst), that Mr. Bradley should relate to us from first-hand knowledge some of the "Mineral Highlights of California." This he has done, bringing forth the salient points in the history of the state's mineral development. He gives due credit to the extremely diversified geological features of California (as shown on the new State Geologic Map) as being responsible for the diversity and abundance of minerals.

Submarine Canyons:

In the ample margin of Sheet No. III of the new Geologic Map of California, appears a much smaller state map entitled, "Geomorphic Map of California." Faults, physiographic boundaries, and surface contours are shown on it, also submarine contours indicating the irregular configuration of the underseaground surface. What is generally regarded as the continental shelf is that part which is not over 100 fathoms (600 feet) below sea level. Beyond this depth, the submarine topography shows marked ruggedness of character and in

many places extremely deep canyons which extend far out to the west. These are much like the canyons formed on continental surfaces, especially along the margins of upraised plateaus, or where rivers cut deep and irregular canyons across a table-land. The submarine canyons of California, clearly shown by the 250-fathom (1500-feet) contours on this map (drawn from new and accurate data of the U. S. Coast and Geodetic Survey), have been and now are being carefully studied in minute detail by the well-known oceanographer, Dr. Francis P. Shepard. At the request of the Geologic Branch, Dr. Shepard has prepared a brief account for the general reader of some of the results of his work in California. He also discusses various theories of how these submarine canyons may have been formed. This study has been made all the more fascinating by the fact that newer methods of undersea investigation are rapidly being developed. There is a vast wealth on the sea bottom in the nature of treasures which have gone down with sinking vessels and probably a still greater wealth in the undiscovered oil pools that lie in the geological structures beneath the bottom of the sea, especially off the coast of southern California.

STRATEGIC MINERALS IN CALIFORNIA [1]

By Charles White Merrill [2]

In the strategy of modern war much attention is given to the possibility that victory or defeat may hinge upon the availability to the combatants of commodities essential to the war industries. Although the United States is particularly favored in its domestic supplies of raw materials, there are, nevertheless, several deficiencies in its resources. These shortages were revealed during the World War, when desperate measures were taken to meet the wartime needs with the result that prices of certain commodities rose to fantastic levels. During that period, California played a very important part in supplying a number of products that had been produced in negligible quantities before the emergency; furthermore, it seems probable that the resources of the State will be called on again should war curtail the flow of commodities from foreign sources.

There are two principal factors in determining the importance of a commodity in the strategy of war. The first consideration is whether or not the commodity is necessary, either directly or indirectly, for the waging of war; the second consideration is whether or not the commodity can be produced in sufficient quantities from domestic sources. It must be borne in mind that to wage war successfully, the military powers must have popular opinion in their favor. Civilian requirements during a time of stress are just as important as are those of the army and navy. After eliminating from consideration those commodities unnecessary to the war industries, it is found that there are wide variations in the surpluses or deficits of the remaining raw materials in any particular country. Here again, those commodities of which there are exportable surpluses or even those of which there are adequate supplies need be given no further consideration from the standpoint of war strategy. Those essential commodities, however, of which there is any deficiency, are termed "critical materials"; those of which there is a marked deficiency are spoken of as "strategic materials." It is obvious that each nation would have a different list of strategic commodities because of the uneven distribution of the world's natural resources.

The Commodities Division of the Army and Navy Munitions Board recognizes 52 materials as being critical; among them are found 22 that are derived from minerals. The board, in preparing for the defense of the United States, listed on September 16, 1937, the following 22 commodities[3] as strategic materials:

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[1] Published by permission of the Director, Bureau of Mines, U. S. Dept. of the Interior.

[2] Supervising Engineer, San Francisco office, Mineral Production and Economics Division, Bureau of Mines, and Captain, Specialist Reserve, U. S. Army.

[3] Those mineral commodities with production records and known reserves in California, superior to any other State, are printed in bold type and those with lesser but appreciable reserves in California are printed in italics.

Aluminum	*Manganese, ferro-grade*	Quinine
Antimony	Manila fiber	Rubber
Chromium	Mica	Silk
Coconut shells	Nickel	Sisal
Coffee	Opium	Tin
Hides	Optical glass	*Tungsten*
Iodine	**Quicksilver**	Wool
Jute		

It will be noted that half of these commodities are either the products of mines or of mineral origin.

There are four methods that should be considered for supplying the deficiencies—the maintenance of trade routes, the use of substitutes, the collection of stockpiles during peace time, and the development of domestic resources. The possibilities of maintaining trade routes depend on many factors. In some cases, routes are easy to keep open where the material is available in a neighboring friendly nation. It is difficult, for instance, to conceive of conditions under which the nickel resources of Canada or the sisal production of Mexico would not be available to the United States in time of war as they are in peace time. Even the manganese resources of Cuba could be obtained with a relatively small expenditure of sea force for their convoy to American ports. Much more difficult, however, would be the problem of assuring passage of tin from British Malaya and the Dutch East Indies were this country at war with a nation or group of nations possessing a powerful navy.

For many years, Great Britain was able to maintain a navy capable of securing its sea lanes against any combination of non-British fleets, but such supremacy is no longer held by any nation. It is obvious, therefore, that sole reliance can not be placed in the maintenance of sea routes although under most conceivable circumstances the United States would occupy an enviable position with respect to sea power. On the other hand, it is obvious that the diverting of naval vessels for convoy service deprives the battle force of part of its strength.

A second defense against the deprivation of strategic materials is the development of substitutes. In some cases, substitutes may prove entirely adequate, but it is generally found that substitution is successful for only a relatively limited number of uses to which a commodity is put. Consequently, substitution, while always an important factor in meeting emergencies, is very seldom a satisfactory solution of the problem. Even where substitutes are developed that meet all the tests that can be given them in laboratories, it is usually found that when quantity production is attempted there remain many problems yet unsolved. It must also be borne in mind that little time is available for such developments in time of war. Moreover, it is usually found that an inferior type of workmen and supervisors is available to industry after the army demands for officers and soldiers are met, which results in additional difficulties when any deviations from routine procedure are proposed.

A third method of meeting the problem is stockpiling. So far most stockpiles that have been suggested as practicable from an economic standpoint have provided only for a short period, after which

it was assumed that the problem could be met by some other method. However, in the case of opium and its derivatives (morphine, heroin, etc.), drugs essential to national defense, a unique situation has provided at least a partial solution to the problem. Narcotics confiscated by the Treasury Department in the enforcement of the Harrison Narcotic Act and the Narcotic Drug Export and Import Law, when of suitable quality, are turned over to the War Department as available stock should normal sources be cut off by an enemy. A serious difficulty sometimes encountered in maintaining stockpiles is that of deterioration. This, however, is of much less consequence in the storing of mineral commodities than agricultural products.

The fourth method of providing supplies of the strategic materials is the development of nonproductive domestic resources. In some cases this method is obviously hopeless, but in many others it offers very great possibilities. There is no chance, of course, that adequate supplies of such commodities as coconut shells, coffee, or chichona bark (source of quinine) could be produced in the United States, largely because of climatic conditions. On the other hand, a number of the strategic minerals are known to occur in large low-grade deposits in various parts of the United States. The development of such resources challenges the mining industry.

Here, again, two points of view have been argued at length. One group holds that bringing such limited resources into production can not help but exhaust them and, consequently, no work beyond prospecting and exploration is desirable. The other group points out that the only practicable way to prove that a deposit can be made productive is to start producing. This group is able to supply many examples of mining camps where the known reserves grew progressively greater as exploitation proceded. The proponents also bring out the fact that the production and preparation of strategic minerals in most cases is largely a foreign industry and, consequently, without some exploitation in the United States, the country must of necessity face a war emergency without technologists and workmen trained in the work. It is also found that domestic product, due to the utilization in many cases of low-grade or impure materials, while satisfactory, may be substantially different from the imported material. It is, therefore, important that consumers of the product be acquainted with the special problems in its utilization. A peace-time industry, even though small, tends to work out such practical problems. It is found, also, that commercial organizations established to exploit the deposits act as focal points for research, which tremendously increases the possibility of solving the special problems of the industry.

Several methods are available for the fostering of such developments. One that so far has been applied is the protective tariff. Time alone will tell whether this has or has not been a wise method. A sizeable production of such metals as quicksilver and tungsten has been maintained since the tariff was enacted, but, on the other hand, the maintenance of production has been attained only by advance in price.[4] Tariff acts for many years have provided a duty of 6 cents a pound on pig tin and 4 cents a pound on tin concentrates effective as soon as the domestic industry reached an annual output of 1,500 long tons

[4] Mercury: U. S. Bur. Mines Minerals Yearbook 1937, pp. 685-686.

of metal. This, however, has not proved a sufficient incentive to expand domestic output.

Agencies such as the United States Bureau of Mines and the United States Geological Survey have played their part in trying to solve the problem of bringing domestic reserves of strategic minerals into production. Deposits have been examined and reported upon. Metallurgical and ore-dressing methods have been devised and tested, and the economic and commercial possibilities of the situation, both from a domestic and world standpoint, have been considered and delineated. State agencies, including the Division of Mines of California, have played an important part in these studies, both in cooperation with the federal agencies and through independent investigations. Funds for such work, however, have been very limited. Like so many government activities predicated on prospective emergencies, great difficulty is experienced in arousing interest in the problem until the emergency is at hand. Unfortunately, action may then come too late.

California's Resources of Strategic Minerals

Probably no state offers as great possibilities for supplying the nation with strategic minerals as does California. Although its resources of aluminum, antimony, sheet mica, nickel, and tin are negligible, it is a leading producer of the country's chromite, iodine, quicksilver, and tungsten; its reserves of low-grade manganese are large; its production of tin, though negligible, exceeds that of any other State; and the possibility of finding minerals suitable for optical-glass manufacture is not hopeless.

Aluminum. Aluminum is of great importance to the war industries because its light weight combined with strength makes it essential in the construction of many kinds of machines. The rapidly expanding motorization of army transport and the tremendous increase in military aviation call for increasingly greater supplies of the metal and its light-weight alloys.

The production of aluminum in the United States is nearly sufficient to meet domestic consumption. In addition, Canada has a large exportable surplus of virgin aluminum metal manufactured in its plants, which would almost certainly be available to the United States in case of war. The difficulty in the aluminum situation, however, lies in the maintenance of the flow of bauxite into the United States, the only ore from which any quantity of aluminum is derived. In 1937 the United States imported over half of the bauxite it consumed. The proximity of the Canadian industry does not relieve the situation, because the manufacturers there must import virtually all of the bauxite they treat.

In the United States the principal bauxite deposits lie in Arkansas, although small productions have been coming from Alabama and Georgia for a number of years. Until some method is worked out to produce aluminum from one of the other aluminum-bearing minerals (clay, for example), any likelihood that California will play an important part in the aluminum industry is small. Although cheap electric power is available, neither bauxite nor most of the other min-

eral commodities necessary to aluminum metallurgy are commercially available in California.

Antimony. Antimony finds a very wide use in industry; its military uses, though more restricted, are essential. It is used in shrapnel, bullets, primers, cable coverings, and to produce white smoke in range finding.

Until very recently, the bulk of the antimony imported into the United States came from China. In 1929 about 70 per cent of all the antimony imported came from China, but in 1936 less than 10 per cent was of Chinese origin and approximately 90 per cent came from Mexico and South America. From a military standpoint, this shift of source has strengthened the American strategic position because trade with points in the Western Hemisphere would almost certainly be easier to maintain than trans-Pacific shipping. The adequacy of antimony reserves in the Western Hemisphere, however, has not been thoroughly investigated. The production of antimony from domestic ores is small and the larger part of it comes from antimonial lead ores. The known resources of straight antimony or antimonial lead ores in California [5] are too small to be of any great consequence even as an emergency supply of the metal.

Chromium. Chromium is of prime military importance as a raw material because it is an essential ingredient in making alloy steels. The chief military uses of chrome alloy steels are armor plate, projectiles, high-speed cutting tools, automobile axles, and springs. Chromium and its derivatives also find wide use in the manufacture of refractories, in chemicals for tanning leather, and a number of other uses of great military importance.

Chromite, the only ore of commerce from which chromium is produced, is mined and exported in large quantities from the Union of Socialist Soviet Republics, Turkey, Southern Rhodesia, Union of South Africa, and New Caledonia. The United States imports almost half of the world's supply.

The production of chromite in the United States has been negligible since the World War period. At that time, however, the domestic industry made a very creditable showing largely due to the production in California.[6]

In 1914 domestic sales amounted to 591 long tons valued at $8,715, but in 1918 sales rose to 82,430 long tons valued at $3,955,567. Imports in 1918 totaled 100,142 long tons valued at $2,892,825. After 1918, however, domestic production sank to almost nothing but imports have increased in both quantity and value.

Under the stimulus of high prices, a large number of small lenses of high-grade chromite were discovered and mined in California, and there seems no reason to believe that similar conditions would not lead to the discovery of many more such deposits in case of another emergency. Moreover, the experience of the World War period tended to define the more favorable localities in which to prospect for the ore. In addition to lenses of rich ore, other areas have been found containing

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[5] Boalich, E. S., and Castello, W. O., Antimony, Graphite, Nickel, Potash, Strontium, and Tin: California State Mining Bureau, Preliminary Report No. 5, 1918, 44 pp.

[6] Bradley, W. W., Huguenin, E., Logan, C. A., Tucker, W. B., and Waring, C. A., Manganese and Chromium in California: California State Mining Bureau, Bull. 76, 1918, 244 pp.

extensive deposits of lower-grade material, which undoubtedly could be concentrated and briquetted were prices high enough to justify the cost.

Adequate supplies of high-grade foreign ore available at low cost on the Atlantic seaboard has left little incentive for the development of the California industry. Nevertheless, the local reserves are certain to prove an important factor in furnishing this strategic mineral commodity should war conditions again interfere with the flow of foreign supplies.

Iodine. Iodine continues to be one of the most important drugs for emergency use and is essential in the treatment of battle casualties. Until recently, over half of the world's supply came from Chile and the second most important center of production was Scotland.

Except during the World War period, little iodine had been produced commercially in the United States prior to 1932; during the war, a small output of iodine was derived from kelp at plants on the California coast. Experimental work has shown, however, that iodine can be extracted profitably from certain brines and oil-well waters, with the result that three plants are now recovering iodine from oil-well brines in Los Angeles County, Calif. In 1937, the production of iodine in the United States was a little less than one-sixth as great as the imports.

Manganese. Although manganese, both in quantity and cost, is a very minor raw material in the steel industry, it is nevertheless absolutely essential to the making of good steel. On the average, approximately 14 pounds of manganese is consumed in each ton of finished steel. There are several types of manganese ore used commercially, but the type that the war industries are principally interested in is termed "ferro-grade." Ore to be ferro-grade must be high in manganese and low in phosphorus and sulphur. It is the use of manganese in the making of steel, of course, that gives it its strategic significance. As modern war can not be waged without huge supplies of steel of the highest grade, and as high-grade steel can not be made without manganese, it is obvious that this metal is one of the most important on the list of strategic mineral materials.

The Union of Socialist Soviet Republics, Gold Coast, Cuba, Brazil, and India are the principal sources of the manganese imports of the United States. These countries, together with the Union of South Africa, Egypt, and Japan, are the principal producers of manganese ore. Unfortunately, with the exception of Cuba and Brazil, the sources of production are remote and the sea lanes that would have to be kept open for importation of the ore would prove difficult to defend.

A most inviting possible solution of the manganese problem lies in the development of a commercial process utilizing low-grade domestic manganese ores where ferro-grade manganese ore is now used. During 1936, the United States Bureau of Mines announced[7] the development in its laboratories of a method for producing metallic manganese by the electrolysis of manganese-bearing solutions. As these solutions may be had from the leaching of low-grade manganese

[7] Shelton, S. M., Electrolysis of Manganese Solutions, Progress Report 13 Metallurgical Division: Rept. of Investigations 3322, Bureau of Mines, 1936, pp. 29-37.

ore, renewed hope has been expressed for the utilization of low-grade manganese deposits in ferrous metallurgy. At present, however, the bureau's process is still in the laboratory stage and no dependence should be placed on it as a solution of the manganese problem.

A number of manganese deposits are known in California,[8] and ore, both low-grade and ferro-grade, has been produced, particularly during the World War period. The known reserves of the State are not great, but further exploration and development might extend them considerably. Any California manganese industry, however, whether in war time or peace time, faces one very serious handicap—the transportation costs between California and the principal iron and steel manufacturing centers are very great. In some cases, the freight costs on California ore alone exceed the delivered price of high-grade manganese ore of ferro-grade from foreign sources.

Mica. It is the electrical properties of sheet mica that place this mineral on the list of strategic minerals. Sheet mica is used as an insulator in the automobile, airplane, and radio industries, all three of which are of great importance from a military standpoint. Over three-fourths of the sheet mica of the world is produced in India; Madagascar and the United States follow India in quantity of output.

The known reserves of sheet mica in the United States are small, and the industries using sheet mica have depended largely on imports for many years. Mica suitable for grinding occurs extensively, however. California has never had a sheet-mica industry and its known resources of this material are negligible. There are areas, however, where general geological considerations indicate that prospecting might not be fruitless. The granite and pegmatite areas of San Diego County deserve attention.

Nickel. The principal military use of nickel is as an alloying metal for steel. Virtually all armor plate is made of nickel steel. Canada is by far the largest producer of nickel, and fortunately the Sudbury district, where virtually all of it is produced, has always been easily accessible to American industry. The second largest producer of nickel is New Caledonia in the south Pacific Ocean.

The production of nickel from nickel ore in the United States has been negligible and no reserves are known that offer much possibility of yielding any appreciable quantities of this metal. The very small production of nickel reported each year comes from copper refineries, where it is a byproduct of copper mining. Even the byproduct nickel can not be fully credited to domestic mines, because some of the blister copper richest in nickel is imported into the United States for refining. California[9] offers no special prospect for developing a domestic supply of this metal.

Optical glass. The problem of supplying optical glass for such military needs as range finders and field glasses is largely one of manufacturing. Under present technology, the constituents of optical glass must be melted in kaolin pots that have been permitted to cure for at least eight months. Although the task of finding domestic sources of raw material for optical-glass manufacture probably would not offer

[8] See footnote 6, p. 287.
[9] See footnote 5, p. 287.

serious difficulties in peace time, the necessity of locating such supplies under war time stress might very probably cause dangerous delays. The search for the materials undoubtedly would be directed to many parts of the United States, but it seems likely that regions like the pegmatite areas of San Diego County, Calif., would receive special attention.

Quicksilver. The principal use of quicksilver in military art is as an ingredient of certain explosives like mercury fulminate, small quantities of which are used in the detonators that start many of the projectiles on their way. For a number of years Spain, Italy, and the United States had been the leading producers of quicksilver, but present war conditions in Spain make it impossible to ascertain the exact recent production in that country.

At the present time California[10] produces more quicksilver than all the rest of the United States together. Although the occurrence of quicksilver is such that blocked-out ore reserves are almost invariably small, there seems to be little reason for expecting California quicksilver production to decline seriously as long as the price and costs remain within the limits of economic ratio. Moreover, geologic considerations lead to the conclusion that the coast ranges of California form a quicksilver province from which a yield of the metal may be expected for many years. It was found during the World War that the stimulus of a higher quicksilver price caused a large increase in the production of the metal, and it seems probable that the miners of California would do much to provide the needed volume of this strategic metal if its price were sufficiently increased.

Tin. Tin has a very large number of military uses; it is a constituent of babbit bearings used in engines of airplanes, tanks, trucks, automobiles, motorcycles, tractors, and other essential military machines. In addition, any nation that depends on an army made up almost entirely of hastily-trained civilians must plan to provide them with easily digestible food. Under field conditions, food preserved in tin cans is the obvious solution to this problem.

The largest source of tin ore is southeastern Asia, where British Malaya, Netherland India, Siam, China, and Burma produce almost three-fourths of the world's supply. Bolivia, in South America, and Nigeria and Belgian Congo, in Africa, are the other principal sources of the metal. The world smelting centers are situated in British Malaya, the United Kingdom, the Netherlands, Netherland India, and China. The United States had a large smelting industry, depending principally on Bolivian tin concentrates, during the World War, but this domestic industry found itself unable to compete with foreign smelters after 1924, due principally to the difference in labor costs.

The production of tin ore in the United States, up until the present time, has been negligible. Surveys of areas where tin has been produced or tin minerals have been reported, particularly during the period of the World War, have revealed nothing to sustain the hope that any appreciable quantity of tin will ever be produced in the United States. The production of about 100 long tons of tin at the

[10] Bradley, W. W., Quicksilver Resources of California: California State Mining Bureau, Bull. No. 78, 1918, 389 pp.

Temescal (Cajalco) mine in Riverside County, Calif.,[11] since its discovery in 1840 probably exceeds the sum of the productions of all the other domestic properties outside of Alaska. The principal contribution towards tin production in California undoubtedly will come from the detinning plants, which reclaim the tin found in tinplate scrap. A plant in South San Francisco, belonging to the Metal and Thermit Corporation, treats large quantities of tinplate scrap, most of which is collected in the can factories serving the huge canning industry of the State.

Tungsten. Tungsten is of tremendous importance to the war industries because of the unique qualities it imparts to tool steels. Tungsten tool steel can be used in high-speed work where the generation of heat brings the tool to a red heat without drawing its hardness. Ordinary carbon tool steel under these conditions becomes soft and worthless almost immediately. In many of the metal-working industries, tungsten tool steel makes possible the speed-up which is so important to profitable industry and absolutely essential to wartime industrial efficiency. China, Burma, the Federated Malay States, Bolivia, and Portugal are the leading producers of tungsten outside of the United States.

Under the protective tariff, the tungsten mines of the United States have been able to supply over half of the industrial needs of the country during the last few years, and California[12] has played an important part in this domestic production. The most important California deposits are situated at the Atolia section of the Randsburg district in San Bernardino County and on the eastern flank of the Sierra Nevada in Inyo and Mono counties. In the former district, both placer and lode ore have been produced.

California in a future emergency. Perhaps the most important factor in meeting an emergency calling for an output of strategic minerals from inactive deposits is detailed knowledge regarding such resources. In addition to its extraordinarily wide assortment of mineral resources, California is very fortunate to have a very large number of mining men, including prospectors, practical operators, mining engineers, and geologists, who have accumulated a vast fund of data regarding the strategic minerals of the State. The existence of this information during the World War was evidenced by the rapidity with which the miners of California began delivering strategic minerals from the mines of the State, notably chromite, quicksilver, and manganese ore. It seems certain that should another emergency arise, a following generation of miners as well informed and as patriotic as those of 1917 and1918 would be found ready to help meet the situation.

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[11] See footnote 5, p. 287.

[12] Boalich, E. S., and Castello, W. O., Tungsten, Molybdenum, and Vanadium: California State Mining Bureau, Preliminary Report No. 4, 1918, 34 pp.

MINERAL HIGH-LIGHTS OF CALIFORNIA

By Walter W. Bradley, State Mineralogist

The new and revised "Minerals of California" (Bulletin No. 113), prepared by Dr. Adolf Pabst, Associate Professor of Mineralogy, University of California, and recently published by the Division of Mines, reveals several, and recalls to my mind other, interesting features in the mineral field in this state. Wm. P. Blake, who as geologist in 1853 accompanied the Lieutenant R. S. Williamson expedition of the Pacific Railroad Surveys, published in 1866 the first list of Californian minerals comprising some 75 species then known in this as yet little-explored territory.

Henry G. Hanks, the first State Mineralogist of California (1880-1886), published a second list of minerals in 1884 as a chapter in the Fourth Annual Report of the State Mineralogist. That list practically doubled the number of species up to that time identified, and gave detailed descriptions of some of the localities as well as data on those particularly of economic value. Thirty years later (1914) the State Mining Bureau issued Bulletin 67, entitled "Minerals of California," written by Dr. Arthur S. Eakle, Professor of Mineralogy in the University of California. In the intervening years much knowledge had been gained of the geology and mineralogy of this state, including the ore deposits of many of the counties, the gem and borate deposits in the southern section, and the petrography of many districts. Eakle's list included at least 300 species, besides subspecies and varieties. A second edition of Eakle's work was published in 1923, as Bulletin No. 91 of the State Mining Bureau, adding still further to our knowledge of California's minerals and cataloguing more details of the localities of occurrences of the economic minerals.

This newest bulletin, by Dr. Pabst, brings our published data down to 1938 and describes over 400 mineral species not including varieties. Of these, 54 were discovered in California, several of them proving of importance commercially, and others of special mineralogic interest. Colemanite, discovered in 1882 and kernite in 1927, has each in its turn been the most important commercial borate mineral, the latter being the principal world-source today. Metacinnabar, discovered in 1870 has yielded important production at times in certain of the quicksilver mines. Lawsonite, first found in Marin County in 1895, has proved to be of great petrographic interest.

The first of the new minerals found in California came, as might be expected, from the gold mining region of the Sierra Nevada, beginning with melonite, the nickel telluride, in Calaveras County in 1867. However, four regions or localities have been the most prolific in yielding new species: the quicksilver mines of the Coast Range north of San Francisco Bay, the saline lake deposits of the desert region, the pegmatite gem-bearing deposits of northern San Diego and adjoining Riverside County, and the metamorphic contact fringe of the limestone deposit at Crestmore in Riverside County. The first-named has accounted for seven new varieties, the second for eighteen, the third for four, and the fourth for nine.

The minerals first found in California and the dates of their published descriptions are as follows:

*Partzite, 1867
Melonite, 1867
*Mariposite, 1868
Calaverite, 1868
Metacinnabar, 1870
*Aragotite, 1873
Roscoelite, 1875
*Posepnyte, 1877
*Ionite, 1878
*Tincalconite, 1878
Colemanite, 1883
*Hanksite, 1884
*Napalite, 1888
Sulphohalite, 1888
*Knoxvillite, 1890
*Redingtonite, 1890
Iddingsite, 1893
Lawsonite, 1895
*Northupite, 1895
Pirssonite, 1896
*Bakerite, 1903
*Boothite, 1903
*Tychite, 1905
*Benitoite, 1907
*Joaquinite, 1909
*Palaite, 1912
*Salmonsite, 1912
*Sicklerite, 1912
*Stewartite, 1912
Inyoite, 1914
*Meyerhofferite, 1914
Searlesite, 1914
*Wilkeite, 1914
*Crestmoreite, 1917
*Griffithite, 1917
*Riversideite, 1917
*Plazolite, 1920
*Vonsenite, 1920
*Jurupaite, 1921
Merwinite, 1921
*Kempite, 1924
*Foshagite, 1925
*Kernite, 1927
*Probertite, 1929
*Curtisite, 1930
Krausite, 1931
*Sanbornite, 1931
*Schairerite, 1931
*Tilleyite, 1933
*Burkeite, 1935
*Woodhouseite, 1937
*Ellestadite, 1937
*Teepleite, 1938
*Veatchite, 1938

Of the above-listed minerals, 41 (marked by *) have not yet been found, so far as known, outside of California.

Of the economic minerals, gold was, of course, as in all new and undeveloped countries, the first to be exploited. Today though California is still the leading state in the Union in gold output, that metal is not now our most valuable product. Petroleum, a mineral substance though not a definite individual mineral, heads California's commercial list. Natural gas, in a similar category, is also important. Other important commercial mineral products such as the building stones, granite and sandstone, are likewise not single minerals but natural mineral aggregates. Diatomite, or diatomaceous earth, is not a distinct 'mineral' but a mixture of fossil opaline silica with variable impurities. California produces on a commercial scale, annually, between 55 and 60 different mineral substances, not segregating the several varieties of gem stones sold, such as the diamond, garnet, tourmaline, chalcedony, et al.

In the mineral industries California is the leading domestic producer of borax, quicksilver, platinum, tungsten, chromite, and magnesite. Some of our gem stones, such as tourmaline and kunzite, are not excelled elsewhere; and in the case of benitoite it has not been found outside of the single locality of its discovery. To our economic list in recent years have been added iodine, bromine, natural carbon dioxide gas, wollastonite, and zircon.

Of borax, California is today the leading world source, as already noted. This mineral was discovered in the waters of Tuscan Springs, Tehama County, January, 1856, and in September of the same year in Borax Lake, Lake County, the latter being worked commercially from 1864 to 1868 inclusive. Production from the 'playa' or dry-lake deposits of Inyo and San Bernardino counties began in 1873, but in 1887 the borax industry was revolutionized by the discovery of the colemanite (calcium borate) beds at Calico, San Bernardino County, and later similar beds in Inyo, Los Angeles, and Ventura counties were utilized. Colemanite was in turn displaced by the discovery in 1926 of kernite (rasorite), a sodium borate, near Kramer in Kern County. Other borate minerals associated with colemanite are borax, inyoite,

ulexite, howlite, meyerhofferite, probertite, hydroboracite. Kernite being a sodium borate with only four molecules of water of crystallization as compared with ten molecules in the borax of commerce, means that in the process of recrystallization approximately one and one-half tons of borax are obtained for each ton of clean kernite mined. Is it any wonder that all other borate minerals were relegated to the background?

California became the leading American producer of mercury, or quicksilver, almost simultaneously with the inception of gold mining here. The New Almaden Mine in Santa Clara County was first worked in a small way in 1824, and its total production has been over a million flasks (of 76 pounds, each), surpassed by only one mine in the world (Almaden Mine, Spain) during the period in which New Almaden operated. Published records show this total, however, has been exceeded also by the Idria Mine in Austria and the Santa Barbara Mine at Huancavelica, Peru, the bulk of whose production was made prior to 1850. The principal mercury mineral of economic value, the world over, is the red sulphide, cinnabar. Metacinnabar has the same composition, chemically, but is black and crystallizes in the isometric system, whereas the red is hexagonal. In certain parts of some of California's mines the black sulphide has constituted important orebodies, but it is usually in minor amounts. Native mercury occurs to some extent in many quicksilver mines, accompanying cinnabar, and generally disseminated in fine liquid globules. In California it seems to be characteristic of the quicksilver deposits within certain serpentine areas, rather than of those outside of the serpentine. The less important mercury minerals, occurrences of which have been noted in California are: amalgam, native alloy of mercury and gold; calomel, mercurous chloride, coccinite, the iodide; coloradoite, the telluride; eglestonite, an oxychloride; montroydite, an oxide; tiemannite, the selenide.

Although California's annual yield of a few hundred fine ounces of platinum-group metals is insignificant compared to the principal world sources, yet that small amount puts this state in the domestic lead. It is practically all obtained as a by-product from the placer-gold operations of the dredges and hydraulic mines. It occurs mostly in grains and occasionally in small nuggets up to at least two or three ounces. Most of the platinum consists of natural alloys with iridium, osmium, palladium, ruthenium, and could doubtless be classified as platiniridium. In fact, the nuggests are in part platiniridium, and some are iridosmine (osmiridium) both of which have a hardness of 6–7, while platinum is only 4–4½. The writer has an osmiridium nugget from Trinity River district which will scratch glass.

Most of California's tungsten ore is scheelite, the calcium tungstate; but wolframite (iron-manganese tungstate) and hübnerite (manganese tungstate) also occur here. Ferberite, the dominantly iron member of the wolframite series so prominent in Colorado, is not known thus far in California. Published data indicate that the deposits at Atolia in San Bernardino County have been the largest and most productive scheelite deposits known, particularly in massive scheelite in veins up to three feet wide.

Chromite (chromic iron oxide), along with magnetite (magnetic iron oxide), is a primary magmatic constituent of such basic igneous

rocks as peridotite, pyroxenite, dunite, which alter readily into serpentine of which there are extensive areas in this state. These two minerals comprise the bulk of the black sands found in nearly all gravel deposits and along the ocean beaches. Chromite has important industrial uses, both as a source of the metal, chromium, for toughening ferro-alloys and as a refractory liner in metallurgical furnaces. It occurs in lenses of massive mineral in the serpentine and as disseminated-crystal orebodies. In the year 1918, due to war-time demand and curtailment of foreign importations, a total of 29 counties in California shipped chromite to a total valuation of over $3\frac{1}{2}$ million dollars.

Magnesite (magnesium carbonate) is another of California's specialties. Commercial production began in the Cedar Mountain district, Alameda County, south of Livermore in 1886, but the shipments were small until 1907. In 1917, owing to war conditions the value reached just short of two million dollars. The first few years it was utilized principally as a source of CO_2 gas, but later for Sorel, or plastic cement and as a refractory.

In her list of gem stones, California has had an interesting history, both mineralogically and commercially. Diamonds were early recognized and recovered in washing the gold-bearing stream gravels, notably at Cherokee, in Butte County, Volcano in Amador County, Smith's Flat in El Dorado County, and French Corral in Nevada County. While mostly small, a number have been over two carats in weight.

Kunzite, a gem variety of spodumene, was first found at Pala in the tourmaline district of northern San Diego County. It has thus far been found in only one locality (Madagascar) outside of California. California's tourmalines are decidedly distinctive in coloring and 'fire' as compared to foreign stones of this classification, the colors ranging from deep ruby to pink, and various shades of green, as well as a blue variety (indicolite).

One of our California gem stones, benitoite, has not been found elsewhere, and in but a single locality here: The Dallas Mine in San Benito County. It is a barium-titanium silicate ranging from colorless to deep blue; and when discovered was thought to be sapphire, but analysis proved it to be a new mineral. Crystallographically it is also interesting in that it is the lone representative of the ditrigonal bipyramidal class of the hexagonal system. Prior to the discovery of benitoite, this crystal class had been projected theoretically by mathematics in accordance with the laws of symmetry.

Beryls of delicate but excellent colors are also obtained in the Pala district, San Diego County, of which the aquamarine (blue) and morganite (pink) varieties deserve special mention. Morganite, like kunzite, has thus far been found elsewhere only in Madagascar. Stones of precious blue topaz of fine quality are being cut from crystals mined in northern San Diego County, being associated with beryl and blue tourmaline.

A small production of tin was made in 1891-1892 and 1928-1929 from the occurrence of cassiterite (the tin oxide) associated with black tourmaline in the Temescal Mine, near Corona, Riverside County.

Common table salt has many other industrial uses besides those that are culinary. In California the bulk of the production, which averages over a million dollars value annually, is obtained by solar

evaporation of Pacific Ocean water. Some is obtained from crystalline deposits in the desert region. From the sea-water plants, by-product magnesium salts (chloride, carbonate, sulphate) and bromine are obtained from the residual bitterns. Iodine is recovered from the saline waters of certain deep oil-wells in the Long Beach area, Los Angeles County.

Aside from those minerals of economic interest and value, some of which are noted in the foregoing paragraphs, California has quite a number that are of mineralogic and scientific interest. Of these, lawsonite (a calcium-aluminum silicate) has already been mentioned.

Troilite, the simple ferrous sulphide, FeS, not previously known except in meteorites has been found and described from northeast of Crescent City, Del Norte County.

We stated that the saline lake deposits of the desert region have accounted for 18 of California's new mineral species. In chronological order they are:

Tincalconite	hydrous sodium borate.
Colemanite	hydrous calcium borate.
Hanksite	a double sulphate and carbonate of sodium with potassium chloride.
Sulphohalite	sulphate, chloride and fluoride of sodium.
Northupite	magnesium carbonate with carbonate and chloride of sodium.
Pirssonite	hydrous carbonate of calcium and sodium.
Bakerite	hydrous calcium silico-borate.
Tychite	carbonate of sodium and magnesium with sodium sulphate.
Inyoite	hydrous calcium borate.
Meyerhofferite	hydrous calcium borate.
Searlesite	hydrous sodium boro-silicate.
Vonsenite	iron and magnesium borate.
Kernite	hydrous sodium borate.
Probertite	hydrous sodium and calcium borate.
Krausite	hydrous iron and potassium sulphate.
Schairerite	sodium sulphate with sodium chloro-fluoride.
Burkeite	double sulphate and carbonate of sodium.
Veatchite	hydrous calcium borate.

Zircon (zirconium silicate) is a common accessory mineral in the acid eruptive rocks, especially granites and syenites. The concentrates from the gold-placer washings and the black sands generally carry some zircon crystals or grains. It was not, however, until the past year that a sufficient quantity has been found present to permit an economic recovery. Zircon sand is now being obtained in commercial quantities in the sluice boxes of the Kaufield dredge, two miles east of Lincoln, Placer County.

Glaucophane, a soda-amphibole rich in alumina and containing little water, is a constituent of metamorphic rocks (particularly schists) high in sodium. Although it is found in many metamorphic regions of the earth, nowhere does it appear to be as common in quantity as a schist as it is in California.

Teepleite is a hydrous sodium borate and chloride. This salt was prepared artificially by John E. Teeple in the course of research work on the Searles Lake, San Bernardino County, brines, and described by him in 1929. When, therefore, in 1937, natural crystals having the same composition were found in Borax Lake, Lake County, associated with trona and halite, the mineral was named Teepleite.

Sanbornite is a white to colorless, translucent silicate of barium, the first simple barium silicate mineral ever found. It was discovered near El Portal, Mariposa County, associated with rose-red gillespite (a rare barium-iron silicate, previously found only as a float mineral on an Alaskan glacier)—and celsian (the barium feldspar, this being its first reported occurrence in the United States). Sanbornite was named for Frank Sanborn, mineral technologist of the State Division of Mines, who made the first qualitative tests on a sample sent in to the laboratory of the division.

The mineral hanksite, a double sulphate and carbonate of sodium with potassium chloride, was named for Henry G. Hanks, the first state mineralogist of California, who occupied the office during the years 1880-1886, inclusive. It was discovered at Searles Lake, San Bernardino County, and later described by Hanks as occurring also, with borax, in the sinks of Death Valley, Inyo County.

Durdenite, a rare hydrous ferric tellurite, though originally discovered (1890) in Honduras was named for Henry S. Durden, for many years curator of the mineral exhibit of the California State Mining Bureau. This mineral was later (1917) identified in a specimen of gold-silver telluride ore from Carson Hill, Calaveras County, in this state.

If one seeks for an explanation of why California has such an abundance and diversity of minerals both of mineralogic and economic interest as well as value, the answer is obtained in a perusal of the geologic map of the state. The formations found in this area run practically the entire gamut of the geological ages from Archean to the present, of igneous, sedimentary and metamorphic rocks. Other states may have more of a given age or era, but few if any can surpass California's diversity. Then, too, being second only to Texas in surface area, we have a lot of territory in which to work.

SUBMARINE CANYONS OFF THE CALIFORNIA COAST*

FRANCIS P. SHEPARD**

During the past decade there has been an enormous increase in information about the form and general character of the ocean bottom, particularly off the coast of California. With the help of the new scientific devices and a well-formulated plan the United States Coast and Geodetic Survey has produced charts in recent years which, in addition to their navigational value, open up a new realm for scientific speculation.

Not long ago when a captain of a vessel was sent to make a survey in deep water out of sight of land, he was confronted with two serious obstacles. In the first place if the depths were of the order of a mile or more he would have to stop his vessel and spend at least an hour lowering a lead weight attached to piano wire to the bottom and reeling it in again. Having determined the approximate depth by the amount of wire let out, he put this depth on the chart at the position which he thought he was occupying. However, a navigator of a vessel out at sea generally has a pretty inadequate knowledge of his exact position. If it is clear weather at twilight, he can find out where he is within half a mile, and perhaps within five or ten miles during the day time, but except when he can get good radio bearings near shore his position is very uncertain in cloudy weather despite all records of his course and speed. For these reasons the soundings recorded during early surveys were subject to considerable inaccuracies of position.

Now a marine surveyor is confronted with an entirely different situation. He does not have to stop his vessel even to make deep soundings. He simply turns on his echo sounding machine, which sends out sound impulses, and he watches the flashes of light on a dial which indicate the return of the sound from the bottom. An accurate timing device gives the depth by measuring the elapsed time between the sending out of the sound and the return of the echo. Furthermore, he may obtain his position a hundred miles or more from land by dropping bombs overboard at regular intervals and recording the time between the explosion of the bomb and the receiving of radio flashes indicating the arrival of his sound at known positions.

These new methods have made possible the extension of our knowledge of submarine topography down to depths of a mile or even two miles below the surface of the ocean for scores, and in some areas hundreds of miles out from the coasts of the United States. The entire coast of California has been explored this way out to depths of 12,000 feet. Furthermore, these methods have shown the way to obtain future surveys of the entire ocean basins and already many echo-sounding lines have been run across the Atlantic and the Pacific.

NEW DISCOVERIES OVERTHROWING OLD IDEAS

Geologists and geographers were familiar with some of the features of the sea floors. They knew, for example, about the broad, shallow

* These submarine canyons are shown on the "Geomorphic Map of California," which is an inset on Sheet III of the Division of Mines' new "Geologic Map of California," prepared by Olaf P. Jenkins, 1938.

** Scripps Institution of Oceanography and University of Illinois.

"continental shelves" extending out from the shores towards the deep ocean basins. Also they were aware that there were a few valleys in these shelves and slopes and one finds references to these features with terms such as "submarine gulley" implying the insignificant role which was formerly applied to them. Beyond these items of knowledge the scientists delved into speculation. They assumed that the continental shelves were largely great embankments of sediment built out from the lands by the undertow of the waves. These shelves were supposed to have coarse sediment inside, such as gravel and sand, and outside the sediment was said to grow finer and finer till "the outer portion was covered by mud alone." Beyond the continental slopes the deep floor of the ocean basin was described as "—in general, monotonously level," or as "—so nearly flat that the eye would not detect its departure from planeness."

With such a picture as this it is no wonder that geologists formerly took very little interest in the oceans. But this is not the right picture. The results of the new surveys and of the investigations which several of us have been carrying on recently have shown that instead of the great banks of fine continental detritus out on the outer shelves there are extensive areas of rock bottom and much sediment as coarse or coarser than that along the coasts. For example, off California there are numerous fishing banks with covering of sand and gravel. Also, instead of a flat ocean bottom we are finding one that is decidedly irregular with less conspicuous plains than on the land surface.

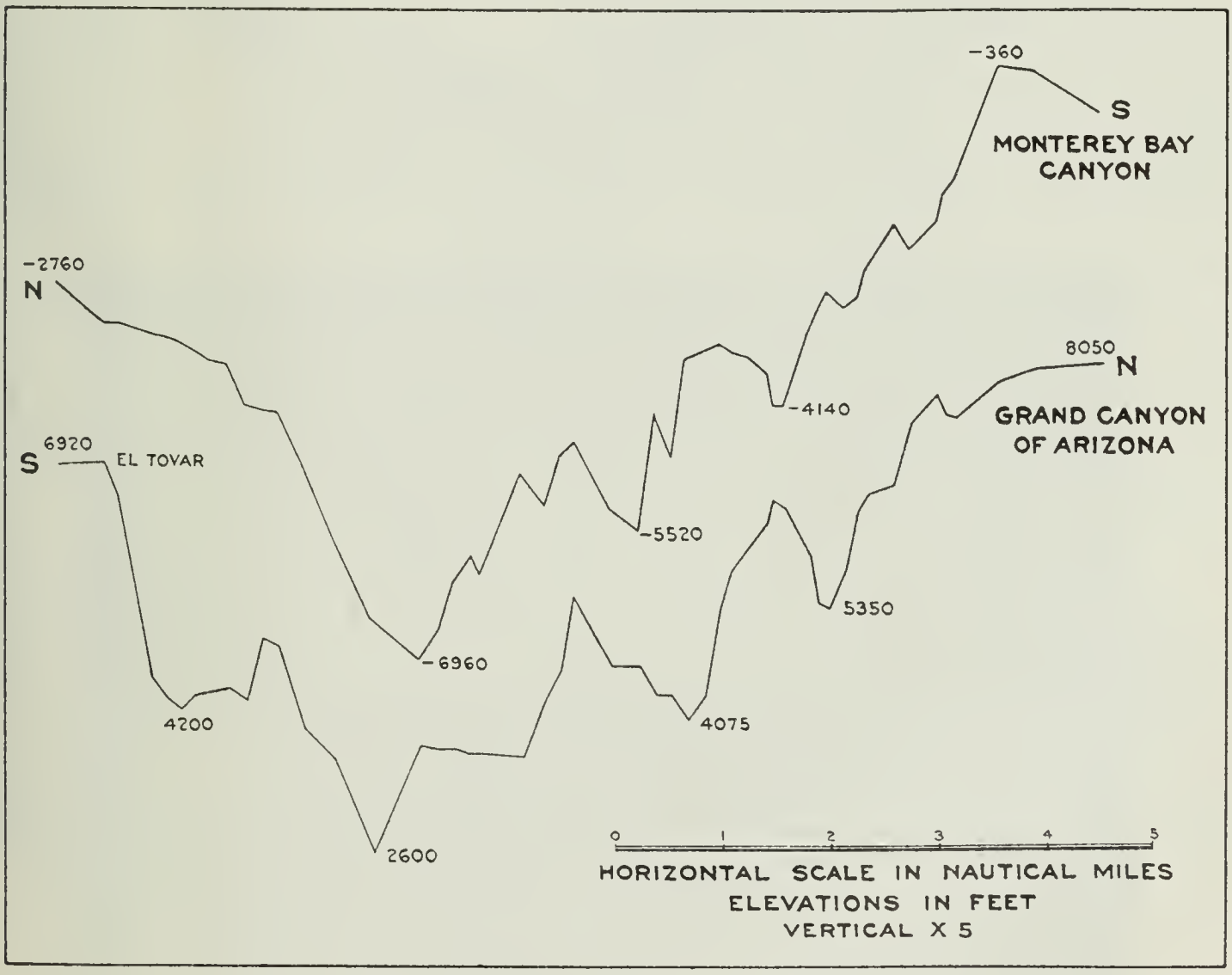


FIG. 1. Profiles showing a comparison between the Grand Canyon and a section across Monterey Submarine Canyon. The same scale and same number of observations used for the construction of each section.

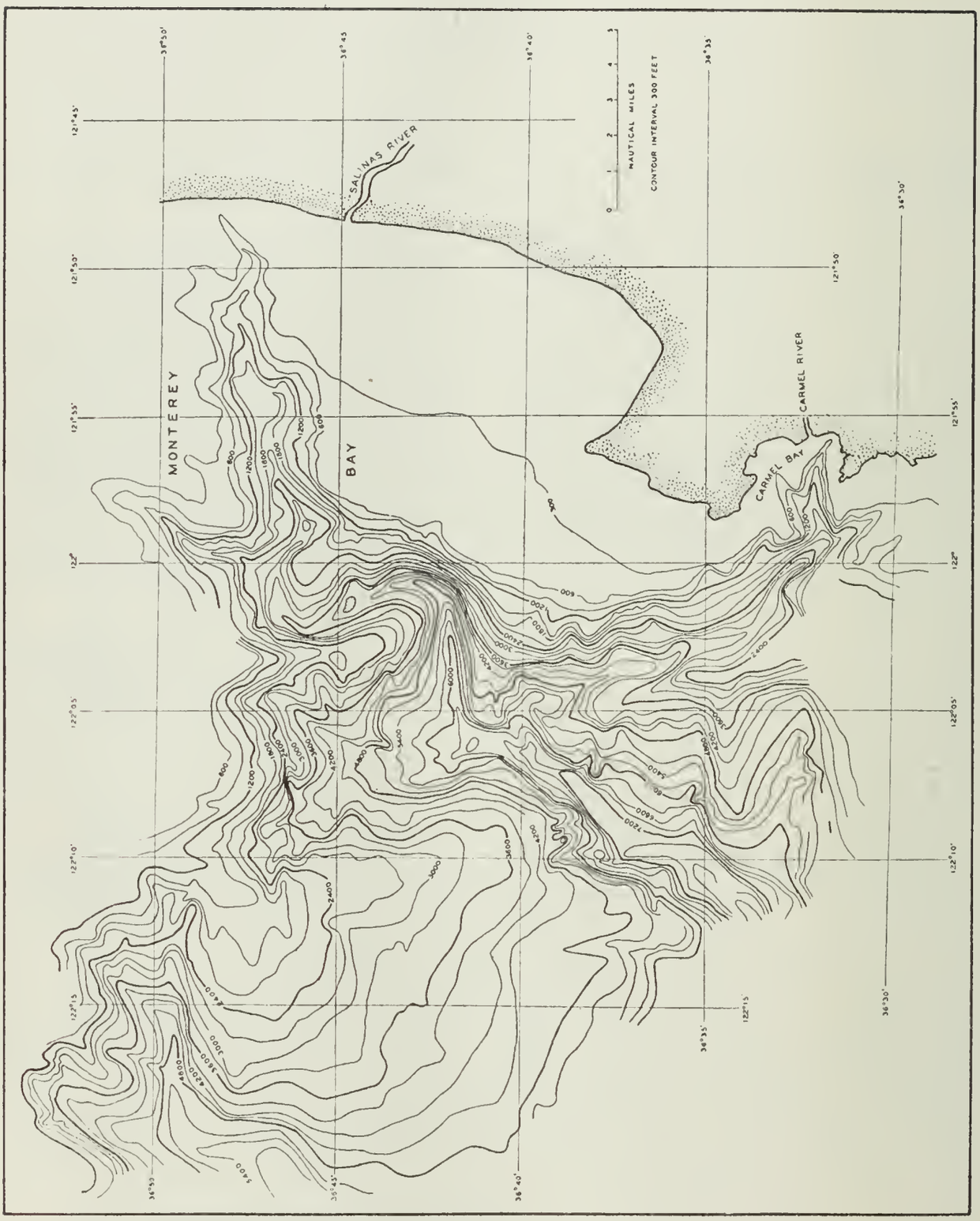


FIG. 2. Contour map of Monterey Canyon showing also the tributary coming out of Carmel Bay and joining the Monterey Canyon.

GREAT MARGINAL ESCARPMENTS

The continental slopes connecting the shelves and the deep ocean floor have been practically undescribed by scientists although one might easily have inferred that if built of great banks of sediment, as claimed by geologists, they would be relatively smooth like the submerged fronts of deltas. In contrast to deltaic foreslopes, we are finding in most places jagged irregular topography comparable to that of the greatest of land escarpments. It is probably correct to say that if we could view the world devoid of its oceans from the surface of the moon the feature which would impress us the most would be these great marine slopes from 5000 to 30,000 feet high. Including the slopes of bordering mountain ranges, which would merge with the continental slopes, a maximum declivity of 40,000 feet would be seen off parts of the Andes on the west coast of South America.

CALIFORNIA SUBMARINE CANYONS

If from an hypothetical lunar observatory we could examine these exposed continental slopes through a high-powered telescope we would see numerous great canyons cut into their upper portions. The canyons off the California coast would impress us particularly. Turning the telescope to the western slope of the Sierra Nevada we would be impressed by the remarkable similarity between the canyons of the oceanic margins and those of the land.

Coming down to the earth's surface while the ocean remained conveniently withdrawn from its basins, we could look more closely at these exposed canyons. Supposing we drove out onto Monterey Peninsula in California along the "17 mile Drive," stopped at Point Pinos, and walked north for three miles over the continental shelf. We could then look down into one of the greatest canyons on the earth's surface.

FIG. 3. A small harbor at the head of Carmel Canyon.

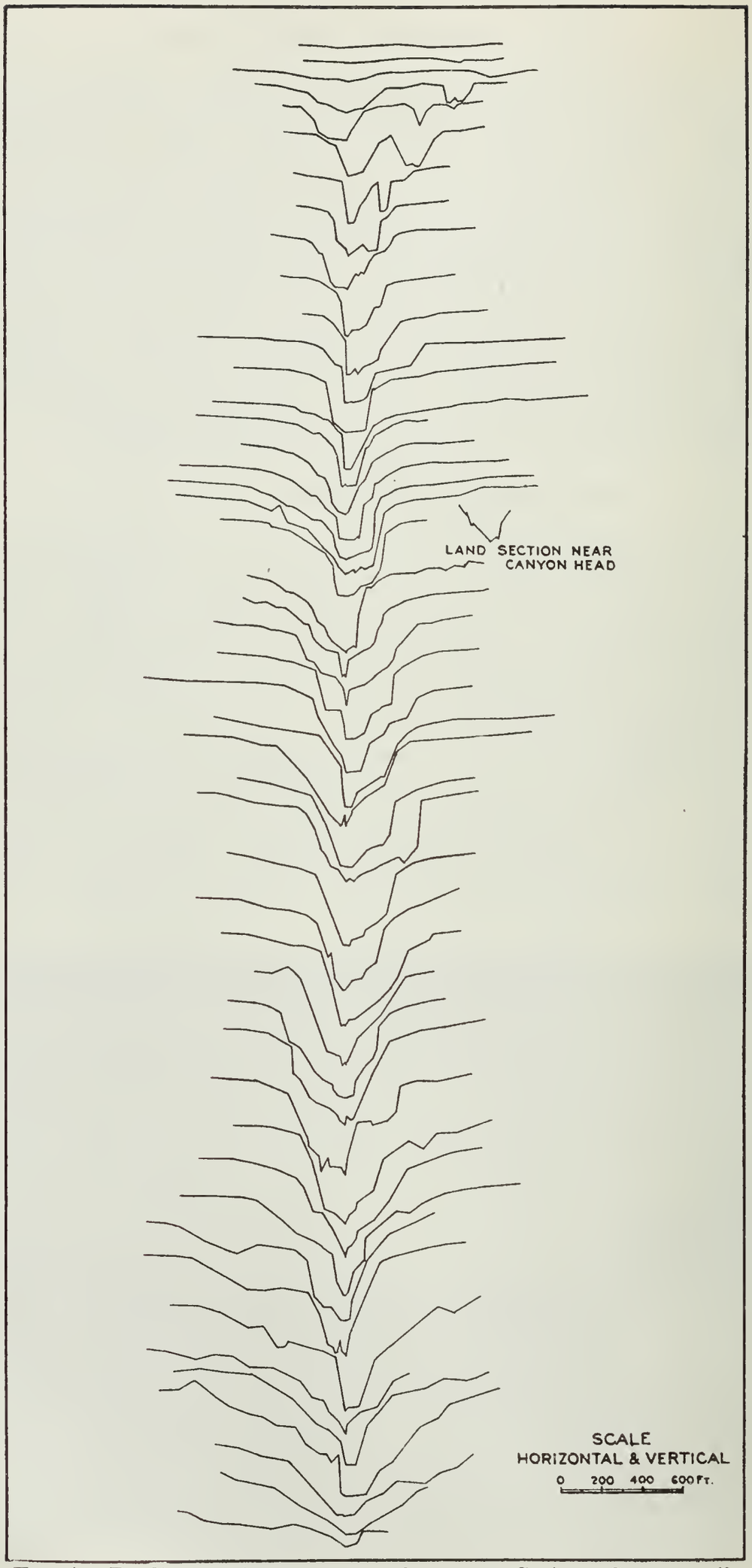


FIG. 4. Profiles made to true scale across Scripps Canyon off La Jolla, California. Note the comparison with the small land canyon.

We could see its floor 7000 feet beneath us and looking beyond we could see the other wall of the canyon rising 5000 feet. The width and vertical dimensions would compare with those of the Grand Canyon (fig. 1). Further to the left we could see a large tributary canyon winding into the main canyon and coming from the direction of Carmel Bay (fig. 2). Walking south along the brink of this tributary canyon we would find that it sent one branch so far up into Carmel Bay that it all but touched the beach at the north end of Point Lobos State Park (fig. 3).

Next, if we flew south in an aeroplane along what is now the coast of California we would pass a number of rocky canyons with a maze of tributaries coming into them. Then we would pass a zone with a gentle continental slope where only shallow valleys exist, but after rounding the corner at Point Arguello and flying over Santa Barbara we would see another series of canyons which cut the short, steep continental slopes at close intervals all the way to San Diego. We could stop appropriately at the Scripps Institution of Oceanography at La Jolla. There we could walk out over a gentle slope for half a mile and come to a stop at the edge of an abyss which would be more striking than anything we would have seen hitherto on this exposed ocean bottom. We could approach the edge cautiously and look over an almost vertical 600 foot cliff to a rocky chasm beneath, which would be so narrow we could almost throw a stone across to the platform on the other side (fig. 4).

EAST COAST CANYONS

At this juncture we might begin to wonder whether the sea bottom canyons were confined exclusively to the California coast. We could again get into our aeroplane, and this time head across country to have a look at the exposed western rim of the Atlantic. Arriving at Newport News we could fly out across the shelf to a position from which we could see the continental slope. Here again we would be greeted with the view of large canyons and as we continued northeast along the slope we could see more canyons, at first rather widely

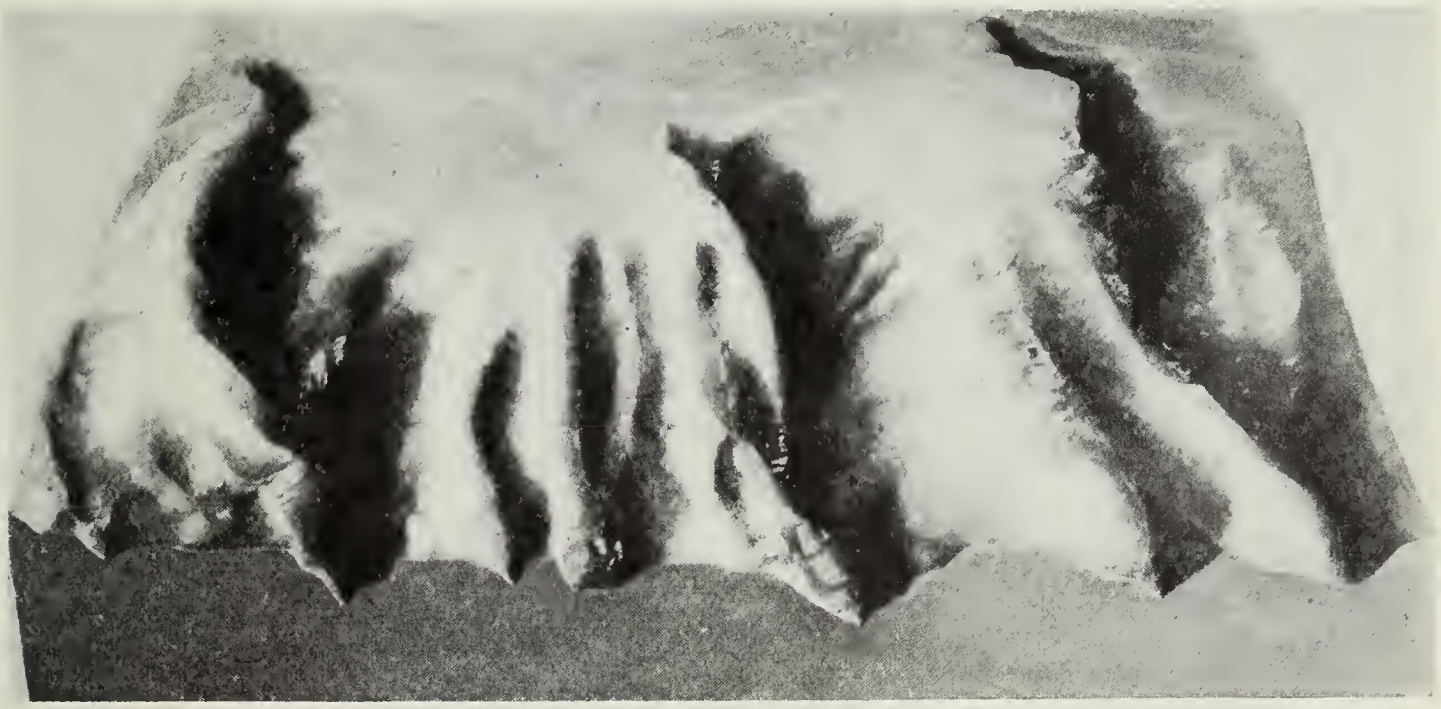


FIG. 5. A model of canyons off the New England coast. Each of these has been cut thousands of feet below the surrounding slope.

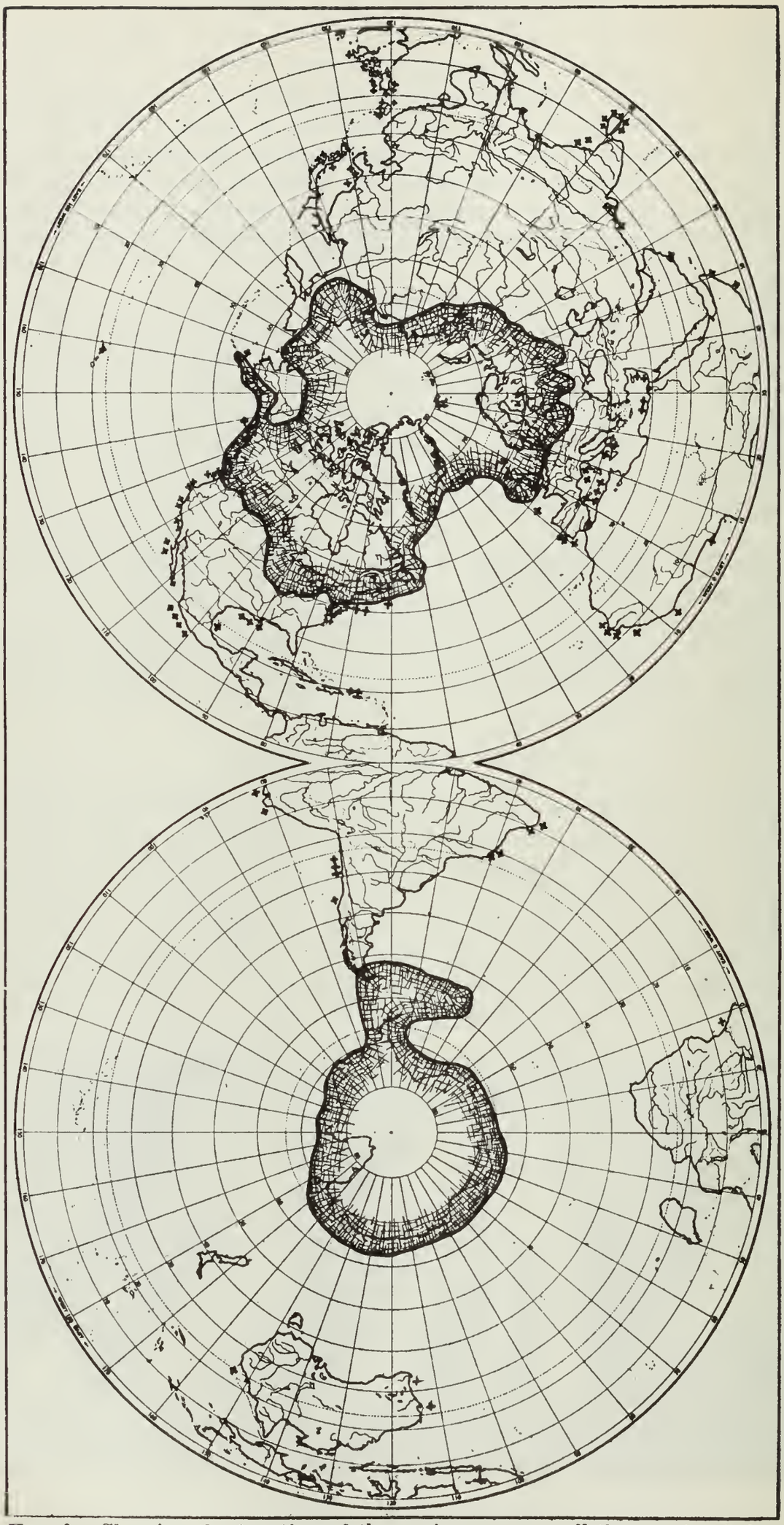


FIG. 6. Showing the location of the major canyons off the coasts of the world. Each cross indicates a canyon or a group of canyons. Shows also the hypothetical extent of the Pleistocene ice caps at the north and south poles which might account for a lowering of sea level of thousands of feet.

spaced and then coming close together till off Georges Bank (the fishing area off Cape Cod) we could find a series of canyons as closely spaced as any we had seen off the California coast. Nor would these east coast canyons appear small in comparison with those off California (fig. 5). Many of them could be found which were cut thousands of feet into the slopes and at least some of them would reveal extremely steep walls with cliffs of rock outcropping on the sides.

CANYONS OF THE OTHER COASTS

The picture which has been given above of the canyons off parts of the coasts of the United States could probably be duplicated off most of the other coasts of the world. Soundings are not as numerous off these other coasts, so that the canyons are only roughly outlined except where they come in close to the shore, and probably many have not yet been discovered. The problem which confronts us is to find an explanation for these marine canyons (fig. 6).

FIG. 7. The Yosemite Valley—a typical U-shaped valley such as is produced by ice erosion.

COMPARISON WITH LAND VALLEYS

During the past century geologists fought out the problem of whether the great valleys of the land such as the Grand Canyon were cut by streams or whether they were the result of disruption of the earth's crust. This problem was finally settled and now scientists are agreed that most of the valleys of the land have been carved by running water, although certain ones have been shaped by ice and still others are largely the result of crustal movements. There are, however, definite characteristics which show that valleys have been cut by ice, as for example, the U-shaped Yosemite Valley (fig. 7). Likewise the long straight valleys with steep walls and broad floors sometimes extending below sea level, such as Death Valley in California (fig. 8), or the Dead Sea Valley in Palestine, are known to have been formed by the sinking, or down-faulting, of blocks of the earth's crust. This faulting is a process which is still in evidence as witnessed by the occasional earthquakes. On the other hand, the winding V-shaped canyon

(fig. 9), which is the most common type of valley in mountain slopes and in the escarpments of the edge of great plateaus is unquestionably the result of the work of running water. The submarine canyons clearly resemble this last type of land valley.

FIG. 8. A view of Death Valley showing the broad floor which characterizes fault valleys.

FIG. 9. A typical V-shaped valley such as is produced by stream erosion.

PERPLEXING SITUATION

Since these ocean bottom canyons are the counterparts of the river-cut land canyons, it is natural to suppose that they must also have been cut by rivers. This idea, however, cannot be accepted without realizing some of the difficulties with which it is confronted. Rivers lose their power where they enter the ocean, so that in order to excavate canyons below the present sea level, they must have flowed over continental margins which stood relatively much higher than they do now. Furthermore, this change of level of many thousands of feet which brought the canyons into their present submerged position would appear to have been a comparatively recent occurrence since the canyons are not filled to any extent with the sediment which is being constantly washed towards them from the lands. Also, the formations off the California coast through which these canyons have been cut are known to be among the most recent of geological history. The coasts inside most of these California submarine canyons, however, are relatively straight, quite different from the great irregularities which would develop as a result of the penetration of the sea into the valleys of a subsiding coast. Finally, the canyons are found most profusely off coasts such as California, where there is much evidence of a rising of the land in relation to the sea rather than of sinking.

SUBMARINE CURRENT ALTERNATIVE

Some geologists, appreciating the difficulties accompanying the above explanation of the origin of submarine canyons, have looked around for other explanations. Alternatives have been proposed mostly by men who had not had the opportunity to observe all of the recent accumulation of data concerning the character of the canyons. A few scientists suggested that submarine faulting had been the cause, but the shapes and trends of the canyons are so obviously unlike land fault valleys that this idea is not taken seriously at the present time. A more likely possibility comes from the suggestion that powerful submarine currents have excavated the canyons. The currents have been variously attributed to the subsurface return of the water driven into bays by violent storms; to the moving down the continental slopes of heavy mud-laden currents; and to the sub-surface counter current set up by outward moving surface water at the mouth of a river.

OBJECTIONS TO CURRENT EXCAVATION

It happens that submarine currents have not been studied very much as yet, but such information as is now available is emphatically in opposition to the idea that the enormous submarine canyons may have been caused by anything of this nature. Observations of the currents in several of the canyons have shown that they are very feeble or non-existent. The collection of water samples from the canyons shows that the dynamics of the situation would make strong currents highly improbable. Furthermore, ocean currents commonly move most vigorously along the shores and yet practically all of the canyons extend out almost at right angles to the coast. Finally, currents are known to have a scooping action on the bottom leaving large, oval depressions and the soundings have not revealed such

features on the bottom of the canyons. Certainly unless more information can be obtained in favor of currents we must discard this idea as the cause of these gigantic marine features.

MUD FLOWS KEEPING THE CANYONS OPEN

Since currents do not promise to be a solution to the problem of explaining the canyons, we ought to see whether the objections confronted by the river erosion hypothesis are insurmountable. In the first place much of the difficulty hinges on the implications of recent submergence. To be sure the rocks on the canyon walls are young enough in some cases to suggest that they were cut during the Quaternary or within the last million years (which is fairly recent in a geological sense), but the unfilled condition of the canyons may not mean that they are much less than a million years old provided that the canyons have been kept open by some process. As has been mentioned, mud is being deposited on the canyon bottoms. If we take the same sort of saturated mud and place it in a trough and give the trough sufficient slope, the mud will flow out; and the greater the accumulation of the mud the less inclination will be necessary to produce that flow. The canyons with their rocky sides represent a trough and their steep outward slope provides the gradient for this flow.

GREAT CHANGES OFF THE JAPANESE COAST

The Japanese earthquake of 1923 which destroyed most of Tokyo and Yokohama was accompanied by a phenomenon which was unique in the annals of the sea. A re-survey of Sagami Bay, which was adjacent to the zone of destruction, showed that there had been enormous changes of depth with deepening that may have been as much as 1,000 feet. This deepening was so much greater than any observed change of elevation due to faulting during an earthquake on land that it caused much surprise. It happens, however, that the change was in a large submarine canyon. It is easy to understand how an accumulation of mud, probably supplemented to a great extent by volcanic ash and even lava flows, could have been given sufficient impetus during the earthquake to start a mud flow down the canyon floor and out towards the great Tuscarora deep. The Grand Banks earthquake off eastern Canada produced a similar effect, only in this case the depth changes could not be determined, but the breaking of cables over a wide area was clearly the result of great submarine mudflows. Cable companies are frequently troubled by this process and in many cases the sliding takes place in submarine canyons.

COAST STRAIGHTENED SINCE SUBMERGENCE

If the canyons have been submerged for a considerable length of time and have been kept open by mudflows, the straightness of the coasts inside is no longer hard to understand. We know that waves and currents are quite capable of straightening coasts by cutting away headlands and building bars across the mouths of bays. Furthermore, the straight coast of California shows upon examination that it has blocked and partially filled remnants of estuaries, some of them opposite the submarine canyons.

CHANGE OF SEA LEVEL

The chief remaining difficulty with the river valley explanation is that the canyons are so universal, being found both off stable and unstable coasts and even off coasts where considerable uplift is thought to have occurred. It is not easy to develop a satisfactory explanation for this difficulty, but there may be one way out of the dilemma. Crustal movements are found to be different in different places, whereas changes of sea level produce worldwide results. Therefore, is it not a sea level change with which we are dealing? If the ocean had been lowered several thousand feet the rivers of the lands would have flowed out over the continental shelves and would have cascaded down the steep continental slopes beyond, cutting rapidly into the relatively soft sediments of this outer zone. Then a rise in the sea level would have drowned these canyons. Nor would it be necessary that the sea level be lowered to the extent of the greatest depths of the canyons because the removal of the weight of water from the ocean would have caused a bulging of the sea floor along the oceanic margins. Also the submergence of canyons along many coasts due to crustal movements may have been going on for many millions of years and the lowering of sea level would have allowed the land streams to flow into the upper end of these canyons, connecting them with the present coast or with the outer edge of the present continental shelf.

A CAUSE FOR SEA LEVEL LOWERING

A still more difficult problem is to explain the lowering of sea level which seems necessary. We know that beyond all reasonable doubt the interior of the earth is solid, so that water could not be drawn into the earth and then returned. The ocean bottom might sink, pulling the water down with it and then rise bringing up the sea level, but the magnitude of such a movement would have to be enormous. For example, if a million square miles of the ocean floor should sink 6,000 feet (which would be comparable to some of the greatest movements which we know have occurred on the lands within a similar period) the sea level would be changed only 34 feet. Furthermore, the movement would have had to have been reversible and we know of no reversible movement of such magnitude in anything like such a short time in earth history. To make matters worse the sinking of the entire ocean would have drowned the oceanic islands and we find that the islands show evidence of having been effected by this sea level change, particularly the coral islands with their submerged reefs.

GLACIERS AND SEA LEVEL CHANGES

It seems not unlikely that the lowering was the result of an actual extraction of water from the ocean. The air could hold only the equivalent of a few feet of ocean water in addition to its present load. However, the ocean could be piled up on the land in the form of ice. It has been suggested that during the glacial period the great continental glaciers contained enough ice to be the equivalent of about 300 feet of ocean water. Such estimates have been made with considerable conservatism. There were several glacial epochs and it is

possible that the glaciers during one or more of the early epochs may have been much more extensive than commonly estimated and also much thicker. The ice, for example, may have covered the entire polar sea as a great ice dome with a thickness of four miles or more. There seems to be no particular reason for doubting such a possibility. If the ice covered the area indicated in figure 6 and had an average thickness of four miles it would have lowered the sea level 3,000 feet and would have thus allowed the cutting of most of the known canyons of the continental slopes. It is even possible that the ice sheets were still larger and thicker so that a lowering of as much as 6,000 feet may have occurred. There are canyons, however, that go to still greater depths. The bulging at the oceanic margins, referred to previously, which would accompany a lowering of sea level may account for those deep canyons. However, much work remains to be done before a thoroughly satisfactory explanation can be given.

A FERTILE FIELD FOR RESEARCH

Since we have been spending millions of dollars every year in trying to find out about the distant stars which under the highest powered telescopes are mere pin points of light, it would seem to be time that we started to investigate some of the truly startling features of the virtually unknown territory of our own planet. Here is a field the exploration of which holds remarkable possibilities. Furthermore, it is not going to be very long before we can actually go down and move around over the canyons and mountains of the ocean bottom, seeing them with our own eyes. Great bathospheres with arms for propulsion on the bottom are already being constructed by diving companies for the purpose of regaining treasure from the bottom. Soon we may hope to have a look at some of the remarkable scenery of the ocean floor. There is no place in the world better fitted for such exploration than off the California coast.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

8—62700

THE MOUNTAIN COPPER COMPANY, LTD. CYANIDE TREATMENT OF GOSSAN

By Chas. Volney Averill, Mining Engineer

Introduction.

This division published an article[1] in 1931 describing cyanide treatment of gossan as then practiced by The Mountain Copper Company, Ltd. The block of 550,000 tons of ore described in that article has been mined. It was comparatively of good grade, easy to mine, and easy to treat. However the plant has been kept in continuous operation since 1931 at an average capacity of roughly 600 tons per day until recent additions were made. Development of additional ore to make this possible has introduced many problems, one of which was an increase of natural clay in the ore, which caused trouble from channeling in sand-percolation tanks. To solve this problem, the plant has recently been remodeled at a cost of approximately $100,000 to provide separate treatment for sand and slime. Capacity has reached nearly 750 tons per day and may be increased. Recovery of gold has been greatly improved, being now over 95 per cent.

Acknowledgments.

Wm. F. Kett, 351 California Street, San Francisco, is general manager of the company, and L. T. Kett is assistant manager. At Iron Mountain (post-office address: Matheson) J. G. Huseby is general superintendent and D. L. King is mill superintendent. The writer is indebted to these officials for the information on which this article is based.

Photograph 1. Cyanide plant, The Mountain Copper Company, Ltd.

[1] Averill, C. V., The Mountain Copper Company, Ltd., Cyanide Treatment of Gossan, California State Mineralogist's Report XXVII, pp. 129-138, 1931.

History.

The property is one of the oldest on the Shasta County copper belt. It was discovered in the early sixties; and The Mountain Copper Company, Ltd., of London, England, purchased it on January 1, 1897. In addition to being at one time among the largest copper producers of the world, the company has produced sulphuric acid, fertilizers, gas purifier and bluestone. A smelter (now dismantled) was operated at Keswick; and there is another at Martinez. In addition to the cyanide plant at Iron Mountain, the company operates the Hornet mine, a producer of pyrite, and the Big Canyon gold mine near Shingle Springs, El Dorado County. The location of the Shasta County property is in Sec. 34, 35, T. 33 N., R. 6 W., M. D. M., 17 miles northwest of Redding. A railroad station on the main north-south line of the Southern Pacific at Matheson serves the property.

The ore formerly treated was a typical reddish-brown gossan, largely porous oxides of iron remaining from the leaching by surface waters of a body of iron and copper sulphides. The weight was about 100 pounds per cubic foot, and about 0.4% copper remained in it. Most of the ore now being mined has much the same appearance, but it has been derived from original sulphide ore in which the country rock was not so completely replaced by sulphides. Hence it is higher in silica and lower in gold and copper content. Present copper content after oxidation and leaching by surface waters is only 0.2%. Natural (primary) slime content goes nearly as high as 40% in some blocks. There is a small content of mercury, which appears in the precipitate, and a little arsenic.

Exhaustive tests on the amenability of this ore to cyanide treatment, made before the original plant was built, were described in some detail in the earlier article, and these descriptions are not repeated here.

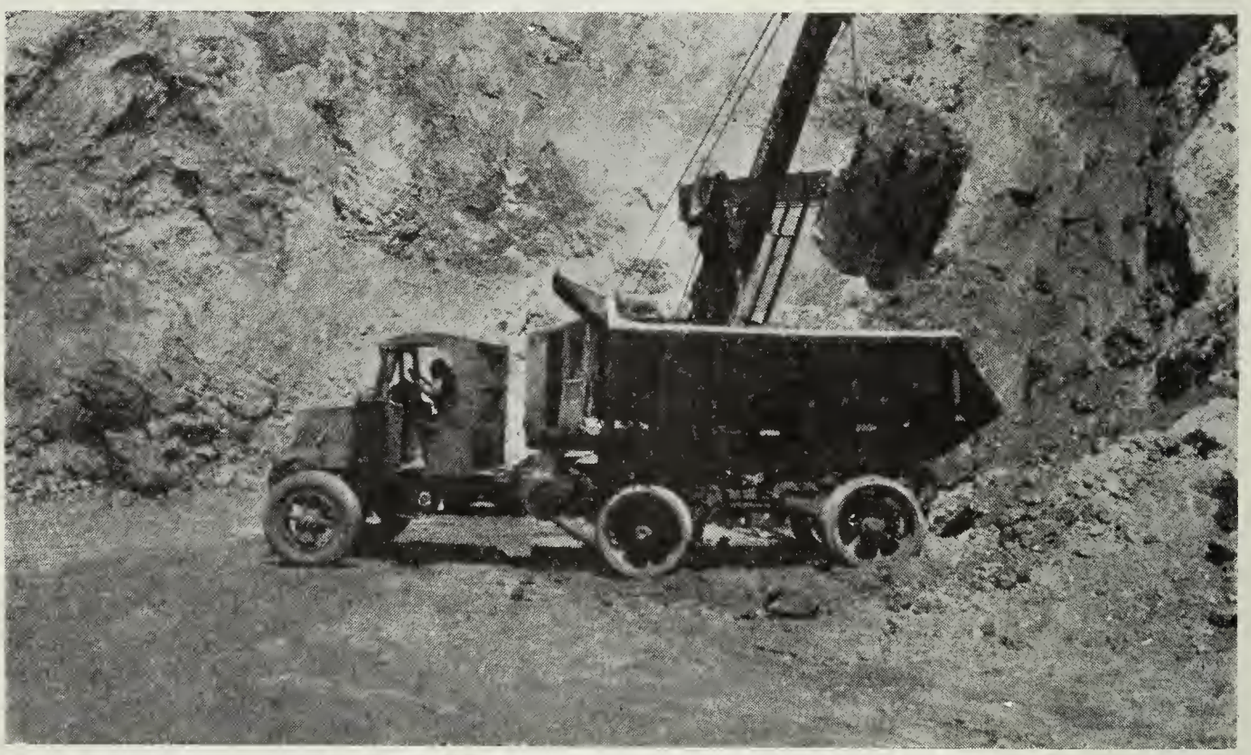
A few alterations were made in the plant prior to the recent addition of slime treatment. Two additional tanks were added for sand-percolation, but these have now been converted to Dorr agitators, and 10 tanks are left for sand-percolation as before. Secondary crushing in the original plant was done with rolls. In 1931, the same hammer-mill that is now in use was installed to take oversize from the vibrating screen. It reduced the ore from 1-inch to $\frac{1}{4}$-inch in size, and was in open circuit with the sand-percolation tanks. To keep the impact-side of the hammer-mill clear of lumps of clay, a revolving breaker drum was installed. This was built like an ordinary roll with a replaceable shell of tool steel. At the present time cyanide solution is fed to the hammer-mill and the revolving breaker drum is no longer needed.

Mining.

Since 1931, heavier equipment has been put in service in the quarry. The main reason for this is that for several years an average of three tons of overburden has been moved to each ton of ore mined. Hence mining costs have increased. The various benches of the quarry now extend from an elevation of 2600 ft. above sea level to about 3300 ft., or for a vertical height of roughly 700 ft. Two shifts of men work in the quarry. Overburden is stripped and some ore is hauled on the day shift, and ore is mined at night.

Mining equipment now includes the following power shovels: ¾-cu. yd. electric, No. 1030 Bucyrus Erie; No. 37B Bucyrus Erie equipped with a 1¾-yd. bucket and driven by a D13000 Caterpillar diesel engine; No. 101 Lima with a 1¼-yd. bucket and driven by a Wisconsin gasoline engine; Model 6 Northwest with 1½-yd. bucket and driven by a Northwest oil engine; ¼-yd. roustabout shovel, which is not used much.

Trucks include four 11-cu. yd. semitrailer AC Mack Bulldog trucks, which carry 16 to 18 tons to a load. They have 40-inch by 16-inch solid tires on both drive-wheels and trailer-wheels, and are equipped with F8 Gar Wood heavy-duty hoists. There are also six 4-cu. yd. AC Mack Bulldog trucks with 18-inch by 24-inch pneumatic tires on drive-wheels. All trucks have chain-drive. A model 50 Caterpiller diesel bulldozer is in use, and an RD8 diesel angledozer. An AC Mack truck is used as a sprinkler and two AB Mack trucks for hauling fuel-oil. A road-grader is provided also.



PHOTOGRAPH 2. Truck and power shovel in gossan quarry.

At present a J12 Le Tourneau Carryall of 14-cu. yd. capacity is being rented; also a three-tooth heavy-duty rooter. The Carryall is drawn by a D8 Caterpillar diesel tractor. Work with this outfit is new, and consists of mining marginal ore at the top of the quarry. Ore is hauled to the edge of the bench by the Carryall, and is then pushed over the edge with a bulldozer. It drops to a lower bench, where it is picked up by a power shovel.

As the method of mining is undergoing changes and a description of present methods probably would soon be out of date, no further details of mining methods or mining costs are given here.

Crushing and classification.

Ore is dumped by trucks on a grizzley with 10½-inch openings set over two storage bunkers each 38 ft. by 16 ft. by 20 ft. high. Beneath

PHOTOGRAPH 3. Carryall and tractor working on top bench of gossan quarry.

each bunker is a Link Belt reciprocating feeder, three-chute type, feeding Stephens Adamson pan-conveyors. The feeders are regulated by changing the throw of eccentrics. Each is powered by a 7½-h.p. motor. Each pan-conveyor is powered by a 5-h.p. motor. The one under No. 1 bunker is 40 inches wide and travels at 8 ft. per minute, the one under No. 2 bunker is 32 inches wide and travels at 30 ft. per minute. Each has a capacity of 100 tons per hour, but they are not used at maximum capacity.

Pan-conveyors are on either side of a grizzley over the crusher, and both discharge on this grizzley. Oversize is crushed in a 15-inch by 36-inch Universal crusher of a modified Blake type, driven by a 50-h.p. motor through a 10-rope Allis Chalmers V-belt drive. Undersize from the grizzley and crusher product join on a 30-inch conveyor, 36 ft. long between pulley-centers. This is called No. 2 conveyor. It travels at 260 ft. per minute and is driven by a 5-h.p. gear-motor. Suspended over it to pick up tramp-iron is a Dings bipolar, high-intensity magnet energized by 1 kw. direct current at 110 volts furnished by a motor-generator set. No. 2 conveyor feeds directly into the feed-chute of a Jeffrey B3, 24-inch by 36-inch impact pulverizer (hammer-mill). This is a standard rotor-type with a rotor carrying 39 double-ended hammers weighing 12 lb. each. It is driven by a 75-h.p. variable-speed, wound-rotor motor through a 10-rope V-belt drive. Maximum speed of the hammer-mill rotor is 1400 rpm. Hammers are made of a high-silica cast-iron of high tensile strength and both wearing-ends are chilled. This application of the hammer-mill is unique, and is made possible by the friability of the ore. Ore is reduced from 2½-inch size to ½-inch size with a minimum of slimes at a cost of $0.006 per ton. To the hammer-mill is added enough cyanide solution to prevent packing in the machine. This amounts to half a ton of solution to one of ore.

The hammer-mill discharges into a custom-built flight-pug conveyor. The simplex flight section is 6 ft. long and contains a screw 16 inches in diameter with 9 turns in the 6 ft. Following this is a duplex pug section containing two rotating shafts, on which are mounted 12 paddles to each shaft. The shafts are turned in opposite directions at 53 rpm. by a 7½-h.p. gear-motor with shear-pin coupling. The purpose is to break up or digest lumps of clay.

Discharge from the pug-section goes directly to the feed-well of a new turret-type Dorr DSFB bowl classifier for separation of sand from slime. It consists of an inclined (1½ inches to 1 ft.) rake compartment, 33 ft. 4 inches long by 9 ft. wide, containing reciprocating rakes. At the lower end is a circular bowl, 11 ft, in diameter, containing rotating rakes. The bottom of the bowl opens into the rectangular rake compartment. This arrangement provides a double separation of sand and slime. Feed goes into a partially submerged cylinder in the center of the bowl, the sand falls to the bottom and is discharged into the rectangular compartment by the rotating rakes in the bowl. Slime overflows at the periphery of the bowl. Sand is picked up by the reciprocating rakes, and is gradually raked up the incline, where it passes under three different sprays of cyanide solution from perforated pipes extending across this compartment. The last of the slime is thus washed back to enter the bottom of the bowl.

Bowl rakes are normally driven at 4 rpm. by a Reeves variable-speed motor drive-unit of 1½ h. p. Reciprocating rakes are driven at 12 to 24 strokes per minute total for the two rakes by a chain and sprocket drive and 7½-h.p. Reeves No. 2 variable-speed transmission. The bowl is equipped with a 'critical size control' to prevent a certain size of particle from accumulating in the central column of the bowl. It is an air-lift supplied with 80 cfm. of air at 1 lb. per sq. inch pressure by a Roots Connersville blower. It has been found unnecessary and has been disconnected.

Sand treatment.

Sand is well drained of moisture in the upper part of the inclined rake compartment of the classifier, and is discharged by the rakes to the 'C' conveyor. This is a 20-inch belt conveyor, 35 ft. long between pulley-centers, driven at 360 ft. per minute by a 90-rpm. Westinghouse-Nuttall gear-motor of 3-h.p. It is inclined at 18° above horizontal and discharges to No. 3 conveyor set at right angle to it. No 3 conveyor is a 20-inch belt, 100 ft. long between pulley centers, set at an angle of about 10° from horizontal. It is driven at 280 ft. per minute by a 19 to 1 Pacific [2] gear reducer directly connected to a 10-h.p., 1800-rpm., General Electric motor. No. 3 conveyor discharges over a 4 ft. by 5 ft. Link Belt vibrating screen of the counterweight type. Weights in the drive-pulley cause the vibration. This is driven through an endless belt by a 5-h.p. motor with a speed of 1800 rpm. Screen cloth is Tyrod with slots ½-inch wide by about 4 inches long. Oversize is returned to No. 2 conveyor feeding the hammer-mill by a 20-inch conveyor, 125 ft. long between pulley-centers. It is driven at 240 ft. per minute by a 5-h.p Pacific G. E. gear-motor. Circulating load is usually 5 tons to 10 tons per hour depending on the friability of the ore and the clearances in the hammer-mill.

[2] Pacific Gear Works, San Francisco.

Screen undersize is conveyed directly to sand-percolation tanks by a 20-inch conveyor, about 350 ft. long between pulley-centers. It is driven by a 20-h.p. G. E. induction motor through an 18 to 1 speed reducer. This is connected to the drive pulley by a chain and sprocket; also by gears to a tandem-drive pulley. The conveyor belt passes through a Jeffrey self-propelled tripper, which runs lengthwise over the row of 10 tanks used for sand-percolation. These are cylindrical wood-stave tanks, 25 ft. 8 inches inside diameter, with 12-ft. staves. They are arranged in units of five each, one unit handled by the day shift, the other by the night shift. For charging, the tripper is run back and forth over a tank, and the gossan is spread in 3-ft. layers.

Strong mill solution is added as the tank is being charged by a spray on the tripper. This is adjusted so as to keep the belt washed clean of fine sand. Enough solution is thus added so that leaching can start immediately as soon as the tank is full of ore. With the slime removed, such care in filling these tanks with sand as was formerly used is no longer necessary, and only the last 3 ft. of fill is spread by hand.

Of the five tanks in a unit, one is always being filled with ore and a second is discharging tailing. Filter bottoms of these tanks consist of cocoanut matting covered with 10-ounce canvas and 2-inch by 2-inch cleats, six inches apart. The bottoms are washed and cleaned once every six weeks by hosing with water. The leaching cycle includes 72 hours of mill solution ($1\frac{1}{2}$ lb. KCN and 0.4 lb. CaO per ton by titration) at the rate of six tons per hour and 24 hours of mill barren solution (0.8 lb. KCN and 0.4 CaO per ton) at the rate of six tons per hour. At the conclusion of 96 hours of leaching the tank is allowed to drain for discharge of tailing. No water wash is used. Tailing is discharged at about 11% moisture. Four holes, 16 inches square, spaced between the sides of the tank and the center, are provided for discharging tailing. Two conveyor belts run under these, discharging to a cross-belt, which stacks the tailing. Three men discharge a 245-ton tank and clean the bottom ready for the next charge in an 8-hour shift. Four safety ropes hang in the tank for protection during this part of the operation. The roof over the conveyor covers about two-thirds of the tank; and for rainy weather canvas curtains are provided to cover the balance and keep the men dry.

All effluent solutions from the sand circuit run by gravity to a common sump, from which they are pumped to gold solution storage by a 10-h.p., 3500-rpm., Pennsylvania [3] motor-pump, a single-stage centrifugal. All mill solution goes to sand-percolation by gravity. To simplify the accompanying flow-sheet, the 10 tanks for sand-percolation are represented by the two tanks marked 'mill solution sand treatment' and the tank marked 'barren solution sand treatment.' While sand-treatment is a batch process, of the 10 tanks in use some are always undergoing solution treatment as shown. This arrangement results in considerable clarification of all solutions, which thus pass through a sand-tank before entering the gold-solution tank. Main solution lines in this department are 3-inch and 4-inch pipes.

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[3] Pennsylvania Pump & Compressor Co., Easton, Pa., or c/o The Merrill Co., Engineers, 343 Sansome St., San Francisco.

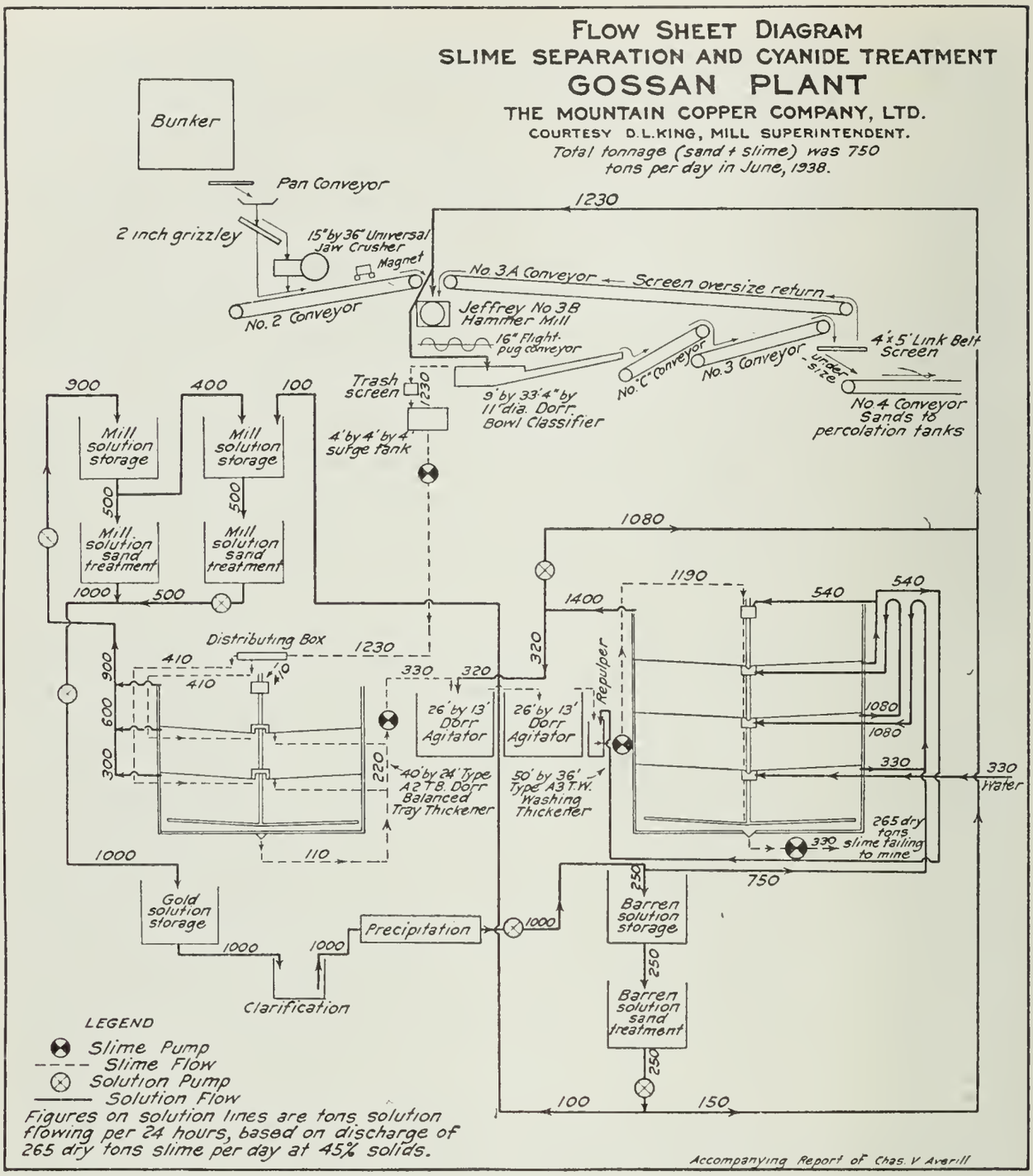
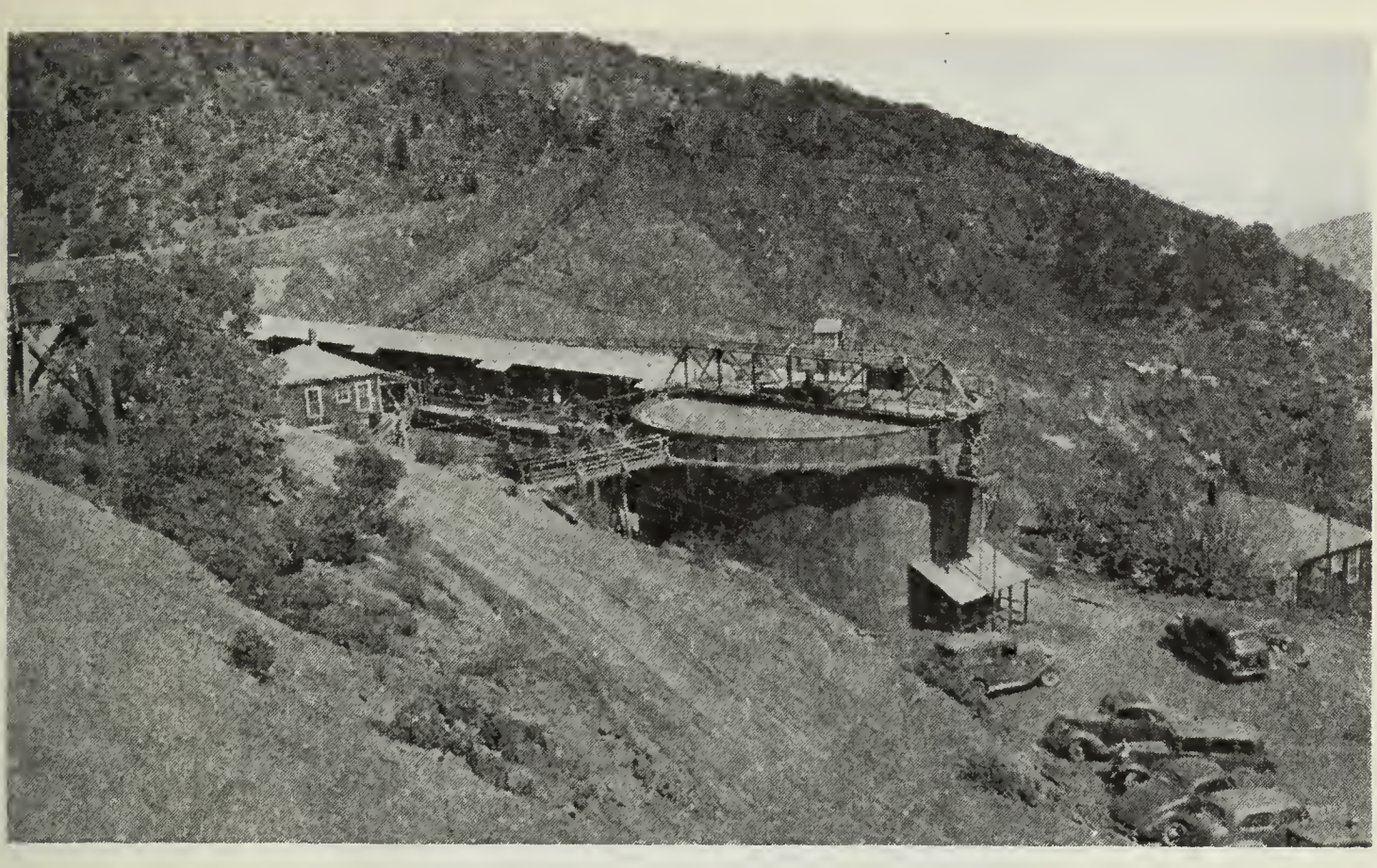


FIG. 1. Flow sheet diagram.

Slime treatment, general.

Slime overflowing the bowl of the classifier goes to a Dorr balanced tray thickener with two trays or three compartments. These compartments are arranged in parallel, that is the feed from the bowl is split into three equal parts, and one part enters each compartment. Thickened underflow from all three compartments joins in the central part of the thickener, and flows to two Dorr agitators. In the pulp leaving the agitators, most of the gold is in solution and the solids are nearly barren. The valuable solution is next displaced by barren solution and water in the four compartments of the three-tray washing thickener, from which the slime-tailing is then discharged. The change of solution causes some additional extraction of gold. In the statement of these extractions that follows, all percentages refer back to the total gold in the original slime as 100%. In crushing and classification 65% of the extraction is made, in the primary thickener and the agitators 25 %, and in the washing thickener 5%—total 95%.



PHOTOGRAPH 4. Washing thickener, 50 feet in diameter.

Counter-current decantation, general.

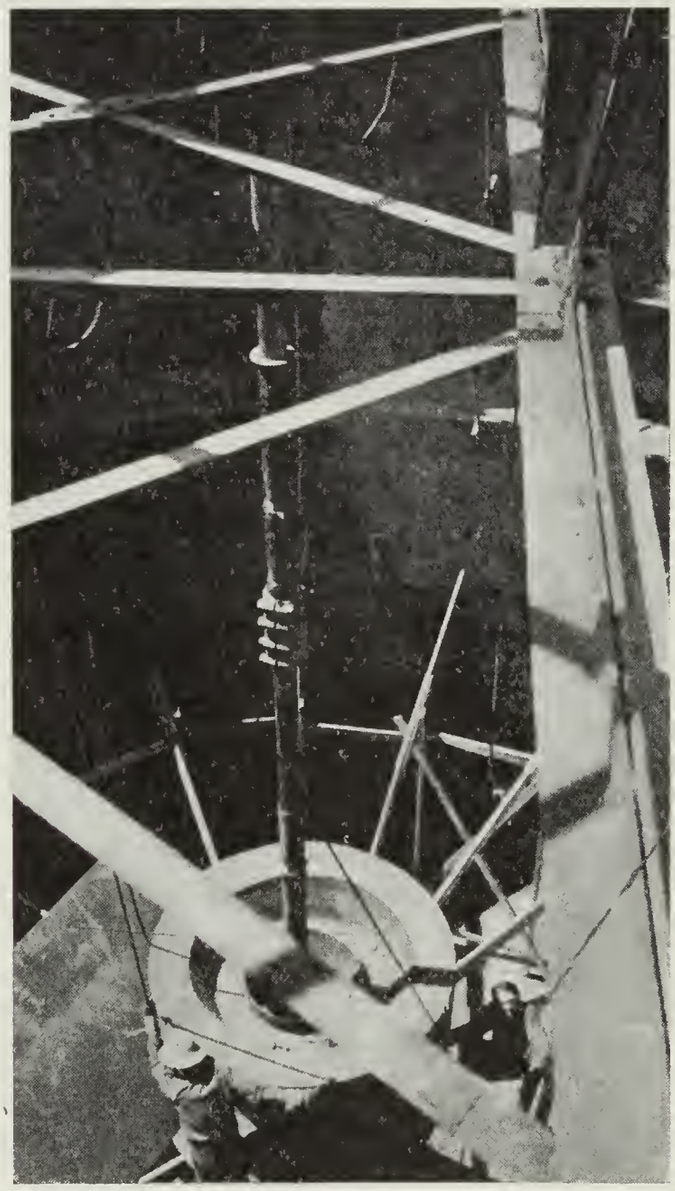
Chemical industries have for many years used decantation to separate a valuable liquid from a mixture of it with a finely divided solid. The earliest method was simply to allow the mixture to settle in a tank, then to decant the clear liquid at the top. Water or other solvent of low value was then added to the tank and the solid was again allowed to settle. The clear liquid at the top was again drawn off and saved. After four or five such steps, the liquid remaining in the settled solid contained little of value. The amount contained is easily calculated if the weight and value of the original liquid is known; also the weight of the liquid finally discarded with the solid. This is described in more detail in a pamphlet issued by The Dorr Company, Inc.[4] This batch-method consumed much time and much labor.

For some years a continuous process of this kind has been used in cyanide mills with about four separate Dorr thickeners. These are settling tanks with a rake-system in the bottom revolving very slowly to discharge the settled solid at the center of the bottom. The gold-solution mixed with the slime enters the first tank of the series, while water enters the fourth or last tank of the series, from which also tailing is discharged to waste. Clear liquid from the last tank overflows to the third. Clear liquid from the third overflows to the second, and so on. The thickened pulp from the underflow of the first tank is raised by a pump and is fed to the center of the top of the second tank, and so on through the series, the flow of thickened pulp being in the opposite direction to that of the wash-solution. Diaphragm pumps are used for handling the thickened underflow. They have an adjustable stroke so that the amount of underflow can be regulated. Between any two tanks of the series, valuable solution can be drawn

[4] The Dorr Company, Inc., Engineers, 570 Lexington Ave., New York, N. Y. Bull. 3141. Continuous counter-current decantation in cyaniding.

off to storage, and barren solution substituted as the solution-feed to the next tank.

In the Dorr [5] washing thickener, all of this is accomplished in a single tall tank separated into four or five compartments by three or four trays. Trays are placed in a horizontal position but each has the shape of a flat inverted cone, sloping downward from the outside of the tank toward the center. This arrangement introduces savings in foundation construction, in space-requirements, and in power. The washing thickener of The Mountain Copper Company, Ltd., is a complete counter-current decantation system with a connected load of only five horsepower.



PHOTOGRAPH 5. Part of tray-seal being installed in washing thickener.
(Photo by D. L. King)

The thickener is of the three-tray or four-compartment type. A central shaft runs down through the entire depth of the tank, carrying four rake systems, one for each compartment; also part of a sealing device for each compartment. For this seal at each tray an inverted cup attached to the shaft engages, with some clearance, a cup-like device attached to the tray. Thickened pulp must pass through the

[5] See also Bull. No. 3071, The Dorr Washing Thickener, The Dorr Company, Inc., Engineers, 570 Lexington Ave., New York, N. Y.

annular space between these cups, and the direction of flow is upward for a few inches. As the thickened pulp passes this seal and starts downward, it meets the flow of solution supplied by a pipe from outside of the tank to the lower compartment. Clearances in all seals as well as clearances between all rakes and their respective trays can be changed by raising the central shaft with a hand-wheel.

Operating details.

The condition of fluid-balance or hydrostatics existing in one of these thickeners is interesting. The central portion of the tank, being filled with a mixture of solid and liquid which has a considerably higher specific gravity than clear solution, is capable of exerting a greater pressure per foot of height than clear solution.

Consider the bottom compartment. A pipe is connected at the outside edge near the top of the compartment for drawing off clear solution. This pipe rises to connect with a steel box at the top edge of the tank. The pressure of the pulp in the center of the tank causes the clear solution to discharge at a considerably greater height than the fluid-level at the top of the tank. The clear solution overflows in the box and is fed by gravity to the center of the next higher compartment through a pipe. The amount of the flow can be regulated by altering the height of the pipe discharging into the box. For this purpose rings cut from pipe are provided. The length of these rings along the pipe varies from half an inch to several inches. The adjustment is a delicate one, and the addition of a $\frac{1}{2}$-inch ring may practically stop the flow. The same applies to the other compartments, but the difference in pressure decreases in the higher compartments and for each successive overflow-line, there is a decrease in the height to which the solution rises. The main point in operating a thickener is to draw off a ton of solids for each ton fed. Some operators have a tendency to let the solids accumulate in the thickeners. However, with these tray thickeners it is also very important to hold down the pressure beneath the trays, as well as to keep solids from accumulating on them.

Consider the washing thickener. Suppose that it is heavily loaded with slimes and that many rings have been added to solution-discharge-lines to hold down the overflow. Suppose that a sudden decrease in the slime-content of the ore causes an equally sudden decrease in the density of the central pulp column of the thickener. The back pressure from the overflow lines might build up such a heavy load on the bottoms of the trays that they would be raised from their supports. For this reason trays must be very securely welded to supports during construction.

Present adjustment of the washing thickener is such that solution-lines overflow when the load in the pulp-column is at its probable minimum. When this adjustment is maintained, operation of the thickener is practically automatic. Other adjustments can be made by altering the amount of underflow handled by the diaphragm pump, raising the rakes and thus altering the amount of seal between compartments. or changing the settling rate of the slime with caustic starch, which is described in more detail below.

The primary thickener is used more or less as a batch machine, and overflow from lower compartments is often adjusted with rings.

Other adjustments mentioned in the foregoing paragraph can be made also.

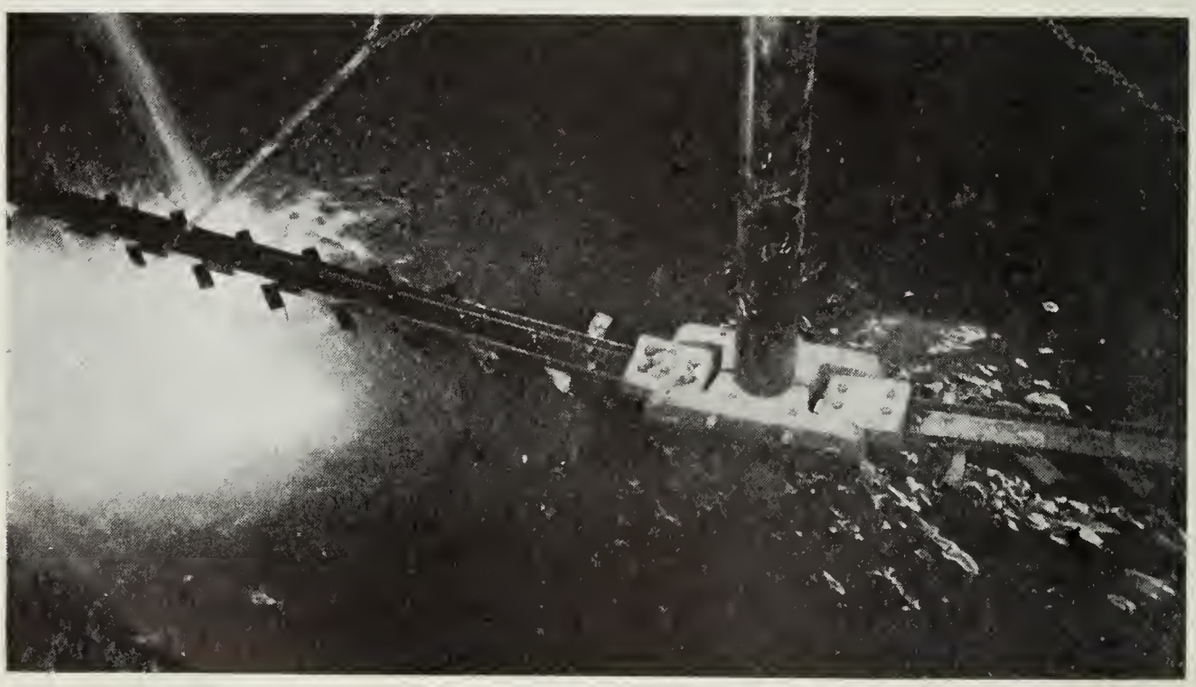
Slime treatment, details.

Slime overflows the periphery of the bowl classifier over an adjustable weir, and flows through a launder to a trash-trommel. It is 14 inches in diameter at the feed end, 30 inches in diameter at the discharge end, and 42 inches long, and is made of screen with $3\frac{1}{2}$ meshes to the inch of No. 12 wire. It discharges on two sets of tray-screens of the same mesh and wire set directly over the surge sump. The trash-trommel is driven at 32 rpm. by a $\frac{1}{2}$-hp. direct-connected Pacific G. E. gear-motor. The bowl classifier overflows at approximately 300 gallons per minute of pulp containing 15% solids. Solution to make up this volume comes from the hammer-mill and from the rake-compartment of the classifier. Screen analysis of the slime by Tyler standard screens follows:

95%			minus	120 mesh
3%	on	120	minus	85 mesh
2%	on	85	minus	60 mesh

The surge sump is a 4-ft. by 4-ft. by 5-ft. tank connected by a 6-inch pipe to the suction of a B-frame Hydroseal slurry pump. This is driven at 840 rpm. by a 10-hp. motor, which actually draws 4.8 hp. Gland solution (barren solution) is supplied to this pump by a Wesco all-iron pump driven by a $\frac{1}{4}$-hp. motor at 1800 rpm.

The Hydroseal pump discharges against a static head of 30 ft. through approximately 260 ft. of 5-inch pipe to the feed-box of a 40 by 24-ft., type A2TB Dorr balanced tray thickener with three compartments. The feed is split so that one-third of it goes to the feed well of each of the three compartments. Supernatent solution overflows a standard weir at periphery of top compartment, and from 4-inch pipes connected to lower two compartments. Overflow boxes, with their rings for adjusting flow, are arranged at 120° from each other around the top of the tank. Overflows are combined in a sump, from which solution is pumped to mill storage by an Ingersoll Rand Cameron cen-



PHOTOGRAPH 6. Rakes in bottom of agitator. (Photo by D. L. King.)

trifugal pump directly connected to a 15-hp., 3450-rpm. motor. The central shaft carrying rakes for all three compartments is driven at 0.162 rpm. by a 130 to 1 turret drive unit, which is in turn driven by a 68-rpm. Watson Flagg G. E. gear-motor through a chain and sprocket. The turret drive mechanism is protected by a dynamometer overload indicator, which signals overloads, and finally stops the motor for a heavy overload. Combined underflows from the three compartments are handled by a Dorrco No. 4 SSM simplex diaphragm pump, which discharges to a small sump. This pump is driven by a 2-hp., 65-rpm. Watson Flagg G. E. gear-motor.

The pulp then flows by gravity through a 6-inch line, about 60 ft. long, to the first of two stages of agitation. Agitators are redwood tanks, 25 ft. 8 inches inside diameter, with 13-ft. staves. They are equipped with standard type A Dorr agitator mechanism. This includes a central air-lift, 4 inches in diameter, fed by a 1-inch air line. A pair of arms extending across a diameter of the tank at the bottom carries rakes, and at a right angle, at the top of the tank, another pair of arms carries launders to distribute the pulp from the air-lift. These arms are turned at 4 rpm. by V-belt drive and turret mechanism with ratio of 130 to 1 connected to a 3-hp., 1200-rpm. motor. Air is supplied at 40 cu. ft. per minute and 20 lb. per square inch pressure to each agitator by a 7-inch by 4-inch single-stage, type A3 Pennsylvania air-cooled compressor driven by a short-center V-belt drive connected to a $7\frac{1}{2}$-inch hp. motor of 1200 rpm. Underflow from the primary thickener is 40% solids, while pulp in agitators is 30% solids by weight. Dilution is effected from mill storage. Time of contact in agitators varies from 12 hours to 20 hours depending on the tonnage of slime treated on the day in question. This varies from 180 tons to 315 tons.

Pulp goes from one agitator to the next by gravity. Overflow from the second agitator goes through a 4-inch pipe to a repulping device of local design and manufacture. It is a cylindrical tank made of $\frac{1}{8}$-inch steel, and is 4 ft. in diameter by 7 ft. high. In the bottom is a cast impeller with two blades of 24 inches set at a pitch of 45°. This is driven from the top of the tank by a 5-h.p., 1800-rpm. motor and Boston [6] right-angle speed reducer. To break up the turbulence, a vertical baffle of $\frac{1}{2}$-inch plate punched with 1-inch holes occupies about 60% of the effective height of the tank. Solution is fed to this repulper by a 4-inch syphon line controlled by a float. The supply is from No. 2 compartment (2d from top) of the washing thickener. Underflow from the repulper is pumped against a 40-ft. static head through about 100 ft. of 3-inch pipe to the feedwell of the washing thickener. A Wilfley pump driven at 1800 rpm. by direct connection to a 15-h.p. G. E. motor is used.

The Dorr type A3TW washing thickener is a welded steel tank, 50 ft. in diameter by 36 ft. high, with three trays or four compartments. Rake mechanism is similar in design and power (3 h.p.) to that on the primary thickener. It turns at 0.169 rpm. This washing thickener is a complete counter-current decantation unit. Compartments are numbered starting with No. 1 at the top. Thickened pulp from No. 1 compartment is admitted through a hydro-seal into the feedwell of No. 2 compartment, where it joins with the overflow from No. 3 com-

[6] Boston Gear Works, Boston, Mass. or c/o C. W. Marwedell, San Francisco.

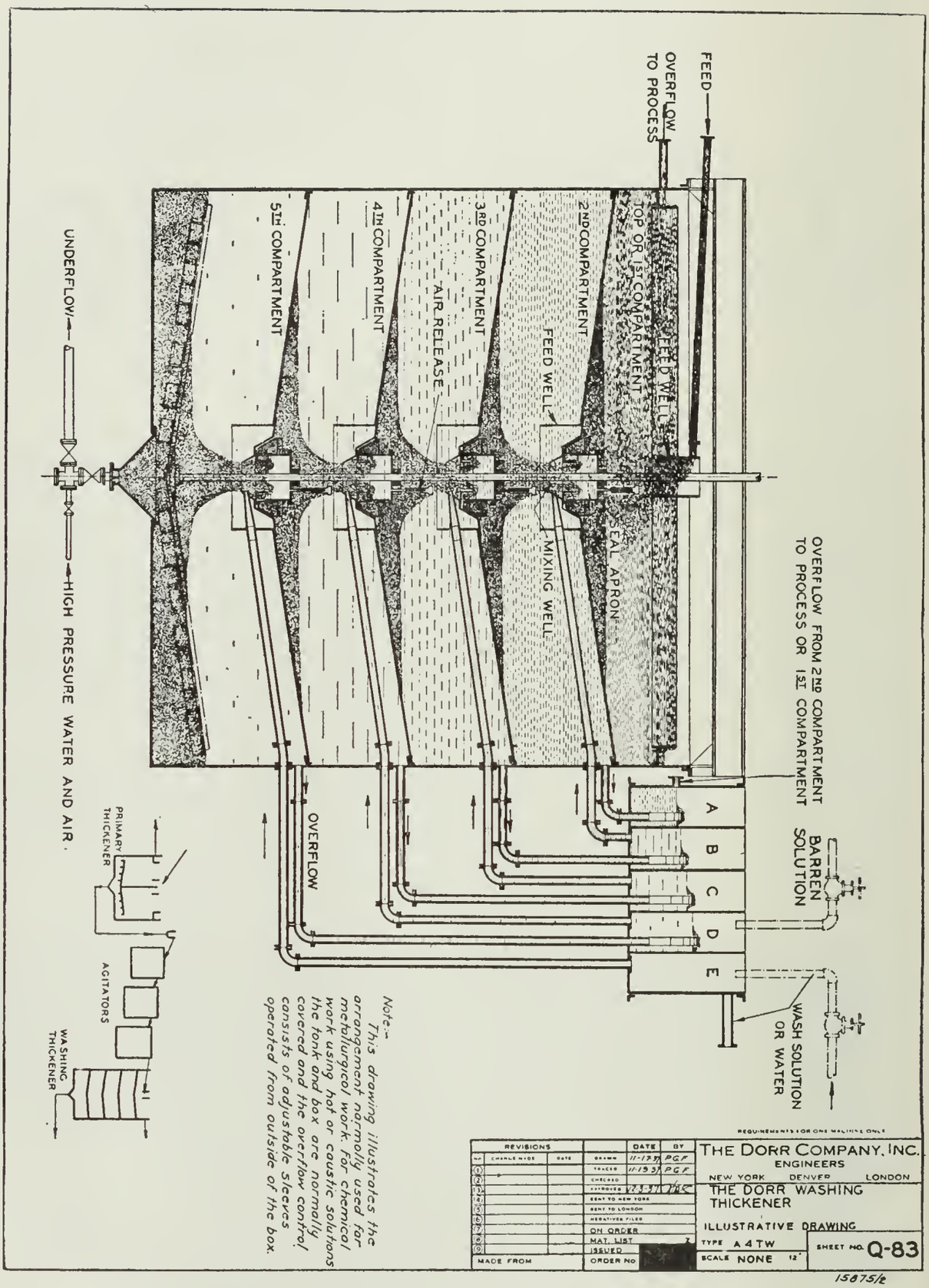


FIG. 2. Washing thickener. (By courtesy The Dorr Company, Inc.)

Stippled parts represent settled solids. Horizontal dots represent dissolved value in liquid. Their number is roughly proportional to dissolved value contained.

partment. Overflow from No. 2 compartment is split by the siphon line so that about 50% goes by gravity to the repulping tank; the balance goes to the feedwell of the top compartment to join with the pulp entering the feedwell. Underflow of thickened pulp from No. 2 compartment passes through the seal into the feedwell of No. 3 compartment, where it joins with the advancing overflow of solution from No. 4 compartment and added barren solution. Underflow of thickened pulp from No. 3 compartment passes through the seal to No. 4 compartment, where it joins with wash solution (barren solution) and water. Underflow from No. 4 compartment is the final slime tailing. It is pumped by a No. 4 SSM Dorrco simplex diaphragm pump connected directly to a 2-h.p., 65-rpm. Watson Flagg G. E. gear-motor. This pump discharges into a small steel sump-box, which in turn discharges into a meter, from which the slime-tailing is pumped underground to the old No. 8 copper mine for disposal. Meter and tailing-disposal are both described in more detail below.

Solution overflowing the weir at the top of the washing thickener goes by gravity through a 4-inch pipe into a steel sump tank made of 10-gage iron, 10 ft. in diameter by 10 ft. high, from which it is pumped back to grinding and classification through 450 ft. of 4-inch pipe. The pump is a Pennsylvania motor pump, a single-stage centrifugal of 20 h.p. running at 3450 rpm.

Meter.

To measure the amount of the slime tailing, a meter was designed and built locally. It consists of two steel tanks each 4 ft. by 4 ft. by 4 ft. made of reinforced 10-gage iron. These are fed by gravity from the sump below the diaphragm pump which handles the final underflow from the washing thickener. The tanks are arranged with both low-level and high-level floats and valves so that one is filling while the other is being pumped out, and the number of times that this is done is counted by a Veeder counter. Valves are 3-inch, three-way, two-port, No. 3465, lubricated, semi-steel, multiport, Nordstrom valves. Two of them are connected to the output shaft of a Boston VAAW, 450 to 1 speed reducer driven by a $\frac{1}{4}$-h.p., 1800-rpm., 440-volt, 3-phase, 60-cycle induction motor. This motor is started in forward and reverse rotation by the floats in the tanks to effect the proper filling and pumping out. 'Limit-switches' are provided to stop the rotation of the valve-shaft at the proper points. Floats are connected electrically in such a way that only full tanks can be pumped out.

From the two compartments of the meter, the slime is pumped out by an A-frame Hydroseal slurry pump powered by a 5-h.p., 1800-rmp. motor through a short-center V-belt drive imparting 1200-rpm. to the rotor of the pump. This pump has 250% of the capacity of the diaphragm pump feeding the meter, and runs intermittently depending on the positions of the floats in the meter tanks. A solenoid control with time-delay relay turns on gland water from the pressure system six seconds before the pump starts. Gland water can not be left on continuously because it would back up into the meter tanks and destroy the accuracy of the meter.

Tailing-disposal.

The discharge of the A-frame Hydroseal pump is connected by approximately 1000 ft. of 6-inch pipe to the extensive underground workings of the old No. 8 copper mine, which is being back-filled with slime tailing. Water now coming from the mine appears perfectly clear. Hence no slime tailing is entering surface drainage.

Scavenger system.

The foundation of the classifier and the drain-apron of the hammer-mill are connected by gravity to a scavenger sump, a cylindrical steel tank 15 ft. by 15 ft. An apron on the trash screen and the floor of the B-frame pump house also drain into this sump. It is pumped out intermittently by a 2-inch Wilfley pump, which returns the pulp to the grinding and classification circuit.

Precipitating.

The Merrill-Crowe vacuum process is used to precipitate gold from solution. A vacuum pump working on a steel tank de-aerates the solution before precipitation. Ahead of de-aeration, and after it leaves the gold-solution tank, the solution passes through two units of clarification. Each of these is composed of 16 Butters type clarification leaves, 5 ft. by 7 ft. The clarified solution is admitted directly into the vacuum tower, and thus simultaneous clarification and de-aeration are effected. The vacuum pump supplies power for both of these steps. It is a 6-inch by 4-inch Ingersoll Rand single-stage vacuum pump driven through a V-belt drive by a 2-h.p. G. E. motor of 1800 rpm.

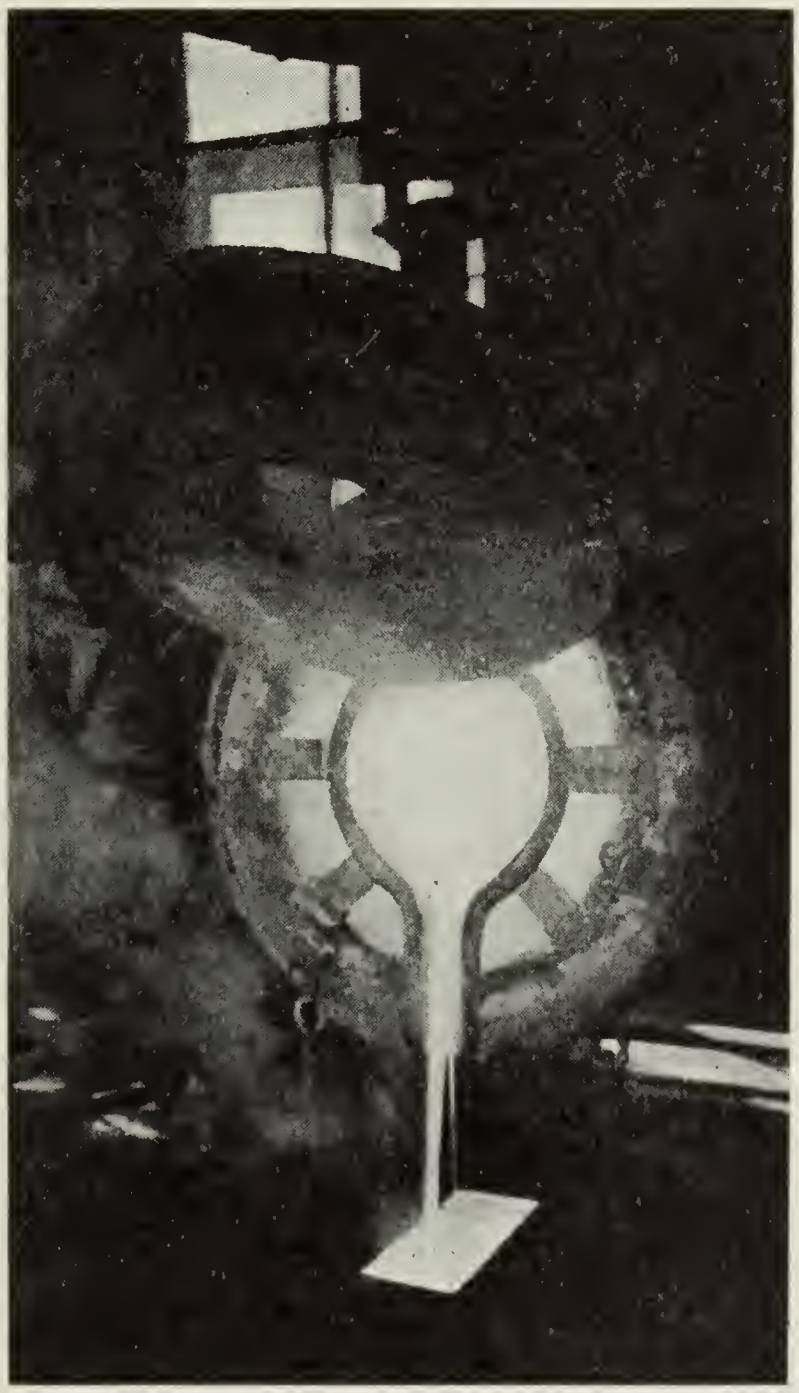
To collect precipitate, small canvas filter leaves, 3 ft. by 3 ft., submerged in a small tank with an agitator of the propeller type in the bottom, are used. Zinc dust is fed to this tank and precipitation takes place in it. At time of cleanup, the contents of this tank and washings from the filter leaves are transferred to a second tank with a filter bottom, where as much moisture as possible is removed with the vacuum pump. Two centrifugal pumps circulate the solution; one is a 4-inch pump driven by a 7½-h.p. motor of 1800 rpm., the other a 2½-inch pump driven by a 10-h.p. motor of 1800 rpm. After a cleanup, precipitation is started again by feeding 10 lb. of zinc dust immediately, then 11 lb. per 8-hour shift. The ore contains mercury, which appears in the precipitate to the extent of 16% of its weight, and which is believed to aid precipitation. Barren solution from this process never assays more than a trace of gold. Each operator makes a colorimetric test (purple of Cassius) twice a shift to detect any gold entering the barren solution circuit. Precipitation is at the rate of 1000 tons of solution per day, or 1.3 tons solution is precipitated for each ton of ore treated.

Melting precipitate.

Precipitate is melted in a No. 200-crucible tilting furnace burning distillate, with the following flux to each 100 lb. of wet precipitate: 12 lb. sodium carbonate, 17 lb. sand, 22 lb. borax, 3 lb. manganese dioxide, 1½ lb. niter, and 3 lb. fluorspar. Slag is decanted into a conical mold down to near the metal line; the bullion is poured in a standard bullion mold. Fineness of bullion averages 400 parts gold, 550 parts silver, and 50 parts base, mostly copper.

Slag from the melt is ground in a 24-inch ball mill and fed to a Deister concentrating table, from which three products are taken.

Concentrate is returned for re-melting in the next melt, middling is re-ground, and tailing is agitated in a 4-ft. by 7-ft. Devereaux type agitator. Solution contains 10 lb. cyanide (KCN) per ton, and two tons of solution are used per ton of slag. Batch decantations from this agitator are admitted into the mill gold circuit. Slag-tailing is thus reduced to a gold content of $3 per ton and a silver content of $5 per ton and is discharged to waste.



PHOTOGRAPH 7. Pouring gold bullion.
(Photo by D. L. King)

Caustic starch.

The plant was designed and built to treat 150 tons of dry slime per day on the basis of a normal settling requirement of 10 sq. ft. settling area per ton per 24 hours. Subsequently it became necessary to treat 185 to 315 tons of slime per day, and the settling characteristics of the ore had to be changed. Extensive tests demonstrated that this could be done with caustic starch used at the rate of $\frac{1}{2}$ lb. to 1 lb. per ton of dry slime.

It is made by digesting with steam a mixture of 100 lb. tapioca flour and 12 lb. of flake caustic soda (lye). It is diluted to contain roughly 1 lb. tapioca flour per gallon of solution. A manifold is provided at the feed box of the primary thickener, where it can be added

as needed. A similar arrangement is provided at the overflow boxes of the washing thickener.

Other chemicals and solutions.

Lime is added to sand-percolation by a feeder over No. 3 conveyor, feeding 8 lb. of 10-mesh quicklime per ton of dry sand. In addition to this, 'milk of lime' is added to both mill solution storage tanks, to barren solution storage tank, to classifier circuit, and to primary thickener underflow. Lime thus added is slaked in an Orinda type slaker consisting of a vibrating hopper feeding a flight conveyor, which admits prepared lime into the slaking chamber. This consists of two lawnmower type blades revolving into each other. Water is added here. The slaker handles a ton of lime per day. This lime is air-floated, 150-mesh, running 90% to 92% CaO. It costs $20 per ton delivered to the mill in 60-lb. bags. The 10-mesh lime costs $18 per ton delivered. Cyanide used is in 1-lb. bricks running 94% sodium cyanide (NaCN).

All effluent solutions coming from sand-percolation are acid, containing hydrogen cyanide (HCN). This is the reason for adding lime to solution tanks. The hydrogen cyanide is converted into calcium cyanide. Mill solution contains 1½ lb. cyanide (titrated as KCN) and 0.4 lb. lime per ton. Barren solution contains 0.8 lb. cyanide and 0.4 lb. lime per ton. Gold solution is acid, requiring 0.2 lb. sodium hydroxide (NaOH) per ton to neutralize. It contains 0.4 lb. cyanide (titrated as KCN) and about 1 dwt. gold per ton. The four main solution tanks are 25 ft. 8 inches in diameter by 12 ft. high, and are set on high ground. Two are used for mill solution, one for gold solution, and one for barren solution. The gold solution tank has a filter-bottom covered with two feet of coarse sand. Water consumption is 0.6 ton of water per ton of ore. In the slime tailing, 330 tons are discharged daily; the balance is lost as moisture in the sand tailing and by evaporation. No lead acetate is now used in the mill.

Approximate distribution of cyanide consumption is calculated as follows:

Washing thickener, 330 tons at 0.172 lb. NaCN per ton	56.76 lb.
Sand tanks, 11% barren solution as moisture	32.21
Mechanical loss per day	88.97
Mill stock contains 1.125 lb. NaCN per ton. It is put on sand tanks at this strength and comes off at 0.60 lb. per ton, a difference of 0.52 lb. per ton.	
Six tanks at 6 tons per hour for 24 hours gives 864 tons at 0.52 lb. per ton,	
Consumed in sand-leaching	450
	539
Cyanide used is 94% NaCN. 539 divided by .94, Commercial cyanide used per day	573 lb.
Actual amount used per day in June, 1938	586 lb.

The difference is no doubt due to chemical consumption in the slime circuit, which is known to be low, but which is not readily calculated because solutions in the washing thickener are in a partly closed circuit.

Sampling.

For mill-heads, a sample is taken from No. 2 conveyor by hand every 30 minutes. The sample weighs about 150 lb. to each sand-tank filled. Sand-head sample is taken every 30 minutes from the tripper. The classifier man takes a sample every 30 minutes to control density of pulp, and an aliquot part of this is saved for assay of classifier overflow or slime-heads. Sand tailing is sampled at discharge by hand. Slime tailing is sampled automatically by an arm attached to the valve mechanism of the meter. A cup cuts an aliquot part of each meter-load, and discharges into a hermetically sealed container, which is equipped with a valve that closes as soon as the sample has passed through it. All sand effluent solutions are assayed daily as well as gold solution (precipitation-heads) and barren solution (precipitation-tails). Sand tonnages are estimated by the use of a 3-cu. ft. weight box installed in one of the sand-tanks. Slime tonnages are metered as already described.

Laboratory.

A complete analytical laboratory for qualitative and quantitative work is maintained in addition to the assay office. Metallurgical testing-apparatus for cyanidation, flotation, and amalgamation is also provided.

One interesting problem solved is the detection of water-soluble gold. Difficulty was at one time experienced in making assay-values check with mill-recovery. Experiments showed that in some samples as much as 44% of the gold would dissolve in distilled water. This gold was at first supposed to be in a colloidal state, but tests proved that it is not. Finally micro-chemical tests with pyridine[7] showed the presence of gold chloride ($AuCl_3$). Of the gold in the ore, it is not unusual for 10% to 15% to be in this water-soluble form. All of the ore does not contain it.

Crew.

The mill crew consists of 3 loading crews of 3 men each (1 crusher man, 1 classifier man, 1 distributor man), 2 discharging crews of 3 men each, 3 solution men, 1 pipe-fitter, 2 mechanics, 1 assayer, 1 assayer's helper, 1 research man, 1 electrician, 3 general laborers, and 1 mill superintendent—total 29. Minimum wages are $4.25 per 8-hour shift.

[7] Directions for pyridine test are given by Short, M. N., Microscopic determination of the ore minerals, U. S. Geol. Survey Bull. 825, pp. 153-154, 1931.

CYANIDE PLANT REPORT FOR JUNE, 1938

Total tonnage treated	22,434	tons
Crushing hours	572½	
Tons crushed and treated per day (30 days)	747.8	
Tons crushed per hour (572½ hours)	39.19	
Tons of dry sand treated (63 charges)	15,370	
Tons of dry slime treated	7,064	
Per cent of mill feed to sand treatment	68.51%	
Per cent of mill feed to slime treatment	31.49%	
Average mill heads, gold	1.0960	dwt.
Average silver content of mill heads	0.1434	oz.
Average sand heads, gold	0.9075	dwt.
Average total sand tails (residue and soluble)	0.0314	dwt.
Indicated sand extraction	96.54%	
Average classifier overflow (total slime heads)	1.8186	dwt.
Average washing thickener underflow residue loss	plus trace	dwt.
Average washing thickener underflow soluble loss	0.0913	dwt.
Indicated slime extraction	94.98%	
Indicated sand and slime overall extraction, prorated	96.05%	
Actual mill heads—(bullion plus tails by tonnage)	1.1617	dwt.
Actual overall extraction—(total: 24,935 dwt.)	95.67%	
Indicated gold content (actual)	26,061.58	dwt.
Indicated silver content—(0.1434 x 22,434)	3,194.60	oz.
Actual silver extraction—(bullion: 1,711.00 oz.)	53.56%	
Tons of dry slime treated per day	235.5	
Tonnage of solution precipitated for the month	28,841	
Average tons of solution precipitated per day	961	
Pounds of tapioca flour used per ton of slime treated	0.998	
Caustic soda used to digest starch used for month	846	lb.
Pounds of lime used per ton of ore treated	7.787	
Pounds of zinc used per ton of solution precipitated	0.035	
Pounds of zinc used per ton of ore treated	0.044	
Pounds of cyanide consumed per ton of ore treated	0.784	
Cost per ton for reagents (total: $4,221.10)	18.82¢	
Gold in bars ‡320 and ‡321	24,935.00	dwt.
Silver in bars ‡320 and ‡321	1,711.00	oz.

Costs.

The following milling costs per ton apply to the tonnage treated in June, 1938, as given above. No amortization of plant, no taxes, and no general expense other than that at Iron Mountain are included. No mining costs are included.

Labor	$0.145
Reagents	.188
Other materials	.045
Laboratory	.022
Power	.051
Iron Mountain general	.022
Administration and overhead	.047
Haulage	.009
Tailing disposal	.05
Express on bullion	.002
Total milling cost per ton	$0.581

USE OF ULTRA-VIOLET LIGHT IN PROSPECTING FOR SCHEELITE

By Ott F. Heizer *

The use of ultra-violet lamps for the detection of scheelite by fluorescence has proven such a boon to the prospector, miner, and mill-man engaged in the search for or reduction of tungsten ores carrying scheelite, that some information on the highly interesting development is timely.

Scheelite, the tungstate of lime, $CaWO_4$, is the most important tungsten mineral mined in the Americas. Comparatively smaller amounts of ferberite, the tungstate of iron, hübnerite, the tungstate of manganese, and wolframite, the combined tungstate of iron and manganese in varying amounts, are produced but they fall without the scope of this discussion, as these dark minerals show no excitation by ultra-violet light. The examination of many specimens of these dark tungsten minerals by ultra-violet light, however, discloses hitherto unsuspected marginal alteration of certain of the dark minerals to scheelite. Cupro-scheelite, a green tungsten mineral in which a part of the calcium has been replaced by copper, usually shows a pale-blue fluorescence. The other and rarer tungsten minerals, none of which occur in commercial amounts (powellite, a calcium tungstomolybdate, stolzite, a lead tungstate, and tungstenite, a sulphide of tungsten), exhibit no fluorescence.

Scheelite, when in mass, is distinguished by its high specific gravity of 5.5 to 6. In color it may vary from snowy white to almost black. Pale-yellow, pink, and brown colors are common. It has a very distinctive greasy luster, and good cleavage in 4 directions. Because some of the other and more common minerals, such as barite and the oxides and sulphates of lead, are likewise heavy and of similar colors, it is not always easy to distinguish scheelite from them in the field with the unaided eye. When scheelite occurs in small isolated grains in heavy ores of the garnet type, its identification is difficult, as such ores usually also show milky quartz grains and intersticial calcite. It is also usually difficult to identify scheelite grains in massive quartz veins by visual inspection, particularly where there is iron staining. Scheelite has a hardness of about 5 and can be easily scratched by the blade of a good knife and thus distinguished from either quartz or calcite. Regardless of its color, scheelite has a white streak; this streak can be obtained by rubbing the mineral on a piece of unglazed porcelain. Crushing and panning offers a good method of determining scheelite, as the mineral 'hangs back' in the pan almost as does gold. The white concentrate, if any be obtained by panning, can be tested by transferring it to a test tube and boiling with a mixture of three parts of hydrochloric (muriatic) acid and one part of nitric acid and adding a small amount of metallic zinc. A blue color will indicate tungsten.

Probably the simplest and most definitive means for determining the mineral scheelite qualitatively is by use of the ultra-violet lamp. It

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is made in several models, for use on a power circuit or with either wet or dry storage-batteries. Ultra-violet lamps are of two general types, the so-called iron-arc type which employs a high-tension disruptive spark for producing the proper radiation, and the quartz-tube type in which high-tension current is passed through a quartz tube containing mercury. The latter type has the advantage of greater portability and absence of noise from the arc. Both types are manufactured and sold by several chemical and supply houses. A highly satisfactory lamp weighing 10 pounds with its batteries, contained in a box measuring $4\frac{1}{2}$ by 11 by 8 inches, and powered by two dry-cells, having a life of over two hours in constant use, has been developed and is employed by the Nevada-Massachusetts Company at its various scheelite properties in Nevada. This lamp is not on the market.

The use of a filter on the lamps is advantageous but not essential. The most satisfactory one has been Red Purple Corex A No. 986 made by the Corning Glass Works. This filter transmits the maximum amount of short wave-length radiation between 2500 and 3000 Ängstrom Units and gives the best results for the detection of scheelite. With the quartz-mercury-tube type of lamps the best effects are not visible until the current has been applied to the tube for three or four minutes. With such a lamp equipped with filter, the most minute specks of scheelite are visible. There is a tendency however, to over-estimate the amount of scheelite when it is viewed with the filter.

When ultra-violet light of the proper wave-length is directed on certain minerals it causes them to glow or fluoresce. These minerals absorb ultra-violet radiation and transform it into colors in the visible spectrum. While this phenomenon has been long recognized, only recently has it been applied to the detection of scheelite, one of many susceptible minerals. Regardless of the color of the scheelite to the unaided eye, whether white, pale-blue, cream colored or yellow, the fluorescence is quite unmistakable.

It is advisable to exclude from the mineral being examined under ultra-violet light as much outside light as possible; the best effects are obtained in total darkness. A flash light, since it is easily turned off, may be used to advantage underground instead of the usual carbide lamp. On rock outcrops one method to exclude light is to drape a blanket over the head; another is to make use of some sort of a hood having a soft heavy curtain on the bottom with an opening on the top only large enough for the eyes, and a slit or self-closing opening for inserting the lamp. With such a device fairly good results may be obtained on outcrops exposed to the sunshine.

Hyalite, a colorless variety of opal which occurs as the lining of vugs, or as thin coatings on many rocks, exhibits a brilliant green fluorescence. The zinc ores from Franklin Furnace, New Jersey, show very brilliant colors under ultra-violet light, the calcite being a deep pink and the zinc minerals vivid greens and yellows. A variety of calcite from Texas fluoresces deep-blue and holds the color for several minutes. Coatings of talc in broken limestone beds and garnetiferous contact-metamorphic scheelite deposits sometimes show a yellow or greenish color, but because of their abundance can not be mistaken for scheelite. Occasionally colored minerals under the lamp are somewhat deceptive and the question arises whether or not fluorescence is being

observed; this can be decided by holding a piece of glass or cellophane over the mineral. If the color persists when the mineral is so covered, fluorescence is absent.

Scheelite has a distinct glow under the ultra-violet light, whereas the other minerals which might be confused with it (except the New Jersey zinc ores the colors of which are too distinctive to be confused with scheelite) are more dull. Because of the usual habit of scheelite to occur in grains and because of its distinctive glow, the operator after a short experience should have no doubt of its identification. Small droplets of oil or grease thrown on the ore from drilling operations fluoresce almost as brightly as scheelite, but a touch of the finger dispels the similarity.

Care should be exercised not to look directly at the lamp as its effect on the eyes is almost as serious as that of an electric welding arc.

The ultra-violet lamp has also been found valuable in milling operations for observing losses in tailings, in magnetic separator rejects, and for inspecting floors and leaky launders for spills.

The zone of separation between scheelite ore and gangue passing over concentrating tables can be definitely determined by darkening the mill and using an ultra-violet lamp with the tables in operation.

While the use of ultra-violet light is essentially a qualitative method, an experienced operator (after checking typical specimens by panning and assay) can make a very close estimate of the grade of ore. In examination by ultra-violet light, allowance must be made for the fact that scheelite from different ore deposits may show different degrees of fluorescence. It is difficult, therefore, to form a close estimate of grade of ore from a deposit where the operator has no criterion based on assay.

Recent improvements in the field of ultra-violet apparatus open up possibilities for more intensive and intelligent search for scheelite deposits than has heretofore been possible. Unquestionably many areas which have been superficially looked over should now be more carefully examined at night with ultra-violet lamps, and indications of any scheelite mineralization followed up by trenching in order to expose fresh surfaces for further detailed examination.

It must be borne in mind when using the ultra-violet lamp that even a slight film of iron oxide, mud, or other material coating the mineral will screen out the ultra-violet rays and prevent fluorescence. Night prospecting has been successfully carried on with ultra-violet lamps powered by small gasoline-driven generators. Some complete portable outfits may be purchased weighing as little as 45 pounds, with lamp cords as long as 150 feet. Three or four lamps can be used to one generator of 175 watts.

It is good practice to mark favorable spots for finding ore with a daub of bright paint or with a sheet of note paper weighted down by a rock. Then, in ordinary light, these particular spots can easily be relocated.

NEW STATE LANDS ACT OF 1938

An act relating to lands owned by the State; reserving all minerals and all oil and gas in State lands; providing for prospecting for and taking such minerals and for the extraction and removal of oil and gas therefrom; providing for the acquisition by purchase or condemnation of interests in privately owned lands to facilitate the operations provided for or contemplated by this act; creating a State Lands Commission, prescribing its powers and duties, and transferring to and vesting in the State Lands Commission the administration of and jurisdiction over State lands; repealing acts or parts of acts in conflict herewith; and making an appropriation.

Approved by the Governor, March 24, 1938

The people of the State of California do enact as follows:

SECTION 1. This act shall be known and may be cited as the "State Lands Act of 1938."

Article 1. General Provisions and Definitions.

SEC. 3. Unless the context otherwise requires, the general provisions and definitions hereinafter set forth shall govern the construction of this act.

SEC. 4. The present tense includes the past and future tenses; and the future, the present.

The masculine gender includes the feminine and neuter.

The singular number includes the plural, and the plural the singular.

SEC. 5. "City" includes "city and county."

"Shall" is mandatory and "may" is permissive, but whenever permissive authority or discretion is vested in any public officer or body under this act, such authority or discretion is subject to the condition that it be exercised in the best interests of the State.

"Commission" means the State Lands Commission created by this act.

"Oil and gas" includes oil, gas and all other hydrocarbon substances.

"Minerals" includes all substances other than oil, gas and other hydrocarbon substances.

Article 2. The State Lands Commission.

SEC. 11. There is hereby created in the Department of Finance a State Lands Commission to consist of the State Controller, the Lieutenant Governor, and the Director of Finance. The commission shall succeed to and is hereby vested with all the powers, duties, purposes, responsibilities and jurisdiction of the Department of Finance as successor to the Surveyor General, Register of the State Land Office, and State Land Office, under section 690 of the Political Code, and of the Division of State Lands in the Department of Finance. Whenever, by the provisions of any statute or law now in force or that may be hereafter enacted, a duty or jurisdiction is imposed or authority conferred upon the Surveyor General, Register of the State Land

Office, or State Land Office, or upon the Department of Finance as successor thereto, or upon the Chief of the Division of State Lands, or the Division of State Lands, such duty, jurisdiction, and authority are hereby transferred to, imposed and conferred upon the commission hereby created and the appropriate officers and employees thereof with the same force and effect as though the title of the State Lands Commission had been specifically set forth and named therein in lieu of the Surveyor General, Register of the State Land Office, State Land Office, Department of Finance, Chief of the Division of State Lands, or Division of State Lands, as the case may be.

The statutes and laws pertaining to matters formerly under the jurisdiction of the Surveyor General, Register of the State Land Office, State Land Office, the Department of Finance as successor thereto, the Chief of the Division of State Lands, and the Division of State Lands, and all laws prescribing their duties, powers, purposes, responsibilities, and jurisdiction, together with all lawful rules and regulations established thereunder, are hereby expressly continued in force except as herein repealed or amended.

The commission shall be in possession and control of all records, books, papers, offices, equipment, supplies, lands or other property, real or personal, now or hereafter held for the benefit or use of the Department of Finance, as successor to the Surveyor General, Register of the State Land Office, and State Land Office, and of the Chief of the Division of State Lands and the Division of State Lands.

SEC. 12. The commission shall administer this act and all laws and statutes committed to it by this act through the Division of State Lands of the Department of Finance, which division is hereby continued in existence. The commission is hereby vested with all the powers conferred upon heads of departments of the State contained in sections 352, 353 and 356 of the Political Code.

The commission may appoint and, with the approval of the Director of Finance, may fix the salaries of such officers and employees in the Division of State Lands as may be necessary for the conduct of the work of the commission.

SEC. 13. The commission shall meet, upon due notice to all members thereof, at such times and places within the State as are deemed necessary by it for the proper transaction of the business committed to it.

SEC. 14. The commission shall adopt rules governing the conduct of the business of the commission, and no action of the commission shall be valid unless authorized by resolution adopted at a meeting after due notice thereof and by at least two of the members of the commission present.

SEC. 15. The commission is hereby empowered to authorize any of its employees or officers to execute any instrument in the name of the State of California, pursuant to resolution adopted by the commission.

SEC. 16. Whenever the commission, pursuant to the authority herein granted, enters into any agreement for the compromise or settlement of claims, such agreement shall be submitted to the Governor, and if approved by him shall thereupon, but not before, be binding upon the State and the other party thereto.

SEC. 17. The commission may from time to time classify any or all State land for its different possible uses, and, when it is deemed advisable, may require the Department of Natural Resources, the Director of Agriculture, or any other officer, organization, agency or institution of the State government to make such classification. It is hereby expressly made the duty of any such officer, organization, agency, or institution to make such classification and to render a report thereon upon the application of the commission.

SEC. 18. The commission may make and enforce all reasonable and proper rules and regulations consistent herewith for the purpose of carrying out the provisions of this act and incidental thereto, and may do any and all things necessary fully and completely to effectuate the purposes of this act.

Article 3. Provisions Relating to All State Lands.

SEC. 31. All oil, gas, oil shale, coal, phosphate, sodium, gold, silver, and all other mineral deposits in lands belonging to the State, or which may become the property of the State, are hereby reserved to the State, except that nothing in this act applies to lands acquired by the State on sale thereof for delinquent taxes, other than lands so acquired, the deed for which is required to be filed in the office of the Department of Finance or of the commission. Such deposits are reserved from sale except upon a rental and royalty basis as herein provided. A purchaser of any lands belonging to the State, or which may become the property of the State, shall acquire no right, title, or interest in or to such deposits. The right of such purchaser shall be subject to the reservation of all oil, gas, oil shale, coal, phosphate, sodium, gold, silver, and all other mineral deposits, and to the conditions and limitations prescribed by law providing for the State and persons authorized by it, pursuant to this act or otherwise, to prospect for, mine, and remove such deposits, and to occupy and use so much of the surface of said land as may be required for all purposes reasonably extending to the mining and removal of such deposits therefrom. The provisions of this section shall not apply to any compromise agreement entered into under this act.

SEC. 32. (a) All applications to purchase State lands which are hereafter filed, and all sales pursuant thereto, shall be subject to and contain a reservation to the State of all oil, gas, oil shale, coal, phosphate, sodium, gold, silver, and all other mineral deposits in all lands so acquired, and shall also contain a reservation to the State, and persons authorized by it, of the right to prospect for, mine, and remove such deposits and to occupy and use so much of the surface as may be required therefor, and all certificates of purchase and patents issued therefor shall contain such reservations.

(b) Whenever authorized by law to make grants of land to the United States of America, or to an officer, department, or agency thereof, either in exchange for other lands or otherwise, the commission may make such grants with or without the reservation of deposits of oil and gas and other minerals required by this act.

SEC. 33. A lease or prospecting permit shall be issued only to and held by:

(a) Any person or association of persons who are citizens of the United States or who have declared their intention of becoming such, or who are eligible to citizenship under the laws of the United States and are citizens of any country, dependency, colony, or province, the laws, customs, and regulations of which permit the grant of similar or like privileges to citizens of the United States; or

(b) Any corporation ninety per cent or more of the stock of which is owned by persons eligible to hold a lease or permit under subdivision (a) of this section; or any corporation ninety per cent of the stock of which is owned either by a corporation eligible to hold a lease or permit hereunder, or by any combination of such eligible persons or corporations, or both; or

(c) Any alien person entitled thereto by virtue of any treaty between the United States and the nation or country of which such alien person is a citizen or subject.

SEC. 34. Any interest held in violation of this act shall be forfeited to the State by appropriate proceedings for that purpose brought by the State of California in the superior court for the county in which the property or some part thereof is located, except that any ownership or interest forbidden in this act which may be acquired by descent, will, judgment, or decree may be held for two years and not longer after its acquisition.

SEC. 35. The commission, in its discretion, in issuing any lease under this act, may reserve to the State the right to lease, sell, or otherwise dispose of the surface of the lands embraced within such lease, in so far as the surface is not required by the lessee. If such reservation is to be made, however, it shall be so determined before the offering of such lease.

SEC. 36. A lease or permit issued under the provisions of this act may be assigned, transferred or sublet, with the consent of the commission, to any person, association of persons, or corporation, who at the time of the proposed assignment, transfer, or sublease, possesses the qualifications provided in this act. A lease shall contain provisions to enable the lessee to quitclaim all or any part of the State land covered by such lease and thereby to be released proportionately from drilling obligations or other obligations with respect to the land so quitclaimed or relinquished.

SEC. 37. The commission shall reserve and may exercise the authority to cancel any prospecting permit or lease upon failure of the permittee or lessee (after thirty days' written notice and demand for performance) to exercise due diligence and care in the prosecution of the prospecting or development work or the production work in accordance with the terms and conditions of the permit or lease, and the commission shall insert in every permit or lease issued under the provisions of this act appropriate provisions for its cancellation by the commission in accordance with the provisions of this section.

SEC. 38. Any permit or lease under this act shall reserve to the commission the right to allow, upon such terms as the commission may determine to be just, the joint or several use of such easements or rights of way, including easements in tunnels, upon, through, or in the lands leased or permitted, as may be necessary or appropriate for the working of such lands or of other lands containing the deposits described in this act.

SEC. 39. The commission, in the name of the State of California, may purchase or receive by donation or lease any right of way or easement in real property, or any real property in fee simple, necessary or proper for sites for drilling operations, storage of oil, dehydration plants, absorption plants, or other operations necessary or proper under this act.

SEC. 40. The commission, if it deems such action for the best interests of the State, may condemn, acquire, and possess in the name of the State any right of way or easement, including surface rights for any operation authorized or contemplated under the provisions of this act, that may be necessary for the development and production of oil and gas from state-owned land and for their removal, transportation, storage, and sale, and for such purposes is authorized and empowered in the name of the people of the State of California, to institute condemnation proceedings pursuant to section 14 of Article I of the Constitution and the Code of Civil Procedure relating to eminent domain. The acquisition of such interests is hereby declared a public use.

Prior to the institution of such condemnation proceedings, the commission shall adopt a resolution declaring that the public interest and necessity require the acquisition of such interest in lands for the purpose of performance of the duties vested in this commission by the provisions of this act and that the interest in such lands described in such resolution is necessary therefor. Such resolution shall be conclusive evidence: (a) of the public necessity of such proposed public use; (b) that such property is necessary therefor; and (c) that such proposed public use is planned or located in the manner which is most compatible with the greatest public good and the least private injury.

SEC. 41. Any interests in lands, or lands in fee simple, acquired by the commission by purchase, donation, lease, condemnation, or otherwise, may be made available to any lessee of the State for the purposes contained in this act and upon such terms and conditions as may be determined by the commission.

SEC. 42. The provisions of this act authorizing the commission to acquire interests in real property include the acquisition of structures and improvements situated on lands sold by the State subject to the reservations provided herein. Such structures and improvements shall be acquired, however, only upon the written request of a lessee under this act to whom the State has granted the right to extract the oil and gas or other minerals from such lands, and only upon the agreement by the lessee to reimburse the State for the cost and expense of such acquisition and the deposit by the lessee with the commission of such security as it may require.

SEC. 43. The commission may, prior to the receipt of any bid for a lease under this act, withdraw any offer to receive bids therefor, and it may reject all bids therefor filed pursuant to invitation of the commission. At any time before the awarding of a lease thereon, all or any portion of a tract proposed to be leased may be withdrawn by the commission and eliminated from the proposal.

SEC. 44. Whenever by the terms of this act the commission may grant a lease of State lands, the commission may, in its discretion,

make and execute an easement of surface or subsurface rights, or both, in lieu thereof and upon the same terms and conditions and subject to the same limitations and prohibitions as are provided in this act for a lease of such lands.

SEC. 45. For the purpose of this act, the commission is hereby authorized to enter into agreements with any person, association of persons, corporation, city, or county, or either of them, claiming the oil and gas in lands adversely to the State of California, which agreements may:

(a) Establish the respective interests of the parties to the agreement in the oil and gas underlying such land;

(b) Establish the boundary line between lands claimed by the State and other parties to the agreement in those cases in which oil or gas is known to exist in such lands or in the vicinity thereof;

(c) Fix the amount of damages for past or future production of oil and gas from wells drilled under color of title on or into land claimed by the State.

SEC. 46. The commission, in the name of the people of the State of California, may bring action to determine the title to oil and gas in land against persons, associations of persons, and corporations claiming the same adversely and to recover damages for oil and gas removed therefrom. Any person, association of persons, corporation, or city not a party to such a suit and claiming the oil or gas in said land, or any part thereof, may intervene in such an action and have his rights adjudicated. The State hereby consents to be sued by any person, association of persons, corporation, or city for the purpose of quieting title to the right to oil or gas, or both, in any land, claimed by the State and by such person, association of persons, corporation, or city. Any other person, association of persons, corporation, or city not made a party to such an action but claiming any interest in said oil or gas may intervene in said suit.

All such actions shall be brought and tried in the county where the land or some part thereof is situated.

SEC. 47. Whenever it appears to the commission that wells drilled upon private lands are draining or may drain oil or gas from lands owned by the State, the commission may enter into agreements with the owners or operators of such wells for the payment of compensation to the State for such drainage, in lieu of drilling offset wells upon such State lands.

Article 4. General Provisions Relating to Oil and Gas Leases.

SEC. 51. Permits for prospecting for oil and gas deposits reserved to the State shall not be issued; and permits for prospecting for minerals, other than oil and gas, reserved to the State shall be issued only pursuant to article seven of this act.

SEC. 52. Leases for the extraction and removal of oil and gas deposits may be made by the commission to the highest qualified bidder, as provided in this act. Such a lease shall be for a term of twenty years, with the option of the lessee to continue the term of said lease as to all wells drilling or producing at the expiration of the original term thereof for so long as oil or gas is produced therefrom.

In addition to the royalty provided therein, each bid and each lease shall also provide for an annual rental payment in advance of such sum as the commission shall specify, which rental shall be credited against the royalties, if any, as they accrue for that year.

SEC. 53. All leases of lands containing oil or gas made or issued under this act shall be subject to the condition that the lessee will use all reasonable precautions to prevent waste of oil or gas developed in the land, or the entrance of water through wells drilled to the oil-bearing strata, to the destruction or injury of the oil deposits. All leases shall further provide that the lessee therein shall comply with all valid laws of the United States and of the State of California and with all valid ordinances of cities and counties applicable to the lessee's operations, including, without limitation by reason of the specification thereof, the lessee's compliance with the act of the State of California creating the office of the State Oil and Gas Supervisor, Statutes 1915, page 1404, and all amendments thereto.

SEC. 54. Every oil and gas lease executed under this act shall include such terms, conditions, and provisions as will protect the interests of the State with reference to securing the payment to the State of the proper amount or value of production; the spacing of wells for the purpose of properly offsetting the drainage of oil and gas from State lands by wells drilled and operated on and within privately owned lands; diligence on the part of the lessee in drilling wells to the oil sands and requirements as to depth of such wells for the purpose of reaching the oil sands and producing oil and gas therefrom in commercial quantities; methods of operation and standard requirements for carrying on operations in proper and workmanlike manner; prevention of waste; protection of the safety and health of workmen; liability of the lessee for personal injuries and property damage; security for faithful performance by the lessee, including reasonable provisions for the forfeiture of the lease for violation of any of its covenants or of any of the provisions of this act by the lessee, and the requirement that the lessee shall, at the time of execution of the lease, furnish and thereafter maintain a good and sufficient bond in such sum as may be specified by the commission, in favor of the State, guaranteeing faithful performance by the lessee of the terms, covenants, and conditions of the lease and of the provisions of this act; and such other covenants, conditions, requirements and reservations as may be deemed advisable by the commission in effecting the purpose of this act and not inconsistent with any of its provisions.

SEC. 55. Such lease shall contain a reservation to the commission of the right to restrict by appropriate rules and regulations the spacing of wells and the rate of drilling and production of such wells so as to prevent the waste of oil and gas and promote the maximum economic recovery of oil and gas from, and the conservation of reservoir energy in, each zone or separate underground source of supply of oil or gas covered in whole or in part by leases issued under the provisions of this act. The commission shall issue rules and regulations which may be amended from time to time to effectuate the purpose of this section, and in connection therewith shall restrict the rate of production from any such zone or separate underground source of supply to that provided by Federal or State laws or rules or regulations thereunder, or

by any reasonable conservation or curtailment plan ordered by the commission or agreed to by a majority of the total production from any such zone or separate underground source of supply.

SEC. 56. Rights of way through all State lands may be granted to any lessee by the commission under such regulations as to survey, location, application, and use as may be prescribed by the commission.

SEC. 57. For the purpose of more properly conserving the natural resources of any single oil or gas pool or field, lessees hereunder and their representatives may unite with each other jointly or separately, or jointly or separately with others owning or operating lands not belonging to the State, in collectively adopting and operating under a cooperative or unit plan of development or operation of the pool or field, whenever it is determined by the commission to be necessary or advisable in the public interest, and the commission may, with the consent of the holders of leases involved, establish, alter, change, and revoke any drilling and production requirements of such leases, and may make such regulations with reference to such leases, with like consent on the part of the lessees, in connection with the institution and operation of any such cooperative or unit plan, as the commission deems necessary or proper to secure the proper protection of the interests of the State.

SEC. 58. The commission, upon such conditions as the commission shall prescribe, may approve operating, drilling or development contracts made by one or more lessees holding oil or gas leases on State lands with one or more persons, associations, or corporations, whenever in the discretion of the commission the conservation of natural products or the public convenience and necessity require it, or the interests of the State may be best subserved thereby.

SEC. 59. Each bid (which shall be in the form of a lease prepared in accordance with the provisions of this act) for an oil and gas lease shall be accompanied by a certified or cashier's check of a responsible bank in California payable to the State Treasurer in an amount to be fixed by the commission, which sum shall be deposited as evidence of good faith and except in the case of the successful bidder shall be returned to the bidder. Upon the execution of the lease the amount shall be applied upon the annual rental for the first year and the balance, if any, shall be returned to such lessee. If the successful bidder fails or refuses to execute the lease within fifteen days after the award thereof, the amount of the check shall be forfeited to the State.

Article 5. Oil and Gas Leases on Lands Other Than Tide and Submerged Lands.

SEC. 71. Lands owned by the State, or lands in which the oil and gas deposits are reserved to the State, other than tide and submerged lands, may be leased for the production of oil and gas in accordance with the provisions of this article and of this act in so far as not in conflict with the provisions of this article.

SEC. 72. Whenever it appears to the commission that any such lands probably contain commercially valuable deposits of oil or gas and that it is for the best interests of the State to lease such lands for the production of oil or gas therefrom, the commission shall then offer such lands for lease, as provided in this article.

SEC. 73. The commission may divide the lands within the tract proposed to be leased into parcels of convenient size and shape and shall prepare a form of lease therefor.

SEC. 74. When the form of lease has been prepared by the commission, the commission shall give notice of intention to lease such lands. The notice shall be published for a period of five consecutive days in a newspaper of general circulation in the county in which such lands or the greater portion thereof are situated and shall state the time (which shall not be less than fourteen days after the last date of publication of the notice) and place for receiving and opening bids, a description of the lands, either as a tract or by parcels, and that the form of lease for the purpose of bidding may be procured at the designated office of the commission.

SEC. 75. At the time and place specified in the notice the commission shall publicly open the sealed bids and shall award the lease for each parcel to the highest qualified bidder, unless in the opinion of the commission, the acceptance of the highest bid for any parcel or parcels is not for the best interests of the State, in which event the commission may reject the bids for such parcel or parcels. Thereupon new bids may be called for and the parcel or parcels for which the bids were rejected may be leased as herein provided.

SEC. 76. Lands, other than tide or submerged lands, belonging to the State and dedicated to a public use may be leased by the commission for the production of oil and gas in accordance with the provisions of this article and of this act in so far as not in conflict with this article.

Article 6. Oil and Gas Leases on Tide and Submerged Lands and Beds of Navigable Rivers and Lakes.

SEC. 85. Tide and submerged lands may be leased by the commission for the extraction of oil and gas in accordance with the provisions of this article and of this act in so far as not in conflict with the provisions of this article. No political subdivison of the State or any city or county or any official of either or any of them shall grant or issue any lease, license, easement, privilege, or permit vesting authority in any person to take or extract oil or gas from tide or submerged lands whether filled or unfilled of which the State is the owner or from which the State has the right to extract oil or gas, or both.

SEC. 86. Whenever it appears to the commission that oil or gas deposits are known or believed to be contained in any such lands and may be or are being drained by means of wells upon adjacent lands not owned by the State, the commission shall thereupon be authorized and empowered to lease any such lands, either as a tract or in parcels of such size and shape as the commission shall determine, for the production of oil and gas therefrom, in the manner provided in this article.

SEC. 87. The commission shall prepare a form of lease which shall contain, in addition to other provisions deemed desirable and necessary by the commission, appropriate provisions contained in this act and the following:

(a) Each well drilled pursuant to the terms of such lease shall be drilled only upon filled lands or shall be slant drilled from an

upland or littoral drill site to and into the subsurface of the tide or submerged lands covered by the lease. The derricks, machinery, and any and all other surface structures, equipment, and appliances shall be located only upon filled lands or upon the littoral lands or uplands, and all surface operations shall be conducted therefrom.

(b) Pollution and contamination of the ocean and tidelands and all impairment of and interference with bathing, fishing or navigation in the waters of the ocean or any bay or inlet thereof is prohibited, and no oil, tar, residuary product of oil or any refuse of any kind from any well or works shall be permitted to be deposited on or pass into the waters of the ocean or any bay or inlet thereof.

SEC. 88. When the form of lease has been prepared by the commission, the commission shall give notice of intention to lease such lands. The notice shall be published for a period of five consecutive days in a newspaper of general circulation in the county in which such lands, or the greater portion thereof, are situated and shall state the time (which shall not be less than fourteen days after the last date of publication of the notice) and place for receiving and opening of bids, a description of the lands, either as a tract or by parcels, and that the form of lease for the purpose of bidding may be procured at the designated office of the commission.

SEC. 89. In any notice of intention to lease tide or submerged lands, the commission may include a requirement that each prospective bidder, as a condition precedent to the consideration of his bid and in addition to the other qualifications required by this act, shall present evidence satisfactory to the commission of his present ability to furnish all necessary sites and rights of way for all operations contemplated under the provisions of the proposed lease. In such event the commission shall reject the bids of all bidders who fail to qualify as provided by this section.

SEC. 90. At the time and place specified in the notice the commission shall publicly open the sealed bids and shall award the lease for each parcel to the highest qualified bidder, unless in the opinion of the commission, the acceptance of the highest bid for any parcel or parcels is not for the best interests of the State, in which event the commission may reject the bids for such parcel or parcels. Thereupon new bids may be called for and the parcel or parcels for which the bids were rejected may be leased as herein provided.

SEC. 91. If the Legislature has transferred to any city or county the administration of the trust, whether or not limited, under which such tide or submerged lands are held by the State, the commission, pursuant to the provisions of this act, may enter into agreements upon behalf of the State to compensate any such city or county for the use of surface drilling and operating sites upon such lands from the royalty or revenue to be derived by the State from oil and gas taken from such lands by lessees of the State.

Any such compensation shall include an amount sufficient reasonably to compensate any such city or county for any damage to or interference with the use or uses to which the surface of such lands are being or may be utilized by or upon behalf of such city or county. The consideration to the State in any such agreement shall include the right to a lessee of the State to carry on all operations on any such

tidelands necessary to accomplish the purposes of this act and such terms and conditions as shall be determined by the commission to be in the interests of the State.

The consideration to the State in any such agreement shall also include a compromise, settlement and release of any and all claims and rights which such city or county has or may have against the State arising out of or in connection with the extraction and removal of oil and gas from such lands as provided in this act.

All money paid to any city or county under this act shall be used by it solely in furtherance of the trust under which the administration of tide and submerged lands has been transferred to such city or county and for the purposes expressed in the act so transferring administration of such lands.

SEC. 92. Should it appear to the commission that any person, association of persons, or corporation, has drilled, or is making preparation to drill, wells upon or into tide or submerged lands for the extraction of oil or gas therefrom, whether or not such person, association of persons, or corporation may be acting under purported authority, the commission shall cause an action to be instituted in the name of and upon behalf of the State in a court of appropriate jurisdiction, to enjoin the occupancy and operations upon or in such lands and to demand compensation for injury and damage, if any, to such lands; except that, should the drilling operations be conducted upon or in lands which have been filled and if such operations have been commenced prior to the date of approval by the Governor of this act, the commission, if it appears to be in the interests of the State, may, upon behalf of the State, issue a lease to any such person, association of persons, or corporation in accordance with the provisions of this act in so far as applicable, and upon a royalty basis, retrospective and prospective, which appears reasonable and just in the circumstances to the lessee and the State.

SEC. 93. The beds of navigable rivers and lakes belonging to the State may be leased by the commission for the production of oil and gas, subject to the same limitations and conditions as are imposed upon tide and submerged lands by this article, and in accordance with the provisions of this act in so far as not in conflict with this article.

SEC. 94. Nothing in this act shall be construed to limit the effect of any grant of tide or submerged lands heretofore made to any city, county or other political subdivision, nor in any manner to prejudice whatever claim the State, on the one hand, or such city, county or political subdivision, on the other, may have in or to the right to extract or authorize the extraction of oil or gas or other minerals underlying such lands.

Article 7. Minerals Other Than Oil and Gas.

SEC. 111. Prospecting permits and leases for the extraction and removal of minerals other than oil and gas from lands belonging to the State, other than tide or submerged lands, may be issued as provided in this article and in this act in so far as not in conflict with the provisions of this article.

SEC. 112. The commission shall issue a prospecting permit, under such rules and regulations as it may prescribe, to any qualified appli-

cant, upon the payment to the commission of one dollar per acre for each acre in area embraced within the boundaries of the lands described in the permit, but no permit shall be issued for any lands which have been classified by the commission prior to such application as containing commercially valuable mineral deposits.

Such prospecting permit shall give to the permittee the exclusive right for a period not exceeding two years to prospect for minerals other than oil and gas upon not to exceed one hundred sixty acres of land wherein such mineral deposits belong to the State.

The commission may, in its discretion, extend the term of any permit for a period not exceeding one year, but the term of any such permit, including extensions, shall be limited to a total of three years.

SEC. 113. If the applicant erects upon the land for which a permit is sought a monument not less than four feet high, at some conspicuous place thereon, and posts written notice on or near the monument, stating that an application for a permit will be made within thirty days after the date of posting the notice, giving the name of the applicant, the date of the notice, and such a general description of the land to be covered by the permit by reference to courses and distances from the monument or from such other natural objects or permanent monuments, or both, as will reasonably identify the land, stating the amount thereof in acres, and if the applicant records a copy of the notice, within two days after the posting thereof, in the county recorder's office of the county in which the land is situated, he shall be entitled to a preferential right over others to a permit for the land so identified for a period of thirty days following such marking and posting.

SEC. 114. In case of an application for a permit or lease covering mineral deposits reserved to the State in lands sold by the State subject to such reservation by any one other than the owner of such lands, such owner shall have six months within which to file an application for a permit or lease, but if such owner fails to comply with the requirements of this act and the rules and regulations made in pursuance hereof, his preferential rights shall thereupon cease and terminate, and the original applicant shall be permitted to proceed with his application.

SEC. 115. The applicant shall, within ninety days after receiving a permit, mark each of the corners of the tract described in the permit upon the ground with substantial monuments, so that the boundaries can be readily traced upon the ground and shall post in a conspicuous place upon the lands a notice that such permit has been granted and a description of the lands covered thereby.

SEC. 116. Upon establishing to the satisfaction of the commission that commercially valuable deposits of minerals have been discovered within the limits of any permit, the permittee shall be entitled to a lease for not more than forty acres of the land embraced in the prospecting permit, if there be that number of acres within the permit. The area to be selected by the permittee shall be in compact form, and if surveyed to be described by the legal subdivisions of the public land surveys; if unsurveyed, to be surveyed by the commission at the expense of the applicant for the lease, in accordance with rules and regulations to be prescribed by the commission, and the lands leased shall be conformed to and taken in accordance with the legal sub-

divisions of such surveys. Such lease shall be upon a royalty, as specified by the commission in the permit, and the annual payment in advance of a rental of one dollar per acre, the rental paid for any one year to be credited against the royalties as they accrue for that year.

SEC. 117. Until the permittee applies for a lease as to that portion of the area described in the permit herein provided, he shall pay to the State twenty per cent of the gross value of the minerals secured by him from the lands embraced within his permit and sold or othewise disposed of or held by him for sale or other disposition.

SEC. 118. All deposits of minerals, other than oil and gas, in lands belonging to the State which have been classified by the commission as lands containing commercially valuable mineral deposits and all deposits of such minerals within lands embraced within a prospecting permit and not subject to preferential lease to the permittee, may be leased by the commission to the highest responsible bidder by competitive bidding under general regulations to qualified applicants in areas not exceeding eighty acres and in tracts which shall not exceed in length two and one-half times the width, in such form as the commission deems to be to the best interest of the State. In addition to the royalty provided therein, each bid and each lease shall also provide for an annual rental payment in advance of such sum as the commission shall specify, which rental shall be credited against the royalties, if any, as they accrue for that year.

SEC. 119. Leases under this article shall be for terms of twenty years with the preferential right in the lessee to renew the lease for successive periods of ten years upon such reasonable terms and conditions as may be prescribed by the commission.

SEC. 120. The commission shall prescribe such additional terms, covenants and conditions, consistent with the provisions of this act, of permits and leases issued under this article as will in its opinion effectually protect the interests of the State in the mineral deposits reserved to it by this act.

Article 8. Miscellaneous Provisions.

SEC. 130. All moneys and remittances received by the State pursuant to this act shall be deposited in the State treasury to the credit of the "State Lands Act Fund," which fund is hereby created. There shall also be transferred to and deposited in said fund the balance of moneys in any appropriation or special fund in the State treasury now remaining or made available by law for the support of the Division of State Lands in the Department of Finance or for the administration of the statutes and laws the administration of which is transferred to the commission by this act. The moneys in said fund are hereby appropriated as follows:

(a) There shall first be transferred to the "school fund" all rents, bonuses, royalties, and profits accruing from the use of State school land.

(b) The moneys transferred to the State lands act fund from existing appropriations and special funds, as provided by this section, shall be expended by the commission only in accordance with law for the support of the Division of State Lands in the Department of Finance and for carrying on the works or performing the duties for which the appropriations were made or the special funds created.

(c) The remainder of the moneys shall be used by the commission, with the approval of the Director of Finance and the consent of the Governor, to carry out the provisions of this act, including the acquisition of real property or interests therein, the purchase of materials and supplies, and the conducting of operations by the State as provided herein, the payment by the State of such sums as may be provided pursuant to agreements or contracts authorized herein, the payment of the necessary expenses of the commission, and the payment of refunds.

(d) Any remaining balance shall be transferred to the general fund on order of the commission, except thirty per cent thereof, which shall be transferred to the "State park maintenance and acquisition fund," which fund is hereby created, to be expended in the manner hereafter provided by law.

SEC. 131. The following acts, together with all amendments thereof, are hereby repealed, but such repeal shall not affect any existing vested rights thereunder or any permit, lease, or agreement entered into under any provision thereof, nor shall it affect the rights or duties of any purchaser of State lands sold prior to the effective date of this act.

"An act to reserve all minerals in State lands; to provide for examination, classification and report on the mineral and other character of State lands; to provide for the granting of permits and leases to prospect for and take any such minerals; to provide for the rents and royalties to be paid, and granting certain preference rights; to provide for the making of rules, regulations and contracts necessary to carry out the purposes of this act; and repealing acts or parts of acts in conflict herewith; providing for an appropriation to defray the cost of administering this act," approved May 25, 1921 (Chapter 303, Statutes of 1921).

"An act to authorize the leasing of certain lands belonging to the State of California containing oil, gas, or other hydrocarbon deposits and providing for the disposition of the moneys received under said leases, and creating a commission to carry out the provisions of this act," approved May 25, 1923 (Chapter 227, Statutes of 1923).

SEC. 132. This act shall not be construed as repealing or otherwise affecting an act entitled "An act relating to lakes and streams, the waters of which contain minerals in commercial quantities; withdrawing State lands within the meander lines thereof from sale; prescribing conditions for taking such minerals from said waters and lands, and providing for the leasing of lands uncovered by the recession of the waters of such lakes and streams," approved April 27, 1911 (Chapter 612, Statues of 1911).

SEC. 133. If any clause, sentence, paragraph or part of this act shall, for any reason, be adjudged by any court of competent jurisdiction to be invalid, such judgment shall not affect, impair, or invalidate the remainder of this act, but shall be confined in its operation to the clause, sentence, paragraph or part thereof directly involved in the controversy in which such judgment shall have been rendered.

SEC. 134. All acts or parts of acts in conflict with the provisions of this act are hereby repealed.

NEW AMENDMENT TO THE 'CAMINETTI ACT,' 1938.

An act to amend section 23 of the Act to create the California Débris Commission, as amended.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 23 of the Act approved March 1, 1893, entitled "An Act to create the California Débris Commission and regulate hydraulic mining in the State of California", as amended by the Act approved June 19, 1934, is hereby further amended by adding at the end thereof the following: "The Secretary of War is authorized to enter into contracts to supply storage for water and use of outlet facilities from débris storage reservoirs, for domestic and irrigation purposes and power development upon such conditions of delivery, use, and payment as he may approve: *Provided,* That the moneys received from such contracts shall be deposited to the credit of the reservoir project from which the water is supplied, and the total capital cost of said reservoir, which is to be repaid by tax on mining operations as herein provided, shall be reduced in the amount so received".

Approved, June 25, 1938.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

The State Personnel Board having approved the addition of a "geological clerk" to the staff of the San Francisco headquarters office, and also the change of classification of the clerk in the Sacramento district office from intermediate stenographer clerk to that of geological clerk, the following appointments to those positions are here recorded:

Miss Elizabeth L. Egenhoff, of Berkeley, a graduate in geology of the University of California, as geological clerk and assistant to the chief geologist of the Division of Mines.

Miss Antoinette Ryan, of San Francisco, a graduate in geology of Stanford University, as geological clerk and assistant to the district mining engineer in the Sacramento office.

New Publications.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, April, 1938, being Chapter 2 of State Mineralogist's Report XXXIV. This chapter contains: "Gold Dredging in Shasta, Siskiyou and Trinity counties"; "Geology of the Central Santa Monica Mountains, Los Angeles County." "Marketing Mica"; also advance statistical data on the production in 1937 of borates, cement, chromite, dolomite feldspar, gypsum, iron ore, magnesium salts, pumice and volcanic ash, silica, slate, soapstone and talc; also a list of mineral specimens recently added to the museum display.

COMMERCIAL MINERAL NOTES (Nos. 181-183, inc.). May, June, July, 1938, respectively. These 'Notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

Tabulations are presented herein showing the complete totals for all substances produced in California during the year 1937, grouped by substances and by counties. The complete detailed annual report on the mineral production of California for 1937 will be available later as Bulletin 116 of the State Division of Mines.

SUMMARY—1937

The total value of the mineral output of California for the year 1937 was $361,515,951, being an increase of $33,711,683 over the total of 1936 which was $327,804,268. There were fifty-seven different mineral substances, exclusive of a segregation of the various stones grouped under gems; and all fifty-eight counties of the state contributed to the list.

As revealed by the data following, the salient features of 1937 compared with the previous year were: All groups such as fuels, metals, industrial minerals, and salines, with the exception of the structural materials, showed an increase in total value. Of the individual mineral products, petroleum showed the greatest increase in value and output, followed in turn by gold, natural gas, brick and hollow building tile, silver, tungsten ore, potash, mineral water, copper, miscellaneous stone, borates, quicksilver, limestone, diatomite, and others; while those showing a decrease in amount and value were cement, granite, magnesium salts, platinum, bituminous rock, pyrite, pumice and volcanic ash, salt, and slate.

Of the fuels, petroleum showed an increase in value of $26,178,687, and an increase in amount of from 214,776,227 barrels to 238,558,562 barrels of crude oil. The average price received for all grades of crude oil was an increase over that received in 1936 although there was no change in the price of crude from June, 1936. Natural gas showed an increase in value and amount from 298,922,708 M cu. ft. worth $18,585,970 to 323,883,714 M cu. ft. worth $19,859,865.

Of the metals, the gold output increased from 1,077,442 fine ounces to 1,174,578 fine ounces; and in value from $37,710,470 to $41,110,230. Silver increased from 2,103,799 fine ounces worth $1,629,392 to 2,888,-265 fine ounces worth $2,234,073; copper from 9,991,799 lbs. worth $919,245, to 10,512,500 lbs. worth $1,272,013, with all other metals showing an increase in output except iron ore and the platinum metals, which showed a slight decrease.

Of the structural materials, miscellaneous stone increased in value from $16,578,238 to $16,917,683 with also lime, marble, magnesite, and sandstone showing increased total values. Cement declined in amount and value from 13,300,188 barrels valued at $18,314,589, to 12,072,062 barrels worth $16,546,229, with all other substances in the group showing lower total values than the previous year.

In the industrial group the total value increased from $5,236,534 to $6,159,918, and with most of the important mineral products therein showing increases, noteworthy were diatomite, limestone, mineral water, pottery clay, gypsum, silica, talc and soapstone. Slight decreases were registered by feldspar, pumice and volcanic ash, and pyrite.

The total value of the saline group increased from $12,416,349 to $13,216,270, with all the larger products showing an increased value with the exception of salt and magnesium salts.

Distribution of the 1937 output of California by substances is shown in the following tabulation:

Substance	Amount	Value	Number of properties
Bentonite	8,425 tons	$140,261	6
Borates	326,099 tons	6,206,619	5
Brick and hollow building tile		3,083,902	43
Cement	12,072,062 bbls.	16,546,229	10
Chromite	1,918 tons	20,830	7
Clay, pottery	354,669 tons	705,200	57
Copper	10,512,500 lbs.	1,272,013	(5)
Dolomite	12,371 tons	24,603	4
Feldspar	2,686 tons	10,930	3
Gems		2,075	5
Gold	1,174,578 fine ozs.	41,110,230	1,751
Granite		207,738	17
Gypsum	186,160 tons	384,431	5
Iron ore	5,490 tons	29,340	4
Lead	2,402,110 lbs.	141,724	(5)
Lime	69,532 tons	681,277	25
Limestone	351,755 tons	830,562	
Magnesium salts	7,733,918 lbs.	313,669	3
Marble		23,667	6
Mineral water	18,309,729 gals.	1,130,810	38
Natural gas	323,883,714 M cu. ft.	19,859,865	(2)
Petroleum	238,558,562 bbls.	237,845,872	
Platinum	530 ozs.	23,704	(5)
Pumice and volcanic ash	10,392 tons	79,005	17
Quicksilver	9,995 flasks	837,789	65
Salt	370,431 tons	1,044,325	12
Sandstone		15,680	6
Silver	2,888,265 fine ozs.	2,234,073	(5)
Silica	84,313 tons	348,987	5
Slate		32,572	7
Soapstone and talc	29,657 tons	347,772	9
Soda	153,685 tons	1,461,057	4
Stone, miscellaneous	(3)	16,917,683	382
Tungsten	611 tons	782,187	8
Zinc	39,643 lbs.	2,577	(5)
Unapportioned[4]		6,813,693	(4)
Total value		$361,515,951	

[1] There were 913 lode mines and 838 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

[2] There was an average of 12,954 producing wells.

[3] Includes macadam, crushed rock, ballast, rubble, riprap, sand and gravel.

[4] Includes barite (2), bituminous rock (2), bromine (2), calcium chloride (2), carbon dioxide (2), coal (3), diatomite (6), fluorspar (1,) iodine (2), magnesite (2), mica (2), mineral paint (3), potash (1), pyrite (1), sillimanite group (2), tube mill pebbles (1), sulphur (1), zircon (1).

[5] Included with gold.

Distribution by counties of the 1937 output for California, by substances, is shown in the following tabulation:

County	Value	Number of mineral products
Alameda	$2,476,302	7
Alpine	22,791	5
Amador	3,917,866	9
Butte	1,798,992	11
Calaveras	3,279,250	12
Colusa	9,424	3
Contra Costa	1,867,309	8
Del Norte	30,647	4
El Dorado	2,607,972	13
Fresno	41,178,791	15
Glenn	136,368	2
Humboldt	100,715	7
Imperial	677,401	14
Inyo	1,439,009	18
Kern	74,162,134	16
Kings	11,008,597	3
Lake	392,585	4
Lassen	86,240	5
Los Angeles	100,337,635	22
Madera	133,165	7
Marin	300,204	4
Mariposa	1,270,774	10
Mendocino	114,705	2
Merced	2,535,126	6
Modoc	36,990	6
Mono	804,925	7
Monterey	262,651	10
Napa	356,146	9
Nevada	11,385,056	9
Orange	22,659,380	7
Placer	1,754,040	12
Plumas	2,354,957	7
Riverside	4,057,127	13
Sacramento	4,230,689	7
San Benito	504,510	6
San Bernardino	16,012,330	26
San Diego	591,479	14
San Francisco	41,825	2
San Joaquin	706,620	6
San Luis Obispo	323,691	13
San Mateo	2,310,784	6
Santa Barbara	10,709,056	10
Santa Clara	722,903	9
Santa Cruz	2,074,463	6
Shasta	2,199,423	8
Sierra	974,680	6
Siskiyou	1,200,351	11
Solano	145,567	4
Sonoma	273,063	8
Stanislaus	940,030	5
Sutter	22,959	3
Tehama	65,193	2
Trinity	721,290	6
Tulare	314,952	10
Tuolumne	1,012,180	10
Ventura	19,230,720	8
Yolo	44,171	3
Yuba	2,587,748	6
Total value	$361,515,951	

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20855 MOLYBDENITE, MoS, molybdenum sulphide. From near Questa, New Mexico.
Donor: V. S. Barber. May, 1938.

20856 Franciscan SANDSTONE. From diamond drill core on west end of San Francisco-Oakland Bay Bridge.
Donor: Jack Zari. May, 1938.

20857 TURQUOISE. From Copper Basin Turquoise Mine of the American Gem Company, eight miles southwest of Battle Mountain, Nevada.
Donor: D. J. Wilson, Mgr. May, 1938.

20858 BARRANDITE, (Al, Fe) $PO_4.2H_2O$, a hydrous phosphate of aluminum and iron. From Gold Metals Mine, Manhattan, Nevada.
Donor: E. Clinton. June, 1938.

20859 CHRYSOCOLLA, $CuSiO_3.2H_2O$, a hydrous copper silicate. From Tumco Mining District, in Cargo Muchacho Mountains, Imperial County, California.
Donor: Thomas M. Smith. June, 1938.

20860 AUGELITE, $2Al_2O_3.P_2O_5.3H_2O$, a hydrous aluminum phosphate. From the White Mountains, Mono County, California.
Donor: C. D. Woodhouse. July, 1938.

20861 WOODHOUSEITE. $2CaO.3Al_2O_3.P_2O_5.2SO_3.6H_2O$, a hydrous aluminum calcium sulphate-phosphate. From the White Mountains, Mono County, California.
Donor: C. D. Woodhouse. July, 1938.

20862 COLORADOITE and CHALCOPYRITE. From Great Boulder, A. M., Kalgoorlie, Western Australia.
Donor: C. D. Woodhouse. July, 1938.

20863 CALAVERITE with chalcopyrite and tetrahedrite. From Boulder Perseverance, A. M., Kalgoorlie, Western Australia.
Donor: C. D. Woodhouse. July, 1938.

20864 CALAVERITE and COLORADOITE. From Boulder Perseverance, A. M., Kalgoorlie, Western Australia.
Donor: C. D. Woodhouse. July, 1938.

20865 CALAVERITE and COLORADOITE, with chalcopyrite and specks of free gold. From Boulder Perseverance, A. M., Kalgoorlie, Western Australia.
Donor: C. D. Woodhouse. July, 1938.

20866 DURDENITE, $Fe_2(TeO_3)_3.4H_2O$, hydrous ferric tellurite. From Goldfield, Nevada.
Donor: Hatfield Goudey. July, 1938.

20867 JAROSITE, $K_2Fe_6(SO_4)_4(OH)_{12}$, a hydrous potassium and iron sulphate. From Goldfield, Nevada.
Donor: Hatfield Goudey. July, 1938.

20868 REALGAR, AsS, arsenic mono sulphide. From Goldfield, Nevada.
Donor: Hatfield Goudey. July, 1938.

20869 REALGAR, AsS; Stibnite, Sb_2S_3. From Goldfield, Nevada.
Donor: Hatfield Goudey. July, 1938.

20870 TOURMALINE. From near the Drummond Mine, Placer County, California.
Donor: W. K. Reed. July, 1938.

20871 ALUNOGEN, $(Al_2SO_4)_3.16H_2O$. Locality not stated.
Donor: Nicholas Baxter. July, 1938.

20872 DIALLAGE, a variety of pyroxene. From Happy Camp, Siskiyou County, California.
Donor: John H. Esselink. July, 1938.

20873 CALCITE (fluorescent). From Brewster County, Texas.
Donor: John H. Esselink. July, 1938.

20874 FLUORITE, CaF_2, after aragonite. From Funeral Mountains, Inyo County, California.
Donor: John H. Esselink. July, 1938.

20875 Iridescent LIMONITE, a hydrous iron oxide. From Swail Mountains, north of Elko, in Elko County, Nevada.
Donor: C. Fischer. July, 1938.

20876 Core from depth of 14,583 ft. Drilling stopped at 15,004 ft. Well later producing between 13,092 and 13,175 ft. From K. C. L. Well A No. 2, near Wasco, Kern County, California.
Donor: Continental Oil Company. July, 1938.

20877 CLINKER formed from the burning of coal seams near the surface. The coal was ignited by prairie fires usually started by lightning. From McKenzie County, North Dakota.
Donor: S. T. Westdal. July, 1938.

20878 Small THRUST FAULT in a Gneiss. Displacement and overlapping of the light colored bands are very marked. From Boulder County, Colorado. Donor: S. B. Fiske. July, 1938.

20879 MALACHITE, copper carbonate—pseudomorph after azurite, from Tsumeb, South West Africa. Exchange. August, 1938.

20880 CHROMITE (black) with UVAROVITE (green) and KAMMERERITE (peach). From west of King City, Monterey County, California.
Donor: C. E. Dolbear. August, 1938.

LABORATORY

GEORGE L. GARY, Acting Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one "Minerals of California," by Adolf Pabst, was published this year by the Division of Mines as Bulletin No. 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

No. 1. Bulletin 113, page 7, last line: 1827 should be *1927*.

No. 2. White grossularite, a calcium-aluminum garnet and brownish-red almandite, an iron-aluminum garnet occurs near the headwaters of the San Benito River in San Benito County.

LIBRARY

JOHN C. O'BRIEN, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, CALIFORNIA JOURNAL OF MINES AND GEOLOGY contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the state are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE SPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

B 895-C Geophysical Abstracts 90, July-Sept., 1937.

Professional Papers:

189 A Species and Genera of Tertiary Noetinae.

189 C Pliocene Diatoms from the Kettleman Hills, Calif.

190 Lower Pliocene Molluska and Echinoids from the Los Angeles Basin, Calif.

Topographic Maps:

Beartrap, Calif.
Beartrap Canyon, Calif., Los Angeles Co.
Bidwell Bar.
Black Mountain, Los Angeles Co.
Camulos.
Colfax.
Damsites, sheets, A-B-C-D-E and F.
Devore, San Bernardino Co.
Gorman.
Kettleman City, Kings Co.
Liebre.
Lethent.
Lost Hills.
Lassen National Forest.
Manzaneta Quad. Los Angeles Co.
Medford, Ore-Calif.
Pacheco Pass Quad.
Plan and Profile of Sacramento River, Calif.
Quail.
Red Bluff.
Redding, Shasta Co.
San Bernardino Quad.
Searles Lake Quad.
Sebastopol.
Ventura.
Yosemite.
Mariposa Quad.

Vegetation Types of California.

Elsinore Quad.
Yosemite National Park.

U. S. Bureau of Mines

Report of Investigations:

3397 Flotation and Agglomerate Concentration of Nonmetallic Minerals. By Oliver C. Ralston.

3399 Bureau of Mines Apparatus for Determining The Dew Point of Gases under Pressure. By W. M. Deaton and E. M. Frost, Jr.

3400 Progress Reports—Metallurgical Division 24. Mineral Physics Studies.

3401 Efficiency of Impingers for Collecting Lead Dusts and Fumes. By J. B. Littlefield, Florence L. Freicht and H. H. Schrenk.

3402 Flow Characteristics, Composition, and Some Liquid-Phase Properties of Hydrocarbon Fluids from a "Combination" Well. By C. K. Eilerts and M. A. Schellhardt.

3407 Earth Vibrations Caused by Mine Blasting Progress Report 2. By J. R. Thoenen and Stephen L. Windes.

Information Circulars:

7008 Verde Antique. By Oliver Bowles and Florence Davidson.

7009 Dewatering and Drying of Coal. By James R. Cudworth and Ellis S. Hertzog.

7010 Advanced Mine Rescue Training Course of the Bureau of Mines. By J. J. Forbes.
7012 Milling Methods and Costs of the Cardinal Gold Mining Co., Bishop Creek, Calif. By Walter B. Lenhart.
7013 Power-Shovel and Dragline Placer Mining. By E. D. Gardner and Paul T. Allsman.
7014 Multiple-Shift Mechanical Mining in Some Bituminous Coal Mines. Progress Report 1. By A. L. Toenges and R. L. Anderson.
7015 Gold Mining and Milling in Northeastern Oregon. By S. H. Lorain.
7016 Smoke Abatement. Selections from Papers by O. P. Hood. By J. F. Barkley.
7019 State Regulations Pertaining to the use of Internal-Combustion Engines in Coal and Metal Mines and in Tunnels. By L. C. Illsley and E. J. Gleim.
7020 Reducing cost of Workmen's Compensation in the Mining Industry. By D. Harrington.
7024 Mining & Milling Methods and Costs of the Golden Anchor Mining Co., Burgdorf, Idaho. By S. H. Lorain and W. Buford Davis.
7025 Some Observations on the Causes, Behavior, and Control of Fires in Steep-Pitch Anthracite Mines. By G. E. McElroy.
7026 A Technique for use of the Impinger Method. By Carlton E. Brown and H. H. Schrenk.
7027 One Hundred-Percent First-Aid Training. Peabody Coal Co., Taylorville, Christian County, Ill. By A. U. Miller.
B. 402. Crushing and Grinding.

Books

The American Philosophical Society Year Book, 1937.
Petroleum and Natural Gas Bibliography, Hardwicke.
Feasibility of Establishing an Iron and Steel Industry in the Lower Columbia River Area Using Electric Pig Iron Furnaces. By Raymond M. Miller. In two volumes, Sections 1 to 7.
Feasibility of Electrolytic Zinc and Cadmium Production in the Lower Columbia River Area. By Raymond M. Miller.
Ground Water. By C. F. Tolman.

The following donation of books was received from W. E. Plank:

California State Mining Bureau Bulletin No. 1.
Proceedings of the 6th Annual Convention of the California Miners Association.
Proceedings of the 7th Annual Convention of the California Miners Association.
Proceedings of the 8th Annual Convention of the California Miners Association.
Mine Development, the Basis of Prospecting. By Almarin B. Paul.
Biennial Message of Gov. R. W. Waterman, 1889.
Total Solar Eclipse, Dec. 1889, etc., Lick Observatory.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.

Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.

Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemmologist, London.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.

Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

ADDENDA

Supplemental Data on El Dorado County Mines (see pp. 206-280 *ante*)

Big Canyon Dredge (Drag-line). On Big Canyon Creek 4 miles east of Latrobe. Geo. King and associates are operating a drag-line with 3-cu. yd. bucket, working a crew of 11 men two shifts and handling over 2000 yards daily. The gravel is yielding a very satisfactory return and it is believed that about two million cubic yards remain to be mined.

Bucks Bar (see ante). Being worked late in 1938 by Horseshoe Mining Company, with a drag-line outfit.

Concordia, Champion, Eden Consolidated and other claims formerly belonging to Thomas Alderson are one mile east of Diamond Springs on the Pleasant Valley road. They occupy part of the Mariposa clay slates on the Mother Lode.

Old workings, run 35 years ago or earlier, include the following:

Champion claim	Open cut 100 ft. long
Cincinnati claim	Open cut 200 ft. long
Concordia claim	Shaft 50 ft.; open cut 100 ft.
Rattler claim	Adit 600 ft., giving 200 ft. depth

Recently Alderson Gee has been doing some work on the Concordia, apparently the first activity on the group for a long time. He reports that in 1933 he sank a new shaft 50 ft. deep 30 ft. south of the old shaft and had 13 tons of ore milled which yielded $11 a ton.

The vein there is reported to average 3 ft. wide but swells and pinches both on the dip and strike. The three veins common to the Mother Lode, called east, middle and west veins are found on these claims and show widths up to 10 ft. On the Rattler claim, Gee states he has a prospect which assays high in gold. The veins and the slate enclosing them, have been turned from the usual northwest course by a quartz porphyrite intrusive, and strike east of north.

Dayton Consolidated Mines Company, a Nevada corporation, Virginia City, Nevada, spent some time prospecting land on three sides of the Black Oak Mine in Garden Valley district. The holdings in which they were interested were the Davey land on the north, the Clark land on the east or hanging wall side and the Davenport land on the strike to the southeast. See under Black Oak Mine, to the owners of which the Dayton company is reported to have transferred their options in January, 1938.

Eagle King Mine. This old mine, 2½ miles northwest of Grizzly Flat, was worked before 1900 by adits, of which the principal one was over 1450 ft. long, with a winze reported 60 ft. deep. It had a 10-stamp mill which was used from 1895 to 1898 inclusive, and during that period over $20,000 was produced.

In June, 1938, B. N. Jackson and E. P. Hurt began work on the property to reopen the adit and sample the veins.

The mine is near the border of the granodiorite with the Calaveras (Carboniferous) formation on the east.

E. R. Skinner Ranch. It is 3½ miles west of Rescue P. O. near the Green Valley road. Henry J. Snyder and Harry Marsh of Grass Valley had this property under lease late in 1937 and early in 1938. There are some good-sized quartz veins which have produced pocket gold, but the lessees were unable to find an ore shoot of any size. After several months work they found a "rich spot" which yielded $10,000 from 36 tons of ore. After removing this they gave up the lease.

In May, 1938, Gilbert Chisholm formed Pilot Knob Mining Company to work the soft, oxidized surface material. A 5-ft. Chilean type mill, gold trap, Wilfley table and corduroy tables were installed and in July, 1938, twelve men were mining and milling from 12 tons to 25 tons of rock daily. Besides the open cut from which ore was being hauled to the mill, a shaft had reached a depth of 75 ft.

Oro Fino No. 1 and No. 2 Claims are a mile south of Garden Valley in a narrow strip of amphibolite schist lying in Mariposa slate. At intervals for 12 years past they have been worked in a limited way by various lessees, with a small production of gold. In August, 1938, John S. Dichesare had the lease and was planning to mill some ore after cleaning out 200 ft. of an adit 250 ft. long. The other workings include a shaft 70 ft. deep and a small open pit.

The vein is from 2 ft. to 12 ft. thick and has been stoped for a length of 20 ft. to 30 ft. to the 70-ft. level. Ore is reported to assay $8 to $10 a ton. There is no mill on the claims and ore in the past has been crushed at the Frog Pond mill, a short distance north. Samuel Collins, Garden Valley, owns both the Oro Fino and Frog Pond mines.

Spanish Oak Prospect. Lot 40 in the N½ sec. 12, T. 11 N., R. 10 E., near the road from Poor's Store to Spanish Flat. Late in 1938, Russell Wilson, operator of the Black Oak Mine, began a shaft here and found a promising showing of gold. John Quiggle, the owner for many years, had previously prospected the land in a small way.

Ore is already being hauled from this property to the mill at the Rozecrans mine.

Tipton Hill Placer Mine. In sec. 3, T. 12 N., R. 11 E., above Rock Creek, into which it drains. This is an old mine worked successively by hydraulicking and drifting. It occupies a bend on a section of white quartz channel, with bedrock 80 ft. below the surface in some of the old workings. The hydraulic pit was opened on the outside of the bend. Adits were run and 4 prospect shafts were sunk. It is said that the slope of bedrock in these indicate the deepest ground has not been opened, and prospecting during the past 7 years has been directed toward opening this. The total amount of old drifting which was 750 ft. 35 years ago, is uncertain. Lately, 270 ft. of adit, largely reclaimed old workings, has been opened, but the objective has not been reached. Frank Irish, Georgetown, is the owner. Ernest Lowell, H. B. Knapp and others have been working under lease. Water costs 25 cents a miner's inch from the Georgetown ditch.

SLATE

Although the black roofing slate deposits of El Dorado County are extensive and have supplied considerable satisfactory material in the past, they are not covered in detail in this report as they have been fully described in our past publications, the last of which was published in October, 1926. Since that time, the only development of importance in slate in the county has been the work of

Pacific Minerals Company, Limited, who have a slate mine and crushing plant at Chili Bar bridge on the south side of South Fork of American River 3½ miles north of Placerville. Started several years ago by Commercial Minerals Company, a business employing from 10 to 20 men has been built up.

Slate is mined underground by wide drifts in order to obtain clean rock. It is crushed in a hammer mill and screened. The larger part of the product is sold in the form of granules which are used for coating prepared roofing. The undersize material is suitable for use as a filler.

The black slate of the Mariposa beds crosses the country from north to south, varying in width from 1 mile to 3 miles. Roofing slate of good blue-black color, of good strength and not fading or softening appreciably in 40 years of use, has come from quarries between Placerville and Kelsey, but largely from *Eureka Slate Quarry,* 1 mile west of Kelsey. This quarry was equipped with hoisting engines, slate saws, and planers and turned out a variety of products for interior use such as sink and table tops, tiling, mantles and electric switchboards. This quarry has been closed for over 20 years.

Other deposits on which some work has been done are

Name of Slate Quarry	Location
Buck	adjoins Chili Bar quarry
California-Bangor	secs. 3, 10, 11, 14 T. 11 N., R. 10. E.
California	secs. 23, 25 T. 11 N., R. 10 E.
Chili Bar	just west of Chili Bar bridge
El Dorado	secs. 6, 7, T. 10 N., R. 11 E.
El Dorado Slate Products Co.	see El Dorado and California
Losh	sec. 25, T. 11 N., R. 10 E.

Bibl: Cal. State Min. Bur. Bull. 38, pp. 150-152; State Mineralogist's Reports, VIII, pp. 199-200; IX, pp. 282-283; XII, pp. 400-402; XV, pp. 306-308; XXII, pp. 446-450.

TUNGSTEN

In June, 1930, B. F. Magee and Lee Wolf found scheelite in sec. 4, T. 11 N., R. 11 E. and located 8 claims calling the group "Comeback Consolidated." In 1931 and 1932 some concentrate was made and sold but no output has been reported since. Besides the old adit that had been already run, a little prospecting has been done since and the property has been examined by several engineers, but disputes regarding ownership are said to have delayed further work.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of California Journal of Mines and Geology, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of California Journal of Mines and Geology.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print. Price Postpaid

**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks ---- ----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks ---- ----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks ---- ----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks ---- ----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks ---- ----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks ---- $0.75
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr. ---- .75
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. ---- ----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr. ---- ----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr. ---- ----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 ilustrations, 10 maps. William Irelan, Jr. ---- ----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps William Irelan, Jr. ---- 1.50
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford ---- ----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford ---- ----
Chapters of the State Mineralogist's Report, Biennial Period, 1913-1914, Fletcher Hamilton:
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper ---- ----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper ---- .75
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper ---- ----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper ---- ----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper ---- ----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper ---- ----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:
A General report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth ---- ----
Chapters of the State Mineralogist's Report, Biennial Period, 1915-1916. Fletcher Hamilton:
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Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Bulletin No. 103. California Mineral Production for 1929, by Henry H. Symons, 1930. 231 pp., paper	----
Bulletin No. 104. Bibliography of the Geology and Mineral Resources of California, to the end of 1930, by Solon Shedd	$2.50
**Bulletin No. 105. Mineral Production in California for 1930 and Directory of Producers	----
Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25
**Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	----
Bulletin No. 108. Mother Lode Gold Belt of California, by Clarence A. Logan, 1934, 240 pp., with geologic and claim maps, cloth	2.25
**Bulletin No. 109. California Mineral Production and Directory of Mineral Producers for 1932, by Henry H. Symons, 200 pp., paper	----
**Bulletin No. 110. California Mineral Production and Directory of Mineral Producers for 1933, by Henry H. Symons, 214 pp., paper	----
**Bulletin No. 111. California Mineral Production and Directory of Mineral Producers for 1934, by Henry H. Symons, 334 pp., paper	----
**Bulletin No. 112. California Mineral Production and Directory of Mineral Producers for 1935, by Henry H. Symons, 205 pp., paper	----
Bulletin No. 113. Minerals of California, by Adolf Pabst, 1938	1.75
Bulletin No. 114. California Mineral Production and Directory of Mineral Producers for 1936, by Henry H. Symons, 199 pp., paper	.80
Bulletin No. 115. Bibliography of Geology and Mineral Resources of California, 1931 to 1936, Supplementing Bulletin No. 104	1.25

PRELIMINARY REPORTS

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin, 4 pp	----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin, 4 pp.	----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.	.05
**Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper	----
**Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper	----
Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton, 1920. 43 pp. Paper	.05
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper	---.
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	---.

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----

MISCELLANEOUS PUBLICATIONS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper	----
Bulletin. Reconnaisance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper	$0.25
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 (15c annually)	Free

MAPS

Register of Mines with Maps

**Register of Mines, with Map, Amador County	----
**Register of Mines, with Map, Butte County	----
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**Register of Mines, with Map, Mariposa County	----
**Register of Mines, with Map, Nevada County	----
**Register of Mines, with Map, Placer County	----
**Register of Mines, with Map, Plumas County	----
**Register of Mines, with Map, San Bernardino County	----
**Register of Mines, with Map, San Diego County	----
Register of Mines, with Map, Santa Barbara County (1906)	.30
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**Register of Mines, with Map, Sierra County	----
**Register of Mines, with Map, Siskiyou County	----
**Register of Mines, with Map, Trinity County	----
**Register of Mines, with Map, Tuolumne County	----
Register of Mines, with Map, Yuba County (1905)	.30
**Register of Oil Wells, with Map, Los Angeles City (1906)	----

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**Map of California, Showing Mineral Deposits (50x60 in.)	----
**Map of Forest Reserves in California	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
**Map of Madera County, Showing Boundaries, National Forests	----
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**Map of Mother Lode Region	----
**Map of Desert Region of Southern California	----
Map of Minaret District, Madera County	.25
**Map of Copper Deposits in California	----
**Map of Calaveras County	----
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**Map of Tuolumne County	----
**Geographical Map of Inyo County. Scale 1 inch equals 4 miles	----
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	----

OTHER MAPS—Continued

	Price Postpaid
Geologic Map of California, 1916. Scale 1 inch equals 12 miles. Shows railroads, highways, post offices and other towns. Geological details lithographed in 23 colors. Mounted	$2.75
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Geologic Map of California, 1938. Scale 8 miles per inch. Lithographed in 80 distinguishing colors and patterns showing geologic units. In 6 sections, each 32 in. x 42 in. Set of 6 sheets, unmounted	4.00
Sheets not sold separately.	
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92. In 4 colors (also sold singly)	----
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt accompanying July-October Chapter of Report XXVIII of the State Mineralogist. (Sold singly)	40
Map of Northern California, showing rivers and creeks which produced placer gold in 1932	.25
Mother Lode Geologic and claim maps in 5 county sections: El Dorado, Amador, Calaveras, Tuolumne and Mariposa. Single sections .25c. Set of 5	1.00
Map of Mariposa County, showing principal gold mines	.25
Geologic Map of Elizabeth Lake Quadrangle, Los Angeles and Kern Counties (accompanying October Chapter of Report XXX), sold separately	.25
Map of Western Portion of Siskiyou County Showing Location of Principal Gold Mines (accompanying July Chapter of Report XXXI), sold separately	.25
Geologic Map of Redding and Weaverville Quadrangles Showing Location of Gold Mines	.25
Map of Ancient Channel System, Calaveras County	.25
Map of Ancient Channels Between San Andreas and Mokelumne Hill	.25

OIL FIELD MAPS

The maps are revised from time to time as development work advances and ownerships change.

	Price (including postage and sales tax)
Map No. 1—Sargent, Santa Clara County	$0.75
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	1.25
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Map No. 4—Brea Olinda and (East Portion) Coyote Hills, Los Angeles and Orange Counties	1.25
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Map No. 7—Sunset and San Emidio, Kern County	1.25
Map No. 8—South Midway and Buena Vista Hills, Kern County	1.25
Map No. 9—North Midway and McKittrick, Kern County	1.25
Map No. 10—Belridge and McKittrick Front, Kern County	1.25
Map No. 11—Lost Hills and North Belridge, Kern County	1.25
Map No. 12—Devils Den, Kern County	1.00
Map No. 13—Kern River, Kern County	1.00
Map No. 14—Coalinga, Fresno County	1.50
Map No. 15—Elk Hills, Kern County	1.25
Map No. 16—Ventura-Ojai, Ventura County	1.25
Map No. 17—Santa Paula-Sespe, including Bardsdale, South Mountain and Camarillo, Ventura County	1.25
Map No. 18—Piru-Simi-Newhall, Ventura County	1.25
Map No. 19—Arroyo Grande, San Luis Obispo County	1.00
Map No. 20—Long Beach, Los Angeles County	1.75
Map No. 21-B—Portion of District No. 5, showing boundaries of oil fields—Fresno, Kings and Kern Counties	1.00
Map No. 21-C—Portion of District No. 4, showing boundaries of oil fields—Kern, Kings and Tulare Counties	1.25

OIL FIELD MAPS—Continued

The maps are revised from time to time as development work advances and ownerships change.

	Price (including postage and sales tax)
Map No. 22—Portion of District No. 3, showing boundaries of oil fields—Santa Barbara County	$0.75
Map No. 23—Portion of District No. 2, showing boundaries of oil fields—Ventura County	1.00
Map No. 24—Portion of District No. 1, showing boundaries of oil fields—Los Angeles and Orange Counties	1.00
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Map No. 27—Santa Fe Springs, Los Angeles County	1.25
Map No. 28—Torrance, Los Angeles County	1.25
Map No. 29—Dominguez, Los Angeles County	1.00
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Map No. 31—Inglewood, Los Angeles County	1.25
Map No. 32—Seal Beach, Los Angeles and Orange Counties	1.25
Map No. 33—Rincon, Ventura County	1.50
Map No. 34—Mt. Poso, Kern County	1.00
Map No. 35—Round Mountain, Kern County	1.00
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Map No. 37—Montebello, Los Angeles County	1.00
Map No. 38—Whittier, Los Angeles County	1.25
Map No. 39—West Coyote, Los Angeles and Orange Counties	1.25
Map No. 40—Elwood, Santa Barbara County	1.25
Map No. 41—Potrero, Los Angeles County	1.00
Map No. 42—Playa del Rey, Los Angeles County	1.50
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Map No. 44—Mesa, Santa Barbara County	1.50
Map No. 45—Buttonwillow gas, Kern County	1.00
Map No. 46—Richfield, Orange County	1.25
Map No. 48—Mountain View and Edison, Kern County	1.25
Map No. 49—Fruitvale, Kern County	1.00
Map No. 50—Wilmington, Los Angeles County	1.25
Map No. 51—Santa Maria Valley, Santa Barbara County	1.00
Map No. 52—El Segundo and Lawndale, Los Angeles County	1.50
Map No 53—Rio Bravo, Greeley, Ten Section and Canal, Kern County	1.25

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER

OF

STATE MINERALOGIST'S REPORT XXXIV

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
CALIFORNIA

65364

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State Mineralogist

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·DEPARTMENT·OF·NATURAL·RESOURCES·
·GEORGE D. NORDENHOLT - DIRECTOR·
·DIVISION·OF·MINES·
·WALTER W. BRADLEY·
·STATE MINERALOGIST·
OUTLINE MAP
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EUREKA
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TRINITY
SHASTA
REDDING
LASSEN
SUSANVILLE
RED BLUFF
TEHAMA
PLUMAS
QUINCY
GLENN
BUTTE
CHICO
OROVILLE
SIERRA
DOWNIEVILLE
WILLOWS
MENDOCINO
COLUSA
YUBA
MARYSVILLE
NEVADA CITY
NEVADA
LAKE
LAKEPORT
UKIAH
SUTTER
PLACER
AUBURN
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IMPERIAL
EL CENTRO
SAN DIEGO
SAN DIEGO
PACIFIC OCEAN
NEVADA
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.
MEXICO

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919-1920 the Mining Bureau was organized into four main geographic divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the location of the branch offices are shown on the accompanying outline map of the state. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

There is no report from the Redding Field District on account of unfinished field work.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field Division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

MINERAL RESOURCES OF INYO COUNTY

W. B. Tucker and R. J. Sampson, Mining Engineers

INTRODUCTION

The field work in this report was carried on at intervals from January until November 1, 1937. The writers devoted most of their attention to the mines actively in operation throughout the county, but also some to obtaining reliable information concerning the many prospects and mining claims that hold considerable promise. Much time was devoted to the nonmetallic and saline deposits of the county.

LOCATION AND DESCRIPTION

Inyo County lies along the eastern border of California and is bounded on the north by Mono County, on the south by San Bernardino County, and on the west by Fresno and Tulare Counties. The county has an area of 10,224 square miles, being the second largest county in California. Independence is the county seat, while Bishop, with about 2000 inhabitants, at present is the center of population. The other towns of importance are Lone Pine, Big Pine, Keeler and Darwin.

Within the borders of the county are both the highest point and the lowest point in the United States. Mount Whitney has an elevation of 14,501 feet, while the lowest point in Death Valley, at Salt Flat is 280 feet below sea level. The Sierra Nevada Range forms the west wall of Owens Valley, and the main divide of the Sierra Nevada forms the western boundary of the county. There are many lofty peaks in the Sierra Nevada Mountains, with elevations from 9000 feet to 14,500 feet, Mount Whitney being 14,501 feet, and next highest peak, Mount Williamson, 14,384 feet. The Inyo Range is the first range of mountains east of the Sierra Nevada. Between these two ranges lies the deep depression of Owens Valley, at whose south end is Owens Lake. The floor of Owens Valley is from two to eight miles wide. The Inyo and White mountains form the east wall of Owens Valley. The range trends northwestward, on the south being separated from the Coso Mountains by a broad depression and on the north terminating in Mount Montgomery, elevation 13,442. The average elevation of the range is 10,000 feet. The eastern border of this range is not sharply marked. In its northern part it is marked by Fish Valley, but between this valley and Saline Valley, to the south, there is an irregular mountainous area that is not clearly separated from the Inyo Range nor the mountain ranges to the east. Still farther, south, the deep elliptical depression known as Saline Valley, whose floor is 2500 feet lower than that of Owens Valley, separates the Inyo Range from the Ubehebe Range on the east. In the northeastern portion of the county, Eureka Valley is located between the White Mountains and the Last Chance Range of mountains. Panamint Valley, which is located between the Argus Range of mountains on the west and the Panamint Range of mountains on the east, extends in a northwesterly direction from the southern boundary line of the county for a distance of about 45 miles, and is from two to

10 miles in width. The Panamint Range of mountains extends from the southern boundary line of the county in a northerly direction, a distance of approximately 75 miles, where it connects with the Last Chance, and Ubehebe mountains.

The highest point of this range is Telescope Peak, with an elevation of 11,045 feet, located north of Panamint City. The Panamint Range of mountains forms the western boundary of Death Valley while the eastern limit of the valley is the Amargosa Range, which is made up of the Grapevine, Funeral and Black mountains. Death Valley extends northwesterly from the southern boundary of the county, a distance of about 90 miles to where it runs into Lost Valley. The floor of Death Valley is from five to ten miles wide.

CLIMATE

Because of the great range in the altitude of the region, the climate in different parts of it is quite diverse. In general, the climate is typical of the southern half of this Great Basin, of which it is a part. In Owens Valley the summer temperature often exceeds 100 degrees, yet owing to the low humidity, it does not become oppressive; but in the deep depressions that are encircled by high mountains, such as Saline, Panamint and Death valleys, the temperature is oppressively hot from June to October, without intermission day or night. The winters are comparatively mild in the valleys. The average precipitation ranges from 3 inches a year in Owens Valley to 40 inches on the Sierra Nevada crest. Sufficient snow falls on the higher peaks of the mountains east of the Sierra Nevada to support several small perennial streams.

DRAINAGE AND WATER SUPPLY

The principal streams of the region are the Owens River and the Amargosa River. The Owens River rises in the Sierra Nevada Mountains near San Joaquin pass, and enters Owens Valley north of Bishop, and meanders through Owens Valley southward towards Owens Lake. Practically all of its tributaries enter from the west, and are fed almost wholly by snows that accumulate just east of the main sierran divide. The water of Owens River flows into the Los Angeles aqueduct. The intake of the aqueduct is 13 miles north of Independence. This main canal has a capacity of over 800 cubic feet per second and a width of 65 feet on the bottom. It diverts the river and various tributaries as they are passed, discharging into the Hawiee reservoir 60 miles below the intake. The Hawiee reservoir has a capacity of 63,800 acre feet. The Amargosa River rises in springs north of Beatty, Nevada, and flows southward across the Amargosa Desert and through Franklin Lake to Resting Springs Lake. It enters a narrow canyon south of Tecopa, between the Black and Kingston mountains, and there spreads out forming a great dry wash, where it is joined by the South Amargosa, which rises in Silurian Lake. The river takes a broad turn to the westward around the south end of Black Mountain, and enters Death Valley flowing northwestward in the region of Saratoga Springs.

TRANSPORTATION
RAILROADS

Two railroads enter the county, the Southern Pacific and the Tonapah and Tidewater. The Nevada and California, a narrow gauge line,

a part of the Southern Pacific system, passes along the east side of Owens Valley. It connects with the Tonapah branch of the Southern Pacific Railroad at Mina, Nevada, and its southern terminus is at Keeler, on Owens Lake. The broad-gauge branch of the Southern Pacific runs from Mojave, Kern County, to Owenyo, where it connects with the narrow-gauge line from Keeler. The Tonopah & Tidewater Railroad has its terminus at Ludlow, San Bernardino County, where it connects with the Santa Fe Railroad. This railroad runs north from Ludlow, and follows the Amargosa River through the extreme eastern part of the county, serves with spur tracks the Tecopa Lead-Silver Mines, Furnace Creek borax mines, and the mining districts near the California-Nevada boundary line.

DEATH VALLEY NATIONAL MONUMENT

The Death Valley National Monument, comprising an area of approximately 1,601,800 acres, was established on February 11, 1933, and all land therein not held under valid existing rights was withdrawn from entry. The restriction thus imposed on mining in this region was removed later by passage of the Act of June 13, 1933, extending the mining laws of the United States to the Death Valley National Monument.

The Director of the National Park Service, under the direction of the Secretary of the Interior, has the supervision, management, and control of the Monument.

The Death Valley National Monument, which is located in the eastern portion of the county and extends from the San Bernardino County line north to Grapevine Canyon, includes the major portion of Death Valley. The eastern boundary along the California-Nevada boundary line is the Funeral Range of Mountains, and on the western boundary is the Panamint Range of Mountains. Within the boundaries of the Death Valley National Monument are a number of mining districts which have been active and productive in the past.

ROADS

Since the report of October, 1926, on the mineral resources of Inyo County, the roads of the county have been greatly improved and the State Highway Commission has taken over the more important routes, which routes are paved, or are being reconstructed and paved.

The main state highways are as follows:

1. The main highway route from Los Angeles, via Mojave to Bishop, enters the county south of Little Lake and runs through Owens Valley to Bishop (known as U. S. Highway 395).

2. The Midland Trail on Westgard Pass Highway, starts from Big Pine and passes through Payson Canyon, Deep Springs Valley, Oasis, to Goldfield, Nevada (State Highway 3).

3. A new highway from Olancha to Darwin Wash, across the Panamint Valley and through Townsend Pass to Stove Pipe Wells, in Death Valley, from which it crosses the Amargosa Range to Beatty, Nevada (known as State Highway 190).

4. The Big Pine and Saline Valley road leaves Big Pine and Alvord and passes through Waucoba Canyon and down Marble Canyon to Saline Valley.

5. Another route to Saline Valley from Lone Pine passes through Keeler and over Darwin-Keeler road to Lee Flats in a new highway system; from there by county road, following northward a canyon which lies east of Inyo Range of mountains to Saline Valley.

6. Another approach to Death Valley is via Baker, San Bernardino County, entering the county near Tecopa, then north to Shoshone to Death Valley Junction where it meets Highway 190. This highway is known as State Highway 127.

7. The establishment of the Death Valley National Monument has caused the National Park Service to construct new roads and improve the old roads within the monument. Such approach roads as the Trona, Ballarat and Wildrose canyon roads have been improved and widened, so as to make travel by automobile and truck quite easy. The park service has been of considerable help to mine operators within the monument in helping repair and build roads to the different mines that are under operation.

GENERAL GEOLOGY

The general geology of the county has been described in detail in the Fifteenth Report of the State Mineralogist, pp. 45 to 60, with the geological map accompanying; also shown on state geologic map of 1938.

The geology of the Inyo Range and the eastern slope of the Southern Sierra Nevada is covered in detail by Adolph Knopf in Professional Paper 110, published by the United States Geological Survey.

"The Geology of a Part of the Panamint Range" by F. M. Murphy was published in the July and October, 1932, issue of Mining in California, pp. 329-376.

Dr. L. F. Noble, geologist for the National Park Service, is at present making a geological survey of the Death Valley region included within the Death Valley National Monument, which when completed will be of great value to those interested in the geology of this region which is located in the eastern part of Inyo County.

The geology and ore deposits of the Darwin Silver-Lead Mining District are described on pp. 503-562, and the sulphur deposits on pp. 563-590.

The eastern slope of the Sierra Nevadas is a great fault escarpment. It attains its greatest and most abrupt relief west of Owens Valley, rising from 3000 feet on Owens Lake to 14,500 feet on Mount Whitney.

The escarpment of the Sierra Nevadas is composed of granite rocks. Granite forms the backbone of the Inyo and White mountains, and of the Panamint Range.

East of Owens Valley, old Paleozoic metamorphic sediments, consisting of limestone, quartzites, and schists, make up most of the mountain ranges.

These are extremely folded and faulted, due principally to granitic intrusions. Overlying the Paleozoic metamorphics of the Inyo Mountains, in places, is an unconformable series of Mesozoic metamorphic rocks consisting of crystalline limestone and slates which in places are fossiliferous. The post-Jurassic (middle Mesozoic) uplift in this region was accompanied by granitic intrusions and the great fault along the east face of the Sierra; also by mountain-making to the eastward, at

which time, or following, the Inyo, White, Panamint, and Amargosa mountain ranges were formed more or less parallel to the fault line.

Intrusions of porphyry and diorite followed, with outbursts of rhyolite, andesite and basalt.

A large area of volcanism was found in the Coso Mountains, and lava broke out along fractures on both sides of Death Valley and eastward. Molten rock also flowed from the main fault along the Sierra, eastward across Owens Valley, south of Big Pine and north of Bishop. In the meantime, early Tertiary sediments were being deposited in the Death Valley region, and saline deposits were forming from the evaporating sea waters. Smaller uplifts and earth movements took place during the readjustment of the cooling mass and Pleistocene lake deposits were laid down in several of the larger inclosed basins, such as in the lower Amargosa and Waucoba Canyons.

POWER

Electric power, generated in the Sierra west of Bishop is available in the northern and western parts of the county. The eastern and central portions of the county are dependent on internal combustion engines. Two power companies have hydro-electric plants on Bishop Creek. The Nevada-California Power Company, owning three plants, confines its operation exclusively to the State of Nevada. The Southern Sierras Power Company has two hydro-electric plants on Bishop Creek. Its lines extend from the plants on Bishop Creek down Owens Valley, with a branch to Keeler; to Big Pine and to Palmetto, Nevada.

The Bureau of Power & Light of the City of Los Angeles operates hydro-electric plants located on Cottonwood Creek, and also a plant below Haiwee reservoir.

MINERAL RESOURCES

The principal mineral resources of the county are antimony, asbestos, barytes, bentonite, borates, copper, dolomite, gems, gold, gypsum, lead, marble, molybdenum, quicksilver, slate, soda, sulphur, talc, tungsten and zinc. Deposits of feldspar, iron, niter, potash and silica occur but have not been developed. Seventeen different mineral substances were produced in 1935.

The following table shows the mineral production from the year 1880 to 1935 inclusive, and the development of the mining industry.

ACKNOWLEDGMENTS

Appreciation is here expressed for the courteous treatment and cooperation of operators and owners of properties throughout the county. Acknowledgments are especially due to Messrs. B. M. Holman, Bishop; H. A. Van Loon, Bishop; Arthur P. Cortelyou, U. S. Vanadium Co., Bishop; Roy Troeger, Estelle Mining Co., Keeler; J P. Hart, Keeler; Ralph Merritt, Independence; Sam Spear, Lone Pine; W. A. Reid, Sierra Talc Co., Keeler; N. W. Sweetser, Ruth Mine, Trona; and F. J. Sanders, Santa Barbara.

The last complete survey of the mineral resources of Inyo County was published in Report XXII of the State Mineralogist, pp. 453 to 530, 1926, and since that publication there has been a considerable

revival of the mining of both metal and nonmetallic minerals. On January 30, 1934, the Gold Reserve Act of 1934 was passed, followed by the President's proclamation of January 31, 1934, which fixed the weight of the gold dollar at 15$\frac{5}{21}$ grains, nine-tenths fine. The value of gold thereby became $35 a fine ounce.

This increase in the price of gold led to a revival of gold mining in the different gold districts of the county, such as the Argus and Panamint districts, and to the reopening of Wilshire-Bishop Creek Mine, now known as Cardinal Mine on Bishop Creek west of Bishop. With the increase in the price of tungsten, there is revival in the development of the tungsten deposits in Round Valley, and Tungsten City areas. The U. S. Vanadium Company during the past year acquired the Pine Creek Tungsten Mine, which is being rehabilitated and developed for both the tungsten and the molybdenum content. The increase in the price of lead and zinc, during the early part of 1937, led to the reopening of a number of lead-silver mines in the Cerro Gordo, Darwin, and Saline Valley districts. At Darwin, the properties of the American Metals Inc. have been acquired by the Darwin Lead Company of Los Angeles, which has installed a 50-ton concentration plant on the property to treat low-grade ores of the Defiance, Independence, and Thompson mines. The installation of two custom mills (one at Keeler Gold Mine, near Keeler, and the Journigan's mill near Emigrant Springs), has caused increased activity in gold mining in the Skidoo and other districts.

The development of the sulphur deposits in the Last Chance Range of mountains during the past three years, has resulted in the shipment of high-grade sulphur for marketing on the Pacific Coast. There has been some activity in mining and development of talc deposits in the Darwin and Saline Valley districts.

MINERAL PRODUCTION OF

Year	Gold, value	Silver, value	Lead		Copper		Zinc		Borax, value
			Pounds	Value	Pounds	Value	Pounds	Value	
1880	$48,648	$173,916							
1881	170,000	140,000							
1882	220,000	130,000							
1883	90,000	38,000							
1884	80,000	82,000							
1885	24,998	73,461							
1886	20,156	101,670							
1887	10,649	103,370							
1888	25,000	75,000							
1889	193,957	30,706							
1890	62,432	88,320							
1891	35,466	112,730							
1892	13,930	35,995							
1893	25,945	52,475							
1894	52,639	83,640	900,000	$27,000					$81,298
1895	92,142	188,329	1,498,000	46,438					40,000
1896	238,507	108,619	1,220,000	36,600					24,900
1897	159,840	50,063	564,000	19,176					
1898	137,107	73,503	580,000	21,170	49,829	$3,986			33,000
1899	114,187	57,529	662,000	28,135					24,000
1900	213,655	113,483	971,000	38,840					13,901
1901	162,406	56,573	601,000	24,040	8,566	1,349			24,250
1902	74,397	14,484	257,500	9,013	1,100	126			36,394
1903	66,045	18,200	95,000	3,420	23,450	3,098			26,400
1904	150,474	7,122	124,000	5,270	25,508	3,252			
1905	135,959	29,741	345,680	16,247	151,606	23,649			
1906	19,449	13,358	208,018	11,857	4,145	800			
1907	57,241	44,440	261,140	13,096	6,779	1,356	144,213	$8,598	*
1908	308,873	30,900	683,401	28,244	6,820	938			*
1909	457,486	47,117	2,364,137	131,199	39,888	5,073			*
1910	408,509	129,590	2,866,227	127,385	58,801	7,489			*
1911	574,945	45,678	1,182,122	53,195	27,889	3,486	*		*
1912	369,758	45,316	1,207,593	54,342	48,584	8,016	*		*
1913	237,310	136,854	3,322,308	146,182	113,860	17,648	*7,149,523	449,701	*
1914	275,000	255,000	4,626,934	180,450	336,423	44,744	399,641	20,381	*
1915	317,905	127,894	4,323,639	203,211	154,722	27,076	4,625,162	573,520	*8,162,727
1916	131,722	232,441	11,185,321	771,787	274,032	67,412	5,758,703	771,666	(1)
1917	125,394	534,599	19,318,642	1,661,403	175,273	47,850	3,535,000	359,550	(1)
1918	100,240	441,548	12,223,471	867,866	338,518	83,614	2,517,045	229,051	(1)
1919	69,560	194,151	3,643,485	193,105	169,713	31,567	1,192,353	87,042	(1)
1920	55,634	258,929	4,612,338	368,987	144,286	26,549	(1)		
1921	80,373	86,020	1,052,253	47,351	45,725	5,898			
1922	85,265	256,009	6,264,138	344,528	69,537	9,388	(1)		(1)
1923	36,702	265,023	9,541,868	667,931	77,349	11,370			(1)

* Combined to conceal individual annual output.
[1] See under 'Unapportioned.'
[2] Includes antimony, borax, gypsum, marble, molybdenum, salt, tungsten.
[3] Includes asbestos, barytes, borax, gypsum, marble, molybdenum.
[4] Includes borax, dolomite, marble, pumice, salt, soda, talc, tungsten.
[5] Includes borax, dolomite, fuller's earth, marble, volcanic ash, salt, talc, zinc.
[6] Includes borax, building stone, marble, pumice, soda.
[7] Includes borax, building stone, clay (pottery), fuller's earth, limestone, marble, pumice, soda, talc, zinc.
[8] Includes building stone, borates, fuller's earth, gems, marble, pumice, tungsten concentrates.

INYO COUNTY, 1880-1937

Soda		Soapstone and talc		Marble		Miscellaneous and unapportioned		
Tons	Value	Tons	Value	Cu. ft.	Value	Amount	Value	Substance
1,530	$20,000			12,500	$62,500			
1,900	47,500			10,000	50,000			
3,000	65,000			3,000	24,000			
5,000	110,000							
7,000	154,000			4,000	12,000			
10,000	250,000							
1,000	50,000					20 tons	$700	Antimony.
8,000	400,000							
7,000	50,000							
*	*			20,000	20,000	300 tons	2,400	Salt.
*	*			3,000	3,000	400 tons	800	Salt.
*	*			17,000	17,000			
*	*			1,200	4,800			
*	*			1,000	4,000			
*	*							
*	*						1,417,217	Unapportioned, 1900-1909.
*	*					45,000 tons	31,500	Rubble.
*	*					46,450 tons	32,555	Rubble.
							174	Gems.
*	*	1,050	$5,250				648	Rubble.
*	*	1,000	4,400	3,200	11,500		835	Rubble.
						13,500 tons	54,000	Salt.
*	*	390	2,060	3,500	10,500	13,500 tons	54,000	Salt.
112,937	*496,250	1,513	14,000				80,430	Antimony, dolomite, marble, pumice, salt.
			Totals	[1]78,400	$219,300			
				Miscellaneous stone[1], value				
10,593	264,825	685	4,606		23,040	3,596 tons	14,700	Dolomite.
							2,317,897	Other minerals.[2]
19,604	861,160	4,736	41,044		3,000	11,315 tons	22,630	Dolomite.
							2,639,600	Other minerals.[3]
						14,390 tons	32,056	Dolomite.
(1)		9,635	72,549		5,000	589 tons	854,025	Tungsten concentrates.
							2,491,727	Borax, limestone, salt, soda.
(1)		(1)			7,850	2,360 tons	12,000	Limestone.
							2,097,271	Other minerals.[4]
23,132	933,023	(1)			1,190	15,240 tons	31,080	Limestone.
							2,214,008	Other minerals.[5]
						22,112 tons	49,073	Dolomite.
(1)		4,350	77,250		16,250	1,185 tons	8,295	Fuller's earth.
							1,089,708	Other minerals.[6]
						43,778 tons	72,284	Dolomite.
(1)		(1)			12,000		1,358,207	Other minerals.[7]
						47,542 tons	79,793	Dolomite.
24,116	662,747	5,981	104,976		19,500		997,539	Other minerals. [8]

MINERAL PRODUCTION OF

Year	Gold, value	Silver, value	Lead		Copper		Zinc		Borax, value
			Pounds	Value	Pounds	Value	Pounds	Value	
1924	$19,997	$115,799	4,813,718	$385,098	79,995	$10,479			(1)
1925	43,774	117,763	6,307,105	548,196	73,003	10,367	145,000	$11,020	(1)
1926	26,871	77,693	6,541,741	523,339	42,462	5,945	76,889	5,767	(1)
1927	10,109	47,384	2,173,032	136,901	30,010	3,931			(1)
1928	10,781	23,948	1,733,120	100,421	22,250	3,204			(1)
1929	16,889	23,209	1,335,831	84,157	17,733	3,121			(1)
1930	20,466	42,961	3,452,159	172,608	19,607	2,549			(1)
1931	40,603	41,311	3,703,232	137,020	8,542	777			(1)
1932	42,113	24,105	2,204,108	66,123	12,672	798			(1)
1933	62,312	7,332	601,135	22,241	7,940	508	255,944	10,741	(1)
1934	266,109	25,943	530,037	19,611	33,363	2,669	721,719	31,034	(1)
1935	656,339	27,621	578,583	23,143	42,589	3,535	274,725	12,088	(1)
1936	744,135	39,895	556,399	25,594	57,230	5,265			(1)
1937	620,585	78,899	1,908,280	112,589	71,080	8,601	22,364	1,454	(1)
Totals	$8,911,328	$5,877,669	133,143,695	$8,505,429	2,770,879	$497,483	26,808,281	$2,571,613	[1]$8,466,870

[1] See under 'Unapportioned.'

[9] Includes alum, borates, building stone (tuff), fuller's earth, glauber salt, lime, limestone, magnesium, sulphate, pumice, radio galena crystals, soda (ash and bicarbonate), tungsten concentrates.

[10] Includes borates, building stone (tuff), fuller's earth, graphite, limestone, pumice, soda (ash and bicarbonate), tungsten concentrates.

[11] Includes borates, building stone (tuff), dolomite, gems, limestone, salt, tungsten concentrates.

[12] Includes borates, building stone (tuff), dolomite, fuller's earth, lime.

[13] Includes borates, dolomite, fuller's earth, gems, granite (tuff), salt, tungsten.

[14] Includes borates, dolomite, fuller's earth, gems, granite (tuff), limestone, marble, pumice, salt, tungsten.

[15] Includes barytes, bentonite, borates, dolomite, gems, granite (tuff), lime, marble, mineral water, pumice, salt, silica, talc, tungsten.

[16] Includes barytes, bentonite, borates, dolomite, lime, limestone, pumice, quicksilver, talc, miscellaneous stone.

[17] Includes bentonite, borates, dolomite, feldspar, quicksilver, silica, slate, talc, soda, sulphur.

[18] Includes bentonite, borates, pottery clay, molybdenite, silica, slate, talc, soda, sulphur, tungsten.

[19] Includes bentonite, borates, dolomite, gems, slate, soda, sulphur, talc.

[20] Includes bentonite, borates, dolomite, quicksilver, slate, talc, soda, sulphur, stone miscellaneous.

[21] Includes bentonite, borates, dolomite, onyx, quicksilver, talc, soda, stone miscellaneous, sulphur, tungsten, slate.

[22] Includes bentonite, borates, dolomite, iron ore, quicksilver, slate, soda sulphur, talc and tungsten ore.

INYO COUNTY, 1880-1937—Continued

Soda		Soapstone and talc		Miscellaneous stone, value	Miscellaneous and unapportioned		
Tons	Value	Tons	Value		Amount	Value	Substance
(1)	----------	5,942	$98,806	$12,500	17,197 tons	$37,491	Dolomite.
					----------	1,429,925	Other minerals.[9]
(1)	----------	5,335	89,134	----------	----------	1,764,891	Other minerals.[10]
					2,275 tons	20,130	Fuller's earth
60,473	$1,232,081	6,487	98,563	12,000	300 tons	1,750	Pumice.
					----------	831,695	Other minerals.[11]
					344 tons	2,496	Pumice.
53,328	1,293,379	7,009	99,416	6,000	----------	920,218	Other minerals.[12]
					163 tons	1,630	Pumice and volcanic ash.
86,664	1,292,165	8,563	121,177	44,831	----------	234,410	Other minerals.[13]
70,440	1,525,060	8,274	120,875	224,625	----------	298,275	Other minerals.[14]
67,119	1,273,098	(1)	----------	310,675	----------	438,409	Other minerals.[15]
56,251	903,511	(1)	----------	(1)	----------	224,486	Other minerals.[16]
					431 tons	4,845	Pumice and volcanic ash.
(1)	----------	(1)	----------	5,800	----------	580,237	Other minerals.[17]
					48,487 tons	164,987	Dolomite.
(1)	----------	(1)	----------	18,690	894 tons	4,150	Pumice and volcanic ash.
					----------	724,346	Other minerals.[18]
					673 tons	5,115	Pumice and volcanic ash.
(1)	----------	(1)	----------	66,081	----------	877,163	Other minerals.[19]
					594 tons	10,034	Pumice and volcanic ash.
(1)	----------	(1)	----------	(1)	----------	827,046	Other minerals.[20]
					1,567 tons	18,492	Pumice and volcanic ash.
(1)	----------	(1)	----------	(1)	----------	633,466	Other minerals.[21]
					2,721 tons	29,518	Pumice and volcanic ash.
(1)	----------	(1)	----------	22,087	----------	565,276	Other minerals.[22]
[4]629,107	$11,883,779	[17]0,950	$954,106	$794,789	----------	$27,739,936	

METALS

ANTIMONY

Nemo Canyon Antimony Mine. It comprises 6 claims located in Nemo Canyon, in the Panamint Range of mountains, six miles northeast of Wildrose; elevation, 5000 to 6000 feet; owner, Farlansee Wells, of Death Valley Junction. Development consists of open cuts and shallow shafts. Samples taken from the deposit were reported to carry 40% antimony.

Wildrose Mine. This deposit is located in the Wildrose Mining District, on the western flank of the Panamint Mountains, south of Wildrose Canyon and 45 miles by road north of Trona; elevation, 5000 ft. Holdings comprise 4 patented claims; formerly owned and worked by the Western Metals Corp., of Los Angeles. This company mined approximately 4000 tons of ore reported to carry 42% metallic antimony. Eleven claims were recently located by T. F. Pierson and Associates, of Los Angeles.

Bibl.: State Mineralogist's Report XII, p. 21; XV, p. 60; XXII, p. 462.

Williams and Johnson Antimony Mine. It is located on the eastern slope of the Argus Mountains, between Revenue and Shepherd canyons, 14 miles by road north of Trona; owners, Ralph Williams and George Johnson, Bishop, Calif. Idle.

COBALT

Bishop Silver-Cobalt Mines. It comprises 6 claims situated in the Sierra Nevada Range of Mountains, at an elevation of 11,000 to 12,000 ft., on a ridge east of Long Lake, in Sec. 14, T. 9 S., R. 31 E., M. D. M., 25 miles southwest of Bishop. The property is reached by auto road to Parcher's Camp from Bishop, a distance of 23 miles; then by trail from South Lake to Long Lake, a distance of 2½ miles; owner, Bishop Silver-Cobalt Mines, Inc., Jack O'Brien, president, Bishop, Calif. The discovery of cobalt on the property was made by Jack O'Brien in 1920.

On the Copconis claim cobalt occurs as coatings and incrustations of erythrite (cobalt bloom) associated with argentite, arsenopyrite, chalcopyrite and pyrite in quartz-barite vein on contact of limestone. There are also coatings of annabergite which is an indication of the presence of nickel minerals that have been oxidized and it is often associated with erythrite. The ore carries values in gold, silver, copper and cobalt, with traces of nickel. The gangue minerals are quartz, calcite, barite, feldspar and wollastonite. The lode outcrops for a distance of 3000 ft. in a northerly and southerly direction. The width of mineralized vein outcrop is about 500 ft. Dip of lode is 70 to 80° W. This lode of crystalline rocks occurs in granite and in a number of places there are sills of granite intruded. On ridge southeast of main workings, there is a massive belt of dolomite which strikes N. 20° E. This dolomite, near contacts with crystalline rocks, is mineralized with argentite, arsenopyrite, galena, pyrite with values

in gold. The mineralization extends into the dolomite for widths of 30 to 100 ft. Samples at different points along this dolomitic limestone are reported to carry from 0.21 to 0.50 oz. in gold and from 14 oz. to 31.00 oz. in silver per ton.

The principal development work has been confined to the Copconis claim. At an elevation of 11,500 ft., a crosscut tunnel was driven N. 20° E. 146 ft. to cut the orebody developed by opencuts along the outcrop. These opencuts are 85 ft. in elevation above tunnel level. The orebody developed by opencuts along the outcrop is 30 ft. in width and 300 ft. in length. The face of the tunnel is reported in ore. Samples of ore taken from two opencuts above the tunnel are reported to have an assay value of .03 oz. in gold, 25.07 oz. in silver, with 2.49% in cobalt. In opencut south of tunnel, there is a vein of quartz 2 ft. wide with incrustations of cobalt bloom. Over a width of 8 ft. to contact with limestone on footwall, the quartz-rock is heavily stained with cobalt bloom. A shipment of ore to the United States Smelting Co., assayed 70.40 oz. in silver and $4.96 per ton in gold.

A drift has been started south from the present tunnel level to intersect cobalt-silver orebody exposed on the surface and the possibilities appear favorable to the development of an orebody carrying values in cobalt and silver.

One man is employed on development.

COPPER

There are deposits of copper in many localities in Inyo County but at the present time there is practically no activity in their development. The greatest production of copper has come from its association with gold, silver and lead ores containing a small percentage of copper.

Copper ores occur in the Ubehebe, Darwin and Greenwater districts. In the Ubehebe and Darwin districts, the ores are found mostly in limestone, in contact with quartz-monzonite or close to it. The Greenwater District is on the eastern slope of the Black Mountains. In the above-mentioned districts the ore consists of oxide of copper, principally malachite, azurite, chrysocolla and cuprite.

For information on different mines the reader is referred to Bulletin 50, State Mineralogist's Report XV, pp. 71, 73; XXII, pp. 463 to 465.

GOLD

There has been considerable activity in gold mining throughout the county from 1934 to date due to increase in the price of gold to $35 per fine ounce.

A number of formerly productive gold properties have reopened and are under development in the Argus, Panamint, Inyo, White, and Funeral mountains. The most noteworthy has been the reopening of the Wilshire-Bishop Creek Mine by the Cardinal Gold Mining Company, and at present writing it is the largest gold producer in the county. In the Wildrose Mining District in the Panamint Range the Skidoo Mine has been reopened during the past two years, the ore from this property being hauled to Journigan's mill, located near Emigrant Springs, for treatment.

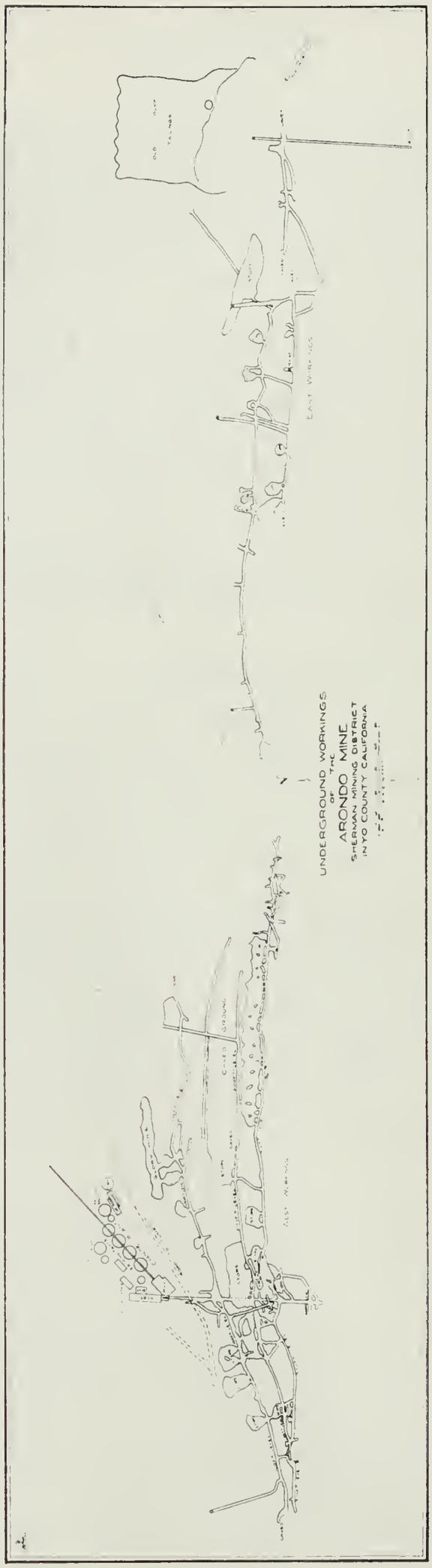

UNDERGROUND WORKINGS
OF THE
ARONDO MINE
SHERMAN MINING DISTRICT
INYO COUNTY CALIFORNIA

FIG. 1.

In this district an important discovery was made on the Del Norte group of claims a few miles north of the Skidoo Mines, indicating a large deposit of low-grade gold ore. In the Argus Range the Arando, Ruth and Mohawk mines have been under operation with some production. The gold placers of Mazourka and Marble canyons in the Inyo Range are being worked in a small way, and some production made. The Cottonwood and Crooked creek placers in the White Mountains on the boundary line of Inyo and Mono counties are being prospected and tested for the purpose of being operated with mechanical equipment.

Alabama-Mohawk Mine (Mohawk). This property comprises 5 claims, situated in the Alabama Hills, 5 miles northwest of Lone Pine; owner, James H. Hodgman and Frank Hilton, of Lone Pine, California; under lease and bond to Alabama Blue Ridge Mining Company, V. R. Ingalls, president, 120 N. Small Drive, Beverly Hills, California.

The vein occurs along an andesitic dike in granite. The vein varies from 2 in. to 18 in. in width. Strike N. 50° W., dip 65° SW. The vein quartz is mineralized with free gold, hematite, chrysocolla, pyrite and chalcopyrite. Development consists of a tunnel driven N. 55° W., 326 ft. At 130 ft. from portal, connects with shaft at a depth of 54 ft. below collar, and shaft extends to depth of 56 ft. below tunnel level. At 222 ft. from portal, a winze was sunk to a depth of 26 ft. connecting with stope from lower tunnel workings.

Equipment consists 118 cu. ft. Denver-Gardner compressor driven by Spillman gas engine. At the shaft there is a 12 h.p. gas engine hoist. Mill equipment consists of 10-ton ball mill, with amalgamation plates and one Wilfley concentrator.

Five men employed.

Anthony Mine (Gold Bug). It comprises 5 unpatented mining claims, situated in the Panamint Range of mountains, on the south side of Pleasant Canyon, 2 miles east of Ballarat; elevation 4200 ft.; owner, Mrs. Ada Norris, Trona, California. The property is described under the name of the Gold Bug Mine in "Mineral Resources of part of the Panamint Range," Report XXVIII of the State Mineralogist, pp. 368, 369.

Arando Mine. This property comprises 26 unpatented claims situated in T. 23 S., R. 43 E., in the Sherman Mining District, on the eastern slope of the Argus Range of mountains, 12 miles north of Trona; elevation, 4000 ft.; owners, Alice H. McIntosh, of Trona, California, and Judge Russ Avery, 214 N. Rossmore, Los Angeles. The property is under lease and bond to the Arando Mines, Inc., 1023 Wall St., Los Angeles; Maurice Shinbane, president; William Rosevelt, secretary. The company operated the mine from March 4, 1934, to November 1, 1936, when operations were suspended. In March, 1938, the property was leased to Henry P. Smith, South Pasadena, California.

The vein is a porphyry intrusion which occurs along a fault fissure in granite. The outcrop is traceable for a distance of some 6000 ft. The strike is east and west with a dip of 54° S. It has a width of 6 to 40 ft. The vein-filling is porphyry, containing considerable quartz with heavy talcose gouge on both foot and hanging wall. The ore is oxidized gold quartz heavily iron-stained, the vein matrix showing considerable hematite. The gold occurs in a very fine state.

G. L. Dean acquired the property in 1901 from the original locators. Ore mined by Dean was hauled to the Slate Range Mill, operated by Dean & Jones. An incline shaft was sunk to a depth of 100 ft. on what is called the east orebody. On the 100-ft. level Dean developed an orebody 900 ft. in length and 40 ft. in width.

Reported to have an average value of $4.25 per ton in gold. Smiley R. Jones became interested in the property with Dean, and the mine was actively worked until 1906. The main or east shaft was sunk on incline of 55 degrees to a depth of 435 ft., with levels at 24, 34, 110, 175, 225 and 310 ft. The total amount of underground workings from this shaft was about 7000 ft.

It is reported that 24,000 tons of ore mined and milled had an average of $8.25 per ton in gold.

J. K. Miller, of Los Angeles, acquired the property in 1907, and operated the mine until 1916. In 1920 the property was leased to the North Star Mining Company, the principals being the Rogers Bros., of Los Angeles.

This company sunk the Cuba No. 1 shaft (Cuba tunnel shaft) on an incline to a depth of 235 ft. with levels at 150 and 200 ft. below the Cuba tunnel.

In 1934 the property was leased to Arando Mines, Inc., of Los Angeles, which company operated the property until January, 1937. During this period the Cuba No. 2 shaft was sunk on incline of 54° to a depth of 400 ft.; with levels at 100, 200, 300 and 400. The 100-ft. level is Cuba tunnel, with drift 500 ft. east and 100 ft. west of shaft. On this level, about 100 ft. west of the portal of the tunnel, an ore shoot was developed, which had a length of 100 ft. with a width of 6 to 20 ft., and reported average value of $6 per ton in gold. On the 300-ft. level drift west 300 ft. and 800 ft. east. At 225 ft. east of shaft cut oreshoot which is 500 ft. in length, with an average width of 20 ft. Value reported to be from $4 to $6 per ton in gold. (See map, Fig. 1.)

On the 400-ft. level crosscut north 90 ft. Estimated tonnage is 10,000 tons of ore between the 400 and 300 ft. levels with an average value of $6.40 per ton, and 10,000 tons above 300 ft. level with an average value of $6 per ton.

Mine equipment: 25 hp. Western Enterprise single drum hoist, 100 cu. ft. Laidlaw compressor, one-ton ore skip.

Mill: 50-ton coarse-ore bin to Gates gyratory crusher driven by a 25 hp. Fairbanks-Morse gas engine; from crusher conveyed to 14 in. by 22 in. Joshua Hendy rolls, where ground to $\frac{1}{8}$ in. size. Product from rolls conveyed by 18 in. belt conveyor to four 5 ft. by 25 ft. steel cyanide tanks,. total capacity per 24 hours being 70 tons; one 4 ft. by 25 ft. solution tank; one sump tank, 5 ft. by 25 ft.; two 10-compartment zinc boxes. Tailings from the tanks are conveyed by a 16 in. belt conveyor 300 ft. in length to dump. Water supply is secured from springs 3 miles west of the mine through 3 miles of $2\frac{1}{2}$ in. pipe line, flowing by gravity to a storage tank with a capacity of 17,000 gallons situated north of Homeward Canyon; from the storage tank pumped by a Worthington Triplex pump over hill a distance of one-half mile through a $2\frac{1}{2}$ in. pipe line to a storage tank above the mill, which has a capacity of 17,000 gallons. Ten men are employed.

Ashford Mine (formerly Golden Treasure), comprising 26 claims, is on the western slope of the Funeral Mountains, 30 miles by road west of Shoshone on the east side of Death Valley; elevation, 2000 ft.; owners, Henry J. and Louis R. Ashford.

Four quartz veins occur in the gneiss. They have been faulted and possibly rotated. The owners believe the general strike to be about N. 80° E., whereas the faulted segments which have been worked strike approximately N. 15° E.; dip about 65° E. The widths vary from 6 in. to 4 ft. Mineralization consists of quartz, chalcopyrite, some chalcocite and bornite, with free gold. Oxidation apparently has taken place to a depth of about 120 ft. In one of the veins the principal values are in silver, probably contained in tetrahedrite and galena.

Development consists of a 320 ft. shaft sunk on an average inclination of about 60°. On the 76-ft. level, crosscut northwest 70 ft. to vein, drift south 60 ft., north 20 ft.; 96-ft. level, drift north 90 ft.; 180-ft. level, drift south 65 ft. On the 180-ft. level, at the shaft, there is a stope 60 ft. long, 55 ft. high. Width of ore is said to average about 15 in. North of the shaft in a canyon, a crosscut tunnel has been driven north 100 ft. to the vein; drift south 120 ft. Here the vein has been stoped for a length of about 170 ft.; average width about 2 ft., maximum 4 ft. Some 400 ft. southwest of the shaft and 150 ft. below the collar, a crosscut tunnel has been driven east 215 ft. to a vein and a winze sunk to a depth of 35 ft. Mineralization here shows, principally, galena and tetrahedrite, carrying silver. At 200 ft. from the portal, a drift has been driven north 375 ft. to connect with the shaft on the 180-ft. level.

Total shipments have amounted to about $135,000; $18,000 of which has been shipped in the last two years. Shipments have averaged about $70 per ton. Equipment consists of Ingersoll-Rand portable compressor and camp. Three men are working.

Bibl.: (Golden Treasure) State Mineralogist's Reports XV, pp. 78-79; XXII, p. 469.

Big Horn Mine. It comprises 8 claims and one millsite, situated in the Beveridge Mining District, between Hunter and Beveridge canyons, on the east slope of the Inyo Range, 10 mi. NE. of Lone Pine; elevation, 6000 ft.; owners, Sam R. Spear and M. A. Wilson, of Lone Pine, California. The mine was discovered in 1877 by W. L. Hunter, who built three arrastras in Hunter Canyon to treat the ore in 1878, and the property was operated by Hunter until 1893. He is reported to have recovered between $8,000 and $10,000 during the period of his ownership of the property. Three parallel veins occur in granite, strike N. 80° E., dip 30° N., widths vary from 2 to 8 feet. The principal development is on the Bronco-Hunter vein; the ore occurs in irregular lenses in a white quartz vein which varies in width from 4 to 8 feet.

The quartz is mineralized with galena, red oxide of copper, chalcopyrite, pyrite, free gold; also gold occurs in galena. Twenty-five tons of silver ore shipped from the property assayed gold, 4.68 oz.; silver, 16.60 oz.; copper, 2%; lead, 2%; value of $155.34 per ton. Development consists of incline shaft sunk on the vein to a depth of 380 ft. with levels at 100, 200 and 300 feet. About 300 ft. west of this shaft and 150 ft. in elevation above is tunnel No. 1, driven on the vein for a distance

of 200 feet. About 75 ft. in elevation above No. 1 tunnel and 150 ft. west of portal is tunnel No. 2, which has been driven west on the vein 650 feet. Incline shaft 100 ft. in depth connects with these workings. Ore is sorted and packed on mules by trail from the mine to Long John Canyon, a distance of 8 miles, then hauled by truck, a distance of 8 miles to Owenyo for shipment to smelters at Salt Lake City. Ore has to

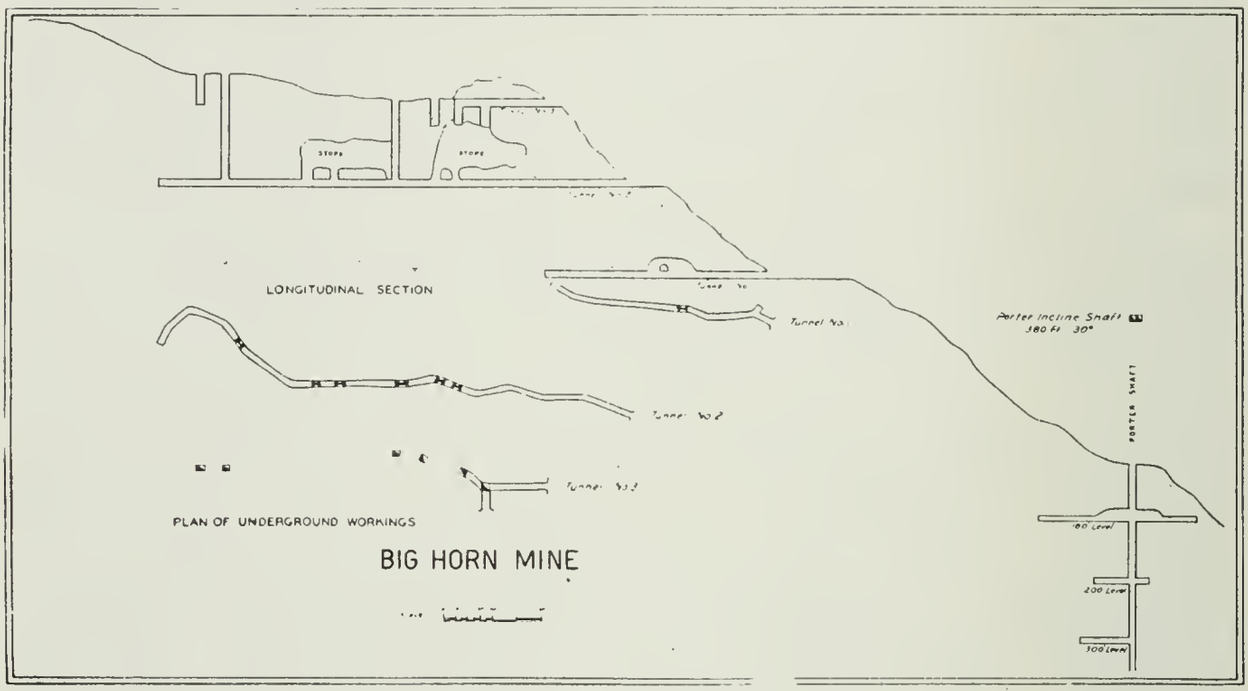


FIG. 2.

carry better than $50 per ton. The property has been worked off and on since 1900 by owners with a small crew. Last production of high-grade ore was made in September, 1934. Idle. (See map, Fig. 2.)

Big Tee Mine. It comprises 4 claims situated in the Coso Mining district, in Coso Range of mountains, 3 miles south of Cold Springs and 16 miles southwest of Darwin; elevation, 5300 ft.; owner, E. J. Reeves, Darwin, California. Three parallel quartz veins occur in granite. Widths vary from 9 in. to 2 ft. Development consists of a shaft 20 ft. deep and a trench 50 ft. in length by 5 ft. deep. Three tons of ore mined from the trench is reported to have assayed $45 per ton in gold. Idle.

Black Eagle Mine. It is situated on the west flank of the Inyo Mountains, 4 miles east of Kearsarge, a station on Owens Valley Branch of the Southern Pacific Railroad; elevation, 8000 ft. Holdings comprise 3 claims known as Black Eagle, Bellview and Black Eagle millsite. Owner, A. T. Smith, of San Clemente, California, and George A. Lewis, 3579 Fourth Ave., San Diego, California; under lease to First National Mines Company, c/o Homer Johnstone, 801 Bartlett Bldg., Los Angeles, California.

There are three parallel veins on the property, one of which has been developed. The Black Eagle vein occurs on the contact of granite and limestone. The vein trends N. 70° E., and dips nearly vertical, with a slight inclination to the south. The vein varies in width from 18 in. to 3 ft. Mill equipment consists of a Hardinge ball mill, Dorr classifier, Merrill amalgamator and flotation cells. The mill is located

at Willow Springs, 2800 ft. below the mine. Idle, but they expect to resume operations in the early spring.

Bibl.: State Mineralogist's Reports XV, p. 75; XVII, p. 279; XXII, p. 466; U. S. G. S. Bulletin 540, p. 116; U. S. G. S. Prof. Paper 110, pp. 120-121.

Blue Belle Mine. It comprises 2 claims situated on the east slope of the Argus Range of mountains, in the Modoc Mining District, 34 miles north of Trona; elevation, 5000 ft.; owner, Jack Cress Estate and Marie E. Streger, of Los Angeles; under option to Chas. F. Hamilton, of Los Angeles. The vein of quartz occurs along contact of granite and limestone; strike N. 50° W., dip 47° SW., width 4 to 6 ft. Development consists of a crosscut tunnel driven 90 ft. north to contact, with drift 150 ft. northwest on the vein. A small amount of stoping has been done above this level. At about 200 ft. northwest of these workings is another tunnel 100 ft. in length. The lower tunnel on the Blue Belle vein is about 300 ft. in elevation below these workings. This tunnel is driven northwest 200 ft. on a narrow quartz vein. Near the face of this tunnel is a raise 50 ft. in height which connects with another tunnel. There are five tunnels varying in length from 50 to 300 ft. A tram line runs from the lower tunnel to the mill, a distance of 500 ft.

Blue Eagle Mine. It comprises three claims in the Coso Mining District about 6 miles southwest of Coso. C. W. Woodson, C. O. Woodson and Roscoe Williams of Los Angeles, are the owners. Development consists of a tunnel [illegible] N. 14° W. 100 ft., with a crosscut east for 110 ft. and west for 15 ft. Six tons of ore mined and shipped are said to have averaged $48 in gold per ton.

Blue Rock Mine. It comprises 4 claims situated in the Coso Mining District, two miles south of Cold Springs, and 12 miles west of Darwin; owners, J. H. Crouch and Walter Palmer, of Darwin. A vein of quartz 4 ft. in width, occurs in rhyolite; strike, N. 55° W., dip 40° NE. Development consists of a shaft 40 ft. in depth.

Two men are employed.

Bonanza Mine, comprising 2 claims, is in the Coso Mountains, 6 miles south of Cold Spring and approximately 7½ miles south of Coso; elevation about 4700 ft.; owner, Western Consolidated Gold Mines, Ltd., Darwin, Calif.; under lease to R. L. Tuttle, 845 South Plymouth, Los Angeles.

A quartz vein in the granitic country rock strikes N.-S., dips 33° W. It varies in width from a mere seam to a maximum of 5 ft. The vein-filling is brecciated quartz, cemented with iron oxide. The gold is all free. The ore occurs in short, lenticular shoots.

Development consists of a crosscut east about 575 ft. to the vein; drift south 200 ft. At 100 ft. from crosscut, there is a raise 200 ft. on the dip. At 245 ft. from the portal, there is a raise 50 ft. and at 200 ft. from the portal, another raise about 80 ft. At 90 ft. above these workings is another tunnel 185 ft. long and 100 ft. south is another 100-ft. tunnel.

A small cyanide leaching plant composed of four 8-ft. tanks is being erected at the mine. Water is to be hauled from Cold Spring.

Four men are working.

Brown Monster-Reward Mines (Eclipse). This property comprises two patented claims known as Reward and Brown Monster, 6 claims held by location and two millsites, situated in the Russ Mining District, on the west slope of the Inyo Range of mountains, 10 miles north of Lone Pine, and two miles east of Manzanar, a siding on the Owens Valley Branch of the Southern Pacific Railroad; elevation, 4000 to 5000 ft.; owners, Guy Eddie and Chas. De Corse, 643 Rives-Strong Bldg., Los Angeles. The vein was discovered in 1878 and worked from 1880 to 1914 by the *Reward Consolidated Mining Company.* The property

PHOTO. 1. Reward Mine on west slope Inyo Range of Mountains, Manzanar, Inyo County.

was idle until 1935, when owners operated the Brown Monster Mine from April, 1935, to February, 1936, during which time they shipped about 2000 tons of ore reported to have an average value of $25 per ton in gold. In March, 1936, the property was acquired under lease by the *Monte Carlo Mines, Inc.;* A. J. Israel, president; W. H. Cook, general manager, and operated until August, 1936. During this period the ore mined from Reward Mine was hauled to the Mt. Whitney-Union Mill for treatment, but due to poor recovery made by flotation, operations were suspended. In Jan. 1936, it was leased to T. L. Brite, of Lone Pine. Ore mined from Reward vein was reported to have an average value of $11 per ton in gold and silver. The Brown Monster and

Reward veins conform to the bedding of enclosing limestone. The Brown Monster vein strikes N. 70° W., dip 25° NE., width varies from 4 to 12 ft. Reward vein strikes N. 40° W., dip 40° NE., width 6 ft. The vein material is mineralized with gold, associated with pyrite, galena, chalcopyrite, azurite and malachite. Ore shoots developed on Brown Monster vein vary from 100 to 200 ft., with an average width of 4 ft.; ore-shoot on Reward vein, 150 to 300 ft. in length, average width being 6 ft.

Development-Reward Workings. No. 1 tunnel is driven 1200 ft. N. 55° E., 650 ft. to the vein and then drift southeast 800 ft. About 50 ft. above this tunnel level is No. 2 tunnel level which is driven southeast 800 ft.; No. 3 tunnel level is 700 ft. in length; No. 4 tunnel level is 600 ft. in length; No. 5 tunnel level is 400 ft. in length; No. 6 tunnel

PHOTO. 2. Open stope on Brown Monster Vein, Brown Monster Mine, Manzanar, Inyo County.

level is 300 ft. in length. The intervals between No. 2 tunnel levels and the others above are 25 ft. Ore-shoots stoped from No. 2 tunnel level to the surface.

Brown Monster Workings. The Brown Monster incline shaft is sunk along a fault, which strikes N. 40° E., to depth 300 ft. with levels at 60, 96, 200 and 250 ft. On the 96-ft. level gold values were discovered in limestone southeast of incline shaft, and in the footwall of the Reward vein on No. 2 tunnel level.

The gold was associated with oxides, carbonates and sulphides of lead, copper and iron, with considerable graphitic slate. The ore was stoped from the 200-ft. level to surface east and west of incline shaft for a length of 200 ft. with average width of 6 ft. On the ridge north of the Brown Monster incline shaft, and about 500 ft. in elevation above collar of the shaft, the vein is exposed on the surface for distance of

500 ft. Ore-shoot developed along the surface outcrop is about 200 ft. in length, with average width of 8 ft. Three incline shafts were sunk on the vein to depths of 30 ft. and 90 ft.; these shafts are about 75 ft. apart. Fifteen hundred tons of ore mined and shipped from these workings are reported to have had an average value of $25 per ton in gold and silver, with 1.5% to 2% lead content.

Equipment: C. P. 300-cu.-ft. compressor, 1500-ft. aerial tram, capacity of the buckets 700 lb. A Williams gasoline hoist drives the tram. Reward incline tram is 1500 ft. in length; 40-ton ore bin.

Ten men are employed in selective mining on the Brown Monster vein, the ore being shipped to Burton Brothers' mill at Tropico, Kern County, for treatment. Ore treated is reported to carry $25 to $40 per ton in gold.

Bibl.: State Mineralogist's Reports VIII, p. 263; XII, p. 136; XIII, p. 180; XV, p. 83; XXII, p. 473; Report of the Director U. S. Mint, 1883, p. 160; U. S. G. S. Bull. 540, pp. 116, 118; U. S. G. S. Prof. Paper 110, pp. 121, 122.

Burgess Mine (Iron Sides). It comprises 19 claims, situated in the Beveridge Mining District, on the summit of the Inyo Range of mountains, 10 miles east of Mt. Whitney, a station on the California & Nevada Railroad; elevation, 9200 ft.; owners, Mrs. Kate Wells, Big Pine, Calif.; under lease to A. B. Gould, Lone Pine, Calif.

A series of parallel quartz veins occur in limestone of the Triassic age with one vein occurring along contact between limestone and diorite porphyry. Dikes of diorite porphyry occur in the vicinity of the mine. Width of veins varies from 12 in. to 2 ft. Strike of the vein is N. 30° W., dip 60° SW.; developed by an incline shaft 200 ft. in depth. West of this shaft are two vertical shafts sunk to a depth of 60 ft. On the east slope of the ridge there is a crosscut tunnel 700 ft. in length. The ore is a milky-white quartz, carrying gold associated with galena. Equipment consists of gasoline hoist and compressor.

Two men are employed.

Bibl.: State Mineralogist's Report XVII, p. 280; U. S. G. S. Bull. 540, p. 119; U. S. G. S. Prof. Paper 110, pp. 122-123.

Burro, New Discovery and Gem Mines. This property comprises 5 claims, situated in Jail Canyon, 14 miles north of Ballarat in the Panamint Range of mountains; elevation, 3700 ft.; owner, R. D. Warneck, Trona, California.

Idle.

Bibl.: State Mineralogist's Reports XV, pp. 81-82; XVII, pp. 470-471; XXVIII, 364-366.

Buster Brown Mine. It comprises 3 claims, adjoining World Beater Mine, situated in Pleasant Canyon on the west slope of Panamint Range of mountains, about 6 miles east of Ballarat; elevation, 5000 ft.; owners, L. E. Kain, of San Pedro; Gustaffison, Leavitt, and Hyatt, Long Beach, California.

The vein occurs on contact of diorite and schist, has a NE.-SW strike and dips SE. Widths vary from 2 to 12 ft. Developed by tun-

nels. Ore mined is reported to carry $30 per ton in gold. Equipment consists of 5-stamp mill and cyanide plant. Four men are employed.

Cardinal Gold Mining Company took over the Wilshire-Bishop Creek Mine from the Anglo-American Mining Corporation, Ltd., in the latter part of 1933. The property consisting of 34 claims, 12 of which are patented, is on the east slope of the Sierra Nevada, on the middle fork of Bishop Creek, 17 miles SW. of Bishop; elevation, 8500 ft. Officers of the company are: A. J. Inderrieden, president; R. H. Travers, vice president; G. H. Janeway, secretary-treasurer, 410 Roosevelt Bldg., Los Angeles, California; mine address, Victor Bongard, general manager, Bishop, California.

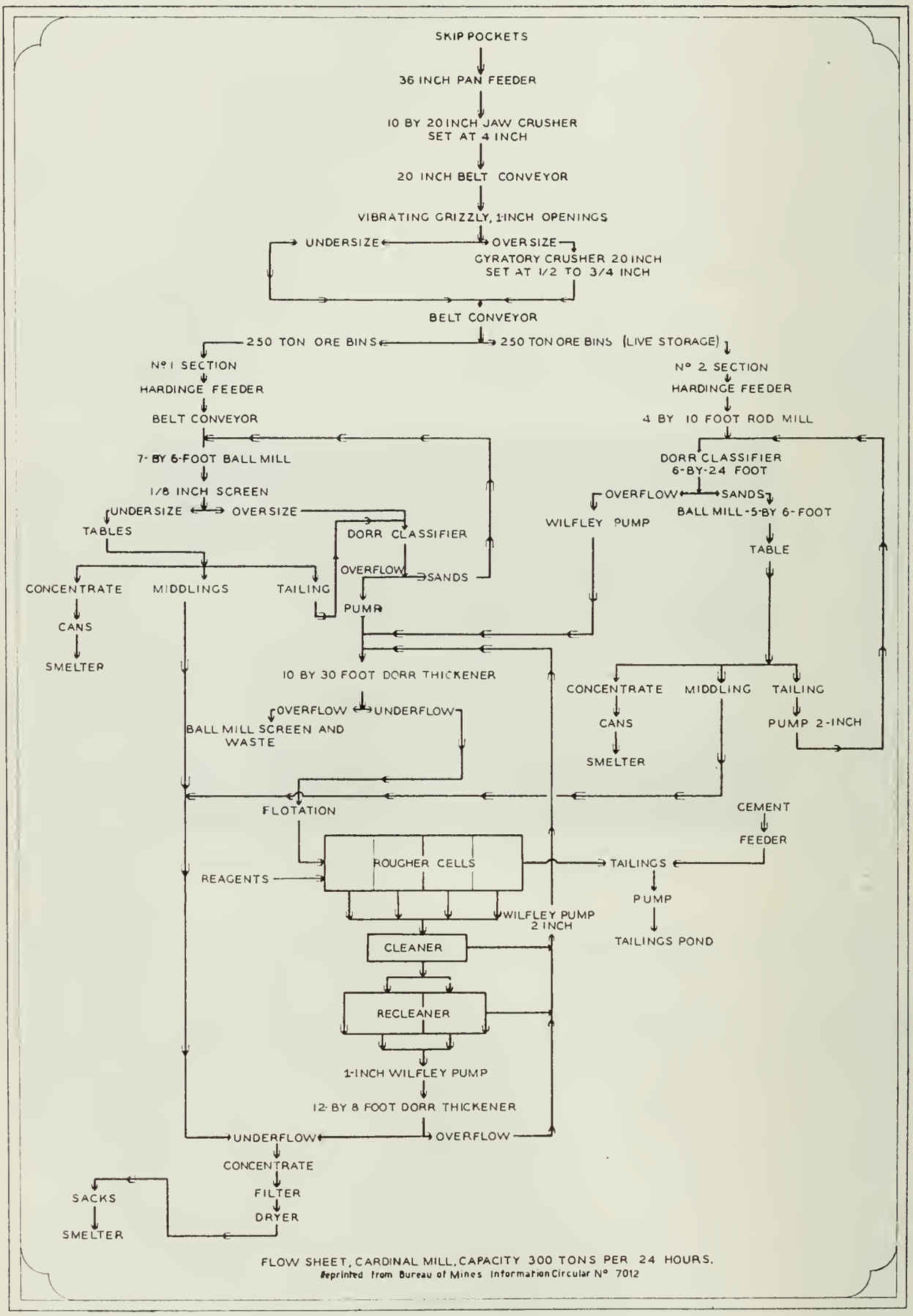
The orebodies occur along a zone of fracturing in the central portion of a body of quartzite. The quartzite, which is partially enclosed by intrusive granite and monzonite, is about 800 ft. wide. Its strike is N. 50° W., dip 60° SW. The lines of fracture, along which the mineralization occurs, strike N. 55° W., and dip 70° NE. Both walls are

PHOTO. 3. Cardinal Gold Mine, Bishop Creek, Inyo County.

determined by assay. The average width mined is about 8 ft., although, locally it may be much wider. Mineralization consists of fine free gold, auriferous pyrite, pyrrhotite, arsenopyrite, chalcopyrite and some sphalerite. Four principal ore shoots have been developed. They vary from 20 to 300 ft. in length and from 6 to 16 ft. in width. The ore bodies to the northwest of the shaft have been displaced 130 ft. to the southwest by the Haggerty Fault, strike N. 60° E., dip 45° SE. Narrow granitic sills also cut the orebodies. These sills are displaced by the Haggerty Fault.

The ore carries $10 to $12 per ton, approximately 99% of which is gold, with a little copper and silver. The ratio of concentration in the mill is about 30 to 1, with a recovery of 92%. Production to date (November, 1937) by this company is $1,570,000.

Development consists of 600-ft. shaft, the first 100 ft. of which is vertical, the remaining 500 ft. is inclined 68° to the NW. Levels have been driven at 60, 200, 300, 400, 500, and 600 ft. horizons. Approximately 4000 ft. of development work has been done. The



FLOW SHEET, CARDINAL MILL, CAPACITY 300 TONS PER 24 HOURS.
Reprinted from Bureau of Mines Information Circular No 7012

FIG. 3.

greatest distance from the shaft is in the 200 ft. level northwest, which is in 1400 ft. and is still being driven. The 200-ft. level at this point is about 900 ft. below the surface.

Mine equipment consists of electric hoist, two Sullivan air compressors, motor driven, having a combined capacity of 2340 cu. ft. per minute; complete blacksmith shop, with Sullivan drill sharpener and automatic (hot lead) tempering machine; carpenter shop, machine shop and assay office. Two sinking pumps and a 3-in. centrifugal pump handle water to the 300 ft. level where a 350 g.p.m. triplex pump boosts it to the surface.

Flow sheet of the mill is printed herewith. Fig. 3.

The company employs 105 men.*

Bibl.: (Wilshire Bishop Creek Mine) State Mineralogist's Reports XV, p. 85; XVII, pp. 281-282; XXII, p. 474.

Cashier (Harrisburg Mine). The property comprises 7 claims situated in Wildrose Mining District, in the Panamint Range of mountains, 55 miles north of Trona and 9 miles south of Skidoo; elevation, 5000 ft.; owner, J. P. Augerebery, Trona, California; worked from 1906 to 1910 by the former owners; acquired by Cashier Mining Company of Los Angeles and operated until 1914; relocated by Augerebery. Ore-bearing fissures strike N. 20° E., dip 70° E., cutting beds of limestone. An intrusion of diorite, having a thickness of 100 ft., occurs on contact of limestone, with a general north and south strike. The ore, free-milling gold, occurs in an irregular lens-shaped body from 6 in. to 12 ft. in width in limestone.

Development: A 400-ft. incline shaft has been sunk on the orebody, and levels driven at 100, 200, 300 and 400 ft. The 100-ft. level is the main working level and connects with the surface at 350 ft. northeast of shaft. At 100 ft. from portal of tunnel cut fissure in limestone, which strikes N. 20° E., with drift north 120 ft. on fissure, and south 60 ft. Ore shoot developed was 100 ft. in length. At 350 ft. southwest of portal of tunnel, there is a drift driven S. 20° W., 450 ft. to incline shaft. At 400 ft. southwest of portal of tunnel there is a drift southwest 250 ft. on N. 20° E. fissure.

Estimated 3000 tons of ore on dump that is reported to carry $15 per ton in gold.

Recently some ore has been mined from tunnel level and hauled to mill of Journigan Mining & Milling Company for treatment. The mill is located at Emigrant Springs. Production $150,000.

Bibl.: State Mineralogist's Reports XV, pp. 75, 76; XXII, pp. 466, 467.

Cecil R. Mine. It comprises one claim situated on the west slope of the Panamint Range of mountains, 4 miles south of Ballarat; elevation 1250 ft.; owners, Edward Hague, M. J. Sherlock, Trona, California.

Bibl.: State Mineralogist's Reports XV, p. 76; XXVIII, p. 366.

Chloride Cliff Mine. It comprises six claims situated in Chloride Cliff Mining District, along the summit of Funeral Mountains, 18 miles

* Later: Development work having failed to show any new ore, the mine was shut down and pumps pulled in the fall of 1938.

southwest of Beatty, Nevada; elevation 5300 ft.; owners, Hiram P. Porter, S. Johnson, Louis McCrea, Beatty, Nev.

Five parallel quartz veins occur in limestone near contact of quartzite. These veins strike northeast and southwest. Widths vary from 2 to 4 ft. The vein quartz contains free gold associated with pyrite and galena. There are seven tunnels driven on the different veins, the longest being 400 ft., the others being about 100 ft. in length. The greatest vertical depth below outcrop being 800 ft. Under lease to Louis McCrea, Beatty, Nevada, from 1932 to 1936, who shipped about 30 tons of ore per month to smelters at Salt Lake City. In 1936 under option to Coen Companies, Inc., G. W. Coen, president, 610 South Broadway, Los Angeles, Calif., operated property to June 26th, 1937.

Bibl.: State Mineralogist's Report XV, pp. 76, 77; U. S. G. S. Bull. 285, pp. 72, 73.

Champion Group of Mines. It comprises 9 claims, situated 16 miles west of Shoshone, and 6 miles east of Confidence Mill, on the western slope of the Black Mountains; elevation 1500 ft., owners, S. M. Barber and F. M. O'Conner, of Los Angeles.

The orebodies are in quartzose schist, and the mineralization parallels the stratification in certain layers of the schist. The silicified schist carrying free gold dips 40° E., with a strike of N. 30° W. Veins vary from 2 to 4 ft. in width.

Bibl.: State Mineralogist's Report XXII, p. 468.

Cinnamon Mine. It is situated in the Beveridge Mining District, 10 miles northeast of Mount Whitney, a station on California-Nevada Railroad; elevation 6500 ft.; owners, F. M. Hess, and A. W. Hess, of Lone Pine, California.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 279; XXII, p. 467.

Cleveland Mine is in the Fish Springs Mining District, on the east slope of the granite hills, on the western side of Owens Valley, six miles south of Big Pine; owner, Mrs. Joseph Mear, Big Pine, California.

Under lease since August 1935 to T. L. Brite.

There are 7 claims known as Cleveland, Cleveland Fraction, Cleveland Extension, Gold Bug, United, United No. 4, and United No. 5.

A series of narrow, roughly parallel veins occur in the granitic country rock. The strike is a little east of north, dip from 15° to 30° NW. They vary in width from 6 in. to 12 in.

Development consists of about 50 tunnels varying up to 800 ft. in length. This work has been done on some 10 or 12 different veins. Principal development is on the Cleveland vein. On this vein a tunnel has been driven 800 ft. About 600 ft. from the portal it intersects an incline shaft from the surface. This shaft has been sunk 60 ft. below the tunnel giving it a total length on the dip of 560 ft. At the bottom, a drift has been driven southwest 100 ft. on a vein about 6 in. wide. This ore, as sorted and shipped, is said to contain from

3 to 11 oz. of gold per ton. The ore is shipped to the Tropico Mill near Rosamond.

Three men working.

Bibl.: State Mineralogist's Reports XVII, pp. 279, 280; XXII, p. 467.

Commetti Mine comprising 10 claims, including 3 millsites, is situated in the Fish Creek Mining District, six miles south of Big Pine, in the low granitic hills on the west side of Owens Valley; elevation 4500 ft.; owner, Commetti Mines Company, Alexander Richards, of Boston, Pres.; under lease to Ellis Rowe and W. B. Engle, of Pasadena, California.

Two parallel quartz veins occur in the granite. They are separated by an andesitic dike which is about 15 ft. thick. Strike of the veins is E.-W., dip 80° S. The average width of the vein is 4 ft. The center of the veins is filled with porphyry, with from 12 to 18 inches of quartz on each side. Mineralization consists of iron oxides, pyrite, some chalcopyrite and free gold.

Development consists of three tunnels, at different elevations and a winze 210 ft. below lower tunnel. The upper tunnel has been driven 300 ft.; the intermediate tunnel 536 ft. and the lower tunnel 450 ft. At 440 ft. from the portal of the lower tunnel a winze has been put down 210 ft. A drift was driven west 385 ft. on the 110-ft. level of this winze; at 256 ft. from the shaft a crosscut was driven to the hanging wall with a short drift east and a small stope above this drift. At the 155-ft. level a drift has been driven 70 ft. west. On the 210-ft. level a drift has been driven 270 ft. west on the north or footwall vein. The average width between walls of the vein is about 3½ ft. The ore in the vein is from 60 to 120 ft. west of the winze. On the lower level it is reported to have been sorted and shipped to the smelter yielding $70 per ton. On the south or hanging-wall vein a drift was driven 30 ft. east on 8 in. of ore which is reported to carry $8 to $13 per ton. There is a drift west on this vein 100 ft. At 30 ft. from the crosscut an incline winze has been sunk 50 ft. and 15 ft. further west a vertical winze was sunk to connect with the incline winze at the bottom. It is reported that 21 tons of ore, carrying $30 per ton has been shipped from these workings. The vein varies from 1 to 3 ft. in width, in the winze.

Two men are working, sinking incline winze.

Bibl.: State Mineralogist's Reports XVII, p. 280; XXII, p. 468.

Confidence Mine. It comprises several patented claims, situated 14 miles west of Shoshone, and 8 miles east of the Old Confidence Mill, on the western slope of the Black Mountains; elevation, 2500 ft. A series of parallel quartz veins occurs in a silicified hornblende schist. Veins trend N. 30° W., and dip 40° E. Widths vary from 2 to 6 ft.

Idle.

Coso Cyanide Plant. Cyanide plant at Coso; owned by Louis Wormken; operating on tailings from old arrastra ponds in the Coso District. Plant consists of a solution tank 3 ft. by 8 ft. by 3½ ft. deep and seven leaching tanks; six, 6 ft. in diameter, and one, 10 ft. in diameter, and all 4 ft. deep. Tanks are loaded from a one-ton Ford

dump truck and leached six days in a solution containing 2½ lbs. of sodium cyanide per ton of water. Precipitation by zinc shavings in a zinc box containing five 14-inch cells. Solution from the zinc box flows to a sump tank and is pumped back into the solution tank. A fifty per cent recovery is claimed on six dollar heads. Capacity is 6½ tons per 24 hours.

Two men are employed.

Coso View Mine. Situated in the Coso Mining District, 3 miles south of Cold Springs and adjoins the Mexican Mine on the north. Consists of one claim owned by M. D. Early and L. E. Early, of Lancaster, California, and C. H. Turner, of Las Vegas, Nevada. Developed by a vertical shaft 165 ft. deep with a 25 ft. crosscut east at 150 ft. depth. The shaft and crosscut were driven to explore a dike which samples $8 to $9 on the surface.

Idle.

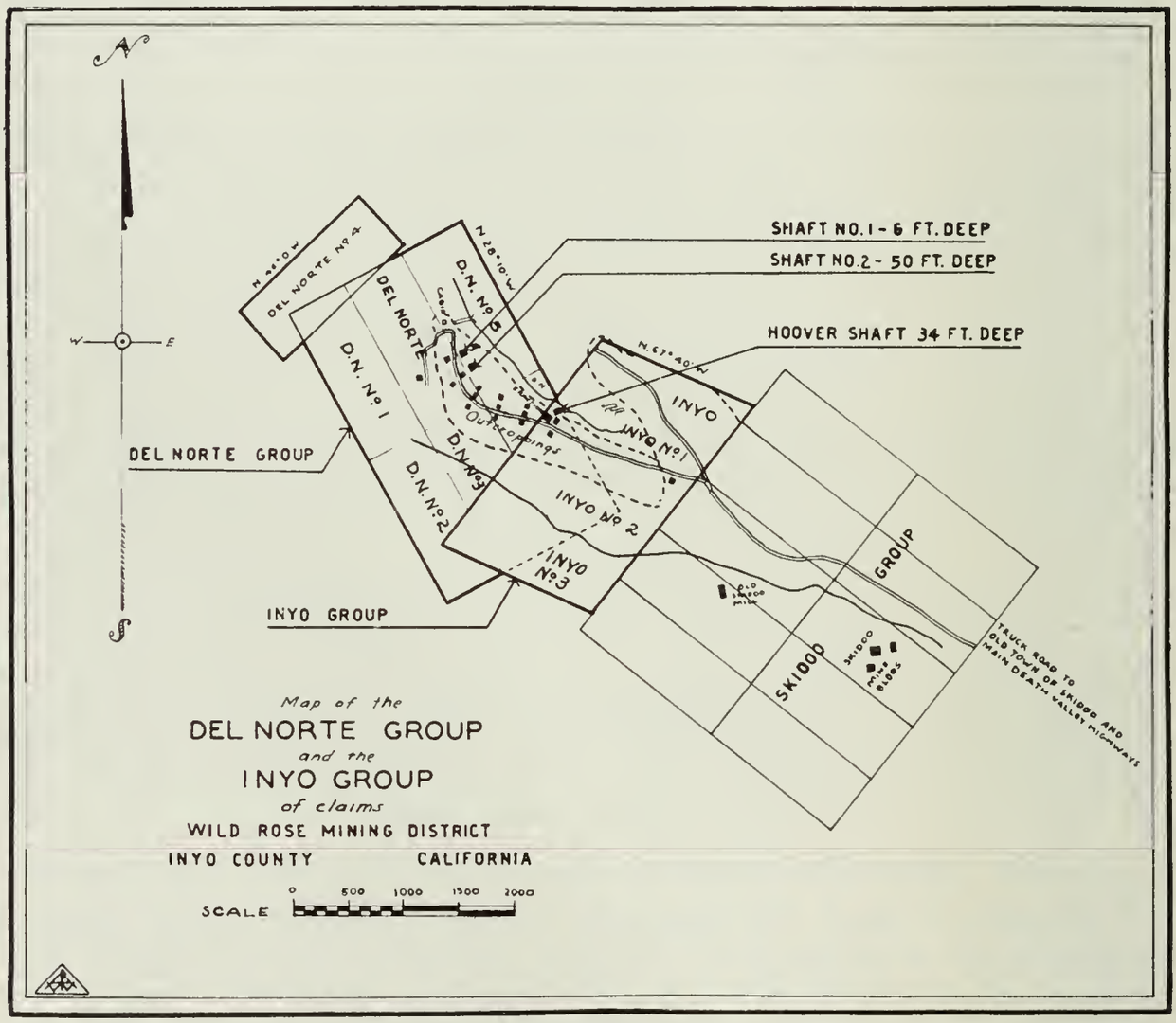


FIG. 4.

Curran Mine. Situated about half a mile northeast of Panamint townsite; is owned by Mrs. H. H. Thompson, of Ballarat.

Idle.

Bibl.: State Mineralogist's Report XXVIII, pp. 366, 368.

Del Norte Group of Mines. This property comprises 6 claims situated in the Wildrose Mining District, in the Panamint Range of mountains, 18 miles north of Wildrose Springs and 45 miles north of Trona;

elevation, 5300 ft.; owners, J. P. McCafferty, of Los Angeles, California; L. V. Howell, of Lone Pine, and James Stewart, of Darwin; under lease and bond to the *Panamint Milling Company;* Adolph Ramish, president; Roy C. Troeger, secretary and manager, 972 Fourth Ave., Los Angeles. (See Fig. 4.)

A massive bed of quartzite 25 to 30 ft. in thickness overlies quartz monzonite; general strike east and west, with a dip of 15 degrees north. The gold occurs in quartz along fractures in the quartzite. This quartzite bed is 500 ft. in width and 3000 ft. in length with an average thickness of 23 ft. Development consists of 10 shafts from 10 to 50 ft. in depth, and a number of trenches about 100 ft. in length, with a depth of 2 feet. There are 2 shafts 50 ft. deep, about 600 ft. apart. Samples cut at 5 ft. intervals in two 50 ft. shafts and along two trenches 100 ft. in length, were reported to have an average value of $6 per ton in gold. Several shipments of selected ore made to Burton Bros., Inc., Rosamond, California, were reported to have averaged from $16 to $25 per ton. In the quartz monzonite that underlies the quartzite bed, a series of quartz veins roughly parallel occur that have a general north and south strike with dips varying from 30° to 70° W.; widths, 12 in. to 2 ft. On one of these a tunnel has been driven SW. 160 ft. entirely in monzonite, the face of the tunnel being vertically below the east edge of the quartzite bed. Six men are employed on development.

Davenport Mine. This property comprises 6 claims, situated in the Argus Range of mountains, on the ridge between Homeward Canyon and Bruce Canyon, adjoining the Arando group of mines on the south, 12 mi. north of Trona; elevation, 4000 ft.; owner, Mrs. Nellie Bliss, Trona, California; under lease and bond to Clifford Burton, Rosamond, California; George Wyman, Trona, and N. W. Sweetzer, Trona, California. The vein strikes east and west, with a dip of 54° S.; width 6 to 20 ft. The vein filling is iron-stained porphyry with granite walls. Development consists of a vertical shaft 100 ft. deep, with crosscuts on the 50 and 100 ft. levels to the vein with about 500 ft. of drifts.

Six men are employed on development work.

Echo-G. H. Edge Group of 5 claims and 2 fractions, patented, is on the south side of Echo Canyon, on the west slope of the Funeral Mountains and the east side of Death Valley, about 12 miles east of Furnace Creek Ranch; elevation about 3000 ft.; owners, D. M. Coon, of Compton, California, and Frank McDonald, of Shoshone.

Country rock consists of limestone, quartzite and andesite. The quartz veins occur in the quartzite. There are three principal veins, strike E.-W., dip, 55° S., one cross stringer, strike NE., dip N. Widths vary from a few inches to 3½ ft.; principal values in gold up to $40 per ton.

Development consists of two shafts, 80 and 60 ft. deep, respectively. Two men are working.

Emigrant Springs Mine (Saddle Rock). This property comprising 4 patented claims and 12 claims held by location is situated in the Wildrose Mining District, in the Panamint Range of mountains, on the ridge east of Emigrant Canyon, 5 miles eoutheast of Emigrant Springs, and 16 mi. south of Stove Pipe Wells; elevation, 4600 ft.; owners,

Emigrant Springs Mining Co.; H. W. Eichbaum, president; Mrs. H. W. Eichbaum, secretary, Stove Pipe Wells, Inyo County, California.

The quartzite bed overlies quartz monzonite; dip 15° northwest. This bed of quartzite has an average thickness of 25 ft. and the quartzite has been fractured in all directions. The fractures have been filled with quartz which carries values in gold. The quartzite, which occurs on the Pima and Golden Rule claims, is about 600 ft. in width and 3000 ft. in length. The gold values are reported to range from $4 to $6 per ton. Some very high-grade ore has been found along fractures on the surface. Development consists of three tunnels and five shallow shafts. No. 1 tunnel, located on the Pima Claim, is driven N. 40° E., as a crosscut for a distance of 90 ft. in quartz monzonite, and is 100 ft. below the quartzite bed. In the face of this tunnel, cut a vein of quartz in the monzonite which strikes N. 30° W., dip 15° E., width 2 feet. About 400 ft. south of No. 1 tunnel, No. 2 tunnel is driven as a crosscut N. 50° E., 90 feet. At 45 ft. from the portal, cut a quartz vein in the monzonite, which strikes N. 60° W., dip 45° S. A drift has been driven on this vein for a distance of 50 feet. The vein has a width of 4 ft. and is mineralized with pyrite. On the south end of the property, where the quartz monzonite is exposed on the ridge, a number of shafts have been sunk on parallel veins to depths of 20 to 70 feet.

The property has potential possibilities as a large low-grade gold deposit, and all prospecting work should be confined to quartzite to determine the average value of the ore.

Idle.

Eureka Mine. It is situated on East side of Owens Valley at the foot of the Inyo Mountains, nine miles northeast of Independence; elevation 4000 ft. The property consists of 4 patented claims. A granite mass, cut by numerous quartz stringers, lies between two dikes of diorite porphyry. The ore is highly oxidized, containing much red and brown iron oxide, with copper silicate (chrysocolla). The oxidized ore shows coarse gold. Development consists of tunnel 100 ft. in length and shaft 100 ft. in depth.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 469; U. S. G. S. Bull. 540, pp. 115, 116; U. S. G. S. Professional Paper 110, p. 120.

Gold Basin Mine. It comprises 7 claims, situated in Argus Mining District, in the Argus Range of mountains, south of Mountain Springs Canyon, 25 miles northeast of Brown; elevation 6000 ft.; owners, J. H. Allen, of Brown, and E. A. Green, of Los Angeles.

A quartz vein occurs along an andesitic-porphyry dike in granite, which strikes NW. and SE. Width 12 in. to 2 ft. Development consists of number of shallow shafts and open cuts. Two men are employed on development.

Gold Bug Mine. Formerly Anthony Mine and originally known as Post Office Springs Mine, comprising 5 unpatented claims, is on the south side of Pleasant Canyon, 2 miles west of the Radcliff Mill and about 4 miles east of Ballarat; elevation at the mine, 4200 ft.; owner, Mrs. Ada Norris, Box 443, Trona, California.

This property was fully described in our Report XXVIII, p. 368.

Gold Hill Mine. It comprises 4 patented claims, on the east slope of the Panamint Mountains, some 12 miles south of Bennett's Well and just east of Butte Valley; elevation 5400 ft.; owners, Fred W. Gray, 3503 McClintock Avenue, Los Angeles, California, and Wm. Hyder, Trona, California.

Bibl.: State Mineralogist's Report XXVIII, p. 369.

Gold Ridge Group of Mines. The property comprises 20 claims, known as the Gold Ridge, Iron Mask, Gold Point, Goodrich, and Old Mexican groups of claims, situated in the Coso Mining District, 20 miles west of Darwin; elevation, 4200 to 5000 ft.; owner, Western Consolidated Gold Mines, Inc.; R. L. Tuttle, president; A. R. Moore, secretary, Los Angeles, California. A series of parallel north and south veins occur in granite. Width of the veins vary from 12 in. to 2 ft.; developed by shafts from 50 to 100 ft. in depth.

Idle.

Gold Spur Mine (Lestro Mine). It comprises 16 claims known as Lestro No. 1 to No. 8, and Caliente No. 1 to No. 8, situated on ridge between Coyote and Goler canyons, in the South Park Mining District, 16 miles southeast of Ballarat; elevation 2200 to 4000 ft.; owners, James Lester and J. J. Rogers, Los Angeles.

Two vein systems occur in gneiss. One consists of a series of parallel veins which strike N. 15° E. Widths vary from 2 to 4 ft. The veins are cut by an andesite dike that strikes N. 48° W. Near the center of Caliente No. 4 Claim, there is a showing of ore on the andesite dike 200 ft. in length. Samples taken across dike are reported to assay from $4 to $40 per ton in gold. The other vein system consists of a series of parallel veins that strikes N. 70°–80° W., dips S. 70°; widths 2 to 4 ft.

Samples taken from workings on the different veins of this system are reported to assay from $8 to $20 per ton in gold.

Development consists of opencuts and tunnels on different veins. Tunnels vary from 50 to 160 ft. in length; one shaft 50 ft. deep. The owners are planning to drive a tunnel 900 ft. in length on andesite dike, with backs of about 600 ft.

Idle.

Bibl.: State Mineralogist's Reports XV, pp. 77, 78; XII, p. 469.

Gold Standard Mine. It comprises 34 claims, situated on the east slope of the Inyo Range of mountains, west of Saline Valley, in the Beveridge-Ubehebe Mining District, 60 miles northeast of Olancha. The property extends from Little Hunter Canyon on the north to and across Craig Canyon on the south; elevation, 5000 to 6000 ft.; owner Gold Standard Mining Company; Col. A. E. Monteith, president and manager, Olancha, California.

The two principal mineral deposits consist of two quartz veins in quartz-monzonite. On the south end of the property, there is a quartz blow-out, about 50 ft. in width, and exposed on the surface for a distance of 150 ft. in length. The strike is NE.-SW. The vein quartz is mineralized with malachite, azurite, tetrahedrite, chalcopyrite, galena, hematite, pyrite, and sphalerite; developed by open cut. The principal vein, known as Gold Standard vein, occurs along a fault, on

contact of dolomite and quartz-monzonite; strike NW.-SE.; dip, 78° SW.; width 4 to 11 ft. The vein can be traced on the surface for a distance of 2100 ft., of which 1200 ft. lies along the limestone contact; developed by 4 tunnels, the longest being 150 ft. Several shipments of sorted ore to smelters at Salt Lake City, Utah, carried 3 oz. in gold, 58 oz. in silver, and 11% copper. Six men are employed.

Gold Tooth Mine. It comprises 2 claims, situated on the west slope of the Panamint Range, 10 miles south of Ballarat; elevation, 1400 ft.; owners, A. R. Greenslitt and R. E. Baughman, Trona, California; under lease to Joseph Horn, Glendale, California.

Bibl.: State Mineralogist's Report XXVIII, pp. 369, 370.

Gold Wedge Mine. It comprises 8 claims, situated in the Pine Mountain District, on the divide between Wyman Creek and Birch Creek, 1¾ miles south of Roberts Ranch, 9 miles north of Deep Springs Ranch and 20 miles northeast of Big Pine; elevation, 8000 ft.; owner, A. T. Wilkerson, Bishop, California.

The mineralization occurs in a belt of schist which strikes northeast and southwest. The schist belt is about 300 ft. in width. The ore occurs in stringers of quartz along joint planes in schist. The ore mineralization extends from 2 to 6 ft. in width in the silicified schist. Developments consist of the east shaft which has been sunk to a vertical depth of 65 ft. On the 45-ft. level there is a drift west 122 ft. connecting with an incline shaft which is 130 ft. deep. Between these shafts for a distance of 55 ft., the silicified schists are reported to have an average value of $7 per ton in gold. Ore mined along joint planes is reported to carry $20 per ton in gold. Mill equipment consists of 6 in. by 8 in. crusher, Challenge ore feeder, five 600-lb. stamps, amalgamation plates (2 ft. wide by 16 ft. in length), Overstrom concentrator. The mill is driven by a 12 hp. Fairbanks-Morse gas engine.

Two men are employed.

Golden Eagle Mine. It is situated in the Beveridge Mining District, 10 miles northeast of Owenyo, a station on the California and Nevada Railroad; owner, John C. Anton, of Lone Pine, California.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 78; XXII, p. 469.

Golden Rod (Marigold) Mine. It is situated in the Coso District, 7 miles south of Darwin on the east slope of the Coso Mountains, at an elevation of 6000 ft.; L. W. Lee, of Darwin, owner. The vein is 6 in. to 4 ft. wide, in granite; strikes E. and W. and dips about 35° S. Principal development is by three tunnels driven west: No. 1, 100 ft.; No. 2, 300 ft., and No. 3, 350 ft. long. There is a 100 ft. vertical interval between tunnels No. 1 and No. 2, and a 200 ft. interval between tunnels No. 2 and No. 3. At 100 ft. west of the portal of tunnel No. 2 the vein is stoped for a distance of 50 ft. and for a height of 100 ft. Ten tons shipped to the Jones Mill at Hughes Lake in 1937 are reported to have assayed $35. There are about ten tons piled on the dump which will be milled at Coso.

Bibl.: State Mineralogist's Reports XV, p. 82; XXII, p. 471.

Golden Treasure Mine (see Ashford Mine).

Gypsy Queen Mine, consisting of 10 claims is on the west slope of the Inyo Mountains, 2½ miles south of Aberdeen, a station on the Southern Pacific R. R. and 4 miles east of the Owens Valley highway; elevation, 4300 ft.; last known owner, Frank Thomas, Big Pine, California.

Here a series of parallel veins, with connecting quartz stringers, occur in a block of quartz-monzonite which lies between two diorite dikes. They strike N. 10° W., to N. 30° W., dip about 80° E. The widths vary from 3 in. to 8 ft. Vein filling is quartz which carries chalcopyrite, chrysocolla, hematite and some free gold. Development consists of 4 tunnels about 80 to 200 ft. in length and a shaft 40 ft. deep. The vein in the shaft is about 3½ ft. wide and is reported to carry good values.

Idle.

Bibl.: State Mineralogist's Reports (Eureka) XV, p. 77; XXII, p. 469; U. S. G. S. Bull. 540, pp. 115, 116.

Harrisburg Mine. It is situated in the Wildrose Mining District, in the Panamint Range of mountains, adjoins the Cashier Mine and is 55 miles north of Trona, California; elevation, 5000 ft.; owner, J. P. Augerebery, Trona, California.

Bibl.: State Mineralogist's Reports XV, p. 79; XXII, p. 469.

Highland Chief Mine. It comprises two claims situated in the Beveridge Mining District, on the east slope of the Inyo Range of mountains, about 2 miles north of Beveridge Canyon on the trail to Keynote Mine; elevation, 6000 ft.; owner. Thomas Hancock, of Lone Pine, California.

Quartz vein in granite, strike NW. and SE., dip 50° NE.; width, 12 in. to 2 ft. Development consists of a tunnel 100 ft. in length. Mill equipment consists of a 6 in. by 8 in. Blake crusher and a Moyle one-stamp mill.

Idle.

Holy Roller Mine. It is situated in the South Park Mining District on the west slope of the Panamint Range of mountains, 25 miles northeast of Trona; owner, A. C. Porter, of Trona, California. Idle.

Bibl.: State Mineralogist's Reports XV, p. 79; XXVIII, p. 370.

Hornspoon Mine. It is situated near the head of Hall Canyon, 10 miles northeast of Ballarat; elevation, 7500 ft.; owner, Christopher Wicht, Ballarat, California.

Idle.

Bibl.: State Mineralogist's Report XXVIII, p. 370.

Inyo Gold Mine, comprising 17 patented and 5 unpatented claims, is situated in Echo Canyon, on the west slope of the Funeral Mountains, in the east side of Death Valley, 10 miles from the highway to Death Valley Junction and 12 miles east of Furnace Creek Ranch; elevation, 3900 to 4400 ft.; owner, *Inyo Consolidated Mines, Inc.;* F. M.

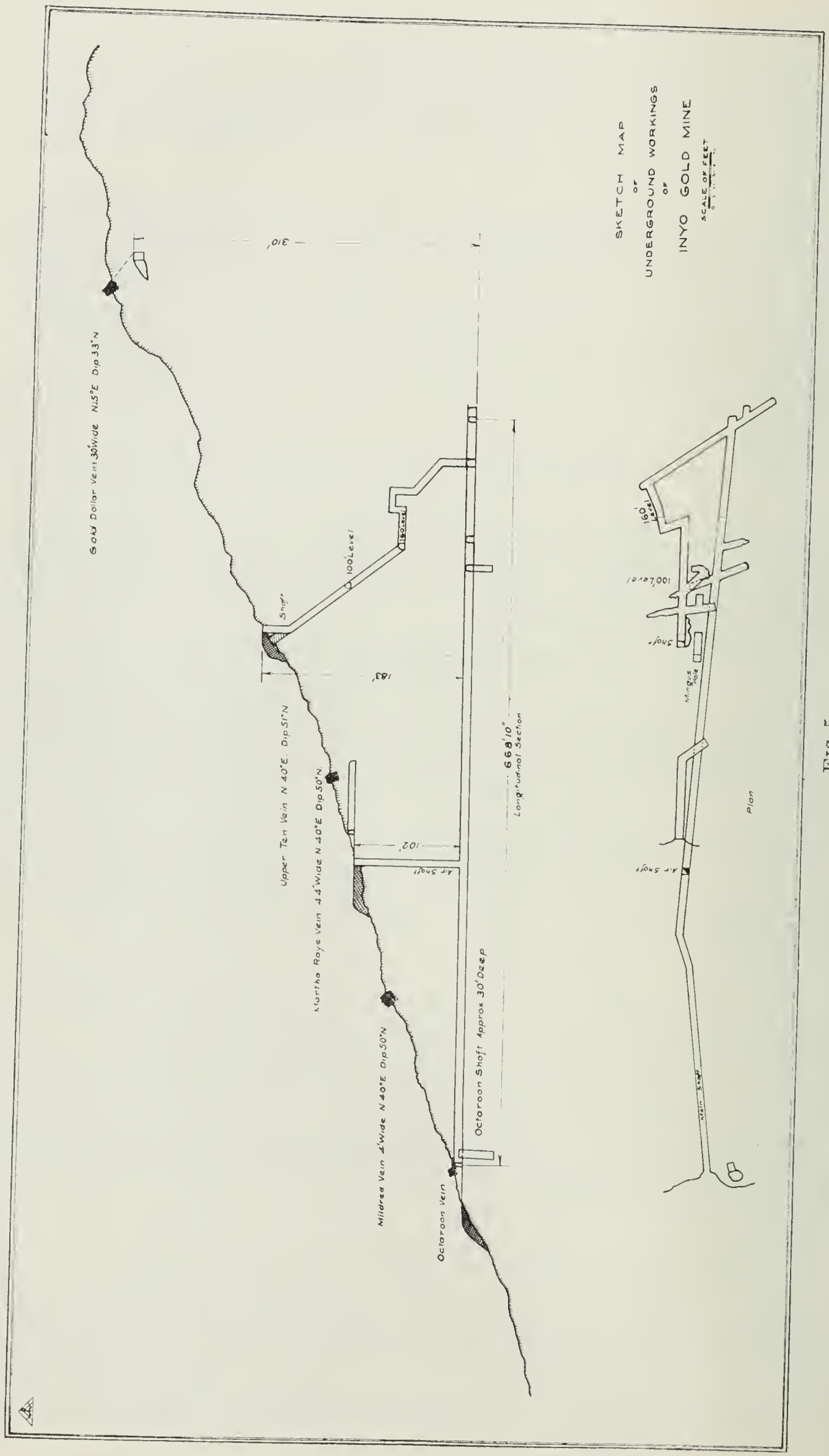

SKETCH MAP
OF
UNDERGROUND WORKINGS
OF
INYO GOLD MINE
SCALE OF FEET
Gold Dollar Vein 30 Wide N.5°E Dip 33°N
310'
100 Level
Shaft
183'
Upper Ten Vein N 40°E Dip 51°N
Martha Raye Vein 4'4 Wide N 40°E Dip 50°N
102'
Air Shaft
668'10"
Longitudinal Section
Octoroon Shaft Approx 30' Deep
Mildred Vein 4' Wide N 40°E Dip 50°N
Octoroon Vein
160' Level
100' Level
Shaft
Mingus Hole
Air Shaft
Main Shaft
Plan

FIG. 5.

Gallaher, president; Stanley Hollister, secretary, 830 State Street, Santa Barbara, California.

The country rock is quartzite and schist. Six quartz veins have been found in the quartzite. Their general strike is NE.-SW., dip from 35° to 55° NW.; widths vary from 12 in. to 15 ft. or more. The quartz is lenticular in shape and neither the length nor the average width of the lenses has been determined. Mineralization consists of oxides of iron and manganese, with which is associated free gold, usually in a finely divided state.

The principal development is on the Upper Ten Claim. It consists of an inclined shaft, 220 ft. long, which connects with a tunnel at the bottom. Levels have been driven at 100 and 160 ft. horizons, 60 and 40 ft., respectively. The tunnel was driven as a crosscut north 695 ft. to the vein, drift east 50 ft. and 80 ft. west to connect with the shaft. At about 200 ft. from the portal an air shaft was raised through to the surface, a distance of 80 ft. At the collar of the air shaft a crosscut has been driven north 50 ft. where it intersected another vein about 10 ft. wide (where cut); strike N. 50° E., dip 45° NW. It is filled with porous quartz and is said to carry $25 per ton in gold. They have drifted northeast 25 ft. on this vein. About 50 ft. east of collar of the main shaft a crosscut exposes the vein for a width of 30 ft., which is said to be good ore. (See Fig. 5.)

At the top of the hill, to the north of these workings another vein outcrops for a length of about 300 ft. with an average width of about 3 ft. No work has been done on this as yet.

A small mill has been erected at the camp, consisting of the following: 50-ton bin, 6 by 10 jaw crusher to 30-ton bin, reciprocating feeder to 3 ft. by 6 ft. ball mill to plates and 2 Simpson tables, drag classifier for dewatering: capacity, 25 tons per day. Water is hauled from the valley for the mill. Eight men are employed.

Ironsides Mine. (See Burgess Mine.)

Josephine Mine consists of 3 claims situated in the Coso Mining District, about 8 miles southwest of Darwin; L. D. Owen, of Darwin, owner.

This mine was idle for many years until 1937 when it was leased by the *Coso Mining and Milling Company*, who subleased it to G. N. Sackett. About 100 tons were mined from a drift off a raise 60 ft. above the lower tunnel. Ten tons shipped to Hughes Lake are reported to have averaged $40 per ton, and 20 tons shipped to the Keeler Gold Mine, $26 per ton.

Idle.

Bibl.: State Mineralogist's Reports XII, p. 138; XIII, p. 181.

Journigan's Custom Mill. It is situated at Emigrant Springs in Emigrant Canyon, in the Panamint Range of mountains, 4 miles west of Skidoo Mine, and 25 miles northeast of Darwin; elevation, 4045 ft.; owner, Roy Journigan, Trona, California.

Capacity of plant is 40 tons per 24 hours. Ore being milled is hauled by truck from Skidoo and Cashier mines.

Journigan's Group of Mines. It comprises 5 claims, adjoining the Big Horn Mine on the west, situated in the Beveridge Mining District,

13 miles northeast of Lone Pine; elevation, 7000 ft.; owner, Roy Journigan, Trona, California.

Quartz vein, in granite, strikes E. and W., dip 80° N.; width 3 ft. Ore shows free gold associated with pyrite and chalcopyrite. Development consists of a tunnel driven west 150 ft. on the vein; ore shoot developed in a tunnel 30 ft. in length, with an average width of 3 ft.; ore stoped 30 ft. above the tunnel level.

Idle.

July Group of Mines. It comprises 2 claims, situated in the Grapevine Mining District, on the east slope of the Grapevine Range of mountains, near the boundary line of California and Nevada, 26 miles northwest of Beatty, Nevada, and 22 miles west of Springdale, Nevada; elevation, 6400 ft.; owner, Charles Phinney, of Beatty, Nevada; under lease and bond to E. W. Batchman, Fort Worth, Texas; Sol Camp, superintendent.

The ore occurs along fault fractures in rhyolite. These fractures strike N. 10° E., dip 60° E.; widths 6 ft. to 30 ft. The vein material is silicified rhyolite showing free gold, with values varying from $5 to $25 per ton in gold. Development consists of tunnel driven S. 74° W., 85 ft. in length with winze sunk from tunnel level to depth of 50 ft. then drift from bottom of winze 30 ft. N. 10° E., in ore. Six men employed on development work.

Jumbo Mine. It comprises 6 claims west of the Black Eagle mine, on the west flank of the Inyo Range of mountains, 4 miles east of Kearsarge; elevation 8000 ft.; owner, Clarence Johnson, Independence, California.

Idle.

Bibl.: State Mineralogist's Report XXII, pp. 469, 470.

Keane Wonder Mine. This property comprises 26 patented claims located in Sec. 6, T. 29 N., R. 1 E., Sec. 31., T. 30 N., R. 1 E., on the west slope of the Funeral Range of Mountains, 22 miles west of Rhyolite; elevation, 3400 ft.; owners, Coen Companies, Inc.; G. W. Coen, president, 610 South Broadway, Los Angeles; under lease and bond to the *Black Mammoth Cons. Mines;* Fred A. Volmer, president, Silver Peak, Nevada; A. N. Sweet, superintendent.

The property was operated by Keane Wonder Gold Mining Company from 1908 until May, 1916, when operations were suspended, as the developed orebodies were worked out. The country rock consists of mica and hornblende-schists and granite, with a limestone capping 150 ft. to 300 ft. in thickness. Intrusions of diorite and granodiorite dikes cut the schists, and along these intrusive dikes occur ore depositions. The dikes and ore-croppings can be traced on the surface for a distance of 2000 ft. Strike N. 25° W., dip 20° E. The orebodies occur as lenticular masses varying in thickness from 5 to 25 ft. and from 100 to 300 ft. in length. The quartz is iron-stained carrying fine gold, associated with galena and pyrite. The development consists of seven crosscut tunnels and a shaft 200 ft. deep. There are over 5000 ft. of underground workings; stoped from 180-ft. tunnel level to surface. The following is a record of production from 1908 to 1912:

1908 mined and milled 17,711 tons of ore, from which recovered $147,585.61 in bullion.

1909—20,222 tons of ore, recovered $196,600.94.
1910—20,500 tons of ore, recovered $180,942.82.
1911—15,552 tons of ore, recovered $161,080.32.
Grand total, 73,989 tons of ore, recovered $682,209.69.

The average value of ore treated was $9.22 per ton in gold, recovery was 93% of the assay value of the ore. Costs of mining and milling were $4 per ton. Total production of the property is reported to have been $1,100,000.

Bibl.: State Mineralogist's Reports XV, pp. 79, 81; XXII, p. 470.

Kearsarge Mine. It is situated in the Kearsarge Mining District, on east slope of the Sierras, at an elevation of 8000 to 9000 ft. The

PHOTO. 4. Keeler Gold Mine and Cyanide Plant, Keeler Gold Mining Co., Keeler, Inyo County.

vein, which is a few feet wide, occurs in quartz-monzonite in proximity to a schist belt that is extensively penetrated by quartz monzonite and aplite dikes. The vein quartz is milk-white in color, rich in free gold and native silver. The vein strikes NE.-SW., dips 80° W. Development consists of a tunnel 250 feet in length; some shallow shafts and short tunnels.

Idle.

Bibl.: State Mineralogist's Reports VIII, pp. 232, 233; XVII, p. 280; XXII, p. 470; U. S. G. S. Professional Paper 110, p. 124.

Keeler Gold Mines, Inc., has 23 claims on the west slope of the Inyo Mountains, 4 miles southeast of Keeler; elevation about 4000 ft. Adolph Ramish, of Los Angeles, is president; Roy C. Troeger, 972 Fourth Avenue, Los Angeles, is secretary of the company.

The vein in limestone, strikes a little west of north and dips 70° W. The ore-shoot rakes to the north or it may be cut off along the intersection with a fracture having approximately the same strike but which

dips 40° W. Vein-filling is silicified wall-rock mineralized with oxides of iron and manganese which carry some free gold.

Property is developed by 250-ft. vertical shaft with levels at 70, 130 and 250 ft. On 70-ft. level, drift 160 ft. northwest; on 130, drift 550 ft. northwest; on 250, drift 350 ft. On the 130 level at 400 ft. north of the shaft, a cross-cut was driven east 120 ft. On the 250, at about 250 ft. from the shaft, a winze was sunk 155 ft. on a 40° inclination to the north. The vein in this winze was 4 to 7 ft. wide but apparently was cut off at the bottom by the fracture mentioned above.

The ore-shoot approximately 160 ft. long has been stoped from the 250 level to within about 70 ft. of the surface. This ore is reported to have averaged $9.40 per ton in gold. Mine equipment consists of electric hoist, 220 cu. ft. compressor, blacksmith shop, change house, etc

The mill has 3 receiving ore bins, 40 tons each, from these to jaw crusher, elevator, through Vezin sampler to 180-ton bin, belt feeder to 4 by 5 ft. ball mill, where it is ground in 2 lb. per ton cyanide solution. Ball mill is in closed circuit with duplex Dorr classifier, overflow to Dorr thickener, thence to 3 agitators in series to three 30-ft. diameter by 10 ft. deep Dorr thickeners. Precipitation is in two 6-compartment zinc boxes. Precipitates are melted in a tilting furnace; capacity, about 50 tons.

Ores from Coso, Skidoo and Wildrose districts were also treated in this mill.

Idle.

Keynote Mine (Golden Princess). This property comprises 7 claims, situated in the Beveridge Mining District, on the ridge north of Keynote Canyon in the Inyo Range of mountains, 12 miles northeast of Owenyo on the Southern Pacific Railroad; elevation, 8000 ft.; owner, *Golden Princess Mining Company:* Jules Canterno, president; F. G. Pauch, vice president; Glenn Tinder, secretary and treasurer; offices, Lone Pine, California.

Two veins occur in granite, known as the War Eagle and Keynote, which are 600 ft. apart. The Keynote vein strikes NW.-SE.; dip 35° W.; width, 2 to 4 ft. War Eagle vein strikes N. 20° W.; dip, 40° SW.; width, 4 ft.

The principal development work has been on the Keynote vein which has been developed by 7 tunnels at different elevations.

The main workings are from tunnels No. 7 and No. 9.

No. 5 tunnel	150 ft.
No. 6 tunnel	300 ft.
No. 7 tunnel	750 ft.
No. 8 tunnel	300 ft.
No. 9 tunnel	600 ft.
No. 10 tunnel	225 ft.
No. 14 tunnel	205 ft.

There are five tunnels on Keynote vein and three on War Eagle vein. No. 6 tunnel on Keynote vein is 300 ft. in length, driven northwest.

There is a stope 150 ft. in length from this tunnel level, and stoped to the No. 5 tunnel level, a distance of 50 ft. on inclination of the vein. No. 7 tunnel level is driven northwest 750 ft.; at 50 ft. from portal cut first shoot of ore. The ore was stoped for a length of 250 ft. with an average width of 4 ft. to No. 6 tunnel level, a distance of approximately

100 ft. The vein quartz is mineralized with free gold, associated with pyrite and chalcopyrite. No. 9 tunnel level caved near portal.

War Eagle Vein. Upper tunnel driven N. 20° W. 240 ft. Two ore-shoots were developed in these workings. Each shoot has a length of 60 ft. with an average width of 4 ft. Ore is reported to have had an average value of $20 per ton.

Intermediate tunnel is 100 ft. in length and lower tunnel 120 ft. in length. Estimated tonnage of ore dump below No. 9 tunnel level is approximately 20,000 tons, reported to have an assay value of $8 per ton. Ore mined from the property was formerly milled in a 5-stamp mill located in Beveridge Canyon. The mine was operated continuously from 1878 to 1894 with a production of $500,000.

Idle.

Bibl.: State Mineralogist's Reports XII, p. 138; XIII, p. 181; XV, p. 81; XXII, p. 470. Register of Mines, Inyo County; Report of the Director of the Mint upon production of Precious Metals in U. S., 1883, p. 159; U. S. G. S. Bull. 540, p. 112.

Last Chance Group of Mines. It comprises 10 claims located on the west slope of the Black Mountains, 16 miles west of Shoshone; elevation, 1500 ft.; owners, L. V. Twining, R. C. Coryell, and S. M. Basher, of Los Angeles.

A quartz vein occurs in schist, strike N. 30° E., and dip 40° SE. The vein has a width of 12 in. to 2 ft.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 470.

Little Mack Mine. It comprises one claim and millsite, situated in the Modoc Mining District, adjoining the Minnietta mine on the southeast and is on the east slope of the Argus Range of mountains, 30 miles north of Trona; elevation, 3000 ft.; owner, Otto Siedentopf, Trona, California.

Three parallel diabase dikes cut the limestone beds. These dikes strike N. 60° W.; dip 60° S. The above-mentioned dikes are about 60 ft. apart.

A series of parallel quartz veins follow the bedding planes of the limestone. These veins strike N. 20° E., and dip 50° S., vary in width from 2 ft. to 4 ft. and carry values in gold associated with lead-carbonate. Short ore-bodies are found on intersections of quartz veins with diabase dikes. Development consists of a tunnel driven N. 70° W. 250 ft., following one of the diabase dikes. At 75 ft. from the portal, cut quartz vein carrying values in gold. Also, at 200 ft. west of the portal, cut another quartz vein carrying gold values. A raise was put up on the vein some 30 ft. and a small stope started. At 250 ft. west of the portal, a crosscut has been run north 55 ft. intersecting a parallel diabase dike. On the hill above the tunnel level, a tunnel has been driven S. 20° W. on a quartz vein in limestone, a distance of 20 ft., then an incline shaft sunk on the vein to a depth of 80 ft. The vein developed had an average width of 4 ft. with gold values stated to be $15 to $20 per ton. Ore mined from the tunnel level is transported by an aerial tram line 325 ft. in length to a 20-ton

ore bin. From the bin the ore goes to one 800-lb. stamp with amalgamation plate. Stamp is driven by a gas engine. Mine equipment consists of Rix compressor; blacksmith shop; and mine cars. Production is $15,000.

One man is employed.

Lost Burro Mine. It is situated in the Ubehebe District, 55 miles southwest of Bonnie Claire, Nevada; elevation, 5350 ft.; owner, Lost Burro Mining Company, Los Angeles; W. H. Blackmer, president.

Idle.

Bibl.: State Mineralogist's Reports XV, pp. 81, 82; XXII, pp. 470, 471.

Lucky Bill Mine. It comprises 3 claims situated on the east slope of the Sierra Nevada Range, on ridge west of Pine Creek, and 20 miles by road west of Bishop; elevation, 8000 ft.; owners, E. R. Elliott, George Cross and A. W. Hass, of Bishop, California.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 471.

Lucky Boy prospect, comprising 8 claims, is on the east slope of Black Mountain, about 12 miles northwest of Independence; elevation, 9000 ft.; owner, Geo. V. Parker, Independence, California.

The country rock is granodiorite, which is cut by a series of north-south diorite dikes. A series of northeast-southwest veins occur in these rocks, dip 65° to 70° NW. The veins are quite narrow and values are erratic.

Development consists of a 50 ft. tunnel.

Idle.

Lucky Red Mine. Located in the Coso Mining District, 5 miles east of Cold Springs; Inez J. MacConnell, owner. A 4-ft. quartz vein in diorite strikes northeast and dips 20° S. Assays average $3.60 in gold and carry from ½ to 1½% copper. A 3-in. stringer in the hanging wall is said to average $45 in gold. Developed by 150 ft. of trenching and three shafts from 8 to 16 ft. deep.

Luella Mine (formerly Abe Lincoln), consisting of 4 claims, is on the east slope of the Alabama Hills, 5 miles by road northwest of Lone Pine; elevation, about 4500 ft. One claim is leased from Mrs. Edwards, of San Clemente, Califoronia, and three held by location by the Luella Mining Company; J. G. McDonald, president, Ventura, California.

The company has a millsite, 3 miles north of Lone Pine and one-fourth mile west of the highway.

Here veins occur on the foot and hanging walls of a felsite dike in the granitic country rock. The strike varies from N. 30° W. to N. 10° E.; the dip changes in a vertical distance of five feet from 40° E. to 65° W. In the dike, which is some 8 ft. wide, there are horizontal joints from wall to wall which are mineralized. These joints are from 3 in. to 5 in. apart and from one in. to 3 in. wide. Vein-filling is largely quartz mineralized with hematite, copper-silicate,

pyrite and some free gold which is associated with hard, reddish-black bands of hematite.

Development consists of several tunnels, the upper ones driven years ago. Principal development consists of two tunnels about 75 ft. apart, vertically. The upper one was driven northwest about 350 ft. on the vein. There is some stoping on shoots apparently about 30 ft. long. The lower tunnel is 460 ft. long. At 210 ft. there is a 35-ft. winze and at 385 ft. there is a 35-ft. winze. There is a stope to the upper tunnel about 120 ft. long; average width approximately 3 ft. This stoping was done years ago and the grade of the ore is not known.

Idle.

Bibl.: State Mineralogist's Reports XII, p. 139; XIII, p. 182.

Magpie Group of Mines. This property comprises 5 claims, situated near Whippoorwill Flat, about 3½ miles north of Waucoba Springs, and 29 miles southeast of Big Pine; owner, C. C. Cunningham, Los Angeles.

Two systems of quartz veins occur in limestone; north and south veins, and east and west veins. The quartz veins vary from 18 in. to 2 ft. and vein quartz shows gold associated with galena. Ore is reported to carry from $3 to $20 in gold, with 10 to 20 oz. in silver, and from 3% to 10% lead.

Development consists of shallow shafts 20 ft. in depth.

Idle.

Mamie Mine comprises 4 claims, including one placer claim, the Coso Maid placer, and the Coso Boy quartz claim, located in the Coso Mining District, two miles northwest of Coso; owned by E. M. Lorenz, of Coso.

The Coso Boy Claim has a shaft 18 ft. deep which was sunk to pick up an east-dipping vein showing on surface. Mr. Lorenz is operating a 3-ft. Chilean mill, grinding to 40-mesh and concentrating in a 20-in. Australian spiral pan concentrator. Power is furnished by an Austin motor. He is working on float ore and material obtained from old dumps in the vicinity.

Mammoth Mine. It comprises 7 claims situated in the Argus Mining District on ridge north of Mountain Springs Canyon, and 24 miles northeast of Brown; elevation, 5000 ft.; owners, M. V. Carr and Earl Carr, of Long Beach, California.

A quartz vein occurs in granite, strikes E.-W.; dip, 70° S.; width, 4 ft. The vein quartz is mineralized with hematite, pyrite and chalcopyrite. Development consists of two tunnels; the upper tunnel is driven west 320 ft. and at 300 ft. intersected ore. A winze has been sunk on the vein to a depth of 30 ft. and a raise put up 30 ft. About 400 ft. in elevation below these workings, a crosscut tunnel has been driven N. 10° W. 1000 ft. to intersect the vein. Equipment consists of a Gardner-Denver compressor driven by a 20 hp. gas engine; and a three-stamp mill.

Idle.

Marble Canyon Placers. These gold placer deposits occur along Marble Canyon, on the east slope of the Inyo Range of mountains,

in T. 10 S., R. 37 E., M. D. M., 23 miles southeast of Big Pine, on the Saline Valley-Waucoba Road; elevation, 7000 ft.

The channel on which the above locations have been made is about 200 ft. in width and 9 miles in length, and the general course of this channel is east and west. Bedrock is limestone and schist. The gravel is well-rounded and is made up of quartzite, granite and quartz. The gold occurs on bedrock and is fairly coarse in size, ranging from the size of wheat grains to nuggets. Development consists of several shafts sunk to bedrock with depths ranging from 70 to 115 ft. The principal drawback in working these placers is the lack of water, and the recovery of the gold is made by operation of dry placer machines.

In 1934 J. C. Lewis discovered some coarse gold in gulches on the ridge north of Marble Canyon, just east of the Waucoba-Saline Valley Road, and with dry washers recovered considerable gold. Following this discovery, a number of locations were made by J. C. Lewis, Frank Bedell and David T. Bedell. The following placer mines are under operation:

Anderson Group of Placer Claims. This group comprises 4 placer claims, situated in Marble Canyon, about 1½ miles east of the Bedell Group of Claims, 23 miles southeast of Big Pine; owner, Helah Anderson, of Big Pine; elevation, 5800 ft.

Two men are employed in sinking an incline shaft; present depth, 75 ft. The general course of the channel is east and west; width, 100 ft.

Bedell Group of Mines. It comprises 2 claims, situated in Marble Canyon, in T. 10 S., R. 37 E., M. D. M., 23 miles southeast of Big Pine; elevation, 6000 ft.; owners, David T. Bedell and Stuart Bedell, of Big Pine, California.

The course of the channel is east and west, with 2400 ft. on the channel. Width of the pay gravel is 15 ft. The pay gravel is from 3 to 6 ft. above bedrock. The gold recovered is coarse, varying from wheat grains to nuggets in size. The fineness of the gold is 914 to 924. The largest nugget recovered had a value of $300. It is reported that gravel on the bedrock will carry $5 to $6 per cu. yd. The bedrock is limestone. There are large boulders, made up of granite, quartzite, and schist.

Development consists of two shafts sunk to bedrock through gravel wash. The west shaft is situated 250 ft. from the west end line, on the north rim of the canyon, and has been sunk on an inclination of 45° to a depth of 100 ft. to bedrock, with a drift on the bedrock on the 100-ft. level, 250 ft. west and 450 ft. east. About 570 ft. east of this shaft, the main working shaft has been sunk on an inclination of 65° to bedrock, to a depth of 96 ft. This shaft is located in the center of the channel. On the 96-ft. level there is a drift 130 ft. west and 150 ft. east, also 100 ft. of crosscuts to the rim of the channel. Equipment consists of a 3 hp. Fairbanks-Morse gas engine hoist, bucket with a capacity of 300 lb., gravel hoisted to ore pocket from which it passes over a 2 in. grizzly, oversize to waste dump, minus 2 in. size to trommel where it is screened to ½ in., which goes to a Stebbins Dry Concentrator with a

capacity of 1½ yd. per hour. The gravel mined amounts to 4 cu. yd. per 8-hr. shift. Two men are employed.

Davis Group of Placer Claims. It comprises 4 claims, situated in the west end of Marble Canyon, about one mile west of Waucoba-Saline Valley Road, 22 miles southeast of Big Pine; elevation, 6200 ft.; owner, Mrs. J. E. Davis, of Big Pine.

The course of the channel is east and west; width, 150 to 200 ft.; length along the channel, 3000 ft. The bedrock is schist and slate. There are large boulders of granite, quartzite and schist.

Development consists of shaft, 150 ft., sunk through gravel. So

Photo. 5. Bedell Shaft. Marble Canyon Gold Placers, Marble Canyon, Inyo County.

far, workings have not encountered bedrock. Some fine gold has been recovered. Mine equipment consists of gasoline hoist and cars. Two men are employed.

Hallelujah No. 3 Placer Mine. It comprises one claim, adjoining the Bedell Group on the east, located in Marble Canyon, 23 miles southeast of Big Pine; elevation, 5900 ft.; owners, Dr. Vaughn, of San Pedro, and Harry Mornway, of Big Pine.

The course of the channel is east and west, with 1400 ft of it on this claim. Width of channel is 60 ft. The pay gravel is on bedrock to 3 ft. above. The bedrock is limestone. Gold recovered is coarse, running from wheat grains to nugget size. The largest nugget so far recovered had a value of $22, with a fineness of 920.

Development consists of incline shaft sunk to a depth of 103 ft., with a drift west on pay gravel 150 ft. and east 150 ft., and a crosscut north across the channel to the north rim, a distance of 60 ft. Gravel, hoisted and screened, is run over a dry washer. Two men are employed.

Iron Nugget Placer Mine. It comprises 2 claims, located in Marble Canyon where Waucoba-Saline Valley Road crosses the canyon, 23 miles southeast of Big Pine; elevation, 6000 ft.; owners, F. B. Krater, W. H. Van Norman and C. H. Van Norman, of Los Angeles; under lease to Glen P. Kelley, of Big Pine.

The course of the channel is east and west, 2000 ft. along the channel; width of channel, 75 ft. The pay gravel is 6 ft. thick; bedrock, limestone. Large boulders are encountered in the channel. The gravel is made up of quartz, quartzite, schist and granite rocks. The gold found on the bedrock is coarse, running from wheat grains to nugget size. The largest nugget recovered is said to have had a value of $29. The fineness of the gold is 924. A number of nuggets recovered ran from $12 to $21. The pay gravel is stated to have a value of $6 per cu. yd.

Development consists of a shaft sunk on an inclination of 65° to a depth of 146 ft. where it encountered the north rim; from bottom of shaft, incline winze 125 ft. to center of channel on 25° slope. The channel has been drifted 550 ft. The gravel is hoisted in a bucket by a gasoline-driven hoist to a bin, then passed over a 2-in. grizzly, oversize to waste dump and minus 2 in. size material to a hopper, from the hopper to a bucket elevator to a trommel screen, where it is screened to $\frac{1}{2}$ in. size, then to a Lewis dry washer. Two men are employed.

Krater-Van Norman Group of Placer Claims. These claims are located in Marble Canyon, 3 miles east of Hallelujah No. 3 Claim, 26 miles southeast of Big Pine; elevation, 5600 ft.; owners, F. B. Krater and W. H. Van Norman, of Los Angeles.

Development consists of incline shaft, 115 ft. deep to bedrock, with a drift north, 150 ft. It is reported that no pay gravel was encountered. Idle.

Lewis Group of Placer Mines. The property comprises 4 placer claims, located in Marble Canyon, in T. 10 S., R. 37 E., M. D. M., 23 miles southeast of Big Pine; elevation, 6000 ft.; owner, J. C. Lewis, of Big Pine.

This mine was one of the first producing placer mines of the Marble Canyon District. The general course of the channel is east and west, following the rims of the canyon. The length is 4800 ft. on the channel. The pay gravel has an average width of 40 ft. The height of the pay gravel above bedrock is 6 ft., reported to average $5 per cu. yd. The gold recovered is coarse, wheat grains up to nugget size. Nuggets recovered vary from $3 to $20 in value. The bedrock is limestone. The gravel is made up of quartzite, granite, quartz, and schists, with some large boulders.

Development consists of two shafts each 115 ft. to bedrock, with 500 ft. of drifts. Mine run of gravel is hoisted in buckets, then passed over a 2 in. grizzly, minus 2 in. size to trommel where it is screened to ½-in size, which goes to a Lewis dry washer for the recovery of gold.

Marigold Mine. (See Golden Rod Mine.)

Mazourka Canyon Placers. These placers are situated on the west slope of the Inyo Range of mountains, in T. 12 S., R. 35 E., 10 miles northeast of Independence; elevation, 5000 to 7000 ft. The gold is found in a wash of Mazourka Canyon extending in a northerly direction from Barrel Springs to Santa Anita Spring. These placers were first discovered in 1894 and worked until 1906 with dry placer equipment. In 1935, *Nodak Mining Company;* G. M. Booker, president; J. H. Blain, secretary, Los Angeles, secured a lease on a group of placer claims along Pops Gulch, one mile east of Santa Anita Spring. The general course of the channel is east and west, is 500 ft. in width and from 5 to 20 ft. deep. The bedrock is lime shale and granite. The gold occurs in glacial drift material made up of lime shale, and angular wash material with occasional pieces of quartz with gold. Nuggets recovered are fairly coarse, ranging in value from 50 cents to $10; fineness, 940 It is stated that gravel being treated will carry 20 cents to $2 per cu. yd. Gravel is loaded into 5-ton truck with P & H gas-driven shovel, with ¾ bucket, then hauled one mile to washing plant at Santa Anita Spring. The gravel is dumped into a bin having a capacity of 50 cu. yd.; material from bins goes to 16-in. belt conveyor, which conveys gravel to hopper on 6-unit Huelsdonk gold concentrator, driven by 30-h.p. caterpillar gas engine. From hopper 6-mesh material goes to concentrator, oversize material to waste dump. Machine has a capacity of 25 yd. per hour. Water supply is secured from well 30 ft. deep, located at Santa Rita Spring. Well has a capacity of 34,000 gallons. Water pumped from well through 4-in. pipe line 600 ft. in length to 4 storage tanks.

Four men employed.

Bibl: State Mineralogist's Reports XII, p. 139; XIII, p. 182.

Merry Christmas (see St. George).

Moffatt Mine. It comprises 7 claims, situated in Buttermilk Mining District, 13 miles southwest of Bishop. Elevation 7000 ft. Owners, J. W. Brown, R. M. Wells, of Bishop, California.

A vein of iron-stained quartz occurs in granite, strike NW.-SE., dip 40° SW., width 3 ft. No. 1 shaft is sunk on vein to a depth of 50 ft. About 200 ft. northwest of this shaft is No. 2 shaft, which is sunk on the vein to a depth of 50 ft. Mine equipment consists of 6-h.p. gas engine hoist. Ore is treated in a 5-stamp mill, with amalgamation plates and Wilfley concentrator.

Two men employed.

Mohawk Mine comprising 12 claims is in the Argus Mining District, on the east slope of the Argus Mountains, 7 miles northwest of Trona. Elevation about 2500 ft. Owner, J. C. Boyles, Trona, California. Under lease to L. E. Netherton, of Red Mountain, California.

Here in the granitic country rock there occurs an E.-W. vein which dips approximately 80° to the north. The width, between walls varies from about 3 to 14 ft. The vein-filling consists of quartz and altered country rock with many encrustations of calcite. The valuable mineral is a fine, free gold, no sulphides.

Development work consists of a shaft sunk on a 70° inclination 168 ft. At 60 ft. the shaft connects with a tunnel which was driven west about 300 ft. The shaft is 200 ft. from the portal of this tunnel. On 110-ft. level a drift about 65 ft. east connects with an old stope, drift west about 300 ft., the last 250 ft. of which is reported to be an ore-shoot. The average width is about 5 ft. At the 160-ft. level, cross-cut 30 ft. south to vein, drift west 400 ft. At 60 ft. from shaft struck ore shoot 160 ft. long, 3 to 14 ft. wide. The last 20 ft. of this drift is reported to be in good ore. At 100 ft. from the cross-cut there is a raise to the 110 ft. level. There is also a drift east 335 ft. of which the east 200 ft. is reported to be ore for a width of 7 ft. Average values are reported to be $8 per ton.

Mill consists of jaw crusher, elevator to screen, rolls to 4 leaching tanks. A 5/16 in. product goes to the tanks. Capacity 30 tons per day. Water is pumped from Homeward Canyon a distance of 6500 ft. Idle at time of visit.

Mountain Springs Canyon Mine (Bonanza). It comprises 20 claims, known as the Convention Group, situated in the Argus Mining District, in Mountain Springs Canyon, in Sec. 7, 8, 9, 17 and 18, T. 23 S., R. 41 E., 20 miles northeast of Brown, a station on Owens Valley Branch of the Southern Pacific Railroad; elevation, 4280 ft.; owner, Mountain Springs Canyon Mining Company; I. C. Lewis, president; J. Torrence, secretary; Ralph Blewitt, vice president and general manager, 907 Van Nuys Building, Los Angeles, California.

A series of parallel veins occur in the granite, along fissures and fault zones and on contacts of intrusive dikes of diorite porphyry and andesite porphyry. All the veins on the property contain quartz with variable amounts of pyrite and chalcopyrite. Seven parallel veins have been developed on the property, with widths varying from 12 in. to 4 ft. The veins strike N. 30° E., to N. 45° E., and dip 30° to 40° NW. The principal development work has been confined to the Convention No. 2 Claim, where a shaft has been sunk on the vein to a depth of 185 ft. On the 138-ft. level, drift SW. 338 ft. and NE. 70 ft. At 75 ft. in elevation and SW. of shaft No. 2 is vein No. 1, on which there is an incline shaft 70 ft. deep, with a drift SW. 130 ft. on the 60-ft. level, and NE. 100 ft.; average width of the vein being 1 ft. Ore values on the two veins so far developed are reported to carry from $9 to $20 in gold and silver per ton.

Mine equipment: 15 hp. Fairbanks-Morse gas engine hoist; 8 by 8 in. Curtis compressor driven by a 30 hp. Climax gas engine; (5½ by 3½ by 5 in.) Fairbanks-Morse station pump; (4½ by 3 by 4 in.) Fairbanks-Morse sinking pump.

Mill equipment: 6 by 8 Blake crusher; 4 by 4 ft. Federal ball mill; Dorr Duplex classifier; Wilfley table.

Idle.

Bibl.: State Mineralogist's Reports XII, p. 136; XIII, p. 180.

Mountain Springs Canyon Gold Placers. It comprises 100 acres situated in Water Canyon, 30 miles northeast of Brown; owner, Curtis W. Shields, Jr., Beverly Hills, California.

Gravel is reported to carry 50 cents to $1 a cu. yd.; developed by shafts 6 to 8 ft. to bedrock.

Mountain View Mine. It is situated in the Beveridge Mining District, adjoining the Keynote Mine on the north, on the east slope of the Inyo Range of mountains, 10 miles northeast of Owenyo, a station on the California and Nevada Railroad; elevation, 8000 ft.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 82; XXII, p. 471.

New Discovery and Gem Mines, comprising 5 claims, is situated in Jail Canyon, on the west slope of the Panamint Mountains, 14 miles north of Ballarat and 3 miles up the canyon from the valley floor. Elevation 3700 ft. Owner, *Gem Mines Incorporated;* E. S. Saint Clair, of Bakersfield, president.

Two veins occur in the granitic country rock near its contact with the schist. Strike N. 25° E., dip about 65° W. The principal vein on which all of the work has been done varies in width from about 2 to 12 ft. The vein-filling is quartz; mineralization consists of pyrite, pyrrhotite, a little chalcopyrite, bornite, galena and zincblende. The gold is associated with the sulphide minerals.

Development consists of a tunnel driven north 260 ft. and a vertical shaft 220 ft. deep. Levels have been driven at 75, 125 and 200 ft. horizons. An ore shoot about 50 ft. long and from 2 to 12 ft. wide was developed and stoped on the 75 and 125 ft. levels. On the 200-foot level a crosscut has been driven 50 ft. into the hanging wall. At a few feet from the shaft the crosscut passed through a stringer zone and at 42 ft. it passed through 11 ft. of talc. The stringer zone probably is the vein. No drifting has been done on this level.

Mine equipment consists of hoist, 6 by 5½ in. compressor driven by gas engine.

The 25-ton mill consists of 9 by 12 jaw crusher, elevator bin, 4 by 5 ft., ball mill, simplex Dorr type classifier, Groch, 4-cell flotation unit and table. Mill power is furnished by 50-hp. diesel engines. Five men working.

Bibl.: State Mineralogist's Report XXVIII, pp. 364-366.

North Star Mine. It comprises 7 claims, situated on the east slope of the Inyo Range of Mountains, 6 miles northwest of Cerro Gordo Mine, and about 45 miles by road east of Keeler; elevation, 5000 ft.; owners, D. E. Boelter, Earnest Mound, and Elhan Hillegast, of Los Angeles. A number of parallel quartz veins occur in granite; strike N. and S., dip 80° W.; widths vary from 2 to 6 ft. Vein quartz is mineralized with galena, pyrite, and chalcopyrite, carrying values in gold and silver. Development consists of shallow shafts and open cuts on different vein outcrops. Four men are employed on development.

O. B. J. Mine (Tyler Mine), with which is consolidated the Thurman and Aster Mines, comprising 14 claims, is on the south side of Tuber Canyon, on the west slope of the Panamint Mountains, some

15 miles north of Ballarat; elevation at principal workings, 3450 ft.; owners, C. W. Tyler, Trona, California, and Mrs. Reed, Santa Barbara, California; under lease and bond to *L & H Corporation;* Wilbur S. Ganse, 629 Subway Terminal Bldg., Los Angeles, California.

These properties were fully described in our Report XXVIII, pp. 371-372, under the name of *Panamint Mines Company.*

The present lessee's operations have been largely confined to sampling and mapping.

Two men are employed on this work.

Bibl.: State Mineralogist's Reports XV, p. 74; XXII, p. 465; XXVIII, pp. 371-372.

Olympic Mine. It comprises 3 claims situated in the Argus Mining District, on the west slope of Argus Range of mountains, 35 miles northeast of Brown, a station on Owens Valley Branch of Southern Pacific Railroad; elevation, 5500 ft.; owner, Joe Conner, Los Angeles, California.

A quartz vein 4 ft. in width occurs in quartz diorite; strike NE.-SW., dip 30° SE. A tunnel 200 ft. in length has been driven on the vein.

Idle.

Orion Mine. It comprises 5 claims situated in the Coso District, 2 miles southeast of Coso; owned by Walter Ross and E. W. Robinson. Developed by an incline shaft on the vein to depth 53 ft.; on 50 ft. level, drift east 15 ft. A 4-inch stringer in the footwall yielded two tons in 1937 assaying 2.34 oz. in gold and 4.16 oz. in silver.

A tunnel was run 185 ft. north on a second vein 14 in. wide; strike E.-W.; vertical dip. averages about $6 in gold. Equipment consists of a Star gas engine hoist.

Two men are employed.

Oro Grande Placer Mine. It comprises one claim owned by Sam S. Clark, situated 1½ miles southwest of Coso.

Clark is operating a small, dry placer machine consisting of a ½-in. screen, bellows and riffles and an 8 ft. conveyor belt stacker. The bellows and conveyor are operated by a Briggs and Stratton 4-cycle gasoline motor.

Polita Mine, comprising 4 claims, one patented, is in Polita Canyon, on the west slope of the White Mountains, 8 miles east of Bishop; elevation, 5500 ft.; owners, C. H. Olds and A. E. Beauregard, of Bishop, California; leased to H. A. Van Loon, of Bishop.

This is an old property, most of the development work having been done many years ago. The quartz vein, having an E.-W. strike, dip 35° N., occurs in limestone. It varies from a few inches to 2 ft. in width. The mineralization consists of pyrite and in the oxidized portions, free gold and limonite.

Development consists of a tunnel some 400 ft. long. At about 200 ft. from the portal of this tunnel, a shaft has been sunk 600 ft. on a 35° inclination. Levels now open and partially accessible are: 200 level; drift E. 400 ft., with a stope 40 ft. long by about 25 ft. high; 250 level, drift W. 250 ft., first 100 ft. stoped and filled; 350 level,

drift E. 150 ft., stoped, with a drift west which has been stoped and filled; 400 level, drift E. 60 ft., stoped and filled; 530 level, drift W. 100 ft., stope 40 ft. long by 30 ft. high; 600 level, drift W. 50 ft., stoped, drift E. 50 ft. The east drift is now being driven. The vein here is about 8 in. wide and carries about $35 per ton in gold.

The mill is in the canyon, about one mile south of the mine and approximately 1000 ft. lower. It consists of 7 in. by 11 in. jaw crusher, to 2½ by 3 ft. ball mill, to 40 mesh revolving screen; screenings to plates, plate tails and over size from screen pumped to drag classifier; overflow to 2 Kraut flotation cells, sands to ball mill. On the sulphide ores an extraction of 96% is said to be made. The plant has a capacity of 12 tons per day at 100 mesh. Some 4000 tons have been treated by the present operation.

Three men are employed.

Bibl.: State Mineralogist's Reports XII, p. 139; XIII, p. 183; U. S. G. S. Prof. Paper 110, p. 120.

Radcliff Mine, consisting of 10 patented claims and a millsite, is situated on the south side of Pleasant Canyon, on the west slope of the Panamint Mountains, about 6 miles east of Ballarat; elevations on the property range from 4000 to 7000 ft.; owner, W. D. Clair on the property; post office address, Trona, California.

Since our last report on this property (1932), Mr. Clair has continued to mill the old tailings left by former operators.

Bibl.: State Mineralogist's Reports XXII, p. 472; XXVIII, pp. 373, 376.

Rainbow Group of Mines. This group comprises 25 claims, situated in Secs. 12, 21, 22, T. 22 N., R. 7 E., 3½ miles east of Shoshone, in Resting Springs Mining District; owner, A. W. Plummer, 2062 Glencoe Way, Hollywood, California.

Series of parallel veins which strike NW.-SE., occur in andesite. Vein widths are from 15 to 25 ft. Large low-grade deposit with values reported to range from $1.25 to $2.50 per ton in gold. Development consists of a number of shallow shafts and open cuts.

Two men are employed on development.

Red Mexican Mine. It comprises one claim and a fraction in the Coso Mining District, 3 miles south of Cold Springs; owned by C. M. Turner, of Las Vegas, Nevada; R. E. Lafink and M. D. Early, of Lancaster, California; under lease and bond to Glenn Hart, Ed. Cardwell, George Pyle, of Lancaster, California.

Developed by a 150-ft. vertical shaft and a tunnel driven 370 ft. northeast on the vein connecting with shaft on the 100-ft. level. On the 150-ft. level a drift has been driven 25 ft. southwest on the vein. The vein is from 6 in. to 18 in. wide and dips 20° W. Eight tons shipped from the tunnel on the 100 ft. level netted $152.

Equipment consists of a 240 cu. ft. Worthington portable compressor. Two men employed.

Reward Mine. (See *Brown Monster.*)

Rex Montis Mine consisting of 4 patented claims is on the north slope of Kearsarge Mountain, about 9 miles northwest of Independence;

elevation 12,000 ft.; owner, Howard Mears, Independence, Calif., and N. E. Conklin Co., San Francisco, Calif.

This is an old property which, from best information obtainable, was last worked from 1875 to 1883. In 1877 Rex Montis Mining Co. produced 12,333 oz. of gold and silver bullion. In 1935 an attempt was made to cut the ice out of the tunnels but weather conditions prevented completion of this work.

It is reported that three quartz veins occur between granite walls. The average width of veins is said to be 3½ ft. The vein quartz carries both native gold and silver. The ore is reputed to have been high grade.

The property was developed by three tunnels, supposedly driven on separate veins. The upper and lower tunnels at 12,000 and 10,500 ft. elevations, respectively, are partially caved and filled with ice. In the summer of 1935, ice was cut from the middle tunnel for a distance of 260 ft. This work exposed stopes on three ore-shoots. These stopes are 80, 20 and 55 ft. long and have an average width of 3½ ft. At an elevation of about 10,500 ft., a shaft was sunk on a wide vein to an unknown depth. Some stoping was done in the shaft as the stopes were holed through to surface. These workings are now caved.

Idle.

Ruiz Mine, comprising three claims is in the Argus Mountains, 5 miles north of Darwin. Elevation about 5200 ft. Owners: R. C. and R. E. Ruiz of Lone Pine, California.

The vein which strikes N. 35° W. and dips 50° to 35° S. W. occurs in the quartz monzonite country rock. It is a fault fissure filled with quartz. It varies in width from 2 to 5 ft. The portion next to the hanging wall, from 1 to 1½ ft. being highly oxidized, carrying values in free gold. The remainder, adjacent to the foot wall, is unstained quartz showing considerable sulphides.

Development consists of a 65-foot shaft sunk on the vein. Assays as high as 14 ozs. in gold have been reported. A shipment of 1½ tons to the Tropico mill is said to have returned $100.

Idle.

Ruth Mine (Graham-Jones). It comprises 13 claims, known as Ruth, Ruth No. 1, No. 2, No. 3; Island, Empire, No. 1, No. 2 and No. 3; Crown, Crown No. 2; Red Bluff, West Extension, and Larry Jean, situated in Homeward Canyon, in the Argus Range of mountains, in South Park Mining District, 12 miles north of Trona; elevation 4000 ft.; owners, Graham Estate, Porterville, Calif.; F. L. Austin, Trona, Calif.; H. R. Evans, Kernville, Calif.; under lease and bond to *Burton Bros. Inc.,* Tropico, Calif.; George Wyman and N. E. Sweetzer, Mojave, Calif.

Ore occurs along a fault fissure in quartz-monzonite, strike N. 75° E., dip 70° S.; width 6 ft. to 40 ft. The gold occurs in a very fine state in iron-stained porphyry, associated with pyrite.

Development consists of tunnel driven N. 75° E., 700 ft. on which level an ore shoot 100 ft. in length, with an average width of 9 ft. was developed. At 700 ft. from portal, a 2-compartment winze was sunk to a depth of 100 ft. with a drift west 150 ft. and 100 ft. east. The ore-shoot developed on this level is 200 ft. in length, with an average width of 10 ft. with a reported average value of $14 per ton in gold. There is a glory hole 40 ft. wide and 200 ft. in length, 150 ft. in elevation

above tunnel level. On glory hole level, a tunnel has been driven east 400 ft. Former operators mined and milled 10,000 tons of ore from the glory hole. Estimated tonnage of ore developed from the glory hole level is stated to be 30,000 tons of ore with an average value of $6 per ton in gold. Between the tunnel level and the glory hole level it is estimated that there is developed 10,000 tons of ore with an average value of $6 per ton. Between the tunnel level and the winze level it is stated that there is developed 10,000 tons of ore with an average value of $15 per ton in gold. The total estimated tonnage of ore is said to be 50,000 tons.

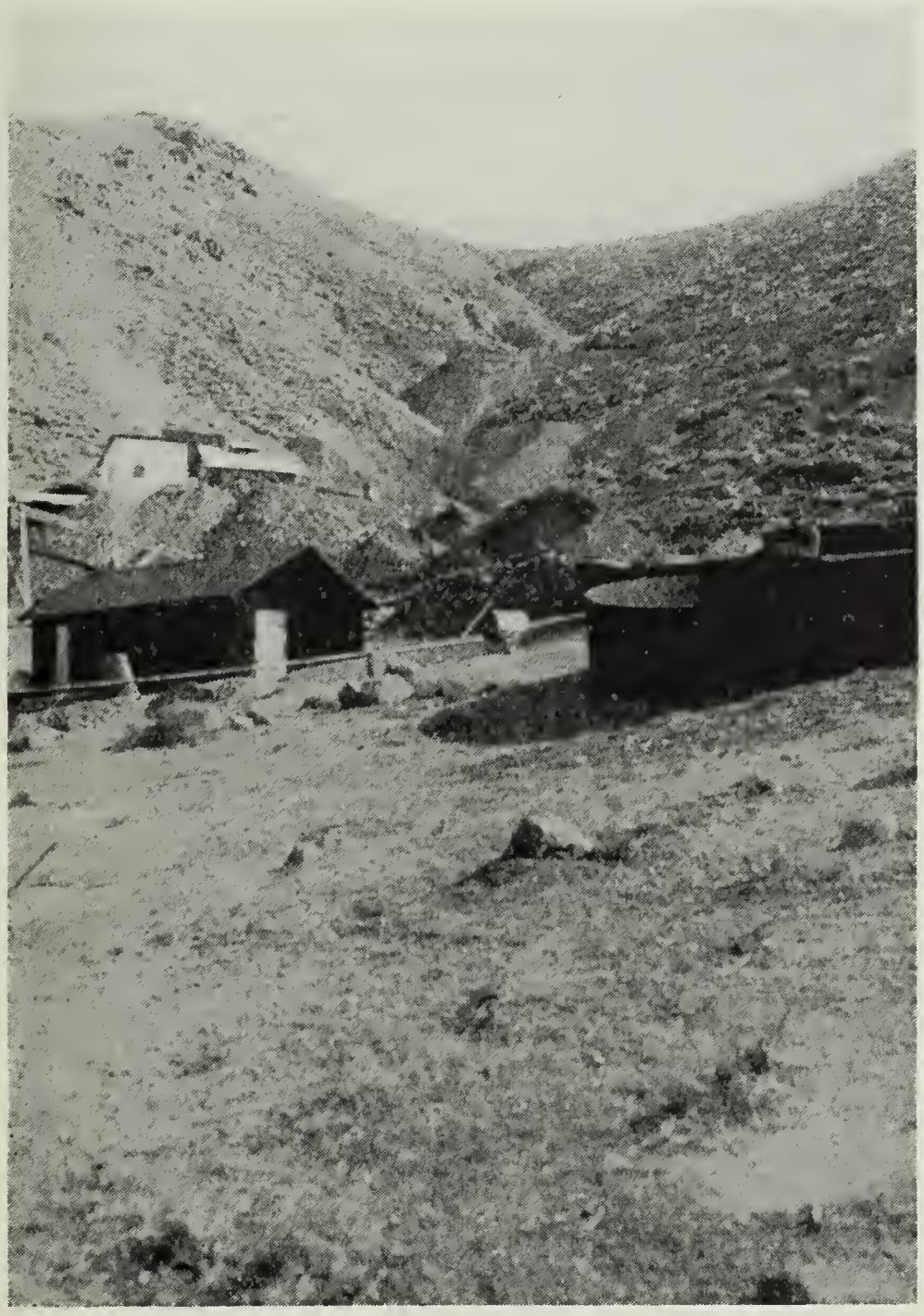


PHOTO. 6. View of Upper and Lower Tunnels Ruth Mine, Argus Range of Mountains, Inyo County.

Water for mining and milling operations is secured from springs one mile west of the mine and flows by gravity through a 2-in. pipe-line to a storage tank having a capacity of 20,000 gallons.

Mine equipment consists of a 75 hp. 2-cylinder Fairbanks-Morse diesel engine which drives 310-cu. ft. Ingersoll-Rand compressor; 15 hp. single drum air hoist; blacksmith shop; air drills, and mine cars.

Mill: Ore trammed in one-ton ore cars to coarse ore bin having a capacity of 35 tons; from the coarse ore bin to a 12-in. by 16-in. Blake crusher, crushed to $1\frac{1}{2}$-in. size to 16-in. belt conveyor over Dings mag-

netic pulley to Symons cone crusher, crushed to ¼-in. material from Cone crusher to 16-in. belt conveyor to revolving screen, the minus ¼-in. material to fine ore bin, capacity 75 tons, oversize material from revolving screen returned to Cone crusher. Mill driven by 80-h.p. Atlas

PHOTO. 7. Crushing Plant—Capacity 70 tons. Ruth Mine, Argus Range of Mountains, Inyo County.

Imperial Diesel engine. From fine ore bin the ore is hauled by truck to eight 6 by 15 ft. steel tanks for leaching; one 5 by 25 ft. solution tank. Solution from tanks to sand filter, then to two 4-compartment zinc boxes. In leaching operations 8 lb. of lime to a ton of ore treated is used, with 2½ lb. of sodium cyanide. Average value of ore treated is said to be $7 per ton in gold, with a loss of 70 cents per ton in tailings. Expect to increase the value of ore to $12 per ton when stoping operations are started on winze level.

Ten men are employed. Present production stated to be $5,000 per month.

St. George Mine (*Merry Christmas*). This property comprises 12 claims situated on the east slope of the Argus Range of mountains, on ridge northwest of Snow Canyon, in the Modoc Mining District, 34 miles north of Trona, California; elevation 4500 to 5500 ft.; owner, J. C. Cress Estate and Marie E. Strezer, of Los Angeles; under lease and bond to Charles F. Hamilton, 1541 So. St. Andrews Place, Los Angeles, California.

From 1895 to 1896 the property was operated by the *Argus Gold Mining Company,* which company installed a 5-stamp mill. In 1913 and 1914, the mine was operated by the *Snow Canyon Mining and Milling Company,* Dallas, Texas. This company installed two aerial tram lines from mines to the mill. In recent years the property was oper-

ated off and on by John C. Cress. Two systems of veins occur in the granite; one strikes N. 50° W., dip 70° to 75° S. Widths vary from 2 ft. to 4 ft. The other system strikes E.-W.; dip 70° S. The vein quartz shows free gold associated with pyrite, chalcopyrite and arsenopyrite. The principal development work has been on the St. George and St. Patrick claims, also on the California group of claims. At an elevation of 5500 ft. on the St. George claims, a tunnel has been driven N. 20° E., 282 ft. to the vein, then a drift has been run on the vein N. 50° W. 500 ft. About 45 ft. south of these workings, there is a tunnel driven along a fault fissure in the granite, N. 70° E. 650 ft. and then a drift N. 40° W. 200 ft. (see Fig. 7). The vein developed in this drift has a width of 3 ft. The St. George shaft has been sunk on the vein to a depth of 200 ft. where it connects with a raise from the north tunnel level, at a point 447 ft. northwest of the crosscut tunnel (see Fig. 6). About 500 ft. northwest of the St. George shaft, there is a tunnel 200 ft. in length on the same vein. Ore mined from levels of the St. George shaft was dropped through the raise to the tunnel level and trammed in cars on the surface for 1000 ft. to the ore bin, then by aerial tram to the mill. The ore mined from the St. George vein is reported to carry from $15 to $25 per ton in gold. On the California claim there is a tunnel driven on the vein N. 50° W. 180 ft.; at 100 ft.

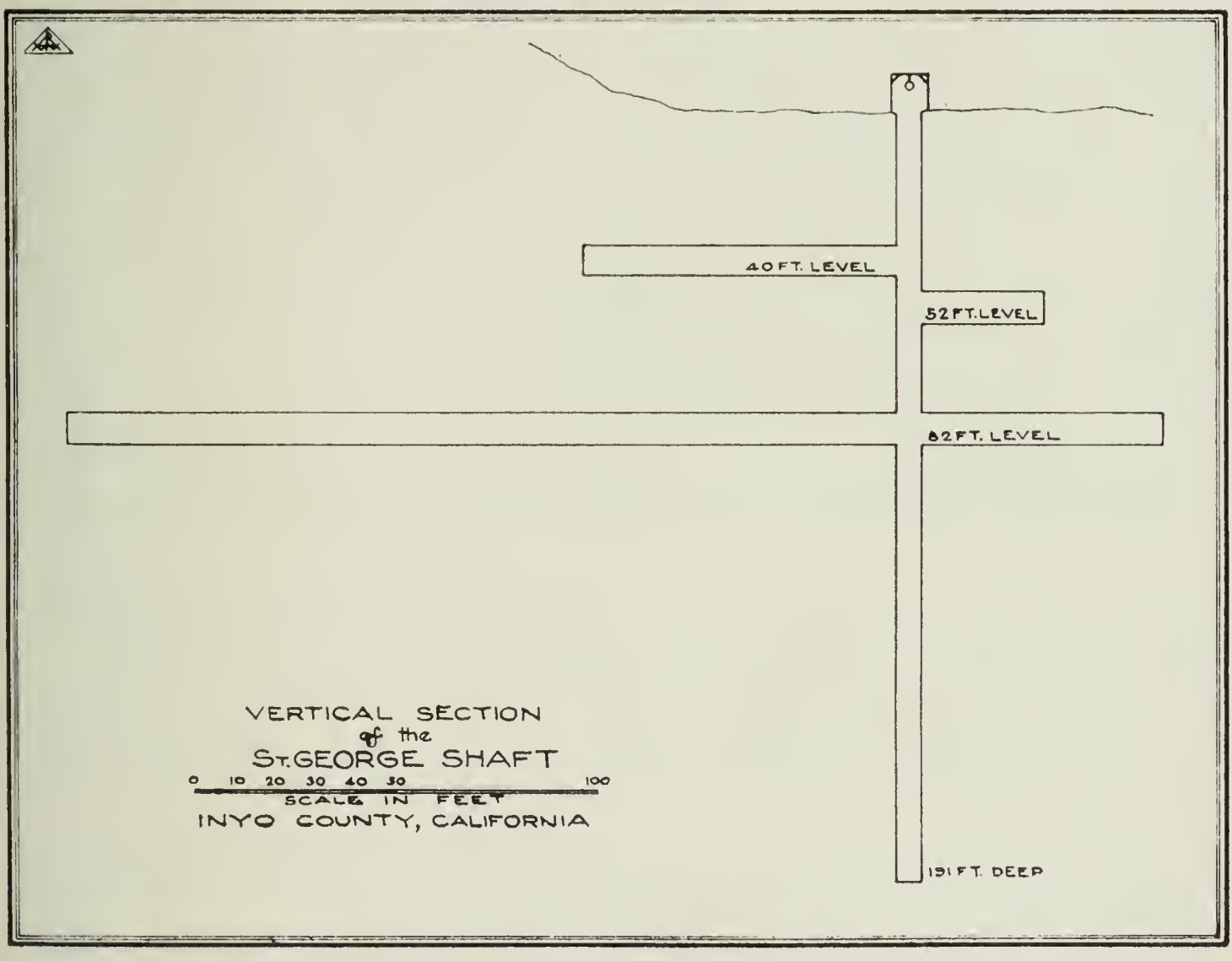


FIG. 6.

from the portal there is a winze 50 ft. deep. The vein strikes N. 50° W., dip 70° SW.; width 4 in. to 12 in., reported to carry high values in gold. This claim is under lease to Jake Hodge and associates who are driving the tunnel on the vein. Mill consists of 25-ton coarse-ore bin,

6 in. by 8 in. Blake crusher, Challenge ore feeder, five 1000-lb. stamps amalgation plates and Diester concentrator. Mill driven by 20-h.p.

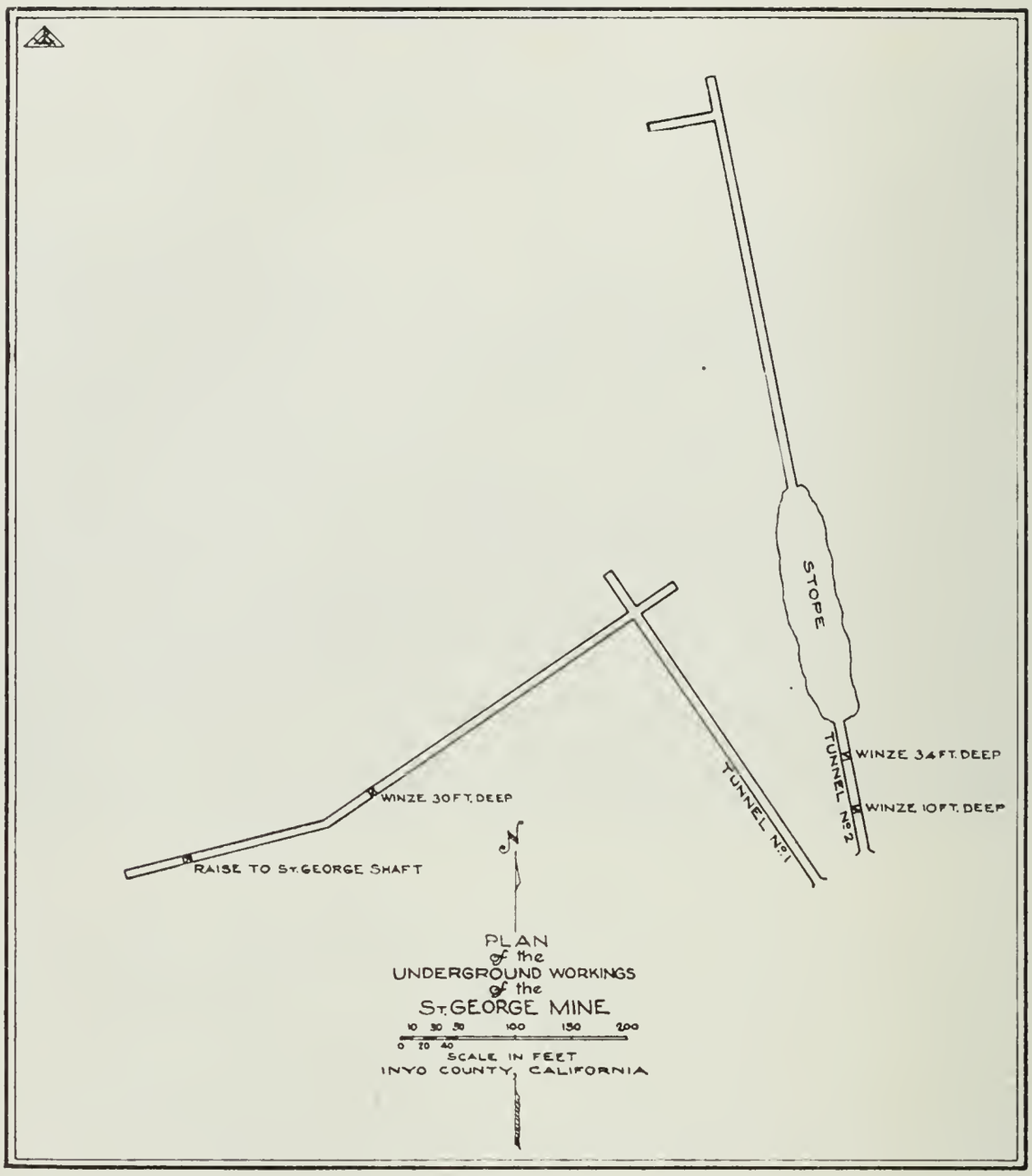


FIG. 7.

Foos gas engine. It is estimated that there are 700 tons of tailings below mill stated to have an average value of $8 per ton in gold.

Two men are employed.

Bibl.: State Mineralogist's Reports XII, pp. 136, 140; XIII, p. 179; XV, p. 82.

Skidoo Mine (Silver Bell). It comprises 12 claims, situated in the Wildrose Mining District, on the west slope of the Panamint Range of mountains, 65 miles north of Trona; elevation, 6500 ft.; owner, Judge W. Gray, Las Vegas, Nevada; under lease to *Journigan Mining & Milling Company;* Roy Journigan, president and manager, Trona, California.

There are two systems of quartz veins that occur in quartz-monzonite. The main vein system strikes northwest and dips from 30° to 40° SW. The other system trends east and dips 60° N. The

veins average from 18 in. to 2 ft. in width, with a maximum width of 4 ft. The ore is free-milling and values range from $15 to $20 per ton in gold. The outcrops of eight veins have been mined from tunnels.

Development consists of incline shaft 300 ft. deep, sunk on the east vein system, and a vertical shaft 300 ft. deep, on the main vein system, with over one mile of tunnels and drifts.

The property was operated by *Gray and Worcester Mining Co.* from 1935 to 1937. The ore mined was hauled by truck to Journigan Mining & Milling Company for treatment. In January, 1937, Roy Journigan secured a lease on the property and at present 5 men are employed getting out ore from old stopes on the property, also hauling dump material to Journigan's mill for treatment.

The mill is situated in Emigrant Canyon, being an amalgamation and cyanide plant with a capacity of 25 tons per day. Twenty-five-ton ore bin, 6 in. by 8 in. Blake crusher, 25-ton fine ore bin, to a 3 ft. by 4 ft. Straub cone-type of ball-mill, ground in cyanide solution to 20-mesh; pulp flows over 4 by 8 ft. amalgamation plates, then to seven 14 ft. by 5 ft. cyanide tanks, solution from tanks to 4-compartment zinc boxes. Mill operated by 15 h.p. Fairbanks-Morse gas engine. This mill also operated as a custom mill for ore in the district. Four men are employed.

Bibl.: State Mineralogist's Report XV, pp. 83, 84; XXII, p. 473.

Southern Homestead Mine, comprising 10 claims is on the west slope of the Panamint Mountains, 10 miles south of Ballarat; elevation about 3500 ft.; owner, Harry E. Briggs, Trona, California, with whom there is associated James E. Babcock, Rives-Strong Bldg., Los Angeles, California.

Here in the quartzite, are found three (possibly there are more) altered diorite dikes. The strike is NE., dip about 10° to 15° SE. These dikes are mineralized with auriferous pyrite, some pyrrhotite and a little very fine, free gold. They vary in thickness from 2 to 15 ft. as now exposed. One of these dikes has been traced by a series of trenches and short tunnels a distance of about 400 ft. along the west slope of the mountain and about 300 ft. in the south side of the canyon. Samples taken show values from $2 to $16 per ton in gold, with an average value of about $10.

Idle at the time of visit.

Star of the West Mine. The property comprises 7 patented claims, situated on the ridge north of Wilson Canyon, 20 miles northeast of Brown, a station on the Southern Pacific Railroad; elevation, 5000 ft.; owner, W. D. Alexander, 320 E. Jefferson St., Los Angeles, California.

A flat-dipping vein of quartz occurs in granite, strike NW.-SE., dip 20° SW.; width 3 ft.; developed by a number of tunnels 50 ft. to 100 ft. in length. The mine was operated in 1916 and the ore mined was transported over an aerial tram to a mill in Wilson Canyon. Southeast of these workings is a diorite dike intruding the granite, strike NW.-SE., dip 75° NE. On the northeast side of this dike there is a vein of quartz 18 in. wide. A shaft has been sunk on this vein to a depth of 20 ft.

Idle.

Stockwell Mine, consisting of 6 unpatented claims, and 10-acre millsite, is on the west slope of the Slate Mountains, 10 miles NE. of Trona; elevation, 3000 ft.; owner, Stockwell Gold Mining Company; E. E. Teagle, president; V. E. Stockwell, secretary, Los Angeles; under lease and bond to *Century Mining Company;* Julius E. Linde, president; Roy E. Orvedahl, secretary; office, Trona, California.

The property was discovered in about 1897, and acquired by B. P. Greenleaf and V. E. Stockwell early in the twentieth century. They organized the company in 1918, after doing about half of the development work described below. Present company started operations September, 1937.

The vein in the granitic country rock strikes N. 20° W. and dips about 60° NE. It varies in width from 3 ft. to 30 ft. between walls, maximum width of ore probably being about 12 ft. Vein filling consists of talc, crushed quartz and altered wall rock. Mineralization consists of iron pyrite with a little chalcopyrite.

Development consists of a cross-cut driven east 136 ft. to the vein; drift N. 240 ft. to a 200-ft. vertical shaft, from surface which it intersects at the 50 ft. level. On the 200-ft. level of this shaft, a cross-cut has been driven 32 ft. to the foot wall of the vein but has not gone through the vein. On the tunnel level a drift has been driven south 574 ft. from the cross-cut. At 510 ft. from the cross-cut, the drift intersects an incline shaft from surface. This shaft is sunk on a 60° inclination for 260 ft. The tunnel level is 120 ft. below the surface. In the tunnel an ore shoot begins some 50 ft. south of this shaft and appears to extend north some 170 ft., varying in width from 3 ft. to 12 ft. It is approximately 200 ft. north from this shoot to another similar one, which is reported to be 200 ft. long.

On the 170-ft. level of incline shaft, drift north about 60 ft. to hole raise from 210 ft. level. On 210-ft. level, drift north about 280 ft. south 30 ft. The north drift picked up the south shoot showing some sulphides. On 260-ft. level, drift north 90 ft. Vein here is vertical, about 12 ft. wide. At 127 ft. south of crosscut, a winze has been sunk to a vertical depth of 100 ft., developing 6 ft. of sulphide ore. The vein material is quartz, mineralized with pyrite and chalcopyrite. About 1000 ft. north of these workings and in the next canyon a vertical shaft has been sunk 150 ft. (inaccessible at time of visit). Reported that on the 150 level, a drift was driven northwest 140 ft. and crosscut from the face northeast, with a drift from the crosscut southeast, a total of 400 ft. on this level. Several short tunnels and open-cuts have been made in this canyon. These workings show a vein on each side of a monzonite dike which is about 100 ft. wide. Some 750 ft. west of this canyon several tunnels have been driven, one of which is about 700 ft. long. This work was done on a vein, strike N. 70° W., which appears to form a junction with the veins mentioned above, in the canyon.

The present company during the latter part of 1937, shipped 400 tons of ore to the Selby Smelting Co. stated to have an average value of $25 per ton in gold and 2% in copper. At the camp and millsite which is 3 miles west of the mine at an elevation of 1900 ft. there is a well 270 ft. deep, which supplies water for the camp and for the mine and mill.

Mine equipment consists of Worthing portable compressor with a capacity of 260 cu. ft. air drills and Ingersoll-Rand tugger hoist.

The company is planning to install a 50-ton flotation plant for treatment of the ore.

Two men are employed.

Sunrise View Mines. The property comprises two groups of claims known as Sunrise View group of 14 claims, and Lucky Strike group of 10 claims, located in the Alabama Hills, 3½ miles north of Lone Pine; owners, A. C. Zell, Lone Pine; R. A. Yahnka and Lillian Yahnka, of Huntington Park, Calif.

The principal mineralization occurs along a shear zone in lime-silicate rock in country rock of granite. The shear zone is about 200 ft. in width, with granite hanging and footwall. The strike of the shear zone is S. 80° W., with a dip 70° to 80° N. Quartz stringers and veins occur in lime-silicate rock and some irregular pockets of high-grade gold ore occur in the quartz.

The principal development work is on the Sunrise group of claims. This development consists of 4 tunnels driven west in the shear zone along a fault slip in lime-silicate rock. The lower or No. 1 tunnel is driven S. 80° W., 275 ft. About 135 ft. west of the portal, there is a crosscut driven S. 10° W. 60 ft. It is stated that this crosscut for a distance of 60 ft. has an average value of $2.10 per ton in gold.

At 40 ft. in elevation above this tunnel, there is a tunnel driven west 100 ft. At 40 ft. in elevation above No. 2 tunnel, No. 3 tunnel has been driven west 75 ft., and No. 4 tunnel 125 ft. in length. Some high-grade ore was extracted from the upper tunnel. A pocket is reported to have been discovered from which $600 in gold was recovered. About 1500 ft. west of these workings, a shaft has been sunk on a quartz vein 8 in. in width on an inclination of 40° to a depth of 150 ft. Two high-grade pockets were encountered in these workings. Five tons of high-grade ore were treated in a small mill near the highway. Idle.

Tom Casey Mine. It comprises 6 claims situated in the Beveridge Mining District, at the head of Craig Canyon, on the east slope of the Inyo Range of mountains, 12 miles northeast of Lone Pine; elevation 8000 ft.; owner, Thomas Casey, Lone Pine, Calif.

The vein strikes E.-W., dip 60° N.; width, 12 in. to 4 ft. It occurs on contact of porphyry and limestone; developed by three tunnels at different elevations, the longest being 400 ft. on the vein.

Two men are employed.

Treasure Hill Mine. It comprises 12 claims situated in Wildrose Mining District, in the Panamint Range of mountains, 55 miles north of Trona; elevation, 5250 to 5800 ft.; owners, L. E. Mendelman, I. Kusnick, Paul Cores and Albert King, of Los Angeles, California.

Five parallel veins occur in a gneissoid granite; strike N.-S., dip 40° E. Widths vary from 12 in. to 4 ft. The vein quartz is mineralized with free gold, associated with pyrite and galena.

Development consists of shafts and tunnels, totaling 488 ft. A tunnel 152 ft. in length intersects a shaft sunk from the surface at a a depth of 65 ft. Ore extracted from these workings is said to carry $7.35 per ton in gold and silver. Idle.

Vin-Blanc Mine. It comprises one claim located in Coso Mining District, 6 miles southwest of Darwin, and 18 miles east of Olancha; owners, George C. Terry, H. F. Miers and C. W. Jones, of Independence.

The quartz vein is in granite; strike, NW.-SE.; dip. 80° SW.; width 6 in. to 2 ft.

Development consists of 2 shafts; one 100 ft. in depth, the other 80 ft. One ton of ore shipped to the Western Graphite Company's mill had an average value of 1.44 oz. in gold per ton.

Two men are employed.

Wahoo Mine. It comprises 2 claims, situated in the Argus Range, 6 miles north of Darwin, California; owner, Walter Hoover, Lone Pine, California; under lease to Paul Braun, Darwin, California.

This property adjoins the Ruiz Mine to the northwest. The country rock is limestone and quartz monzonite. The vein strikes N. 40° W.; dip 40° W.; width 3 ft. to 4 ft. The vein occurs in the monzonite.

Development consists of shaft sunk on the vein to a depth of 90 ft. A drift has been driven south on the vein for a distance of 80 ft. It is reported that 60 tons of ore were shipped to Burton Bros. Inc., at Tropico, California.

Equipment consists of 6-h.p. hoist and truck. Four men are employed.

Wonder Mine. It is situated in the Sara[illegible] Ibex Mine, 10 miles southwest of Tecopa, on the east slope of the Argus Range of mountains; elevation, 3000 ft.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 85; XXII, p. 474.

Yucca Mine. It is situated in the Coso Mining District, 8 miles by road south of Darwin; elevation, 6000 ft.; owner, L. D. Owen, of Darwin, California.

A series of parallel quartz veins occur in granite; strike north and dip 30° east. Veins vary in width from 6 in. to 2 ft. There are two incline shafts sunk on one of the veins to a depth of 200 ft. These shafts are connected with drifts on the vein at 120 ft. and 165 ft. On other veins there are a number of shallow shafts from 10 ft. to 20 ft. deep, from which good ore has been shipped. The property has been worked off and on by the owner since 1908. Six tons of ore mined and shipped in 1937 are reported to have an average value of $36 per ton in gold.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 85; XXII, p. 474.

IRON

Deposits of iron occur in the Coso Range, and in the Slate Range. The ore from the iron deposits in Coso mountains was formerly used for flux at the Darwin and Keeler smelters in treatment of lead-silver ores from those districts from 1869 to 1877. The ore from the iron deposit in the Slate Range was formerly used as a flux at the smelter of the Modoc Mine, from 1880 to 1884.

Coso Iron Deposit. This deposit is situated on the north slope of the Coso Range of mountains, in the Coso Mining District, 12 miles east of Olancha; elevation, 5650 ft. Holdings comprise 22 claims, held by location; owner, G. W. Dow, of Lone Pine, California.

Iron-bearing veins occur in granite, varying from a few feet to 100 feet wide, and can be followed along their outcrops for a distance of 1000 ft. Several open cuts have been made on the croppings.

The ore is predominantly hematite, with occasional masses of magnetite. Much of the hematite contains disseminated magnetite. A considerable amount of the ore is very pure and high-grade, containing between 60% and 64% metallic iron, and less than 0.06% phosphorus. Analysis: Iron, 64.25%; phosphorus, 0.057%; silica, 4.49%; sulphur, 0.22%. It is estimated that this deposit contains 3,000,000 tons of commercial ore.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 87; XXII, p. 475.

Hoot Owl Iron Deposit. It is situated on the east slope of the Slate Range, 20 miles north of Trona; elevation, 2400 ft.; owner, Lloyd Helm, Inyokern, California; under lease to Bradley and Exstrom, 320 Market Street, San Francisco, California.

A massive outcrop of iron ore occurs in granite, with a strike of NE.-SW. It is 200 ft. in length and 50 ft. wide. The mineral is hematite carrying 64% metallic iron with low phosphorus content; [illegible] in gold. Development consists of a 2-compartment vertical shaft 150 ft. deep in iron ore. About 500 ft. northeast of the shaft, there is a tunnel driven southwest 240 ft. The face of this tunnel is in ore. Ore is being hauled by truck to Trona, for shipment to San Francisco. To date they have shipped 150 tons.

Four men are employed.

Le Cyr Iron Deposit. It is situated on the north slope of the Coso Range, in the Coso Mining District, 15 miles southeast of Olancha; elevation, 5600 ft. Holdings comprise 6 claims held by location; owner, J. R. Le Cyr, Los Angeles, California.

A series of parallel veins of iron occur in granite. The ore is hematite and magnetite, reported to carry 59% metallic iron with less than 0.06% phosphorus. Estimated tonnage is said to be 1,300,000 tons. Analysis: Iron, 59.07%; silica, 3.04%; phosphorus, .047%; sulphur, 1.06%.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 475.

Roper Iron Deposit. This deposit is situated 7 miles east of Kearsarge, a station on the California and Nevada Railroad, on the west slope of the Inyo Range. The ore is specular hematite, said to carry values in gold.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 87; XVII, p. 282; XXII, p. 475.

LEAD, SILVER, ZINC

The earliest mining in Inyo County was that of the lead-silver ores in the southern part of the county, by Mormon colonists, previous to 1859. The principal productive silver-lead districts mentioned in order of their importance are:

Cerro Gordo District, which was discovered between 1862 and 1866 has been the largest producer of lead, silver and zinc ores in the state, and mining has been more or less active to date. The productive mines have been the Cerro Gordo, Cerro Gordo Extension (Royal), Estelle, Silver Reef and Santa Rosa.

The ores of the Cerro Gordo district consist of galena, lead carbonate, cerusite, anglesite, also some smithsonite, sphalerite, tetrahedrite and pyrite, with small amounts of gold.

The Cerro Gordo District has yielded to date over $17,000,000 (see Fig. 8).

Darwin District. The mining of lead-silver ores in this district has been from 1870 to date, and the approximate production has been between $3,000,000 and $5,000,000. The ore deposits are generally inclosed in lime-silicate rocks, and consist of argentiferous galena, with small amounts of pyrite and sphalerite. As a rule the galena is largely oxidized to lead-carbonate and sulphate. The productive mines have been Argus-Sterling, Christmas Gift, Custer, Defiance, Independence, Lucky Jim, Keystone, Thompson, and Wonder. In the past year the Darwin Lead Company acquired a lease on the Defiance-Independence-Thompson Group of mines, and installed a pilot concentration and flotation plant for the treatment of the low-grade ores from these mines.

In development work on lower levels of Defiance mines, leasers have developed 6 ft. of high-grade galena and lead-carbonate ore. This ore is being shipped to smelters at Salt Lake City, Utah. Shipments are reported to carry 40% lead with 20 oz. to 30 oz. in silver. Another important development made in the district in 1937 was the development of Keystone Mine by the Darwin Keystone Mining Company, and the shipment of a considerable amount of ore.

Tecopa District. This district which is situated in the Nopah Range in the southeastern end of the county has been an important producer of lead and silver ores. The principal productive mines in this district were the Gunsite, Noonday, Grant, and War Eagle formerly operated by the Tecopa Consolidated Mining Company. From 1912 to 1928 this company produced $3,000,000.

The principal production of *zinc ores* was from the Cerro Gordo Mine in the form of smithsonite. The main production was mined and shipped from 1911 until September 18, 1915. In the Darwin District on Zinc Hill, a considerable tonnage of zinc was shipped in 1914 and 1915 in the form of oxide of zinc and sphalerite. Other productive lead-silver deposits occur on the east slope of the White Mountains. The productive mines have been the Bunker Hill, Custer, Mineral Point (Sangar), Monster, and Montezuma.

Modoc District. This district is situated on the east slope of the Argus Range, 35 miles north of Trona, and 15 miles southeast of Darwin. The productive mines were the Minnietta, and the Modoc, which

properties were operated from 1880 to 1890. The Minnietta has been operated off and on until 1915, and during 1936. The mine was acquired under option by Ralph Merritt, of Independence, who started development work on the property in the hopes of developing the downward extension of the orebodies formerly worked. Some high-grade ore was developed, but no large orebodies discovered to date.

The Modoc Mine, was operated by the Modoc Consolidated Mines Company of San Francisco, and the production amounted to $1,900,000.

The Minnietta mine is said to have a production record of $1,000,000.

Slate Range District. This district is situated on the west slope of the Slate Range, 9 miles north and east of Trona, in the southern part of Inyo County. The Ophir Mine, and the Slate Range Mine (Copper Queen) were under operation during 1936 and 1937. The Ophir Mine is stated to have produced $800,000 and Slate Range Mine is said to have a production of about $900,000.

MINES

American Mine (*copper-gold-silver*). It is 12 miles southwest of Shoshone, a station on the Tonopah and Tidewater Railroad, on the eastern slope of the Black Mountains and 4 miles south of Sheepshead Springs. Holdings comprise 5 claims; owner, J. W. Stocker, Death Valley Junction, California.

The ore occurs in a narrow, barite vein in a thin, schist belt on a contact of monzonite and granite. The ore varies from a few inches to 2 ft. wide. Mineralization consists of argentiferous tetrahedrite, copper silicates and sulphides with a little gold.

Development consists of several tunnels, two of which are 800 and 200 ft. long, respectively. Above the 200 ft. tunnel is a stope 20 ft. long and 50 ft. high, to surface. Two men are employed.

Bibl.: State Mineralogist's Reports XV, p. 71; XXII, p. 476.

Argus-Sterling Mine (*lead-silver*). It is situated in the Darwin District, on the west slope of the Argus Mountains, 11 miles south of Darwin; elevation, 5850 ft.; owner, A. C. Taylor Estate, Gardena, California; Theo Peterson, agent, Darwin, California.

The vein, averaging 3 ft. in width, fills a fissure in limestone near a granitic contact. Shipments averaged 30% lead and 15 oz. of silver.

Developments consist of a 450 ft. tunnel and a 155 ft. shaft.

Bibl.: State Mineralogist's Reports XVII, p. 283; XXII, pp. 476-477.

Baxter Mine (*lead-silver*). It is situated in the Resting Springs District, 4 miles east of Evelyn, a station on the Tonopah and Tidewater Railroad, on the slope of Resting Springs Mountain; elevation 4000 ft.; owner, J. P. Madison, Shoshone, California.

Bibl.: State Mineralogist's Reports XV, p. 88; XVII, p. 283; XXII, p. 477.

Bedell Mine (*Daisy Mine*). The property comprises 8 claims, known as the *Le Roy Group,* situated on the east slope of the Inyo

Range of mountains, 14 miles southeast of Big Pine; elevation, 7500 ft.; owner, D. T. Bedell, of Big Pine, California.

Orebodies of galena and lead-carbonate occur along parallel fissures in the limestone. There are four mineralized fissures in the limestone that have been productive. These fissures strike N. 30° W., dip 45° E., and are about 40 ft. apart. The ore shoots developed vary in widths from 2 ft. to 4 ft.

The ore is galena associated with lead-carbonate, carrying $3 to $6 in gold; lead, 15% to 20%; silver, 15 oz. Selected ore shipped to the U. S. Smelting, Refining and Mining Company's smelter at Midvale, Utah, is reported to carry 40% lead, 30 oz. in silver, with gold values.

Development consists of a number of tunnels driven on the four fissures mentioned above. No. 1 tunnel is driven S. 30° E. 150 ft. At an elevation of 75 ft. above No. 1 tunnel, a shaft has been sunk to a depth of 50 ft. on a vertical fissure. On the west fissure an incline shaft has been sunk to a depth of 70 ft. with a drift 60 ft. southwest.

Mine equipment: 110 cu. ft. compressor, air drills, cars and trucks. Two men are employed on development.

Bibl.: State Mineralogist's Report XV, p. 94.

Belmont Mine (*lead-silver*). It is situated in the Cerro Gordo District, 11 miles northeast of Keeler and three miles by trail southeast of the Cerro Gordo Mine; elevation, 8000 ft.; owner, W. L. Hunter Estate, Keeler, California.

Argentiferous quartz veins occur in a crystalline rock of granitoid texture. The values are chiefly in silver with a percentage of lead. The silver minerals are tetrahedrite, argentite and stephanite. The veins vary from 8 in. to 6 ft. in width; strike is N. 75° W. and dip 60° to 70° SW.

Developments consist of a tunnel 400 ft. long and a shaft 150 ft. deep. There are about 3600 ft. of tunnels and drifts on the property.

Past production is said to be about $500,000.

Bibl.: State Mineralogist's Reports XVII, p. 283; XXII, p. 477.

Big Silver Mine (*Essex*). It is situated on the eastern slope of the Inyo Mountains, in the Ubehebe Mining District, one mile south of Hunter Creek, on the western edge of Saline Valley. The property is 50 miles by road north of Keeler, a station on the California and Nevada Railroad. Elevations range from 1600 to 3000 ft. Development consists of 3 tunnels, the longest being 240 ft.

The two groups of claims, known as the Essex and the Hudson, containing 120 acres, are owned by the *Big Silver Mining Company* and *National Silver Corporation;* Paul Bolton, trustee, Los Angeles; reorganization: *Saline Valley Mining Co.;* Paul Bolton, president; A. B. Ganfield, secretary, 247 S. Ardmore St., Los Angeles.

Bibl.: State Mineralogist's Report XXII, pp. 477-478.

Black Rock Group of Mines (*lead-silver*). It comprises 6 claims, located north of the Gunsite Mine on the western slope of the Nopah Mountains, 7 miles east of Tecopa; elevation, 2500 ft.

The ore occurs in irregular lenses along a fissure in the dolomite. It is principally carbonate of lead with some galena.

Development consists of 900 and 200 ft. tunnels with a raise from the lower tunnel into the shoot which was worked in the upper tunnel.

Bibl.: State Mineralogist's Report XXII, p. 479.

Blue Dick Mine. It comprises 4 claims situated in the Kingston Range of mountains, southeast of Tecopa, near the San Bernardino County line; owner, Henry Lang, Tecopa, California.

Lenticular masses of lead-carbonate ore occur along a fissure in limestone.

Development consists of 500 ft. of tunnels and drifts.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 89; XVII, p. 283; XXII, p. 479.

Bull Domingo Mine (lead-silver). It comprises 6 claims known as *Galena Group of Mines*, situated in the Pine Mountain Mining District, on the ridge southwest of Wyman Creek, about one-half mile west of Roberts Camp, in the White Mountains, 36 miles by road northeast of Big Pine; elevation, 8000 ft.; owner, P. N. Johnson, 302 E. Anaheim St., Long Beach, California. During 1934 the property was under lease and bond to P. N. Johnson, 355 Ocean Center Bldg., Long Beach, who operated the property until July, 1935.

The galena and lead-carbonate orebody with high silver values occurs along a contact fissure of limestone and schist; schist being the hanging wall and limestone the footwall. The contact fissure has a strike of N. 30° E., dip 60° E.; width varies from 6 ft. to 8 ft.; developed by a shaft 120 ft. deep with a drift 150 ft. in length on the 120-ft. level. Ore stoped to the surface for a length of 150 ft. At 200 ft. below the collar of the shaft, a crosscut tunnel was driven northwest 200 ft. intersecting the workings from the shaft. At 600 ft. in elevation below the shaft a cross-cut tunnel was driven N. 55° W., 600 ft. without intersecting fissure exposed in upper workings. The mine was reported to have been discovered in 1871 and worked by Mexicans, who had a small Vaso smelter at Roberts Camp. Idle.

Bunker Hill Mine. The property comprises 12 claims, situated 35 miles northeast of Big Pine, on the eastern flank of the Inyo Range of mountains, between Willow Creek and Keynote Canyon; elevation, 5500 ft.; owner, Bunker Hill Mining Co., Leo. Benjamin, president, 689 E St., San Bernardino, Calif.

The orebodies consist of irregular lenses of galena and lead-carbonate ore which occur in the limestone or on contact of limestone and porphyry. The ore that has been shipped from the property is reported to have carried from 30% to 60% lead, 33 oz. in silver and $4.50 in gold per ton.

Development consists of a shaft 600 ft. deep and a tunnel 400 ft. in length.

Equipment consists of 1500-ft. aerial tram from tunnel to mill. Mill equipment consists of 50-ton ore bin; 6 by 8 in. Blake crusher; revolving screen; and 3 concentrators. Mill driven by McCormick-Deering gas engine.

Two men employed on development.

California Queen Mine No. 4. It comprises a group of claims located 10 miles northeast of Trona, on the west slope of the Slate Range of mountains; owner, California Queen Mining Co.; C. S. McCarthy, Trona, Calif.

Bibl.: State Mineralogist's Report XXII, p. 479.

California Smelting & Refining Co.; F. W. Jackson, general manager; R. H. Lyon, superintendent. It is situated in Darwin Wash, about 5 miles east of Darwin. Consists of a 20-ton ore bin from which the ore is fed to a Wheeling jaw crusher set to $\frac{1}{2}$ in., thence to 8 in. by 6 in. rolls, elevated by bucket elevator to $\frac{1}{4}$-in vibrating screen; oversize returned to rolls, undersize flushed to Western ore concentrator jig. Concentrates are shipped to Western Graphite Company at Lake Hughes. Jigs will be replaced by tables soon and the concentrates shipped to Selby. Power is a 15-hp. Fairbanks-Morse semi-Diesel engine. Water is obtained from a well in Darwin Wash and pumped to a 6000-gal. tank at the mill. The mill has treated about 100 tons in 1936-37, principally lead-carbonate ore tailings from the Darwin Lead Company and some ore bought from leasers on the Santa Rosa Mine.

Idle.

Campbird Group of Mines (silver). This property comprises the Campbird group consisting of 10 claims. It is in Jacob's Gulch north of Surprise Canyon, on the west slope of the Panamint Range, 11 miles northeast of Ballarat, and one mile west of Panamint City; elevation, 7300 ft.; owner, J. V. Leigh, 307 Union League Bldg., Los Angeles.

Two quartz veins, the Stewart Wonder and the Rainbow, varying in width up to 15 ft., occur in limestone. The Stewart Wonder vein strikes N. 75° W., dip vertical. The Rainbow vein has an easterly strike and dips 30° to 35° N.

Development consists of a crosscut tunnel driven north 25 ft. and drift east and west for a total distance of 400 ft. From this tunnel level a winze has been sunk to a depth of 150 ft. on the vein. The silver mineral occurring in the vein quartz is freibergite, a sulphantimonite of silver and copper.

Idle.

Bibl.: State Mineralogist's Reports XXII, pp. 479-480; XXVIII, pp. 359-361.

Carbonate Mine (Queen of Sheba), consisting of 7 claims, is on the east slope of the Panamint Mountains about 7 miles north of Warm Springs Canyon, on the west side of Death Valley about 40 miles northeast of Zabriskie, a station on the Tonopah and Tidewater Railroad; elevation 1200 ft; owner, *New Sutherland Divide Mining Company,* 156 Montgomery St., San Francisco; Dr. Thos. A. Stoddard, president; under lease to J. P. Madison, of Shoshone, California, who has been shipping for about 7 years.

The ores occur as replacements along the bedding planes of dolomitic limestone. The lenticular bodies strike a little E. of N. and dip 35° E. In the Carbonate Claim they occur along a length of about 400 ft. to a depth of 150 ft., having an average width of approximately 10 ft. and a maximum of 20 ft. Mineralization consists principally of lead-

carbonates with silver and a little gold. On the Queen of Sheba the ore is principally galena, carrying silver.

Shipments have aggregated approximately $300,000; the last 50 cars of which averaged 20% lead, 14 oz. of silver and $3 in gold. The ore on the Carbonate Claim has apparently been exhausted and work is now confined to the Queen of Sheba.

Development consists of a series of tunnels (all stoped) on the Carbonate Claim to a depth of 150 ft. and a long crosscut tunnel below which they failed to encounter any ore. On the Queen of Sheba a tunnel 1000 ft. long with a few crosscuts was formerly driven. No ore was developed. The present operator has crosscut W. about 40 ft., some 200 ft. above the old tunnel and has stoped some ore from 2 to 8 ft. wide, in drifts from the crosscut 100 ft. N. and 100 ft. S. In general, this ore is higher grade than the average shipments of the past.

The property is temporarily idle.

Bibl.: State Mineralogist's Reports XV, pp. 89-90; XXII, p. 480.

Cerro Gordo Mine. The property comprises 43 claims, about 550 acres, situated in the Cerro Gordo Mining District, near Cerro Gordo Peak, 8 miles by road east of Keeler; elevation, 8000 ft.; owner, Cerro Gordo Mines Company; F. J. Hambly, president; C. A. Stockton, secretary, San Jose, California.

Property in receivership: Receiver, Mordon H. Eddy, c/o W. I. Titus, Pacific Southwest Bldg., Los Angeles.

The Cerro Gordo Mine has been the most productive lead-silver mine in Inyo County, having yielded about $15,000,000. The mine was discovered in 1866 and worked continuously from 1869 to 1876, then periodically up to 1936.

The zinc orebodies were worked from 1911 until September 18, 1915. The property was idle from 1915 until 1923, when it was worked under lease by W. W. Waterson, of Bishop, until 1927. From 1928 until 1929 it was under lease to the *Estelle Mining Company;* Adolph Ramish, president; Roy C. Troeger, secretary and manager, Los Angeles, California.

A lease was secured on the mine in June, 1929, by the *American Smelting and Refining Company,* and this company operated the mine until April, 1933. During this period the ore mined and shipped by this company totaled over 10,000 tons with a gross value of $305,630. The approximate average grade of ore shipped was gold, .053 oz.; silver, 29 oz.; and lead 41%. The ore mined by this company was shipped to the Selby Smelting and Lead Company's smelter at Selby, California.

From May, 1935, to September, 1936, the property was under lease to the *Silver-Lead Syndicate;* J. J. Beeson of Salt Lake City, Utah, president, and Charles E. Trezona, secretary. During 1937 and 1938 the mine was idle.

GENERAL GEOLOGY

The Inyo Range is a long narrow, elevated fault block of relative recent age. Opposite Keeler, it is composed principally of Palaeozoic sediments; limestones, shales and quartzites, with minor amounts of

mesozoic shales and extrusives. These formations are invaded by numerous igneous dikes and sills, which are doubtless connected with larger intrusive masses exposed not far distant to the north. The sedimentary formations have been folded into an anticline of northerly-

PHOTO. 8. Cerro Gordo Peak, Belshaw Shaft and Camp. Cerro Gordo, Inyo County.

southerly trend, the axis of which near the Cerro Gordo mine nearly coincides with the crest of the range. All the commercial orebodies of the property are confined to Devonian limestones. The sedimentary formations in the vicinity of the mine have been intruded by three series of igneous dikes, which, in order of age are monzonite porphyry, diabase, and quartz diorite porphyry.

Extensive faulting, both pre-intrusive and post-intrusive, pre-mineral and post-mineral has taken place in the mine and as some of the faults are of considerable displacement a complicated structure has been produced. Three periods of mineralization are recognizable in the mine; the earliest of pyrite; the second of argentiferous galena and sphalerite with some pyrite; and the last, quartz with subordinate amounts of galena and argentiferous tetrahedrite.

OREBODIES

Six orebodies were developed and mined in the Cerro Gordo Mine, known as the China stope, Jefferson, Diabase Dike, La Despreciada, Union, and Belshaw orebodies. These are of the silver-lead-zinc-iron type. The San Felipe and Santa Maria are argentiferous quartz veins, and although stoped in places during periods of high silver prices, are of secondary importance. The six orebodies are ore-chimney type, and have been formed by mineralized solutions ascending along joints and sheeting planes in the fracture zone in the Devonian limestone, creating pipe-like channels, in which the ore has been deposited. The

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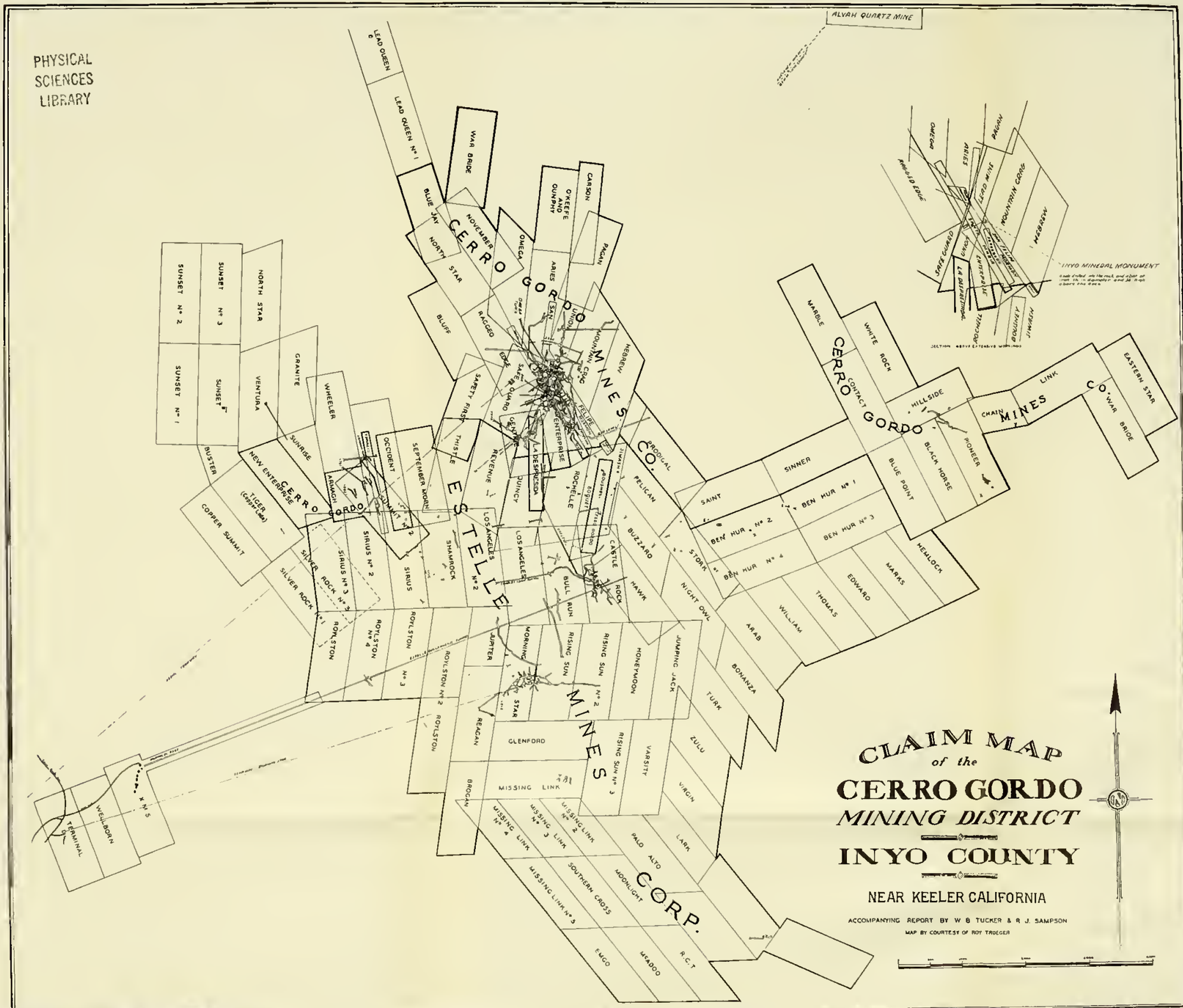

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rocks of the ore-bearing zone strike in a north to northwesterly direction, and dip on the average of 70° SW., the orebodies conforming to the trend of the inclosing rocks. The ore was mined through the Belshaw shaft, 900 ft. deep, with levels at 200, 400, 500, 700 and 900 ft. There is a winze from the 900-ft. level, 160 ft. north of the shaft sunk to a depth of 200 ft., from which drifts have been run on the 1000 and 1100-ft. levels. Total underground workings amount to about 15 miles (see Plate IV).

Idle.

Bibl.: State Mineralogist's Reports VII, p. 250; X, p. 213; XV, p. 94; XX, pp. 185, 187; XXII, pp. 480, 482; U. S. G. S. Bull. No. 540, pp. 97, 109; Professional Paper 110, pp. 106, 116.

Cerro Gordo Extension Mine (*Royal*). It comprises 7 claims, situated in the Cerro Gordo District, 9 miles east of Keeler; elevation, 8400 to 9000 ft.; owner, Mrs. R. C. Spear, Lone Pine.

Under lease and bond to the Cerro Gordo Extension Mining Company; J. P. Hart, president and manager; E. S. Hicks, secretary, Los Angeles, California.

This group of claims adjoins the Cerro Gordo Mining Company's property on the north. The formation consists principally of limestone with a belt of slates on the west slope of the ridge. On the Lead King and Lead Prince claims, there are three intrusions of diorite porphyry in the limestone that trend northwest. On the east slope of

PHOTO. 9. Belshaw Shaft, Cerro Gordo Mine, Cerro Gordo Mining District, Inyo County.

the ridge there is a belt of white marble that trends with the ridge. Three parallel veins occur in the limestone and strike N. 30° W. and dip 70° W. These veins vary in width from 12 in. to 3 ft.; average width is about 18 in. The ore occurs as lead-carbonate, with occasional

bunches of galena and zinc-carbonate with gold and silver values. The principal production of lead ore has come from the shaft on the Lead Queen claim, while the zinc production has come from workings on Lead King and Lead Prince claims. The principal development consists of a cross-cut tunnel on the Emperor claim, which at an elevation of 8400 ft. was driven east 1145 ft. No ore was developed in this tunnel. The principal development work is now confined to the Lead Queen claim, where the shaft has been sunk to a depth of 200 ft. on inclination of 70 degrees, with drifts on 50, 100, 150 ft. levels. The fissure strikes, N. 30° W. dip, 70° W.; width 18 in. to 3 ft. On the 50-ft. level, drift N. 75 ft. and S. 100 ft. On the 100-ft. level, drift S. 175 ft. and N. 100 ft. On 200-ft. level, drift S. 100 ft. and N. 50 ft. also crosscut E. 50 ft.

Recent ore shipped to the United States Smelting, Refining and Mining Company's smelter at Midvale, Utah, carried the following values: Gold, 0.115 oz.; silver, 15.40 oz.; copper, 0.55%; lead, 20.20%; zinc, 3%.

Mine equipment consists of 300-cu. ft. compressor, 15-h.p. hoist, jack-hammers, truck.

Four men are employed on development.

Bibl.: State Mineralogist's Report XXII, pp. 497-498.

Cerrusite Mine (*silver-lead*). It comprises 6 claims in the Lee Mining District, on the west slope of the Hunter Mountain, about 37 miles via the Saline Valley road from Keeler; owner, W. A. Reid, of Keeler, and under lease to Chauncy Lee, of Keeler.

The vein is in limestone and strikes northeast-southwest and dips about 40° N. Development consists of 3 tunnels 200 ft. long at 100 ft. intervals. Values are reported from $12 to $25 per ton, chiefly silver.

Idle.

Chesamac Mine (lead-silver). It comprises 6 claims situated in the Wildrose Mining District, on the east slope of the Panamint Range of mountains, 18 miles northeast of Ballarat; owner, Donald MacDonald, of Los Angeles, California.

Idle.

Bibl.: State Mineralogist's Reports XXII, p. 482; XXVIII, page 361.

Christmas Gift Mine. It is situated in the Darwin District, 2 miles north of Darwin; elevation, 5300 ft. Holdings consist of 5 claims; owners, W. L. Skinner and J. C. Boe, Darwin, California.

Idle.

Bibl.: State Mineralogist's Reports VIII, p. 226; X, p. 211; XVII, pp. 284-285; XXII, p. 482; U. S. G. S. Bull. 580-A, pp. 10-12.

Cliff Mine. It comprises 6 claims situated in the White Mountains, in the Deep Springs District, 5 miles south of Oasis.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 93; XXII, p. 482.

Columbia Mine. It is situated in the Darwin District; owner, Wagner Assets Realization Corporation, Chicago, Ill. Idle.

Bibl.: State Mineralogist's Reports XXII, p. 482; U. S. G. S. Bull. 580, pp. 17-18.

Custer Mine (lead-silver-copper). It is situated in the Darwin District, one mile east of Darwin; owners, Frank Long and Charles Grimes, Pasadena, California.

The ore, principally lead-carbonate and galena, is found in bunches in a large irregular body of coarsely, crystalline calcite.

Development consists of a shaft 400 ft. deep. Reported production is over $250,000.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 94; XVII, p. 285; XXII, p. 483; U. S. G. S. Bull. 580, pp. 15-16.

Custer Mine (lead-silver). It comprises 6 claims known as Custer No. 1, No. 2, No. 3, No. 4, No. 5 and No. 6 situated on east slope of the Inyo Range of mountains, 16 miles northeast of Independence; elevation, 5000 ft.; owner, Dr. J. G. Baxter, Independence, California.

The ore is lead-carbonate and galena with silver and gold values. It occurs on contact of limestone and granite. Strike of contact is N. 40° E., dip 40° NW. Width is 4 to 6 ft.

Development consists of two tunnels, upper tunnel being 50 ft. in length, and lower tunnel is 100 ft. in length. The mine has been worked off and on since 1926, producing some high grade gold-lead-silver ore.

Shipments carried 2 oz. to 3 oz. in gold, 30 oz. to 80 oz. in silver, with 35% lead and 5% copper. Ore has to be packed on animals over range of mountains to Mazourka Canyon, then hauled by truck to Kearsarge, a station on narrow gauge branch of the Southern Pacific Railroad. Shipment costs to U. S. Smelting, Refining and Mining Company's smelter at Midvale, Utah, amount to $50 per ton. Four men are employed.

Darwin Cyanide Plant. It is situated in the Darwin Wash, 4 miles south of Darwin, operating on tailings from the Darwin Lead Co. Richard Wallace has a lease on the tailings, and has given a sub-lease to Louis Warmkin, Darwin; Fritz Schwram, superintendent.

The plant consists of steel tanks 8 by 10 by 4½ deep; capacity 18 tons; one water tank, capacity 5000 gallons and one cyanide solution tank, capacity 5000 gallons. Tailings are leached for 6 days in a solution containing 2½ lb. of sodium cyanide per ton of water and precipitated in 6 barrel-type zinc boxes. Barren solution flows to sump tank and is pumped back to the solution tank by a centrifugal pump. Water is secured from a well in Darwin Wash. Heads are reported to carry $3 per ton in silver.

Darwin-Keystone Mine (silver-lead). It consists of 25 claims in Sec. 24 and 25, T. 19 S., R. 40 E. and Sec. 19 and 30, T. 19 S., R. 41 E., Darwin Mining District, on the east slope of the Argus Range, about 3 miles east of Darwin; A. A. Rubel, Pres.; Mrs. A. A. Rubel, Sec.-Treas.; A. Yoder, Supt.

Developed by the Keystone tunnel, elevation 4700 ft., driven west about 375 ft. and the McDonald tunnel 291 ft. above and 88 ft. south, driven 135 ft. west. Near the face of the Keystone tunnel, a crosscut was driven south 88 ft. and a raise in ore driven to connect with the McDonald tunnel. A vertical winze 6 by 12 ft. was being sunk in ore near the face of the Keystone tunnel and was down 50 ft. in October, 1937.

The ore is chiefly lead-carbonate, occurring in lenses and chimneys in blue limestone, associated with red and brown oxides of iron. About 800 tons of sorted ore from the raise and winze shipped to Salt Lake City is reported to have averaged $35 (15% Pb, 28 oz. Ag and $1.25 Au).

Equipment consists of a 180-h.p. Fairbanks-Morse diesel engine, 150 KVA generator, Worthington 440-cu. ft. compressor, U. S. 75-h.p. motor; Rix VI, 120-cu. ft. portable compressor; and a Kohler 5 KVA 110-volt light plant. A 1600-ft. jig-back tram with two 1000-lb. capacity buckets carries the ore from the bins at the tunnel portal to the loading bins at the camp. An electric power line runs from the generator to the tunnel for light and power. A 3 in. air line delivers air to a 10 ft. by 24 in. diam. receiver at the portal.

The camp has 16 one-room cabins, change house, recreation hall and commissary and offers modern accommodations for about 45 men. All buildings are new and built of corrugated iron. Water is obtained from a well in Darwin Wash, about 3 miles distant where they have a water right to 0.075 cu. ft. per second.

Ten men are employed on development.

Defiance, Independence, and Thompson Mines, which include a total of 66 claims 20 patented and 46 unpatented claims, are situated in the Darwin Mining District, 2 miles north of Darwin, in Sec. 13, 23 and 25, T. 19 S., R. 40 E., M. D. M.; elevation, 5100 to 5600 ft.; owner, *Wagner Assets Realization Corporation,* of Chicago; under lease to *American Metals, Inc.* The *Darwin Lead Company* has sub-leased from the last-named company. Officers of the Darwin Lead Company are Col. H. R. Montgomery, secretary-treasurer, and H. E. Olund, vice president and general manager.

The orebodies occur chiefly as replacement deposits along the bedding planes of a hard, silicified limestone at or near its contact with a quartz-diorite. Their general trend is N. 45° W., dip 35° SW., and the widths vary from 6 to 20 ft. On the hanging-wall side, the ore consists principally of galena in massive calcite, while on the footwall it is largely lead-carbonate. As previously mined, it is said to have averaged 12% lead and from 8 oz. to 10 oz. of silver per ton. The present operators estimate some 80,000 tons above the Thompson tunnel which averages 6% lead and 8 oz. of silver per ton.

Development on the Defiance consists of a shaft sunk on a 35° inclination for 500 ft. with levels at intervals of 100 ft. The orebody was worked for about 500 ft. in length. It is reported that recent work on the lower levels has opened a new orebody from 4 ft. to 6 ft. wide; shipments carried 40% lead and 20 oz. of silver per ton. Defiance has been sub-leased to Paul and William Braun, of Darwin, by Darwin Lead Co., shipping 50 tons per month.

The Thompson is developed by a tunnel driven northwest 1000 ft. At 450 ft. from the portal it encountered an ore shoot 100 ft. long and 30 ft. wide. Two raises have been driven from this tunnel to the intermediate and Defiance levels.

The Independence has been opened by two tunnels, 200 ft. and 150 ft. long, respectively.

The mines are equipped with machine shop, carpenter shop, electrical shop, assay laboratory, warehouse, bunk houses and five staff houses.

Ore from Thompson tunnel is dumped into 75-ton bin at portal, passed through 12 by 20-in. jaw crusher and over one in. shaking screen, undersize to bin by 20-in. conveyor. Trucks haul it to 50-ton bin at the tram terminal. An aerial tram one mile long conveys it to the 100-ton mill bin. From bin by belt feeder to 20-in. conveyor to 30-in. by 14-in. rolls crushing to $\frac{1}{4}$-in.; classifier delivers coarse material to a Bendelari jig with $\frac{3}{4}$-in. screen; tailings and middlings to 30-in. by 14-in. rolls, set at $\frac{1}{8}$ in.; thence to classifier, coarse ore to jig, 16-in. slotted screens, to classifier, dewatered tails to dump, middlings to 50-ton mill bin, thence by belt feeder to 3 ft. by 8 ft. rod mill in closed circuit with duplex Dorr classifier, overflow to 2 thickeners (in series), thickened slimes to conditioner, thence to two 6-ft. and one 10-ft. K. & K. flotation cells, concentrates to thickener and filter, flotation tails to Diester-Plato table. Mill has about 100 tons capacity. Extraction has not been satisfactory and the plant is shut down, pending results of research work on the ore.

Bibl.: State Mineralogist's Reports VIII, p. 226; X, p. 211; XV, p. 98; XVII, pp. 287-288; XXII, p. 483, 486, 487. Reports of Director of the Mint, Precious metals in U. S. 1883, p. 164; 1884, p. 103; U. S. G. S. Bull. 580, pp. 14-15.

Ella Group of Mines. It comprises 8 claims held by location situated in the Cerro Gordo District, one mile north of the Cerro Gordo Mine and 7 miles east of Keeler; elevation 7000 ft.; owner, William Betts, 331 W. 31 St., Los Angeles.

The ore occurs in irregular lenses of galena and lead-carbonate along two well-defined fissures in Devonian limestone which trend NW. and dip 70° NE. Developments comprise two tunnels, with a total of 2500 ft. of drifts. No. 1 tunnel is 300 ft. in elevation below the outcrop of the veins and No. 2 tunnel is 300 ft. in elevation below No. 1 tunnel and is 600 ft. in length.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 483.

Estelle and Morning Star Mines. The property comprises 71 claims with an approximate total of 1400 acres, situated in the Cerro Gordo Mining District, on the west slope of the Inyo Range of mountains, 5 miles east of Keeler, the terminal of the Owens Valley narrow gauge at Owenyo, 17 miles north of Keeler; elevation 6200 to 8000 ft.; owner, Estelle Mining Corp.; Adolph Ramish, Pres.; Roy C. Troeger, Sec. and Mgr., Los Angeles; under lease to *Morning Star-Keeler Gold Mines Lease;* Dr. R. B. Denton, Trona, Calif., and Lawson Linde, Keeler, Calif. (see Plate VIII)

PHOTO. 10. Panorama View—Estelle Mine Corporation Properties—Keeler, Inyo County, California.

At an elevation of 6290 ft. the Dellaphine tunnel has been driven N. 70° E. 8100 ft., intersecting the Morning Star vein at a depth of 1700 ft. At 7676 ft. from the portal, cut the San Felipe vein which is developed in the Cerro Gordo Mine at a depth of 2401 ft. The San Felipe vein strikes N. 35° W.; dip 70° SW. At 6942 ft. from the portal of the tunnel, intersected the Santa Maria vein, also worked in the Cerro Gordo Mine. The Santa Maria vein strikes N.-S.; dip 60° E.

DEVELOPMENTS:

Drifting on main tunnel level	4783 ft.
Main raise	800 ft.
140-ft. level from raise	1360 ft.
340-ft. level from raise	602 ft.
660-ft. level from raise	2456 ft.
Total	9957 ft.
Main tunnel	8070 ft.
Total underground workings	18027 ft.

At 7500 ft. from the portal of the tunnel is an 800-ft. vertical 2-compartment raise, with levels at 140 ft., 340 ft. and 660 ft. The face of the north drift on the 660-ft. level is 776 ft. below the Cerro Gordo 900-ft. level and 340 ft. below the Cerro Gordo 1100-ft. level. The principal tonnage of ore mined on the main tunnel level was from two stopes on the San Felipe vein. The length of these stopes along the strike of the bedding of the limestone is 150 ft., with 40 ft. above the level. Width of stopes is from 3 ft. to 7 ft. The ore was largely galena with some lead-carbonate. The ore mined from stopes on the 140, 340 and 660-ft. levels was principally galena and lead-carbonate; reported to carry 30% lead and 30 oz. in silver per ton. The production of ore from the Estelle tunnel level from 1916 to 1926 was 2700 tons with an average value of 0.16 oz. in gold and 20.8 oz. in silver and 21.61% in lead, with a total value of $80,146.

Morning Star Mine. The Morning Star workings are situated 4600 ft. due south of the Cerro Gordo shaft; elevation 7700 to 7900 ft.

The orebodies developed in the Morning Star Mine occur in the Devonian limestone and marble, called the Cerro Gordo Formation. This formation has a thickness of about 1500 ft. and outcrops continuously from the Cerro Gordo Mine to a point south of the Morning Star workings, where it disappears beneath the overlying White Pine shale formation of the Mississippian age.

The principal orebody cut on the 1700-ft. tunnel level is known as the Gold stope orebody, due to the fact that the ore mined carried 0.80 oz. in gold. This orebody was found on a bedding in the limestone with a strike of N. 50° W.; dip 45° SW. The vein filling is iron. The stope is about 70 ft. in length and its thickness varies from 3 ft. to 10 ft. The ore mined had an average assay value of 0.80 oz. in gold, 30.67 oz. in silver, 5.55% lead and 25.7% iron. The lead-zinc orebodies worked in the Morning Star Mine were developed from the winze from the 1700-ft. tunnel level to the 1400-ft. level. The general strike of the orebodies was N. 30° W., dipping 70° W. The ore mined is iron-stained, siliceous ore carrying values in silver.

Ore extracted from the Morning Star workings is reported to have been 6000 tons of ore with a gross value of about $150,000.

Developments: The mine has been developed by two tunnels. At an elevation of 7972 ft. the upper tunnel (1700-ft. level) has been

driven east 1530 ft. The lower tunnel (1400-ft. level) is 218 ft. vertically below the upper tunnel and at an elevation of 7754 ft. is driven east 930 ft. (see Plate IV).

These two tunnels are connected by a winze sunk on an inclination of 80°, from which sub-levels have been driven which are called the 1450, 1500, 1550 and 1600-ft. levels The vertical distances below the 1700-ft. level are 150, 100, 70 and 40 ft.

Development, exclusive of raises, winzes and stopes, totals about 6400 ft. Ore from the Morning Star Mine is being mined and shipped to Keeler Gold Mine mill for treatment.

Six men are employed.

Bibl.: State Mineralogist's Reports XV, pp. 108-109; XVII, p. 286; XX, pp. 187-189; XXII, pp. 483-484; U. S. G. S. Bull. No. 540, p. 110; U. S. G. S. Professional Paper 110, pp. 116-117.

Fairbanks Mine. It comprises 8 claims situated in the Darwin District, 3 miles north of Darwin and northwest of the Lucky Jim Mine; elevation, 5500 ft.; owner, Alex Rouna, Darwin, Calif.

The fissure in lime-silicate rock strikes northwest. The width varies from 2 ft. to 4 ft. The ore is galena with lead-carbonate. The fissure is developed by a shaft 150 ft. in depth. Mine equipment consists of a 6-h.p. gas engine hoist. Two men are employed.

Fernando Group of Mines. It comprises 7 patented claims, known as Fernando and St. Charles, situated in the Darwin District, in Sec. 24, T. 19 S., R. 40 E., M. D. M., one mile east of Darwin, adjoining the Custer and Jackass mines on the east; elevation, 4850 ft.; owner, *Coso Copper Company;* F. H. Long, president, Pasadena, California; under lease to Theo Peterson, Darwin, California.

The orebody occurs as irregular lenses of lead-carbonate and galena on contact of diorite and lime-silicate rock. The vein trends east and dips 40° N. Width of vein is from 3 ft. to 4 ft.

Idle.

Bibl.: State Mineralogist's Report XXII, pp. 484-485.

Gibraltar Mine (*Big Horn*). It comprises 4 claims situated in the South Park Mining District, 7 miles southeast of Ballarat; elevation, 7000 ft.; owner, John Thorndike, Ballarat, California.

The ore occurs as irregular lenses of lead-carbonate and galena in a fissure in the limestone. Shipments are said to have carried 30% lead and 20 oz. of silver per ton.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 95; XXII, p. 485; XXVIII, p. 361.

Gunsite Mine is in the Nopah Range, 7 miles east of Tecopa; elevation, 2350 ft.; owner, *Tecopa Consolidated Mining Co.;* L. D. Godshall, vice president and general manager, 722 South Oxford Ave., Los Angeles, California.

There is a railroad from this property and the Noonday to Tecopa, where it connects with the Tonopah and Tidewater.

The country rock is the Silver Rule dolomite which is underlain by Algonkian shales and conglomeratic sandstones. The ore occurs as irregular lenses of lead-carbonate and galena, along a fissure in the dolomite which strikes N. 45° W. and dips 35 to 50° NE. A series of

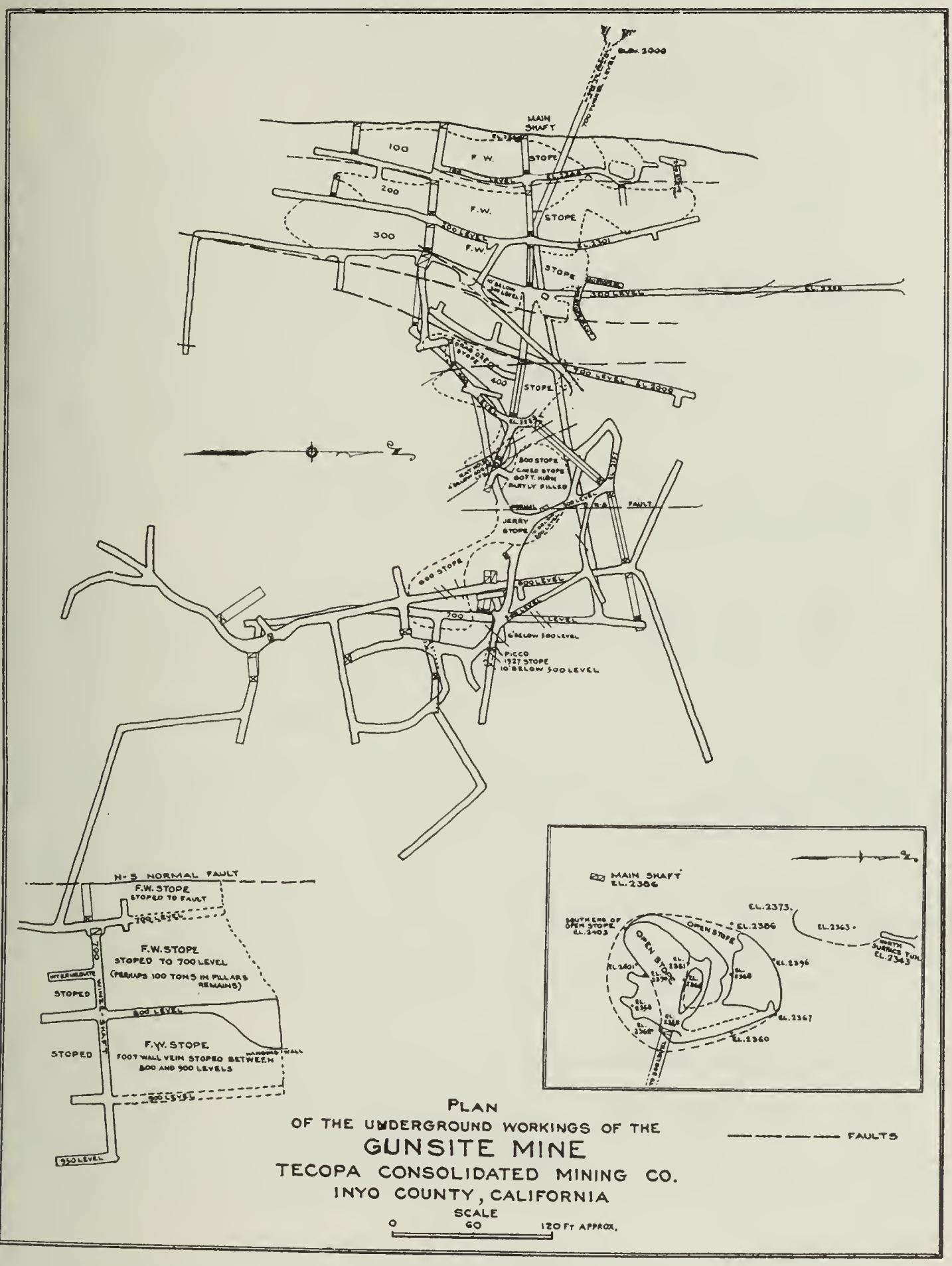


FIG. 8.

N.-S. faults, dipping from 35 to 55° W., show displacement of the ore-bodies up to 30 feet.

Development, consisting of several thousand feet, is shown on a map published herewith.

During its period of operation, 1912-1928, some 55,000 tons of ore was shipped to the smelters. This ore ranged from $6 to $50 per ton in value. The average assay value of all shipments was: gold, .077 oz.; silver, 9.38 oz.; lead, 7.84%. Shipments of the lower grade ore were made possible through cooperation of the smelter which needed this class of ore in their charges. All of this ore was taken from one shoot, as indicated on the map. Since the company ceased its operations an occasional carload has been shipped by leasers.

Idle at present.

Bibl.: State Mineralogist's Reports XV, pp. 95-96; XVII, pp. 286-287; XXII, p. 485; Report of the Director of the Mint, Precious Metals in the U. S., 1883, p. 166.

Ignacio Mine (formerly Ygnacio) (lead-silver). It comprises one patented claim situated in the Cerro Gordo District, on the west slope of Inyo Range of mountains, 6 miles east of Keeler; elevation, 7800 ft.; owner, *Cerro Gordo Mines Company,* San Jose, California.

A vein of quartz occurs in lime-silicate rock, strikes N.-S.; dip E.; width 8 ft to 10 ft.; developed by shaft 500 ft. in depth and tunnel driven south 2000 ft. on vein; workings caved. The ore mined was galena with lead-carbonate, reported to carry 30% lead with 20 oz. to 30 oz. in silver per ton.

Idle since 1916.

Bibl.: State Mineralogist's Reports XV, pp. 97-98; XVII, p. 287; XXII, 485; R. W. Raymond, Mineral Resources West of the Rocky Mountains, 1870, p. 17.

Independence and Thompson Mines (see Defiance Mine).

Jackass Mine. It is situated in the Darwin District, one mile northeast of Darwin, on the east flank of the Darwin Hills; elevation, 5000 ft.; owner, Black Metal Mining Company, Los Angeles.

The ore deposit occurs in mineralized zone 45 ft. in thickness in lime-silicate rocks; strike NW.-SE., dips 70° SW.. The ore is galena and lead-carbonate with some sphalerite, and is said to carry 12 to 15 oz. silver and 4 to 6% lead; developed by an incline shaft to a depth of 140 ft. with drifts northwest and southeast on the fissure.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 288; XXII, p. 487.

Kane Group of Mines. It comprises 15 claims situated on the northeast slope of the Slate Range, 12 miles north of Trona; elevation, 3900 ft.; owner, Belcher Extension Consolidated Mines Company, Jersey City, N. J.

Idle.

Bibl.: State Mineralogist's Report XXII, pp. 487-488.

Lane Mine. It is situated in the Darwin District, two miles northeast of Darwin, on the east flank of the Darwin Hills; elevation, 4100 ft.; owner, Wagner Assets. Realization Corp., of Chicago; under lease to American Metals Inc.; sub-leased to the Darwin Lead Company; H. E. Olund, vice-president and manager.

Bibl.: State Mineralogist's Reports XII, p. 24; XIII, p. 32; XV, pp. 98-99; XVII, p. 288; XXII, p. 488; U. S. G. S. Bull. 580.

Leadfield District

The Leadfield District is located in Lost Valley in T. 12 S., R. 45 E., M. D. B. & M. in the Grapevine Mountains of the Amargosa Range, 22 miles westerly from Beatty, Nevada; elevation, 3950 ft. to 5200 ft. The ore deposits occur in a belt of limestone that strikes N. 30° W. The limestone is folded and the beds strike and dip 60° N. At various points for a distance of about 2 miles galena occurs disseminated in hard, blue limestone, and along certain bedding planes of the limestone replacing calcite. The principal mineralization of lead-zinc occurs where north-south fractures intersect bedding planes of the limestone. The orebodies exposed carry from 5% to 7% per cent lead, with 5 oz. silver, and 5% to 6% zinc.

The Leadfield District was active in 1925-1926 but since that date has been dormant.

Bibl.: State Mineralogist's Report XXII, pp. 504-510.

Lee Mine. It comprises 6 claims situated in the Lee Mining District, 18 miles east of Keeler; elevation, 5000 ft.; owners, Franklin Booth and W. A. Reid, of Keeler, California; under lease to B. F. Shively and John Hopkins.

A series of parallel veins occur in a mineralized zone in the limestone. The mineralized zone is about 400 ft. wide and 1000 ft. in length, with an E.-W. strike, dipping 70° N. The ore is in the form of chlorides; chloro-bromides of silver, argentite and occasional bunches of galena are found filling fractures that cut the bedding planes in the limestone. Developments consist of several shafts sunk to a depth of 80 ft. with about 1000 ft. of underground workings. During 1937, 250 tons of ore was shipped, reported to have a net value of $49 per ton in silver.

Three men are employed.

Bibl.: State Mineralogist's Reports XV, pp. 99-105; XVII, p. 289; XXII, p. 488; Report of the Director of U. S. Mint, Precious Metals in U. S., 1883, p. 163.

LeMoigne Mine. It comprises 12 claims situated in the LeMoigne Mining District, on the east slope of the Panamint Range, 15 miles southwest of Stove Pipe Wells and 50 miles by road west of Beatty, Nevada; elevation, 4950 to 5700 ft.; owner, *Buckhorn Humboldt Mining Company,* W. R. McCrea, Reno, Nevada.

Massive galena and lead-carbonate occur in irregular lenses along fissures in the limestone. The fissures strike N.-S., dipping 65° W. Ore shipped from the property in the past is reported to carry 50% lead with 5 oz. in silver per ton.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 488.

Lincoln Mine (Silver Dome). It comprises 6 claims situated in the Deep Springs Mining District, 4 miles north of Deep Springs Ranch on the Midland Trail and 25 miles northeast of Big Pine; eleva-

tion, 6200 ft.; owners, A. T. Wilkerson and B. W. Holeman, of Bishop, California.

A series of narrow fissure veins occur in granite. Widths vary 6 to 12 in.; strike E.-W.; dip 65° N.; developed by a number of shafts sunk on the veins to depths of 50 ft. to 100 ft. Some high-grade silver ore shipped is reported to carry from 100 oz. to 300 oz. in silver per ton.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 289; XXII, pp. 488-489.

Long John Mine. It comprises 7 patented claims, situated on ridge south of Long John Canyon on the west slope of the Inyo Range, 8 miles east of Lone Pine; elevation, 5900 ft.; owner, James A. Walker, 1201 N. Isabel St., Glendale, California.

The property was formerly owned and operated by the Inyo Lead Syndicate, of Las Vegas, Nevada, and operated from 1925 to 1926. The grade of ore shipped was reported as containing 40% lead, with 40 oz. in silver per ton, reported production being $60,000. Orebodies occur along a fissure in limestone; strike N. 30° W., dip 60° E.; width 4 ft. to 6 ft. The ore is galena and lead-carbonate with silver values; developed by shafts and tunnels.

Idle.

Lucky Jim Mine. It comprises 18 patented claims known as Lucky Jim group, situated in the Darwin District two miles north of Darwin and 24 miles southeast of Keeler; owner, *Wagner Estate Corporation,* of Chicago; under lease to *American Metals, Inc.,* Darwin, California; elevation, 5000 ft. Development consists of a vertical shaft 300 ft. deep, then a winze from 300-ft. level 450 ft. in depth to 750-ft. level, with about 10,000 ft. of drifts and cross-cuts. The shaft was sunk on a fissure that cuts across the beds of the limestone. The course of the fissure is N. 50° E. with a dip of 80° W. Width of ore mined was 4 ft. to 6 ft. Workings are caved, no equipment on property. Mine produced over $2,000,000.

Idle.

Bibl.: State Mineralogist's Reports VII, p. 226; X, p. 211; XII, p. 24; XV, pp. 100-101; XVII, pp. 289-290; XXII, p. 489; Mineral Resources West of Rocky Mts., 1876, p. 25; Report of Mint, Precious Metals in U. S. 1883, p. 163; U. S. G. S. Bull. 580, pp. 12-18.

Mineral Hill Group of Mines. This group comprises 11 claims located on east slope of the White Mountains, in Sec. 29, T. 8 S., R. 36 E., 17 miles by road northeast of Big Pine. Elevation, 6500 ft.; owners, R. W. Swank and L. Ludwick, of Big Pine, California.

Bibl.: State Mineralogist's Report XXII, p. 489.

Mineral Point Mine (Sanger Mine). It comprises 7 claims, located in Secs. 13, 14, 23, 24, T. 7 S., R. 34 E., on the west slope of the White Mountains, on a ridge two miles south of Black Canyon and 14 miles east of Bishop; elevation, 8200 ft.; owners, Chas. W. Bretz and Flynn Bros., Bishop, California.

In 1925, 600 tons of high-grade lead-silver ore was shipped from the property.

Idle.

Bibl.: State Mineralogist's Report XXII, pp. 489-490.

Minnietta Mine. The property comprises the following claims: St. Charles, St. John Dividend, St. Arthur, Helen G. and St. John Millsite, totaling 105 acres, situated T. 19 S., R. 42 E., in the Modoc Mining District, on the east slope of the Argus Range of mountains, 30 miles north of Trona and adjoining the Modoc Mine on the south; elevation, 3000 ft. to 4000 ft.; owner, Mrs. Jack Gunn, Independence, California; under lease and bond to Ralph Merritt, Los Angeles.

The property was discovered in 1889 and has been worked off and on to date. The reported production of the mine is said to have been over $1,000,000.

The orebodies occur in fissures in limestone and on bedding planes of the limestone which are cut by diabase, intrusive dikes. The principal mineralization occurs on the hanging wall of diabase dikes. These dikes are from 10 ft. to 25 ft. thick. The fissures strike N. 50 to 60° W. and dips 35° S. The width of the orebodies worked was 5 ft. to 20 ft., the ore being argentiferous galena, silver chloride and chlorobromides, said to carry $\frac{1}{4}$ oz. in gold, with 30% to 50% lead, and 50 oz. to 200 oz. in silver.

Development consists of 6 tunnels and 3 shafts. At an elevation of 2000 ft., the lower tunnel No. 1 is driven south 2700 ft. with a drift along a diabase dike 600 ft. in length. Other tunnels are 50 ft. to 200 ft. in length. Below Jack Gunn stope, a shaft is sunk on an inclination of 35° to a depth of 340 ft. At 200 ft. in depth the ore is cut off by thrust fault. On 165-ft. level, drift north 150 ft. and south 147 ft.; on 220-ft. level, drift north 50 ft. and south 50 ft.; on 330-ft. level, drift south 75 ft. A small lens of ore was developed on 165-ft. level. (See Plate V.)

Mine equipment consists of 18-h.p. gas engine hoist; portable Ingersoll-Rand compressor, 300 cu. ft. capacity; 1-ton ore skip; trucks; blacksmith shop.

Six men are employed.

Bibl.: State Mineralogist's Reports X, p. 212; XV, p. 101; XVII, p. 290; XXII, p. 490; R. W. Raymond, Mineral Resources West of Rocky Mountains, 1876.

Modoc Mine. It comprises 8 patented claims, totaling 160 acres, situated in T. 19 S., R. 42 E., on the east slope of the Argus Range, in the Modoc Mining District, 32 miles north of Trona and 15 miles southeast of Darwin; elevation, 3500 ft. to 4000 ft.; owner *Hearst Estate*, San Francisco, California.

The property was discovered in 1875 and operated until 1890, during which period the production was $1,900,000. The orebodies worked occur along fissures in the limestone of the carboniferous age which has been intruded by diabase dikes.

The ore deposits occur along the bedding planes of the limestone where intersected by diabase dikes and sills. The general strike of the ore fissures is northwest and southeast. The ore mined is an argen-

tiferous galena and lead-carbonate, with gold and silver values; reported to carry $\frac{1}{4}$ oz. gold, 30% to 50% lead and from 50 oz. to 200 oz. silver. The dumps were worked by leasers, being treated in jigs, and concentrates produced are said to have carried 70 oz. to 160 oz. in silver, with 30% to 50% lead. (see Fig. 5)

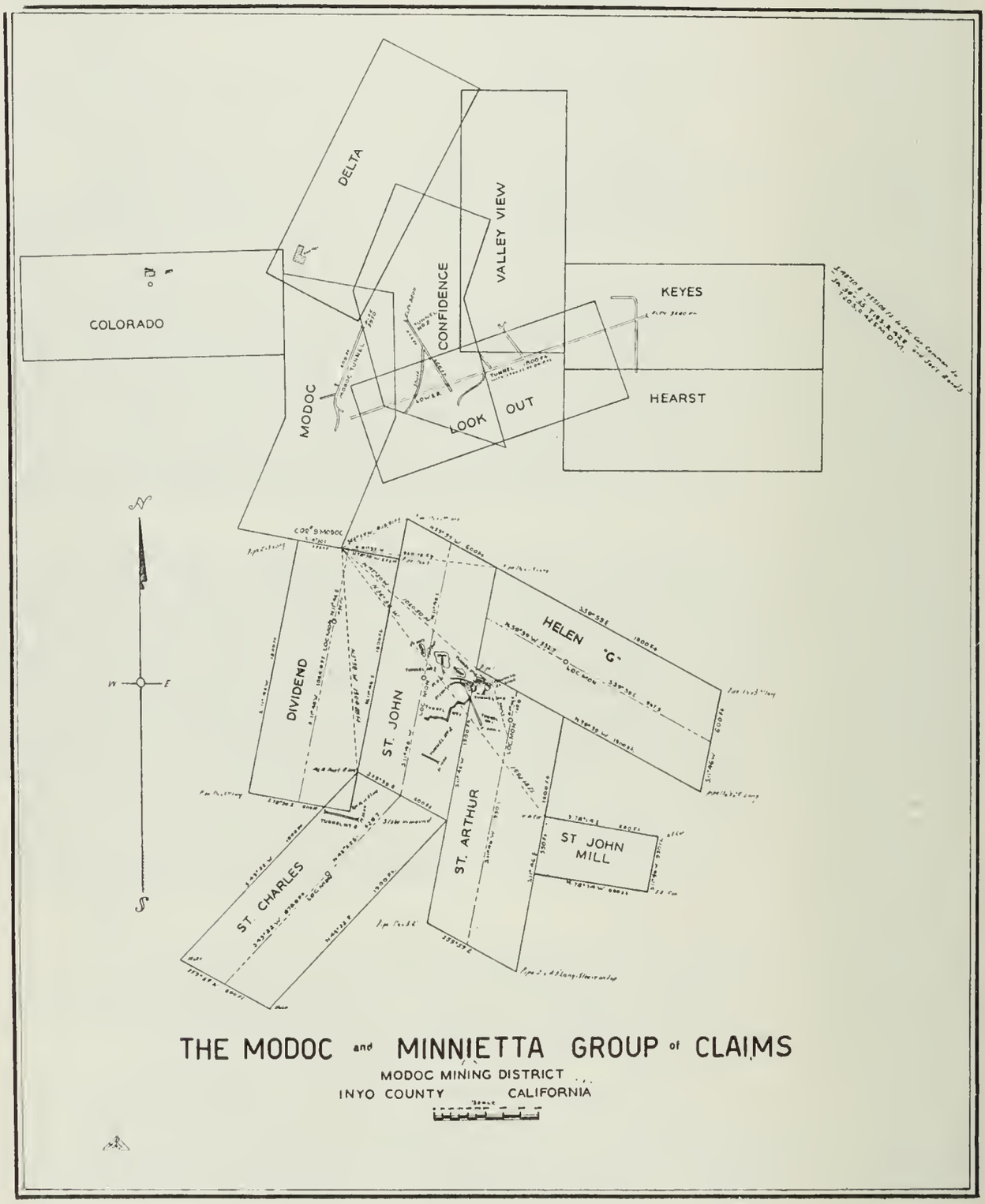


FIG. 9.

Development consists of a number of tunnels and shafts. At an elevation of 3240 ft. the lower tunnel has been driven southwest 1800 ft., with 2000 ft. of drifts. The tunnel is 1150 ft. in elevation below the vein outcrops. This tunnel is connected with Tunnel No. 2 by a raise 560 ft. between levels. At an elevation of 3800 ft., tunnel No. 2 is driven southeast 500 ft.; at 200 ft. southeast of portal, drift south

500 ft. There are about 1200 ft of crosscuts and drifts on this level. At an elevation of 3950 ft., the Modoc or No. 3 tunnel is driven 600 ft. south. The Modoc shaft is 600 ft. deep and there is an incline shaft 200 ft. The major portion of the tonnage mined was from No. 2 level, with a small amount from lower tunnel, indicating that the ore deposits bottomed about 100 ft. below the lower tunnel level. There is about 40,000 tons of ore on mine dumps, carrying 6% to 10% lead and 10 oz. to 15 oz. in silver.

Idle.

Bibl.: State Mineralogist's Reports XII, p. 24; XIII, p. 32; Report of Director of U. S. Mint, 1883 p. 164; 1884 p. 104.

Monster Mine (Blue Monster). It comprises 6 claims situated on the east slope of the Inyo Range of mountains and northwest of Saline Valley; owner, Dr. John MacLean, 2039 W. 68 St., Los Angeles.

The orebody occurs as an irregular lens of galena in a brecciated limestone. The trend of the ore-bearing fissure is northwest. Development consists of a tunnel driven N. 40° W. 275 ft. An open stope 200 ft. in length by 12 ft. in width extends from tunnel level to the surface.

The mine was operated by leasers in 1935, who shipped 50 tons of ore to U. S. Smelting, Refining and Mining Company's smelter at Midvale, Utah. Shipment was reported to carry $100 per ton in lead and silver.

Equipment consists of 1500-ft. jig-back tram to mill. Mill equipped with jigs.

Three men are employed on development work.

Bibl.: State Mineralogist's Reports XV, p. 101; XXII, p. 490; U. S. G. S. Bull. 540, p. 111; U. S. G. S. Professional Paper No. 110, pp. 117-118.

Montezuma Mine. It comprises 6 claims situated on the west slope of the Inyo Range, 10 miles southeast of Big Pine; elevation 4700 ft.; owner, Joseph Bros., Big Pine, Calif.; under lease to L. W. Sockman, Big Pine, Calif.

The country rock is limestone and slates which have been shattered and faulted. The ore forms in irregular lenses along a fault between limestone and clay slates. The ore is argentiferous galena, lead-carbonate, associated with sphalerite and zinc-carbonate, in a gangue of iron-oxide and decomposed lime. Ore shipped from the property carried 12% to 18% lead, 9% to 10% zinc and 10 oz. to 12 oz. in silver per ton.

Developed by three cross-cut tunnels driven northeast to intersect orebody at different elevations. Lower tunnel is 1400 ft. (caved), intermediate tunnel is 400 ft. and upper tunnel 200 ft. All ore has been worked out.

Idle.

Bibl.: State Mineralogist's Reports XIII, p. 32; XV, p. 102; XVII, p. 291; Reports of the Director of Mint, Precious Metals in U. S. 1883, p. 158; 1884, p. 100; U. S. G. S. Bull 540, pp. 109-110; U. S. G. S. Professional Paper No. 110, p. 116.

Noonday and Grant Mines are approximately 1½ miles southeast of the Gunsite Mine. They are also owned by the *Tecopa Consolidated Mining Co.*, which is controlled by Dr. L. D. Godshall, 722 South Oxford, Los Angeles.

An 8-mile railroad spur track connects the mine with the Tonopah and Tidewater at Tecopa.

The Grant adjoins the Noonday on the south and the outcrop of the fissure-filling is readily traceable between the two.

Shipments from the two properties have aggregated approximately 93,000 tons.

The Noonday produced 85,000 tons ranging in value from $10 to $75 per ton; average value of all shipments: gold, .091 oz.; silver, 7.29 oz.; lead, 15.39%.

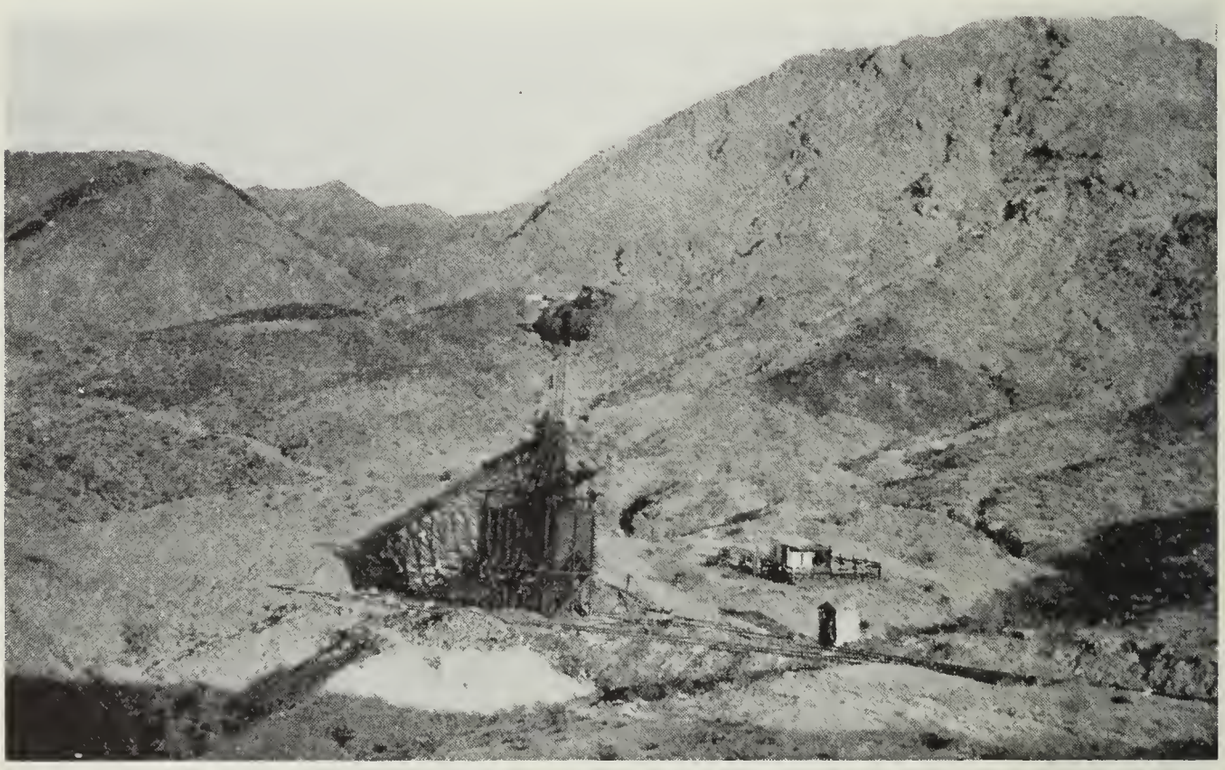


PHOTO. 11. Noonday Mine, Tecopa Cons. Mining Co., Tecopa, Inyo County.

The Grant shipped 8000 tons with values from $8 to $50 per ton; average: gold, .064 oz.; silver, 5.87 oz.; lead, 11.05%.

The working of these mines are in the same fissure as those of the Gunsite Mine. The country rock is the Silver Rule dolomite. Here the vein strikes N. 40° W. and has an average dip of about 45° NE., although locally it flattens to 30° and, in places, may dip as steeply as 60°.

The main orebodies occur along a series of N.-S. fractures in the dolomite. In places the width may be 30 ft. or more. A series of N.-S., steeply dipping to vertical faults have probably influenced the position of the shoots in the vein. Two principal ore-shoots have been mined; one at the main shaft, the other at the winze. These may, in places, consist of a series of overlapping lenses, but the zone of the occurrences is more or less continuous within the shoots. The ore consists largely of lead-carbonates with some unoxidized galena.

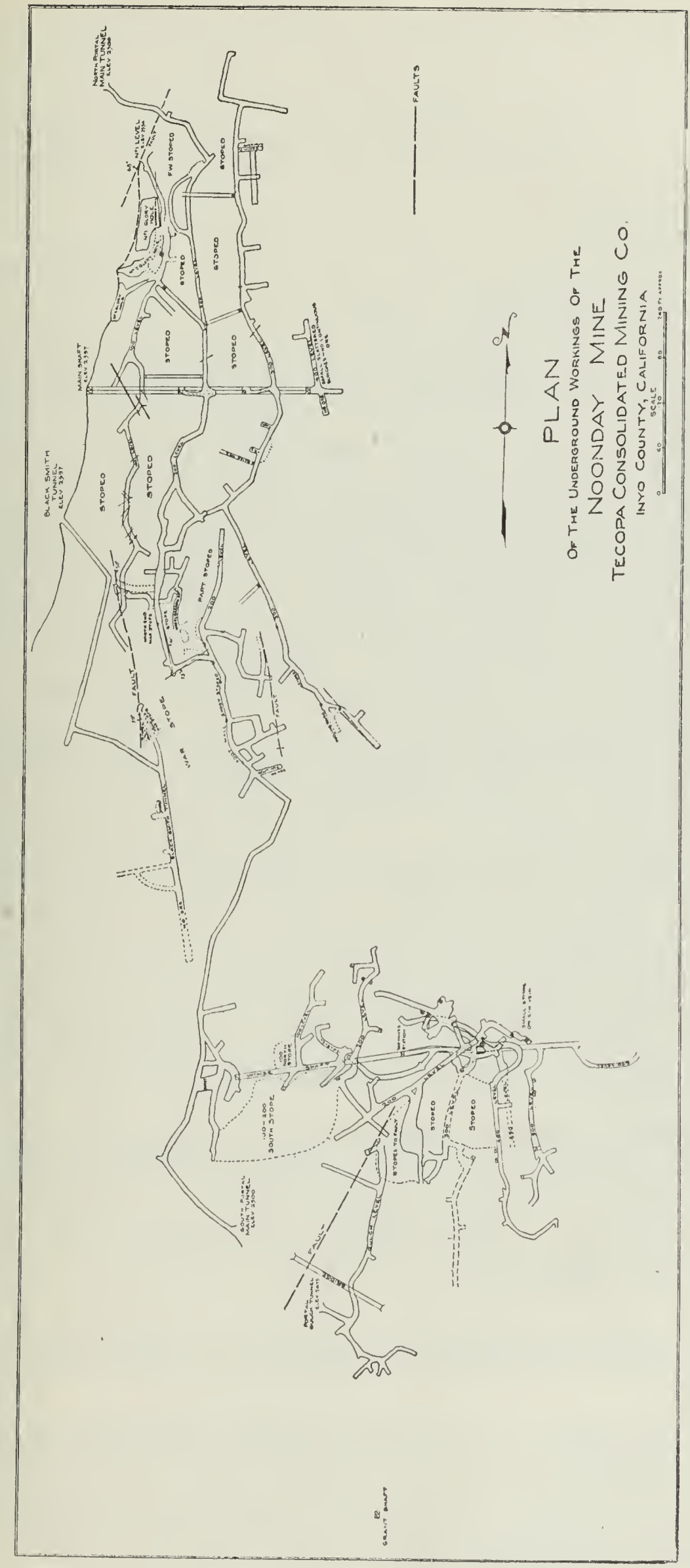

FAULTS
PLAN
OF THE UNDERGROUND WORKINGS OF THE
NOONDAY MINE
TECOPA CONSOLIDATED MINING CO.
INYO COUNTY, CALIFORNIA
SCALE
STOPED
SOUTH STOPE
PART STOPED
MAIN SHAFT
BLACK SMITH TUNNEL ELEV 2997
NORTH PORTAL MAIN TUNNEL ELEV 2708
SOUTH PORTAL MAIN TUNNEL ELEV 2500
GRANT SHAFT

FIG. 10.

The development, consisting of a shaft to the 400-ft. level and a 600-ft. winze below the tunnel, is shown on the accompanying map. (Fig. 10.)

Equipment consists of gasoline hoists at the shaft and winze of the Noonday. A 25-hp. gas engine operates a 2-drill compressor at the south portal of the tunnel. The Grant shaft is equipped with a 35-hp. gasoline hoist.

Idle at present.

Bibl.: State Mineralogist's Reports XV, pp. 103-104; XVII, pp. 291-293; XXII, pp. 491-492.

Ophir Mine. It comprises 15 claims, 2 patented and 13 unpatented, situated on the west slope of the Slate Range of mountains, 10 miles northeast of Trona; owner, *Engineers Exploration Company;* W. A. Coons, president; Edith Coons, secretary; C. O. Mittendorf, manager, California Reserve Bldg., Los Angeles, California.

The orebody consists of a fissure in limestone which strikes N. 30° with a dip of 60° to 70° W. which has been developed along its strike for over 1000 ft. Width of orebodies developed along the fissures varies from 2 ft. to 20 ft.. The ore is galena and lead-carbonate, and lead-vanadate. The ore shipped from the property carries 30% lead, 3% zinc, 20% iron and from 5 oz. to 7 oz. in silver.

The company operated the property from 1926 to March 1, 1930, when operations were suspended due to a drop in metal prices. In 1929 a 100-ton concentration plant was installed on the property which operated from Nov. 1, 1929, to March 1, 1930.

Mill: 300-ton coarse ore bin, Wheeling jaw crusher, 2-in. Symonds disc cone crusher, 100-ton fine ore bin, Hardinge rod-mill in closed circuit with Duplex Dorr classifier; Dorr bowl type of classifier, 2 Wilfley sand tables and 4 Wilfley slime tables. Mill is driven by electric motors; total hp., 130. Electric power is secured from the Southern Sierras Power Company.

The mine was reopened and operated under lease to C. O. Mittendorf in June, 1936, to September 1, 1937, who shipped 400 tons of ore to Selby Smelting Co., with an average grade of 40% lead and 7 oz. in silver per ton.

Development consists of three shafts, the main vertical shaft being 500 ft. Deep underground workings consist of 2500 ft. of drifts and cross-cuts.

Mine equipment consists of 50-hp., double drum, electric-driven hoist 300 cu. ft. Ingersoll-Rand compressor. The property is reported to have produced $500,000.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 105; XXII, pp. 492-493.

Paddy Pride Mine. It comprises 5 claims, situated at the southern end of the Amargosa Range of mountains, 9 miles west of Zabriskie, a station on the Tonopah & Tidewater Railroad; elevation, 3500 ft.; owner, Paddy Pride Silver Mining Company; John T. Overburg, president, Shoshone, California.

The ore occurs as irregular, lenticular deposits of carbonate of lead in limestone. The general trend of the fissure is northwest, dip 60° to 70° SW. The vein varies in width from 4 ft. to 8 ft.

Development consists of two tunnels, one 150 ft. in length, the other 200 ft.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 294; XXII, pp. 493-494.

Panamint Mines (*silver*). This property comprises 11 patented claims and 7 claims held by location, situated in the Panamint Mining District, in Surprise Canyon, on the west slope of the Panamint Range, 10 miles northeast of Ballarat; elevation, 6000 to 7500 ft.; owner, A. D. Myers, Los Angeles, California.

The vein system comprises a series of parallel quartz veins in schist and limestone; strike NW.-SE., dip 60° to 70° NW. Widths vary from 6 to 8 ft. The vein quartz is mineralized with tetrahedrite and stained with bromides of silver, azurite, and malachite.

Development consists of tunnels, the main cross-cut tunnel being 2300 ft. in length. Property has been idle since June, 1926.

Bibl.: State Mineralogist's Reports XVII, pp. 280-281; XXII, pp. 495-500; XXVIII, pp. 361-364.

Pennsylvania Mine. It is situated in the Swansea District at the old camp of Swansea, 3½ miles northwest of Keeler; elevation, 4000 ft.; owner, J. D. Leary, Lone Pine, California.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 293; XXII, p. 495.

Pete Smith Mine. It comprises 6 claims, situated on the west slope of Inyo Range of mountains, 4½ miles east of Keeler; elevation, 4850 ft.; owners, Paul Watterson and William Skinner, Lone Pine, California.

Bibl.: State Mineralogist's Report XXII, pp. 495-496.

Pierson Mining Company's Group of Mines. It comprises 20 claims situated on the west flank of the Inyo Range, 7 miles east of Independence and 3 miles northeast of Kearsarge; elevation, 4450 ft.; owner, R. B. Whiteside, of Duluth, Minnesota.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 496.

Promontory Mine. It is situated in the Darwin District, 1½ miles south of Darwin; elevation, 5000 ft.

Idle.

Bibl.: State Mineralogist's Reports XV, pp. 105-106; XXII, p. 496.

Raven Mine (*lead-silver*). It comprises 6 claims, situated in the Ubehebe District, 5 miles north of Dodds Springs, and 70 miles northwest of Death Valley Junction; elevation, 3800 ft.; owner, Archie Farrington Estate, Bishop, California.

Redwing Mine. It is situated in Resting Springs District, 4 miles northeast of Shoshone, on the west slope of Resting Springs Mountains; owner, R. J. Fairbanks, of Shoshone, California. Idle.

PHOTO. 12. Santa Rosa Mine on east slope of Inyo Range. Photo by J. R. LeCyr, Keeler, California.

Reed Flat Mine. It comprises 8 claims and millsite claim at Black Canyon Spring, situated on the western slope of the White Mountains, two miles south of Reed Flat and 16 miles by road via Black Canyon east of Bishop; owners, Judge J. O. Ray, Beatty, Nevada, and Fred Smith, of Bishop.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 497.

Royal Mine. See Cerro Gordo Extension Mine.

Sam Lucas Mine. It comprises 7 claims situated in the Cerro Gordo District, on the west slope of the Inyo Range, two miles east of Cerro Gordo Mine, and 9 miles east of Keeler; elevation, 7500 ft.

Idle.

San Pedro Mine. It comprises 2 claims, situated on the east slope of the White Mountains, 16 miles southeast of Big Pine; elevation, 7700 ft.; owner, W. A. Coulter, San Pedro, California.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 498.

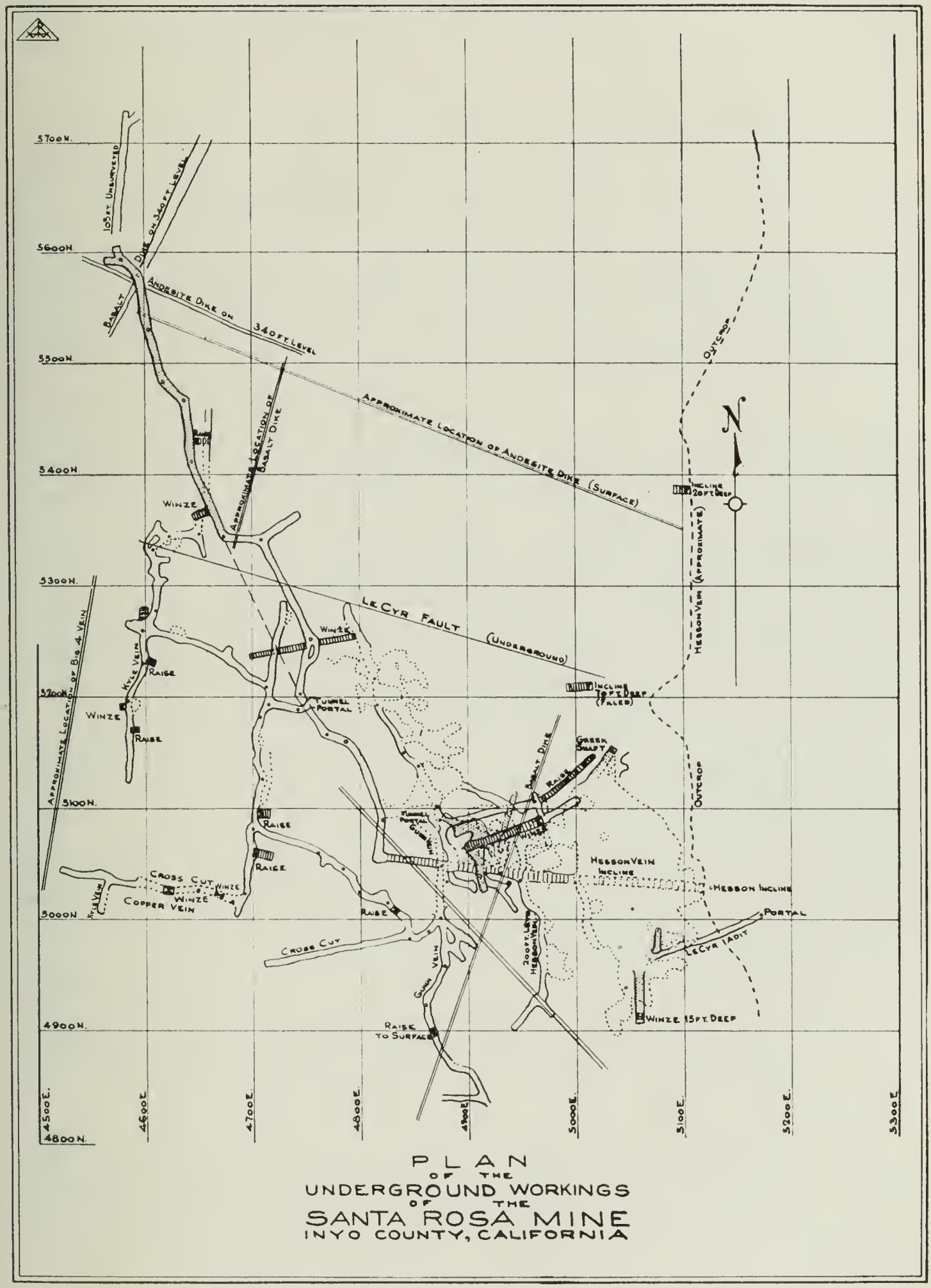
Santa Ana Mine. It comprises 3 claims, situated in the Darwin District in the Argus Range, 1½ miles east of Darwin; elevation, 4450 ft.; owner, Alex Rouna, Darwin, California.

The mine is on the ridge north of Lone Canyon, here a fissure in the limestone strikes N. 40° E. with a width of 6 to 8 ft. The ore occurs as lenses of galena and lead carbonate. Development consists of shaft 200 ft. deep with levels at 75, 150, and 200 ft.

Idle.

Santa Rosa Mine (lead-silver). It comprises 6 contiguous patented claims totaling 113 acres and one millsite, situated in the Lee

Mining District, on the east slope of the Inyo Range, 26 miles by road east of Keeler; elevation, 6500 ft to 7000 ft.; owner, Santa Rosa Mining Company; J. R. LeCyr, president, 310 Black Bldg., Los



PLAN
OF THE
UNDERGROUND WORKINGS
OF THE
SANTA ROSA MINE
INYO COUNTY, CALIFORNIA

FIG. 11.

Angeles, California; Lessee, Santa Rosa Mines Development Company; operating through receivership; C. W. Dow, of Lone Pine, Trustee. Two sets of leasers have operated the property since 1935, R. E. Mac-

Donald and C. Grand, of Keeler, and John McPherson and Walter Uttich, of Keeler. The ore shipped by the leasers amounted to 1500 tons; reported to average 16.62% lead and 15.35 oz. in silver per ton. The production of the property from 1915 to 1931 was 20,735 tons with an average assay value of 0.015 oz. gold, 17.28 oz. silver, 1.69% copper and 22.74% lead. The total production of the property has been about $1,000,000.

GENERAL GEOLOGY

The formation in which the orebodies occur consists of a series of partly metamorphic, thin-bedded quartzites, argillites and limestone of Pennsylvanian age, which strikes northerly and southerly, dip easterly at angles varying from 40° to 70°. The individual beds are from 1 ft. to 5 ft. in thickness. These formations are exposed for only about 500 ft. vertically and not more than 2000 ft. on the strike, being completely surrounded by post-mineral basalt tuffs and flows of late Tertiary age.

A post-mineral fault has dropped all formations to the east a distance of 500 ft. to 1000 ft. The sediments and orebodies are cut by three post-mineral dikes; two of basalt and the other of andesite. The orebodies are of the fissure-vein type and occur in a dozen or more closely spaced veins, from 25 ft. to 100 ft. apart, which strike N. 17° W. and dip from 30° to 70° W. These fissures are cut by a few small, easterly-westerly fissures which are also mineralized in places.

The orebodies consist of replacement of the walls along fissures together with more or less irregular impregnations of the adjoining rock, by pyrite, galena, sphalerite and chalcopyrite. With the exception of some of the galena, these minerals are now all oxidized.

Development: The Hesson vein which is the largest and most productive is developed by a single-compartment incline shaft 340 ft. in depth which follows the Hesson vein orebody on its dip of about 35°. The lower 70 ft. of the shaft, flattens to 17°, leaving the vein. Drifts have been driven on the vein on the 200-ft. level, 270-ft. level and 340-ft. level. The main production of ore mined has so far been from the Harper and Hesson veins. On the 270-ft. level, about 40 ft. north of the shaft, a crosscut has been driven east 170 ft. cutting a mineralized fissure. At this point there is a raise up 100 ft. and a winze has been sunk on the fissure to a depth of 165 ft. in the ore. On the 340-ft. level, drift north 960 ft. on the Harper vein. The other veins are developed by tunnels and shallow shafts and surface cuts. (See Fig. 11.)

Mine equipment consists of 60-hp. semi-Diesel engine 18-hp. Western gas engine hoist one 350-cu. ft. Gardner-Denver compressor driven by the 60-hp. semi-Diesel engine, Ingersoll-Rand tugger hoist, jack hammers and stopers, together with various other underground equipment.

Six men are employed.

Bibl.: State Mineralogist's Reports XV, p. 107; XVII, p. 294; XXII, p. 498.

Silver Button & Shamrock Mines. See Darwin Keystone Mines.

Silver King Mine. It is situated in Sec. 8, T. 24 S., R. 43 E., M. D. B. & M. on the west slope of the Slate range, 9 miles north of Trona; elevation, 3600 ft.

Bibl.: State Mineralogist's Report XXII, p. 500.

Silver Peak Mine (Hemlock). See Panamint Mines.

Silver Reef Mine. It is situated in the South Park District, 6 miles east of Ballarat, near the summit of the Panamint Range.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 108; XVII, p. 294; XXII, p. 500.

Silver Rule Mine. It comprises 12 claims situated in Resting Springs District, on the southwest slope of the Kingston Range, 17 miles east of Morrison's siding, on the Tonopah and Tidewater Railroad; owner, *Pacific Lead & Silver Mining Company;* A. J. Jarmuth, president, Los Angeles, California.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 104; XVII, pp. 365-366; XXII, p. 500.

Silver Spoon Mine. It comprises 5 claims, situated in the Darwin District, on the west slope of the Argus Range, 2 miles southeast of Darwin; owner, Theodore Peterson, Darwin, California.

The ore occurs along a fissure in limestone which strikes N. 30° W., dip 40° W. Width of the vein varies from 3 ft. to 6 ft. The ore is galena and lead-carbonate, carrying values in silver. Ore shipments show a value of 20% to 30% lead with 15 oz. to 25 oz. in silver per ton, also a small amount of gold.

Development consists of a shaft sunk on an inclination of 75° to a depth of 250 ft. with levels at 150 ft. and 250 ft. On the 150-ft. level, a drift has been driven west 150 ft. in ore. On the 250-ft. level, a crosscut has been driven south 100 ft. to a vein that strikes E.-W. and dips 75° S.; width, 2 to 8 ft.; drift on fissure, 125 ft. west. The vein material is iron-stained, carrying bunches of galena and lead-carbonate. Ore mined is reported to carry 38% lead with 25 oz. in silver per ton.

Mine equipment consists of a 6-hp. gas engine hoist.

Two men are employed.

Bibl.: State Mineralogist's Report XXII, pp. 500-501.

Slate Range Mine. (See California Queen or Gold Bottom Mine.)

Standard Group of Mines. It comprises 11 claims, situated in the Darwin District north of Lane Canyon, in the Argus Range, 4 miles by road east of Darwin; owner, Alex Rouna, Darwin, California.

A series of fissure veins in lime-silicate rock strikes northwest. Width varies from 40 ft. to 50 ft. The ore occurs as lenses of galena and lead-carbonate with widths ranging from 2 ft. to 6 ft. Developments consist of tunnels and opencuts.

Mine equipment consists of two Ingersoll-Rand portable compressors.

Two men are employed.

Sterling Mine (silver). The property comprises 6 claims situated in T. 20 S., R. 42 E., M. D. B. & M., in Revenue Canyon, on the slope of the Argus Range of mountains, 28 miles north of Trona; elevation, 3000 ft.; owner, Sterling Mining Company; James Stevenson, president, Trona, California.

A quartz vein, 4 ft. to 6 ft. wide, occurs on contact of quartz monzonite and limestone. The vein quartz is mineralized with argentite and bromide of silver; said to carry from $8 to $15 per ton in silver. The vein strikes N. 10° E., dips 60° E.

Development consists of a shaft sunk on the vein to a depth of 285 ft. On the 150-ft. level, a drift has been driven 50 ft. south in ore. On the 280-ft. level, drift south 20 ft. About 50 ft. south is another shaft 120 ft. in depth sunk on the vein with stopes each side of the shaft. Ore mined goes to jig-back tram with a length of 1500 ft. to a 35-ton ore bin located in the canyon 500 ft. in elevation below the mine. From the ore bin, ore is delivered to a No. 2 Wheeling crusher, then to a 4 ft. by 4 ft. Kohler ball mill; in closed circuit with Dorr Duplex classifier, then to 2 Wilfley concentrators and 3 Groch flotation cells. Concentrates produced were reported to be 2.5 oz. in gold, with 300 oz. in silver per ton, the ratio of concentration being 60 to 1. A 75-hp. semi-diesel gas engine drives the mill. Water to operate the mill comes from a spring in Revenue Canyon, a distance of one mile through 1½-in. pipe line to a storage tank having a capacity of 10,000 gallons.

Mine equipment consists of a 6-hp. hoist and 310-cu. ft. National compressor.

Fifteen men are employed.

Swansea Mine (lead-silver). It is situated in the Swansea Mining District, on the west flank of the Inyo Range, 2½ miles north of Keeler; elevation, 4550 ft.; owner, W. F. Whiteside, Duluth, Minnesota.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 501.

Swansea Chief Mine. It is situated in the Swansea Mining District, on the southwest slope of the Inyo Range, 4 miles northeast of Keeler; elevation, 4600 ft.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 294; XXII, p. 501.

Ubehebe Mine. It comprises 12 claims situated in the Ubehebe Mining District, in the Ubehebe Range, 50 miles northwest of Furnace Creek Ranch; elevation 3930 ft.; owner, *Archie Farrington Estate,* Bishop, California; under lease to Grant Snyder, Salt Lake City, Utah, and C. A. Rankin, Los Angeles, California.

The deposit is an irregular replacement in limestone, varying up to 15 ft. in width. The limestone is cut by intrusions of diorite dikes. The ore consists principally of oxidized ores of lead-carbonate and lead-sulphate with occasional bunches of galena.

Development consists of tunnels and open-cuts. Ore is hauled by truck to Death Valley Junction. Shipments are reported to carry from 50% to 60% lead with silver values.

Ten men are employed.

Union Mine (Mount Whitney-Union, Big Wedge, Monte Carlo) (lead-silver-gold). The property comprises 7 claims situated in the Russ Mining District, in Sec. 14, T. 14 S., R. 36 E., M. D. M., on the west slope of the Inyo Range, 3 miles northwest of Owenyo, a station on the Southern Pacific Railroad; elevation, 5500 ft.; owner, *Monte Carlo Mines, Inc.;* A. J. Israel, president, Los Angeles.

The property was operated by the *Mt. Whitney-Union Mining Company* from 1926 to 1928; then by *Hollinger Mines Company,* Ontario, Canada, from 1928 to 1929; in August, 1934, by the *Big Wedge Mining Company;* E. J. Harrison, president, until August, 1935. This company became involved in financial difficulties and a receiver was appointed by the Federal Court of Los Angeles.

In February, 1936, at a receivership sale the property was purchased by A. J. Israel, of Los Angeles, who formed the Monte Carlo Mines Company and operated the mill on ore from the Brown Monster and Reward Mines from March, 1936, to August, 1936, when operations were suspended due to unsatisfactory recovery made by flotation on the gold-silver ores of the Reward Mine. No work was done by the Monte Carlo Mines Company on the Union Mine. In 1928 the Hollinger Mines Company drove No. 4 tunnel 700 ft. east in the hanging wall of the Union vein, and then a crosscut was driven 100 ft. north on the assumption that the vein was faulted to the north. If the crosscut had been run south they would have intersected the vein. The Big Wedge Mining Company put up an incline raise 50 ft. east of the portal of the tunnel intersecting the vein, and is then driven on the vein for a distance of 200 ft. At the top of the raise a tunnel was driven on the vein a distance of 100 ft. The ore developed in these workings was treated in the mill. The Union vein is a massive quartz vein which cuts across thin-bedded limestones and calcareous slates. The vein strikes N. 70° E., dip 60° to 65° W. Width varies from 6 ft. to 20 ft. The vein quartz is mineralized with galena and lead-carbonate and carries values in gold and silver. The vein has been developed by eight tunnels at different elevations. These tunnels vary from 400 ft. to 700 ft. in length. Total amount of underground workings is about 3000 ft. The mill is a flotation plant having a capacity of 150 tons per day. The equipment comprises 10 in. by 20 in. Wheeling crusher, 150-ton fine ore bin, 6 ft. by 22 in. Hardinge ball mill in closed circuit with 6 ft. by 22 ft. Dorr Duplex classifier, 4 ft. by 8 ft. Marathon Rod mill (in open circuit), 6 ft by 6 ft. conditioner tank, 2-12 ft. Southwestern Engineering Company's Airfloat rougher cells, one 8 ft. Southwestern Engineering Company's Airfloat cleaner cell, one 3 ft. by 6 ft. cone thickener, one 3 ft. by 6 ft. American 2-leaf filter. All the equipment was recently purchased by the Mine and Mill Machinery Company, of Los Angeles.

Mine equipment consists of Ingersoll-Rand compressor; capacity, 750 cu. ft.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 84; XXII, pp. 501-502.

Utacala Mine (zinc). It comprises 12 claims situated in the Darwin District, on Zinc Hill, in the Argus Range, 9 miles east of Darwin; elevation, 4000 ft.; owner, Albert Miller, of Keeler, California.

The country rock is limestone and quartz monzonite. The ore is deposited as zinc-carbonate and sphalerite along fissures in the limestone. These fissures strike N. 30° W. The width of the ore mined was from 4 ft. to 8 ft. Development consists of five tunnels, from 100 ft. to 600 ft. in length.

Idle.

Bibl.: State Mineralogist's Reports XVII, pp. 294-295; XXII, p. 503.

Ventura Mine (Silver Reef). It comprises 16 claims, one patented and 15 unpatented, adjoining the Ignacio Mine on the north, on the west slope of the Inyo Range of Mountains, 7 miles east of Keeler; elevation, 7300 ft.; owner, Mrs. Charles Baagoe, Keeler, California.

Two well-defined veins occur in limestone; one vein strikes N. 30° W., and dips 70° to 80° W., the other strikes N. 20° E., and dips 80° E.; widths of veins vary from 2 ft. to 5 ft. These two veins intersect on the ridge north of the Ventura shaft, and to the west of this intersection is an intrusion of quartz-monzonite. This intrusion has effected a large amount of contact metamorphism and converted an extensive body of carboniferous limestones into garnet and other dense fine-grained, lime-silicate rocks. The ore occurs as irregular lenses of galena and lead-carbonate in fissures in the lime-silicate rocks. Shipments of ore carry 12 oz. silver per ton, 30% to 33% lead and 1% to 2% of zinc.

Developments consist of a shaft 150 ft. deep and four tunnels, 100 ft. to 400 ft. in length. The lower tunnel is driven northeast 400 ft. Reported production of the property is $100,000.

Idle.

Bibl.: State Mineralogist's Reports XV, p. 110; XVII, p. 295; XXII, p. 503; U. S. G. S. Professional Paper 110, p. 117.

War Eagle Mine. It comprises 9 patented claims situated in Sec. 14, 15, 22, 23, T. 20 N., R. 8 E., S. B. M., in the Resting Springs District on the western slope of the Nopah Range, 9 miles southeast of Tecopa and one mile south of the Grant Mine; elevation, 2600 ft.; owner, *Tecopa Cons. Mining Company;* Dr. L. D. Godshall, general manager, Los Angeles, Calif.

The deposit is a continuation of the Gunsite-Noonday vein. The ore is lead-carbonate, with some unoxidized galena and carrying values in gold of 0.50 oz. per ton. Developments consist of a crosscut tunnel driven N. 60° E., 450 ft. to the vein, with drift south 450 ft. on the vein; also winze sunk on the vein 100 ft. below the tunnel level.

Idle.

Bibl.: State Mineralogist's Report XXII, pp. 503-504.

Westgard Mine (Chalmers) (lead-silver). It comprises 14 claims, situated in the Deep Springs Mining District, on the eastern slope of the Inyo Range, near Antelope Springs, about 16 miles northeast of Big Pine; elevation, 6000 ft.; owner, Westgard Consolidated Mining Com-

pany; Mark G. Bradshaw, president; C. K. Loring, secretary, Tonopah, Nevada.

The ore is galena and lead-carbonate that occurs on contact between limestone and quartz-diorite. The fissure strikes northwest and dips 45° southwest. The orebody is from 2 ft. to 6 ft. wide. Developments consist of two shafts, one 100 ft. deep with 250 ft. of drifts, and two tunnels, 100 ft. and 200 ft. in length, respectively.

Idle.

Bibl.: State Mineralogist's Reports XVII, p. 284; XXII, p. 482.

Wonder Mine. It comprises 4 claims situated in the Darwin District, in the Argus Range, 1½ miles east of Darwin; elevation, 4700 ft.; owner, Richard Wallace, Darwin, California.

The ore occurs as irregular lenses of galena and lead-carbonate along a fissure in the limestone that strikes northwest and dips 45° W. The vein-filling is a coarse calcite with some crystalline fluorite. Development consists of two incline shafts, one 225 feet deep, the other 100 feet deep.

Idle.

Bibl.: State Mineralogist's Report XXII, p. 504.

MOLYBDENUM

Deposits of molybdenite, the sulphide, occur in a number of localities in Inyo County. Wulfenite, lead-molybdate, occurs, associated with lead ores in the Slate Range, especially at the Ophir Mine. Crystals of wulfenite occur with linarite and caledonite in the Cerro Gordo Mine. It is also reported to occur in mines of the Darwin District with crocoite. Molybdenite occurs scattered through a quartz vein along a contact on the east slope of the Inyo Range, 7 miles east of Kearsarge, also in the Pine Creek Tungsten Mine in commercial quantities, associated with scheelite. It is reported that in certain sections of the mine an orebody has been developed which has a thickness of 30 ft. and is said to have an average value of 1% to 2% MoS_2. A recent discovery of molybdenite disseminated in a granite formation has been made north of Hamilton Canyon on the west slope of the Coso Range that may prove of commercial importance.

Coso Molybdenite Mine. It comprises two groups of claims known as the Desoto Group and the Molybdenite Group, each consisting of 6 claims, totaling 240 acres, situated in T. 20 S., R. 38 E., in the Coso Mining District, north of Hamilton Canyon in the Coso Range, 12 miles by road southeast of Olancha; elevation, 6000 ft.; owners, H. A. Clark and John Stuart, of Darwin, locators of the Desoto Group, and Lacy Harper, of Olancha, of the Molybdenite Group; under lease and bond to J. Frank Reeves, 5514 Wilshire Blvd., Los Angeles. The molybdenite occurs disseminated in a granite stock, in seams and joints of the rock which has been shattered by folding. The mineralized area is about 400 ft. wide and 900 ft. in length. The development consists of two tunnels and a number of open cuts. Samples taken from different points along the outcrop are reported to carry from 0.08% to .65% MoS_2, with a general average of .35% MoS_2.

Mine equipment consists of a Gardner-Rix portable compressor.

Five men are employed on development work.

Pine Creek Tungsten Mine. It comprises 12 claims and a millsite, situated on the south slope of Mount Morgan, in the Sierra Nevada Range, 45 miles by road northwest of Bishop; elevation, 10,500 ft.; owner, *United States Vanadium Corporation;* R. J. Hoffman, presi-

PHOTO. 13. View of Trenches on Coso Quicksilver Deposit, Coso Hot Springs, Inyo County.

dent; J. R. Van Fleet, vice president and manager; B. G. Smith, secretary; Clarence H. Hall, Supt.; offices, 30 E. 42d Street, New York; local office, Richfield Building, Los Angeles.

It is a contact metamorphic deposit between dolomite and granite, carrying values in scheelite and molybdenite, traceable for over 4000 ft., with a width of 50 ft. and proved to a depth of 900 ft. The molybdenite ore occurs on contact of granite and the tungsten orebody, striking N. 50° E., dip vertical. A highgrade stringer of molybdenite ore, 6 in. to 8 in. wide, occurs on the hanging-wall granite, and the molybdenite is also disseminated in the footwall rock for a thickness of 10 ft. to 30 ft. The rich stringer runs as high as 90% molybdenite. For a description of the mine and mill, see under Tungsten. The company plans to treat the ore in a 300-ton concentration plant, at present operating on tungsten ore from the mine.

QUICKSILVER

Coso Quicksilver Deposit. It comprises 1000 acres, situated in Secs. 7, 8 and 16, T. 22 S., R. 38 E., M. D. M., in the Coso Range, 2½ miles southwest of Coso Hot Springs, and 11 miles east of Coso Junction, a siding on the Southern Pacific Railroad; elevation, 3635 to 4300 ft.; owner, F. J. Sanders, 1434 Garden St., Santa Barbara, California; under lease and bond to A. W. Leege, Santa Barbara, California.

The discovery of mercury in Devil's Kitchen Canyon near Coso Hot Springs was made by F. J. Sanders some time in 1929 and since that date a considerable amount of trenching and surface cuts have exposed a large area mineralized with mercury. The principal mineralization is confined to rhyolite which overlies granitic rocks in Devil's Kitchen Canyon and on the hill south of the canyon. The mineralized area in the Devil's Kitchen Canyon is 1200 ft. in length, about 600 ft. in width and about 300 ft. thick. In places the orebody is covered with unaltered rhyolite in thickness from 2 ft. to 20 ft. Samples taken from this orebody are reported to range from 0.16% Hg to 6% Hg. Samples of selected ore carried from 7% to 11% Hg. The second area of enrichment is located one-half mile northeast of Devil's Kitchen, and embraces about 40 acres, known as the Nicol property. The major portion of development has been confined to this property. This development consists of 4 trenches about 8 ft. deep, 6 ft. wide and from 200 ft. to 400 ft. in length, in north and south direction. These cuts are about 250 ft. apart. There are also a number of shallow shafts, 10 ft. to 40 ft. in depth. Samples cut at 5-ft. intervals in the above-mentioned cuts are reported to give an average assay value of 7 lb. to 8 lb. of mercury per ton of ore. In 1935 a 12-pipe Johnson-McKay retort was installed which had a capacity of one ton of ore per 24 hours. The retort was

PHOTO. 14. 20-ton Herreschoff Multiple-Hearth Furnace at Coso Quicksilver Mine, Coso, Inyo County.

operated on selected ore mined from cuts and during 7 months of operation produced 7296 lb. of mercury, or 96 flasks.

Early in 1938 a Herreschoff furnace, Cottrell dust-precipitation and condenser plant, having a capacity of 25 tons per day, were installed. A small power shovel was installed in the Devil's Kitchen

area and most of the ore at present (May, 1938) comes from there. A recovery of 8 lb. to 10 lb. of quicksilver per ton is reported.

Nine men are employed.

Bibl.: State Mineralogist's Report XXVI, pp. 58-63.

TUNGSTEN

Tungsten ores occur in Inyo County as scheelite (calcium tungstate) in the Tungsten Hills west of Bishop, Round Valley, in the low foothills 3 miles south of Bishop, Deep Springs Valley, Ubehebe District, and in the Pine Creek area of the Sierra Nevada.

In the past, commercial production has been confined to those deposits on the west side of Owens Valley. These occur in the Sierra Nevada and its foothills. They have been found in an area which is some 20 miles long and constitutes one of the few known localities of the world where scheelite occurs in commercial quantities in contact-metamorphic deposits. The orebodies are found in limestone at its contact with the granitic rocks which form the core of the main mountain range. The bodies of limestone are remnants of the original deposition and are now found largely as roof pendants, projecting into the granitic rocks to varying depths.

The deposits were discovered in 1913 [1] but were not developed until the spring of 1916. They were operated until 1920 and shut down on account of low prices. In 1924 the Tungsten Products Company started operations in Pine Creek, which continued until 1929. Recent increase in the price of tungsten has so stimulated interest that there were in April, 1938, four mills operating in the county, with a combined capacity of approximately 450 tons per day.

Adamson Tungsten Deposit, comprising 8 claims, is in the Pine Creek District, on Morgan Creek. It adjoins the Pine Creek Mine on the north and is approximately 21 miles (air line) west of Bishop; elevation about 11,000 ft.; owner, D. B. Adamson, Bishop, California; under lease to W. B. Lenhart and Charles F. Johnston, Bishop, Calif.

It is reported that a vein carrying one per cent scheelite has been traced by means of trenches for a distance of 2500 ft.. Its width varies from 4 ft. to 30 ft. Fifteen hundred feet east of this vein there are two parallel outcrops, approximately 20 ft. in width, reported to carry 2% WO_3. Another outcrop 25 ft. in width, for a length of 225 ft., reportedly carries one to 1½% WO_3.

It is understood that the lessees are now preparing to develop the property.

Bishop Tungsten Company: A. T. Wilkerson and Ralph H. Moore, of Bishop, have under lease and option 28 acres of patented land and 4 mining claims in the low granite foothills, 4 miles south of Bishop on the west side of Owens Valley; elevation, about 4500 ft.; owner, Joseph Rossi, Bishop, California.

Scheelite occurs in limestone along its contact with the granitic country rock; the strike is NE.-SW. The mineral-bearing zone has been exposed, in places, across a width of 20 ft. or more. The associ-

[1] U. S. G. S. Bulletin 640-L, p. 249.

ate minerals are garnet and magnetite, with subordinate amounts of epidote and quartz.

Development consists of a 60-ft. tunnel and a series of open cuts. The ore from above the portal of the tunnel has been removed and sent to the mill. This open cut is about 12 ft. wide, 30 ft. long and 20 ft. high. It is reported that approximately 20 lb. of scheelite is recovered per ton of ore treated.

The mill, which is 3 miles southeast of the mine and $\frac{1}{2}$ mile west of the highway, consists of the following: 40-ton coarse-ore bin, 8 by 8

PHOTO. 15. 50-ton Mill—Rossi Tungsten Mine, Bishop Tungsten Company, Bishop, Inyo County.

jaw crusher, elevator to 50-ton fine-ore bin, to 12-mesh vibrating screen, oversize to 3 by 3 low-discharge ball mill, product and screenings to 2 Overstrom tables, in series; concentrates to an electric dryer and a Stolle electrostatic separator. A 70% to 72% concentrate is made. At the time of visit (Nov., 1937), the plant had been running only a few days, so that the percentage of extraction had not been definitely determined. Capacity is about 30 tons daily. Seven men are employed.

Crawford deposit, consisting of 4 claims, is on Mount Tom, 2 miles south of Big Pine Creek; elevation, 10,000 ft.; owner, Cord Crawford, Bishop, California.

It is reported that this deposit, which is undeveloped, carries from 2% to 5% WO_3 across considerable widths.

Idle.

El Diablo Mining Company: H. O. Johanson, secretary, Bishop, has subleased 8 claims at Tungsten City from the Tungsten City Milling Company. The property is 8 miles west of Bishop in the Tungsten Hills and was formerly known as the *Aeroplane Group;* elevation, about 5500 ft.; owner, J. V. Baldwin, Los Angeles.

The orebody occurs in limestone at its contact with the inclosing quartz-diorite. This limestone pendant trends N.-S. and stands practically vertical. The ore is scheelite occurring in a gangue consisting of garnet and epidote, principally, with subordinate amounts of quartz. The ore occurs as lenticular masses from 50 ft. to 80 ft. long and 10 ft. to 20 ft. wide.

Development consists of a cross-cut tunnel driven west about 700 ft. with several hundred feet of drifts in the ore-bearing zone. Considerable stoping has been done above these drifts, and raises from the tops of these stopes connect with the bottom of a large glory hole which is some 150 ft. above the cross cut. The glory hole is approximately 200 ft. long by 200 ft. wide by 200 ft. high (at the highest point). The present operators are raising on good ore out of the top of one of these stopes. They have milled considerable low-grade material out of the old chutes.

The mill, which is located near the Bishop Creek road, some 3 miles west of Bishop, consists of the following: 50-ton bin, 9 by 14 jaw crusher, elevator, 18 in. Symons disc crusher, 18 in. by 36 in. rolls, 12-mesh vibrating screen, oversize elevator return to rolls, screenings to 2 Overstrom tables. A 30% concentrate from the tables is cleaned to 70%-72% by a Stolle electrostatic separator. Capacity is about 40 tons per day. Six men are employed.

Bibl.: (*Standard Tungsten Mine*) State Mineralogist's Reports XV, pp. 129-130; XVII, p. 303; XXII, p. 512; (*Aeroplane Group*) U. S. G. S. Bull. 640L, pp. 243-245.

Emergency Group of 8 claims is on the ridge east of Beer Creek at its mouth, in Deep Springs Valley, 22 miles northeast of Big Pine and 6 miles west of Deep Springs School; owners, Harry Brown and Frank Bedell, of Big Pine, California.

In the limestone at its contact with the granite, scheelite occurs in a lode which strikes N.-S. and dips 70° W. The width of the mineralized belt is 50 ft. It is traceable for a length of 4500 ft. It is reported that the ore runs 0.5 to 1% WO_3.

Idle.

Feldman Tungsten Mine. It comprises 5 claims located in T. 23 S., R. 38 E., M. D. M., in south end of the Coso Range, 2 miles east of Little Lake; elevation 3500 to 4000 ft.; owner, Frank Feldman, Independence, California; under lease and bond to E. E. Brown, Los Angeles, California.

This deposit of scheelite in a quartz vein was discovered in January, 1937, by Frank Feldman, and some high-grade ore sorted out reported to carry 60% WO_3.

A vein of quartz 2 ft. to 4 ft. wide occurs in granite, and can be traced along its outcrop for a distance of 2800 ft.

The quartz is mineralized with scheelite crystals which are white to orange in color. The vein quartz is reported to carry from 1% to 5% WO_3.

Development consists of a tunnel driven on the vein a distance of 200 ft. At the portal of the tunnel a shaft has been sunk on the vein to depth of 30 feet.

Idle.

Pine Creek Tungsten Mine, comprising 12 claims, is situated on Morgan Creek, which is tributary to Pine Creek from the north, about

PHOTO. 16. Pine Creek Tungsten Mine, Pine Creek, Bishop, California. Photo by John M. Hague.

20 miles (air line) west of Bishop; elevation, 10,500 to 11,000 ft.; owner, *United States Vanadium Corp.,* R. J. Hoffman, president, 30 East 42d St., New York; Clarence H. Hall, superintendent, Bishop, Calif. This property was located in 1918 after which two or three attempts were made to operate it, the most serious effort having been made by the *Tungsten Products Co.*

The deposit is a product of contact metamorphism. It occurs between a dolomitic footwall and a granitic hanging wall. Its strike is north-south; the width varies from 15 ft. to 50 ft. The mineralization consists of scheelite, molybdenite, chalcopyrite, with a little silver and gold, in a garnetiferous gangue. In general, the higher-grade scheelite ores occur near the footwall, while molybdenite values are greater in the vicinity of the hanging wall. The ore is reputed to carry $1\frac{1}{2}$% WO_3, 1% MoS_2, 1% Cu, about $\frac{1}{2}$ oz. silver and .01 oz. gold. Two orebodies, with a 200-ft. barren zone between, have an aggregate length

of 1000 ft. Practically all of the ore so far developed lies to the north of the crosscut.

Development consists of crosscut tunnel driven N. 30° E. 2500 ft. At 1700 ft. a raise connects with upper tunnel and glory hole, a distance of 375 ft. Upper tunnel is 325 ft. above main tunnel and is 500 ft. in length. A sub-level has been developed below the upper tunnel through a winze 80 ft. deep. At the end of the lower crosscut, drifts have been driven south 300 ft. and north 5800 ft. A series of raises has been put up from this drift 145 ft. They will be connected to form a sub-level 100 ft. below the winze sub-level. A shrinkage stope 300 ft. long, about 15 ft. to 20 ft. wide and 145 ft. high has been completed. There is now remaining in this stope 18,000 tons of broken ore.

The ore is trammed to the head of the mill in 6 to 8 one-ton car trains by storage battery locomotives. From grizzly to 12 by 20 jaw crusher, to belt over which is suspended a Stearns magnet to remove tramp iron, to 3-ft. Symons crusher, to 33° inclined conveyor to 230-ton crushed-ore bin. From this point on, the mill is under construction. It is a combination of flotation and concentration and the following machines will be used: Symons shaking screen, two 5-ft. ball mills, Jeffrey screen, Richards 3-spigot pulsating classifier, twin-unit Denver flotation cells and 4 Denver Sub-A cells and 14 concentrating tables, 8 of which are now installed and working.

The tables make a 50% scheelite concentrate which goes through a drying screw-conveyor to a Dings magnetic separator, to sacks. The molybdenite concentrates from flotation cells go to a 10-ft. Dorr thickener, to a 4-ft., 2-disc filter, through a drying screw conveyor to sacks; copper concentrates, carrying the gold and silver, from flotation cells to cone thickener, to filter.

The plant, now running 50 tons per day, when completed will have a capacity of 300 tons per day.

The surface plant at the mine consists of modern blacksmith shop, machine shop, compressor plant and assay office. All equipment in both mill and surface plant is operated by motors, electric power being supplied by Southern Sierras Power Co. Comfortable bunk houses and cottages can accommodate more than 100 men. The mine surface plant, mine and crushing plant at top of mill are all connected by completely enclosed snow sheds.

At present 60 men are employed, 10 underground, the other 50 on mill construction and the building of a road up Pine Creek from Brown's Camp.

Bibl.: State Mineralogist's Report XVII, pp. 301-302; XXII, pp. 511-512.

Round Valley Tungsten Mine, comprising 8 claims, 11 miles northwest of Bishop on the north slope of the Tungsten Hills on edge of Round Valley, has been leased to the *Pacific Tungsten Corp.,* 5514 Wilshire Blvd., Los Angeles; elevation, 5350 ft.; owner Al Stevens, Bishop, Calif.

Six men are employed on rehabilitation work.

(Later): Lessee has driven crosscut 250 ft. E. to granodiorite-limestone contact. This contact, in places, up to 6 ft., in width, carries scheelite, disseminated in a gangue of garnet and epidote, with little

or no quartz. The following mill was erected: 10 in. by 20 in. jaw crusher, 14 in. by 30 in. rolls, elevator to 12 mesh screen, oversize to 4-ft. by 4-ft. ball mill, 2 Overstrom tables, rotary dryer, Stolle electrostatic separator. Operated a very short time and shut down, supposedly, account of ore shortage.

Bibl.: State Mineralogist's Reports XVII, pp. 302-303; XXII, p. 512; U. S. G. S. Bull. 640-L, p. 247.

Shannon Creek Tungsten Deposit (Buckshot) is on Shannon Creek, about 4 miles north of Big Pine and between four and five miles west of the Owens Valley highway; elevation about 5700 ft.

The deposit, having a northwest-southeast trend, occurs at the contact of granite and limestone. The scheelite is disseminated through a garnetiferous gangue, varying in width from 7 ft. to more than 15 ft.

Idle.

Tungsten City Milling Co., Raymond Stolle, P. O. Box 641, Bishop, Calif., has leased the Tungsten City property from J. V. Baldwin, of Los Angeles. This property has been variously known as the *Aeroplane Group* and the *Standard Tungsten Mine.* The lessees have to date confined their operations to the treatment of tailings from the old mill.

The following described mill was built and put into operation in January, 1937. It has been operating continuously on the tailings and had successfully treated about 20,000 tons by the middle of September, 1937. A caterpillar tractor with a $1\frac{1}{4}$-yd. scraper delivers material to the foot of an inclined grizzly, drag-line to 40-ton bin, elevator to 12-mesh screen, oversize saved to grind later, under size to Stolle electrostatic separator, tailings are stacked by a belt conveyor. All machines are connected to a dust-collecting system. A satisfactory recovery is made and it is reported that they market a 72% WO_3 concentrate. The entire treatment is dry. Capacity is 120 tons per day. Eight men are employed.

Waucoba Tungsten Deposit. It comprises 7 claims situated on the east slope of the Inyo Range, in T. 11 S., R. 37 E., M. D. M., 22 miles southeast of Big Pine, and 3 miles southwest of Waucoba Springs. The distance from Big Pine over the Waucoba-Saline Valley road is 40 miles; owners, Stuart Bedell and Clyde McBride, of Big Pine.

Scheelite occurs in a belt of limestone some 100 feet in thickness between beds of quartzite. The general strike is N. 30° W., with a dip of 50° to 60° N.E.

On contact of quartzite and limestone, a shaft has been sunk on an inclination of 60° to depth of 40 ft., developing 4 ft. of ore, reported to carry 2% WO_3. Southeast of these workings is a massive outcrop of quartz, on which a shaft has been sunk to a depth of 30 ft.

The vein quartz is mineralized with copper silicates, and copper carbonates, and said to carry $2.00 in gold. The property was located some 50 years ago as a copper mine.

About $1\frac{1}{2}$ miles north of the property two claims have been located along a garnetiferous outcrop, which is about 6 ft. in thickness and can be traced for distance of 200 ft. Scheelite occurs associated with fluorite. Developed by a series of open cuts. Two men are employed on development.

METAL MINING CLAIMS, INYO COUNTY

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Adamson		6 S.	30 E.	D. B. Adamson, Bishop	160	Herein
Advance Army		8 S.	31 E.	John H. Armington, Bishop	360	
Ajax Group (Carbonate)		24 N.	1 E.	New Southerland Divide Mining Co., Trona	100	R. XV, pp. 89-90
Alabama Mine	15, 22	21 S.	45 E.	Alabama Silver Mining Co., 8266½ W. Norton, Hollywood	16.84	Herein
Alabama-Mohawk Mine		15 S.	35 E.	Frank Hilton, et al., Lone Pine	100	
Alice Mine	4, 9	21 S.	45 E.	Alice Silver Mining Co.	20.63	
Alvah Mine		16 S.	38 E.	Eleuterio Diaz, Keeler	20.65	
American Mine		20 N.	5 E.	J. W. Stocker, Death Valley Junction	100	R. XV, p. 71; XXII, p. 476; herein
American Mine		22 S.	45 E.	F. N. Banta	20	
American Eagle Group		19 S. 20 S.	41 E.	W. R. Wallace, Darwin	380	See Wonder Mine
American Group	31	24 S.	44 E.	Slate Range Minerals Mining Co.	70.002	
Anaconda Mine	4	21 S.	45 E.	Death Valley Mining Co., Trona	20.67	
Anderson Placers (see Marble Canyon Placers)		10 S.	37 E.	H. W. Anderson, et al., Big Pine	800	
Anthony Mine (Gold Bug)		22 S.	44 E.	Mrs. Ada Norris, Trona	100	R. XXVIII, pp. 368-369
Antinomium Group		21 S.	46 E.	Geo. Montgomery, et al., 1009 Great Republic Life Bldg., Los Angeles	42.33	
Apex Cons. Group	9, 10, 15, 16	20 N.	8 E.	Tecopa Cons. Mining Co., Tecopa	75.93	
Arctic Group		13 S.	33 E.	Arctic Gold & Silver Mining Co., Independence	4.12	
Argenta Group		18 S.	45 E.	Ed. L. Wright, Trona	360	
Argus Group		20 S.	42 E.	A. H. Leonard, Trona	120	
Argus Group		23 S.	41 E.	Paul Schultz, Darwin	240	
Argus Mines		19 S.	41 E.	L. T. Lynn, Darwin	60	
Argus-Sterling Mine		20 S.	41 E.	A. C. Taylor Estate, Darwin	20	R. XVII, p. 283; XXII, pp. 476-477; herein
Aries Cons. Group		16 S.	38 E.	Newton Development Co.	47.65	
Armagh Mine		16 S.	38 E.	Geo. Jackson, Keeler	20.64	
Armistice Mine		20 N.	3 E.	Carl D. Engle, Shoshone	40	
Arondo Mine		23 S.	43 E.	Alice H. McIntosh, Judge Ross Avery, Trona	580	R. XVII, p. 281; XXII, p. 472
Ashford Mine (Golden Treasure)				H. J. and L. R. Ashford, Shoshone	520	R. XV, pp. 78-79; XXII, p. 469; herein
Astor Mint Group		20 S.	44 E.	Dan E. Lane, et al., Trona	240	
Auguste Mine		16 S.	38 E.	C. H. Crohn, Keeler	20.661	
August Group		22 S.	38 E.	F. J. Sanders, et al., Santa Barbara	2880	
Badgette-Lafayette		16 S.	38 E.	Marie Badgette, Keeler		
Ballarat Mining Co.		21 S.	45 E.	R. H. Thompson, et al., Trona	620	R. XXVIII, p. 376
Baushey Mine		16 S.	38 E.	Baushey Silver Quartz Mining Co.	6.91	
Baxter Mine		23 N.	7 E.	J. P. Madison, Shoshone	20	R. XV, p. 88; XVII, p. 283; XXII, p. 477; herein
Bedell Group		10 S.	37 E.	David T. Bedell, Big Pine	320	Herein
Bedell Mine (Daisy Mine)		10 S.	37 E.	David T. Bedell, Big Pine	160	R. XV, p. 94; XVII, p. 285; XXII, p. 483
Belmont Mine		16 S.	39 E.	W. L. Hunter Estate, Keeler	20	R. XVII, p. 283; XXII, p. 477; herein

Bernon Mine	14	19 S.	40 E.	Patrick Reddy	19.95	
Big Bell Cons. Group	29, 12	30 N.	1 E.	819 Parkview Ave., Los Angeles	42.32	
		15 S.	46 E.			
Big Dike Group		13 S.	33 E.	Albert Blunt, et al., Independence	100	
Big Horn Mine		14 S.	37 E.	Sam Spear and M. A. Wilson, Lone Pine	165	R. XXII, 465-466; herein
Big John Group		12 S.	36 E.	Fred F. Hughes, Independence	160	
Big Silver Mine (Essex)		13 S.	38 E.	Big Silver Mining Co., Los Angeles	120	R. XXII, pp. 477-478; herein
Big Sister Group	11, 12, 13	7 S.	31 E.	Tungsten Mines Co.	41.284	R. XV, p. 133; XVII, pp. 304-305; XXII, p. 512; U. S. G. S. Bull. 640b
Big "T" Group		21 S.	40 E.	Russell Lange, et al., Darwin	80	
Big Wedge				See Union Mines		
Birthday Group		23 S.	41 E.	Peter E. Erickson, Darwin	80	
Bishop Silver Cobalt Mines	14	9 S.	31 E.	Jack O'Brien, et al., Bishop	120	Herein
Bishop Tungsten Co.		7 S.	32 E.	Joseph Rossi, Bishop	108	Herein
Black Canyon Group	34	7 S.	34 E.	Black Canyon Gold Mining Co.	58.151	See Mineral Point Mine, XXII, p. 489-490
Black Cat Group	12, 13	7 S.	31 E.	Tungsten Mines Co.	208.799	R. XV, p. 133; XVII, pp. 304-305; XXII, p. 512
Black Eagle Gold Mine		13 S.	36 E.	A. T. Smith, San Clemente	45	R. XV, p. 75; XVII, p. 279; XXII, p. 466; herein; U. S. G. S. Bull. 540, p. 116
Black Mountain Group		23 N.	3 E.	James Edwards, et al., Shoshone	60	
Black Prince Mine		19 N.	8 E.	Tecopa Cons. Mining Co., Tecopa	20	
Black Rock Group		20 N.	8 E.	Unknown	120	R. XXII, pp. 478-479
Blue Belle		20 S.	42 E.	Estate of J. C. Cress	40	
Blue Bell Group		17 S.	45 E.	Ed. Attaway, et al., Trona	160	
Blue Dick Mine		20 N.	8 E.	Henry Lang, Tecopa	80	R. XV, p. 89; XVII, p. 283; XXII, p. 479; herein
Blue Eagle Group		13 S.	36 E.	Oscar Fausel, Independence	80	Herein
Blue Eagle Mines		20 S.	42 E.	J. H. Townsend, et al., Darwin	120	
Blue Eagle Mine		21 S.	39 E.	C. W. Woodson, et al., Los Angeles	60	
Blue Jacket Group	19, 20	24 N.	3 E.	Furnace Valley Copper Mining Co.	34.89	
Blue Moon Group		23 S.	41 E.	Wm. T. Lange, Darwin	160	
Blue Rock Mine		21 S.	40 E.	Walter Palmer, et al., Darwin	80	Herein
Bluff Group		16 S.	38 E. 39 E.	Cerro Gordo Mines Co.	102.375	
Boomerang Mine		13 S.	33 E.	Boomerang Gold Mining Co.	3.43	
Bonanza Group		20 S.	40 E.	L. A. Lee, Darwin	140	Herein
Bonanza Mine		21 S.	40 E.	Western Cons. Gold Mines, Ltd.	820	
Brick Mine	20	24 N.	3 E.	Furnace Creek Copper Mining Co.	1.41	
Brown Bear Group		14 S.	37 E.	J. Emil Smed, Lone Pine	60	
Brown Monster Mine	3	14 S.	36 E.	A. W. Eibeshutz	17.22	
Brown Monster Reward (Reward Brown Monster)		14 S.	36 E.	Guy Eddie, et al., 543 Rives-Strong Bldg.	130	R. VIII, p. 263; XII, p. 136; XIII, p. 180; XV, p. 83; XXII, p. 473; herein; Register of Mines, Inyo Co., 1902; Rept. of Director of the U. S. Mint, 1883, p. 160; U. S. G. S. Bull. 540, pp. 116-118; U. S. G. S. Professional Paper 110, pp. 121-122
Bull Domingo		6 S.	35 E.	P. N. Johnson, 302 E. Anaheim Blvd., Long Beach	120	Herein
Bunker Hill		6 S.	35 E.	Bunker Hill Mining Co., 689 E St., San Bernardino	240	R. XVII, p. 283; XXII, p. 479; herein
Burro, New Discovery and Gem Mines		22 S.	44 E.	R. D. Warneck (deceased), Trona	100	R. XV, pp. 81-82; XVII, pp. 470-471; XXVIII, 364-368; herein
Burro Mine		20 S.	44 E.	D. D. Corum, Trona	20	
Burros Mines		13 S.	37 E.	C. D. Carll, Independence	60	
Buster Brown		22 S.	45 E.	L. E. Cain, et al., San Pedro	60	

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Buster Group		24 S.	42 E.	Chas. E. Saltman, et al., Trona	40	
California Queen No. 4		24 S.	44 E.	California Queen Mining Co., Trona	120	XXII, p. 479; herein
California Smelting & Refining Co.		19 S.	41 E.	California Smelting & Refining Co.		Herein
Campbird Group of Mines		21 S.	45 E.	J. V. Leigh, 307 Union League Bldg., Los Angeles	200	R. XXII, pp. 479-480
Canyon No. 2 Mine	31, 32, 6	30 N. / 29 N.	1 E.	Keane Wonder Mining Co.	27.98	
Carbonate Mine (Queen of Sheba)				New Southerland Divide Mining Co., 156 Montgomery St., San Francisco	140	R. XV, pp. 89-90; XXII, p. 480; herein
Cardinal Gold Mining Co. (Wilshire-Bishop Creek)		8 S.	31 E.	Cardinal Gold Mining Co., Bishop	680	R. XV, p. 85; XVII, pp. 281-292; XXII, p. 474; herein
Carriboo Mine	3	21 S.	45 E.	Carriboo Silver Mining Co.	20.63	
Casey Mine		15 S.	38 E.	Thomas Casey, Lone Pine	20	
Cashier (Harrisburg Mine)		18 S.	45 E.	J. P. Augerebery, Trona	140	XV, p. 76; XXII, p. 467; herein
Cecil "R" Mine		23 S.	43 E.	M. J. Sherlock, Trona	20	R. XXVIII, p. 366; herein
Cerro Gordo Mine		16 S.	38 E.	Cerro Gordo Mines Co., San Jose	550	R. VIII, p. 250; X, p. 213; XV, pp. 90-92; XX, pp. 185-187; XXII, pp. 280-482; herein; U. S. G. S. Bull. 540, pp. 97-109; Professional Paper 110, pp. 106-116
Cerro Gordo Extension Mine (Royal)		16 S.	39 E.	Mrs. R. C. Spear, Lone Pine	140	R. XV, p. 106; XVII, p. 294; XXII, pp. 497-498; herein
Cerrusite		16 S.	41 E.	W. A. Reid, Keeler	120	Herein
Challenge	10	21 S.	45 E.	Challenge Silver Mining Co., 811 W. 7th St., Los Angeles	11.66	
Champion Group		20 N.	4 E.	Orin F. Blabon, Death Valley	240	
Champion		20 N.	4 E.	S. M. Barbour, et al, Tecopa	180	R. XXII, p. 468
Champion Mines		20 N.	4 E.	Ben Hartzinger, et al., Tecopa	240	
Chesamac		20 S.	45 E.	Donald McDonald, Los Angeles	120	R. XXII, p. 482
Chloride-Bromide Group		16 S.	39 E.	Ellen Maysen, et al., Darwin	180	
Chloride Cliff Mine		30 N.	1 E.	W. R. McCrea, et al., Beatty, Nevada	640	R. XV, pp. 76-77; XXII, p. 467; U. S. G. S. Bull. 285, pp. 72-73
Christmas Gift Mine		19 S.	40 E.	W. L. Skinner, et al., Darwin	100	R. VIII, p. 226; X, p. 211; XVII, p. 284-285; XXII, p. 482; U. S. G. S. Bull. 580A, pp. 10-12
Cinnamon Mine		14 S.	38 E.	F. M. Hess, et al., Lone Pine	20	R. XVII, p. 279; XXII, p. 467
Cleveland		10 S.	34 E.	Mary Dunlap Mears, Big Pine	320	R. XVII, p. 279-280; XXII, p. 467
Cliff		6 S.	36 E.		120	R. XV, p. 93; XXII, p. 470
Colorado Group		26 N.	1 E.	Carroll D. Willis, Death Valley	140	
Colorado Group		18 S.	41 E.	A. G. Miller, Darwin	120	
Columbia Mine	31	19 S.	41 E.	Wagner Assets Realization Corp., Darwin	20.661	R. XV, p. 93; XVII, p. 285; XXII, p. 482; U. S. G. S. Bull. 580, pp. 17-18
Comet No. 1 and No. 2 Mines	13	20 N.	5 E.	John F. Imel, 503 Sun Fidelity Bldg., Los Angeles	41.008	
Commetti Mine		10 S.	34 E.	Cometti Mines Co., Leased to Ellis Rowe, Pasadena	215	R. XVII, p. 280; XXII, p. 468
Comstock Mine	4	21 S.	45 E	Comstock Silver Mining Co.	20.61	
Contact Mines		15 S.	41 E.	Roy Albin, Darwin	80	
Continental Group		20 S.	39 E.	Pioneer Mfg. Co., Darwin	160	

Copper Bar Group	10, 15	23 N.	3 E.	Butte & Greenwater Copper Co.	75.30	
Copper Bell Group		14 S.	40 E.	Geo. F. Crook, Big Pine	80	
Copper Bell Group	20, 21, 29	24 N.	3 E.	Furnace Creek Extension Copper Co.	387.04	
Copper Glance Group	27	24 N.	3 E.	Greenwater-Death Valley Copper Co.	304.163	
Copper Queen Group	12, 7	6 S.	36 E. 37 E.	James Jacoby, et al., Big Pine	91.49	
Copper Queen Group No. 2	31	24 S.	44 E.	T. A. Wells, et al.	17.385	
Copper World Group	10, 11, 14, 15	7 S.	39 E.	Ulida Cons. Copper Co.	152.295	
Cosmopolitan Group		20 S.	39 E. 40 E.	Paul Wilbur, Darwin	340	
Coso Divide Group		21 S.	39 E.	Wm. S. Lewis, Darwin	340	
Coso Iron Deposit		19 S.	38 E.	G. W. Dow, Lone Pine	440	R. XV, p. 87; XXII, p. 475
Coso Molybdenite		20 S.	38 E.	H. A. Clark, et al., Darwin	240	
Coso Pass Group		20 S. 40 E.	39 E.	E. H. Rushton, Darwin	180	
Coso Quicksilver Deposit		22 S.	38 E.	F. J. Sanders, 1434 Garden St., Santa Barbara	1000	R. XXVI, pp. 58-63
Coso View Mine		21 S.	40 E.	M. O. and L. E. Early, Lancaster	20	
Crater		10 S.	37 E.	F. B. Crater, Big Pine	160	
Crawford Tungsten Deposit		7 S.	30 E.	Cord Crawford, Bishop	80	
Curran Group		21 S.	45 E.	Ballarat Mining Corp., et al., Trona	520	R. XXVIII, pp. 366, 368
Custer Group		12 S.	36 E.	J. C. Baxter, Independence	300	
Custer		19 S.	40 E.	Frank Long, et al., Pasadena	-------	R. XV, p. 94; XVII, p. 285; XXII, pp. 482, 483; U. S. G. S. Bull. 580; pp. 15, 16
Darwin-Keystone	24, 25, 19, 30	19 S.	40 E. 41 E.	A. A. Rubel, Darwin	500	
Davenport Group		23 S.	45 E.	Nellie E. Bliss, Leased to Geo. Wyman & M. W. Sweetzer, Trona	120	
David Group		10 S.	37 E.	Mrs. J. E. Davis, Big Pine	20	
Davis Mine		10 S.	37 E.	Chas. Davis, Big Pine	20	
Death Valley-Wonder Mine		17 S.	44 E.	Geo. E. Cook, et al., Trona	200	
Defiance		19 S.	40 E.	J. S. Taber	19.51	
Defiance-Independence-Thompson	1, 2, 11, 12, 13, 14, 23, 25, 26, and 30	19 S.	40 E. 41 E.	Wagner Assets Realization Corp., Darwin	2349.121	R. VIII, p. 226; X, p. 211; XII, p. 24; XVII, p. 285; XXII, p. 483. Report of the Director of the Mint, Precious Metals in U. S., 1883-1884. U. S. G. S. Bull. 580, pp. 13-14
Delaware Mine	15	21 S.	45 E.	Delaware Silver Mining Co.	20.63	
Del Norte Group		17 S.	44 E.	J. P. McCafferty, et al., Los Angeles. Leased to Panamint Mining & Milling Co., Roy C. Troeger, Los Angeles	120	
Dennis Jr., Mine	5	13 S.	36 E.	H. B. Whiteside	15.376	
De Sota Group		20 S.	38 E.	See Coso Molybdenite	120	
Doctor Mine	26	24 N.	3 E.	United Greenwater Copper Mining Co.	6.69	
Dolomite Mine	4	16 S.	37 E.	Emil Fernandez	18.08	
Don Juan Mine	4, 9	21 S.	45 E.	Panamint Cons. Mining Co.	20.661	
Driver Mine	13, 14	19 S.	40 E.	Patrick Reddy	14.45	
Echo Guilt Edge Group	1	27 N.	2 E.	The Echo Gilt Edge Mining Co.	87.050	
Eclipse Mine	34	19 S.	42 E.	Lone Star & Eclipse Gold Mining Company	20.04	
Eclipse Mine	34, 3	13 S. 14 S.	36 E.	Isaac Friedlander	36.83	

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Eclipse No. 1 and No. 2 Mines	13, 18	20 N.	5 E. 6 E.	John F. Imel, Shoshone	41.322	
El Diablo Mining Co. (Standard)		7 S.	31 E.	El Diablo Mining Co., Bishop	160	Herein. R. XV, pp. 129-130; XVII, p. 303, XXII, p. 512. U. S. G. S. Bull. 640, pp. 243-245
Ella Group of Mines		17 S.	39 E.	Wm. Betts, 331 W. 31st St., Los Angeles	160	R. XXII, p. 483; herein
Emergency Group Mines		6 S.	36 E.	Harry Brown, et al., Big Pine	160	Herein
Emigrant Group	2, 3	29 N.	1 E.	Vermont Rose Mining Co.	109.352	
Emigrant Springs Mine (Saddle Rock)		18 S.	45 E.	Emigrant Springs Mining Co., Stove Pipe Wells	80	Herein
Ernestena Group		11 S.	35 E.	Ralph Hazlett, et al., Big Pine	280	
Essex Group				See Big Silver Mine		
Esta Bien Mine	20	24 N.	3 E.	Butte Furnace Range Copper Co.	73.541	
Estella Fraction Mine	27	24 N.	3 E.	Greenwater Death Valley Copper Co.	20.661	
Estelle and Morning Star Mine		16 S.	38 E.	Estelle Mining Corp., Keeler	1400	R. XV, pp. 108-109; XVII, p. 286; XX, pp. 187, 189; XXII, pp. 483, 484; herein; U. S. G. S. Bull. 540, p. 110; U. S. G. S. Professional Paper 110, pp. 116, 117
Eureka Mine	10, 15	21 S.	45 E.	Geo. M. Pinney, et al.	21.02	
Eureka No. 2 Mine	13	19 S.	40 E.	Inyoreka Gold Mining Co.	20.27	
Eureka Group	31, 32	11 S.	35 E.	R. C. Chambers	54.061	
Fairbanks Mine		19 S.	40 E.	Alex Ruona, Darwin	160	
Fearless Mine	12	6 S.	33 E.	W. J. Monahan, Bishop	80	
Feldman Tungsten Mine		23 S.	38 E.	Frank Feldman, Independence	100	
Fernando Group of Mines	24	19 S.	40 E.	Theo. Peterson, Darwin	140	R. XXII, pp. 484, 485
Flapjack Group	4, 5	28 N.	3 E.	D. J. Cushman	26.75	
Fortune Group		22 S.	45 E.	John H. Thorndyke, Trona	80	
Francis Group		13 S.	37 E.	Chester A. Wilson, Lone Pine	100	
Furnace Creek Group	16	24 N.	3 E.	Furnace Creek Copper Co.	93.35	
Georgia Queen		22 S.	45 E.	Harold Goodwin, Trona	80	
Gibralter Mine (Big Horn)		22 S.	45 E.	John Thorndyke, Trona	80	R. XV, p. 95; XXII, p. 485; XXVIII, p. 361; herein
Gold Basin Mine		23 S.	40 E.	J. H. Allen, et al., Darwin	140	Herein
Gold Bug				See Anthony Mine		
Gold Crown Copper Mine	35	24 N.	3 E.	Greenwater Death Valley Copper Co.	20.15	
Gold Group		22 S.	45 E.	H. H. Thompson	169.73	
Gold Hill Mine		21 N.	1 E.	Death Valley Mining Co., Trona	19.66	
Gold Hill Mine		22 S.	46 E.	Fred W. Grey, et al., 3503 McClintock Ave., Los Angeles	80	R. XXVIII, p. 369; herein
Gold Hill Group		16 S.	38 E.	W. P. Betts, Keeler	60	
Gold Ridge Group		18 S.	38 E.	Western Cons. Gold Mines, Ltd.	400	Herein
Gold Spur Mine		24 S.	45 E.	Unknown		R. XV, pp, 77, 78; XXII, p. 469; herein
Gold Standard Mine		14 S.	38 E.	Col. A. E. Montieth, et al., Keeler	600	Herein
Gold Star Group		9 S.	37 E.	W. E. McDonald, et al., Big Pine	80	
Gold Star Group		23 S.	43 E.	C. Ferge, Trona	40	
Golden West Group		23 S.	41 E.	E. C. Wasmuth, Trona	240	

Grand Mine	14	19 S.	40 E.	Wm. D. Brown, et al.	20.661	
Grand View Mine	4	21 S.	45 E.	Death Valley Mining Co., Trona	17.97	
Grand View Group		19 S.	40 E.	Alex Ruona, Darwin	220	
Great Group		7 S.	35 E.	C. B. Wilkerson, et al., Bishop	240	
Green Eyed Monster		13 S.	35 E.	Green Mountain Gold & Silver Mining Co., Independence	20.67	
Grubstake Group		20 S.	43 E.	J. E. Ratcliffe, Trona	120	
Gunsite Mine		20 N.	8 E.	Tecopa Consolidated Mining Co., 722 S. Oxford Ave., Los Angeles	20	R. XV, pp. 95, 96; XVII, pp. 286, 287; XXII, p. 485; XXIII, pp. 264, 266; herein. Report of the Director of the Mint, Precious Metals in the U. S., 1883, p. 166
Gunsite and Extension Mines		20 N.	8 E.	Los Angeles Mining & Smelting Co.	33.93	
Gypsy Queen Mine		12 S.	33 E.	Frank Thomas, Big Pine (last known owner)	200	Herein
Gold Tooth Mine		23 S.	44 E.	A. R. Greenslitt, et al., Trona	40	R. XXVIII, p. 369
Gold Tooth Extension		23 S.	45 E.	R. E. Baughman, et al., Trona	20	
Gold Wedge Mine		6 S.	35 E.	A. T. Wilkerson, Bishop	160	Herein
Golden Eagle Group		10 S.	34 E.	Fred A. Armstrong, Big Pine	60	
Golden Eagle Mine		14 S.	37 E.	John C. Anton, Lone Pine	20	R. XV, p. 78; XXII, p. 469; herein
Golden Gate Group		20 S.	40 E.	J. O. Nelson	111.111	
Golden Gate King		19 S.	41 E.	C. C. King, Darwin	200	
Golden Gate Syndicate, Tungsten Group		7 S.	32 E.	J. J. Dunlap, Bishop	240	
Golden Marvel Mines		8 S.	36 E.; 37 E.	Lucien Anderson, Big Pine	480	
Golden Rod (Marigold Mine)		20 S.	40 E.	L. W. Lee, Darwin	20	R. XV, p. 82; XXII, p. 471; herein
Golden Treasure				See Ashford Mine		
Golden Treasure Group		22 S.	47 E.	Louise B. Grantham, Shoshone	80	
Hallelujah No. 3 Placer		10 S.	37 E.	Dr. Vaugh, et al., San Pedro	160	
Harrisburg				See Cashier		
Harrison Mine	15, 22	21 S.	45 E.	Harrison Silver Mining Co.	20.6	
Hayseed Gold Mine	28	29 N.	3 E.	Hayseed Mining Co., Death Valley Junction	18.8	
Hemlock Silver Mine (Silver Peak)	11, 14, 15	21 S.	45 E.	Hemlock Silver Mining Co.	23.60	R. XXII, p. 500; XXVIII, p. 362
Hidden Treasure Con. Group	21, 28, 33	29 N.	3 E.	Lee Hidden Treasure Gold Mining Company	133.162	
Hidden Treasure Group	3, 4	14 S.	36 E.	Reward Gold Mines Co.	73.715	
Highland Chief Mine		13 S.	37 E.	Thomas Hancock, Lone Pine	40	
Hillside Group		23 S.	42 E.	Lee Taylor, Brown	60	
Hirsh Mine	3	14 S.	36 E.	Nathan Rhine, Independence	15.98	
Holy Roller		22 S.	44 E.	A. C. Porter, Trona	20	XV, p. 79; XXVIII, p. 370
Homestake Group		18 S.	40 E.	E. Lockhart, et al., Darwin	160	
Hoot Owl Iron Deposit		23 S.	43 E.	Lloyd Helm, Inyokern	20	
Hope Group		17 S.	44 E.	R. G. Nelson, et al., Trona	120	
Hornspoon Group		19 S.	45 E.	Chris. Wicht, Trona	45	R. XXVIII, p. 370
Hortense Group		21 S.	40 E.	Margaret Wilbur, Darwin	160	
Hudson Group				See Big Silver Mine		
Hudson River Mine	21, 22	21 S.	45 E.	Hudson River Mining Company	20.53	
Ibex Mine (Arcturas) (Lead-Silver-Zinc)		20 N.	5 E.	Standard Engineer's Mining Corporation of Nevada, Tecopa	240	R. XV, pp. 96, 97
Ida Mine	10, 11, 15	21 S.	45 E.	Geo. M. Pinney, et al.	24.37	
Ignacio (Formerly Ygnacio)		16 S.	38 E.	Cerro Gordo Mines Co., San Jose	3.66	R. W. Raymond, Mineral Resources West of Rocky Mts., 1870, p. 17; S. M. B. Reg. of Mines, Inyo County, 1902; XV, pp. 97, 98; XVII, p. 287; XXII, p. 485.

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Independence Group		13 S.	33 E.	Vera Oerding, et al., Independence	60	
Independence Mine	14	19 S.	40 E.	A. D. Meyers, Darwin	13.11	
Independence & Thompson Mine		28 N. 27 N.	3 E. 2, 3 E.	Inyo Cons. Mines, Inc.	440	R. VIII, p. 226;, X, p. 211; XV, p. 98; XVII, pp. 287, 288; XXII, pp. 486, 487. Reports of Director of Mint. Precious Metals in U. S., 1883, p. 164; 1884, p. 103; U. S. G. S. Bull. 580, pp. 14, 15
Iron Dike Group		11 S.	37 E	L. B. Pickett, et al., Big Pine	80	
Iron Gossan Group	34, 35 2	20 N. 19 N.	10 E.	Wm. H. Beck	106.131	
Iron Mask Group		21 S.	40 E.	Ralph L. Tuttle, et al., Darwin	160	
Iron Nugget Placer		10 S.	37 E.	F. B. Krater, et al., Big Pine	320	
Ironsides Group		15 S.	38 E.	G. F. Marsh, Lone Pine	160	
Ironsides Mine				See Burgess Mine		R. XVII, p. 280; XXII, p. 469
Iroquois Group		19 S.	39 E.	John Stewart, Darwin	60	
Jackass Silver Mine	13	19 S.	40 E.	Black Metal Mining Co., Los Angeles	17.13	R. XVII, p. 288; XXII, p. 487
Jessie Mae Silver Mine	4, 8	21 S.	45 E.	Panamint Cons. Mining Co.	25.49	
Jim Dandy		24 S.	45 E.	J. W. Montgomery, et al., Trona	20	
Josephine-Yucca Mines		20 S.	40 E.	Louis D. Owen, Darwin	120	R. XV, p. 85; XXII, p. 474; XII, p. 138; XIII, p. 181
Journigan's Group		14 S.	38 E.	Roy Journigan, Trona	100	
July Group		11 S.	43 E.	Chas. M. Pinney, Beatty, Nevada	40	
Jumbo Group		22 S.	43 E.	Fred A. Alley, et al., Trona	120	
Jumbo Group		7 S.	35 E.	R. W. Fordson, et al., Bishop	80	
Jumbo Mine		13 S.	36 E.	Clarence Johnson, Independence	120	R. XXII, pp. 469-470
Kane Group of Mines		23 S.		Belcher Extension Mining Co., Jersey City, N. J.	300	R. XXII, pp. 487, 488
Kate Consolidated Group		24 N.	3 E.	Patrick Clark	33.63	
Kate Group		24 N.	3 E.	Wm. J. Cleary	36.071	
Keane Wonder Mines	31, 32 6	30 N. 29 N.	1 E.	Coen Companies, Inc., 610 S. Broadway, Los Angeles	464.329	R. XV, pp. 79, 81; XXII, p. 470
Kearsarge Mine		13 S.	33 E.	Clifford T. Gates, Independence	120	R. XVII, p. 280; XXII, p. 470
Keeler Mines		17 S.	38 E.	Adolph Ramish, 972 4th Ave., Los Angeles	460	
Kempland Group	23, 18, 19	24 N.	2 E. 3 E.	Kempland Copper Company	284.30	
Kennedy Mine		21 S.	46 E.	Geo. Montgomery, et al., 1009 Great Republic Life Bldg., Los Angeles	20.661	
Keynote Mine		14 S.	37 E.	Golden Princess Mining Co., Lone Pine	140	R. XII, p. 138; XIII, p. 181; XV, p. 81; XXII, p. 470; Report of Director of U. S. Mint, 1883, p. 159. U. S. G. S. Bull. 540, p. 112; U. S. G. S. P. P., 110, p. 118
King Fissure Group		22 S.	45 E.	Frank H. Long, Trona	320	
Klad Group		20 S.	40 E.	C. Al. Draper, Darwin	280	
Krater Van Norman Group of Placers				F. B. Krater, et al., Big Pine	160	

Lane Mine		19 S.	41 E.	Wagner Assets Realization Corp., Darwin	20	
Last Chance Group	13, 18	19 S.	40 E. 41 E.	Wagner Assets Realization Corp., Darwin	60.371	R. XII, p. 24; XIII, p. 32; XV, pp. 98-99; XVII, p. 288; XXII, p. 488; U. S. G. S. Bull. 580
Last Hope Group		9 S.	37 E.	Geo. M. Kruze, et al., Big Pine	120	
Lead Hill Mine	17, 20	12 S.	37 E.	Sam G. Musser, Big Pine	20.661	
Lebanon Mine		20 S.	40 E.	F. E. Maxwell, Darwin	20	
Le Cyr Iron Deposit		18 S.	38 E.	J. R. Le Cyr, Los Angeles	120	R. XXII, p. 475
Lee Mine		16 S.	41 E.	W. A. Reid, et al., Keeler	120	R. XV, pp. 99-105; XVII, p. 289; XXII, p. 488. Report of Director of U. S. Mint, 1883; p. 163
Le Moigne Mine		16 S.	44 E.	W. R. McCrea, Reno, Nevada	240	R. XXII, p. 488
Lester Group		24 S.	45 E.	Edw. M. Lester, et al., Trona	240	
Llewella Mine		15 S.	35 E.	Y. C. Ruiz, Lone Pine	25	
Lewis Group of Placers		10 S.	37 E.	J. G. Lewis, Big Pine	640	
Liberty Group	30, 25	19 S.	40 E. 41 E.	Darwin Silver Lead Mining Co., Darwin	87.566	R. XXII, p. 482; U. S. G. S. Bull. 580, pp. 17-18
Lincoln Mine (Silver Dome)		6 S.	37 E.	A. T. Wilkerson, et at., Bishop	120	R. XVII, p. 289; XXII, pp. 488-489
Little Chief Silver Mine	10, 15	21 S.	45 E.	Little Chief Silver Mining Co.	25.30	
Little Mack Mine		20 S.	42 E.	Otto Seidentopf, Trona	15	
Lone Star Mine	3	20 S.	42 E.	Lone Star Eclipse Gold Mining Company	20.65	
Long John Mine	16, 21	15 S.	37 E.	Jas. A. Walker, 1201 N. Isabel St., Glendale	140	
Los Angeles Placer Group	23, 26	14 S.	38 E.	J. Hartley Taylor	160	
Lost Burro Mine		14 S.	41 E.	W. H. Blackmer, et al., Los Angeles	20	R. XV, pp. 81-82; XXII, pp. 470-471
Lost Burro Mine		14 S.	41 E.	A. McCormick, Darwin	80	
Louisiana Mine		22 S.	40 E.	Wortley Mining Co., Darwin	60	
Lucky Bill Mine		6 S.	30 E.	E. R. Elliott, et al., Bishop	60	
Lucky Boy Mine		13 S.	34 E.	Geo. V. Parker, Independence	160	
Lucky Boy Group		11 S.	37 E.	Saint Edwards, Big Pine	240	
Lucky Day Group		24 S.	44 E.	Harry C. Warton, Trona	100	
Lucky Jim Mine	1, 2, 11, 12	19 S.	40 E.	Wagner Assets Realization Corp., Darwin	329.372	R. VIII, p. 226; X, p. 211; XII, p. 24; XV, pp. 100-101; XVII, pp. 289-290; XXII, p. 489; Report of Director of U. S. Mint, 1883; p. 163; U. S. G. S. Bull. 580, pp. 12-18
Lucky Red Mine		21 S.	41 E.	Inez J. McDonald, Cold Springs	20	
Lucky Slim Group		14 S.	36 E.	Herman Tietz, Jr., Lone Pine	260	
Lucky Strike Group		14 S.	35 E.	R. A. Yannka, Lone Pine	180	
Luella Mine (Formerly Abe Lincoln)		14 S.	35 E.	J. G. McDonald, Ventura	80	
Mabel Mine (Noonday Group)		19 N.	8 E.	Tecopa Cons. Mining Co., Tecopa	25.661	R. XV, pp. 103-104; XVII, p. 293; XXII, pp. 491-492
MacLean Group		13 S.	37 E.	John MacLean, Independence	160	
Magpie Group		10 S.	37 E.	C. C. Cunningham, Los Angeles	100	
Mamie Mine		20 S.	40 E.	E. M. Lorenz, Coso	80	
Mammoth Group		23 S.	41 E.	M. V. Carr, Brown	400	
Marble Canyon Placers		10 S.	37 E.	Helah Anderson, David T. Bedell	960	
March Storm Group	33, 34, 10, 11	12 S. 13 S.	45 E.	Western Lead Mines Co.	329.63	R. XXII, pp. 509-510
Marigold Mines		20 S.	39 E.	W. N. Claus, et al., Darwin	80	R. XV, p. 82; XXII, p. 471
Marigold Mine				See Golden Rod		
Mariposa Mine		20 S.	40 E.	Mariposa Quartz Mining Co., c/o American Bank Bldg., San Francisco	25.661	
Marvel Mine	15	21 S.	45 E.	Marvel Silver Mining Co.	16.71	
Mary Dee		21 S.	40 E.	Geo. Duitz, Darwin	160	
Mature Group		23 S.	44 E.	Peter B. Mathiason	41.322	
Maxmaur-Marguerite Group		20 S.	40 E.	Oliver A. Thorson, Darwin	100	

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Mayflower Group		14 S.	38 E.	M. A. Willson, Lone Pine	80	
Mazourka Canyon Placer Mines		12 S.	35 E.	G. M. Booker, Los Angeles	40	R. XII, p. 139; XIII, p. 182
Mazourka Placer Mines		13 S.	36 E.	O. Brander, et al., Independence	120	
Merry Christmas				See St. George Mine		
Mexican Hat Mine		20 S.	40 E.	George Wolf, et al., Darwin	120	
Michigan Mine	2, 11	19 S.	40 E.	Thomas May, et al.	20.57	
Mineral Hill Group of Mines	29	8 S.	36 E.	R. W. Swank, et al., Big Pine	220	R. XXII, p. 489
Mineral Point Mine (Sanger)	13,14,23,24	7 S.	34 E.	Flynn Bros., et al., Bishop	140	R. XXII, pp. 489-490
Minnietta Mine		19 S.	42 E.	Mrs. Jack Gunn, Independence	105	R. X, p. 212; XV, p. 101; XVII, p. 290, XXII, p. 490; R. W. Raymond, Mineral Resources West of Rocky Mts. 1876
Modoc Mine		19 S.	42 E.	Hearst Estate, San Francisco	160	R. XII, p. 24; XIII, p. 32; XV, p. 101; Report of the Director of the U. S. Mint, 1883, p. 164; 1884, p. 104.
Moffatt Mine		8 S.	31 E.	J. W. Brown, et al., Bishop	140	
Mohawk Mine		24 S.	42 E.	J. C. Boyles, Trona	240	
Mojave View Group		21 S.	41 E.	Vina H. Haggerty, Darwin	160	
Molybdenite Group		20 S.	38 E.	See Coso Molybdenite		
Monarch Iron Group	28, 29	22 S.	43 E.	Geo. Johnson, Jr.	86.042	
Monster Mine (Blue Monster)		14 S.	38 E.	Dr. John MacLean, 2039 W. 68th St., Los Angeles	120	R. XV, p. 101; XXII, p. 490; U. S. G. S. Bull. 540, p. 111. U. S. G. S. Professional Paper 110, pp. 117-118
Monte Carlo Mines (Mount Whitney-Union Mines)		14 S.	36 E.	C. P. Eddie, Lone Pine	300	R. XV, p. 80; XXII, pp. 501-503
Montezuma Mine		10 S.	35 E.	Joseph Bros., Big Pine. Leased to L. W. Sockman, Big Pine	120	R. XIII, p. 32; XV, p. 102; XVII, p. 291; XXII, p. 491. Report of the Director of the Mint, 1883, p. 158; 1884, p. 100; U. S. G. S. Bull. 540, pp. 109-110; U. S. G. S. Professional Paper 110, p. 116
Mormon Mine		16 S.	39 E.	Cerro Gordo Mines Co.	11.885	
Morning Glory Group	17,18,19,20	24 N.	3 E.	Clark Copper Co.	79.89	
Mountain Boy Group		22 S.	45 E.	Haskell Mining Company	55.043	
Mountain Spring Group	18	23 S.	41 E.	Alfred Giraud, Darwin	20.661	
Mountain Springs Canyon Placers		23 S.	42 E.	Curtis W. Shields, Jr., Beverly Hills	100	
Mountain Springs Canyon Mines	7,8,9,17,18	23 S.	41 E.	Mountain Spring Canyon Mines, Ltd., 907 Van Nuys Bldg., Los Angeles	400	R. XII, p. 136; XIII, p. 180
Mountain View Copper Group	20	24 N.	3 E.	Furnace Creek Extension Copper Company	97.15	
Mt. Tom		7 S.	30 E.	G. Crawford, Bishop	80	
Mt. Whitney				See Union Mines		
Nantasket		13 S.	36 E.	R. J. Daymon, et al., Independence	180	
Nemo Canyon Antimony Mines		19 S.	45 E.	Farlansee Wells, Death Valley Junction	120	
Nemo Chief Antimony Group		17 S.	45 E.	Ed. Attaway, Trona	80	
Neptune Mine (Loretta Mine)	16,17,20,21	8 S.	37 E.	Loretto Copper Co., New York City, N. Y.	102.71	R. XV, p. 73; XXII, p. 464
New Deal Group		23 S.	44 E.	Paul M. Koenecke, et al., Trona	120	
New Discovery & Gem Mines		20 S.	44 E.	Gem Mines, Inc., Bakersfeld	100	R. XXVIII, pp. 364-366

New Enterprise Mine		16 S.	38 E.	Thomas Henning	20.55	
New Hope Group		22 S.	41 E.	H. R. Bradley, et al., Darwin	160	
New Moon Group		24 S.	31 E.	Ted Sterling, et al., Brown	140	
Ninety-Eight Quartz & Placer Mines		21 S.	40 E.	Leigh Moyle, Darwin	180	
Noonday & Grant Mines		20 N.	8 E.	Tecopa Cons. Mining Co., Dr. L. D. Godshall, 722 S. Oxford Ave., Los Angeles	205.741	R. XV, pp. 103-104; XVII, pp. 291-293; XXII, pp. 491-492; XXXIII, p. 267
North Star Group		21 N.	4 E.	C. O. Benson, Tecopa	160	
North Star Mine		15 S.	38 E.	D. E. Boelter, et al., Los Angeles	140	
Nu-Nah Group		10 S.	37 E.	Nu-Nah Mining Co., Big Pine	100	
O. B. J. Mine (Tyler Mine)				G. W. Tyler, et al., Trona	280	R. XV, p. 74; XXII, p. 465; XXVIII, pp. 371-372
Oasis Group		12 S.	37 E.	J. W. Wright, Big Pine	240	
Occident Mine		16 S.	38 E.	Geo. Jackson	10.32	
Ocean Queen Mine	16	21 S.	45 E.	Geo. S. Evans	19.79	
Ojala Group		20 N.	5 E.	F. A. Markley, Tecopa	100	
Old Mexican Mines		20 S.	40 E.	Mrs. Lucy Stanley, Darwin	120	
Olympic Mine		21 S.	41 E.	Joe Conner, Los Angeles	60	
Omega Group		16 S.	38 E. 39 E.	Cerro Gordo Mines Co.	98.443	
Ophir Mine		20 S.	40 E.	Walter Ross, et al.	100	
Oro Fino Mines	23	20 N.	8 E.	Tecopa Cons. Mining Co., Tecopa	41.322	
Oro Grande Placer		20 S.	40 E.	Sam S. Clark	20	
Oro Plato Mines		24 N.	3 E.	Furnace Creek Copper Co., Death Valley Junction	35.84	
Otso Group		20 S.	40 E.	L. Razner, Darwin	80	
Overlook Group		15 S.	41 E.	Cliff Palmer, Darwin	120	
Owens Lake View		14 S.	37 E.	Ellen Maysen, et al., Darwin	140	
Paddy Pride Mine		21 N.	5 E.	Paddy Pride Silver Mining Co., Shoshone	100	R. XVII, p. 294; XXII, pp. 493-494
Pagan Group		16 S.	39 E.	Cerro Gordo Mines Co.	339.713	
Palma Mine		16 S.	43 E.	Skiddo-Saddle Rock Mining Co., Trona	20.661	
Panamint Mine		21 S.	45 E.	A. D. Meyers, Los Angeles	360	R. XVII, pp. 280-281; XXII, pp. 495-500; XXVIII, pp.361-364
Panamerica Group		24 S.	45 E.	Fred Gray and Wm. Hyder, Trona	80	
Panamint Group		19 S.	44 E.	Louis A. Kuehne, et al., Trona	600	
Paymaster		14 S.	37 E.	S. A. Banks, Independence	60	
Pennsylvania		16 S.	37 E.	J. D. Leary, Lone Pine	20	R. XVII, p. 293; XXII, p. 495
Pete Smith Mine		17 S.	38 E.	Wm. Skinner, et al., Lone Pine	120	R. XXII, pp. 495-496
Pierson Mining Co. Group of Mines		13 S.	36 E.	R. B. Whiteside, Duluth, Minn.	400	R. XXII, p. 496
Pine Creek Tungsten		7 S.	29 E.	U. S. Vanadium Corp., 30 E. 42d St., New York. Bishop	245	R. XVII, pp. 301-302; XXII, pp. 511-512
Pine Tree Group		22 S.	45 E.	Harvey Searing, Trona	120	R. XXII, p. 496
Pioneer Mines		19 S.	45 E.	C. E. Babcock, Darwin	40	
Pittsburg Group	36, 1	21 N. 20 N.	5 E.	J. H. Riddle, et al.	41.162	
Plummer Group		21 S.	7 E.	Albert W. Plummer, Shoshone	280	
Poco Pronto Mines		24 N.	3 E.	Furnace Valley Copper Co.	38.28	
Polita Mine		7 S.	34 E.	Polita Gold Mining Co., Bishop	20.65	R. XII, p. 139; XIII, p. 183
Primus Mine	30	22 S.	43 E.	Geo. Johnson, Jr., Trona	11.19	
Promontory		19 S.	40 E.	Darwin Development Co., N. Y.		R. XV, pp. 105-106; XXII, p. 496
Pumpkin Group		29 N.	3 E.	Pumpkin Gold Mining Co.	36.75	
Radcliff Mine		22 S.	46 E.	Radcliff Cons. Gold Mining Company, Trona	137.487	R. XV, p. 83; XXII, p. 472; XXVIII, pp. 373-376
Rainbow Mine	10	20 N.	8 E.	Tecopa Cons. Mining Co., Tecopa	25.60	

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Rainbow Group of Mines	12, 21, 22	22 N.	7 E.	A. W. Plummer, 2062 Glencoe Way, Hollywood	500	
Rattler Group	20, 21	24 N.	3 E.	Furnace Creek Extension Copper Company	51.38	
Raven Mine		15 S.	40 E.	Archie Farrington Estate, Bishop	120	
Red Boy Group	35, 36, 1, 2	24 N. 23 N.	3 E.	Greenwater Red Boy Copper Co.	104.32	R. XV, p. 106; XVII, p. 293; XXII, p. 496
Red Hill Group		20 S.	39 E.	Walter Palmer, Darwin	400	
Red Mexican Group		20 S.	39 E.	M. D. Early, et al., Lancaster	40	
Red Rock Group		21 S.	40 E.	Fred J. Wilbur, Darwin	120	
Red Top Group		21 S.	39 E.	Harry E. Woodson, et al., Darwin	160	
Red Wing		22 N.	7 E.	R. J. Fairbanks, Shoshone	20	R. XV, p. 106; XXII, pp. 497
Reed Flat Mine		7 S.	34 E.	Judge J. O. Ray, Beatty, Nevada	165	R. XXII, p. 497
Reno Group		19 S.	40 E.	Charles Richardson, Darwin	30.98	
Republic Group	5	13 S.	36 E.	H. B. Whiteside	94.677	
Reward Mine				See Brown Monster		
Rex Montis Mine		13 S.	33 E.	Howard Mears, Independence	84.12	
Richardson Group	13,24,18,19	19 S.	40 E. 41 E.	Chas. Richardson, Darwin	127.211	
Ridge Lookout Group		13 S.	34 E.	Geo. V. Parker, Independence	520	
Rio Tinto Groupe	24	19 S.	40 E.	Joseph L. Giroux, Darwin	166.572	
Rob Roy Mines (Ibex)	35, 2	20 N. 19 N.	5 E.	Ibex Springs Mining Company, Shoshone	73.458	R. XV, pp. 96-97
Rock Point Group (Cardinal)	19,20,29,30	8 S.	31 E.	Cardinal Gold Mining Co.	252.832	R. XV, p. 85; XVII, pp. 281-292; XXII, p. 474
Rosario Group	31, 32	28 N.	3 E.	Rosario Gold Mining Co.	117.243	
Round Valley Tungsten Mine		6 S.	31 E.	Pacific Tungsten Corporation,5514 Wilshire Blvd., Los Angeles	160	R. XVII, pp. 302-303; XXII, p. 512. U. S. G. S. Bull. 640b
Round Valley Mines		7 S.	31 E.	Al Stevens, et al., Bishop	100	R. XVII, pp. 302-303; XXII, p. 512. U. S. G. S. Bull. 640b
Royal Mine				See Cerro Gordo Extension Mine		R. XV, p. 106; XVII, p. 294; XXII, p. 497-498
Ruth Mine		23 S.	42 E.	F. L. Austin, Trona	260	
Saddle Rock Mine		16 S.	43 E.	Skiddo Saddle Rock Mining Co.	66.22	
San Benito Mine		16 S.	38 E.	Levi Lasky, Keeler	19.28	
San Pedro		9 S.	37 E.	W. A. Coulter, San Pedro	160	R. XXII, p. 498
Santa Ana		19 S.	40 E.	Alex Ruona, Darwin	60	
Santa Maria		16 S.	38 E.	Santa Maria Silver Lead Mining Co.	5.48	
Santa Rosa	26, 35	17 S.	39 E.	Santa Rosa Mining Co., 357 S. Hill St., Los Angeles	113.62	R. XV, p. 108; XVII, p. 294; XXII, pp. 498-499
Saratoga Copper Mines	1	23 N.	3 E.	Greenwater-Saratoga Copper Co.	100	
Scotchman Group	13	22 S.	45 E.	Ballarat Gold Mining Co., Trona	66	
Senator Mine	32, 5	11 S. 12 S.	35 E.	R. C. Chambers	20.58	
Seymore Mine	11, 14	21 S.	45 E.	Geo. M. Pinney, et al.	21	
Shannon Creek Tungsten (Buckshot)		8 S.	33 E.	H. R. Bartel, Big Pine	20	
Silver Button & Shamrock Mines				See Darwin-Keystone Mine		R. XXII, pp. 499-500
Silver Dome Group		7 S.	36 E.	M. E. Holman, et al., Big Pine	280	R. XVII, p. 289; XXII, pp. 488-489

Silver Peak Hemlock				See Panamint Mines		
Silver Reef Mine				See Ventura Mine		R. XV, p. 110; XVII, p. 295; XXII, p. 503; U. S. G. S. Professional Paper 110, p. 117
Silver Rule Mine		19 N.	10 E.	Pacific Lead-Silver Mining Co., Los Angeles	240	R. XV, p. 104; XVII, pp. 365-366
Silver Spoon Mine Group		19 S.	40 E.	Theo Peterson, Darwin	100	R. XXII, pp. 500-501
Skidoo (Silver Ball) Mine		17 S.	44 E.	Judge W. B. Gray, Trona	240	R. XV, pp. 83-84; XXII, p. 473
Slate Range Mine				See California Queen of Gold Bottom Mine		R. XXII, p. 501
Sleeping Beauty Group		6 S.	36 E.	Harry Miller, et al., Big Pine	180	
Southern Homestead Group		23 S.	44 E.	Harry E. Broggs, Trona	200	
Southwest Mine	13	19 S.	40 E.	David C. Lang, Darwin	17	
Speculator Group	26,27,34,35	24 N.	3 E.	United Greenwater Copper Co.	227	
Squash Group		29 N.	3 E.	J. P. Nelson, et al.	39.38	
St. George (Merry Christmas) Mine		20 S.	42 E.	J. C. Cress, et al. Leased to Chas. F. Hamilton, 1541 S. St. Andrews Place, Los Angeles	120	R. XV, p. 82; XXII, p. 471
Standby Group		15 S.	36 E.	Robt. Lawrence, et al., Lone Pine	480	
Standard		22 S.	45 E.	Frank Groch, Trona	240	
Standard Group		19 S.	40 E.	Alex Ruona, Darwin	380	
Star Mine		21 S.	45 E.	Star Silver Mining Co.	20.28	
Star of the West Mine	4, 5, 8, 9	24 S.	31 E.	Star of the West Mining Co., 320 E. Jefferson, Los Angeles	121.749	
State Line	28, 33	29 N.	3 E.	Hayseed Mining Co.	19.32	
State Line Mines		26 N.	5 E.	Oliver C. Edwards, Jr., Beatty, Nevada	160	
Sterling Mine		20 S.	42 E.	Sterling Mining Co., Trona	120	
Stewart's Wonder Mine (Panamint Mine)	10	21 S.	45 E.	A. D. Meyers, Los Angeles	25.661	R. XVII, pp. 280-281; XXII, pp. 495-500, XXVIII, p. 363
Stockwell Mine		23 S.	44 E.	Stockwell Gold Mining Co., Los Angeles	130	
Summit No. 2 Mine		16 S.	38 E.	A. R. Conklin, et al.	18.34	
Sunrise View Mines		15 S.	36 E.	A. C. Zell, Lone Pine	480	
Syndicate Mine	14	20 N.	8 E.	Los Angeles Mining & Smelting Company	15.25	
Telescope Group. (See Reward Mine)	3	14 S.	36 E.	Reward Gold Mines Co.	64.215	
Telescope View Group		18 S.	45 E.	O. F. Dearborn, et al, Trona	80	
The Sterling Mine		20 S.	42 E.	M. A. Collins, et al., Trona	120	
The Wanderer Mines		23 S.	42 E.	D. W. Whipple, Trona	140	
Tip Top Mine		22 S.	45 E.	I. J. Sopp, et al., Trona	320	
Tom Casey Mine		13 S.	37 E.	Tom Casey, Lone Pine	120	
Topah Group		21 N.	1 E.	Carl Mengel, Trona	260	
Treasure Mine		21 N.	1 E.	Death Valley Mining Co.	45.93	
Treasure Hill Mine		17 S.	45 E.	L. E. Mendelman, et al., Los Angeles	240	
Tucki Mine		17 S.	45 E.	Ed Attaway, et al., Darwin	120	
Ubehebe Mine		14 S.	40 E.	Archie Farrington Estate, Bishop	240	R. XI, p. 109; XVII, p. 294; XXII, p. 501
Ulida Mines		14 S.	41 E.	P. E. Day, Darwin	240	
Uncle Sam Mine (See Ophir Mine)	24	24 S.	43 E.	Engineer's Exploration Corp., Trona	61.983	
Union Cons. Group	5	13 S.	36 E.	Union Cons. Mining Co.	35.115	R. XXII, p. 496
Union Mines	14	14 S.	36 E.	Monte Carlo Mines, Inc., Los Angeles	140	R. XV, p. 80; XXII, pp. 501-503
Utacala Mine		19 S.	42 E.	Albert Miller, Keeler	240	R. XVII, pp. 294-295; XXII, p. 503
Ventura Mine		16 S.	38 E.	Thomas Henning, et al., Keeler	20.63	
Ventura Mine (Silver Reef)		16 S.	38 E.	Mrs. Chas. Bangoe, Keeler	340	R. XV, p. 110; XVII, p. 295; XXII, p. 503; U. S. G. S. Professional Paper No. 110, p. 117
Vermont Group (See Keane Wonder Mine)	1, 12, 16	15 S. 29 N.	46 E. 1 E.	Keane Wonder Mining Co.	41.32	
Vernon		24 S.	44 E.	Stockwell Gold Mining Corp., Trona	205	

METAL MINING CLAIMS, INYO COUNTY—Continued

Name of mine	Location			Last owner's or operator's name and address	Area, acres	Bibliography
	Sec.	Twp.	Range			
Victor Group	3, 9, 10, 11	8 S.	37 E.	C. E. Cady, et al.	243.085	
Virginia Group		13 S.	33 E.	Virginia Cons. Mining Company	26.63	
Vin Blanc Mine		20 S.	40 E.	Geo. C. Terry, et al., Independence	20.00	
Vulcan Group		22 S.	42 E.	F. W. Chappell, Darwin	120	
War Eagle Mine	14, 15, 22, 23	20 N.	8 E.	Tecopa Cons. Mining Co.	180	R. XXII, pp. 503-504
Waucoba Tungsten Mine		11 S.	37 E.	Stuart Bedell, et al., Big Pine	240	
Westfalia Group	24	23 S.	42 E.	Peter B. Mathiason	61.09	
Westgard Mine (Chalmers)		7 S.	35 E.	Westgard Cons. Mining Co., Tonopah, Nevada	280	R. XVII, p. 284; XXII, p. 482
West Point Group		23 S.	42 E.	Geo. G. Widman, Darwin	420	
Westward Ho Group		21 N.	3 E.	Lyle W. Rucker, Shoshone	520	
White Eagle Group		22 S.	44 E.	C. Ferge, Trona	80	
White King Group		21 N.	7 E.	John and Silvia Prato, Shoshone	80	
White Star Group		20 S.	38 E.	J. M. Henry, Olancha	140	
Wild Rose Antimony Mines		19 S.	45 E.	T. F. Pierson, et al., Los Angeles	220	R. XII, p. 21; XV, p. 60; XXII, p. 462
Williams & Johnson Antimony Mine		19 S.	45 E.	Ralph Williams & Geo. Johnson	20	R. XV, p. 62; XXII, pp. 462-463
Wilshire Bishop Creek Mine				See Cardinal Gold Mining Co.		R. XV, p. 85; XVII, p. 281-282; XXII, p. 474
Winnie Mae Group		22 S.	44 E.	Ralph A. Stuckley, et al., Trona	200	
World Beater		22 S.	45 E.	Ballarat Mining Co., Trona	280	R. XXVIII, p. 376
Wonder Mine		19 S.	41 E.	Richard Wallace, Darwin	80	R. XXII, p. 465
Wyoming Mine	10, 11, 14, 15	21 S.	45 E.	A. D. Myers, Los Angeles	25.661	R. XXII, p. 495; XXVIII, pp. 363-364
Yankee Girl Mine		13 S.	36 E.	Sierra Syndicate, Independence	120	
Ygnacio (Ignacio)		16 S.	38 E.	Cerro Gordo Mines Co., San Jose	3.66	R. XV, pp. 97-98; XVII, p. 287; XXII, p. 485; R. W. Raymond, Mineral Resources West of the Rocky Mountains, 1780, p. 17
Yucca Mine		20 S.	40 E.	L. D. Owen, Darwin	20	R. XV, p. 85; XXII, p. 474

NONMETALLIC MINERALS

Inyo County has a great variety of commercial minerals which are used locally, and large tonnages of both industrial and structural materials are shipped out of the county to manufacturing centers along the Pacific Coast. Deposits of barytes, bentonite, clay, dolomite, limestone, marble, pumice, sulphur, and talc are distributed throughout the county and transportation and other facilities are gradually being extended so that the growing demand may be met. Since Report XXII of the State Mineralogist was published, a number of new talc deposits were developed and put under production. An important feature has been the development of the sulphur deposits in the Last Chance Range in the northeastern section of the county near the Nevada state line. A considerable tonnage of high-grade sulphur, both crude and refined, was shipped to Los Angeles from these deposits in 1936 and 1937. Another feature was the development of the pumice deposits in the Coso Range and the White Mountains near Laws.

BARITE

Gunter Canyon Barite Deposit. It is located in Gunter Canyon on the west flank of the White Mountains, 6 miles northeast of Laws; elevation, 6300 ft.

A series of parallel veins of barite occurs in the Cambrian schists and slates. A considerable tonnage was shipped from this deposit in 1928 and 1929. The barite is gray to white in color and is reported to carry 94% barium sulphate with specific gravity of 4.2. Idle.

Bibl.: State Mineralogist's Report XXII, pp. 512-513.

Poso Baryta Deposit. It comprises 4 claims and a millsite, located in Sec. 23, and 24, T. 24 S., R. 36 E., M. D. M., on the eastern slope of the Sierra Nevada, at an elevation of 7500 ft. in Tulare County, 15 miles west of Linnie, a station on the Southern Pacific Railroad. Although the property is located in Tulare County, it will be described in this report, as it is near to the boundary line of Inyo and Tulare counties, and all shipments made from the deposit are from Linnie in Inyo County. Owner is *Western Barium Corporation,* 1643 Russ Building, San Francisco; R. A. Fredricks, president and general manager.

Three parallel veins occur along a shear zone in quartz-diorite. In the shear zone along the veins there is schist with a dolomite outcrop on the footwall side of the vein. The vein outcrops show widths varying from 10 ft. to 70 ft., the average being about 20 ft. These outcrops can be traced continuously for over 4000 ft. The strike of the veins is N. 20° W., dip 50° to 60° SW. The width of the vein exposed in the main working tunnel is 12 ft.

Development consists of a tunnel, driven north 200 ft. with 75 ft. of backs. The tunnel is 400 ft. below the highest point on the hill. The analysis of the barite is stated to be 80% to 90% barium sulphate, with 8% to 10% silica, and lime content, 1.5%; specific gravity of 4 to 4.2. The barite is white in color and is of the soft, crystalline variety. The company has under construction a barium products plant

at Rosamond, Kern County. Ten men are employed on plant construction and 6 men at the mine.

Warm Springs Canyon Barite Deposit. It comprises 6 claims located on the eastern slope of the Panamint Range, in Warm Springs Canyon, 45 miles west of Shoshone, a station on the Tonopah and Tidewater Railroad; elevation, 3000 ft.; owners, Harry P. Gower and Owen Montgomery, of Death Valley Junction, California.

The outcrop is reported to be 6 ft to 8 ft. wide and has been exposed by open cuts along the surface for some distance. Analyses of the ore show the barite to carry 90% barium sulphate, with a specific gravity of 4.2. The barite is white in color. This is a new discovery, located in the latter part of 1937. Three men are employed on development.

DOLOMITE and MARBLE

The principal mountain ranges east of the Sierra Nevada range are made up in places of dolomitic limestone. The only commercial deposits being developed at the present time are those of the Inyo Marble Co., of Los Angeles, Calif. These deposits occur on the southwestern flank of the Inyo Range and extend for about 6 miles northeastward from Swansea Station. Some tonnage of dolomite is shipped to the soda plant of the Pacific Alkali Co. at Bartlett on Owens Lake. A considerable amount is shipped to Los Angeles for flux for steel plants and for terrazzo, art stone, stucco aggregates and poultry grits. The marble outcroppings along the base of this range show a thickness of at least 500 ft. The beds are tilted at a high angle, dipping to northeast into the mountain. The marble is dolomite, fine-grained and hard. Three varieties of marble are found in this deposit; a pure white, a yellow, and a variegated marble of white ground-mass. At the time the deposit was visited no marble was being quarried on account of the lack of demand on the Pacific Coast.

Owner, *Inyo Marble Co.;* D. H. Dunn, president and manager; offices, 359 North Avenue 22, Los Angeles.

Bibl.: State Mineralogist's Reports X, p. 215; XII, p. 392; XIII, p. 628; XV, p. 111; XVII, p. 295; XXII, pp. 515-516; Bull. 38, pp. 99, 100.

MARBLE ONYX

Death Valley Onyx Deposit is in Revenue Canyon on the east slope of the Panamint Mountains about 12 miles northwest of Ballarat; owner, *Artcraft Onyx Co.,* E. N. Degner, president; H. C. Degner, secretary; 2923 Kenwood Ave., Los Angeles.

This deposit occurs on the top and west slope of a small knoll, resting on crystalline limestone. It occurs in bands varying from 6 in. to about 2 ft. thick, the total thickness being approximately 6 ft. Colors are red, cream and brown.

It is developed by open cuts. One on top of the hill is about 25 ft. long, 20 ft. wide, with a maximum depth of about 8 ft. It is also opened up on the slope of the hill about 300 ft. east where the total thickness appears to be about 4 ft. At this point the red color predominates.

Worked intermittently.

FELDSPAR

Nine-Mile Canyon Feldspar Deposit. It comprises 3 claims located in T. 24 S., R. 37 E., S. B. B. M., 5 miles west of Linnie, a siding on the Owens Valley Branch of the Southern Pacific Railroad; elevation, 4000 ft.; owner, E. G. Washmuth, Inyokern, California.

Two massive outcrops of silica and feldspar occur in the granite on the ridge west of Nine-Mile Canyon. The lower outcrop is about 250 ft. in elevation above the floor of the canyon. This outcrop is 40 ft. in width and 100 ft. in length.

Development is by a crosscut tunnel driven south 50 ft. in granite. In the face of the tunnel there is exposed 6 ft. of feldspar and 8 ft. of silica. A raise has been put up on the feldspar to the surface, and the material is mined from a glory hole. The feldspar mined is brown to pink in color. About 250 ft. south of the glory hole, and about 300 ft. in elevation above these workings, is a massive outcrop of feldspar and silica which is 150 ft. wide and 200 ft. in length; developed by an open cut.

Analysis:	Silica (SiO_2)	63.82%
	Aluminum oxide (Al_2O_3)	18.54%
	Ferric oxide (Fe_2O_3)	0.11%
	Magnesium oxide (MgO)	0.61%
	Potassium oxide (K_2O)	13.33%
	Sodium oxide (Na_2O)	1.35%
	Calcium oxide (CaO)	Trace
	Loss in ignition	0.04%

Idle.

Bibl.: State Mineralogist's Report XXVII, pp. 415-416.

White King Feldspar Deposit. It comprises 6 claims located in Sec. 31 and 32, T. 23 S., R. 37 E., 12 miles west of Linnie, a siding on the Owens Valley Branch of the Southern Pacific Railroad; elevation, 6500 ft.; owner, H. W. Wright, South Pasadena, California.

Massive outcrops of feldspar occur on five small, round hills in a mountain valley in the Sierras. These outcrops have a width of 50 ft. and indicate that a large tonnage of feldspar can be developed. The feldspar is white in color and free of iron. A number of cars were shipped to Los Angeles in 1933.

Analysis of orthoclase feldspar by John E. Skelton, chemist of the Natural Soda Products Co., Keeler, Calif.:

Silica (SiO_2)	64.90%
Ferric oxide (Fe_2O_3)	Trace
Aluminum oxide (Al_2O_3)	18.95%
Calcium oxide (CaO)	0.84%
Magnesium oxide (MgO)	Trace
Sodium oxide (Na_2O)	2.92%
Potassium oxide (K_2O)	12.60%
	100.21%

A fusion test showed sample fused to a white, opaque, glassy mass. Idle.

FLUORITE

Warm Springs Canyon Deposit, comprising 4 claims, is in Warm Springs Canyon, on the east slope of the Panamint Mountains, 70 miles southwest of Death Valley Junction; owner, Owen Montgomery, Death Valley, Calif.

The deposit has been traced for several hundred feet along the surface by open cuts and about 100 ft. of tunnel work.

Idle except for assessment work.

FULLERS EARTH (BENTONITE)

Fullers earth includes many kinds of unctuous clays. It is usually soft, friable, earthy, white and gray to dark green in color and some varieties disintegrate in water. The principal production in Inyo County of the clay known as bentonite and "shoshonite," a colloidal clay, has been from Shoshone, a station on the Tonopah & Tidewater Railroad, and from a deposit located in the Coso Range east of Olancha. The most extensive beds are those along the Amargosa River in the vicinity of Tecopa, Shoshone, and Ash Meadows, extending across the state line into Nye County, Nevada. Only a small amount of material is shipped from Shoshone, as the principal production at present is from the Ash Meadows deposits in Nye County, Nevada. The bentonite from here is ground in the grinding plant of the Pacific Coast Borax Company at Death Valley Junction.

Calearth Fullers Earth Deposit. It comprises 1120 acres located in Sec. 13, 14, 23 and 24, T. 18 S., R. 38 E., M. D. M., in the foothills at the north end of the Coso Range, 12 miles east of Olancha, a station on the Owens Valley Branch of the Southern Pacific Railroad; elevation, 4500 ft.; owner, Calearth Corporation; W. R. Cantley, president, Los Angeles, California. The *Filtrol Company*, 315 W. 5th Street, Los Angeles, recently purchased 160 acres.

The fullers earth occurs in a bed, which strikes N. 85° E., dipping 10° N. The bed, covered by a flow of rhyolite, has a thickness of from 15 ft. to 50 ft. The outcrop is traceable for one mile in a north-south direction and 3500 ft. in an east-west direction. The material is mined by stripping and benching, and is being shipped to the Olancha Mineral Products Company's grinding plant at 6300 E. Slauson Ave., Los Angeles, also to the Filtrol Company's plant in Los Angeles. Four to 6 men are employed.

Filtrol Company's Deposit. It is situated 2 miles northwest of Shoshone. Holdings comprise 280 acres; owner, Filtrol Company, Los Angeles. Idle.

Bibl.: State Mineralogist's Reports XVIII, p. 298; XXII, p. 514.

Shoshone Bentonite Deposit. This deposit is located one-quarter of a mile west of Shoshone. Holdings comprise 320 acres; owner, *Associated Oil Company*, of San Francisco, California.

Idle.

Bibl.: State Mineralogist's Reports XVII, pp. 297, 298; XXII, p. 514; Min. Jour. Press, Vol. 121, pp. 837-842, May 22, 1926.

PUMICE and VOLCANIC ASH

Deposits of pumice occur in the Coso Range, 6 miles east of Coso Junction, a station on the Southern Pacific Railroad, and also northeast of Laws, on the west slope of the White Mountains, near the Mono

County line. Extensive beds of volcanic ash occur in the Tertiary sediments of the Amargosa Valley near Shoshone and also south and west of Death Valley Junction.

Coso Mountain Pumice Deposit. The deposit is located on the west slope of the Coso Range, 6 miles east of Coso Junction. Holdings comprise 320 acres; owners, H. P. Thelan, of Coso Junction, and Walter W. Brown, Balboa Beach, California.

Bibl.: State Mineralogist's Report XXII, p. 521.

Hidecker Pumice Deposit (formerly Hunter Canyon). It is located in Hunter Canyon, 3½ miles northeast of Laws, on the west slope of the White Mountains. Holdings comprise 20 acres; elevation, 5500 ft.; owners, Wm. Rea and Tom Gracy, of Bishop.

The pumice is exposed over the entire 20 acres, with only a small amount of overburden. It is white in color, and very fine, the maximum size being 2 inches. A screening plant has been erected and several hundred tons taken from an open cut which is 100 ft. long, 20 ft. wide and 8 ft. deep. Idle.

Little Lake Pumice Deposit. It comprises 4 claims totaling 160 acres, situated in Coso Range of mountains, in Sec. 35, T. 21 S., R. 38 E., 5 miles east of Sykes, a siding on the Southern Pacific Railroad; owners, Little Lake Pumice Co., 1204 South Monterey St., Alhambra, California; W. A. Ried, president; W. H. Faust, manager.

An open cut has exposed a bed of white pumice 50 ft. thick. The pumice varies in lumps up to walnut size.

The material is hauled by trucks to crushing, screening plant at Sykes Siding. Pumice is dumped from trucks into hopper, from which it goes to cylindrical drier 43 in. in diameter and 30 ft. long, heated by crude oil. The dried product is elevated to trommel 3 ft. in diameter and 10 ft. long, with 30 mesh screen; over-size from trommel to set of rolls 14 by 26 in., driven by 20-h.p. gas engine. Plant has a capacity of 4 tons per hour. Six men are employed.

Pumice Products Company's Deposit. It comprises four 160-acre placer claims, totaling 640 acres, situated in T. 22 S., R. 40 E., on the south slope of Volcanic Butte, in the Coso Range, 24 miles by road northeast of Brown, a station on the Southern Pacific Railroad; elevation 4000 ft.; owner, Lee Early, Bishop, California. The property is under lease to Pumice Products Co., Paul E. Splane, 417 S. Hill St., Los Angeles.

On the White Pumice Claim, a bed of white pumice is exposed which strikes N. 40° W., dips 40° SW. and is capped by 6 ft. to 8 ft. of basalt. The bed of pumice is 50 ft. thick.

On the Tired Boy Claim which is located about one mile northwest of White Pumice Claim, a bed of pumice has been exposed on the surface for about 2000 ft. in length, with an average thickness of 30 ft. It is capped with basalt. The strike of the bed of pumice is N. 30° E., dip 30°. It is developed by open-cuts and incline shaft 40 ft. deep. Equipment consists of hoist and trucks.

The ore is treated in the company's plant in Van Nuys. Products produced: Pumice aggregate ¾-in. to 8-mesh; acoustic plaster material

minus 10-mesh plus 20-mesh, minus 12-mesh plus 30-mesh; polish material 150-mesh to 400-mesh. Four men are employed.

Bibl.: State Mineralogist's Report XXII, p. 521.

Shoshone Volcanic Ash Deposit. The deposit is located one-quarter of a mile west of Shoshone. Holdings comprise 480 acres; owner, Charles Brown, Shoshone.

A bed of tuff, 8 ft. to 10 ft. thick, is deposited in the Pleistocene sediments of the Amargosa Valley. The bed of volcanic ash is covered with an overburden of sand, gravel and clay, 3 ft. to 4 ft. thick. An open cut on the deposit is 200 ft. wide by 300 ft. in length. The method of working consists of first stripping off the overburden, then loading material into trucks. Four hundred tons were shipped in 1937 to the Western Talc Company's grinding plant in Los Angeles, for the West Coast Soap Company, of Los Angeles. Two to 4 men are employed.

Bibl.: State Mineralogist's Report XXII, p. 521.

The Sierra Minerals Inc., of Los Angeles, are operating a pumice deposit, located about 4 miles southeast of Olancha, T. 20 S., R. 37 E. Holdings consist of 3 claims, owned by L. T. Lynn, Homer Chase and John D. Calloway, of Olancha.

The pumice bed is about 20 ft. thick and is mined by benching. Holes are drilled with hand augers and the blasted material loaded into wheelbarrows and dumped into the ore bin. From the crude ore bin the pumice is fed to a Weaver jaw and hammer type crusher, driven by a 14-hp. Fairbanks-Morse gasoline engine, thence to a cylindrical drier, 3 ft. in diameter and 21 ft. long, heated by crude oil. The dried product goes to 2 trommels, 3 ft. in diameter and 10 ft. long with 30-mesh screens. The screened product is elevated to a loading bin by a bucket elevator. The screens and elevator are driven by a $7\frac{1}{2}$-hp. Fairbanks-Morse gas engine. Production is about 15 tons per day. Six men are employed.

Tripoli Volcanic Ash Deposit. It comprises 4 claims, located 6 miles south of Death Valley Junction and one mile west of the Tonopah and Tidewater Railroad; owners, Patrick Miles and William Maher, of Death Valley Junction.

It is a bedded deposit of volcanic ash, 20 ft. to 30 ft. thick, covered by a basalt flow. The exposures along the bed can be followed for 3000 ft. The strike is east and west. A large commercial tonnage can be developed. Idle.

Virginia Volcanic Ash Deposit (Glendenning). It is located 2 miles south of Shoshone in Sec. 31 and 32, T. 22 N., R. 7 E., M. D. M., on the west side of Amargosa River; elevation, 1800 ft.; Virginia Group of 8 claims; owner, R. W. Glendenning, Los Angeles. Idle.

Bibl.: State Mineralogist's Report XXII, pp. 521-522.

SLATE

A deposit of slate is located on the west slope of the Inyo Range, 4 miles northeast of Keeler. Holdings comprise seventeen 160-acre

placer claims; owners, R. B. McIlroy and Sons, of Keeler, California; W. B. Pinney, 112 W. Jefferson St., Los Angeles, distributing agent.

Beds of black, gray and red slate strike N. 30° W., and dip 70° W. The red slate is quarried by hand and shipped to grinding plants to be ground for roof granules. Some material is used for flagstones.

SULPHUR

The sulphur deposits of the Last Chance Range occur in sedimentary beds with gypsum and limestone. The sulphur is probably formed by the reduction of gypsum by organic matter, and occurs in lenses along bedding planes of limestone which have been tilted, dipping steeply to east, and massive bedded-deposits 16 ft. to 30 ft. thick,

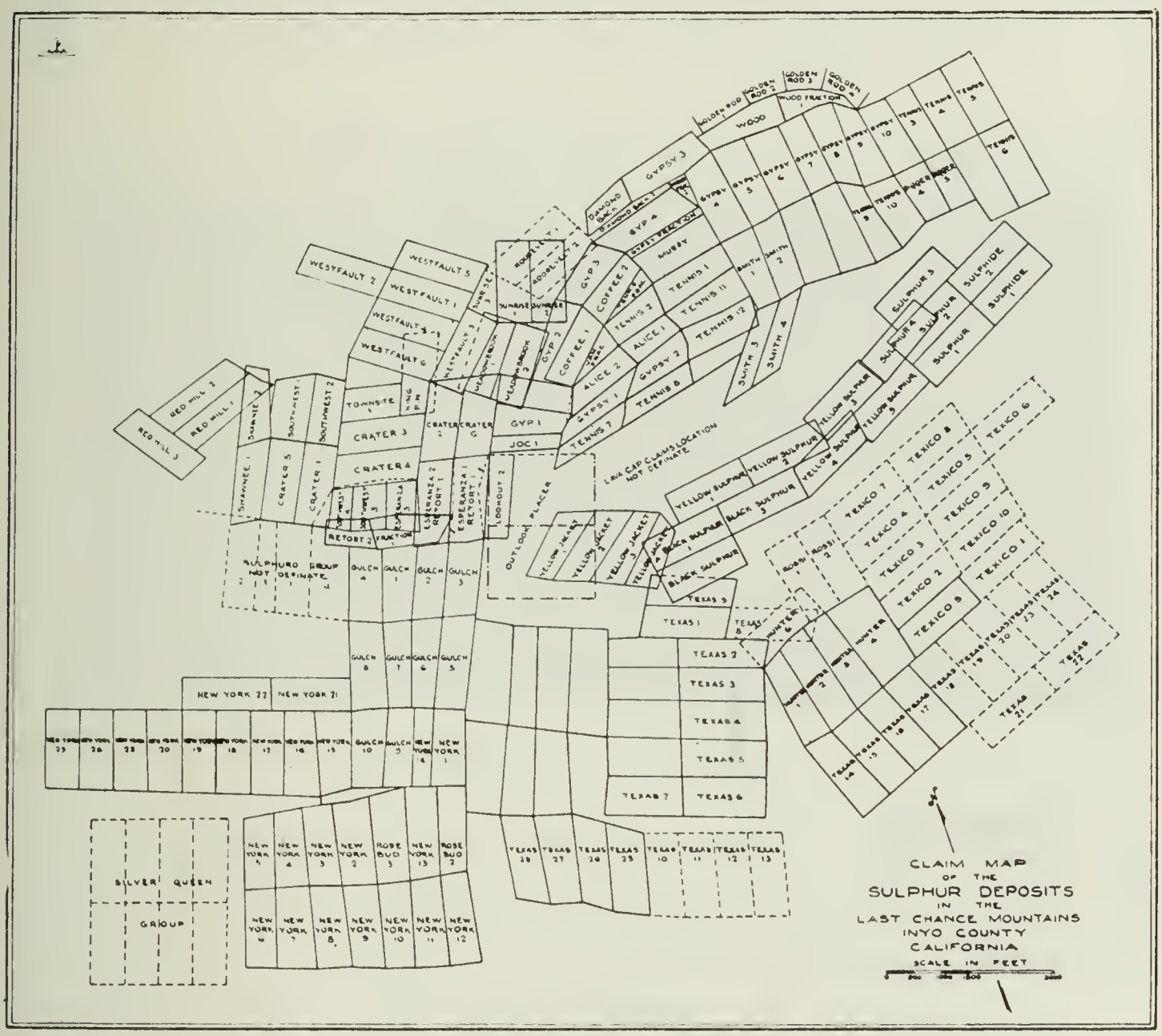


FIG. 12.

overlain with beds of gypsum and limestone from 2 ft. to 15 ft. in thickness. The sulphur content varies from 30% to 80%.

Sulphur was first discovered in the Last Chance Range in 1917 and since that date, about 200 claims have been located in the area. The mineralized area is about 3 miles in length by one mile in width, with a general north and south strike. The principal deposits so far discovered are in T. 8 S., R. 39 E., M. D. M. The first active development was on the Crater Group of Claims in June, 1929, by the *Pacific Sulphur Co.*, of New York. Since that date the Crater Group has been actively worked by different companies and a considerable tonnage of high-grade sulphur shipped to Los Angeles (see Fig. 12).

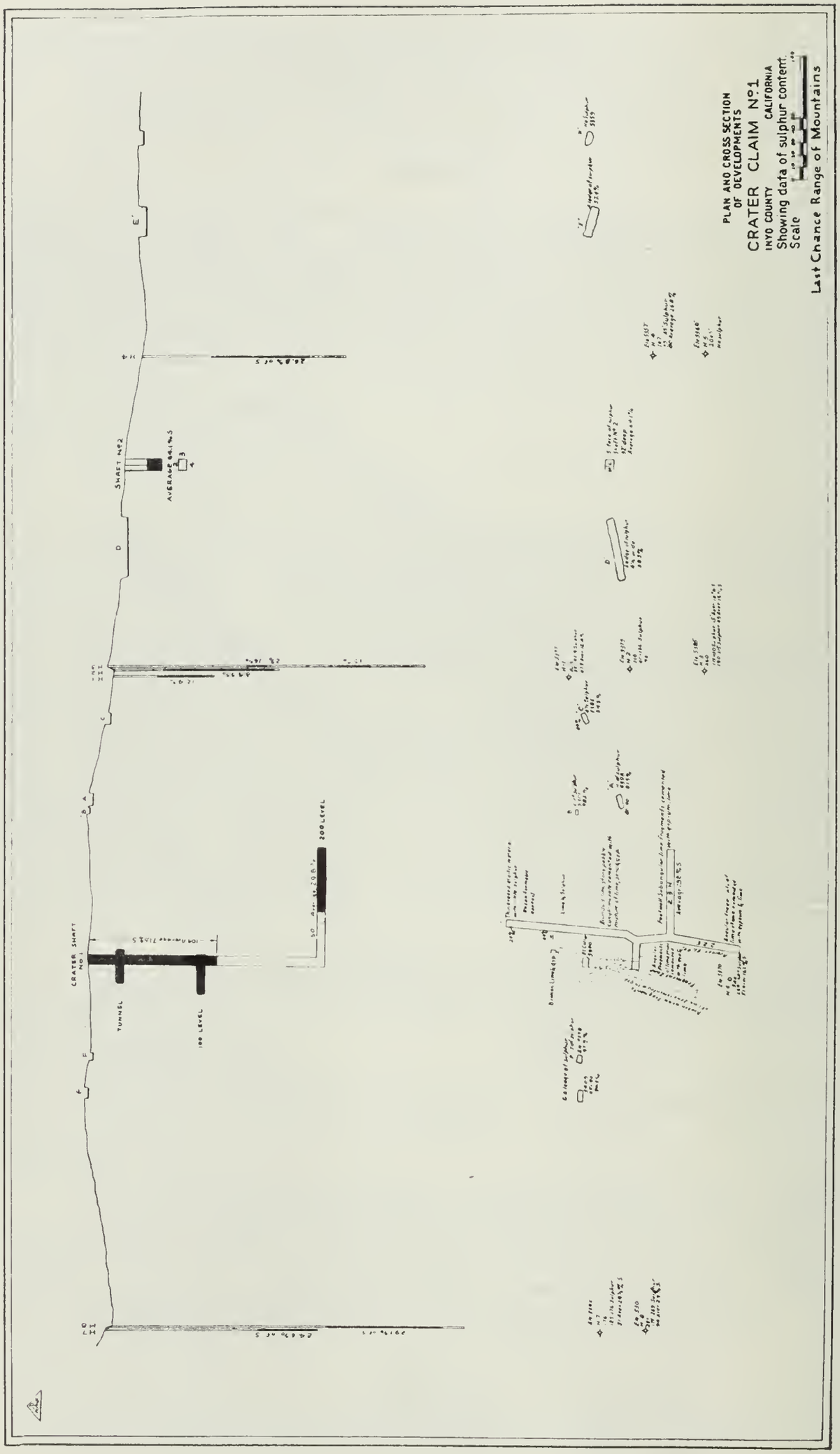

PLAN AND CROSS SECTION
OF DEVELOPMENTS
CRATER CLAIM No.1
INYO COUNTY CALIFORNIA
Showing data of sulphur content.
Scale
Last Chance Range of Mountains
CRATER SHAFT No.1
TUNNEL
100 LEVEL
200 LEVEL
SHAFT No.2
AVERAGE 66.1 %
A
B
C
D
E
E'
F

FIG. 13.

Crater Sulphur Mine. It comprises 7 claims, located in Sec. 16 and 17, T. 8 S., R. 39 E., M. D. M., 64 miles by road east of Zurich, a station on the Owens Valley Branch of the Southern Pacific Railroad, and 27 miles south of Oasis; elevation 5380 ft.; owners, F. B. Mechling, Alexander Bonthrone, Paradise, Butte Co., Calif., and Frank Hicks, Big Pine, Calif. Under lease to *Western Mining Co.,* J. C. Baldwin, president and general manager; C. W. Van Alstine, general superintendent; A. C. Palmer, mine superintendent. Sales agent: Western Sulphur Products, Inc., 1427 E. Fourth St., Los Angeles. The property was operated by the *Pacific Sulphur Co.,* of New York, from June, 1929, to December, 1930.

On Crater No. 1 Claim, this company put down 8 drill holes to depths of 80 ft. to 300 ft.; also sunk a 2-compartment shaft on inclination of 68° to a depth of 200 ft., with levels at 100 ft. and 200 ft. (see Fig. 13).

PHOTO. 17. Open cut and portal—Crater Sulphur Mine, Last Chance Range of Mountains, Inyo County.

The property was operated under lease by W. H. Sanger and Morris Albertoli, of Big Pine, from September, 1932, to 1934, when it was acquired under lease by the *Western Sulphur Industries, Inc.,* of Los Angeles. This company shipped some 4500 tons of 96% sulphur to Stauffer Chemical Co., of Los Angeles.

In August, 1936, the *Sulphur Diggers, Inc.,* Sidney Wood, Jr., president, New York City, acquired the property under lease and operated the property until September, 1937. During the period of operations, the Sulphur Diggers, Inc. installed retorts on the property and also a 60-ton vertical retort at Zurich, the latter operating only a short time before operations were suspended. The Sulphur Diggers, Inc., shipped 5000 tons of crude ore, running 96% sulphur, and refined sulphur running 99.5% was shipped to Los Angeles.

The Western Mining Co. acquired the property in January, 1938, and started construction of new retort which was completed in May, 1938. Present mining operations are confined to the open pit on

Crater No. 6 Claim. The open pit has been excavated for 200 feet in an east-west direction by 110 ft. north-south course. Three beds of sulphur have been mined in this open pit. Thickness of the different beds was from 8 ft. to 20 ft. The beds of sulphur strike north and south and dip about 12° W. The filling between beds is gypsum and lime.

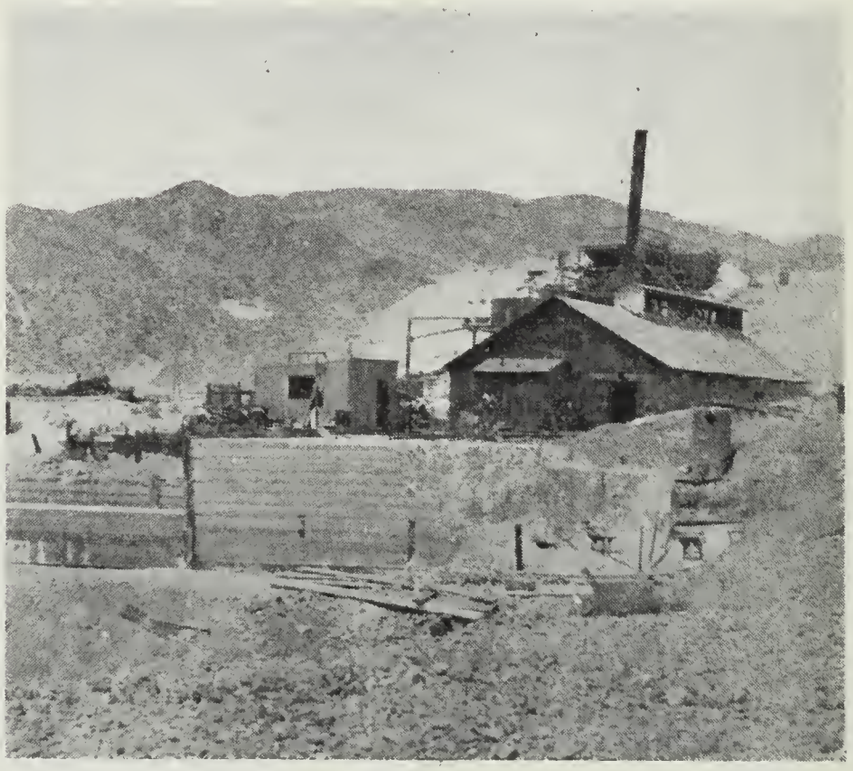


PHOTO. 18. 100-ton Retort, Crater Sulphur Mine, Western Mining Co., Last Chance Range of Mountains, Inyo County. (Later) This plant was destroyed by fire.

From the open-pit floor, the main entry is driven north 110 ft., with galleries driven 50 ft. east and west exposing a bed of sulphur 16 ft. to 20 ft. thick. A slope shaft has been sunk on an inclination of 12° to a depth of 200 ft. to the west, with galleries driven north and south 100 ft. The capping over the sulphur bed is 16 ft. to 20 ft. thick of gypsum, lime and soil. It is reported 10,000 tons of sulphur are developed which will average 80% sulphur. At south end of open pit a shaft has been sunk to a depth of 50 ft. developing another bed of sulphur 27 ft. thick.

They are at present mining about 100 tons per day. Ore mined from different underground workings goes to slope shaft where it is hoisted in one-ton cars by 15-hp. hoist to ore bins having a capacity of 100 tons. From ore bins, it is loaded into trucks and hauled to coarse-ore bin above refinery. The refinery has a capacity of 100 tons of crude sulphur. The refinery consists of two circular horizontal retorts. Each retort has a capacity of three 2-ton steel cars. Steam for retorts is furnished by 125-hp. boiler. Refined sulphur produced runs 99.8%. Storage vats have a capacity of 600 tons of refined sulphur. Water for operation of plant is secured at Oasis and is hauled in two tank trucks having a capacity of 2800 gallons each. The amount of water required to operate refinery is 3250 gallons per 24 hours.

Fifteen employed in mine and 15 men in refinery. The total number of men employed is 50.

Bibl.: State Mineralogist's Reports XVII, p. 300; XXII, p. 523.

Fraction and *Southwest Sulphur Group of Mines.* It comprises one claim known as Fraction, containing 18 acres, and an option on the Southwest Sulphur Group of 11 claims. It adjoins the Crater group of mines on the south and is north of the Gulch group of claims. The property is located in the Last Chance Mountains, 64 miles east of Zurich, a station on the Owens Valley Branch of the Southern Pacific Railroad; elevation 5300 ft.; owner, *Italio Sulphur Industries Co.;* Vincent Burchiere, president and manager.

Sulphur occurs in limestone, with a strike of NW. and SE.; dip 60° W.; width 6 ft. to 8 ft. The deposit is high grade, carrying from 70% to 85% sulphur.

Development on Fraction Claim consists of an incline shaft 50 ft. deep, with a drift southwest 50 ft. A number of shafts from 50 ft. to 75 ft. deep have been sunk on Southwest Sulphur claims, developing some high-grade ore. The thickness varies from 6 ft. to 12 ft.

PHOTO. 19. 3-Compartment Sulphur Ovens, Fraction Sulphur Mine, Italio Sulphur Industries Co., Last Chance Range of Mountains, Inyo County.

Sulphur ore mined on Fraction Claim is hauled by truck to 3 sulphur ovens, each oven having a capacity of 25 tons of crude ore. The ovens are 12 ft. in height and 11.6 ft. in diameter. The refined sulphur is drawn out of ovens into wooden molds. The individual cakes weigh 175 pounds each. The refined sulphur carries 99.5%.

At the time the property was visited there were 50 tons of refined sulphur on hand for shipment. Three men are employed.

Gulch Group of Sulphur Mines. It comprises 10 claims, situated in T. 8 S., R. 39 E., in the Last Chance Mountains, 64 miles east of Zurich, a station on Owens Valley Branch of the Southern Pacific Railroad; owners, Frank Rossi and Tom Wade, Big Pine, Calif.

The deposit was located by James Jacoby, Denver, Colo., in 1918 and relocated by Frank Rossi and Tom Wade, of Big Pine, in 1920.

The sulphur occurs in pure, crystalline form, intermixed with a koalinized material in limestone, gypsum, and cherty shales. Three parallel strata of sulphur occur in limestone. These strata strike north and south and dip 40° W. The thickness varies from 10 ft. to 20 ft.

Development consists of open cut 200 ft. in length by 50 ft. in width and 30 ft. high. Other development consists of tunnels and shallow shafts. In open cut there is exposed 20 ft. in width stated to carry 40% sulphur and 10 ft. of massive crystalline sulphur said to be 90% pure. Idle.

TALC

Talc has been commercially produced from deposits on the east slope of the Sierra Nevada, west of Big Pine, from both the east and west slopes of the Inyo Mountains, east of Keeler, from the east slope of the Panamint Range, on the west side of Death Valley and from Kingston Range, southeast of Shoshone.

Blue Star Mines, Ltd., has 9 claims on Big Pine Creek, on the east slope of the Sierra Nevada, 9 miles west of Big Pine; elevation, 8000 ft.; owner, Blue Star Mines, Ltd.; A. Getty, president, 840 San Julian St., Los Angeles.

The talc, which is white and free of lime, occurs in irregular masses in the serpentine or on the contact of serpentine and crystalline limestone. The largest of these masses as yet encountered is up to 15 ft. wide, 70 ft. long by 45 ft. high. Square-set system of mining is used.

Development consists of a tunnel driven SE. 200 ft. At 140 ft. from the portal a drift has been driven SW. 120 ft. Adjacent to the talc the limestone has been quarried. The quarry pit is now about 50 ft. long, 40 ft. wide and 30 ft. high. These materials are lowered down the hillside on a 1200-ft. gravity tram to a 3-compartment bin. Trucks take the talc and limestone 11 miles to the grinding plant at Zurich, a station on the railroad, 2 miles east of Big Pine. The grinding plant consists of the following: 11-in. by 18-in. jaw crusher, elevator to bin; to Raymond mill, 48-in. fan to cyclone dust collectors and Bates packer. Fines from cyclone to 96 cotton and silk tubes, to single-nose Bates packer. All machines have individual motor drives. The warehouse is 100 ft. by 160 ft.

Eight men are employed at the mine, 5 at the mill and 2 truck drivers.

Davis Talc Deposit (High Chief), comprising 5 claims, is situated on the west slope of the Inyo Mountains, 4 miles east of Zurich, a station on the Southern Pacific Railroad; elevation 4500 ft.; owner, Mrs. J. E. Davis, Big Pine, Calif.

The talc, having a maximum thickness of 20 ft. to 30 ft. is interbedded with strata of hard limestone. Strike NE.-SW., dip 30° NW. It is traceable on surface for a distance of 750 ft.

Development consists of tunnel driven N. 10° W. 50 ft., then 100 ft. northwest in talc. Another tunnel 30 ft. below has been driven N. 10° W., 100 ft. in limestone. In 1937 the property was under lease to the Blue Star Mines, Ltd. This company mined 200 tons. Idle.

Death Valley Talc Company's property, comprising 10 claims, is on the west side of Death Valley, in the Panamint Mountains, 30 miles south of Furnace Creek Ranch; owner, Death Valley Talc Co., S. D. Pepin, 421 South Westminster Ave., Los Angeles.

The talc up to 30 ft. thick occurs along the contact of dolomitic limestone and serpentine. It has a northeast strike and dips about 25° SE. The outcrop may be traced for about 6000 ft. The talc is white and contains little or no lime.

It has been opened on the south side of the canyon by a crosscut south 80 ft., drift E. 35 ft. and W. 125 ft. At 75 ft. west of the crosscut, a raise has been driven to the surface. At the end of the crosscut, a winze has been sunk 78 ft. on 20° inclination.

The following grinding plant has been erected on the south side of the canyon: 40-ton bin, steel chute about 100 ft. long, to hammer mill, elevator, to air separator where minus 200 product is taken out to two other air separators, products minus 400 and minus 700 mesh; oversize to 6 by 5 pebble mill, discharge back to air separation system. Products are sacked by hand. Sixty h.p. Venn-Severn oil engine supplies the power. Capacity 36 tons per day.

When operating 8 men are employed.

Florence Mine, comprising 6 claims, is in the Cerro Gordo Mining District, on the east slope of the Inyo Mountains, about 3 miles east of Cerro Gordo; owner, *Sierra Talc Co.;* P. H. Booth, president; Franklin Booth, secretary.; W. A. Reid, superintendent.

Vein is from 2 ft. to 6 ft. wide, strikes N. 85° E. and is horizontal. Ore occurs in lenses associated with dolomite. Talc is of a good quality but the lenses are thin and spotty.

About 800 tons was shipped by truck to the Sierra Talc Company's mill at Keeler. All ore came from development tunnels, shafts and surface trenches. Idle.

Pacific Coast Talc Company (formerly Mount Whitney Talc Co.) Deposit. This deposit is in Sec. 25 and 36, T. 18 S., R. 40 E., M. D. M., on the west slope of the Inyo Mountains, 8 miles northwest of Darwin. They have 9 claims in Sec. 25 and have leased 80 acres in Sec. 36 from the State of California; elevation 5400 ft.; owner and lessee, Pacific Coast Talc Co., 2149 Bay St., Los Angeles, W. S. Lockhart, president.

Talc occurs in lenses in a dolomitic limestone near its contact with an igneous intrusive. The general strike is N. 35° W., dip about 55° E. The lenses vary up to 9 ft. in width. As mined, the width averaged about 6 ft. One lens has been mined along a length of 80 ft.

Development consists of tunnel driven northwest 250 ft., where it connects with a shaft 50 ft. below the surface. A winze has been sunk below tunnel 110 ft., with levels at 60 and 110 ft.

There is another talc vein some 1200 ft. north of these workings. Strike N. 30° W. It is about 15 ft. wide. A tunnel has been driven southeast 110 ft. on this vein. Several thousand tons of talc have been shipped from these workings to a grinding plant in Los Angeles.

Sierra Talc Co. (Inyo Talc Co., Simonds Talc Mine) is situated in the Darwin District, 17 miles southeast of Keeler; elevation 5850 ft.; P. H. Booth, president; Franklin Booth, secretary; W. A. Reid, superintendent.

The deposit occurs in a crushed zone in impure limestone, close to or in contact with an igneous intrusion. The strike of the orebody is N. 30° E. and dip is 60° W. to vertical. The outcrop can be traced for 3000 ft. The color is gray, green, and white.

The deposit is developed by a tunnel 900 ft. long driven southeast through limestone and a 200-ft. crosscut east. At 260 ft. from the portal, it cut the glory hole orebody which was 70 ft. wide and has been stoped to the surface. The bed was 70 ft. thick at this point. Along the crushed zone east of the tunnel, a number of lenses of talc of good quality, 20 ft. to 60 ft. wide, have been developed. A winze sunk on a 45° incline 185 ft. deep, with a 280-ft. crosscut southeast developed a second orebody. At about 750 ft. southeast from the portal, a winze has been sunk 50 ft. on a 56° incline and a crosscut driven east for 40 ft. and west 25 ft.

In October, 1937, three men were employed sorting and loading ore from a caved stope at the end of the tunnel and tramming ore to the bin from which it is hauled by trucks to the mill at Keeler.

Sierra Talc Mill is located at Keeler, Calif.; C. O. Best, superintendent; owner, *Sierra Talc Co.*

The ore is hauled in five 5½-ton trucks from the mine and dumped into ore bins; capacity 800 tons. It is loaded into rubber-tired, concrete buggies and wheeled to a Wheeling jaw crusher; crushed to ½-in. and elevated 40 ft. by a bucket elevator to the crushed-ore bin; capacity 18 tons. From this bin the ore flows to a Raymond whizzer separator with a Reeves variable speed drive. Six products, from 200 mesh to 350 mesh can be obtained by changing the speed of the whizzer separator. The ground talc is delivered into powder bins of 3, 6, and 12-ton capacities by an exhaust fan. It is loaded into sacks for market by 2 Iron Clad and one Bates packer-machines. Plant capacity is 30 tons per shift to 200 mesh or 25 tons to 325 mesh. All machinery is electrically driven.

Three men were employed in October, 1937.

Bibl.: State Mineralogist's Reports XV, pp. 126-127; XVII, pp. 300-301; U. S. B. of M. Rept. of Investigations No. 2253, May, 1921.

Warm Springs Canyon Talc Deposit comprising 5 claims, is on the east slope of the Panamint Mountains, 2 miles south of Warm Springs. It is in T. 22 S., R. 47 E.; owner, Miss Louise Grantham, 932 South Irolo St., Los Angeles.

Development consists of 2 tunnels and several open cuts. Showings reported in these openings would indicate a large deposit of talc of good quality. Idle.

Western Talc Company has 2 claims in Anvil Springs Canyon, 9 miles west of the road which traverses the west side of Death Valley; elevation about 2100 ft.; owner, Western Talc Co.; F. H. Savell, president, 1901 East Slauson Ave., Los Angeles.

On these claims occurs a talc deposit at the contact of dolomitic limestone and serpentine. The strike is N.-S. and the dip, while not as yet definitely determined, appears to be about 40° E.

A tunnel is being driven into the hill some 60 ft. below the outcrop. This tunnel is driven nearly north for 320 ft. through a granitic rock, then turns easterly for 105 feet. The last 85 ft. is in serpentine. The talc vein has not yet been reached.

Equipment consists of a portable compressor and tent.

Three men are employed driving tunnel.

White Mountain Talc Mine (Troeger), comprising 2 patented claims owned by Roy Troeger, of Los Angeles, is situated on the east slope of the Inyo Mountains, about 6 miles northeast of Cerro Gordo at an elevation of 8000 ft. It was operated under lease and bond by the *Sierra Talc Co.,* from September, 1935, to October, 1937.

The vein strikes east and west and lies about horizontal in beds associated with dolomite and calcite. Talc is white to gray and of good quality.

Developed by a tunnel 300 ft. east on the vein and a 50-ft. winze, 150 ft. east of the portal. Crosscuts east and west 50 ft. from the bottom of the winze. Numerous surface trenches and short tunnels. About 900 tons was shipped to the Sierra Talc Company's mill at Keeler.

The Sierra Talc Co. constructed 4½ miles of road to the property; also installed a one-inch pipe line from Cerro Gordo Spring to the mine, a distance of one mile. Idle.

Bibl.: State Mineralogist's Report XXII, p. 524.

SALINES

BORAX

The colemanite (calcium borate) deposits occur in the foothills of the Black Mountains east of Furnace Creek. They extend in a narrow belt for many miles and are owned by the Pacific Coast Borax Co. The borate-bearing beds in the vicinity of Ryan are a part of a series of Tertiary lake beds which consist of thin-bedded, light-colored shales. Underlying these shales are thick beds of sandstone and tuff. The borate-bearing beds are capped with basalt which forms the crest of the ridge back of the mines. The colemanite deposits are distinctly bedded and vary in thickness up to 100 ft. The strata have been considerably faulted so there is no great regularity to the deposits. The borax deposits of Inyo County are the largest deposits of colemanite and have been the most productive of any county in California. The county has been a steady producer of borax since its discovery in 1874, until discovery and development of extensive deposits of the new mineral known as 'kernite', (or rasorite), a sodium borate, in southeastern Kern County, near Kramer. In 1926 the Pacific Coast Borax Co. acquired the kernite deposits in Kern County and suspended operations at the mines near Ryan, Inyo County; also moved the calcining and concentration equipment at Death Valley Junction to their new plant at Borate, Kern County.

Bibl.: State Mineralogist's Reports XV, pp. 62-69; XVII, pp. 274-277; XXII, pp. 524-526.

GYPSUM

Deposits of gypsum occur in the Resting Springs District, on the Morrison Ranch, one mile northeast of Acme Station, on the Tonopah & Tidewater Railroad. The Pacific Coast Borax Co. owns a large deposit of gypsum located in the foothills of the Black Mountains.

Bibl.: State Mineralogist's Reports XV, pp. 85-87; XVII, p. 282; XXII, p. 526.

NITRATES

The nitrate deposits are situated in the southeastern part of Inyo County along the Amargosa River, near the boundary between Inyo and San Bernardino counties, and are associated with beds of clay of the Tertiary age. The principal deposits are known as the Confidence beds, located in the Confidence Hills which extend from a point nearly opposite the old Confidence mill, 10 miles northward along the west side of south Death Valley. The Confidence nitrate field is about 27 miles by road south of Shoshone.

The Zabriskie, Resting Springs, Tule Springs, Upper Canyon and Lower Canyon nitrate deposits are located in the valley of the Amargosa River, between Shoshone and Sperry stations on the Tonopah & Tidewater Railroad. There has been no commercial production.

The reader is referred to U. S. G. S. Bull. 724, Nitrate Deposits in the Amargosa Region Southeastern California; also U. S. G. S. Bull.

820, pp. 62-71 and pp. 88-91; State Mineralogist's Reports XV, pp. 117-119; XXII, p. 526; Bull. 24, pp. 165-174.

POTASH

Potash occurs in Inyo County in small amounts in the saline deposits of Death Valley, Deep Springs Valley, Owens Lake and Saline Valley. There has been no commercial production to date from the above-mentioned deposits, although considerable test work has been made on the Deep Springs Valley lake deposits.

Bibl.: State Mineralogist's Reports XVII, p. 296; XXII, p. 526; U. S. G. S., Bulletins No. 540 and No. 580.

Deep Springs Valley Deposit. It comprises 2560 acres on the east side of Deep Springs Lake. The land in the lake and on the clay flat immediately adjoining the lake, comprises 640 acres, in the NW. $\frac{1}{4}$ of the SW. $\frac{1}{4}$ of Sec. 9; and NE. $\frac{1}{4}$ of SW. $\frac{1}{4}$ of Sec. 4; and one-half of NW. $\frac{1}{4}$ of Sec. 4, in T. 8 S., R. 36 E., 24 miles east of Big Pine; elevation 5000 ft.; owner, A. G. Barmore and associates, of Big Pine.

The property was formerly owned by *Inyo Chemical Co.*, Henry M. Leland, president, Detroit, Mich. This company put down test holes and did some experimental work on the brines for the extraction of soda and potash.

From a hole 10 ft. deep sunk on the northeast edge of the lake, about 200 yards northwest of the center of Sec. 4, T. 8 S., R. 36 E., a sample of the brine, analysis by Smith-Emery Co., showed 14.19% total salts, which contained 7.05 K_2O. Sample of lake water showed 8.42% salts, and the salts contained 4.81% K_2O. No. 2 hole, 36 ft. deep is in the SE. $\frac{1}{4}$ of the NW. $\frac{1}{4}$ of Sec. 4, T. 8 S., R. 36 E. No. 3 hole is 39 ft. deep and located in the NE. $\frac{1}{4}$ of the SW. $\frac{1}{4}$ of Sec. 4.

Determinations of sample of brine from Hole No. 3.

Sample in ft.	*Potash in Brine*	*Water Sol. Salts*	*Potash in Salts*
0 ft.–4 ft. 6 in.	1.25%	9.63%	12.99%
4 ft. 6 in.–8 ft.	2.03%	9.80%	20.64%
8 ft.–12 ft.	1.74%	14.60%	11.90%
14 ft.–21 ft.	1.14%	9.50%	12.00%
21 ft.–39 ft.	1.16%	10.60%	10.99%

Analysis of brine by Smith-Emery Company.

Water Sol. Potash (K_2O)	1.38%
Chlorine (Cl)	6.72%
Sulphur trioxide (SO_3)	3.80%
Boron trioxide (B_2O_3)	0.08%
Carbon dioxide (CO_2)	0.82%
Total solids	20.32%

Hypothetical form of combination:

	On Brine Basis	*On Dry Solid Basis*
Potassium chloride (KCl)	2.19%	10.75%
Sodium chloride (NaCl)	9.37%	45.98%
Sodium sulphate ($NaSO_4$)	6.74%	33.07%
Sodium borate ($Na_2B_4O_7$)	0.11%	0.54%
Sodium carbonate (Na_2CO_3)	1.97%	9.66%
		99.00%

Idle.

SALT

Sodium chloride is deposited as a major ingredient in the saline crusts of Death Valley, Saline Valley and Salt Wells Valley and in the brines of Owens Lake. The only commercial production in the county has been from the Saline Valley deposits.

Saline Valley Salt Deposit. It is situated in Saline Valley, east of the Inyo Mountains, 13 miles northeast of Swansea and 50 miles by road from Keeler, a station on the California and Nevada Railroad; elevation, 1100 ft. Holdings comprise 3 patented placer claims of 160 acres each; total 480 acres. Also 4 patented placer claims of 160 acres each; total 640 acres. The total salt land owned and controlled is 1120 acres. The company also owns 160 acres of land at the southwest end of the aerial tramway, at Tramway Station on the Southern Pacific Railway, upon which is located a mill and dwellings for employees; owner, *Taylor Milling Co.*, 1520 San Fernando Rd., Los Angeles.

History: The property was operated by *Saline Salt Co.*, White Smith, president, Bishop, Calif., from 1911 to 1913; from 1915 to 1919 by *Owens Valley Salt Co.*, of Los Angeles; from 1926 to 1930 by the *Sierra Salt Corporation*, of Los Angeles, G. W. Russel, president; A. S. Henderson, secretary. This company shipped a considerable tonnage of salt.

The total area of the salt field as shown by a dotted blue line on the Ballarat Quadrangle map of the U. S. Geological Survey, is about 16 square miles. The depth of the salt deposit is known to be at least 30 ft., as determined by bore holes sunk a number of years ago. The analysis shows the salt to be of rather exceptional purity. One of the principal factors in its favor is the absence of soluble salts of magnesium or calcium. Due to the large area and the depth of the field there is an inexhaustible supply of sodium chloride. Water for operation of the salt field is secured from Hunter Creek and from 40-acre tract of water-bearing land. Harvesting season is from May 1 to October 1 when the solar heat reaches 115° to 120° F.

Analysis of a sample of unwashed and washed salt, by Smith-Emery Co., of Los Angeles, gave the following results:

	Unwashed	*Washed*
Sodium chloride	98.71%	99.60%
Calcium sulphate	none	none
Sodium sulphate	1.26%	0.37%
Magnesium sulphate	none	none
Magnesium carbonate	none	none
Sodium borate	none	none
Water, insoluable	0.03%	0.03%
	100.00%	100.00%

When the property was in operation by the Sierra Salt Corporation, the aerial wire-rope tramway which extends from Saline Valley salt field to Tramway Station, a distance of 13 miles, was overhauled and put in first-class condition in 1929. About 30,000 tons of salt has been transported over the tramway since it was built in 1913. The tramway is equipped with 268 buckets and carriers, the capacity of each being 12 cu. ft., which at 60 lb. per cubic foot, would carry 720 pounds each, of dry salt. The mill at Tramway has a capacity of 70 tons of salt per day of 24 hours.

Mill equipment: One hot-air dry furnace; one revolving dryer, 4 ft. diameter by 36 ft. in length; 2 sets of grinding rolls; one single-deck

scalping screen; one double-deck scalping screen; 2 double-deck Hummer electric vibrating screens. All equipment is electrically operated, gravity flow of product from all screens to finish bins, 5 in number; packing devices and automatic scales.

Electric power for operation of tramway and mill is secured from Los Angeles Bureau of Light & Power. Idle.

Bibl.: State Mineralogist's Reports XV, pp. 122-123; XVII, p. 297; XXII, p. 527; U. S. G. S. Bull. 540, pp. 416-422; Transactions of American Society of Civil Engineers, Vol. LXXXI, p. 709 (1917).

SODA

Pacific Alkali Co. has a plant on the west shore of Owens Lake about 10 miles south of Lone Pine. Harvey S. Mudd, 1206 Pacific Mutual Bldg., Los Angeles, is president of the company; Geo. E. White, general manager; Geo. D. Dub, superintendent.

This plant began real operations in about 1930. The brine of Owens Lake is pumped through $2\frac{1}{2}$ miles of 14-in. pipe into 3 vats

PHOTO. 20. Pacific Alkali Company's Soda Plant, Owens Lake, Inyo County.

which range from 15 to 50 acres in size. It is left here until evaporation has raised the soda content to 12% to 14%. From the vats it goes to a storage reservoir where it is pumped into 16 six-ft. in diameter by 80 ft. high carbonating tanks. The carbonating is done by CO_2, solids going to centrifugal dryers. The soda is further dried and screened for laundry use or is calcined in Herreshoff furnace, making soda ash which is screened and sacked.

After soda is removed, the liquor is chilled either by spraying or the atmosphere, removing the crude borax. This sludge goes to a 6-ft. Oliver filter. Liquor is returned to the lake. The cake is diluted and pumped to tanks where it is redissolved, treated chemically and filtered in Sweetland filters, chilled and borax crystals go to centrifugal dryer, screened and packed, liquor to lake.

Capacity of plant is about 1000 tons of soda and 2000 tons of borax per season. Power is supplied by Los Angeles Bureau of Power and Light.

Fifty men are employed.

Natural Soda Products Co. has a plant just south of Keeler on the east side of Owens Lake. Stanley Pedder is president; Charles Eckland, secretary, 405 Montgomery St., San Francisco; G. A. Keep, general superintendent.

In the past two years this company has spent $500,000 erecting a 100-ton plant employing a new process for the manufacture of soda ash. At this time they do not care to divulge the details of this process.

This plant has been shut down for the last three months (August, 1938) on account of the fact that too much water has been allowed to flow into Owens Lake, instead of being diverted into the Los Angeles Aqueduct.

Forty-four men are normally employed.

Bibl.: State Mineralogist's Reports XV, pp. 125-126; XVII, p. 299; XX, pp. 190-191; XXII, p. 530.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

In This Issue

In addition to the Division's general mining report on Inyo County, two special geologic reports have been contributed to this issue: one is on the geology of the silver-lead mining district of Darwin, by Vincent C. Kelley; the other is on the geology of the sulphur deposits which occur on the west slope of the Last Chance range, Inyo County, by Edward D. Lynton. The first represents the results of field and laboratory study done in connection with an advanced degree granted by the California Institute of Technology; the second represents the results of special geological investigation, generously released for publication by the commercial concern for which it was done.

In Preparation

A map of the State showing not only the boundaries of the geologic formations, but also all of the quicksilver deposits known to be of any consequence in California, is now being prepared by the Geologic Branch. In the margins of the map will appear much significant information as regards the geology, economics, and production of quicksilver. The scale of the map will be one-half that of the Geologic Map of California, or 1 inch=16 miles. It will represent one of a series of such State mineral deposit maps, the data for which are now being compiled.

GEOLOGY AND ORE DEPOSITS OF THE DARWIN SILVER-LEAD MINING DISTRICT, INYO COUNTY, CALIFORNIA *

By Vincent C. Kelley **

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* This report represents the results of a doctorate thesis prepared at the California Institute of Technology.

** Instructor at the University of New Mexico, Albuquerque.

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ABSTRACT

The Darwin Silver-Lead mining district is located in the Darwin Hills, Inyo County, California. These hills rise 1000 to 1500 feet above the more or less flat top of a large mountain mass which lies between Owens Valley on the west and Panamint Valley on the east.

The flat portion of this large mountain block or horst covers some 250 square miles and is called the Darwin plateau. It is delineated on the north and the northeast by abrupt descents into Saline and Pana-

mint Valleys. On the southeast the plateau is bounded by the Argus Range which rises abruptly by a series of faults above a somewhat dissected portion of the plateau. On the southwest the plateau is bounded by the Coso Range which has been elevated also by a recent fault. On the west the plateau is bounded in part by the southern end of the Inyo Range, and in part merges into broad washes dissected in lake beds and descending gradually into Owens Lake.

The Darwin Hills owe their origin to faulting, particularly on the west side, and to recent dissection of the southern part of the plateau by the Darwin Wash.

The oldest rocks within the hills are a series of Pennsylvanian limestones, shales, and quartzites. The strata of this series are considerably folded, especially along the eastern slopes of the hills. Impure limestones comprise the bulk of the Pennsylvanian rocks which aggregate some 5000 feet as exposed in the Darwin Hills.

Intruded into the folded series is an elongated stock. This stock, five miles in length and two-thirds of a mile in maximum width, parallels the north-northwesterly trend of the stratified rocks. The stock widens in depth and cuts across the west limb of a large fold. The intrusive rock is medium-grained quartz diorite on the average, bu more acidic and basic phases are common.

The igneous intrusion has effected marked transformations in the country rock, particularly in the limestones. The metamorphic aureole is as much as 2500 feet in width. Within this zone the limestones have been converted into silicate-carbonate rock termed tactite. The silication of the limestone was caused by the action of igneous emanations which accompanied the intrusion. The original stratification of the limestones is retained despite the transformations. The zone as a whole has been bleached to a grayish or greenish white, which stands in contrast to the gray or brown of the unaltered sedimentaries.

Following the metamorphism and the consolidation of the stock, the rocks were fractured and faulted. These fractures fall into two prominent sets. One set trends northwesterly and the other east-northeasterly nearly at right angles to the stock. The major or master fracture of the district is a large fault on which the greatest component of displacement appears to be horizontal. This fault crosses the northern end of the hills where it is made plain by both structural and physiographic effects. The principal movement on most of the faults has been such as to displace the north walls westward.

The ore mineralization took place after the fracturing, and the localization of the ore mineralization shows three structural controls: igneous contacts, bedding planes, and cross fractures. Of the fractures only those trending east-northeasterly have proved productive. The northeasterly-southwesterly stresses which caused the faulting and which were active during part of the mineralization at least were such as to more effectively open the east-northeasterly fractures to the ore-bearing solutions. On the west side of the stock the beds roughly parallel the igneous contact and only on this side are important deposits of ore found at the contact between the stock and the country rock. Deposits along favorable bedding planes are found on both sides of the

stock. Deposits along faults or fissures are more numerous and more productive on the east side of the stock.

The original ore mineralization of the deposits consists principally of galena with lesser quantities of sphalerite and chalcopyrite and minor quantities of the gray-coppers, luzonite and tennantite. Near the surface the sulphides have been extensively oxidized and much of the ore consists of gossan in which is found principally the lead-carbonate, cerusite. Lesser quantities of anglesite, smithsonite, malachite, and chrysocolla with small quantities of horn silver are also present. The associated gangue consists of pyrite, jasper, calcite, fluorite, kaolin, and occasionally barite.

The mineralization belongs to the intermediate or upper mesothermal group of ore deposits having thus originated in the presence of temperatures and pressures neither extremely high nor extremely low. The geologic epoch or period of mineralization probably occurred during late Mesozoic comparable in time with the formation of the gold deposits of the Mother Lode of California.

INTRODUCTION

LOCATION

The Darwin district is located within the desert basin and range province of eastern California about 20 miles east of Owens Lake (Fig. 1). Darwin is 230 miles from Los Angeles and 24 miles from Keeler, the branch terminus of the Southern Pacific railroad. The Death Valley highway which passes through Darwin has been steadily improved since the establishment of the Death Valley National Monument in 1933. Eastward from Darwin for many miles the road follows the wash which drains a large upland area subject to summer cloudbursts. Because of the repeated destruction of the section of the highway in the wash a new road has been proposed and surveyed which will pass six or eight miles to the north of Darwin.

The area described herein as the Darwin silver-lead district is coextensive with the Darwin Hills which in turn fall within the legal confines of the New Coso mining district. The town of Darwin lies at an altitude of 4750 feet along the western edge of the Darwin Hills. The population of Darwin and the adjacent camps in 1937 was about three or four hundred.

HISTORY

The Darwin deposits were discovered in the early seventies and the district flourished during the first two decades largely from the rich surface ores. Before 1880 several smelters had been built near Darwin with capacities from 20 to 100 tons. In 1875 water was piped down from the Coso Mountains, a distance of eight miles. During those early days Darwin is said to have spread eight blocks in either direction and to have had a population of 5000.

Only the slag dumps mark the former presence of the smelters. Poor transportation facilities and exhaustion of the rich near-surface ores caused the district to lie dormant or only sporadically active until the World War gave new impetus to mining. About that time many of the larger properties were consolidated and development began anew with modern methods and equipment. In the early twenties a new camp and mill were erected and additional water was obtained from the Darwin basin. Although these were shut down during the depression, plans for their reopening were formulated in 1936, and mining began again early in 1937. The district is estimated to have produced nearly $6,000,000 in lead, silver, and zinc. About half of this amount was gained before 1900.

PHYSIOGRAPHY (See Figs. 2 and 3)

The Darwin Hills, in which the deposits occur, lie near the center of a large arched mountain block some 30 miles in width, which trends in a north-northwesterly direction in common with other ranges in this region. This large block is usually considered in three smaller and

separate physiographic units, namely, the Inyo, Coso, and Argus Ranges. The Darwin region is a separate unit or central plateau above which these adjacent ranges have been elevated by faults. The general character of the oldland surface which existed prior to the basin and range faulting of Quaternary time is still well preserved on the Darwin plateau.

The Darwin Hills rise only slightly above the general level of the plateau and trend in a northwesterly direction. The Darwin Hills proper are six miles in length and rise from 500 to 1000 feet above the broad Darwin Wash which borders the hills on the west, south, and east. One's first impression is that the smaller physiographic features on the plateau, such as the Darwin Hills, are erosional remnants on the oldland surface. Obscure structural evidence, however, in the form of remnants of displaced lava sheets indicates that even the Darwin Hills are a small fault block on the plateau surface.

Erosion of the Darwin Hills has reached the stage of early maturity since the Quaternary elevation. Throughout most of this period the erosional base of the hills has been the surface of the plateau itself. Very recently, headward erosion in the Darwin Canyon and Wash has cut into this old base east of the hills and is at present effecting their rejuvenation in preparation for a second dissection.

CLIMATE

The climate at Darwin is similar to that of the basin and range province in general. Scant rainfall, low humidity, and continued moderate shifting winds are the characteristic climatic elements. On the whole the climate at Darwin is perhaps somewhat more equable than in the adjacent areas. In the winter the temperature is apt to be very little lower than that of the Owens Valley to the west where cold air masses settle from the snow-covered Sierra Nevada and Inyo Range. During the summers the temperatures are correspondingly cooler than in the adjacent desert basins. The summer temperature rarely exceeds 105° F. The average rainfall at Keeler, the nearest station for which records have been kept, is only slightly over three inches. Although the rainfall is undoubtedly greater at Darwin, it probably does not exceed an average of four or five inches. Most of this comes during the winter months. Scattered rainfall in the form of thunder showers is common during the months of July and August, but much of this runs torrentially into the adjacent basins.

WATER-SUPPLY

No water for domestic or mining purposes is available in the Darwin Hills. The deepest mines in the district, the Lucky Jim and the Lane, are dry on their lowest levels which are 1000 and 800 feet, respectively. The lowest level in the Lane mine is lower than the bottom of the Darwin Wash two miles down the alluvial slope to the east, where abundant water is available. The dryness of the Lane mine thus indicates the influent nature of the Darwin Wash.

A gravity water supply for mining and domestic purposes was developed as early as 1875 by an eight-mile pipe line from a spring in the Coso Mountains. This sold at the rate of a half cent a gallon for mining purposes and one cent a gallon for domestic purposes. Water

for subsequent mining and milling operations was obtained from a shallow well near the head of Darwin Canyon where the large underground water supply from the 160 square miles of watershed on the Darwin plateau is forced near the surface. The water is pumped through a four-inch pipe line with a lift of 800 feet in three miles to the mill and 1800 feet in four miles to the mine and camp. The Keystone Darwin Limited plans to pump water to their camp from a new well in the wash near that of the Darwin Lead Company. Abundant water should be available in the wash upstream from these wells but at greater depths. In 1937, the domestic supply for the town still came from the spring in the Coso Mountains at a cost of one cent a gallon.

PAST WORK

From time to time since the discovery of the district in 1874 the reports of the State Mineralogist have contained brief descriptions of the mines and geology. These have been reports on the existent mining operations, equipment, and production, with notes on the local geology. The only strictly geological report was written by Adolph Knopf as the result of a five-day examination of the district following his work in the Inyo Range in 1913.

As in the present report, Knopf's observations were confined almost exclusively to the Darwin Hills. Knopf determined the age of the limestones as Pennsylvanian, summarized the general geology, and from study and description of the individual mines and prospects, deduced a genetic relationship between the pyrometasomatic deposits and fissure veins of the district. In addition, he briefly described the general character and composition of the intrusive rocks and the associated tactites.

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SCOPE OF PRESENT WORK

The present report is the outgrowth of nearly two months of field work during the summers of 1935 and 1936 in which time a topographic and geologic map of the Darwin Hills was made on the scale of 1000 feet to the inch. In addition, geologic reconnaissance mapping was extended over much of the Darwin plateau and small portions of the Argus and Coso Ranges with the view of obtaining a broader geologic background for the detailed work in the Darwin Hills. Detailed geologic maps were made of the Defiance-Independence mine group on the scale of 200 feet to the inch.

During the investigation the following features were given special consideration: (1) the character of the silicate zone about the intrusive, (2) the origin of the zone, (3) the form of the intrusive, (4) the structural pattern of the fissure system, and (5) the geologic occurrence of the orebodies. The wide silicate zone about the intrusive originated under the influence of magmatic emanations which thoroughly penetrated the surrounding impure limestones. Although the composition of the original beds was in many places the controlling factor in the resulting mineralogic make-up of the zone, concrete evidence is present for the introduction of large quantities of new materials, principally silica. The deposits are classed as mesothermal in contrast to the pyrometasomatic grouping given by Knopf. The period of metallization is sharply set off in time from the silication * process by consolidation of the magma and by post-intrusive fracturing.

ACKNOWLEDGMENTS

The field work and the compilation of this report were completed while attending the California Institute of Technology in the Balch Graduate School of the Geological Sciences. The writer wishes to thank the members of the faculty for criticism of the manuscript and for suggestions in the field. At Darwin many of the residents helped with information about the history of the camp, locations and names of mines, etc. Special thanks are due to H. E. Olund, manager, and Sam Davis, assistant manager of the Darwin Lead Company; L. D. Skinner, owner of the Christmas Gift mine; A. Yoder, manager and superintendent of the Keystone Limited; Theo Peterson, owner of the Darwin Garage; and Alex Rouna, owner of the Standard and Fairbanks mines.

* The process of changing to silicates; whereas *silification* is the process of changing to silica, either as quartz, chalcedony, or opal.

GENERAL GEOLOGY

GENERAL GEOLOGIC SETTING

Two contrasting rock types underly the Darwin plateau. The southwestern portion, generally south and west of the road from Darwin to Keeler, is underlain by granodioritic rock closely comparable in texture, composition, and structure to the intermediate rock of the Sierra Nevada batholith. Occasional patches of older rocks are present as for example on Centennial Flats where large deposits of iron ore occur in a remnant of schist and marble. Commonly the granodiorite of this region is cut by basic dikes which often display marked persistency for considerable distances. The widespread granodioritic body of the area is referred to in this report as the Coso batholith.

The northeasterly part of the plateau is underlain chiefly by folded upper Paleozoic rocks similar to those in the Darwin Hills and in the north end of the Argus Range. Knopf (pp. 36-48, 1918) has described these rocks in the south end of Inyo Range southeast of Keeler where they form folds of Mesozoic age. In the Inyo Range southeast of Keeler these folds are covered by extensive lava sheets, but they emerge again along the strike to the southeast of the Darwin plateau. There they are partially cut off and offset in their distribution around the Coso batholith. The same system of folds passes through the Darwin Hills and thence southeastward, by step-faulting into the Argus Range.

Here and there the Paleozoic rocks are pierced by small intrusives which may well be off-shoots from the Coso batholith. Knopf (p. 5, 1918) described such intrusives as common in the Inyo Range. In the general Darwin region they are exemplified by the quartz diorite stock of the Darwin Hills, the small granitic intrusion near the Lee mine, the gabbroic stock at Darwin Falls, the monzonite plug at the north end of the Argus Range, and several smaller intrusives southward in the same range. Northeast of Darwin the truncated Paleozoic beds are extensively capped by basaltic flows which form a large part of the plateau surface and may conceal the presence of other intrusive stocks.

SEDIMENTARY ROCKS

Pennsylvanian Series

A series of Pennsylvanian strata consisting largely of pure and impure limestones intercalated with some quartzite and shale constitute the oldest rocks of the Darwin Hills. Fossil corals, crinoids, fusulinae, bryozoa, and occasional ammonoids occur in these beds. The state of preservation of the fossils is usually rather poor and exact determinations are therefore difficult. On the basis of determinations made by George H. Girty, Knopf (1914) called the formation Pennsylvanian. The strata dip westerly across most of the width of the hills and therefore, excluding complete overturning for which there is no evidence, the younger beds crop out on the west flanks of the hills. The oldest beds, or the lowest in the exposed series, crop out on the

east side of the hills and locally they are considerably folded. The lower strata east of the stock and on the east side of the hills are generally drab and uniform gray or brown with few distinct horizons or marker beds. The younger strata, on the other hand, which crop out on the western slopes of the Darwin Hills, consist of and are marked by prominent, contrasting light and dark colored members. The beds along the western half of the hills generally dip steeply west and aggregate about 2500 feet in thickness. The contrasting nature of the members of a portion of this series is shown by the following section between the sill beneath the east escarpment of Ophir Peak to the western edge of the hills:

(1) 2-300 feet of thin-bedded, dark-gray, impure limestone
(2) 4-500 feet of white and grayish white limestones
(3) 3-400 feet of dark-gray to black limestones
(4) 4-500 feet of pure, massive, white limestones

Alluvium overlaps the youngest strata at the base of the hills and the Coso granodiorite probably intrudes the limestones a short distance beneath the alluvial cover. The members of the above series appear to finger and wedge out southward toward the Darwin Lead Company's camp, where they are further confused and their identity obliterated by local folding and silication. An isolated patch of folded, pure white limestone probably equivalent to the third member listed above occurs at the entrance of the Radiore tunnel.

A section across the southern end of the hills shows an inclined series dipping 40-60° west. The thickness of this section, although neither the top nor the bottom of the series is exposed, approximates 5000 feet. At the top of this section is a prominent member of dark-gray impure limestone which marks the bold front of the hills southward from the town of Darwin. To the north near Darwin the character of this member is obliterated by bleaching and silication; to the south it is partially cut out by a lobe of the Coso batholith. In the center of the hills along this east-west section silication has again obliterated the original nature of the sedimentary material, but along the southeastern tip of the hills at the statigraphic bottom of the section a dark-gray to black limestone member 6-700 fee in thickness makes up the oldest Pennsylvanian rocks in the Darwin Hills. This member occurs just east of the Columbia mine where it forms bold cliffs 2-300 feet high facing the Darwin Wash.

The east slope of the Darwin Hills consists of closely folded, thin-bedded limestone strata in which conspicuous lithologic members are absent except as noted above. The beds in general are drab brown and gray color. No white limestone strata occur and only occasional relatively thin, blue-gray limestone beds are present.

The blue-gray limestone which makes up so much of the Pennsylvanian rocks throughout the hills is commonly spotted in texture. In many instances this is due to fusulinal and crinoidal remains which, because of their differential coloring and solubility, cause a spotted texture in the outcrop. A similar spotty texture is also due to small lenses and nodules of chert in the limestone.

The lithology in the north end of the Darwin Hills north of the large east-west fracture here referred to as the Darwin tear fault

is noticeably different. Magenta, lavender, and brown, thin-bedded shales are common. A massive quartzite bed 30-40 feet in thickness crops out as a prominent ridge about 1300 feet north of the Lucky Jim mine. An even more striking feature of these beds is the increased spottiness of the limestones. Although some of this texture indicates organic origin, much of it is fragmental and undoubtedly many of the beds are depositional limestone breccias. No age determination was made of those beds north of the fault, but because of the structure and direction of displacement along the fault they are thought to be older than the beds south of the fault.

In connection with studies of the silication process a chemical analysis of a sample of typical blue-gray limestone from the ridge above the Thompson mine was made. This showed a content in $CaCO_3$ considerably higher than the average for limestones of Carboniferous age.[1]

The table below shows the comparison of the Darwin limestone with Daly's[2] analyses of Carboniferous and Cretaceous limestones.

Limestones	Ratio $CaCO_3 : MgCO_3$	Ratio Ca : Mg
Carboniferous	8.8 : 1	12.4 : 1
Darwin	22.8 : 1	31.5 : 1
Cretaceous	40.2 : 1	56.3 : 1

Richard Wallace of Darwin reports analyses of the white limestone on the west slope of the hills which show 98 per cent $CaCO_3$. The high ratio of calcium to magnesium in the Darwin limestone suggests that dolomitization has been relatively unimportant in the Pennsylvanian rocks.

Pleistocene Lake Beds

About 50 feet of nearly horizontal white lake beds have been exposed by recent dissection in the wash east of the Darwin Hills. The material of the beds is fine-textured and thick-bedded and probably originated, in part at least, from volcanic ash. The beds are capped by recent alluvium; their base is unexposed. In the Coso Mountains J. R. Schultz[3] has found similar beds of early Pleistocene or late Pliocene age overlying older gravels and in turn capped by basaltic lavas which are probably age equivalents of the lava sheets at Darwin. At Darwin, however, the age relationship between the lake beds and the lava sheets is reversed. The lake beds in the Darwin Wash are not capped by lava. Furthermore, about 700 feet east of the lake beds in the wash, on a small tilted fault block at the base of the Argus Range, basalt directly overlies Paleozoic beds and lake beds are absent. From this relationship it appears that the lake beds are not only younger than the basaltic lavas, but also that they are younger than the faulting which dislocated the basalt. Although beyond the scope of this report, the evidence suggests that the lowermost step fault in the Argus Range was at one time the obstruction to the drainage of the wash which created the lake in which the white beds accumulated. These lake beds, then, are distinctly younger than those

[1] Grout, F. F., Petrography and petrology: p. 302, 1932.

[2] Daly, R. A., Evolution of the limestones: G. S. A. Bull. vol. 20, p. 165, 1909.

[3] Schultz, J. R., Late Cenozoic vertebrate fauna from the Coso mountains: Carnegie Inst. Wash., Pub. No. 487.

described by Schultz in the north end of the Coso Mountains. If those in the Coso Mountains are early Pleistocene, then the Darwin lake beds may be middle or even late Pleistocene in age. No fossils have been found. Headward erosion in the Darwin canyon has subsequently dissected the lake beds by cutting through the outlet of the lake.

Recent Alluvium

The alluvial deposits of the broad washes and fans surrounding the Darwin Hills are of two types, older dissected gravels and recent gravels. The younger gravels are in part derived from the older and in places they grade into each other. These two types do not result from diastrophic rejuvenation, but rather from the down-cutting of the outlet to the Darwin lake which was the former temporary base level for the erosion around the Darwin Hills. The dissected gravel, where it overlies the exposed lake beds, is usually not more than 10 to 20 feet in thickness. Upstream from the exposed lake beds and especially in the wash south of the Darwin Hills the gravels are much thicker, and arroyos as much as 50-75 feet in depth have been carved. Dissection of the gravels on the west side of the hills is very slight compared to that on the east by reason of the bench of hard rock through which the stream flows at the south tip of the Darwin Hills. At this point is a "dry falls," 50-60 feet in height. Adjacent to the limestone hills not only the alluvium but also the lake beds are well cemented by calcium carbonate.

IGNEOUS ROCKS

Coso Granodiorite

The Coso granodiorite is batholithic in extent and underlies most of the plateau south and west of the Darwin Hills. A small area of this rock crops out in the southwest edge of the hills where it forms low rounded hills in contrast with the sharper relief of the limestones. Along the road to the Promontory mine it can be seen in intrusive contact with dark-gray limestones. Although thin sections from the rock of this area indicate it to be granite, the designation granodiorite is retained because it more nearly proximates the average composition of the batholithic material throughout the plateau. Megascopically it is a coarse-grained, light-colored, granitoid rock in which the principal minerals are quartz, feldspar, and green hornblende. Under the microscope most of the feldspar proves to be orthoclase or microcline. Biotite is common and such accessory and secondary minerals as sphene, apatite, chlorite, and epidote may be present. A few dark-green kersantite dikes cut the granite in the Darwin Hills.

Darwin Quartz Diorite

General Features. The formation name Darwin quartz diorite is here applied to the elongated stock which occupies the center of the Darwin Hills. All metallization is associated with this intrusive. The stock is about 3500 feet in its greatest width just northeast of Darwin. To the north and south it narrows and terminates in smaller isolated stocks, dikes, and sills. It ends within the hills and its total length is about five miles.

The drab brown color of the intrusive causes it to stand out nearly everywhere in strong contrast to the surrounding white silicate zone. The greater ease with which the intrusive weathers has caused it to form a lower interior belt of subdued topography surrounded by boldly outcropping stratified rocks. Variations in composition and texture within the igneous mass itself have also resulted in differential weathering. Thus, near the Defiance mine are several small knobs and ridges of quartz diorite standing out in otherwise subdued relief.

Composition and Variations. The stock as a whole displays considerable heterogeneity of composition, but for the most part these variations are only phases of the one intrusive. In nearly all of its phases the rock is medium-grained and nonporphyritic. It is normally a light colored, white or light-gray rock when fresh. Pinkish and greenish-gray types are also common. In general, variations in the intrusive range from quartz monzonite to diorite or gabbro. Nearly all of the phases with the exception of the gabbro are of the over-saturated type in which quartz is always present in essential quantities. In the quartz diorite or even the granodiorite the euhedralism of the plagioclase is the striking textural feature under the microscope.

In the over-saturated phases the ferromagnesian minerals are ordinarily not abundant. The most common ferromagnesian mineral is biotite. Hornblende and augite are decidedly less common and in many phases absent. Where the ferromagnesian content is high the mineral is most commonly augite.

Distribution and Origin of the Phases. The more basic phases of the rock occur in the north and south ends of the elongate stock. The change towards basicity is gradual yet very irregular. There is greater heterogeneity of phases and greater concentration of the melanocratic phases in the narrower terminations. Examples of the basic rock areas are well shown near the Christmas Gift mine where the rock is augite diorite or gabbro. Near the southern end of the Christmas Gift extension claim is a considerable area of very dark-colored rock which is almost entirely composed of augite with a little labradorite. In the southern end of the hills west of the Silver Spoon mine and south of the Promontory mine are areas of diorite or locally augitic rocks. These various types of rocks are not separate intrusions but different expressions of one magma.

There is little to indicate that the stock differentiated in place. Furthermore, except locally, reactions with the country rock do not appear to have influenced the composition. No regular border phase of more basic rock exists. Instead, phases appear to be due to original variations in the intruded material.

Perhaps the first intruded material was basic and later surges, intermediate in composition, pushed the basic material outward and toward the ends. As the stock grew, more acidic material continued to concentrate at the center.

Related Dikes. In places the border portion of the intrusive and the nearby contact aureole contain many dikes. Some of these are direct offshoots of the stock and cut only the country rock, while others are later and also cut the intrusive. The dikes are all more acidic than the main intrusive. In a few cases offshoots from the intrusive, where

traced outward, become increasingly acidic, changing sometimes to alaskitic or syenitic dikes. The syenite dikes are very common in the contact aureole between the Defiance mine and the Thompson mine. They are coarse-grained and composed almost entirely of orthoclase. The color varies between pink, green, and white. Whereas these and other dikes may have originated as magmatic dikes in the ordinary sense, the evidence suggests in some cases an origin by metasomatic processes. South of the George Washington shaft in the southern part of the hills, alaskitic material has spread in an anastomosing manner from stratification planes through several adjacent beds converting them completely to alaskite or quartz-orthoclase rock. In other places feldspar dikes appear to fray out and permeate adjacent walls in a manner suggesting replacement. This subject is treated more fully under igneous metamorphism. The subject of alteration of the intrusive is dealt with in the same chapter.

Basalt and Tuff

Many square miles of the Darwin plateau are covered by basaltic flows. The surface upon which this material was extruded was remarkably smooth, but it has since been broadly warped and block- or step-faulted. As a result the sheets are not everywhere continuous and in large areas they have been entirely removed by erosion. Furthermore, in downwarped or downfaulted areas much of the volcanic material has been covered by alluvium.

The northeastern edge of the Darwin Hills is covered by a basaltic sheet sloping 10°-15° toward the east. At the west edge of the sheet the thickness is about 20 feet, but eastward it thickens to 400-500 feet and four of five flows are distinguishable. Several thin isolated remnants of basaltic cap occur at distinct levels along the west flank of the hills, and while the uppermost of these is being exhumed by erosion, the lower patches are being covered by the outspreading alluvial apron. The pronounced difference in thickness of the sheet on the higher slopes of the Darwin Hills and to the east near Darwin Wash and Panamint Valley may be in part due to the lateral stripping of the flows in the higher area, but for the most part this difference is probably original. The difference in thickness and number of flows together with the occurrence of agglomeratic ejectamenta beneath the lavas in the lower course of the Darwin Wash suggest that the source of the volcanic flows in the northern part of the Darwin Hills was in the east, probably near the edge of the present Panamint Valley. The base of the basalt series is nearly everywhere characterized by loosely consolidated brown cinder beds. Near Darwin these are only a few feet in thickness, but toward the east they thicken considerably.

The extensive basaltic sheets of this region are all pre-basin and range faulting and were thought by Knopf to be probably of early Quaternary age. In this respect it is interesting to note the presence in this region of small basaltic cones which are younger than most of the basin and range faults. As in Owens Valley to the west many of these have had their position determined by the basis and range faults. To the east of the Darwin Hills along the flank of the Argus Range are two such cones. One of these has its locus along the Darwin tear fault and the other rose along one of the step-faults of the Argus Range.

STRUCTURE

SHAPE OF THE STOCK (See Figs. 4 to 9, inclusive)

The Darwin stock has a length of five miles and a maximum width of about two-thirds of a mile midway of its length. From the central part it tapers irregularly into narrow north and south tips which are only a few tens of feet wide. The general trend, N. 25° W., is parallel to that of the sedimentary formations into which it is intruded. In detail its original outline was rather irregular with many large and small protuberances and outliers. However, much of its present irregularity has been caused by subsequent cross faults which have offset the body in many places. In the northern part, the stock is characterized by many inliers of tactite which attest to the proximity and irregularity of its apex in this region.

In general the contact of the stock dips outward on both sides and so it widens in depth. On the west side the contact dips under the tactites approximately parallel to their stratification which is inclined, on the average, 50° to 60° westward. On the east side, especially in Lane canyon, the contact crosscuts the westward dip of the tactites. Toward the north and south ends of the stock the contact may conform to the west dip of the tactites in which places the stock would appear sill-like in cross-section.

FOLDS

The stock is intruded into steeply inclined beds of a folded Pennsylvanian series. The deformation of the Pennsylvanian rocks on the west side of the stock differs from that on the east side. The series on the west side of the stock is practically homoclinal and dips generally S. 65° W. at 50°. Two types of small local folds interrupt this general attitude of the beds. One consists of small, nearly upright and horizontal folds with axes parallel to the trend of the formation. Only two or three such folds occur in the series, the most noteworthy of which is the one near and parallel to the intrusive contact between the Defiance and Essex mines. The second class of local folds represents warps in the regional trend and, although the exact axial attitudes are difficult to determine, they are steep and usually at a considerable angle to the general strike of the beds. One such fold with axis pitching steeply westward occurs in the hills west of the Fairbanks mine. Another occurs high on the slope of Ophir Peak and can be seen from the highway approaching Darwin. These folds are like local knots in the otherwise even grain of the formation. It seems likely that the stresses which produced this second class of folds were different in direction from those which caused the first class of folds.

The beds on the east side of the stock are considerably folded. Immediately east of the contact the beds dip west into the stock, and and the first fold is usually encountered at a distance of 1000 to 2000 feet from the contact. In places this is a large anticlinal fold with limbs dipping 60° to 80°. Along the highway through the hills the folding consists of one anticline and syncline between the east contact of the stock and the alluvial edge, a distance of about one-half mile. If this simple folded belt is followed northward to the steep slopes of the hills east and southeast of the Christmas Gift mine, the folding resolves into

an intricate belt consisting of many closely spaced and nearly isoclinal folds. To the south of the highway along this same folded belt, which generally occupies the east front of the hills, are similar closely folded zones particularly in the vicinity of the Fernando mine and south of the Keystone mine. Immediately east of the Lucky Jim mine in the north end of the hills, another zone of close folds exists in which one of the folds is overturned and broken into a high angle overthrust to the east. In many other places the close folds are slightly overturned toward the east, and, if the isoclinal belts are viewed from the east front of the hills, the beds appear as a simple inclined series dipping steeply west. The eastern edge of this zone of close folds coincides approximately with the base of the hills. It seems best to consider the zones as incompetent folds superimposed upon the larger and broader folds of the region. There is some suggestion that these zones may be due to crowding of the stock during emplacement, but where the stock is widest and crumpling by shouldering of the intrusive might be expected to be the greatest, the folding consists of a single anticline and syncline. The zones of close folding parallel the narrower portions of the stock. Furthermore, since protuberances from the stock cut the limbs of the broader folds it is probable that most of the folding antedates the intrusion of the stock.

FAULTS (See Fig. 6)

Faults in the Darwin Hills and displacements thereon can be given the following age grouping: (1) post-Pennsylvanian and pre-intrusive, (2) post-intrusive and pre-mineralization, (3) post-mineralization and pre-lava sheets, and (4) post-lava sheets.

No faults of the first group have been positively identified in the district. It is probable, however, that the folding of the Pennsylvania beds prior to the intrusion of the stock was accompanied by some fracturing. A few of the faults described as post-intrusive in age may have had their inception before the intrusion. No evidence of the age relationship between the Darwin tear fault and the intrusive is available, inasmuch as the fault crosses the hills north of the stock. This fault may be older or younger than the stock. All of the displacements, however, on the smaller cross-faults which cut the stock are in the same direction as that on the Darwin tear fault. This may be evidence that the large fault is also later than the intrusion and hence belongs to the following group.

Faults of the second group are numerous and they are the structural feature which controls much of the metallization in the district. These faults, many of which were later mineralized to form fissure veins, developed after the consolidation of the stock, and may be divided into two subgroups. The first, which has proved to be of the most economic significance, are most numerous, shorter, and roughly normal to the intrusive contact. Practically all of their strikes fall between N. 54° E. and N. 65° E. Many show no measurable displacement. The maximum displacement is not over 100 or 200 feet. Some of the more persistent, such as the Lane and Standard Extension have lengths of 4000 feet. Most of them occur within the tactite zone around the intrusive and end at or shortly within the intrusive contact. Only rarely do they cut entirely across the stock as in the case of the Standard

Extension fissure. Where the direction of displacement is ascertainable the movement is dominantly horizontal with the north side moving relatively westward.

The faults of the second subgroup of this age are rather limited in their distribution and they strike N. 50°-70° W. These faults, few in number, constitute a shear zone which cuts through the entire stock in the first canyon and valley north of Lane canyon. (See Plate VII.) The direction of movement is the same as that on the previous group, but the displacement is greater and later. Both subgroups have been subjected to post-consolidation mineralization. The length of this zone of faults is 8000 or 9000 feet. Although they crosscut the strata on the east, to the northwest and on the west side of the stock they either die out or are taken up by strike slip along bedding planes. The northwesterly faults which displace the Lucky Jim vein belong to this group although they are not within the immediate zone.

The time period represented by the next group of faults, post-mineralization and pre-lava sheets, is great, several distinct periods of movement are suspected, but can not be definitely proven. Many of the fissures previously described show signs of movement after mineralization, and this movement in some cases appears to have had steep vertical components as evidenced by the slickensided gouge zones in many of the fissures. Some of this may represent minor adjustments which resulted from the block faulting following the lava eruptions in early Quaternary time.

A few faults which offset veins are also present. These faults have a trend which is more nearly east-west than the previously described fissures. (See Fig. 6.) They strike N. 70°-80° E. and the direction of movement on them was the same as on the previous two groups, that is, the north side shifted relatively west. A notable example is the Christmas Gift fault which offsets the Christmas Gift vein and oreshoot. The displacement on this fault near the mine is 300-400 feet. Another such fault crosses the ridge east of the Darwin Lead Company's camp and near the Rip Van Winkle shaft. Here the displacement is about 150 feet.

The largest fracture in the district is the Darwin tear fault. It cuts across the hills about 1000 feet north of the Lucky Jim mine. The fault strikes N. 75° W. and dips 75° S. This steep southerly dip is also characteristic of the above described faults offsetting the fissure veins. In most places it is a shear zone 200-300 feet in width. The striking manner in which the northerly trending beds are dragged parallel to the fault zone clearly indicates the direction of movement. The Darwin tear is of considerable extent and can be traced for several miles to the west of the hills where it gradually passes into a series of folds. About three miles east of the hills it causes the Darwin Wash to swing easterly along the belt of weakness. It is traceable to the top of the Argus Range where it passes beneath the basalt capping. It has a total length of at least ten miles.

Dr. Richard Hopper of the California Institute of Technology has since shown in the Argus Range that the Darwin tear fault has a considerable vertical component of displacement such that the north side has moved upward as well as westward.*

* Oral communication.

The Darwin tear fault appears to be the master fracture of the district and all of the smaller dislocations formed prior to the lava flows are in a way related to it. The direction of movement on the smaller faults in the hills is the same as that on the large tear. In strike the Darwin tear fault appears closely related to the northwesterly trending fractures described above. The age of the Darwin tear is rather uncertain. It may have had its inception prior to, during, or after the development of the fissure veins, but evidence is present that at least some of the movement is later than the lava caps of early Quaternary age. Near the top of the Argus Range the lavas appear to be somewhat deformed by late movements on this fault.

The fourth group of faults are large fractures which trend northwesterly and are to be identified as basin and range faults developed in Quaternary time. These were undoubtedly instrumental in forming the Darwin Hills. Their presence and position is in part based on physiographic evidence, but this is supported by the positions of certain remnants of basalt flows surrounding the hills. From several such remnants located at levels along the northwestern edge of the hills it appears that they have been elevated or perhaps tilted toward tht east along at least two parallel faults. On the east side of the hills the slopes are very steep, a fact which caused Knopf (1913) to postulate a fault along their base. He also noted that toward the north the fault must terminate because unbroken lava sheets cross the extension of the postulated fracture. The ruggedness of the eastern slope, especially in its southern part, is due to some extent to undercutting by the Darwin Wash, but that some of the relief is due to faulting appears evident from the position of the lake beds and the lava caps in the giant step faults in the Argus Range east of the Darwin Wash.

From the geologic map it is evident that the regional trend of the folded Pennsylvanian rocks determined the trend and elongate shape of the stock. The question arises as to the influence of the intrusion on the development of fracturing in the adjacent rocks. Ingersoll and Zobel[4] have supposed that the cooling and contraction of the rocks behind a heat wave advancing from the intrusive have been the cause of fracturing in which later mineralization takes place. Emmons[5] has pointed out that the fissures formed in the outer part of intrusives and in the adjacent country rocks are often formed by the forces of intrusion or the pressures generated during cooling.

At Darwin the displacements on the fracture systems are closely related to tectonic forces. The uniform direction of displacement and accompanying shearing attests to this fact. It may be true, however, that some of the fractures upon which displacements later took place owed their origin to forces developed by the intrusion. The answer to this could be obtained by the determination of the relative abundance of fissures adjacent to the stock as compared to their abundance and trend at a distance. Not enough detailed mapping has been done in areas outside of the Darwin Hills to determine whether the outlines of the fracture systems are extensive over the larger terrain of the plateau.

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[4] Ingersoll, L. R., and Zobel, O. J., An introduction to the mathematical theory of heat conduction: p. 129, 1913.

[5] Emmons, W. H., Relation of ore deposits and batholith: Ore Deposits of the Western States, p. 339, 1933.

ILLUSTRATIONS FOR REPORT

By VINCENT C. KELLEY

Geology and Ore Deposits of the Darwin Silver-Lead Mining District, Inyo County, California

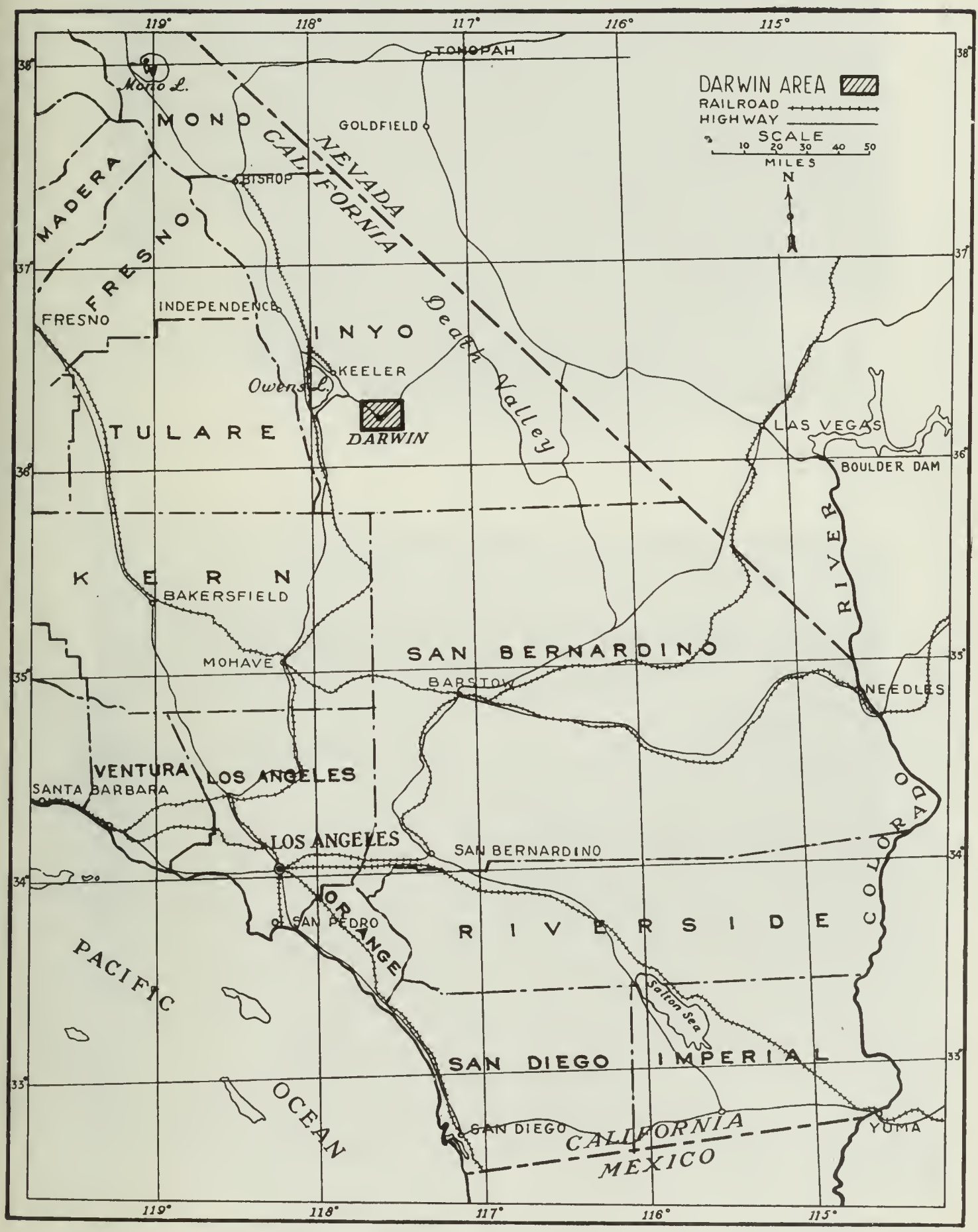


FIG. 1. Location map, showing area covered by this report on the Darwin silver-lead mining district.

FIG. 2. View across the Darwin plateau from the east over Panamint Valley. (1) North end of the Darwin Hills. (2) North end of the Coso Range. (3) Sierra Nevada. (4) Owens Lake. (5) South end of the Inyo Range. (6) Darwin Wash. In the foreground is the north end of the Argus Range.

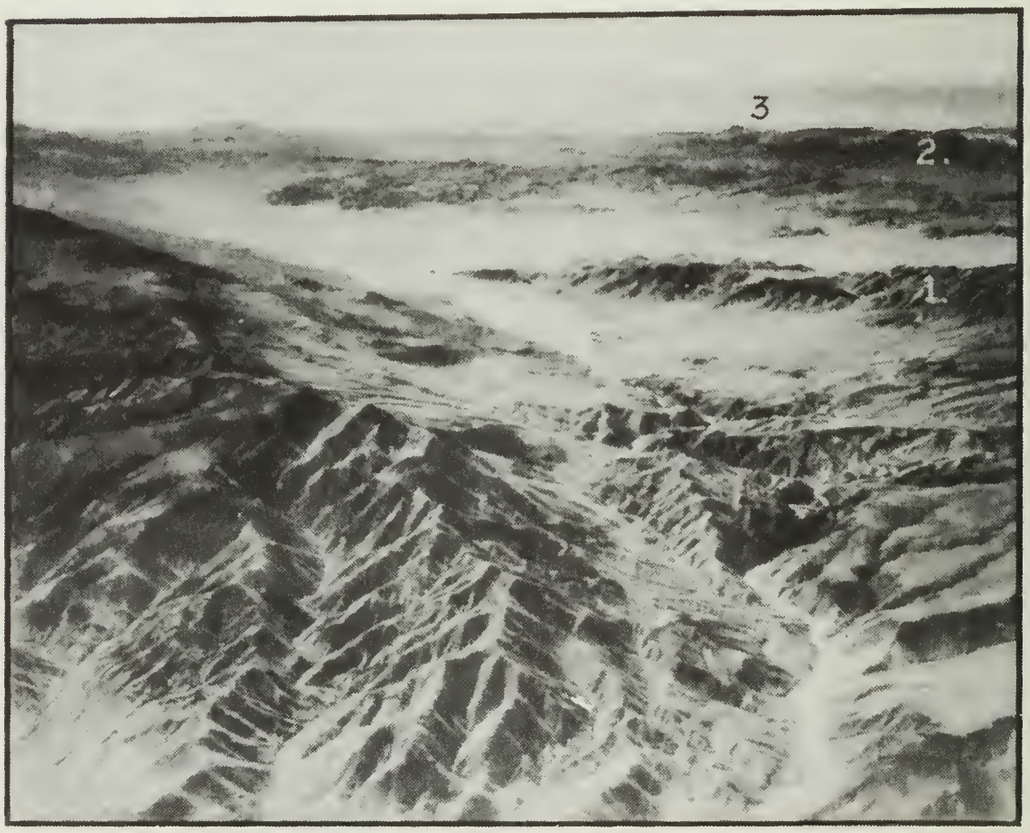


FIG. 3. North end of the Argus Range and Darwin Wash from over Panimint Valley. (1) South end of the Darwin Hills. (2) Coso Mountains. (3) Sierra Nevada. The lava sheets capping the Argus Range on the left are equivalent to those in Darwin Wash at the right.

FIG. 4. Alaskite sill with offshooting dikes in tactite near the Defiance mine.

FIG. 5. The irregular configuration of the west contact of the stock near the Independence mine (1). Tactite at the left and quartz diorite of the stock at the right. Equipment at the Thompson mine can be seen at the lower right.

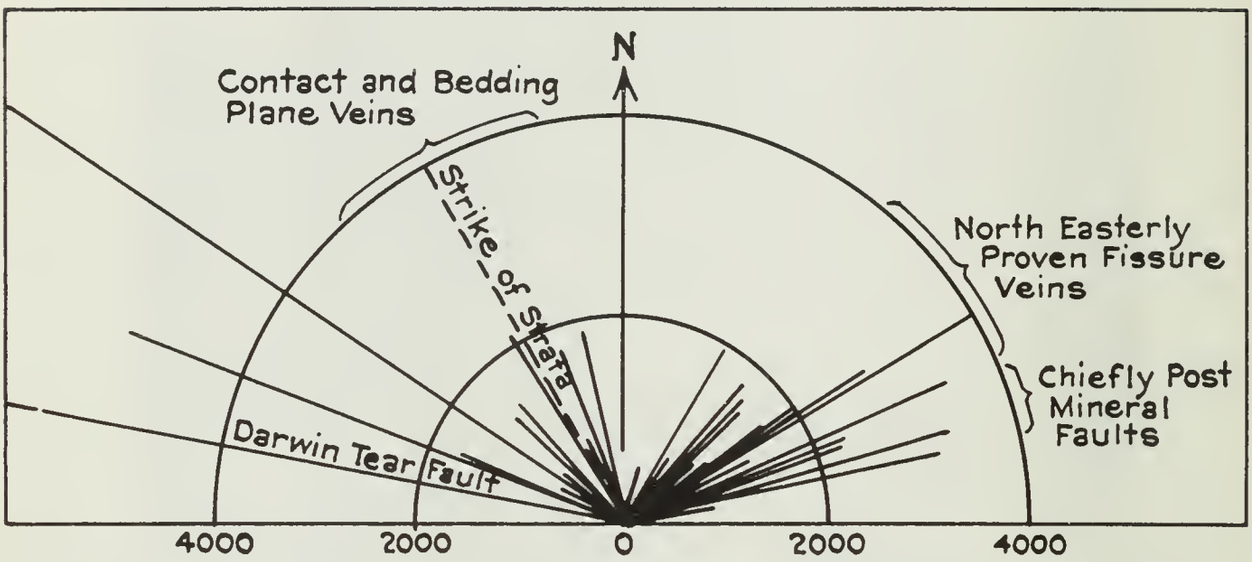


FIG. 6. Analysis of direction and magnitude of faults and of veins in the Darwin Hills.

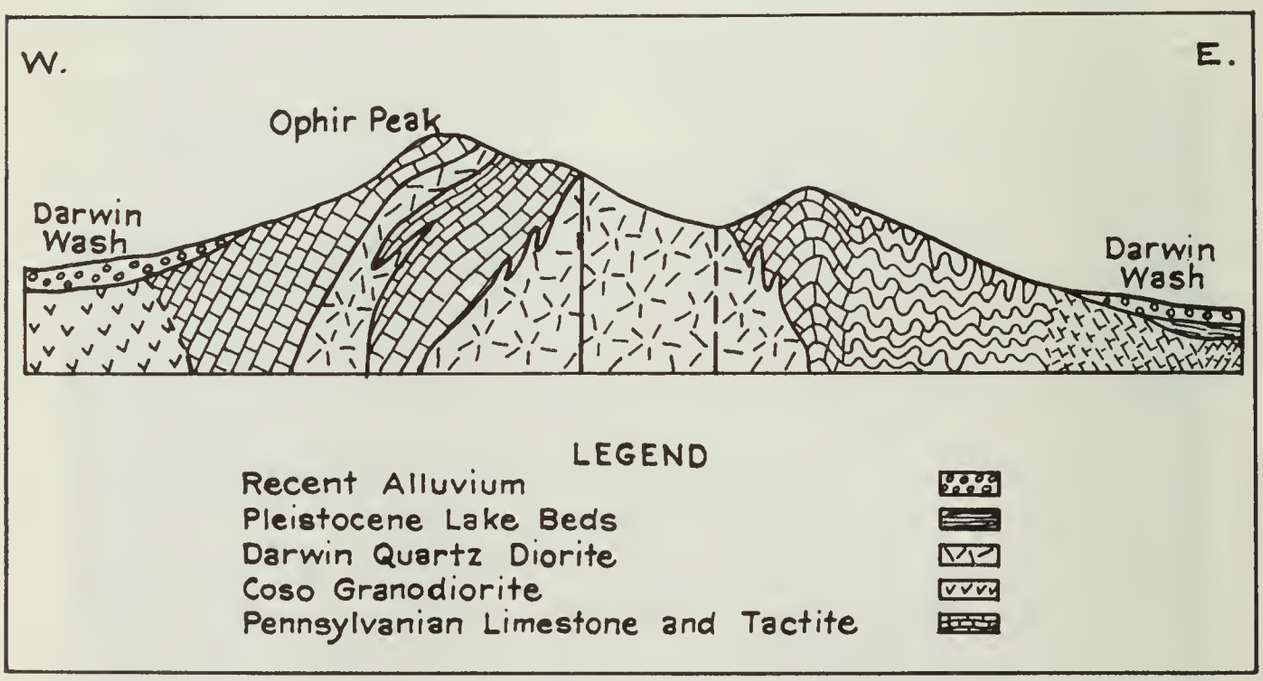


FIG. 7. Generalized structure section through the Darwin Hills near Ophir Peak.

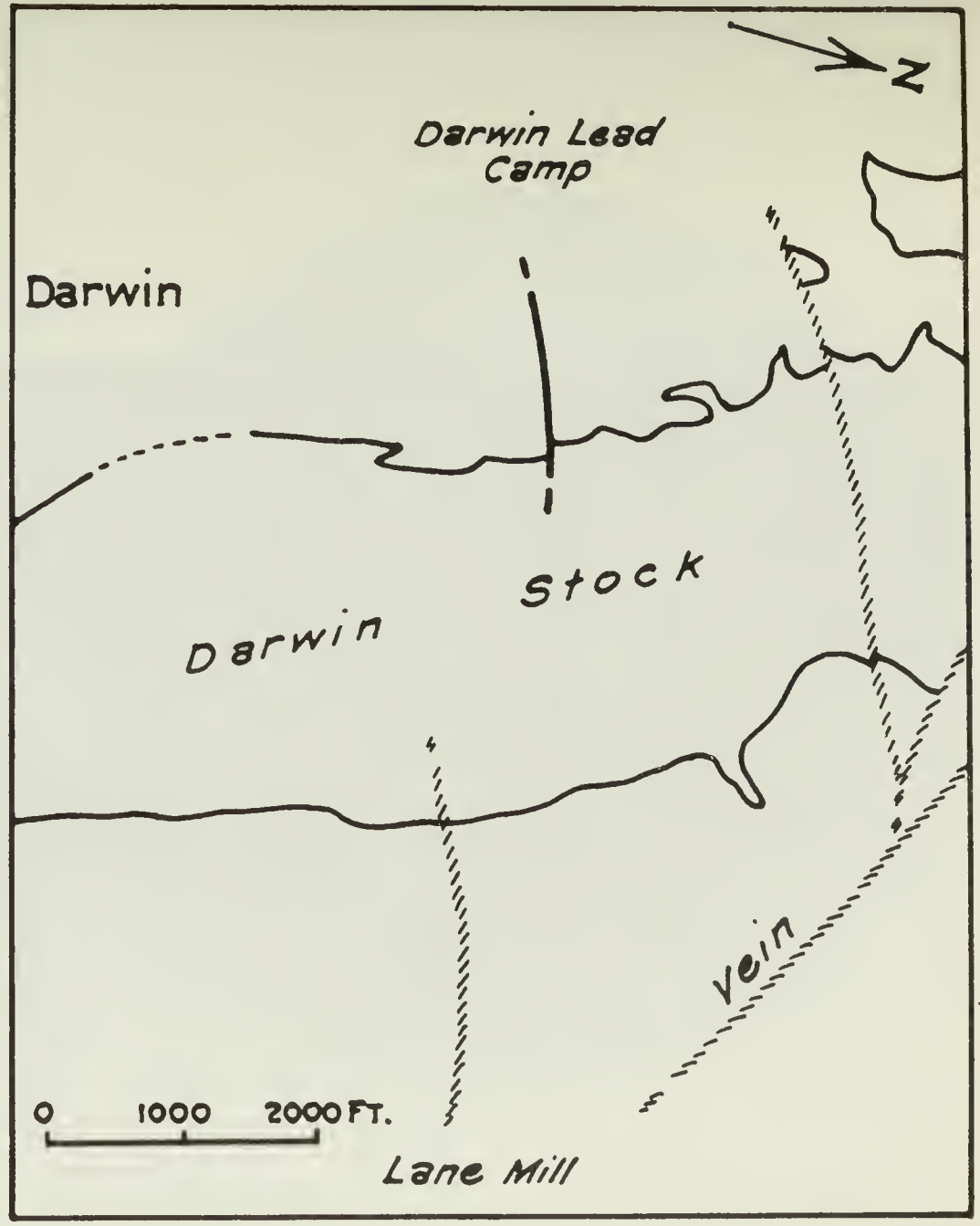


FIG. 8. Vertical air-view of Darwin Hills in the vicinity of the town and the Darwin lead camp. (Graphic explanation given in line-drawing.)

FIG. 9. General view of the contact of the stock (d) and the tactite (t) zone along the ridge between the Defiance and Independence mines.

FIG. 10. Spots of wollastonite in fine-grained limestone. An early stage in the development of wollastonite tactite. Crossed nicols. Magnification 11X.

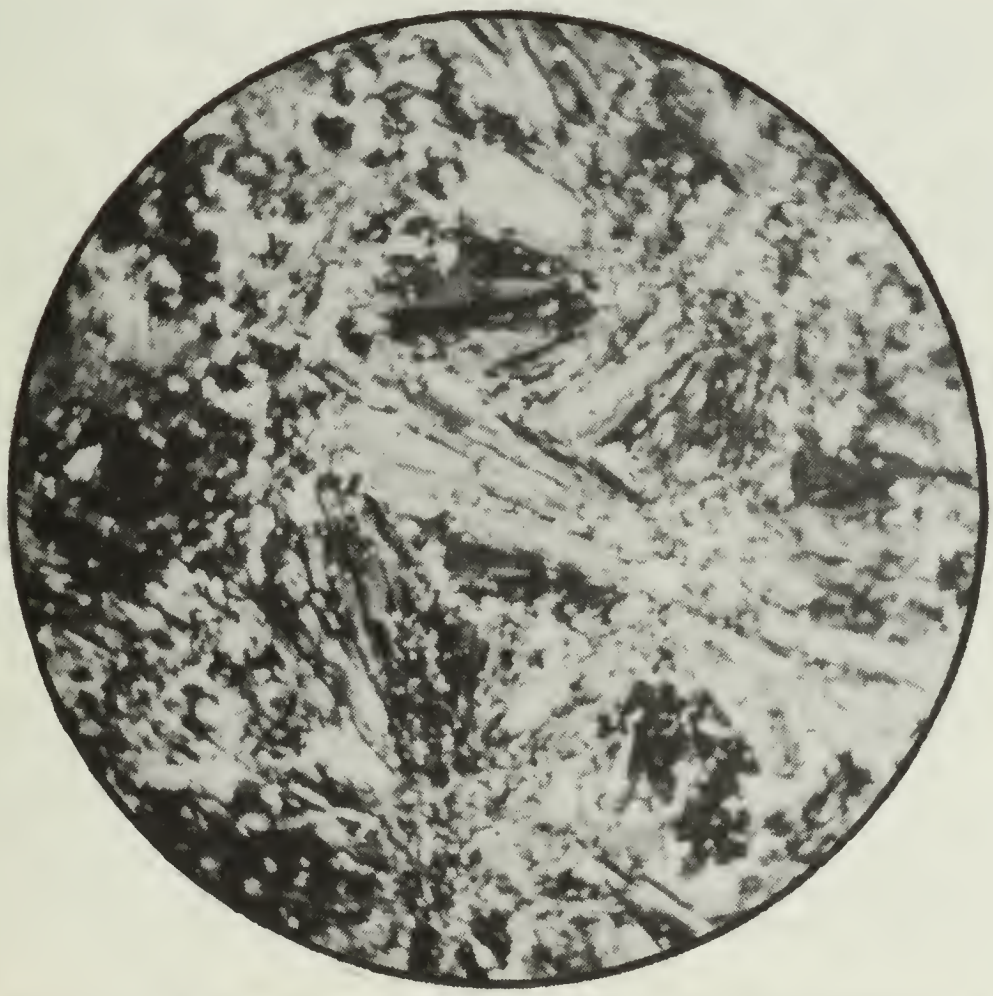


FIG. 11. Radiated wollastonite with interstitial calcite, a more advanced stage in the formation of wollastonite tactite. Crossed nicols. Magnification 20X.

FIG. 12. A wollastonite tactite. Crossed nicols. Magnification 20X.

FIG. 13. Large wollastonite crystal (wo) with twinned calcite (ca) and isotropic garnet (ga). Crossed nicols. Magnification 20X.

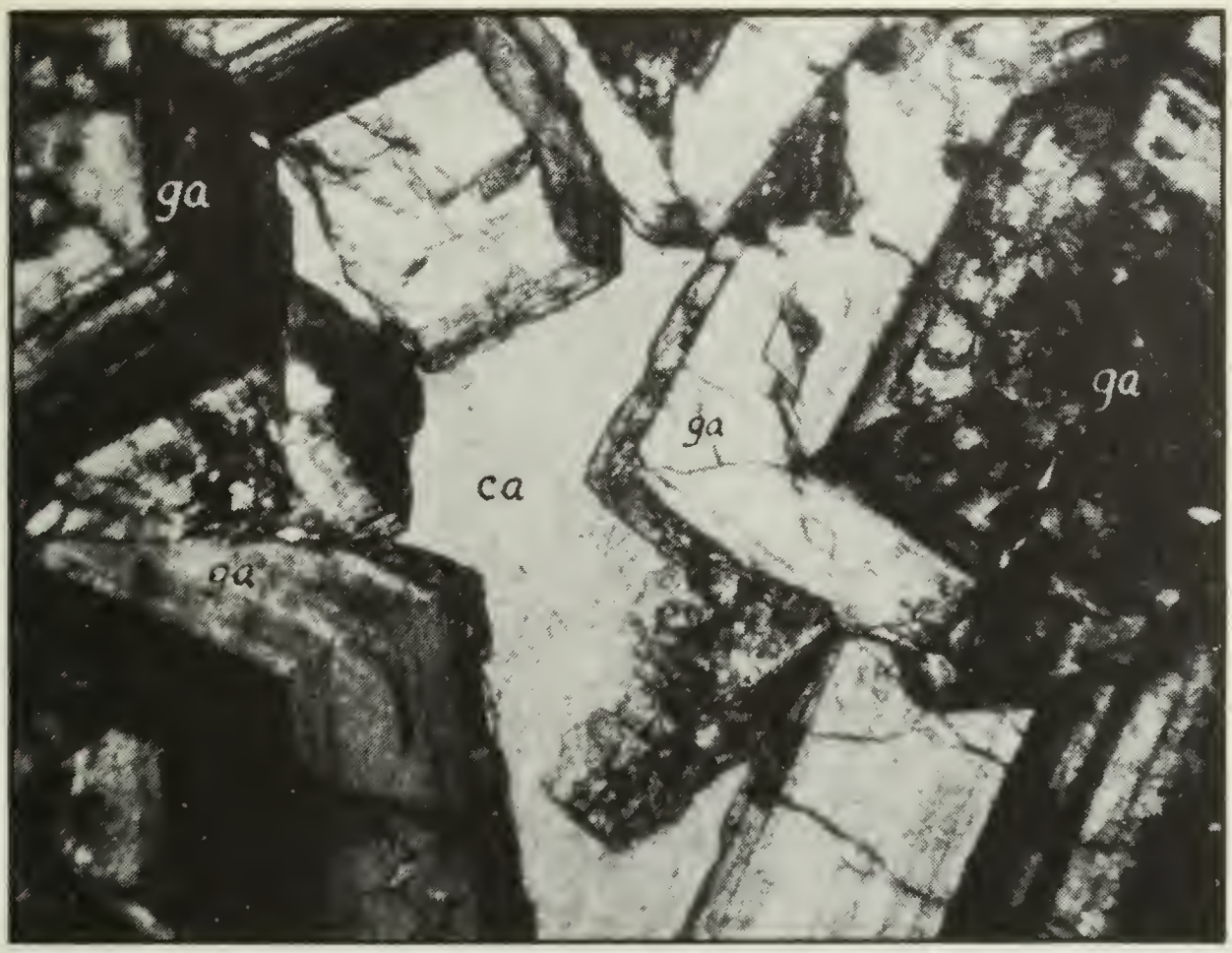


FIG. 14. Polysynthetic twinning in garnet (ga) with interstitial calcite (ca) from the tactite near the Thompson mine. Crossed nicols. Magnification 75X.

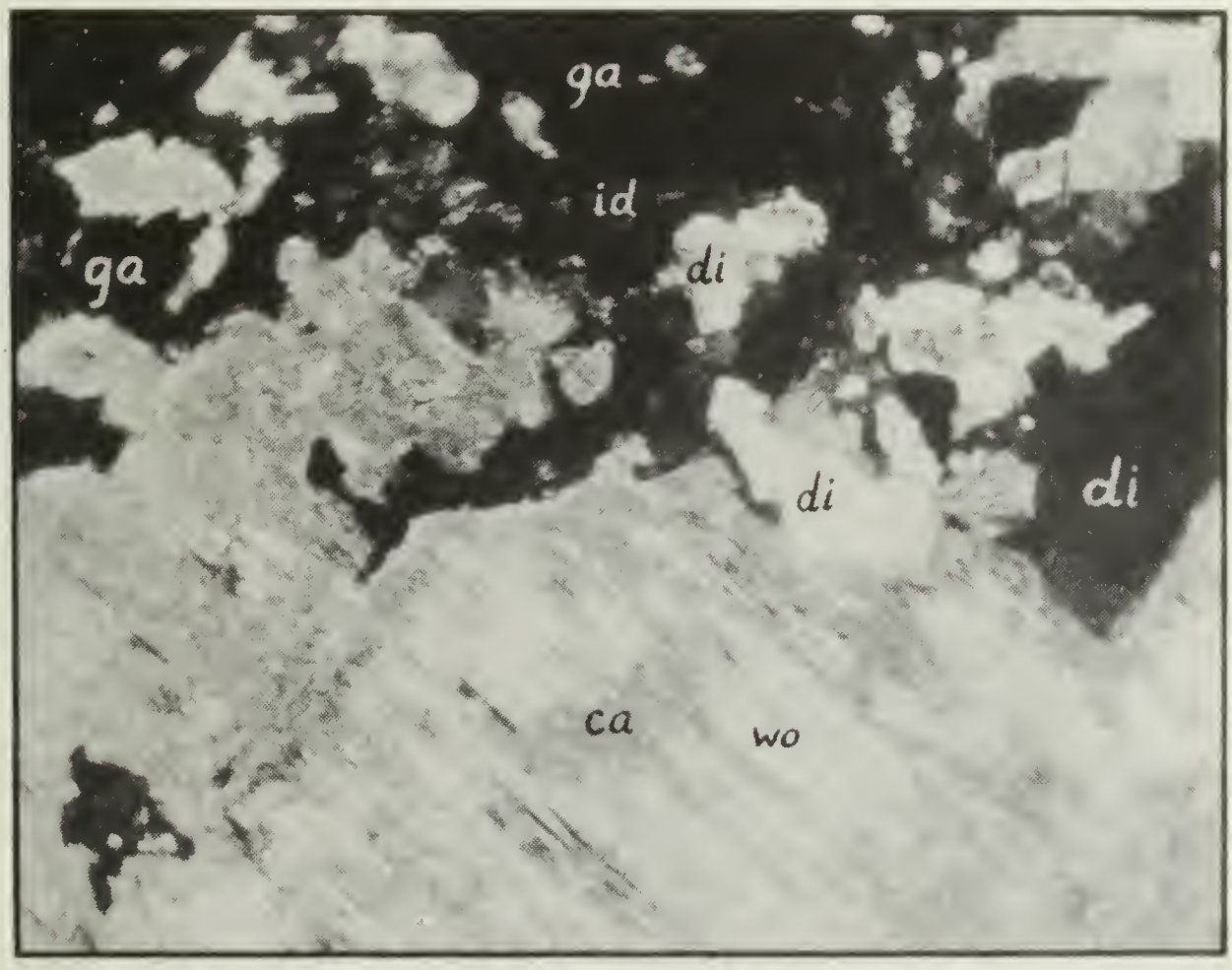


FIG. 15. Wollastonite (wo) replaced by garnet (ga) and calcite (ca) with some diopside (di) and idocrase (id). The shaded areas along the wollastonite cleavage and fractures are calcite. Crossed nicols. Magnification 75X.

FIG. 16. Evidences of metasomatism from the outer portion of the silicate zone, quartz and calcite veinlets cutting fine-grained quartzite and crystals of pyrite. Crossed nicols. Magnification 75X.

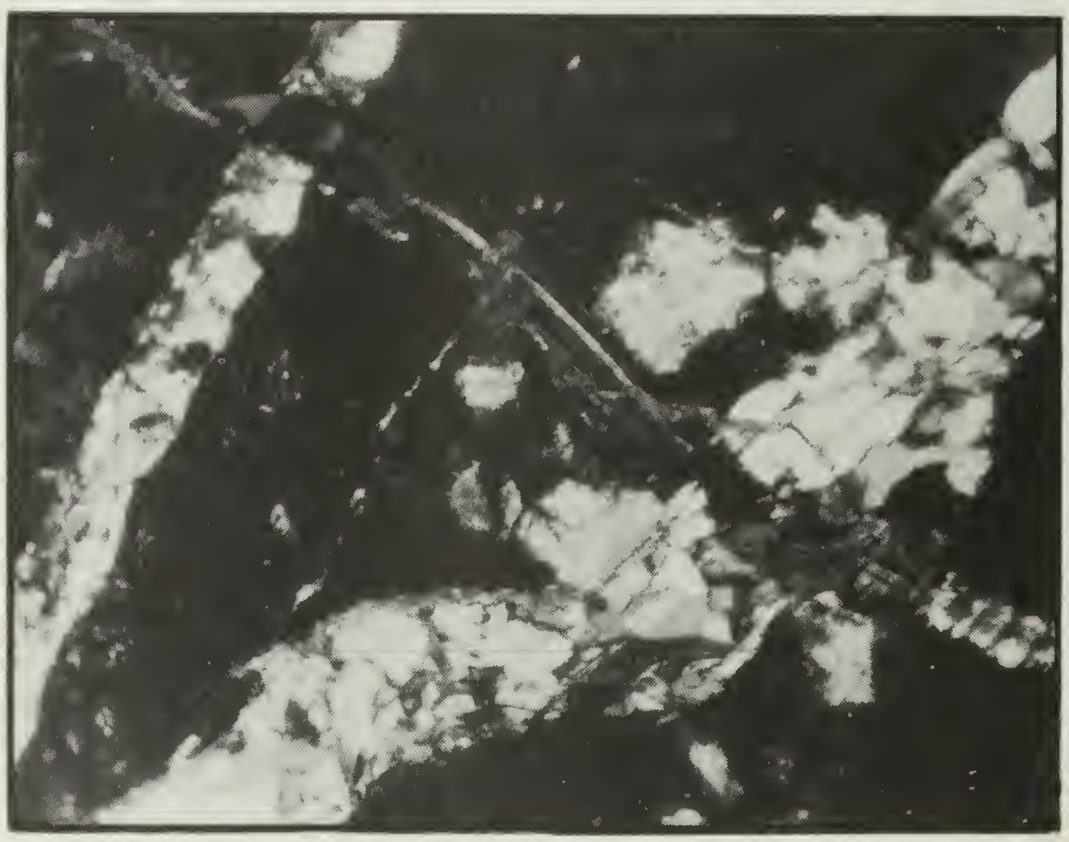


FIG. 17. Veinlets (large) of wollastonite and idocrase cutting impure partially silicated limestone or tactite (dark) and in turn cut by chalcedonic quartz veinlets. Crossed nicols. Magnification 75X.

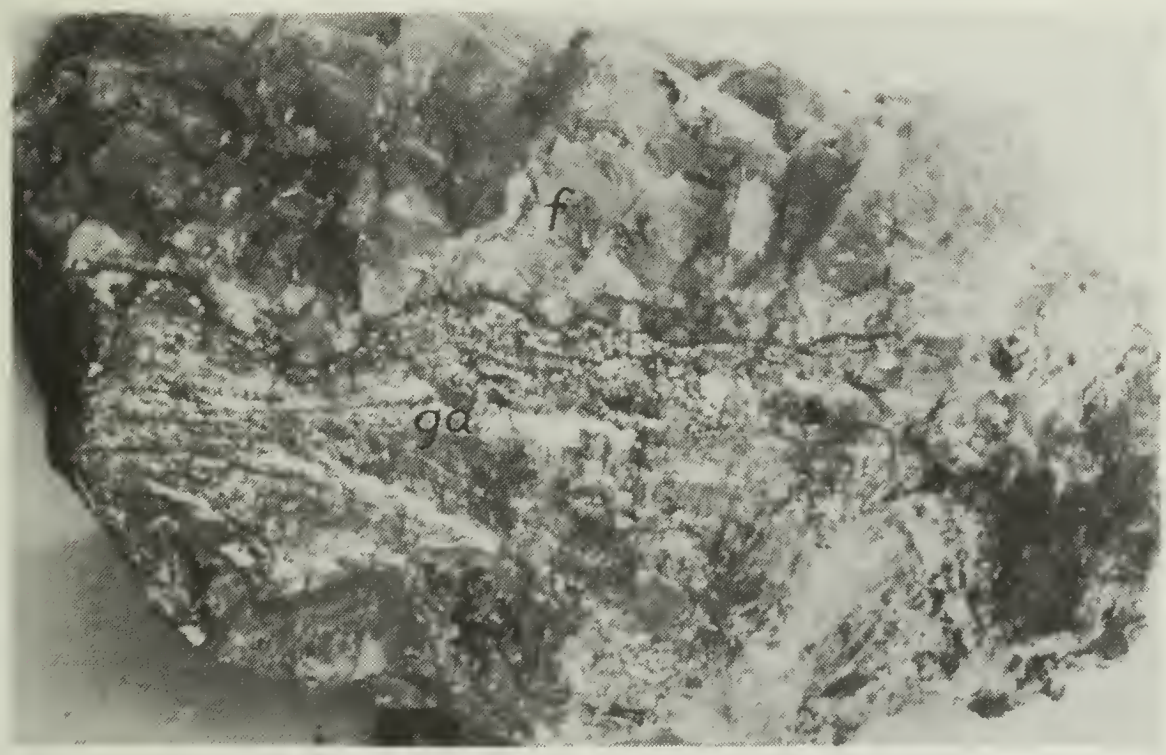


FIG. 18. Banded galena (gn) with fluorite (f). Note the dark seam of anglesite between the galena and fluorite. Defiance mine. Magnification 34X.

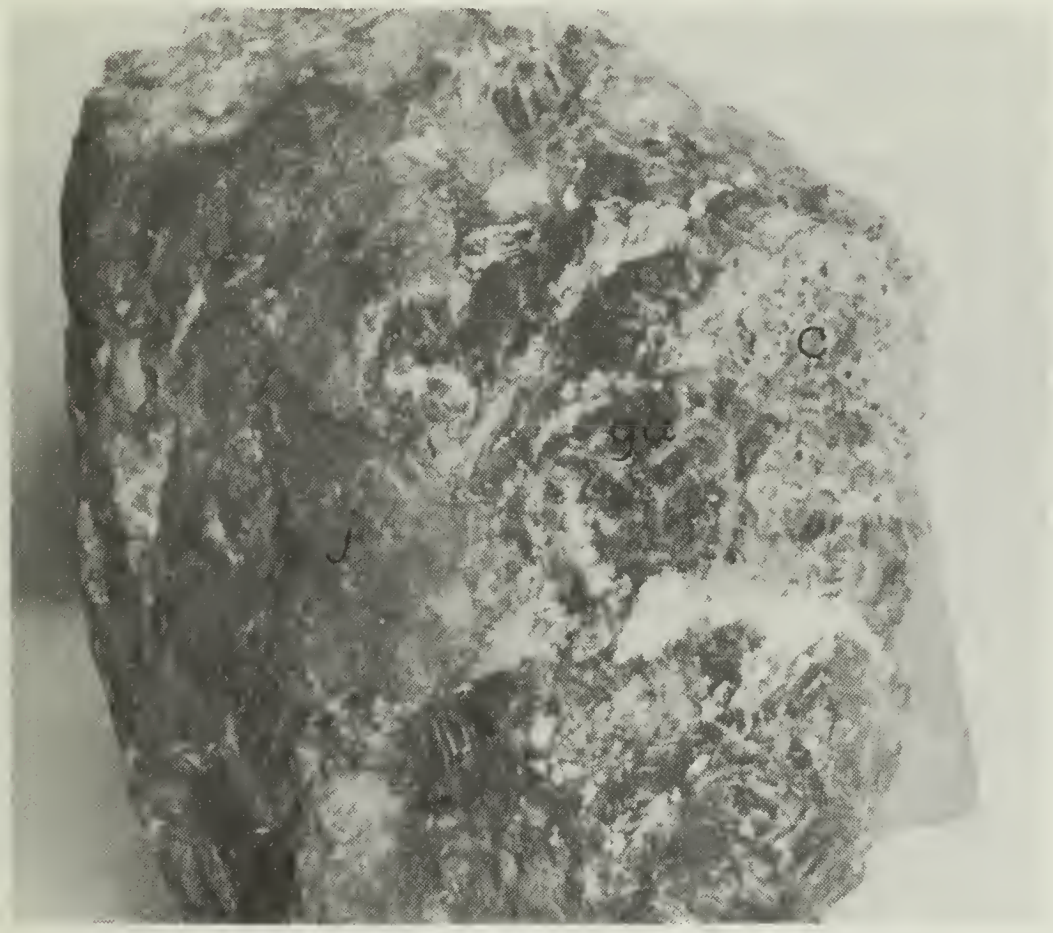


FIG. 19. Galena (gn) with jasper (j) and cerussite (c) from the Fernando mine. Magnification 34X.

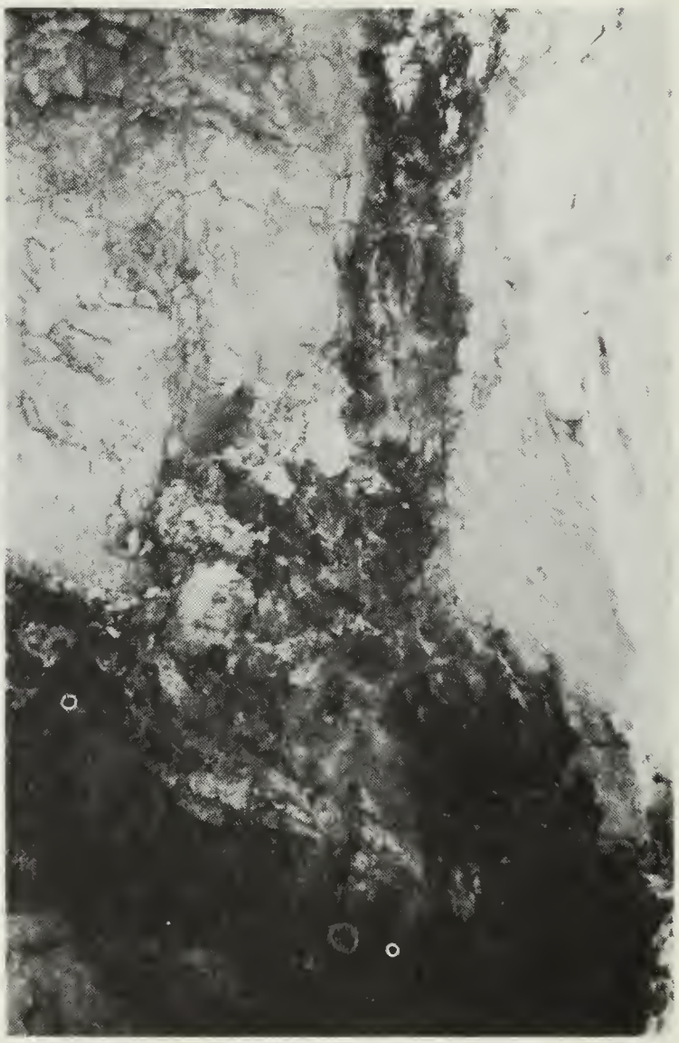


FIG. 20. Small jasper vein (1 ft. wide) in tactite (white). The vein cuts across a diorite dike (bottom) and forms a bunch on top of the dike. Prospect lode near the Christmas Gift mine.

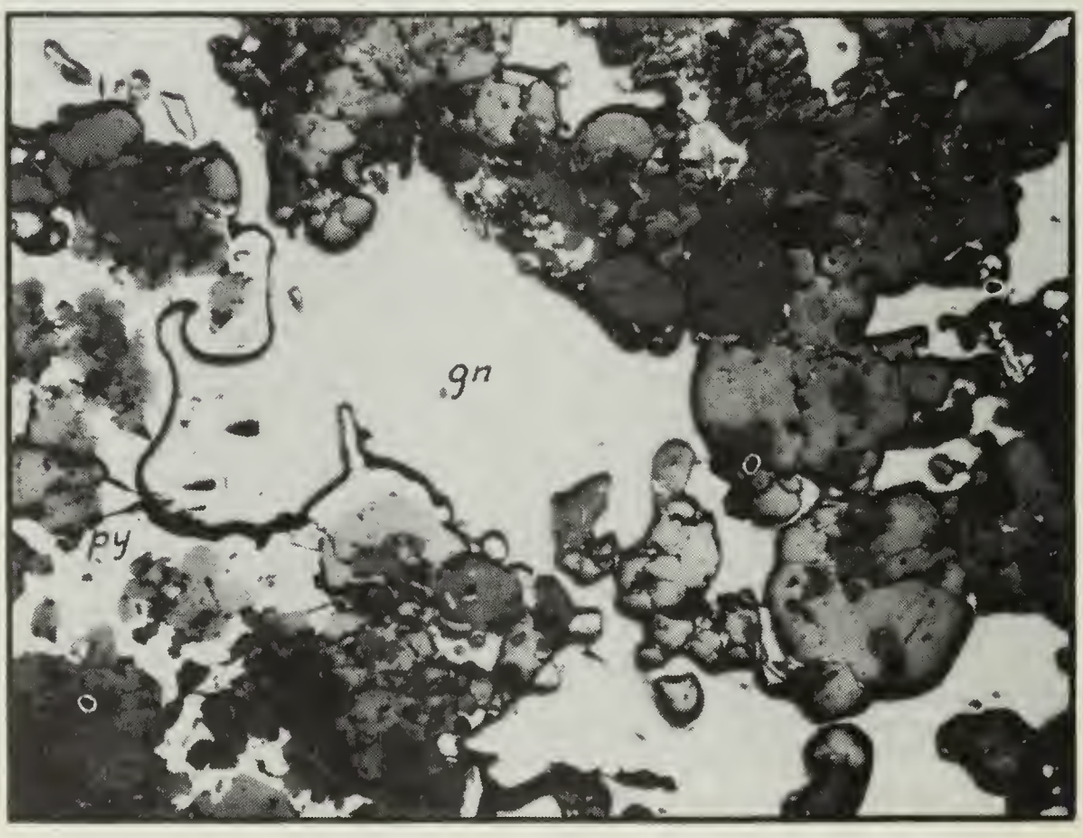


FIG. 21. Galena (gn) replacement of pyrite (py) in a gangue of garnet, calcite, and fluorite. Magnification 75X. Essex mine.

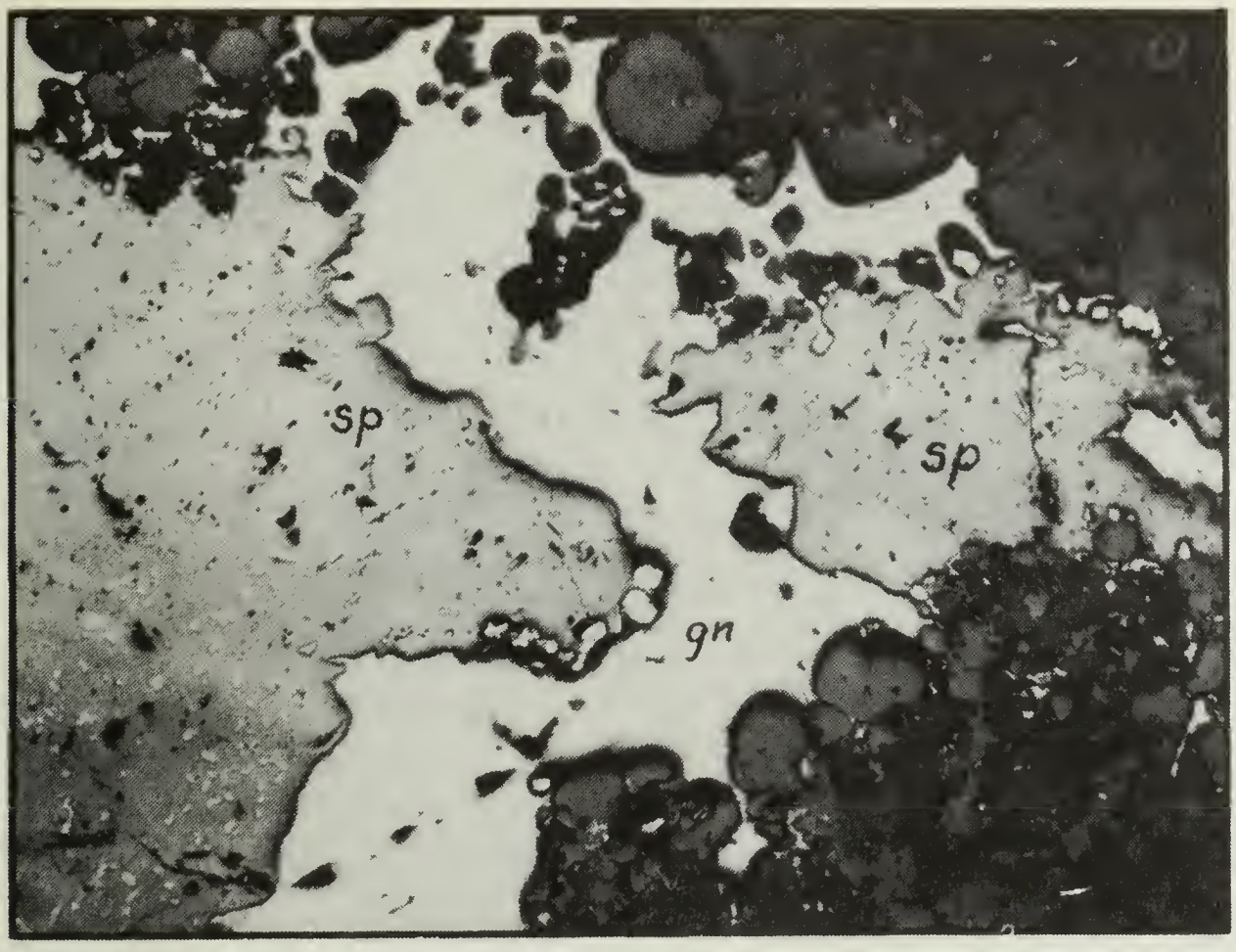


FIG. 22. Galena (gn) replacement of sphalerite (sp) dotted with chalcopyrite inclusions. Gangue is mostly garnet. Magnification 75X. Essex mine.

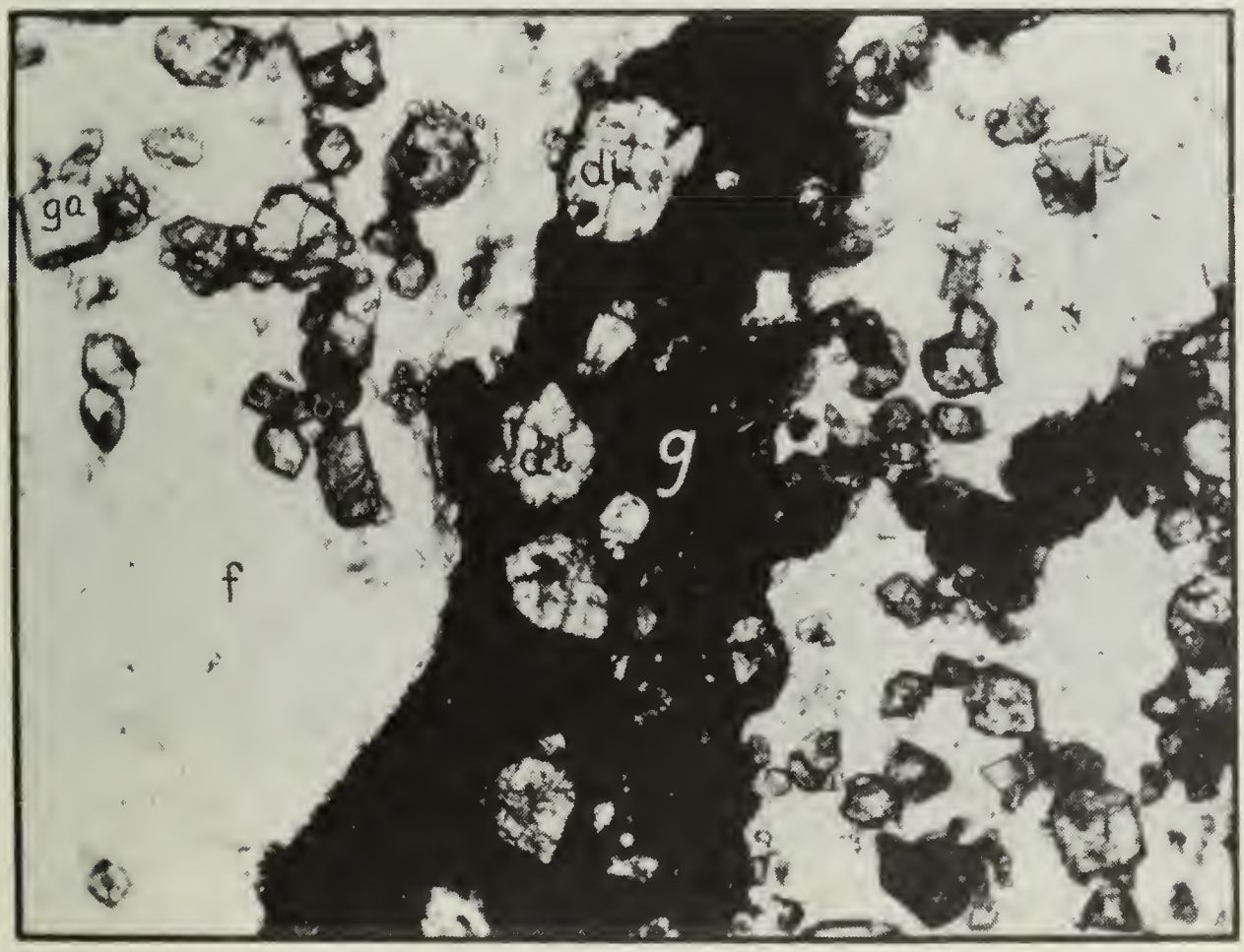


FIG. 23. Replacement of fluorite (f) by galena with residual metacrysts of diopside (di) and garnet (ga). Primary ore from the Essex mine. Plain light. Magnification 75X.

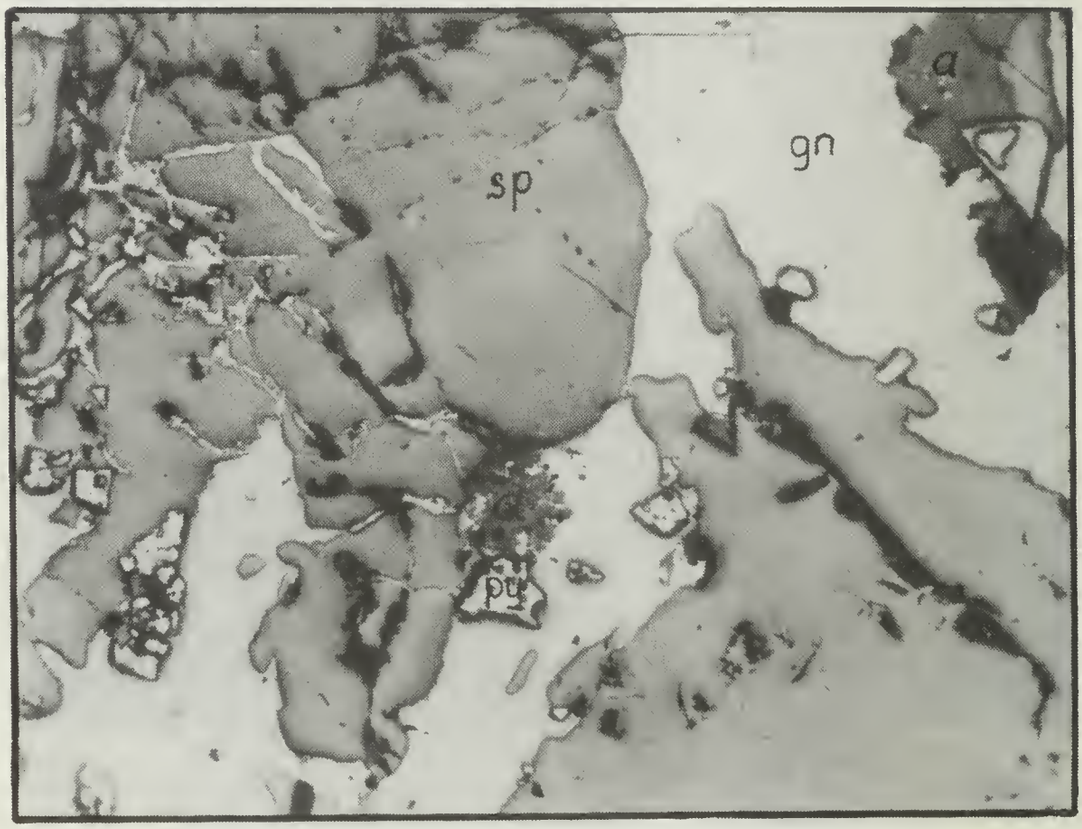


FIG. 24. Galena (gn) replacement of sphalerite (sp) and pyrite (py). Anglesite (a). Magnification 75X.

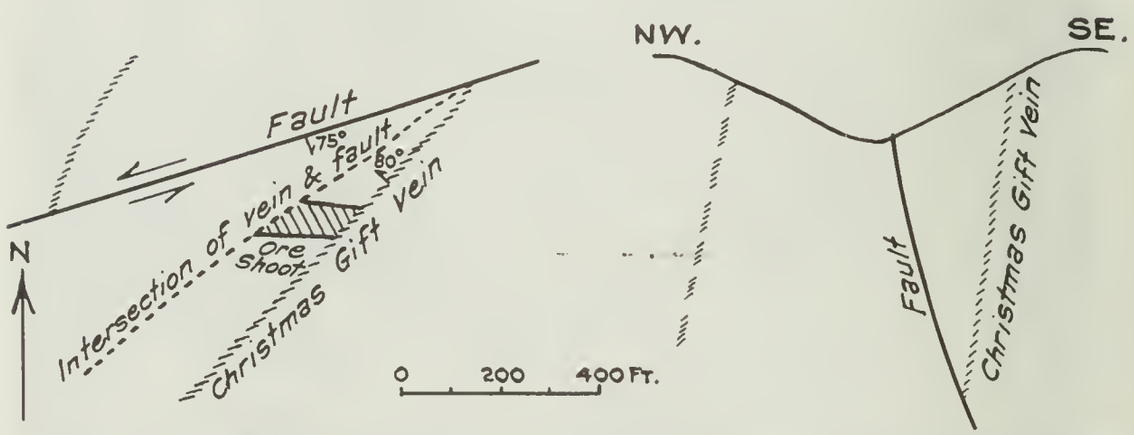


FIG. 25. Diagrammatic section (right) and plan sketch (left) of Christmas Gift vein and fault showing rake of ore shoot.

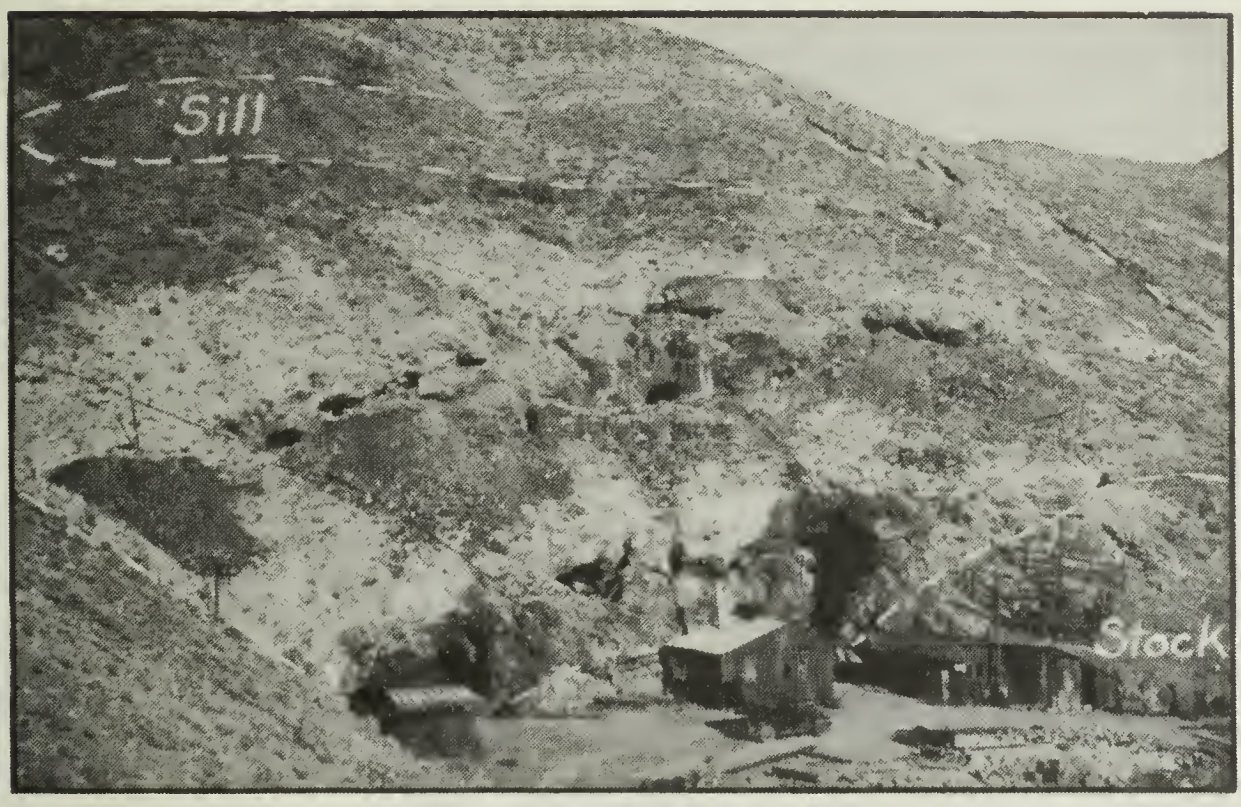


FIG. 26. View of the Defiance mine showing the lower and upper ore bodies lying between the stock in the foreground and the sill above the white tactite wedge in the center of the picture.

FIG. 27. View of the Independence mine (right of center) and the Essex mine (lower left). The prominent white tactite outcrop in the center of the picture lies as a blanket over the large Independence orebody within the ridge and a part of which may outcrop in the dark area in the extreme left in the picture.

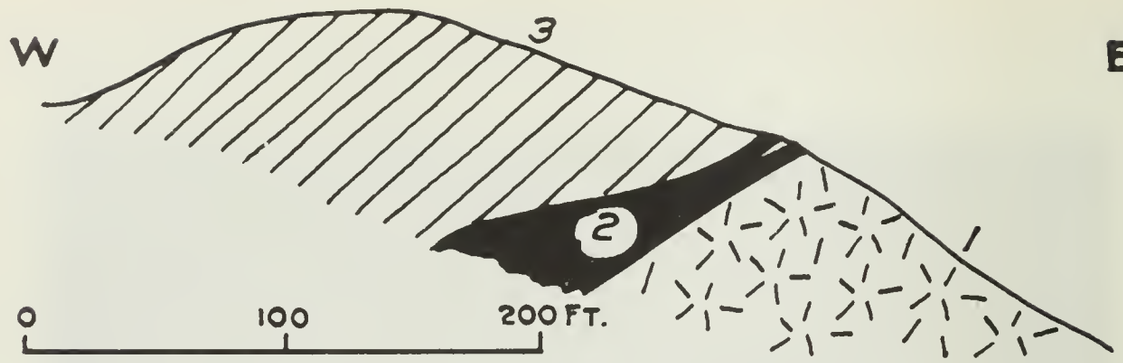


FIG. 28. Diagrammatic section through the Independence orebody. 1. Quartz diorite. 2. Orebody. 3. Stratified tactite.

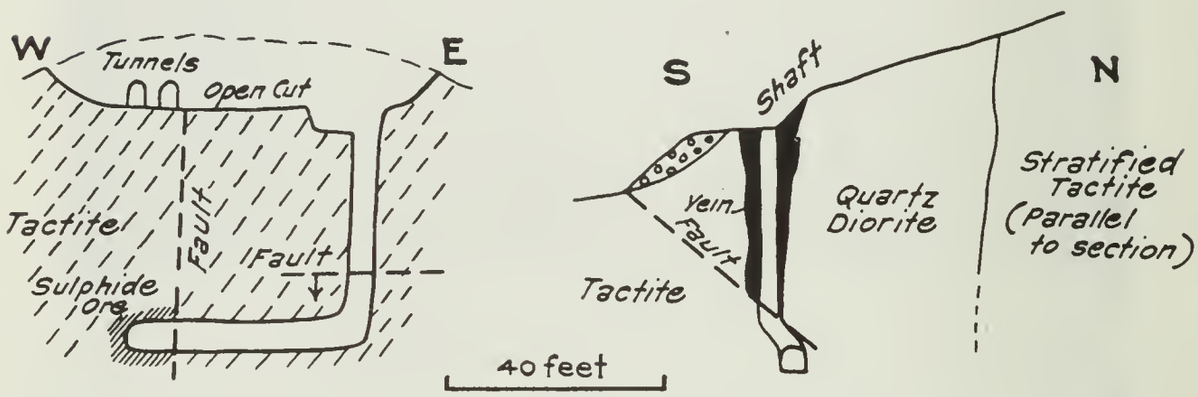


FIG. 29. Diagrammatic sections through the Essex orebody. Left, parallel to the vein. Right, across the vein.

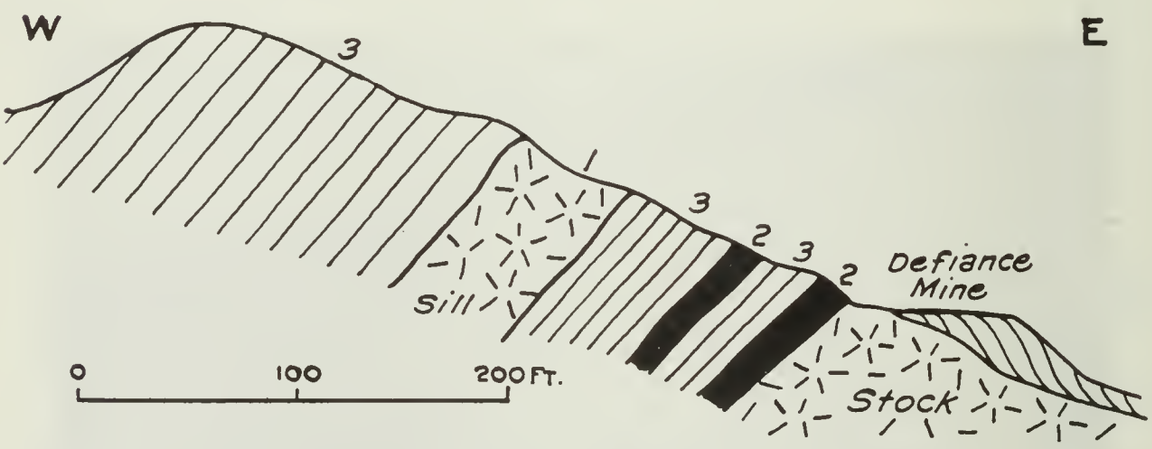


FIG. 30. Generalized section through the Defiance orebodies. 1. Quartz diorite. 2. Orebody. 3. Stratified tactites.

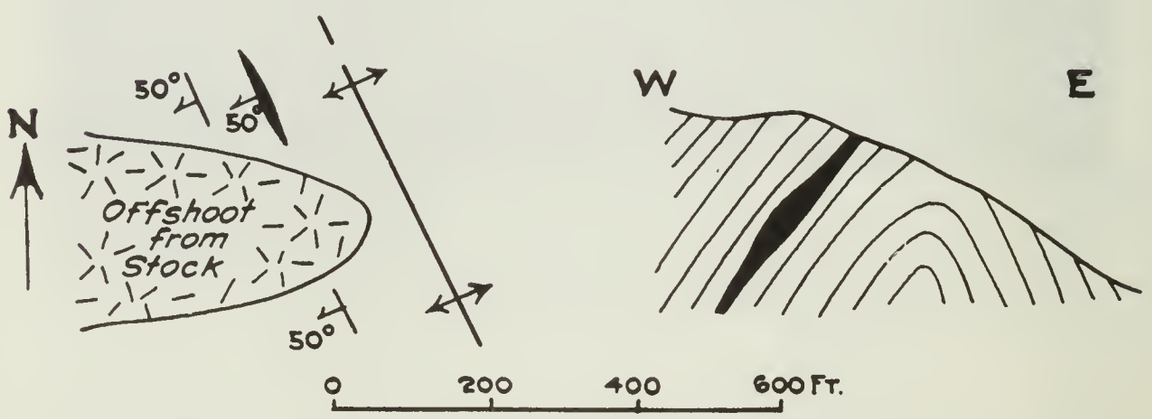


FIG. 31. Plan (left) and section (right) of the Custer orebody showing its relationship to the stock and the structure of the tactite.

It might be noticed in favor of the tectonic character of the fracture systems that Knopf and Kirk (p. 21, 1918) found much the same trend of fractures on a larger scale in the Inyo Range. The general conclusion reached for the Darwin Hills is that the fractures and especially the subsequent movements thereon are not related to intrusion, but rather to tectonic forces.

In summary, the structure of the Darwin Hills is characterized by a considerably folded series of impure Pennsylvanian limestones intruded by an elongated stock which occupies the center or core of the range of hills. Although parallel to the strike of the formations the stock transects the west limb of a large fold in depth. The major axis of this large fold is generally about 1000 feet east of the stock. The east limb generally occupies the steep eastern slope of the hills. It is considerably crumpled into a series of closely spaced nearly isoclinal folds. A system of northeast and northwest fractures transverses the whole. The common direction of movement on all of these has been westward on the north side. The total affect of the displacements on all of the fractures has been to move the tip of the elongate stock several hundred feet west of its original position with reference to the south tip. Uplift along faults roughly bounding the hills slightly tilted the range above the plateau in Quaternary time.

IGNEOUS METAMORPHISM

ALTERATION OF THE SEDIMENTARY ROCKS

General Character

Since most of the minerals of the silicate zone about the intrusive are calcium silicates, the term *tactite,* proposed by Hess,[6] is applied herein to these rocks as a whole. Hess applied the term to calcium silicate strata or rock affected by magmatic emanations. The term *hornfels tactite* is used for the fine-grained or aphanitic tactites. Other descriptive terms are prefixed to the name, such as wollastonite tactite or garnet-diopside tactite.

At Darwin the tactites are whitish, medium- to fine-grained, stratified rocks. The width of the tactite zone about the stock varies from a few tens of feet to nearly 2000 feet. The outer limit of the zone is roughly determinable by the extent of bleaching of the original rocks. An aureole about 1000 to 1500 feet in width is most common. The retained stratification is the principal existent structure. Although in many places the tactite is fine-grained or aphanitic, large areas of stratified tactite composed of visibly felted aggregates of wollastonite occur. Locally, decidedly coarse textures are found. Light green garnets one to three inches in diameter imbedded in wollastonite are common, and one garnet a foot in diameter was found south of the Defiance mine. On the prominent white ridge south of the Lucky Jim camp are areas of tactite in which wollastonite prisms three to six inches in length are abundant associated with garnet and considerable idocrase. Idocrase crystals attain dimensions of one to two inches. In general, the coarser the texture, the less is the mineral diversity. Coarseness of grain, except in a broad way is not related to proximity

[6] Hess, F. L., Tactite, the product of contact metamorphism: Am. Jour. Sci., vol. 48, pp. 377-378, 1918.

of the igneous contact. Thus, at the Defiance mine the tactite at the igneous contact is dense, fine-grained, white rock, while westward from the contact to the top of the ridge there are many beds of medium and coarse-grained tactite.

Minerals and Textures

Wollastonite. Wollastonite is perhaps the most abundant mineral of the silicate zone. It occurs in felted masses which may comprise bed after bed of the tactites over considerable areas. Locally, usually near the igneous contact, wollastonite forms in large reticulating prisms associated with small quantities of garnet or idocrase. (Fig. 15.) In the outer part of the tactite zone it occurs in small radiating groups imbedded in fine-grained calcite or limestone in such a way as to make it apparent that its formation was the first manifestation of the silication process. (Figures 10 and 11.) Even in this initial stage of silication it is common to find small amounts of idocrase associated with the wollastonite. Wollastonite also occurs in veinlets with garnet and idocrase cutting a matrix of hornfels tactite or in some cases pure limestone. (Figures 16 and 17.) Thus it is common to find wollastonite in the groundmass and in veinlets cutting that matrix.

Garnet. With the exception of wollastonite, garnet is the most conspicuous mineral of the tactites. It is typically a light-green garnet. Qualitative tests indicate approximately equal quantities of aluminum and iron in addition to calcium. It is, therefore, most generally a mixture of grossularite and andradite molecules. By far the greatest percentage of the garnet is birefringent, showing remarkable zoning and polysynthetic twinning. (Fig. 14.) In addition to the regular arrangement of the birefringent parts, it often shows wavy and irregular anisotrophism. Also it often shows two stages of growth in which the core may be greenish and the periphery colorless or vice versa. Perimorphs of garnet are very common in calcite. Some of the totally isotropic green garnet is probably almandite. Rarely a little dark brown or black garnet is found, and it also is isotropic.

Garnet is widespread throughout the zone, but the larger and more perfect crystals occur near the igneous contacts. In some places massive garnet zones a few feet in thickness border the immediate contacts. Garnet is found in association with all of the silicate zone materials, but most commonly with calcite which occurs not only between the garnet crystals but in veins replacing them. Garnet replaces wollastonite and in some instances appears to form pseudomorphs after the latter mineral. Garnet also forms veinlets cutting a matrix which may include earlier garnet among other silicate minerals. Locally garnet develops as a post-fissuring silicate mineral cementing or replacing earlier silicates, calcite, or igneous rock. Small crystals of tourmaline or sphene are commonly found included in the garnet.

Diopside. Diopside is practically the only pyroxene present. It is abundant in fine-grained tactites with wollastonite, garnet, calcite, and other minerals. Poikiloblastic diopside and sometimes hedenbergite in orthoclase are common near the contacts. Diopside is occasionally found replacing wollastonite, but it did not continue to form as long as garnet.

Idocrase. Idocrase, although not as abundant as the preceding minerals, is nevertheless common at Darwin. It occurs in dense green masses closely resembling garnet and in euhedrons in calcite or wollastonite. Calcite is nearly always present veining the idocrase. Under crossed nicols the Darwin idocrase shows strikingly anomalous Berlin blue or green colors. Polysynthetic twinning and zoning similar to that in the garnet are common. Idocrase replaces wollastonite and is idioblastic against it, but in contact with garnet the latter mineral is euhedral. The large metacrysts of idocrase are found only near the igneous contact, but disseminated grains and small veins are found in the outer portion of the tactite zone associated with wollastonite.

Epidote. Epidote occurs only sparingly in the tactites proper. It is mostly confined to the immediate contact where it forms in veins replacing orthoclase in dike rocks or in the intrusive proper.

Orthoclase. Orthoclase is a very common mineral in the tactites, especially in the areas of more intense alteration or near the igneous contact. Likewise, border phases of the intrusive are sometimes unusually rich in orthoclase, enclosing poikiloblastic garnet, plagioclase, hedenbergite, or biotite. Orthoclase is found intimately intergrown with wollastonite, diopside, garnet, and calcite in the hornfels tactites. Its occurrence in dikes anastomosing through the tactites has already been mentioned. Orthoclase is also found lining post-consolidation fractures in the intrusive, indicating its late deposition in part.

Calcite. Calcite is the most widespread mineral of the tactite zone. In many of the tactites, both coarse and fine, it forms a matrix with lesser quantities of orthoclase, plagioclase, or quartz for the more idioblastic minerals such as wollastonite, garnet, or diopside. Coarsely crystalline, marmorized limestone is not exceedingly common in the tactite zone. More common are remnants of blue-gray limestone in which the calcite is clouded by argillaceous impurities. Late calcite veinlets in all other minerals are very abundant.

Quartz. Quartz is only sparingly present in the silicate zone. Under the microscope quartz is sometimes found intergrown with calcite scattered through the garnet. Occasionally it is found interstitial to euhedral aggregates of garnet. Also small veinlets of quartz are found cutting most of the silicate minerals. Many of these veinlets are chalcedonic. As will be mentioned later, quartz is more abundant as a post-fissure mineral.

Plagioclase. Plagioclase is very abundant in some of the tactites. Practically all of the plagioclase seen in the tactites is untwinned oligoclase. It is for the most part quite fresh and closely resembles quartz, for which it is easily mistaken, by reason of the fact that the two are not usually found together. The oligoclase occurs in a much sutured intergrowth with calcite, the latter mineral being the more abundant of the two. Idioblastic and xenoblastic garnet is scattered through both minerals and oligoclase appears to replace the garnet in several instances. A noticeable feature of the oligoclase-calcite tactite is the absence of wollastonite. Thus, in one petrographic study made normal to the igneous contact, thin-sections of the first 100 feet show abundance

of wollastonite and some garnet, diopside, and calcite, but no oligoclase. Sections of the next 100 feet reveal considerable oligoclase with calcite and garnet as mentioned above, but no wollastonite. Still farther away the situation is reversed again. Since this profile was taken across the strikes of the tactites it seems likely that the original composition of the sediments was the controlling factor. However, it appears likely that the oligoclase and wollastonite are incompatible. The case is undoubtedly analogous to the observations made by Harker [8] that anorthite and wollastonite combine to form grossularite and quartz, although in the case of oligoclase it is not quite clear what becomes of the albite molecule. A small quantity of twinned poikilitic plagioclase occurs in orthoclase in small dikes near the igneous contacts.

Miscellaneous Minerals. Tourmaline and sphene are common in the tactites. Of the two, sphene is the more common and forms the larger crystals. It is nearly euhedral and is more abundant in the more highly silicated rocks. Tourmaline is common in small crystals in the hornfels tactites. Apatite is not common, but is found occasionally near the igneous contacts. Tremolite and forsterite, common to many contact zones, are rare at Darwin. Their scarcity is probably the result of the relatively low magnesian content of the original sediments. The little tremolite encountered is the actinolite variety, and its occurrence is practically at the contact. A little fluorite is found in the tactites, but much of this is probably late, and principally the result of hypogene mineralization.

EVIDENCE OF ZONING AND MINERAL SEQUENCE

Zoning is not conspicuously present in the tactites at Darwin. The existence of mineral zones of metamorphism about intrusives is well known. However, the best examples of metamorphic zoning are in argillaceous rocks. Furthermore, homogeneity in bulk composition of the country rocks is necessary to establish clear cases of zoning.

At Darwin the igneous contacts generally parallel the stratification of the tactites and hence no uniformity of original bulk composition can be assumed normal to the heat source. The pure and impure limestones do not mineralogically zone with the readiness of some argillites. As a result of the irregular permeation of the country rock by igneous emanations, no uniformity of temperature gradient existed away from the contacts.

For these reasons mineral zones are only meagerly developed. However, certain tendencies can be indicated:

(1) Decrease in size of grain away from contacts and metasomatic centers.

(2) Epidote practically confined to the immediate contact.

(3) Darker colored garnet zones adjacent to some contacts, indicating introduction of iron into the lime silicates near the intrusive.

(4) Hedenbergite in place of diopside near contacts, probably indicating a similar enrichment.

Sequence of mineralization in the silicate zone at Darwin is difficult to establish, and overlapping appears to exist in most cases. Wollastonite is without much doubt the earliest mineral to form. It is clearly replaced by idocrase and garnet. Sequential relationships between

[8] Harker, A., Metamorphism: p. 94, 1932.

diopside, garnet, and idocrase do not admit of positive proof. Orthoclase appears to form more abundantly near the contacts, while oligoclase forms at a greater distance and is indicative of lower grade metamorphism and therefore formed earlier. The paragenesis of the principal silicate minerals is about as follows: wollastonite, idocrase, garnet, diopside, plagioclase, and orthoclase. If this order of formation is correct, then it may be observed that the earlier minerals are the highest in lime and that the trend is toward increased silica and alkalies. This is perhaps the trend to be expected in the metamorphism of a carbonate rock adjacent to a siliceous intrusive, and it further demonstrates the metasomatic nature of the silication process.

ALTERATION OF THE IGNEOUS ROCK

The intrusive rocks have suffered considerable yet variable alteration paralleling that in the tactites and in the ore-bodies. The alteration minerals fall into two groups. The earlier higher temperature group includes garnet, orthoclase, diopside, calcite, clinozoisite, and epidote. The second, lower temperature group includes sericite, chlorite, pyrite, quartz, kaolin, leucoxene, and possibly jarosite. It must be admitted, however, that the division between the two groups is not sharp, and proof that some of the minerals in the two groups did not develop contemporaneously is wanting. In general, garnet, diopside, calcite, and epidote are products which involve some transfer of material, particularly lime, from the sedimentaries. These minerals are common in the intrusive near the contacts. Thus, in the quartz diorite near the Thompson mine there has developed considerable calcite, epidote, and pyrite, the last mineral being clearly related to fractures. In addition, diopside, clinozoisite, chlorite, sericite, and tourmaline are present in smaller quantities.

Garnetization of the intrusive has already been mentioned and this type of alteration is very well shown in many places. In the sill-like offshoot of the stock about 200 feet above the Defiance mine, garnet is abundantly developed. In some places here nearly the entire rock may be converted to light green, granular garnet. In other places the garnet is distinctly developed along joints. Another area of intense garnetization occurs about 300 yards west of the Charistmas Gift mine on the Hahn claim where the igneous material has been almost entirely converted to medium-grained, light brown garnet.

It is a noticeable feature that orthoclase is more abundant in many of the border phases and offshoots of the intrusive. The intrusive near the Definance mine is quartz diorite, but at the immediate contact back of the blacksmith shop orthoclase makes up nearly 90 per cent of the rock. Sometimes this development of orthoclase takes the form of small dikes or veins which in places so permeate the rock as to lose identity. Where orthoclase forms much of the rock poikilitic plagioclase, diopside, epidote, or sphene are commonly present. Perhaps epidote is the most common associate of orthoclase of this occurrence. The formation of the potash feldspar is roughly correlated with orthoclasization of the limestones.

Sericitization is widespread and sometimes very intensely developed. In places near the igneous contacts the rock is composed almost entirely of quartz and sericite. Sericitization first begins in the plagio-

clase, and pseudomorphs of sericite after plagioclase are preserved in completely altered rock. In feeble alteration where only the plagioclase is attacked, orthoclase is more or less kaolinized. In the more advanced stages, sericite spreads to the potash feldspar and at the same time quartz appears to increase as though it were a by-product of the sericite. In the final stage sericite even invades the quartz.

Much leucoxene accompanies the sericitization process and most of the leucoxene is an alteration of a black metallic mineral, possibly ilmenite. Associated with the leucoxene alteration is a small quantity of jarosite. The jarosite occurs partly as veins cutting all other minerals and partly as grains intimately associated with leucoxene and sericite alteration in areas clouded with kaolin and containing minute grains of sphene. The occurrence of jarosite intimately associated with leucoxene and sericite may indicate that the assemblage is of hydrothermal origin. Sericitization probably represents a lower temperature, hydrothermal continuation of orthoclasization. This process of forming orthoclase, along with the development of garnet, tourmaline, sphene, calcite, diopside, and epidote is best correlated with the bulk of silication of the limestones. On the other hand, sericitization and accompanying products are more nearly to be correlated with later hydrothermal processes and the metallization epoch.

Pyrite is extensively developed in the igneous rocks and for the most part is of late hydrothermal origin contemporaneous with metallization.

HYPOGENE ORE AND GANGUE MINERALIZATION

The mineralization which gave rise to the silver-lead deposits at Darwin is sharply set off from the silication process mentioned above. The silication of the limestones is conceived as having taken place during the emplacement of the stock, whereas the ore and gangue mineralization occurred after the formation of the tactite zone in subsequent fractures and other structural loci. Quantitatively, the major metalliferous deposition occurred within the tactites. This post-consolidation mineralization may be discussed in two groups: gangue and ore mineralization.

GANGUE MINERALIZATION

The gangue mineralization consists chiefly of calcite, pyrite, jasper, and fluorite. In addition garnet, orthoclase, quartz, hematite, siderite, and barite are present in lesser quantities. Garnet, orthoclase, quartz, and pyrite are deposited in the above order, replacing the quartz diorite walls of the Lane vein near the igneous contact in Lane canyon. Again in the Wonder mine 300-400 feet from the contact a similar assemblage is to be found replacing tactite walls. Here coarse calcite and fluorite are intergrown and directly associated with the ore minerals. However, the occurrence of garnet and orthoclase as post-fissuring gangue minerals is quantitatively of minor importance. In the majority of deposits, calcite, fluorite, jasper, kaolin, or pyrite make up the early-formed gangue minerals. Spongy and earthy iron oxides, derived from oxidation of the jasper and pyrite, are very closely associated with galena.

A small quantity of scheelite occurs in coarse calcite with pyrite and chalcopyrite on the Bruce claim in Lane canyon where ore carrying as much as two per cent tungsten and traces of molybdenum are reported.

There is a general decrease in the grain size and abundance of certain of the gangue minerals with distance from the stock. Extremely coarse calcite in cleavable masses 18 inches on a side characterizes such deposits as the Defiance, Custer, and Wonder, all of which are at or near the intrusive. Farther from the contact calcite is finer textured and somewhat less common. Rose, green, or white varieties of fluorite, common associates of galena in deposits near the igneous contacts, are much less common or are absent at a distance. Pyrite or pseudomorphs of limonite after pyrite, in sizeable pyritohedrons and cubes are abundant in deposits near the stock. In contrast, the pyrite in deposits at some distance from the intrusive is granular, less common, or absent. Likewise, the early garnet-orthoclase mineralization is relatively more common in proximity to or within the intrusive. Jasper, on the other hand, is universally present, but relatively more abundant as a gangue mineral in those deposits situated some distance from the stock. (See Fig. 20.)

ORE MINERALIZATION

Galena and its alteration products constitute the principal ore minerals of the district. Galena is found in association with all of the gangue minerals mentioned above and in a few places, as at Essex mine, it has impregnated and replaced the silicate minerals of the tactite. (Fig. 21.) Occasionally it is found replacing igneous rock along fractures. Notwithstanding its varied associations, its dominant occurrence is in lenticular or tabular deposits with calcite, fluorite, pyrite, or jasper, or the oxidation products therefrom. Sphalerite and, to a lesser extent, chalcopyrite, occur with galena in many places.

Megascopic Features of the Ore

The primary ore is predominantly argentiferous galena and it occurs in bunches, lenses, or tabular veins distributed through the gangue of the deposits. The galena varies in texture from fine-grained or steel galena to coarser material in which individual interlocking crystals may attain one or two inches in diameter. The most common variety is medium-grained and it is often characterized by a banded texture in which curved cleavage faces are the rule rather than the exception. (Fig. 18.) Nearly all of the galena contains occasional visible inclusions of chalcopyrite. In one or two of the deposits of the district chalcopyrite and its oxidation products make up the entire ore mineralization. However, as a rule the quantity of chalcopyrite seen in the galena is small. Sphalerite and pyrite are associated in greatest abundance with galena. Sphalerite is very common in parts of the Defiance, Thompson, and Intermediate orebodies. Some of the masses of sphalerite in the Thompson mine are very coarsely crystalline with individual cleavage pieces two or three inches in diameter. Masses of argentite are reported from some of the deposits, but none was found during this investigation. Likewise thin sheets of native silver are reported from several of

the properties, but these were probably secondary products resulting from local reduction of silver solutions or silver minerals.

The sulphides are later than the primary gangue minerals. In polished hand specimens from the Rip Van Winkle and the Essex ores small veinlets of pyrite and galena cutting quartz, fluorite, and calcite can be seen.

In the north end of the Darwin Hills about one mile northwest of the stock there is an antimony prospect containing irregular bunches and radiating groups of stibnite. Blades three to four inches in length replace a matrix of arenaceous limstone along bedding planes and small cross fractures. The stibnite has been largely oxidized to cervantite. Numerous cavities contain pseudomorphs of cervantite after stibnite. The isolated nature of this deposit makes it impracticable to relate it to the lead mineralization about the stock.

Microscopic Features of the Ore

Polished specimens were studied of all the varieties of primary ores that could be obtained in the district. The mineralogy was found to be rather simple and the paragenesis in all of the ores examined, whether from near the intrusive or at a distance, was essentially similar. Galena is the latest primary mineral to form. It replaces all other minerals including sulphides and nonmetallic gangue minerals alike. (See Figs. 21 and 22.) It commonly contains numerous inclusions of pyrite, chalcopyrite, sphalerite, luzonite, and tennantite. All of these inclusions are clearly residual to the galena replacement. They may occur as individual inclusions, or more often, as irregular intergrowths of the two. The sulpharsenides of copper were considered the most likely to carry silver values in the galena, but a microchemical test gave no test for silver.

A noticeable feature of polished galena from the Christmas Gift mine and from the Promontory mine is that inclusions of luzonite and tennantite are more numerous than in the galena from the Defiance-Independence group of mines. The Defiance and Independence ores have averaged about one ounce of silver to each one per cent of lead, whereas ores from the Lucky Jim, Christmas Gift, and Promontory have averaged about two or three ounces to each one per cent. In other words, the silver values have been higher from the deposits near the ends of the stock which were in association with the more basic rocks. Since it is common for the sulpharsenides of copper to be the source of silver in galena ore, it may be that the increase in silver values is proportional to their abundance.

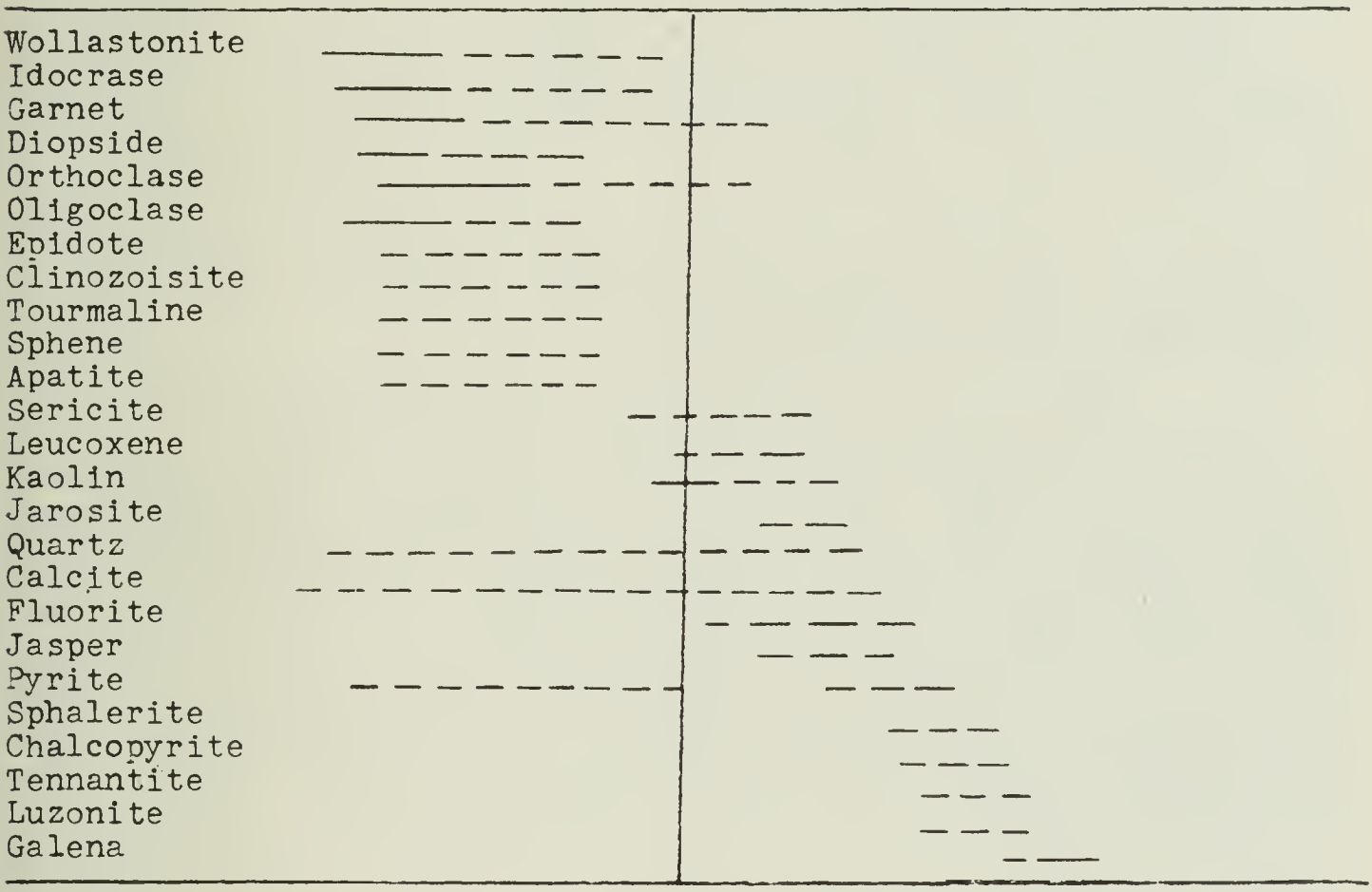
The microscopic evidence indicates a sequence of deposition in the following order: pyrite, sphalerite, chalcopyrite, tennantite-luzonite, galena. The accompanying photomicrographs show most of these relationships. Sphalerite commonly contains small spines of chalcopyrite more or less uniformly scattered through it in a manner suggesting an origin by unmixing.

SUMMARY OF THE MINERAL PARAGENESIS

Wollastonite and idocrase, the earliest minerals formed, were rich in lime. Minerals formed later were increasingly enriched in silica. Silica was introduced into the limestones at an early stage and con-

tinued to be introduced until the deposition of the sulphides. The early high-temperature introductions of silica produced silication. The final consolidation of the igneous rock was followed by a period of fracturing. However, silica continued to be supplied, but under lower temperatures silication gave way to *silification* in the intrusive and in the epigenetic deposits, first as a quartz and later as jasper. In a similar manner, but to a lesser extent, iron was added over a long period, beginning during the silication with the formation of garnet zones adjacent to some contacts, and continued under hydrothermal conditions in the form of jasper and pyrite.

A generalized picture of the paragenetical relationships is given in the table below.



SUPERGENE ALTERATION

At Darwin, as might be expected from the aridity of the climate, oxidation and supergene alteration have extended to great depths. The present depth of mining operations, which is only 1000 feet in the Lucky Jim mine, has not penetrated below the zone of oxidation. Oxidation has been very thorough as revealed by the abundance of porous, gossanized gangue in nearly all of the deposits. The gossanized material has been almost entirely derived from pyrite, jasper, and hematite. A small amount has been derived from the decomposition of iron-bearing sphalerite.

Cerusite greatly predominates among the oxidized lead minerals. To date a larger portion of the lead production has been obtained from cerusite than from galena, thus indicating the completeness of oxidation. Anglesite is not common except in the thin coronas immediately surrounding the galena masses. Plumbojarosite is reported from some of the deposits, and its origin was probably supergene. In the more

highly oxidized near-surface ores it is probable that the oxides of lead formed in small quantities, although none was observed. Native sulphur is rather common associated with some of the sulphide oxidation products. Considerable horn silver was probably present in the surface ores, although none was found during the present work. It was probably so intermixed with either the iron oxides or oxidized lead ores that it was seldom seen. In any event its presence seems substantiated by the fact that the surface ores, spoken of as the 'cream' of the deposits, were often very high in silver. Moreover, some of the early mining reports describe the ore as consisting in part of horn silver.[13] This is, of course, in keeping with the known facts regarding concentration of silver values near the surface during oxidation of the primary ore.

The thin sheets of native silver reported to have been found in the Thompson and Lucky Jim mines probably resulted from alteration and local reduction of the primary argentiferous lead ores.

A little smithsonite, in keeping with the quantity of sphalerite present, is also found. Likewise the small quantities of chalcopyrite and sulpharsenides of copper found in the primary ores have contributed to the formation of chrysocolla and melaconite in many of the oxidized ores. An almost insignificant amount of secondary sulphide enrichment is seen in some of the primary sulphides in the form of covellite and, more rarely, chalcocite.

STRUCTURAL CONTROL OF ORE DEPOSITION

From the position and nature of the deposits about the Darwin stock it is evident that structure was the dominant controlling factor in their location. However, to some extent the composition of the enclosing wall rocks has had a modifying influence on the local accumulation of ore. There are three types of structural controls: (1) intrusive contacts, (2) bedding planes, and (3) transverse fissures. A single deposit may be localized by two controls, or pass from one into another. Commercial deposits of the first type are found only along the west contact of the stock.

DEPOSITS ALONG INTRUSIVE CONTACTS

The deposits formed at igneous contacts are the largest in the district. Along straight stretches of the contact, deposits of this type may be long, narrow, tabular bodies resembling the fissure deposits. In general, however, the contact deposits are lenticular in plan and although shorter in outcrop length than the cross fissure deposits, they are usually thicker. They vary in length along the contact from a few feet to two or three hundred feet. Likewise the width may vary from less than one foot to 20 or 30 feet. They extend downward irregularly along the igenous surfaces.

Irregular protuberances of the intrusive into the country rock often show more pronounced mineralization. Local warping of the adjacent strata or flattening of the contact surface also appear to be instrumental in impounding of ore. Such features may have been effective along the contact between the Defiance and Independence mines, where the intrusive has forced its way into a small anticlinal

[13] Inyo County: Calif. Min. Bur., 12th Ann. Rpt., p. 24, 1893.

fold paralleling the stock and thus flattening the contact surface to some extent. Underground development of these deposits has, however, not been sufficient to permit a full analysis of their localization.

The Defiance and Independence orebodies are the outstanding examples of deposits along igneous contacts; but smaller deposits of a similar nature are to be found at several points north and south of these. On the west side of the stock the contact roughly parallels the stratification of the tactites, forming an effective structural trap along the surface for deposition of ore. In contrast the east side of the stock bears cross-cutting relationships to the stratification. Here the contact surface formed practically no effective trap for the ore solutions, which probably passed outward along the bedding planes and fractures. As a result of this structural condition, there are no mines of any consequence located on the east contact of the stock. The only deposits at the contacts which have produced are those located on the west side of the stock. The type of ore mineralization together with the associated gangue is similar or identical to that of many of the bedding-plane and fissure deposits.

BEDDING-PLANE DEPOSITS

Numerous deposits have been formed along bedding planes, particularly along the east side of the stock where ore solutions found easier avenues of escape from the contact both by reason of more numerous cross fractures and by bedding planes which dip steeply into the contact. The outstanding deposits of this type are the Custer, Jackass, Fernando, and Keystone on the east side, and the upper Defiance and Promontory on the west side. Many of the deposits are layered or sheeted as a result of replacement of several thin beds. Others, such as the Fernando and Keystone, have formed at the intersection of fissures with favorable stratification planes, and as a result have a chimney-like shape. At the Keystone the deposit is dominantly on the fissure. In some instances where the igneous contact cuts slightly across the stratification, contact deposits continue or branch into bedding-plane deposits. The Custer and upper Defiance bedding-plane deposits are only 20 or 30 feet from the igneous contact. Others such as the Promontory and the Keystone deposits, are 1000 to 1500 feet from the contact.

TRANSVERSE FISSURE DEPOSITS

Deposits of this type are the most numerous in the district; although of considerable importance it is doubtful whether they will outproduce the deposits formed at the igenous contacts. The fissure deposits are most important and numerous on fractures trending northeasterly, nearly at right angles to the elongate direction of the stock. Many of these are confined to the tactite or extend only a short distance into the intrusive, where they are taken up by multiple adjustments along joint planes. Others, such as the Standard or Lane veins, cut entirely across, or extend well into the stock. Fissures of this type are mostly vertical, or dip steeply to the north.

Fissure veins of this type are intersected by a northwesterly belt of mineralized fissures which lie north and east of Ophir Mountain. On these fissures much shearing is evident, accompanied by greater

width of mineralization, in the form of jaspar, calcite, and barite. Metallization, however, is sporadic and the ground of these veins is as yet unproven.

The Christmas Gift, Lucky Jim, Lane, and Columbia mines are the outstanding producers of fissure veins. The width of the fissure veins averages two to six feet; locally, stopes 25 to 30 feet in width have been mined. Ore and gangue mineralization in the transverse fissure veins is in many places the same as in the deposits along the igneous contacts. Those veins which extend from the tactite into the igneous rock show by contrast the influence of the wall rock on deposition. In the intrusive the veins become restricted and ore and gangue scarce and sporadic.

In the following table the mines of the district are arranged according to their distance from the stock, and the dominant structural control and mineralization are indicated. Mines on deposits along contacts are restricted to the west side of the stock.

	Mines	Structural control			Feet from Ig. contact	Characteristic gangue minerals				
		Contact	B. plane	Fissure		Pyrite	Jasper	Quartz	Calcite	Fluorite
West side of stock	Independence	x			0	x	x		x	
	Essex	x			0	x				x
	Defiance	x	x		0	x	x	x	x	x
	Bernon		x		50	x	x			
	Thompson			x	100	x	x	x	x	
	Lucky Jim	x		x	200	x	x	x		
	Bell Union		x		200	x	x			
	Rip Van Winkle			x	500	x	x	x	x	x
	Promontory		x		1,000	x	x	x		
	Fairbanks			x	1,500	x	x	x		
East side of stock	Standard Ext.			x	50	x	x	x	x	x
	Custer		x		50	x	x	x	x	x
	Christmas Gift			x	300	x	x			
	Standard			x	400	x	x		x	x
	Silver Spoon			x	500	x	x	x		
	Wonder		x		1,000	x	x	x	x	x
	Fernando			x	1,000	x	x	x		
	Jackass		x		1,200	x	x			
	Keystone		x		1,500	x	x			
	Santa Ana			x	2,000	x	x			
	Lane			x	2,200	x	x			
	Columbia			x	3,000		x			

ORIGIN AND CLASSIFICATION OF THE DEPOSITS

The position of the Darwin silver-lead deposits is clearly controlled by the form and extent of the stock. The stock was guided in its emplacement by the structure of the strata of Pennsylvanian age.

Advancing with and ahead of the igneous material were emanations which carried great quantities of silica and lesser quantities of other metals, chief among which was iron. Heat energy which promoted recrystallization and metasomatism was carried largely by the magmatic emanations. The effect of conducted or diffused heat was distinctly subordinate to that of conveyed heat. The heat and chemical action of the pervading emanations caused great quantities of carbon dioxide to be liberated and driven off. Simultaneously with the liberation of carbon dioxide, silica and other metals were added, thus preventing any appreciable volume reduction and consequent obliteration of bedding structure.

The stock was intruded into rocks already considerably silicated and thoroughly heated. This is evidenced by the absence of chilling on the margins of the stock or the small dikes in the tactite, and by the lack of any detailed relationship of silicate aureoles to these offshoots of the stock. That a lesser amount of silicate replacement accompanied or followed the intrusion is shown by garnet zones marginal to the stock or replacing it.

The development of the tactite aureole and the final consolidation of the intrusive was followed by a period of fracturing. Many of the fissures of the resulting fracture system are rather persistent and continue through the stock and the wide silicate aureole alike. Displacements, which offset the igneous contacts occurred along some of the fissures prior to their mineralization.

All of the hypogene lead mineralization and deposition of ore in general occurred after this period of major fracturing. Some dislocations actually post-date the period of metallization and have brecciated or offset the orebodies. This period of fracturing distinctly separates the period of silication, in which the tactites developed, from the period of metallization in which all of the ore of the district was formed. The silication developed under high temperatures in advance of and attendant upon the intrusion. The ore deposition developed under low temperature, hydrothermal conditions.

Knopf thought the deposits indicated a "sequence in time" with decreasing temperature as "The fissure veins are regarded as representing the low temperature end of a genetically related series of deposits formed at progressively decreasing temperatures," Knopf, (p. 9, 1914) and "the galena ore of the Darwin district began to be deposited under pyrometasomatic conditions, but its maximum deposition occurred at a lower temperature," Knopf, (p. 533, 1933) and further, in comparison, "the Coeur d'Alene district represents a sequence in time." Knopf, (p. 10, 1914).

A temperature gradient existed away from the intrusive, but this only effected a crude zoning of grain size and to a lesser extent of mineralization. If decreasing temperature determined the place of deposition it is more likely that deposition would first take place at a distance from the intrusive in fissures and bedding planes, and later, as the temperature fell, at the contact; but there is no indication of long continued deposition of ore with falling temperatures, and temperature was apparently not the controlling factor in the relative time or position of the deposits. The simplicity of the ore and paragenesis does not warrant a long continued deposition, and there is little or no

overlapping of mineralization. Instead, the controlling factors were (1) a deep-seated supply of differentiated metals and their associated gangue substances following consolidation of the intrusive and fracturing of the rocks, and (2) the effective opening of fissures, stratification, and contacts to the ore-bearing solutions. The ore deposition was all accomplished during a single short period under nearly constant temperature conditions following fracturing. The only division or classification to be made is one of structural control as already described.

Knopf (1933) has chosen Darwin as an example of a pyrometasomatic lead deposit. As evidence of a connection between pyrometasomatic deposits and fissure veins Knopf (1914) cited the Independence orebody as an example of the contact pyrometasomatic type of deposit, and the Defiance orebody as intermediate or transitional link between the contact type and the fissure veins of the district. This conclusion was based on finding apatite in orthoclase associated with primary sulphides at the Defiance mine and andradite garnet with galena at the Independence.

The deposits occur near each other along the same intrusive contact, and on the whole the mineralization is much the same except that in the Defiance orebody exceedingly coarse calcite is more abundant. Galena and other sulphides have impregnated the tactite walls to some extent in both deposits, but such close association does not necessarily indicate that the sulphides formed under the high temperature and pressure conditions that the garnet or orthoclase did. In fact, there is little in either deposit which can be used to set them apart, or to set either apart genetically from the fissure veins, especially as regards time, sequence, and substances available through ore-forming solutions. In a sense, it is better to view them all as fissure deposits. During metalization some fissures were effectively opened along contacts and bedding planes, and others along transverse fractures.

The deposits along contacts and in fissures are similar mineralogically and structurally. There is little necessity for demonstrating a transition, for they are genetically identical. The fissures have the regularity of strike and dip of mesothermal deposits. The walls are smooth and well-defined. Furthermore, the regularity and sharp definition of the contact deposits compares with that of the fissures. The mineralization directly associated with the deposits is not on the whole of the pryometasomatic type. Jasper, which is one of the most common gangue minerals in the deposits, is indicative of formation at temperatures attributed to mesothermal deposits. Both fluorite and barite are common minerals in low temperature deposits. During the existence of the pyrometasomatic environment about the stock, the characteristic minerals developed were garnet, orthoclase, quartz, specularite, and scheelite; but this mineralization was not great. The lead mineralization developed at a later stage in association with fluorite, calcite, barite, and jasper in a mesothermal environment. There is no pyrometasomatic galena. Both fluorite and barite are common in mesothermal or epithermal deposits.[14] Initial pressures and temperatures may have been such that a hypothermal stage was not represented.

[14] Lindgren, W., Differentiation and ore deposition: Ore Deposits of the Western States, p. 154, 1933.

Umpleby,[15] from findings at Mackay, Idaho, and from study of numerous other districts, has formulated the generalization that ore about intrusive bodies tends to form on the limestone side of garnet zones. It was his observation that where ore came directly against the igneous contact practically no barren lime silicate would extend beyond the ore. Darwin appears to be an exception to this, for the silicate rocks in most cases extend far out beyond orebodies at contacts. Of the two contacts, silicate-igneous and silicate-limestone, the latter would in all probability be more easily penetrated by ore solutions. Where the silicate zone is wide, stratification well preserved, and fissures common, the rule formulated by Umpleby would be less applicable because of the preponderance of structural control.

EPOCH OF MINERALIZATION

The epoch of metallization and hence most of the ore mineralization took place after the intrusion of the stock. The silication of the limestones occurred during the emplacement of the igneous rock. Fracturing of both the tactite and the consolidated intrusion set the stage for the ore deposition. There is evidence that displacements continued during the ore deposition of the type termed by Hulin[16] as intermineralization fault movements. And as pointed out by Hulin these movements facilitate the accumulation of ore shoots. The ore-forming epoch which followed shortly the intrusion of the stock is probably best dated as late Mesozoic.

MINING HISTORY AND PRODUCTION

During the early seventies the rich ores of Panamint City and the Ballarat district were shipped by pack train through Shepherd Canyon in the Argus Range and thence by a route following springs along the east front of the Coso Mountains to Owens Valley. A Mexican searching for a mule lost from the packers' camp at Old Coso or Coso Springs is reported to have discovered an outcrop of ore in the Darwin Hills. The initial discovery is reported to have been made in 1874. The lode which was found was evidently rich enough to have attracted considerable attention, for during the year many other deposits in the district were located. Most of the important mines were started during the years 1874 and 1875. A good-sized town soon sprang up and was named after Dr. Darwin French who had lead a party of 15 men through Darwin Canyon in 1860 in search of the mythical Gunsight silver lode in Death Valley.

During the early boom days of the seventies there were eight blocks of buildings along the main street and six in the other direction. The population is said to have then exceeded that of Los Angeles. In the early days, Darwin was twice burned to the ground by wind-whipped fires, which probably accounts for the present lack of indications of the former size or character of the town.

From 1875 to 1877 three smelters were built near Darwin. The Cuervo had a capacity of 20 tons per day; the Defiance 60 tons; and the

[15] Univ. of Calif., Publ. Geol., vol. 10, p. 26, 1916.

[16] Hulin, C. D., Structural control of ore deposition: Econ. Geol., vol. 24, pp. 15-49, 1929.

New Coso 100 tons. The lead well of the New Coso smelter was started from lead obtained from Cerro Gordo. Iron oxides used at the smelter were obtained from iron mines on Centennial Flats in the Coso Mountains. Charcoal was obtained from timber burned in the Coso Mountains. It is also interesting to note that many of the eight by eight stulls still present in some of the older workings were hand-hewn from timber obtained in the Coso Mountains.

During the early days of mining all freight had to be hauled by team from Los Angeles, and consequently costs were very high. Only the richest ores were sent to the smelter; according to De Groot,[17] about one foot broken out of the ledge averaging twelve feet in width constituted ore at the Defiance mine. About four-fifths by bulk and about one-half of the value went into the dumps. Because of the excessive transportation costs and the exhaustion of these more easily mined rich ores, the smelters were shut down within a few years, prior to the completion of the narrow-gauge railroad to Keeler in 1883. After shutdown of the smelters, jigging of the ores came into practice and concentrates obtained from newly mined ore and from the dumps were shipped to smelters at Selby or Salt Lake.

During the eighties and nineties mining and production were sporadic and at times practically dormant due to poor transportation, lack of modern mining facilities, and some litigation. Some leasing and shipping were carried on from 1900 to 1910, but only small activity was reported by Knopf in 1914. In 1915 the Darwin Development Company consolidated the Lucky Jim, Promontory, Lane, and Columbia mines and began the construction of a mill on the Lane property. This company soon gave way to the Darwin Lead-Silver Development Corporation, and finally, in 1917 the Darwin Silver Company consolidated the above properties with the Defiance and Independence mines purchased from the Reddy Estate. Modern equipment, roads, and camps were constructed with the view of mining on a large scale, and although considerable ore was blocked out and nearly a half-million in richer ore was shipped, real mining awaited camp building and surface developments. The camp was financed by E. W. Wagner and development was managed by A. G. Kirby in 1921. During the height of the development Wagner committed suicide because of reverses in speculation growing out of the grain crash in 1920. Kirby leased the properties from the Wagner Estate during the period of 1922 to 1924 and produced some ore, but on account of estate complications was forced to quit.

The Lucky Jim mine, one of the big producers of the district, was mined extensively in the early days. According to J. A. McKenzie, who owned the mine at the time Goodyear reported on the district in 1888, the mine at that time produced about $1,250,000 or $1,500,000, but probably more money had been spent on the mine than had been taken out. At the time of Goodyear's visit the mine had been opened 300 feet by vertical shaft and 180 feet below the bottom level by an inclined winze. Although some mining had been done during the intervening time, no greater depth had been attained at the time of Knopf's work in 1913. The Darwin Development Company working the mine in 1915 had deepened it to 600 feet. The Lucky Jim camp above the

[17] Calif. Min. Bur., Tenth Ann. Rpt., p. 211, 1890.

mine was built about this time, and the Lucky Jim continued to be deepened and mined until about 1926 when a depth of about 1000 feet was reached. The Defiance, Independence, and Lane mines were also worked to a considerable extent during the period from the World War to about 1927. The larger ore body in the Independence mine was opened up and worked during this period.

With the straightening out of the Wagner Estate affairs, the American Metals Company under C. H. Lord of Chicago leased the properties and operations again began. Considerable ore was concentrated and shipped during the period 1925 to 1927. But by 1927 the lead industry was becoming depressed and the camp was again shut down. In 1928 an open switch in the Lucky Jim mine caused a fire which burned out much of the shaft and mine timbering. As a consequence this mine, perhaps the largest in the district, is inaccessible.

In 1936 with the return of more favorable mining conditions and better prices for lead and silver, the Darwin properties were again opened up in preparation for mining. The Wagner Estate properties were reorganized as the Darwin Lead Company. By the end of 1936 the Lane mill had been rebuilt to 200-ton capacity and early in 1937 the Thompson tunnel was cleaned out in preparation for working the Independence orebody at a lower level. A. A. Rubel in 1936 purchased the Keystone properties in the south end of the hills and constructed a modern camp in preparation for extensive development under the name of Keystone Darwin Limited.

It is evident from the history of the camp that there have been two contrasting periods of production. The first, in the early seventies, was halted because of depletion of the rich surface ores, and because of lack of modern methods of mining and milling and transportation applied to low-grade ores. The second began with the World War impetus to mining during which consolidation of properties and large-scale operations were effected. This later period faltered during the unprecedented depression, but should now swing into full stride again. With modern methods of mining, ore treatment, and transportation the Darwin district should prove its position as a silver-lead producer.

The following table of production from the more important mines in the district is based partly upon figures and estimates made by previous writers and partly upon estimates from information gained during the present survey:

Mine	Estimated Production
Lucky Jim	$2,000,000
Defiance	1,500,000
Christmas Gift	550,000
Independence	500,000
Lane	300,000
Custer	250,000
Promontory	200,000
Thompson	100,000
Columbia	100,000
All others	300,000
Total	$5,800,000

MINES

MINES IN THE NORTH END OF THE DARWIN HILLS

Fairbanks Mine—The Fairbanks mine is situated about three miles north of Darwin and about 1700 feet northwest of the Lucky Jim mine at an altitude of 5500 feet. The orebody occurs in a small chimney-like vertical vein which strikes northeasterly within the zone of the Darwin tear fault. The wall rock, composed of impure limestones, strikes S. 38° W., a trend considerably at variance with the regional trend due to the drag effect of the large fault. Although the exact relation of the ore-vein to the tear fault could not be determined, the vein is probably subsidiary to the major fault, the ore originating from solutions which rose along the fault. The vein matter consists of galena and cerusite in a gangue of quartz, fluorite, calcite, and iron oxides, the latter probably derived as gossan-like material from jasper and pyrite in the original vein. Some galena occurs in the outcrop.

Lucky Jim Mine—The Lucky Jim mine is situated about three miles north of Darwin at an elevation of 5000 feet. It is located on a rather persistent vein which strikes N. 50° E. and dips 80° NW. About 500-600 feet southwest of the shaft the vein is broken by two faults which strike northwest. The dislocation on each of these faults is about 50 feet, and, as is the rule in the district, the north side has moved westward. The principal ore shoot is inclined to the southwest about 30° and has been worked downward in a series of tunnels and winzes to about 1000 feet. The vein averages four to six feet in width, but in places is nearly 20 feet. To the northeast the vein cut less metamorphosed limestones that have been throne into series of small folds. The ore consists of bunches of galena and cerusite occurring in an oxidized jasper gangue. Only small quantities of calcite, pyrite, and fluorite are found. The ore averaged 1-1½ ounces of silver to each one per cent of lead. The lead percentage of the ore mined varied with the stope, but is reported to have been 8-10 per cent. The surface cuts are reported to have been much higher in silver than at depth.

Christmas Gift Mine—The Christmas Gift mine (Fig. 25) is located about 2000 feet southeast of the Lucky Jim mine on a vein which strikes N. 40° E., and dips about 80° NW. The rock in the vicinity of the mine is stratified tactite which has been pierced by many small dikes and irregular offshoots, of the Darwin stock as shown in Plate V. Although the tactites are considerably disturbed by the intrusions, in general they strike N. 30° W. and dip 30-40° W.

As can be seen on the geologic map of the Christmas Gift claim group, an intricate system of fissures and faults has been superimposed upon the multiplicity of small intrusions into the tactites. Among the fissures are several parallel to the Christmas Gift vein; these in general have been most highly mineralized. The Christmas Gift vein is cut off by a compound fault about 200 feet northeast of the shaft. This fault strikes N. 70° E. and dips 75° S. The north side of this fault has shifted west and in the vicinity of the mine the displacement is about 450 feet. The apparent displacement dies out very rapidly to the east and west. The ore shoot mined in the Christmas Gift mine pitches steeply southwest and is about 300 feet in stope length. The mine is

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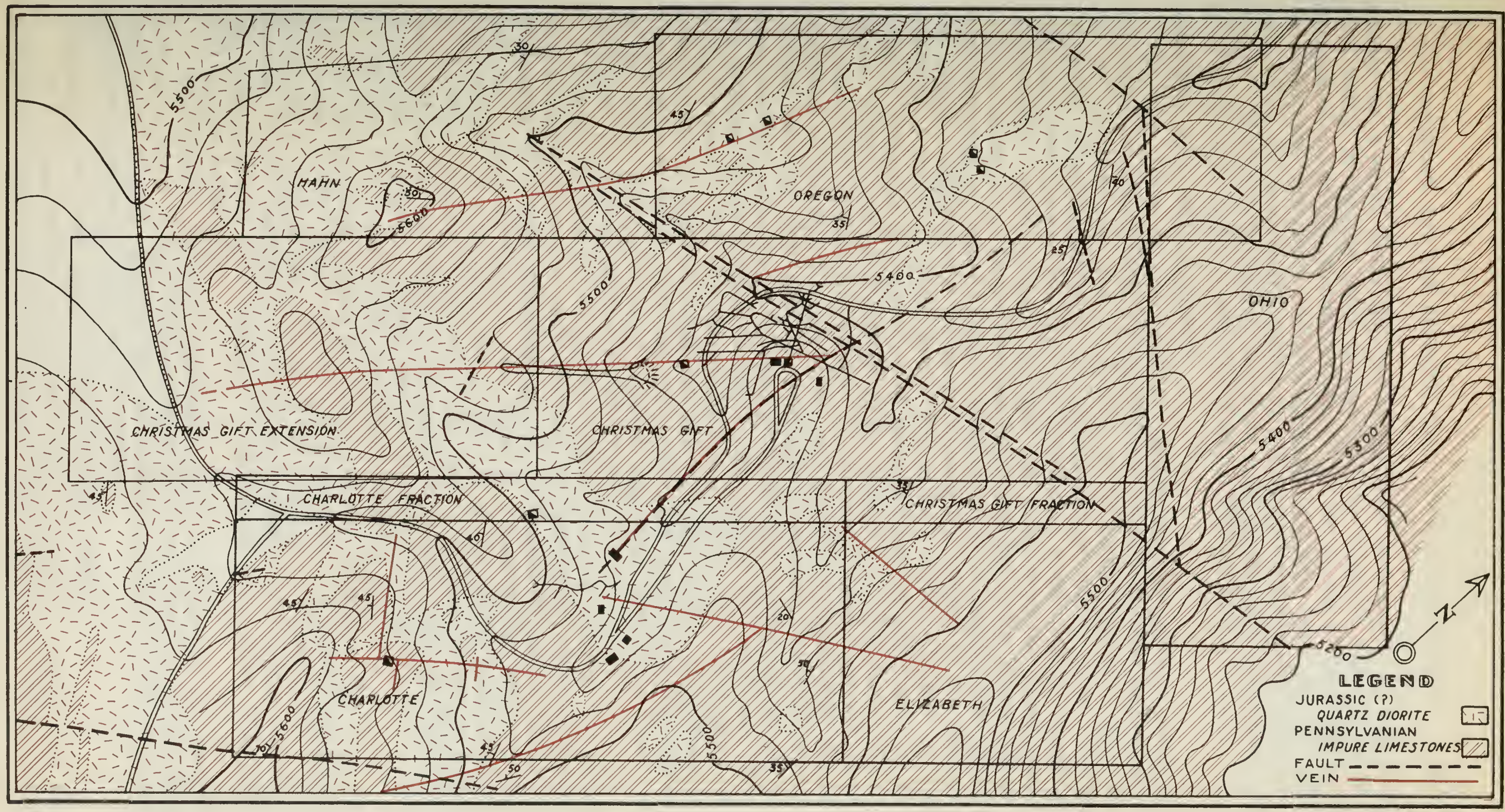

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GEOLOGIC MAP OF THE CHRISTMAS GIFT CLAIM GROUP

BY VINCENT C. KELLEY 1936.

SCALE
0 100 200 400 FT.
CONTOUR INTERVAL 20'

opened by a shaft down the dip of the vein to a depth of 400 feet with drifts along the fault or the vein to intersect the ore shoot. Because of the trough structures formed by the planes of the fault and the vein, the ore shoot ends sharply against the fault on the 250 level. The ore consists of bunches of galena and considerable lead carbonate. The ore is imbedded in earthy iron oxides apparently derived from pyrite and jasper, remnants of which still occur in the vein.

MINES OF THE ROUNA GROUP

In this group are included the mines and prospects located in the canyon north of Lane Canyon through which the highway passes. All of the deposits are in fissure veins along the east side of the stock, directly opposite the Independence mine. Most of the work has been done on two large and persistent northwesterly trending fissures which converge from the west and unite near the development camp in the canyon. In the twenties both branches of the fissure system were explored by tunnels several hundred feet in length, but no ore was found. These fissure veins are among the largest in the district, attaining a width of 40-50 feet. The walls are very definite as the result of irregular impregnation of sheared zones on either side of the fissure. Jasper and calcite make up the bulk of the veins, but considerable barite can be found in places. In the tunnels and open cuts small quantities of chalcopyrite, sphalerite, and pyrite are occasionally found. To date, however, practically no production has come from these northwest-trending veins, and it is quite probable that, in spite of the extensive gangue mineralization of jasper and calcite, they were not effectively opened to sulphide mineralization. These veins have been followed by narrow dikes of basalt and aplite in the vicinity of the tunnels. The basaltic material is not like any of the dike rocks definitely related to the major stock, and there is some suggestion that these dikes are later than the mineralization of the fissures.

Several northeast-trending veins have been exploited in this group and, although these are narrower and less persistent, they show mineralization of a more encouraging type. Of these veins the Standard has been most developed, and from it, considerable lead ore has been mined. It outcrops on the south side of the canyon and lies south of the above-mentioned fissures. The vein is two to six feet in width and contains coarse calcite, much gossan iron oxide, and the favorable ore indicator, fluorite. Large masses of galena were found in the vein in addition to a considerable amount of oxidized lead ore.

In the twenties, during the driving of the tunnels on the large fissure veins, a small camp was built in the canyon. A recent cloudburst destroyed or washed away much of the equipment. That which is left consists of two portable pneumatic compressors of 130-foot capacity, an Ingersoll-Rand drill sharpener, blacksmith shop, mine cats, rails, and air and water pipe.

Considerable electrical exploration work was done by the Radiore Company prior to the development work in an effort to find the best indications of ore. Most of the indications obtained by the electrical work are, however, evident on the surface.

MINES OF THE DEFIANCE-INDEPENDENCE GROUP

The mines of this group are lcoated along the east side of the prominent ridge back of the Darwin Lead Company's camp, within

one mile of Darwin. The mines are centered about two large tabular orebodies at or near the west contact of the stock. The southern orebody is worked by the Defiance mine and the northern orebody is opened by the combined workings of the Independence, Essex, and Thompson mines.

The *Independence Mine* (Figs. 27 and 28) is located one and a half miles north of Darwin at an elevation of 5600 feet near the top of the prominent ridge extending southeasterly from Ophir Mountain. The orebody is poorly exposed at the surface. The initial discovery and entrance to the orebody was made by an inclined shaft located on the crest of the ridge at an elevation of 5700 feet. At this point, along the contact, a tabular vein about 20 feet in width outcrops. Northward from this entrance the outcrop of the vein can be traced several hundred feet before it pinches out. South of the ridge crest the outcrop of the vein pinches out in about 50 feet. Two smaller parallel veins lie in the beds a few feet above the vein at the contact. Entrance was later made to the orebody by a tunnel on the south side of the ridge through a lobe of quartz diorite near the contact. The orebody within the ridge above the elevation of the tunnel is enormous and stopes in this region are the largest in the district. At the tunnel level the orebody is 100 to 150 feet in width and the stope length is about 200 feet. The footwall of the orebody is in most places quartz diorite although sometimes a narrow layer of tactite intervenes. The hanging wall is limestone and tactite. The bulk of the orebody consists of a porous, highly weathered, gossan-like material which contains many pseudomorphs of limonite after pyrite. Considerable kaolin, calcite, siderite, quartz, and jasper occur throughout the gossanized vein material, much of which is mined as high-grade milling ore. Small unmined remnants of galena and cerusite which undoubtedly occurred in larger masses can be found scattered through the gossanized walls of the stopes. The ore stoped from above the tunnel level probably extends downward along the contact for a considerable distance. The unmined ore in this orebody probably constitutes one of the largest reserves of ore in the district.

The *Essex Mine* (Fig. 29) lies 200 feet southwest of the Independence mine at an elevation of 5500 feet. The workings consist of an open cut from which are driven two short tunnels each about 100 feet in length and a vertical shaft 40 feet deep. The vertical shaft is sunk on a vein 7-20 feet wide, striking N. 65° W., and dipping 85° S. The deposit has formed on the south side of a small lobe of the stock. The vein has several small branches into the tactite and intrusive. Near the bottom of the shaft the vein is faulted. A vertical north-south fault is encountered 25 feet west in a drift driven in the footwall of the fault beyond which tactite is impregnated with pyrite, steely galena, and fluorite. The fluorite is purple and darkens upon lying in the open. The sulphides replace the tactite in very small veinlets and masses. This is one of the few places in the district where sulphides have impregnated the tactite in quantities sufficient to constitute ore. As it is mined, it runs 15 per cent lead and seven ounces in silver. Aside from this occurrence west of the fault in the bottom of the mine, most of the material in the Essex vein is the gossany material similar to that found in the Independence mine. A peculiar vein consisting of white lami-

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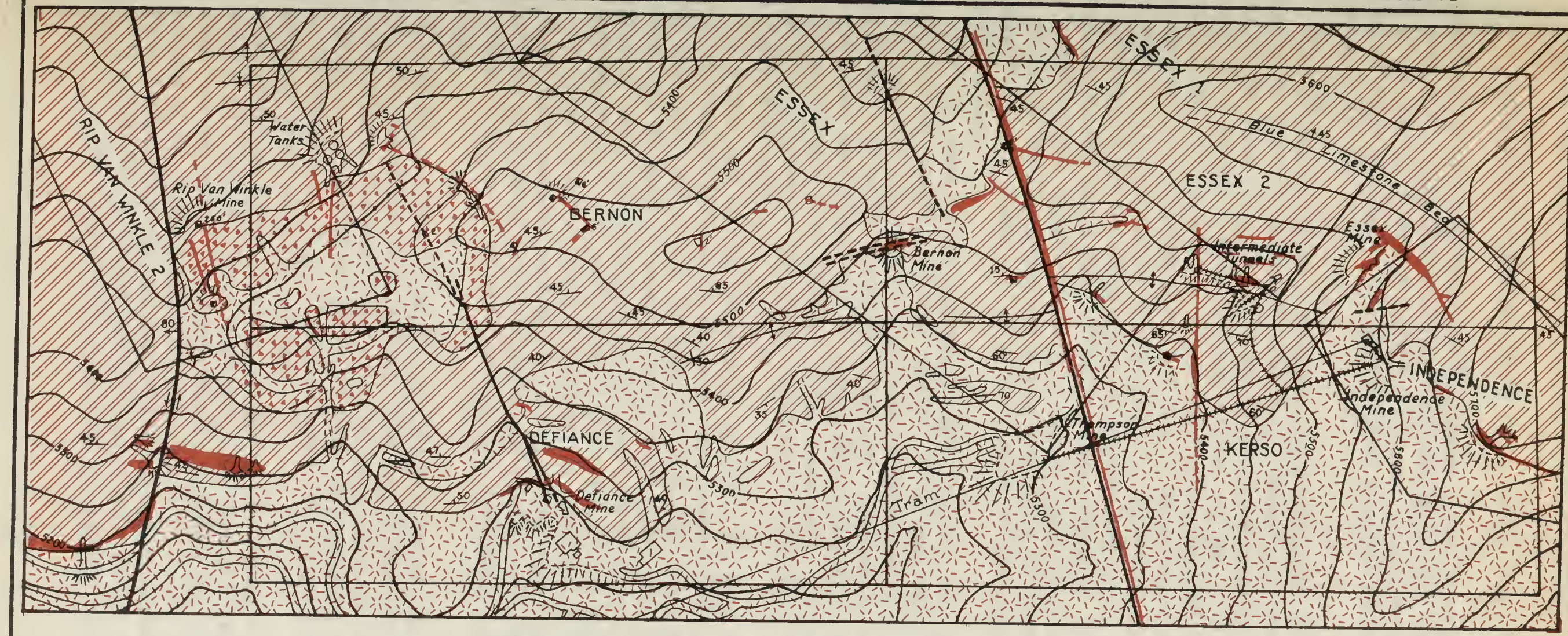

GEOLOGIC MAP OF THE DEFIANCE-INDEPENDENCE MINE GROUP

BY VINCENT C. KELLEY

JURASSIC (?)
QUARTZ DIORITE

PENNSLYVANIAN
TACTITE WITH SOME IMPURE LIMESTONE

SCALE
0 100 200 400
FEET

CONTOUR INTERVAL 50 FEET

N.

BRECCIATED TACTITE
FAULT
VEIN

nated fluorite carrying considerable galena occurs in a small open cut at the west end of the Essex dump. Fifteen or twenty tons of good sulphide ore are piled near the shaft. In some of this material blue radiating crystals of linarite, the double basic sulphate of lead and copper, have been found.

The *Thompson Mine* is situated about 1000 feet north of the Defiance mine at an elevation of 5300 feet. Access to the principal workings of the mine is gained by a 400-foot tunnel driven N. 65° W. The portal is in quartz diorite and the contact of the tactite is about 260 feet in from the portal. A mineralized zone about 60 feet in width is encountered in the tactite about 350 feet in from the portal of the mine, and most of the stopes are in this ground. The presence and extent of the mineralized zone is determined by a prominent cross fracture which bounds it on the north side. This fracture strikes N. 75° E., and cuts the tactite-quartz diorite contact in the canyon 350 feet northwest of the portal to the Thompson mine, at which point the fracture is heavily gossanized for a width of 10-15 feet, both in the tactite and in the quartz diorite.

The ore consisted of galena, cerusite, pyrite, and sphalerite with calcite, quartz, jasper, and iron oxides. That chalcopyrite is a constituent of the ore is shown by numerous chrysocolla veinlets in the outcrop directly over the principal workings. Unusually large masses of galena were encountered in the stopes and considerable native sulphur occurs as an oxidation product of the lead ores. Unusually coarsely crystalline sphalerite, attaining dimensions of several inches, occurs associated with calcite.

Near the end of the Thompson tunnel a 175-foot raise has been driven to the surface along a prominent cross fracture. Ores from small cuts and tunnels are dropped through this raise and hauled out through the Thompson tunnel. Because of their position between the Thompson and Independence mines, these tunnels are known as the Intermediate mine. The entrance to the main tunnel was entirely covered by debris from a recent cloudburst at the time of the field work. All of the Intermediate workings lie north of the cross fracture and they are located on bedding-plane deposits and smaller cross fractures. Several small tongues of syenite or alaskite intrusives occur near the workings.

The *Defiance Mine* (Figs. 26 and 30) is situated one mile north of Darwin at an elevation of 5250 feet. It is one of the oldest mines in the district and as a producer ranks with the Lucky Jim mine, although the ratio of silver to lead in the Defiance mine has not been as high as that at the Lucky Jim. At the Defiance mine two large lens-shaped orebodies occur parallel to the contact.

The principal orebody crops out along the intrusive contact for a distance of 215 feet and has a maximum thickness of about 40 feet. At the mine the contact of the stock roughly parallels the stratification of the tactites which strike N. 25° W., and dip 35° W. The other orebody lies about 50 feet above the contact orebody along the bedding of the tactites. It is 190 feet in length and 30 feet in its greatest width. About 100 feet above the upper orebody is a sill of quartz diorite 100 feet in

thickness which follows the gently arched tactite in a curve to the north where it joins the main stock near the cook house 250 feet north of the mine.

Thus, the orebodies lie in a curved wedge of tactite between the stock and a branch sill. The northward extent of the orebodies is limited by the sill. It is evident from the underground workings that the orebodies are more extensive to the south than the surface outcrops would indicate. The mine is opened by an inclined shaft in the footwall of the orebody to a vertical depth of about 300 feet. In addition a tunnel 550 feet in length has been driven straight into the hill at the surface level of the mine and considerable ore from the upper orebody was stoped by drifts from this level. Drifts north and south from the inclined shaft have been run at various levels from which the bulk of the ore produced has been stoped.

Most of the veins consist of highly gossanized and kaolinitic material within and along which are found masses of calcite, quartz, pyrite, fluorite, and jasper. In addition, large remnants of limestone and tactite are included in the veins. In the early days of mining at the Defiance mine much of the highly oxidized material of the veins was either left unmined or thrown on the dumps. However, under present conditions of mining and milling much of this would undoubtedly form good milling ore. The calcite of the deposit is exceedingly coarse and cleavage pieces 12-18 inches in diameter are common. Fluorite is also coarse-grained and may be white, lavender, or green in color. Galena and cerusite occur in bunches and small shoots in the highly oxidized material or enclosed in calcite or fluorite with pyrite and dark brown sphalerite. Pyrite crystals ranging from a fraction of an inch up to two inches are very abundant and near the outcrop the walls of the stopes are in places lined with pseudomorphs of limonite after pyrite. Chalcopyrite in small quantities is common with the galena, and as a result chrysocolla and melaconite are to be found near the surface. In places the tactite walls are impregnated with pyrite and sphalerite, the latter often in bands following the stratification. In the future, ore found in this mine will most probably lie to the south of the entrance of the shaft and from a structural standpoint the ground around the breccia tactite south of the drifts on the 215 and 290 levels is the best to explore.

The *Rip Van Winkle Mine* is situated on the west side of the Defiance ridge about 1000 feet south of the Defiance mine. It is opened by a vertical shaft 250 feet in depth along a cross fracture striking N. 45° E. It is one of the few producers from a fissure vein on the west side of the stock. The ore is highly pyritic and is reported to run unusually high in silver. Galena, sphalertie, and pyrite together with considerable calcite and fluorite impregnate the tactite walls adjacent to the fissure. The mine, which is owned by the Darwin Lead Company, has not been worked for many years and was inaccessible at the time of the field work.

MINES IN LANE CANYON

Several mines and prospects occur in Lane Canyon along the highway through the Darwin Hills. The following are described in this section (1) Wonder Mine Group, (2) Standard Extension, (3) Jackass, (4) Santa Ana, and (5) Lane.

Wonder Mine Group. The mines and prospects of this group are situated at an elevation of 4700 feet near the highway about half-way down the Lane grade near the sharp turn in the canyon. The old Wonder mine described by Knopf is situated on the south side of the highway and is located on a deposit which appears to have formed along the bedding of the tactite. The deposit is opened by a short tunnel and a shaft which is inaccessible. The tactite along the deposit is characterized by much vuggy garnet with crystals of quartz and pyrite formed in the cavities. The main gangue of the vein, however, is coarse cleavable calcite intergrown with white, iron-stained fluorite. The ore, chiefly carbonate, is found in this gangue.

North across the Lane canyon are several prospects on the Wonder No. 1 and the Bruce claims. The Bruce prospect is located on a large mineralized area some 50 feet in width and 1200 feet in length. The rocks of the mineralized ground are tactites which dip S. 76° W. at 53°. Two small tongues of quartz diorite occur in the canyon to the north. The tactite is brecciated to some extent and the bedding has been mineralized by calcite, fluorite, quartz, pyrite, and chalcopyrite. A little scheelite has been found and assays of 2.2 per cent tungsten were reported as well as traces of molybdenum.

The *Standard Extension Mine* is located north of the Bruce claims at an elevation of about 4950 feet near the top of the ridge. The deposit is a fissure vein. It is almost directly across the stock from the Independence mine. The workings consist of two tunnels opened up along a fissure which strikes N. 55° E. obliquely across the bedding. The vein is four to eight feet wide and consists of quartz, calcite, fluorite, jasper, and ore mostly in the carbonate form.

Santa Ana Mine. The Santa Ana shaft is located just north of the mouth of Lane Canyon at an elevation of 4450 feet. There are two veins striking N. 40° E. The principal vein to the south is opened by a vertical shaft 200 feet in depth, with a 30-foot winze below the bottom (200) level. Two other short levels have been driven on the vein at 75 and 150 feet. The ore material consists chiefly of powdery iron oxides in which are occasional small siliceous seams. These are reported to run higher in silver. The width of the vein varies from 1-6 feet on the surface to 8-10 feet on the lower beds. The shaft was sunk and most of the development done in the nineties with a geared hand-hoist.

The *Lane Mine* is situated at at the east edge of the hills just south of the Lane Mill at an elevation of about 4400 feet. The mine is opened up by two vertical shafts to a depth of about 800 feet. The deposit on which the mine is located is known as the Lane vein. It is traceable on the surface from the mine westward into the east edge of the stock, a distance of over 3000 feet. In the canyon west of the shaft portals, a tunnel has been driven 1300 feet on the vein. The strike of the vein is roughly N. 65° E. The country rock in the vicinity of the mine consists chiefly of blue-gray limestone, but westward the vein passes through increasingly metamorphosed limestones and into tactites. The vein matter is principally brecciated and gossanized jasper which carried the shoots of primary sulphides and carbonate ore. Chrysocolla veinlets are common in the vein matter on the dump. According to a

recent lessee the lead values give way to copper on the lower levels, and gold values are said to increase with the copper.

The *Jackass Mine* is situated near the eastern crest of the hills at an altitude of 5000 feet. The orebody is on a bedding plane on the west limb of the anticline which occupies the ridge west of the Lane mine. The vein is only 1-2 feet wide in the outcrop where it is exposed in a shallow cut for about 30 feet. Some sulphides, galena, chalcopyrite, pyrite, and secondary covellite, occur in the outcrop disseminated in green garnet-diopside tactite. At the 50-foot level the vein is widened to 8-10 feet and consists of highly pyritized tactite and considerable clay jasper, and hematite stalactitic, while aragonite has filled cracks in many places.

MINES OF THE SOUTH END OF THE DARWIN HILLS

The mines described under this heading all lie south of the highway through the hills.

The *Custer Mine* (Fig. 31) is situated one mile east of Darwin in the canyon next south of Lane canyon, the one through which the state highway runs. The elevation is 4700 feet. The deposit occurs near the tip of a very prominent cross-cutting lobe of the quartz diorite protruding from the east side of the Darwin stock. Knopf (1914) considered the ore to be formed in the broken arch of a fold. As a matter of fact, however, the deposit is located 150 feet west of the axis of the fold along the bedding of the tactites, which strike N. 25° W. and dip 50° W. The steeply dipping tactites in which the ore chimney has formed are cut off 25 feet south of the inclined shaft in the ore by the lobe of quartz diorite. Thus, the deposit is of the bedding-plane type located a short distance from the contact which is in this case approximately normal to the stratification. The inclined shaft is 335 feet in depth with levels at 130, 150, 185, 230, and 310 feet.

The vein minerals in addition to the usual lead ores consist principally of gossany iron oxides, coarse calcite, pyrite, jasper, and fluorite. In addition, garnet appears to be one of the vein minerals and its association with coarse calcite cementing brecciated fragments of the tactite was noted by Knopf (1914). Also, a little specularite hematite is to be found in cavities in the vein. Coarse calcite is remarkably developed on the 200-foot level where it is at least 50 feet thick and 75 feet along the strike. This represents a local swelling in the vein, for above and below this level the calcite body is not nearly as large. Lead ores were scattered through the calcite body in association with iron oxides.

The *Fernando Mine* is situated in the next canyon south of the Custer mine at an elevation of 4600 feet. The deposit occurs at the intersection of a prominent cross fracture and the bedding of the tactite. The mineralization is greater on the cross fracture or fissure vein which is rather persistent and traceable on the surface for about 2000 feet in a direction N. 65° E. The tactites strike N. 15° W., and dip 55° W. An inclined shaft 125 feet in depth has been sunk on the bedding and the deposit opened up therefrom by numerous short tunnels and stopes from several levels. The inclined shaft is intersected by a tunnel

driven along the fissure about 30 feet below the shaft entrance. Along this tunnel considerable displacement is evidenced by brecciation, clay and iron oxide gouge, and well-preserved slickensides. Striations on the fault plane dip parallel to the bedding, i.e., 50°-60° west, the north side having moved down and to the west. The mineralization along the stratification is not confined to one horizon and locally has spread through several closely spaced beds. On the 100-foot level mineralization paralleling the fissure has affected a width of 30-40 feet. The ore minerals are galena, cerusite, and anglesite and the gangue consists of jasper, hematite, much gossany limonite and a little calcite. Galena found in the stopes is coarse-grained and in places imbedded in jasper. Ore shipped from the mine when it was last worked in the late twenties is reported to have carried 30 per cent lead and 30 ounces in silver.

The *Promontory Mine* is situated about one mile southeast of Darwin at an elevation of 5000 feet. The deposit is one of the initial discoveries made in the district. Three closely spaced bedding-plane veins are exposed in the cut behind the shaft. These are in tactite which strikes north and dips 33° W. It is opened by an inclined shaft down the dip of the beds to a depth of 320 feet. Drifts not over 100 feet in length lead to extensive stopes north and south of the shaft. The veins range from a fraction of a foot to 6 or 8 feet and locally more in width. The veins have been subjected to considerable slippage which took place largely along the veins themselves causing considerable gouge material and slickensiding. Some of the movements, however, have been at angles to the veins, but the displacements do not appear to be large. Iron oxides and jasper are the most abundant gangue minerals of the vein, but some calcite and siderite are present. Much secondary calcite in flat rhombohedrons occurs throughout the mine.

The *Silver Spoon Mine* is situated about two miles southeast of Darwin and 3000 feet northwest of the Columbia mine at an elevation of 4500 feet. It is located on a prominent fissure vein which strikes N. 65° E., and dips roughly 80° N. The fissure is traceable for about 2500 feet and at the mine it has been opened up to a depth of 250 feet by a shaft at the bottom of which is a drift 125 feet to the west. The ore is mostly carbonate with a little galena in highly oxidized and siliceous vein matter. The vein varies from one to four feet in width. Ore shipped carried 35 per cent lead and 18 ounces of silver per ton. Some of the ore was evidently crudely cleaned and concentrated by screening on the dump.

The *Columbia Mine* is the southernmost mine in the Darwin Hills and is about $2\frac{1}{2}$ miles from Darwin at an elevation of 4350 feet. It is located on a fissure vein which strikes N. 60° E. and is about 2000 feet beyond the southern end of the Darwin stock. The vein cuts across blue-gray, unsilicated limestone and the mine is one of two in the district which is located outside of the silicate aureole. The vein, which is vertical, has a maximum width of 15-20 feet. It has been worked along the strike for about 200 feet and to a depth of about 225 feet. The chief feature of this vein is the abundance of dense jasper. The lead ores consist of galena and carbonate.

FUTURE EXPLORATION

The immediate future of the Darwin district lies almost entirely in mining to greater depth deposits already discovered. Practically all of the production at Darwin has come from within 300 feet of the surface. Successful mining will have to be carried out on a large scale and it will be necessary to keep ores blocked out in advance of extraction if mining operations are to be more than sporadic. Orebodies of the contact type are irregular or bunchy and they may terminate suddenly. New bodies, unless exposed at the surface, are difficult to find and hence considerable exploration and proving of new ore should parallel mining at all times.

In regard to future prospecting for deposits it should be borne in mind that only the west side of the stock has revealed orebodies at the immediate contact. Deposits at the west contact are pod-shaped bodies which are irregularly distributed along the contact surface. They vary considerably in size but the largest generally exceed the dimensions of fissure or bedding-plane deposits. The entire unexposed contact surface is potential ground for such deposits. Some deposits, like the Independence body, may be exposed only slightly or hidden entirely. In general, it may be found that irregularities or protuberances of the surface of the stock, especially where paralleled by the stratification of the country rock, are favorable loci for deposits along the contact.

Most of the fissure veins are rather persistent, but only certain stretches of the fissures have been sufficiently mineralized to constitute ore. The ore in such deposits makes in bunches or shoots. In the case of the Lucky Jim and the Christmas Gift deposits the ore shoots rake to the west. This may or may not be true for other such fissure deposits. To date the northeasterly trending fissure veins only have produced ore. In a few cases the fissure veins have been dislocated. Although in most cases the displacements have not been large, the usual direction of displacement is the north side westward. The fissure veins are more prominently developed in the tactite zone. The portions of such fissures extending into the intrusive as a rule have not constituted desirable ground.

In the past there has been considerable experimentation and money expended for selecting an entree to the ores beneath the Defiance-Independence ridge. The Radiore tunnel driven through hundreds of feet of barren ground is one evidence. Most of the deposits dip westward under this ridge more or less comformably with the bedding or the surface of the contact of the stock.

A considerable amount of geophysical prospecting by electrical methods was carried on during the late twenties in an effort to locate ore. The writer has had access to some of the maps compiled from such work and in only very few instances were electrical indications plotted which were not evident in the outcrop. The electrical indication obtained may be from bodies of pyrite. This type of exploration may be successful in locating a few deposits of hidden ore. From the high jasper content of most of the deposits it seems that a magnetometer survey might also be useful. However, it is felt that a smaller expenditure in geologic advice in connection with active mining and exploration would be more beneficial.

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PLATE VII

MINES AND PROSPECTS

1. Fairbanks
2. Lucky Jim
3. Christmas Gift
4. Belle Union
5. Snowstorm Tunnel
6. Colonel Tunnel
7. Standard
8. Independence
9. Essex
10. Thompsan
11. Standard Extension
12. Bernon
13. Santa Ana
14. Defiance
15. Wonder
16. Rip Van Winkle
17. Lane
18. Radiore Tunnel
19. Susquehanna
20. Jackass
21. Custer
22. Jeroo
23. [illegible]
24. Keystone
25. Promontory
26. Silver Spoon
27. Columbia

GEOLOGIC MAP
OF THE
DARWIN SILVER-LEAD MINING DISTRICT

SCALE
0 1000 2000 3000 4000
FEET

GEOLOGY BY V. C. KELLEY
1936

LEGEND

SEDIMENTARY ROCKS
- QUATERNARY
  - RECENT ALLUVIUM
  - LAKE BEDS
- PENNSYLVANIAN
  - IMPURE LIMESTONE AND TACTITE

IGNEOUS ROCKS
- EARLY QUATERNARY
  - BASALTIC CAP
- LATE MESOZOIC
  - DARWIN QUARTZ DIORITE
  - COSO GRANODIORITE

Symbols
- Vein
- Fault
- Axis of Anticline
- Axis of Syncline
- Dip and Strike
- Mine

T. 19 S. R. 40 E.
T. 19 S. R. 41 E.

DARWIN

TO PANAMINT VALLEY

TO BROWN

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SULPHUR DEPOSITS OF INYO COUNTY, CALIFORNIA

By Edward D. Lynton, Glendale, California

INTRODUCTION

There are two well-defined sulphur-bearing areas on the west slope of the Last Chance Range in Inyo County, California. The most important is covered by the Crater Group of six claims and adjoining claims; the other is covered by the Black Sulphur, Yellow Sulphur, and Sulphur claims, 12 in all, and lies about 1½ miles east of the first group.

Sulphur in Inyo County is reported to have been discovered in 1915, by Frank and Dan Hicks of Lida, Nevada, who kept up the assessment work annually on the claims. In June, 1929, an option was taken on the Crater and adjoining claims of the Southwest Sulphur Company by the Pacific Sulphur Company, who expended about $45,000 in development work, consisting of an inclined shaft 200 feet deep, with cross-cuts on the 100-and 200-foot levels. In addition, they put down 11 churn drills on the various properties.

In June, 1932, various leasers worked the claims and shipped high-grade ore to Los Angeles. The first were Sanger and Albertoli of Big Pine, California; they were followed by Smith Brothers, the West Coast Sulphur Company, and Sulphur Diggers, Inc., all of Los Angeles. They shipped in all over 30,000 tons averaging 75 to 80 per cent sulphur to one of the chemical plants in Los Angeles. Shipments by the West Coast Sulphur Company, totaling 12,000 tons, averaged better than 83 per cent sulphur. The cost of the mined sulphur, f.o.b. Los Angeles, was $13 per ton. The Sulphur Diggers, Inc., ceased work in September, 1937, and the properties are now held by the Western Mining Company of Los Angeles.

ACKNOWLEDGMENTS

Acknowledgment is here made to Mr. and Mrs. Stewart of the Stewart Ranch at Oasis for the many courtesies extended to the writer; to Mr. F. B. Mechling, who furnished the logs of the churn-drill holes; and to Messrs. Frank and Dan Hicks for information on the various properties; also to Mr. G. L. Knox, who assisted in the sampling, and to Mr. L. L. Tabor, who continued a study of the geology of the region intermittently for two years, during which time he collected much valuable information which he has kindly furnished to the writer.[1]

LOCATION

The Crater Group of sulphur claims is located partly in Secs. 33 and 34, T. 8 S., R. 39 E., M.D., on the west slope of the Last Chance Range, which separates the Eureka Valley on the west from the north end of Death Valley on the east. These claims were tied in by triangu-

[1] Personal communications.

lation to a Government survey stake of 1884. As such ties are very scarce in this region, and as this tie was found only after considerable effort, a description of its location is inserted here:

As the road from Oasis to Crater leaves the easterly side of the Eureka Valley, it climbs up steeply for about 0.3 of a mile before entering the long canyon grade to the mine. At the entrance of this canyon the road bends sharply from the north to the east.

From this bend walk 2,000 feet south to the first long, most prominent terrace; on the south slope of a small saddle at its western termination, the Government stake will be found.

The markings on this 53-year old stake are those used by the General Land Office surveyors during that time, and are as follows:

1. The northwest side of the stake is marked "S. 25."
2. On the north corner are five notches, indicating that it is five miles north to the township corner.
3. The northeast side of the stake is marked "S. 30."
4. The southeast side of the stake is marked "R. 39 E., T. 8 S."
5. On the south corner of the stake there is one notch, indicating that the township corner lies one mile to the south.
6. The southwest side of the stake is marked "R. 38." The rest is undecipherable.

The above inscriptions indicate that this stake is the southeast corner of Sec. 30, T. 8 S., R. 39 E., M.D. This monument is on the township line dividing Ranges 38 and 39 East.

At the present time the sulphur deposit can only be reached via a fair desert road from the town of Oasis, a distance of about 28 miles, which can be traveled in about 1 hour and 20 minutes. Oasis, on the main road between Big Pine and Tonopah, is 40 miles northeast of Big Pine, California, over a well graded, partly oiled mountain road. The nearest railroad point is Zurich, a station on the branch of the Southern Pacific that runs from Mojave up the Owens Valley to Tonopah. The distance from the deposit to the railroad at Zurich is 68 miles by the present road.

MAPS

Crater Claims (Fig. 1)

This property consists of six unpatented claims, known as the Crater Group, and covers about 125 acres. The most valuable of the claims are Crater Nos. 1, 5, 2, and 6.

Fig. 1 shows the detailed survey of the claims. A true north line was established from a fixed station by a sight on Polaris on the nights of January 18 and 19, 1932. This station was found to be in Lat. 37° 14′ 42″ and Long. 117° 42′ 42″ east of Greenwich. The magnetic variation was found to be 16° 50′ east of north.

General Map of Claims (Fig. 2)

This map shows the claims which have economic importance, and the relation of the group to the sulphur bearing area to the east (the Black Sulphur, Yellow Sulphur, and Sulphur groups) before the amended locations were made.

Black Sulphur Claims (Fig. 3)

This map shows the amended location of the eastern group of claims. The claims follow the trend of the faulted zone which carries sulphur. While pits and trenches show the presence of a good grade of sulphur, insufficient work has been done to prove whether the occurrence

is local or continuous. The author believes that commercial sulphur is present in isolated bodies, but considerable exploration work will have to be done to outline the economic areas.

These claims were tied into the Crater Group by stadia survey with the corrected section corners shown.

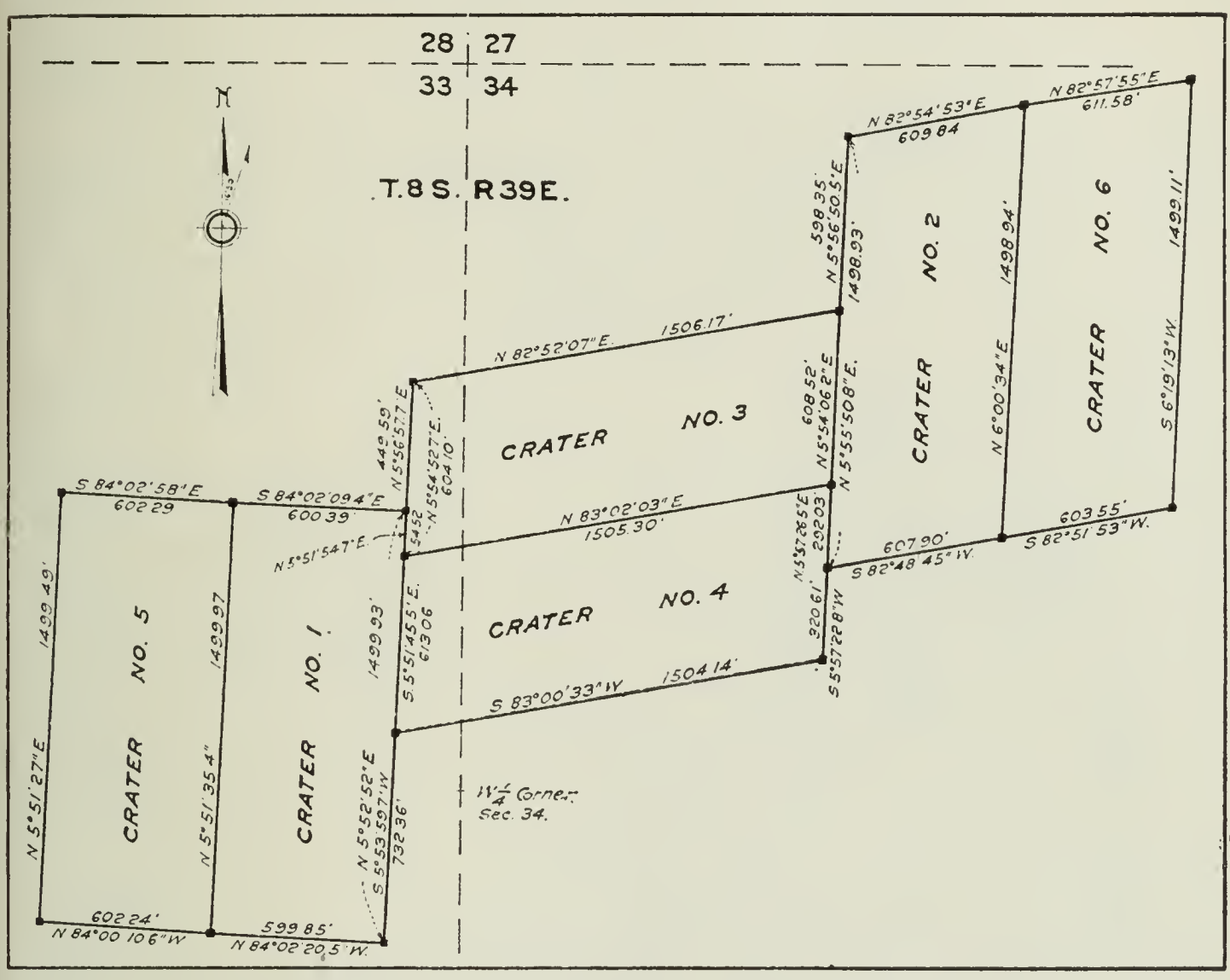

FIG. 1. Claim map of Crater Group of claims, Inyo County. Transit and chain survey by E. D. Lynton and L. L. Tabor, January, 1932.

Geological Map (Fig. 4)

This is a topographic and geologic map of a part of the Last Chance Range, with special reference to the Crater Group of claims. It shows the general geology, the main faults to which mineralization is related, and the several mineralized zones of economic importance. The open-cut pit on Crater No. 2 claim is roughly outlined. This mining operation was carried on from 1933 to 1937, subsequent to the time of the mapping.

Sample Map, Crater Mine (Fig. 5)

This map shows an east-west section through the 200-ft. shaft on the Crater No. 1 claim, and a plan of the workings, giving the relationship between the work on the different levels. All the sample localities and the grades of sulphur are also indicated. The tunnel dump, which was thoroughly sampled, averaged 20 per cent sulphur. The associated rock is of a highly siliceous nature, running 70 per cent SiO_2.

Cross-Section of Ore Body (Fig. 6)

This sample map of the Crater No. 1 ore body shows plan, sections, percentages of sulphur, and tonnage of ore in sight. The churn-drill

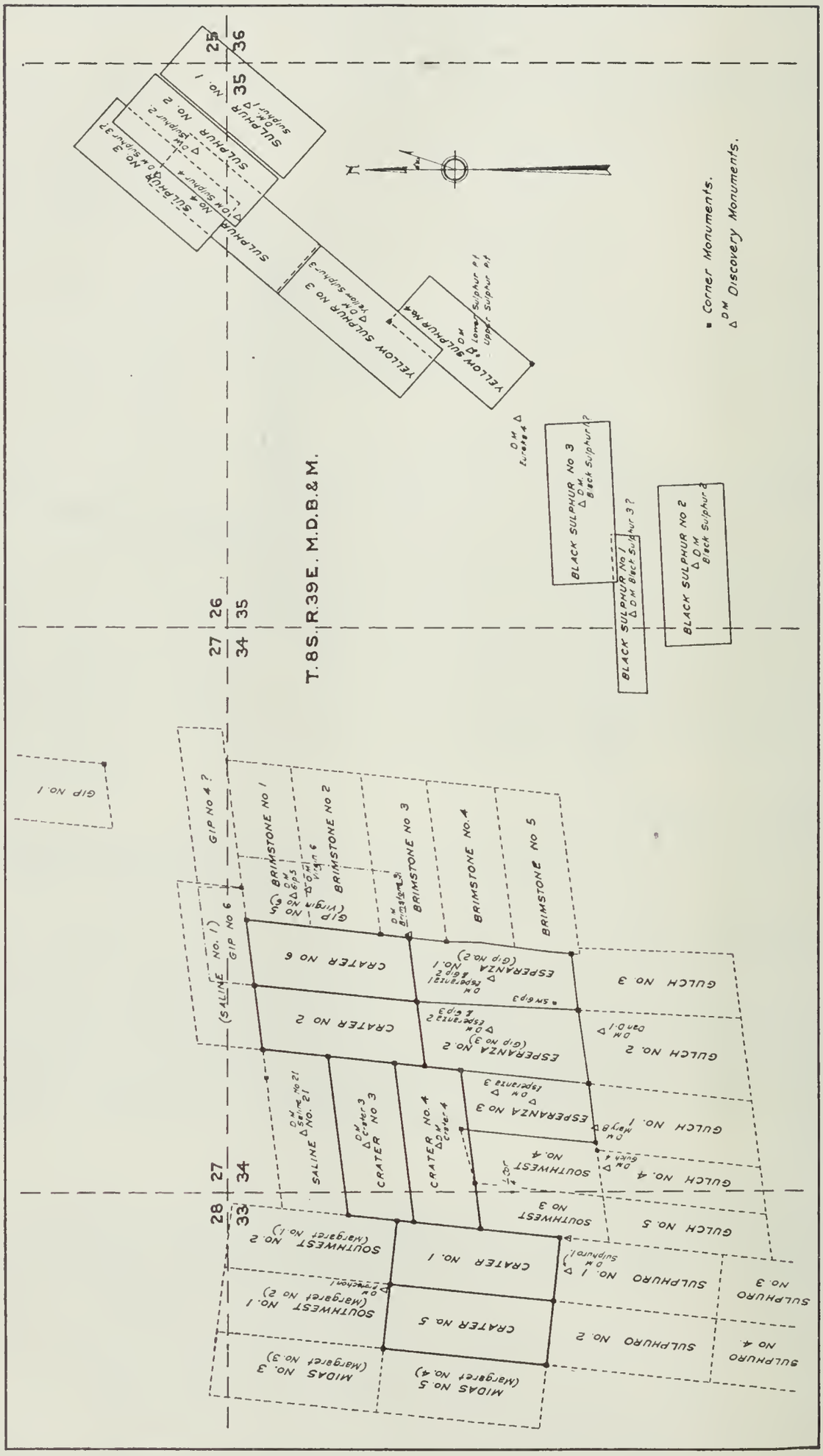

FIG. 2. Crater claims, adjacent claims, and Black Sulphur, Yellow Sulphur, and Sulphur groups, T. 8 S., R. 39 E., M. D. Survey by E. D. Lynton and L. L. Tabor, January-February, 1932.

holes are also shown as they entered and passed through the orebody.

From the sections and drill holes through the orebody, the tonnage and grade of ore in sight were calculated. There is a total length of over 900 feet of ore in sight, with varying widths. Over 250,000 tons of 40+ per cent sulphur is in sight in this small area. The 40 per cent grade could be materially increased by sorting.

TOPOGRAPHY

The Last Chance Range is typical desert mountain country—steep, rugged, and cut by numerous narrow canyons. At the mouths of these canyons the alluvial material is spread into fans consisting of sand,

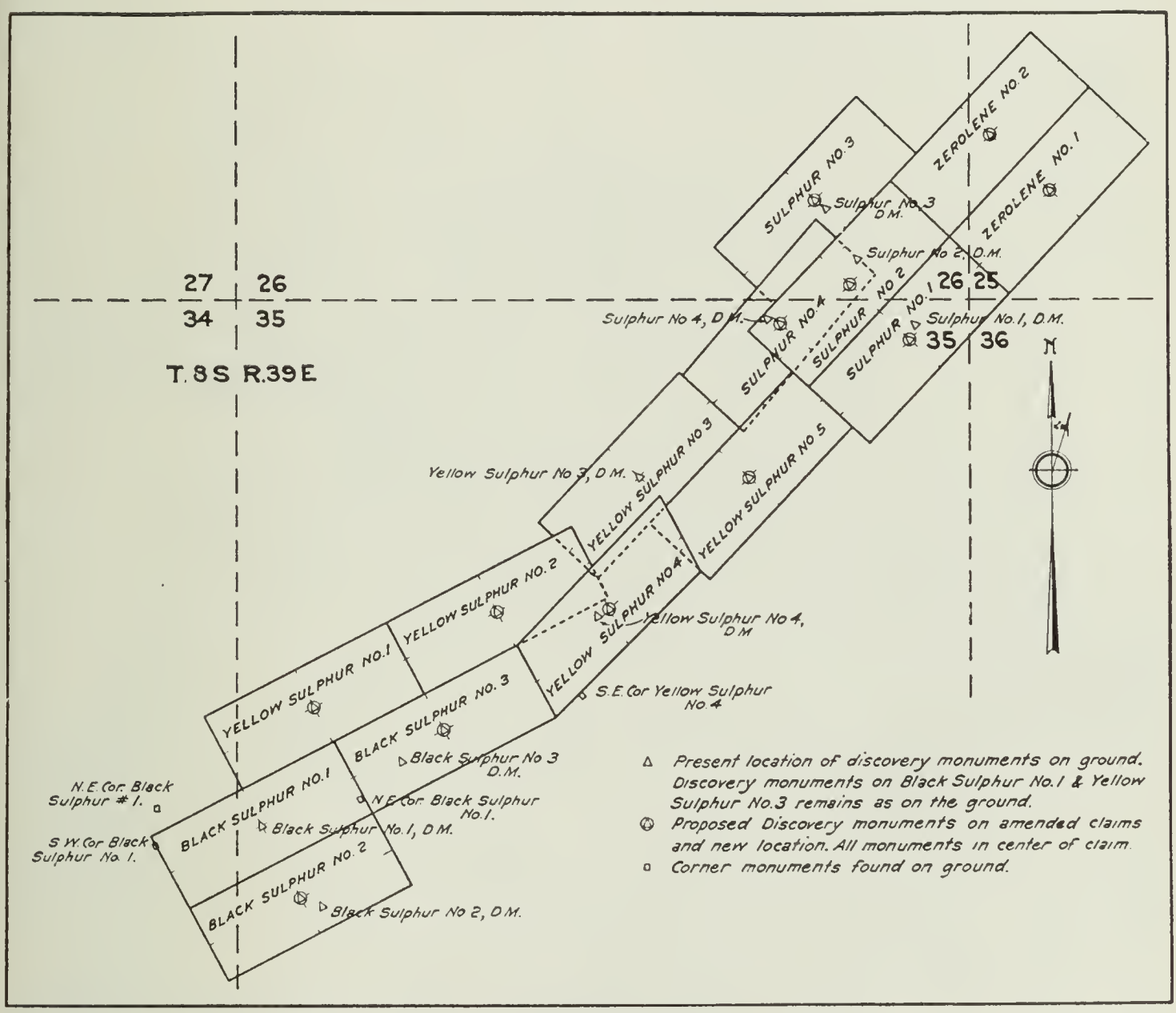

FIG. 3. Proposed amended location of Black Sulphur, Yellow Sulphur, and Zerolene groups, T. 8 S., R. 39 E., M. D.

gravel, and large boulders. The smaller detrital material has been washed down onto the floor of Eureka Valley, so that it can not be traversed by automobile unless a road is scraped.

This region is one of interior drainage. No streams that rise within it carry contributions to the ocean; the snow and rain that fall within it are returned to the atmosphere by evaporation, either directly from the soil, or after they have found their way into some of the sinks in the irregular surface.

Eureka Valley and the north end of Death Valley, which separate certain mountain ranges, are absolute deserts, totally destitute of water and trees, except for gray sagebrush and some mesquite. Eureka Valley

has in its lowest depression, at an elevation of 2,960 ft. above sea level, a playa left by the evaporation of intermittent waters. A shallow well sunk in the center of this playa might obtain water.

Climatic characteristics are excessive summer heat, and dryness. The temperature rises occasionally to 125°F. in the shade, rarely falls below 70° at any time during the five hot months, and averages over

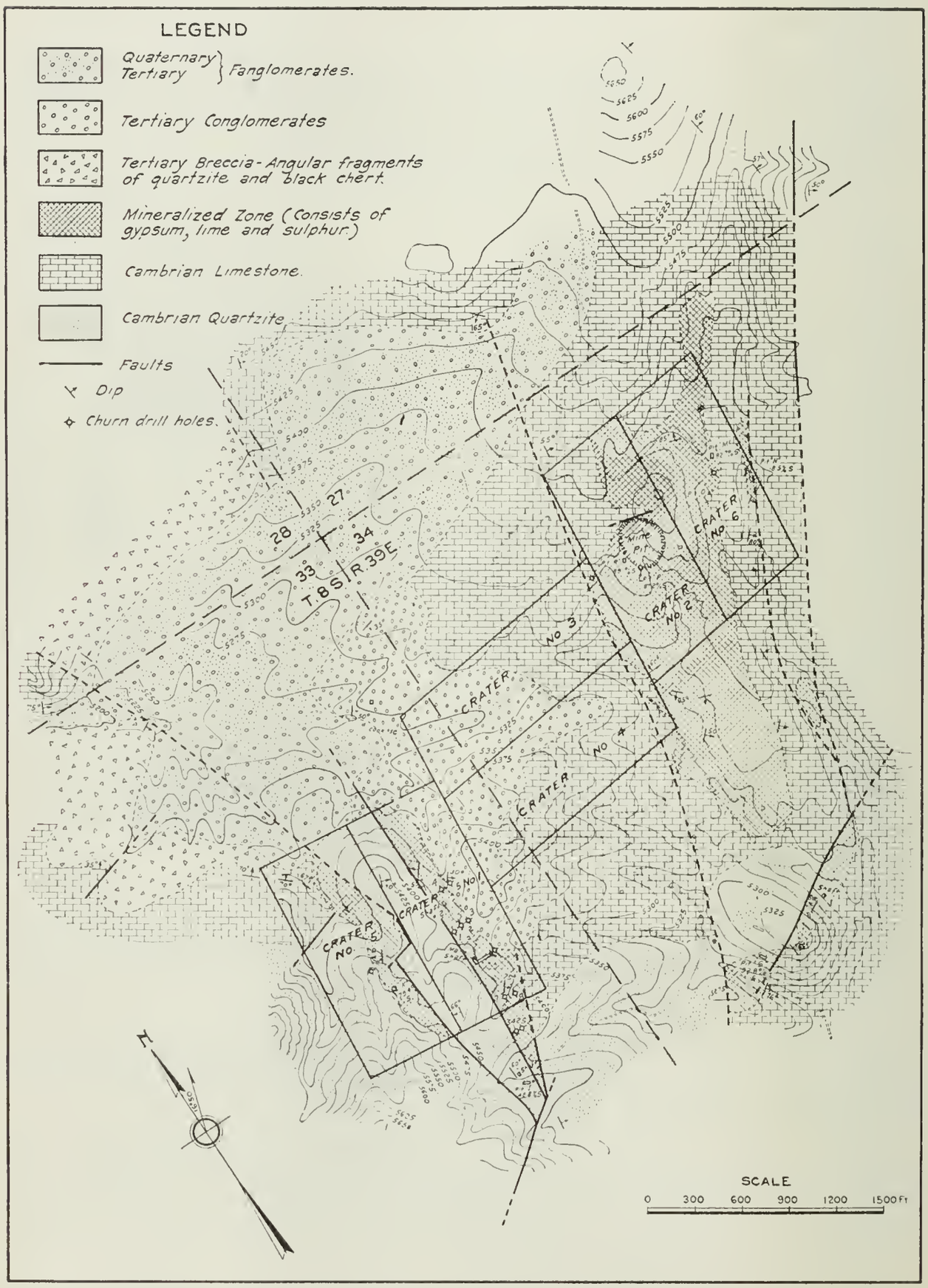

FIG. 4. Topographic and geologic map of a part of Last Chance Range, showing Crater Group of claims, Inyo County, T. 8 S., R. 39 E., M. D. Topography by G. L. Knox; geology by E. D. Lynton.

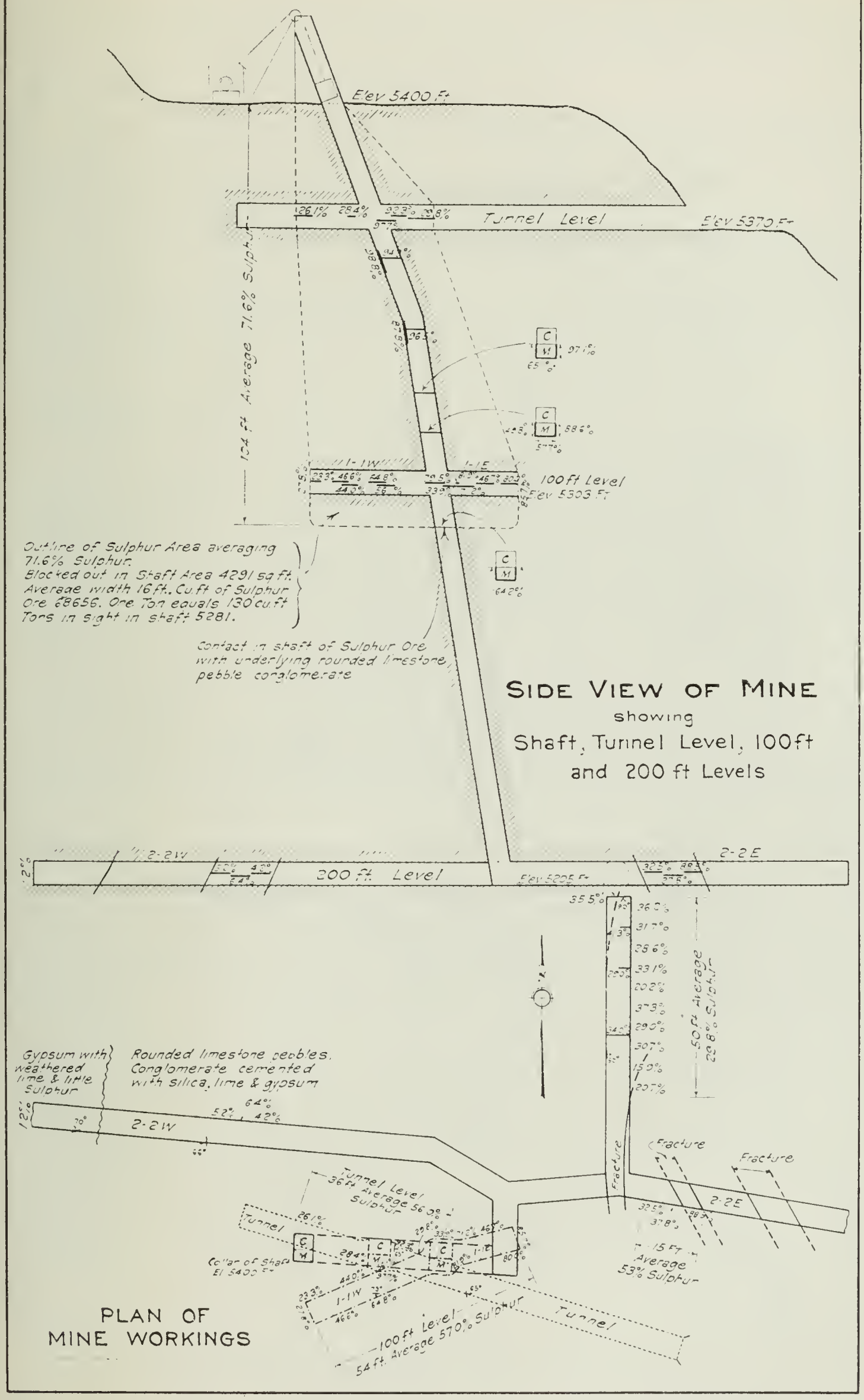

FIG. 5. Sample map of shaft and cross-cuts, Crater Group of sulphur claims, Last Chance Range, Inyo County.

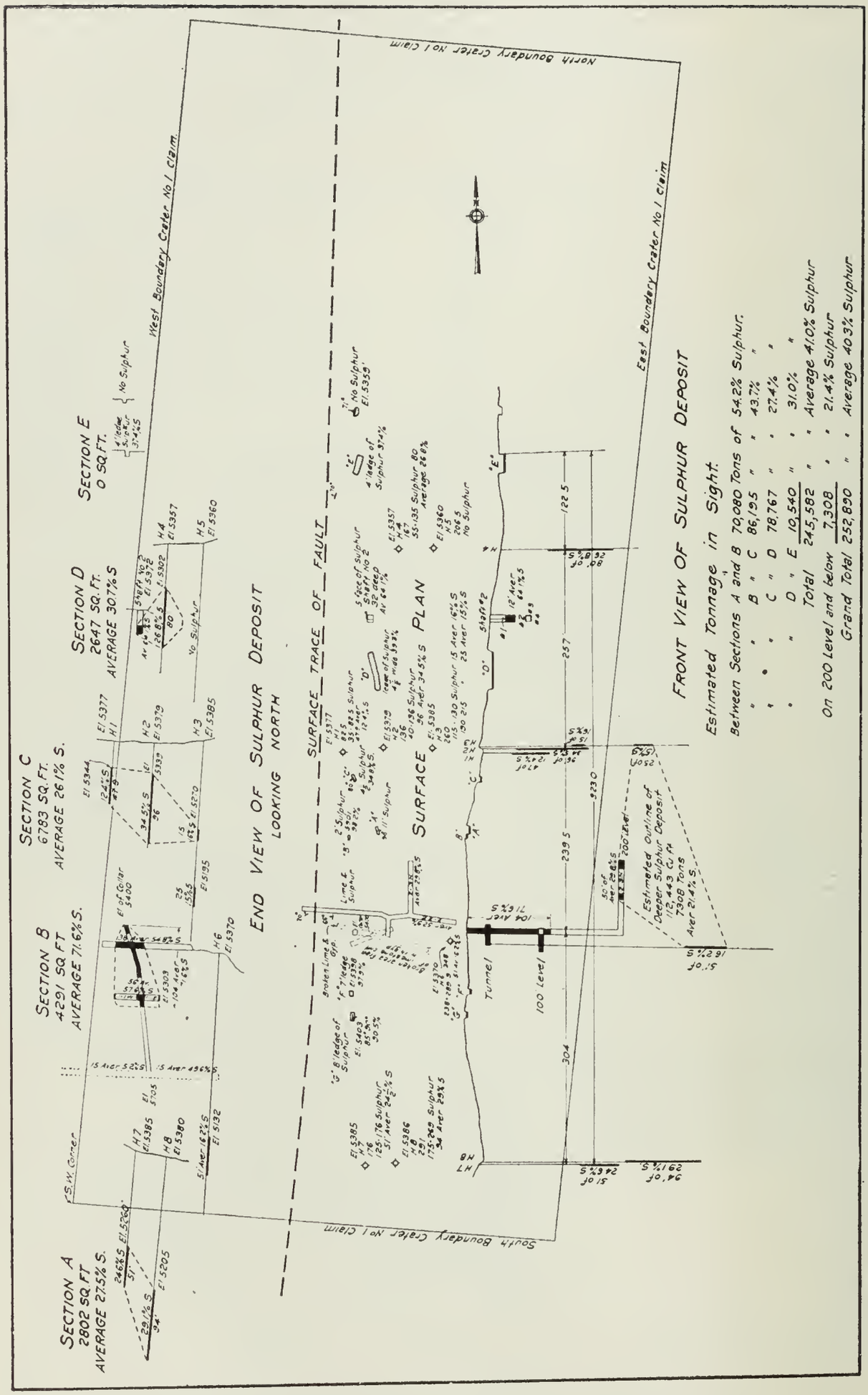

FIG. 6. Sample map of Crater Group of claims showing plan, sections, percentages and tonnage of sulphur ore in sight.

90° during this period. In winter the temperature may reach 85° or 95° F. during the day, and fall to the freezing point before midnight.

ELEVATIONS

Elevations above sea level were obtained at the sulphur deposit and at Last Chance Spring by means of repeated observations with an altimeter from the U. S. G. S. Bench Mark at Oasis, whose elevation is recorded as being 5,031 ft. above sea level.

The following elevations are the averages of several readings:

Oasis B. M.	5,031 ft. above sea level
Top of divide, 10 mi. SE of Oasis	5,606 ft. above sea level
Eureka Valley (lowest point on road)	3,536 ft. above sea level
Old cook house at sulphur deposit	5,277 ft. above sea level
Collar of shaft	*5,389 ft. above sea level

*(This was taken as 5,400 ft. for the planetable survey.)

ROADS AND OTHER FACILITIES

From the railroad at Zurich, in the Owens Valley, there is at present only one good road to the property. It goes northeast 40 miles from Zurich to Oasis, which is the approximate half-way point to Tonopah, Nevada. From Oasis, the road goes southeast 14 miles, where it meets the old Big Pine-Willow Springs-Lida road. About two miles southwest of this junction point, at the eastern border of Eureka Valley, the Pacific Sulphur Company built a road 12 miles long to the sulphur deposit.

Timber is not at all plentiful. Scrub pine can be cut and hauled to the property at a considerable expense from the ranges to the west. All squared timber would have to be hauled from the railroad. However, very little timbering would have to be done on the property, as the type of ground, because of cementation with the sulphur, stands up well.

GEOLOGY

The lowest exposed formation at Crater is white quartzite. The next overlying formation is a red, brittle, mottled limestone exposed in erosional patches. As one enters Hanging Rock Canyon on the road from Eureka Valley, this reddish limestone can be seen on the south shoulder. It is overlain here by a whole cliff of west-dipping, indurated, dark gray-brown shales, grits, gravelly conglomerates, and thin, brown quartzite bands. This, in turn, is overlain by green-gray, bluish slates with fine sand and tuffaceous streaks and indurated gravelly conglomerates, so prevalent in the northern Crater area. There are many occurrences of limestone lenses in these blue slates. These lenses are interesting because they contain minute fossils which in section look like crinoid stems. Overlying these slates are the black limestones. Presumably, everything from the white quartzite up to and including the black limestone is Paleozoic. The white quartzite is very similar to other quartzites which have been classified as middle (or upper?) Ordovician.

The Tertiary at Crater apparently includes limestone breccias, conglomerates, some rubbly sandstone, and volcanics; but it is impossible to ascertain the relative superposition of these materials, except that the breccia may be lower Tertiary despite the fact that it is not altered by the volcanics. The conglomerates seem to have preceded the volcanic action as evidenced by their alteration at the shaft on Crater No. 1

claim. The gravelly sandstone, mostly loose or unconsolidated, exposed southeast of the shaft, may be younger than the volcanics. It is believed to be closely allied to some of the fanglomerates sloping into Eureka Valley.

The volcanics consist of pyroclastics (tuff and breccias), possibly thin rhyolitic flows, and a small intrusive at the shaft consisting of

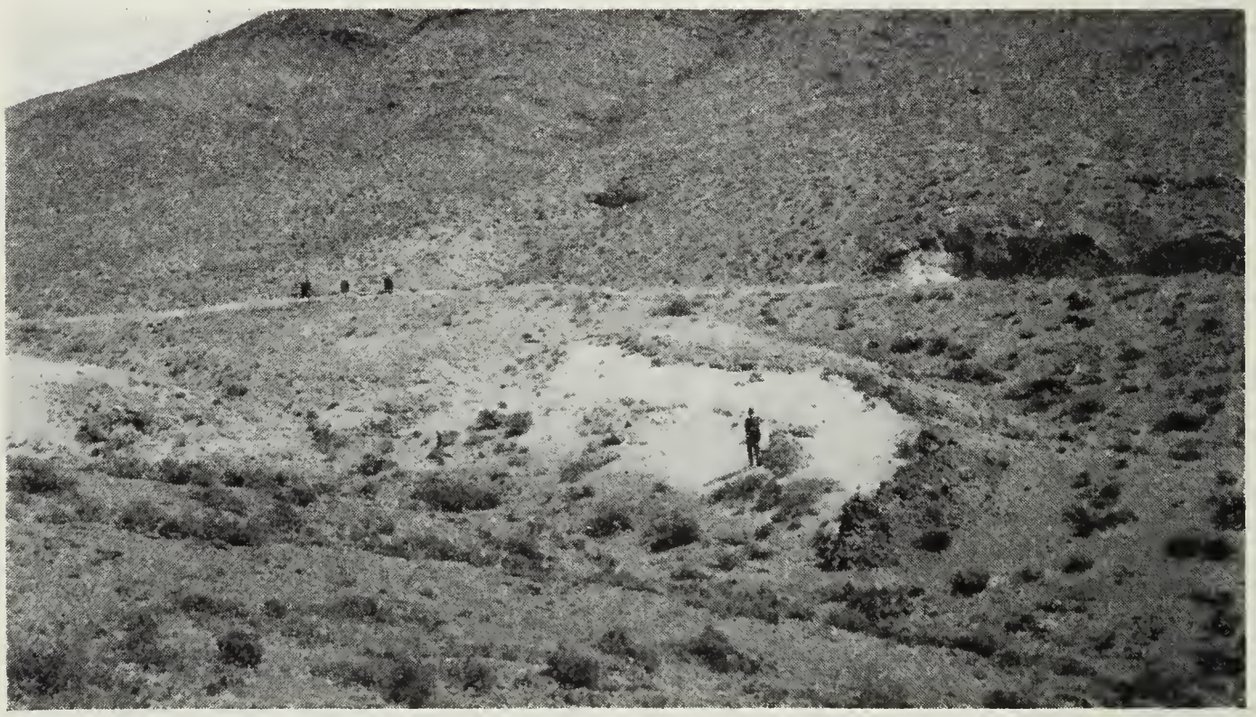

FIG. 7. Reddish altered rhyolite on Crater No. 2. claim. Because of its circular shape, the name Crater was given to this area.

FIG. 8. Mine pit on Crater No. 2.

chunky gray rock, very hard, with dark elongated nodules. A thin section of this intrusive rock shows the texture of an acid intrusive.

Petrographic work has been most difficult owing to the extreme alteration of some of the rocks. In some cases, about all that is left to

go on is the original texture.[2] The shaft rock, that platy white material, is doubtless a rhyolite, and judging by the flow lines in it, is probably in the form of a shallow intrusive. The gray, chunky rock at the collar of the shaft is the same shallow rhyolitic intrusive, either in dike, or irregular stock form. The shaft passes out of this rhyolite (and high grade sulphur) at 108 ft., into a conglomerate. The No. 6 churn drill hole at the mouth of the tunnel shows the following:

0′ —	22′	Detritus
22′ —	85′	Conglomerate
85′ —	322′	Sulphur, gypsum, "chert" (interpreted as altered rhyolite)
322′ —		Conglomerate

FIG. 9. Hanging Rock Canyon. On road from Eureka Valley to Crater mine, showing white quartzite rocks.

The shaft and drill hole data suggest a steeply east-dipping rhyolite intruded through the conglomerate. The rhyolitic material is so badly altered that it is almost impossible to tell exactly what it is.

There is a sparse outcrop between the shaft and the pitted hillside south of the shaft, of brick-red pyroclastic material strung out linearly from the shaft to a point about 500 ft. south. The dip is 75° east.

[2] Personal communication from L. L. Tabor to the author.

This outcrop is just south of the main north-south fault through the shaft.

On Crater No. 2 claim, south of the open pit, is a prominent outcrop, circular in shape, of reddish material badly altered. It is probably a rhyolite, but its groundmass is micro-felsitic, and the few phenocrysts in it have unfortunately gone over to secondary fillings.

The large gulch that empties on the flats just west of the original cook house has several interesting outcrops in it. Down toward its mouth, the blue slates, in places altered to a white powder, are standing almost vertical and striking northwest. Around the first main bend in the gulch, on the west side, is a thin layer of fossiliferous limestone. The next outcrop of interest is at the little falls a few hundred feet farther up. The rock there is a faintly bedded, dense, light bluish-gray formation which is probably igneous. Above this outcrop is the hard, dark brown metamorphosed conglomerate.

FIG. 10. Looking westerly across Crater Group of claims towards mine shaft. Quartzite ridge in background.

On the west side of the high quartzite ridge which forms the westerly boundary of the area, there is a section exposed which helps to unravel the salient points of the stratigraphy of the area. The top of the section, beginning at the east edge of the alluvial material of Eureka Valley, is none other than the blue slates, the same ones exposed from Hanging Rock up to the old camp along the road. The base is the white quartzite of the quartzite ridge. In between there is a nondescript, although well-bedded, series of metamorphosed sediments including sandstones, shales, and gravelly conglomerates. Their base is covered by patches of impure dark limestone, in which no fossils have yet been found. These limestones, in patches, rest on the quartzite of the ridge, and can be seen on the top of the ridge.

The geologic map, Fig. 4, is only a generalized one, as its primary purpose is to tie in the mineralized areas with the faults and associated rocks.

STRUCTURE (Fig. 11)

Structurally, the region is anticlinal. An east-west section through the shaft on Crater No. 1 claim starts on its westerly side in west-dipping beds, flattens on top of the quartzite ridge, and begins dipping east and northeast on the east side of the ridge. The structure is badly faulted, and so this relation is anything but a textbook picture.

The main faults, starting on the west, are: (a) a north-south fault through a point half-way down the east flank of the quartzite ridge; (b) a shattered zone north-south through the shaft, that may connect to the north through the knob above the main road to camp; (c) the fault just west of the mine pit along the easterly boundaries of Crater No. 3 and No. 4 claims; and (d) the large, prominent north-south fault at the base of the black limestone ridge east of the Crater Group of claims. There are many other faults, but these are the main ones, all of which bear some relationship to the mineralized zone.

A general glance at this east-west section suggests a large collapsed arch, with the implication that the black limestones ought to be found somewhere under Eureka Valley. These black limestones seem to be disconformable on the slates. There is reason to believe, however, that these limestones have been thrust westward over the slates, and that normal faulting occurred later, almost completely masking the thrust. The effects of normal faulting are what impress one at Crater, and it may be that these effects are so predominant that they tend to unduly minimize the results of possible thrusting.

The north-south faulted strip to the west of the shaft is so disturbed that it can only be generalized. On the south end of this strip are patches of red limestone resting directly on the white quartzite. From the way these overlying rocks disappear to the south, it seems as if the whole section must be dipping northeasterly, as the dips farther north indicate. In that case, if the red limestone is continuously exposed, or, rather, if it wholly underlies the quartzite, one would expect to see it describe a graceful arc around the rims of the limiting gulch to the south, but it certainly does not. It lies in the most amazing places, and the only possible explanation is a system of faulting which one would be reluctant to describe without painstaking detailed work. Faulting, however, is very prominent, as indicated by the many fault breccias, fault saddles, fault scarps, and slickensides in the area.

ORIGIN AND OCCURRENCE OF THE SULPHUR

Mineralization was at least as recent as the Tertiary, as there is little doubt that the conglomerates in the shaft are of Tertiary age. The apparently different rocks in the vicinity of the sulphur outcrops are nothing more than hydrothermally, or pneumatolitically altered material. This alteration was brought about by means of gases or vapors emanating from the late basalts and other eruptive rocks.

The origin of the sulphur is no doubt of two types: leaching of the gypsum with which the limestones in the area are impregnated; and solfataric action. The association of sulphur with gypsum and organic matter suggests their genetic relationship, since sulphur can be formed by the reduction of gypsum. Organic matter reduces gypsum ($CaSO_4 2H_2O$) to CaS_2, which, acted on by carbonic acid waters, yields $CaCO_3$ and H_2S (hydrogen sulphide gas). The oxidation of the

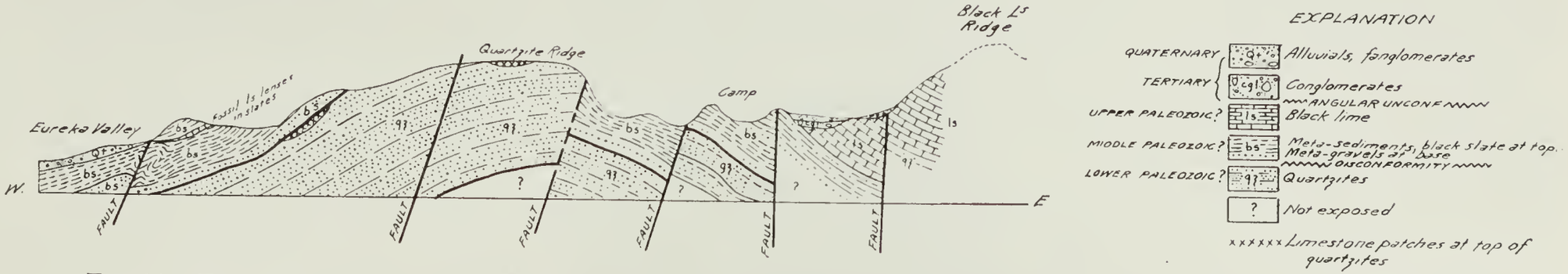

FIG. 11. East-west geologic section from Eureka Valley through Crater sulphur deposit, Inyo County, after L. L. Tabor.

H_2S or the interreaction of the H_2S and SO_2 produces the sulphur. The deposition of sulphur by solfataric action is due to the incomplete oxidation of H_2S escaping as an emanation from cooling magmas. This theory is supported by the presence of volcanic rocks in the area.

The sulphur is intimately associated with fault zones. The north-south fault zone across the Crater No. 1 claim is the only one on which any extensive development work had been done up to 1932. The sulphur is sometimes almost pure in the center of the ore body, but along the edges it is mixed with altered rhyolite. The sulphur does not extend either into the quartzite or into the conglomerate to the east except for a few isolated stringers found on the 200-ft. level. The limits of the sulphur can generally be determined, as the percentages drop off rapidly.

The largest mineralized zone, outlined on surface evidence, occurs only on the eastern edge of the area, running through Crater No. 2 and

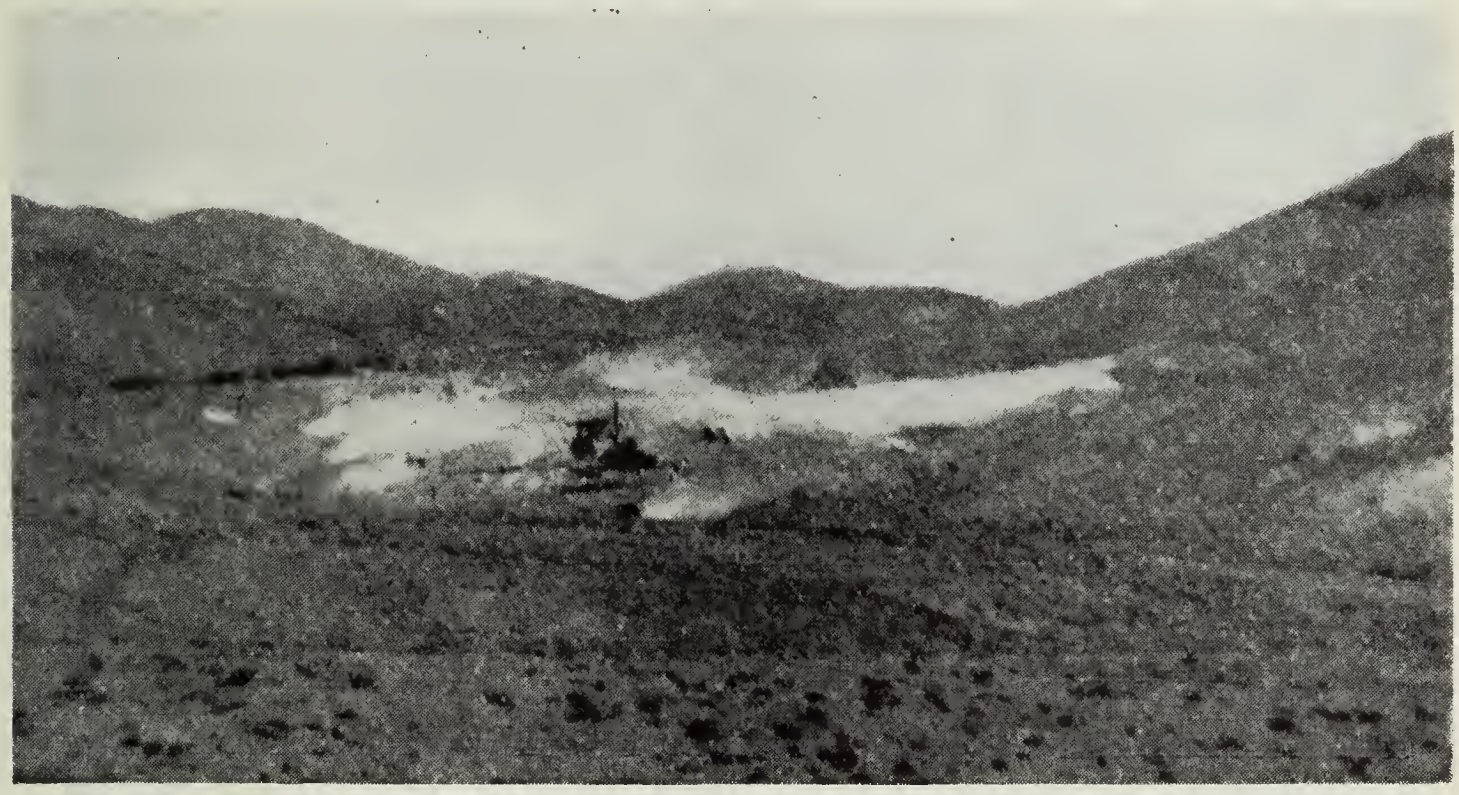

FIG. 12. Looking due north up Main Creek across Crater No. 2 and 6 claims, showing mineralized zone, refinery, and black limestones on east.

No. 6 claims. It is quite distinct and forms a belt between two prominent north-south faults in limestone. Several pits show a good grade of sulphur, and mining operations from 1932-1937 revealed the presence of a good grade of sulphur. The flat-lying beds of sulphur in the pit suggest that hot waters, after rising vertically through a vent, spread out horizontally, changing gypsum in the surrounding limestone to sulphur, as limestone is most prevalent around this particular deposit.

MINING OPERATIONS

Crater No. 1 Claim (Fig. 5)

Shaft No. 1: The main development work consists of a two-compartment shaft 7.55x5 ft., which starts at an incline of 70°, and at a depth of 56.4 ft. changes to an incline of 81°. The depth on the incline is 200.5 ft., making a true vertical depth from the collar to the bottom of 195.3 ft.

From the collar of the shaft, at a vertical depth of 30.35 ft., is the floor of a tunnel which is 78 ft. long and bears S. 72° E. to the portal. The tunnel continues for a distance of 35 ft. on the same bearing, toward the footwall on the west side of the shaft. This tunnel cuts across the sulphur orebody for a distance of 36 ft., the highest grade sulphur being around the shaft. At a vertical depth of 96.56 ft. the 100-ft. level is located. Cross-cuts 34 ft. and 20 ft. have been made west and

FIG. 13. Looking north from Crater No. 1 shaft along mineralized zone, showing sulphur pits and No. 2 shaft.

FIG. 14. Crater No. 1 mine shaft and dump.

east, respectively, from the shaft, all in good ore, total exposed width being 54 ft. At a depth of 108 ft. the sulphur ore is sharply cut off by the conglomerate. The bottom of the shaft, at a vertical depth of 195.3 ft. from the collar, is the 200-ft. level. The most extensive drifting has been done on this level, total footage being approximately 287 ft. Of the various cross-cuts, only the two designated as 2-3N. and 2-2E.

encountered any ore. Cross-cut 2-3N. followed a fractured zone for 50 ft., which averaged 29.8 per cent sulphur, and 2-2E. cut across 15 ft. of ore averaging 53.0 per cent sulphur. The other drifts are all in conglomerate, which does not carry any sulphur.

Shaft No. 2: This shaft is located about 425 ft. north of No. 1, and is only 32 ft. deep, with dimensions of 9 x 3 ft. At 18 ft. below the collar, it enters the sulphur orebody, and the bottom is still in it. The grade of sulphur here is very good, averaging 64.1 per cent sulphur for the 14 ft. exposed.

In addition to the above two shafts, seven large pits or trenches have been dug on the outcrop that strikes almost north and south, and has an apparent dip of 70° east. Other smaller additional pits tend to indicate that the sulphur outcrops definitely along the fault for a distance of 923 ft. The total length of the mineralized zone may be as much as half a mile, but only over this actual distance of 923 ft. has sulphur been exposed.

Churn Drill Holes: Altogether, eight churn drill holes were put down on this mineralized zone on the Crater No. 1 claim. They were sunk to depths varying from 82.5 ft. to 346 ft. One of them, No. 5, was sunk in the footwall and is the only one that did not encounter sulphur, while No. 2 had 96 ft. of sulphur, averaging 34.5 per cent.

The logs of these churn drill holes, together with the results of the sampling, are given below:

CHURN DRILL HOLE No. 1

Location—Center of Crater No. 1 Claim

Elevation—5379 feet

Date	*From*	*To*	*% S.*	*Remarks*
June				
23	Surface	5		3′ Gravel. Chert
	5	10		Chert. Some gypsum
24	10	15		Chert. 1.5′ conglomerate at 13′
	15	20		Chert
	20	25		Chert
	25	30	1	Chert
25	30	35	6	Chert
	35	40	25	Chert. 2′ ore at 37′
27	40	45	14	Chert. Ore at 44′
	45	50	6	Ore to 47′. Chert
28	50	55	6	Chert, hard
	55	60	13	Chert. Ore 56′ to 61′
	60	65	14	Ore to 61′. Conglomerate
30	65	70	13	Conglomerate
July				
1	70	75	13	Conglomerate with S.
2	75	82.5	14	Conglomerate with S.

Spudded in evening June 21.

Bottomed noon July 2.

(Believe the high grade S showing from 70 to bottom knocked in by top of stem) (ETH)

CHURN DRILL HOLE No. 2

Location—Center of Crater No. 1 Claim
Elevation—5378 feet
Spudded in July 4, 1929
Bottomed at 136′ July 14, 1929 On Section 250 N.

From	*To*	*Feet day*	*% S.*	*Remarks*
0	5	5		Chert
5	10			Chert
10	15			Chert
15	20			Chert
20	25			Chert
25	30	25		Chert
30	35			Chert
35	40			Chert. 38′ to 41′ very hard
40	45	15	17	Chert. Ore at 41′
45	50		31	Ore
50	56		61	Ore
56	60	15	63	Ore
60	65	5	44	Ore (Bitstuck. Fished)
65	70		42	Ore Black S. and gypsum
70	75		42	Ore Black S. and gypsum
75	80	15	35	Ore Black S. and gypsum
80	85	5	32	Ore Black S. and gypsum
85	90		44.5	Ore Black S. and gypsum
90	95		30	Chert, some S.
95	100	15	45	Chert, some S.
100	105	5	30	Chert, some S.
105	110		25	Chert, some S.
110	115		19	Chert, some S.
115	120		25	Chert, some S.
120	125	20	20	Chert, some S.
125	130		15	Conglomerate, some S.
130	135	10		Conglomerate, some S.
135	136	1		Conglomerate, some S.

PACIFIC SULPHUR CORPORATION

CHURN DRILL HOLE No. 3

Location—Center of Crater No. 1 Claim
Elevation—5384 feet
Spudded in July 24, 1929 On Section 250 N.
Bottomed at 260′ August 21, 1929

From	*To*	*Ft. day*	*% S.*	*Remarks*
Surface	20	25		Gravel and semiconsolidated conglomerate
20	25	25		Conglomerate
25	30			Conglomerate
30	35	10		Conglomerate
35	40	5		Conglomerate
40	45			Conglomerate
45	50	10		Conglomerate
50	55			Conglomerate
55	60			Conglomerate
60	65	15		Conglomerate
65	70			Conglomerate
70	75			Conglomerate
75	80			Conglomerate
80	85	20		Conglomerate
85	90			Chert
90	95			Chert
95	100		7	Chert with S.
100	105	20	7	Chert with S.
105	110		8	Chert with S.
110	115	10	5	Chert with S.
115	120		14	Chert with S.
120	125	10	20	Chert with S. (Black S.)
125	130		14	Chert with S. (Black S.)
130	135		2	Chert with S.
135	140		1	Chert with S.
140	145	20	2	Chert with S.
145	150			Chert
150	155	10		Chert
155	160			Chert
160	165			Chert with trace of S.
165	170	15		Chert with trace of S.
170	175			Chert with trace of S.
175	180			Chert with trace of S. Major fault at 176′
180	185	15		Chert with S.
185	190			Chert with S.
190	195		16	Ore
195	200		17	Ore
200	205	20	18	Ore
205	210	5	17	Chert with black S.
210	215		9	Chert with black S.
215	220	10	8	Chert with S.
220	225		8	Chert with S.
225	230		8	Chert with S.
230	235	15		Chert with some S.
235	240			Chert with some S.
240	245	10		Chert with some S. and gypsum
245	250			Chert with some S. and gypsum
250	255			Chert with some S. and gypsum
255	260			Chert with some S. and gypsum

CHURN DRILL HOLE No. 4

Location—N. ½ of Crater No. 1 Claim
Elevation—5357 feet
Spudded in August 23, 1929
Bottomed at 167 ft. August 30, 1929 On Section 500-N.

Date Aug.	*From*	*To*	*Ft. day*	*% S.*	*Remarks*
23	Surface	5			Detritus to 3′. Chert with gypsum
	5	10			Chert with gypsum
	10	15			Chert with gypsum
	15	20			Chert with gypsum
	20	25			Chert with gypsum
	25	30			Chert with gypsum
24	30	35			Chert with gypsum
	35	40			Chert with gypsum
	40	45			Chert with gypsum
	45	50			Chert with gypsum
	50	55	25		Chert with gypsum
25	55	60		8	Chert with gypsum to 57′. Ore at 57′
	60	65		38	Ore
	65	70		53	Ore
	70	75	20	55	Ore
26	75	80		40	Ore
	80	85		27	Ore
	85	90		33	Ore
	90	95	20	26	Chert with S.
27	95	100		25	Chert with S.
	100	105		21	Chert with S.
	105	110	15	20	Chert with S.
28	110	115		21	Chert with S.
	115	120		20	Chert with S.
	120	125		17	Chert with S.
	125	130	20	12	Chert with S.
29	130	135		13	Chert with S.
	135	140		8	Chert with gypsum and some S.
	140	145		7	Chert with gypsum and some S.
	145	150	20	7	Chert with gypsum and some S.
30	150	155			Chert with gypsum and some S.
	155	160			Chert with gypsum and some S.
	160	165			Chert with gypsum and some S.
	165	167	17		Chert with gypsum and some S.

CHURN DRILL HOLE No. 5

Location—N. ½ of Crater No. 1 Claim
Elevation—5360 feet
Spudded in Sept. 1, 1929
Bottomed at 206.5 ft. Sept. 11, 1929 On Section 500-N.

Date	*From*	*To*	*Ft. day*	*% S.*	*Remarks*
Sept.					
1	Surface	5			Detritus
	5	10			Semi-consolidated conglomerate
	10	15	15		Conglomerate
2	15	20			Conglomerate
	20	25			Chert and gypsum
	25	30			Chert and gypsum
	30	35			Chert and gypsum
	35	40			Chert and gypsum
	40	45			Chert and gypsum
	45	50			Chert and gypsum
	50	55	40		Chert and gypsum
3	55	60			Chert and gypsum
	60	65	10		Chert and gypsum
4	65	70			Chert and gypsum
	70	75	10		Chert and gypsum
5	75	80			Chert and gypsum
	80	85			Chert and gypsum
	85	90			Chert and gypsum
	90	95			Chert and gypsum
	95	100	25		Chert and gypsum
6	100	110			Chert and gypsum
	110	115	15		Chert and gypsum
7	115	120			Sulphur, chert and gypsum
	120	125			Sulphur, chert and gypsum
	125	130	15		Chert, gypsum, some sulphur
8	130	135			Chert, gypsum, some sulphur
	135	140	10		Chert, gypsum, some sulphur
9	140	145			Chert, gypsum, some sulphur
	145	150			Chert, gypsum, some sulphur
	150	160	20		Chert, gypsum, some sulphur
10	160	165			Chert, gypsum, some sulphur
	165	170			Chert, gypsum, some sulphur
	170	175			Chert, gypsum, some sulphur
	175	180			Chert, gypsum, trace of sulphur
	180	185			Chert, gypsum, trace of sulphur
	185	190	30		Chert, gypsum, trace of sulphur
11	190	195			Chert and conglomerate at 193′
	195	200			Chert and conglomerate
	200	205			Conglomerate
	205	206.5	16.5		Conglomerate

PACIFIC SULPHUR CORPORATION

CHURN DRILL HOLE No. 6

Location—S. ½, east center of Crater Claim No. 1
Elevation—5370 feet
Spudded in Oct. 5, 1929. Bottomed at 346 ft., Oct. 28, 1929.
Casing—None

Date	*From*	*To*	*Ft. day*	*% S.*	*Remarks*
Oct.					
5	0	15	15		2′ fill, 13′ detritus
6	15	22			Detritus
	22	30	15		Conglomerate, gypsum
7	30	40	10		Conglomerate, gypsum
8	40	60	20		Conglomerate, gypsum
9	60	85	25		Conglomerate, gypsum
10	85	110	25		Chert, gypsum
11	110	135	25		Chert, gypsum
12	135	145			Chert, gypsum
	145	150	15		Chert, gypsum, sulphur
13	150	155	5		Chert, black gypsum, sulphur
16	155	160	5		Chert, black gypsum, sulphur
17	160	170	10		Chert, gypsum, sulphur
18	170	185	15		Chert, gypsum, sulphur
19	185	195			Chert, gypsum, sulphur
	195	205	20		Sulphur, chert, gypsum
20	205	215	10		Sulphur, chert, gypsum
21	215	225	10		Sulphur, chert, gypsum
22	225	238			Sulphur, chert, gypsum
	238	242		18	Sulphur, chert, gypsum
	242	245	20	20	Sulphur, chert, gypsum
23	245	249		32	Sulphur, chert, gypsum
	249	253	8	29	Sulphur, chert, black gypsum
24	253	256		22	Sulphur, chert, black gypsum
	256	259		19	Sulphur, chert, gypsum
	259	262	9	15	Sulphur, chert, black gypsum
25	262	265		18	Sulphur, chert, black gypsum
	265	268		11	Sulphur, chert, black gypsum
	268	277			Chert, traces sulphur
	277	280	18	14	Sulphur, chert, gypsum
26	280	283		19	Sulphur, chert, gypsum
	283	286		17	Sulphur, chert, gypsum
	286	289		13	Sulphur, chert, gypsum
	289	292		7	Sulphur, chert, gypsum
	292	298			Sulphur, chert, gypsum
	298	301	21		Gypsum, some chert, trace sulphur
27	301	322	21		Gypsum, some silica
28	322	330			Gypsum, conglomerate, silica
	330	340			Conglomerate, gypsum
	340	346	24		Conglomerate, bottom

PACIFIC SULPHUR CORPORATION

CHURN DRILL HOLE No. 7

Location—South center of Crater Claim No. 1
Elevation—5385 feet
Spudded in—October 11, 1929. Bottomed at 176 ft., Oct. 29, 1929
Casing—150 ft. 6" landed at 149'. Pulled 150'. No shoe
Hours drilling—169.5

Date	*From*	*To*	*Ft. day*	*Hrs.*	*% S.*	*Remarks*
Oct.						
11	0	1	1	1.5		Chert, Fe stain
12	1	5	4	9		Chert, Fe stain
13	5	10	5	9		Chert, Fe stain
14	10	25	15	9		Chert, gypsum
15	25	30	5	9		Chert, gypsum
16	30	35	5	9		Chert, gypsum
17	35	45	10	9		Chert, gypsum
18	45	55	10	9		Chert, gypsum
19	55	60	5	9		Chert, gypsum
20	60	70	10	9		Chert, gypsum
21	70	85	15	9		Chert, gypsum
22	85	95	10	9		Chert, gypsum
23	95	105	10	9		Chert, gypsum, sulphur
24	105	115	10	10		Chert, gypsum, sulphur
25	115	125				Chert, gypsum, sulphur
	125	130			35	Sulphur, chert
	130	133	18	10	32	Sulphur, chert
26	133	136			31	Sulphur, chert
	136	139			43	Ore
	139	142			52	Ore
	142	145	12	10	17	Chert, gypsum, sulphur
	145	148			9	Chert, gypsum, sulphur
	148	151			14	Chert, gypsum, sulphur
	151	154	9	9	9	Chert, gypsum, sulphur
28	154	157			39	Ore
	157	160	6	9	27	Conglomerate, chert, gypsum, S.
29	160	163			15	Conglomerate, chert, gypsum, S.
	163	166			20	Conglomerate, chert, gypsum, S.
	166	169			26	Conglomerate, sulphur
	169	172			19	Conglomerate, sulphur
	172	176	16	10	10	Conglomerate, sulphur, bottom
30	Pulling Casing			2		
				169.5		

CHURN DRILL HOLE No. 8

Location—South center of Crater Claim No. 1
Elevation—5380 feet
Spudded in—Oct. 30, 1929. Bottomed at 291′, Dec. 6, 1929

Date	*From*	*To*	*Ft. day*	*% S.*	*Remarks*
Oct.					
30	0	10	10		Gravel
31	10	20			Red chert breccia
	20	30	20		Chert, gypsum
Nov.					
1	30	45	15		Chert, gypsum
22	45	60	15		Chert, gypsum
23	60	80	20		Chert, gypsum
24	80	95			Chert, gypsum, trace S.
	95	105	25		Chert, gypsum, trace S.
25	105	125	20		Chert, gypsum, trace S.
26	125	140	15		Chert, gypsum, trace S.
27	140	150	10		Chert, gypsum, trace S.
28	150	160	10		Chert, gypsum, trace S.
29	160	165	5		Chert, gypsum, S.
30	165	170	5	4	Chert, gypsum, S.
Dec.					
1	170	175		6	Chert, gypsum, S.
	175	178		17	Chert, gypsum, S.
	178	181	11	15	Chert, gypsum, S.
2	181	184		24	Chert, gypsum, S.
	184	187		32	Chert, gypsum, S.
	187	190		36	Chert, gypsum, S.
	190	193		41	Ore
	193	196		45	Ore
	196	199	18	27	Ore
3	199	202		22	Ore
	202	205	6	16	Ore
	205	208		45	Ore
	208	211		47	Ore
	211	214		48	Ore
	214	217		32	Chert, sulphur, gypsum
	217	220		29	Chert, sulphur, gypsum
	220	223		32	Chert, sulphur, gypsum
	223	226	21	29	Chert, sulphur, gypsum
5	226	229		31	Chert, sulphur, gypsum
	229	234		29	Chert, sulphur, gypsum
	234	239		33	Chert, sulphur, gypsum
	239	244		36	Chert, sulphur, gypsum
	244	249		38	Chert, sulphur, gypsum
	249	254		32	Chert, sulphur, gypsum
	254	259		31	Chert, sulphur, gypsum
	259	264		19	Chert, gypsum, sulphur
	264	269	43	17	Chert, gypsum, sulphur
6	269	274		6	Chert, gypsum, conglomerate, sulphur
	274	279		2	Conglomerate, gypsum, sulphur
	279	284		2	Conglomerate, gypsum, sulphur
	284	289			Conglomerate, gypsum, sulphur
	289	291	22		Conglomerate, gypsum, sulphur, bottom

Casing: 198′ of 6″ I.D. landed at 200′ below collar. Pulled 115′. Bottom 4 joints left in hole. (ETH)

Crater No. 5 Claim

Trenches and surface cuts have been dug on this smaller mineralized zone. At the southerly end there is a sulphur ledge striking north-south, dipping 65° west, 3½ ft. wide, 2½ ft. of which is blue-black sulphur instead of the customary resinous yellow variety. An average sample across the ledge gave an assay of 79.4 per cent sulphur. A smaller excavation with 2 ft. of mostly black sulphur ran 83.1 per cent sulphur. This ledge also strikes north-south and dips 80° to the west.

Crater Nos. 3 and 4 Claims

No prospect work has been done on these claims, for the surface material consists of pebble-conglomerate and black limestone. No faults

are discernible, and there is an apparent lack of mineralization on the surface which makes these two claims somewhat unfavorable for prospecting.

Crater Nos. 2 and 6 Claims

As indicated above, the mineralized zone mapped in 1932 on these two claims appeared to have considerable economic possibilities. From 1932 to 1937, various leasers, of whom the Sulphur Diggers, Inc., was the most important, carried on open-cut mining operations on these two claims. Sulphur was developed to a depth of about 40 ft. from the surface, of which 6 to 10 ft. was overburden. From this large pit some 30,000 tons have been mined over a period of five years. The ore averaged 80 to 90 per cent sulphur, and was shipped to Los Angeles. Considerable ore averaging 40 to 50 per cent was left in place or thrown over the dump.

Various methods of treating the lower grade ore were attempted, such as vertical retorts, and steaming sulphur ore in cars in tunnels; but none proved economical, and each in turn was abandoned.

Yellow Sulphur Claims (Figs. 2 and 3)

These claims lie approximately two miles east of the Crater No. 6 claim, over the mountain ridge. They are reached by a trail up a canyon which leads off the main canyon shown on the southeast corner of Fig. 4. Due to their present inaccessibility, they were not thoroughly investigated. A superficial examination showed a well-defined fault running approximately northeast, along which is a good mineralized zone. This faulted zone could be seen to extend for almost a mile. Several pits and trenches exposed some good sulphur.

SAMPLING

The shaft and mine workings were thoroughly sampled, as were many pits and trenches showing a ledge of sulphur of sufficient width.

The shaft was sampled on the average of every 15 feet of depth from the tunnel level to 8 feet below the 100-ft. level, where the ore rests on the coarse pebble-conglomerate. Two or three samples were taken at each point to get the percentage value on each side of the walls of the shaft (Fig. 5).

The tunnel level, 100-ft. level, and 200-ft. level were thoroughly sampled wherever any ore showed. Each sample represented a groove cut along the walls for a distance of five feet. The cuttings were caught on a large canvas, the sample broken and thoroughly mixed, then coned and quartered to an amount that could be easily inserted into a Braun paper sample bag. The sulphur ledges in the pits and trenches were sampled by cutting a groove across their width. These samples were also crushed, coned, and quartered.

Following is a list of all samples taken with the percentage of elementary sulphur of each:

SULPHUR SAMPLES FOR ANALYSIS

		Spec. Grav.	*Sulphur*
Crater Claim No. 1 Pit	A	2.02	81.5
	B	1.99	98.2
	C	2.08	94.8
	D	2.28	39.3
	E	2.41	37.4
	F	2.12	97.9
	G	2.07	90.5
	H	2.02	98.4
Crater Claim No. 2 Pit	I	2.01	87.2
	R	2.04	89.1
No. 5 Pit	K	2.09	79.4
	L	2.13	83.1
No. 6 Pit	M	2.06	81.7
	N	2.26	18.5
	O	2.04	82.6
Crater Mine Shaft No. 1 Sample	No. 1	2.06	98.8
	No. 2	2.01	94.3
	No. 3	1.99	87.8
	No. 4	2.06	96.5
	No. 5	2.08	65.1
	No. 6	2.06	97.1
	No. 7	2.10	88.6
	No. 8	2.18	49.8
	No. 9	2.10	57.7
	No. 10	2.08	64.2
Crater Mine Tunnel Sample	No. 1	2.51	29.8
	No. 2	2.16	92.3
	No. 3	2.02	97.7
	No. 4	2.33	28.4
	No. 5	2.35	26.1
Crater Mine Drift 1-1E Sample	No. 1	2.05	85.7
	No. 2	2.08	80.0
	No. 3	2.22	46.7
	No. 4	2.20	71.2
	No. 5	2.19	33.9
	No. 6	2.01	81.9
Crater Mine Drift 1-1W Sample	No. 1	2.21	27.8
	No. 2	2.20	23.3
	No. 3	2.08	46.6
	No. 4	2.14	44.0
	No. 5	2.08	64.8
	No. 6	2.10	56.1
	No. 7	2.27	79.5
Crater Mine Drift 2-2E Sample	No. 1	2.02	28.5
	No. 2	2.17	37.8
	No. 3	2.16	32.5
Crater Mine Drift 2-2W Sample	No. 1	2.37	1.2
	No. 2	2.31	5.2
	No. 3	2.43	6.4
	No. 4	2.39	4.2
Crater No. 1 Drift 2-3N Sample	No. 1	2.20	35.5
	No. 2	2.12	26.2
	No. 3	2.11	31.7
	No. 4	1.99	28.6
	No. 5	1.99	33.1
	No. 6	2.06	20.2
	No. 7	2.19	37.3
	No. 8	2.15	29.0
	No. 9	1.92	30.7
	No. 10	2.30	19.9
	No. 11	2.20	20.7
	No. 12	2.11	34.0
	No. 13	1.95	29.0
	No. 14	1.98	41.3
Crater Claim No. 1 Shaft 2 Sample	No. 1	2.00	96.5
	No. 2	2.05	92.8
	No. 3	2.29	29.4
	No. 4	2.17	37.8
Southwest Sulphur Co. 8 ft. Shaft Sample	No. 1	2.00	95.2

ESTIMATED TONNAGE

It is always a difficult matter to estimate tonnage of ore in a property where the development work has not been very extensive. In making the following estimate, only the limits of the sulphur orebody as revealed by the drill holes, mine, and pits were included. The balance of the mineralized zone, which probably also carries sulphur, was not figured. The estimate is made on the basis of the distance between

the two extreme sulphur showings, a distance of 923 ft. horizontally. The width of the ore was based on the actual width found in the shaft and the width east and west between drill holes. The depth of the main orebody was taken from the shaft and the various churn drill holes.

If reference be made to the sample and tonnage map (Fig. 6), the method of calculation will be clearly understood. The property was divided into a series of sections lettered A, B, C, D, and E. The total number of square feet in each section was calculated with a planimeter, and the mean of the two adjoining sections multiplied by the distance between them. The total number of cubic feet was multiplied by 130, which is the total number of pounds in a cubic foot of sulphur rock, and the tonnage obtained by dividing by 2,000. The following figures give the estimated tonnage obtained from the various sections:

Section A contains	2802.348 sq. ft.
Section B contains	4290.732 sq. ft.
Section C contains	6783.000 sq. ft.
Section D contains	2647.308 sq. ft.
Section E contains	None

	Tons	*Per cent sulphur*
Total tons in upper orebody	245,581.0	41.0
Estimated tonnage below 200′ level	7,308.0	21.4
Total tonnage in both orebodies	252,890.0	40.3

This estimated total tonnage of approximately 253,000 tons of 40.3 per cent sulphur is believed to be very conservative, and covers only the ore in sight in a small part of an extensive mineralized zone. No doubt considerable additional ore would be developed during mining operations. A very rough estimate of the total tonnage that might be developed in the three various mineralized zones can be made by assuming 250,000 tons of sulphur ore for every 900 feet of mineralization. The results of such a calculation are given below:

Crater No. 5 orebody	360,000 tons
Crater No. 1 orebody	640,000 tons
Crater Nos. 2 and 6 orebodies	750,000 tons
Total possible ore reserves as of 1932	1,350,000 tons

Later work on Claims Nos. 2 and 6 indicate that probably another million tons can be developed on them. It is believed that there are approximately 2,500,000 tons of sulphur available on all the six Crater claims.

If such a tonnage of 40 per cent sulphur ore is obtainable at the mine, it seems reasonable to suppose that it would be more economical to bring in fuel and extract the sulphur from the ore, freighting 99.5 per cent crude sulphur to Los Angeles, than to ship out for reduction waste in the amount of 60 per cent.

ECONOMIC POSSIBILITIES

There is no doubt that the Crater area of Inyo County has considerable economic possibilities, providing sufficient capital is available to place the properties on an efficient operating basis. To date, mining has been limited to high-grade ore which could be extracted with the least trouble and expense. The largest tonnage, running into several million tons, consists of probably 40 per cent sulphur ore. A method

either to reduce this 40 per cent ore to 99 per cent pure sulphur, or to concentrate it by milling operations must be devised to make this an economic project. Milling or metallurgical tests to devise the best process on several carloads of run of the mine sulphur ore should be made by some reputable concern in that business.

The great drawback to reduction work at the mine itself is the lack of water. It is believed that water is available on the floor of Eureka Valley at some point opposite the entrance to the sulphur deposit. The author recollects being told by a water well-drilling operator that water had been found in that immediate locality at a depth of 40 feet. If such is the case, and it could be proven at a small expense, a reduction plant should be located in Eureka Valley four or five miles from the sulphur deposit. The cost of hauling sulphur and waste rock four or five miles should be small, as the loaded trucks would coast downhill and make the up-grade return trip empty.

The present long haul of 68 miles from Zurich to Crater via Oasis should be eliminated because of the cost of hauling over three steep grades. It is feasible to build a road in a westerly direction across Eureka Valley from the sulphur deposit to connect via Marble Canyon with the Salinas Valley road to Zurich.

The open-cut pit on Crater No. 2 has revealed the existence of a large body of ore underlying the mineralized zone outlined in Fig. 4. It is reasonable to suppose that this orebody extends for a considerable distance at a shallow depth, lending itself to further open-cut mining. Underground mining, as it has been carried on by means of laterals from the open cut, should be discontinued because of the excessive cost.

The mine shaft with its compact linear orebody offers good economic possibilities. Topographically, Crater No. 1 claim adapts itself readily to open-cut mining. The bottom of the ore in the shaft is 108 ft. below the collar of the shaft. By starting operations at a point 100′+ below the collar of the shaft in the draw north of the shaft, open-cut mining could be carried on progressively to the south on the orebody. A face of sulphur ore up to a vertical height of 100′± would be available as operations approached the shaft.

Inyo County has a valuable nonmetallic deposit in the Crater sulphur mine, which should be efficiently exploited for the benefit of both the county and the owners.

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

BIENNIAL REPORT OF THE STATE MINERALOGIST

Hon. George D. Nordenholt, *Director,*
Department of Natural Resources,
Sacramento, California.

Sir: Herein I have the honor to present the biennial report of the State Mineralogist as required by law (Stats. 1913, Chap. 679) for transmittal to His Excellency, Governor Frank F. Merriam, covering the work and activities of the Division of Mines of the Department of Natural Resources, for the period July 1, 1936, to June 30, 1938.

General Summary.

Looking back over the past two years, the staff of the Division of Mines can view with genuine satisfaction the amount and quality of the work accomplished in behalf of the mineral industries of California. This state is an extensive empire and has widespread and diversified resources of minerals not excelled by any other equal area on the face of the planet. It is a big task for the small staff of the division to adequately cover this large assignment and keep up-to-date on the economic developments in all of the various mineral industries and areas within our borders. That we have accomplished much, commensurate with the means available, is testified to in letters and oral commendations from many identified with our mineral industries, and is evidence of the loyalty and sincere interest of the staff in their field of endeavor.

Activity has continued unabated in gold mining in California; likewise in the oil fields. In the latter, geophysical prospecting followed by drilling has resulted in the discovery of several new fields, particularly in the southern end of the San Joaquin Valley area. Building and structural materials as well as other nonmetallic industrial minerals and salines have varied, some being active while others have fluctuated considerably.

The mineral technologist in the laboratory of the division headquarters office has been kept busy, with his assistant, in indentifying and classifiying samples sent in from every section of the state. Our file shows reports made on 13,190 samples during this two-year period, an increase of 19 per cent over the preceding two years. While a considerable proportion of these samples received prove not to be of apparently commercial value, yet the value of the service rendered has a greater significance than that fact would indicate on its surface. Negative information is frequently as important as positive, as it tells the prospector or other sender whether expenditure of time and money in further digging is justified.

Successive renewals have been obtained of the Federal Works Progress Administration projects in the San Francisco headquarters

office of this division, also for the mining-claim mapping and records projects in the Sacramento and Los Angeles offices. The mining-claim projects in the county recorders' offices were concluded and the records concentrated in those two district offices of the division. The clerical, cataloguing, indexing and map-making project in the San Francisco office was renewed each year and has been expanded to a total personnel of 60 persons. Through the assistance obtained in these WPA projects we were able to complete the preparation ready for the printer

High-grade gold specimens and nuggets, exhibited by the Division of Mines, at the State Fair.

of three pieces of work in particular: 1. The Geologic Map of California by Olaf P. Jenkins, Chief Geologist; lithographed in eight colors and showing 80 segregated formational units. 2. Bulletin 113, on the "Minerals of California," by Adolf Pabst, Associate Professor of Mineralogy, University of California. 3. Bulletin 115, on the "Bibliography of California Geology and Mineral Resources, 1931 to 1936 inclusive," by Dr. Solon Shedd, librarian of Branner Memorial Library (Geological) at Stanford University; and which supplements the master bibliography, our Bulletin 104, issued in 1932 covering all publications on these subjects from the earliest known writings up to the end of 1930.

Each year at the State Fair at Sacramento, the Division of Mines has placed an exhibit with members of the staff in attendance, showing in visual evidence some measure of the great value and diversity of California's mineral resources. Included each time has been an electric-lighted safe with gold, platinum, and gem specimens.

Ore Buyers Inspector's Summary.

September, 1936, in cooperation with the United States Secret Service, nine men and one woman were arrested in Nevada County for violation of the Gold Reserve Act. The total amount of gold sold in these cases was $300,000. Cases against two of these men involved in this case were dismissed for lack of evidence; two others were aquitted before the Federal Court, and the other six were convicted. They received sentences ranging from 18 months to 5 years.

December, 1936, three men were arrested and charged with conspiracy to violate the Gold Act; later the three were convicted in Federal court and received sentences of 8 months in the county jail. The amount of gold involved in this case was $8,000.

March, 1937, four men from Los Angeles were arrested and later two of them were convicted and fined $2,500 each. Later two more men were arrested in Mariposa County and charged with falsifying affidavits to the United States Mint and were sentenced to 2 years in Federal penitentiary.

August, 1937, three men were arrested in Sierra County, one of whom was charged with grand theft and the other two with petty theft. The man charged with grand theft was given 6 months in the county jail, and the other two charged with petty theft were sentenced to 60 days each in the county jail.

February, 1938, John Bongard, the Ore Buyer's Inspector of this Division, in cooperation with the authorities of El Dorado County, arrested eight men for grand theft and ten for petty theft. Six of those charged with grand theft pleaded guilty and were sentenced to 90 days in the county jail and 5 years probation. Two elected to stand trial and were convicted; they were sentenced from 1 to 14 years in San Quentin. The 10 charged with petty theft pleaded guilty and were sentenced to 90 days in the county jail. The total recovery of around $15,000 was netted in high-grade rock and currency.

The following number of receipt books were issued to licensees: 1936, 796; 1937, 824; Total, 1620.

The following number of licenses were issued: Limited—1936, 98; 1937, 81; Total 179. Unlimited—1936, 111; 1937, 109; Total, 220.

Geologic Branch.

The most notable achievement of the Geologic Branch has been the final publication of the Geologic Map of California, scale 1:500,000, colored, in 6 sheets. Though this map is not a full 100 per cent "complete," it was considered best to leave the geology blank on those areas on which data were not available comparable in quality and accuracy to the balance of the state. These "white spots" should offer an incentive to geologists to work and to the holders of our purse strings to furnish funds to *complete* the job thus far so well done. The Geologic Branch has also made steady progress in cooperation with outside institutions and in the compilation of published data through the assistance of WPA projects. A considerable number of reports and maps have been published during the biennium (as indicated below) and several manuscripts are ready to be printed; others are in the process of preparation. In order to complete unfinished reports, the Geologic Branch should be supplied with a special fund for necessary expenses. In order to make these reports available to the public, a larger allotment of money is needed for printing.

Until very recently, only one person has been regularly employed on the staff, the Chief Geologist. Now he is supplied with one technical assistant, a geological clerk. In a short while, a geological draftsman is to be added to the staff. There is much need for a stenographer in this work, and it is hoped that sometime in the future at least one assistant field geologist may be employed to carry on special investigations of the geology of economic mineral deposits.

REPORTS PREPARED UNDER THE DIRECTION OF THE GEOLOGIC BRANCH

(Including publications of this biennium, reports in press, and reports ready for the printer)

1937

Source Data of the Geologic Map of California, January, 1937—by Olaf P. Jenkins (Chief Geologist).

The Geology of Quicksilver Ore Deposits—by C. N. Schuette (Consulting Mining Engineer and Geologist).

Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County—by Gorden B. Oakeshott (University of Southern California).

Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California—by John C. Hazzard (University of Southern California).

1938

Geologic Map of California, in six sheets, scale 1:500,000—by Olaf P. Jenkins (Chief Geologist).

Minerals of California (Bull. 113)—by Adolf Pabst (University of California).

Bibliography of the Geology and Mineral Resources of California for the years 1931 to 1936, inclusive (Bull. 115)—by Solon Shedd (Stanford University).

Doing Something About Earthquakes—by R. R. Lukens (U. S. Coast and Geodetic Survey).

Gold and Petroleum in California—by Waldemar Lindgren (Massachusetts Institute of Technology).

Geology of the Central Santa Monica Mountains, Los Angeles County—by E. K. Soper (University of California at Los Angeles).

Submarine Canyons off the Coast of California—by Francis P. Shepard (University of Illinois and Scripps Institute of Oceanography).

Strategic Minerals in California—by Charles W. Merrill (U. S. Bureau of Mines).

Geology and Ore Deposits of the Darwin Silver-Lead Mining District, Inyo County, California—by Vincent C. Kelley.

Geology of the Newberry and Ord Mountains—by Dion Gardner.

Reports Now in Preparation, Under Direction of Geologic Branch

Geologic Formations and Economic Development of the California Oil and Gas Fields—by many contributors, prepared under direction of Olaf P. Jenkins (Chief Geologist).

A Series of Economic Mineral Maps of California—by the Geologic Branch.

Geology and Mining of the Borate Deposits of the Kramer District, San Bernardino County—by Hoyt S. Gale (Consulting Geologist).

Geology and Mineral Deposits of the Duncan Mills and Sebastopol Quadrangles—by F. A. Johnson (University of California).

Geology of the Shasta Copper District—by G. F. Seager (Yale University).

Geology and Ore Deposits of the Bodie Mining District, Mono County—by Francis Frederick (University of California).

Geology of the Amboy Quadrangle, San Bernardino County—by John C. Hazzard (University of Southern California).

Geology of San Nicolas and Santa Barbara Islands—by Luis E. Kemnitzer (California Institute of Technology).

Tertiary Geology of a Part of Northern California—by R. Dana Russell.

Quicksilver Resources of California—by Alfred Ransome.

PUBLICATIONS

Publications issued July 1, 1936, to June 30, 1938:

July and October chapters of State Mineralogist's Report XXXII, 1936.

Among the more important subjects included are:

Mines and Mineral Resources of Calaveras County.
Mineral Resources of Lassen County.
Mineral Resources of Modoc County.
Mechanics of the Lone Mountain Landslides, San Francisco.

Special articles on:

Placer Mining in California by Power Shovel.
Assessment Work on Mining Claims within Withdrawn Areas.
Joshua Tree National Monument.
Cost of Producing Quicksilver at a California Mine in 1931-1932.
The Age of Mineral Utilization.
Biennial Report of the State Mineralogist.
Properties and Industrial Applications of Opaline Silica.

State Mineralogist's Report XXXIII, 1937. Among the more important subjects included are:

Source Data of the Geologic Map of California, January, 1937.
The Geology of Quicksilver Ore Deposits.
Mineral Resources of Plumas County, with Geologic Map.
Mineral Resources of Los Angeles County, with map.
Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County, with Geologic Map.
Mineral Resources of the Resting Springs Region, Inyo County.
Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County.

Special articles on:

Prospecting for Lode Gold.
New Placer Mining Debris Law.
Native Arsenic from Grass Valley, California.

January and April, 1938, chapters of State Mineralogist's Report XXXIV. Among the more important subjects included are:

Mineral Development and Mining Activity in Southern California during the year 1937.
Doing Something About Earthquakes.
Gold and Petroleum in California.
Gold Dredging in Shasta, Siskiyou and Trinity Counties.
Geology of the Central Santa Monica Mountains, Los Angeles County.

Special articles on:

Gem Minerals of California; and Lapidary Art.
Marketing Mica.

Bulletin 112. California Mineral Production and Directory of Mineral Producers for 1935, by Henry H. Symons, 205 pages, 7 illustrations. Gives detailed figures of commercial production of all mineral substances in California for the calendar year 1935.

Bulletin 113. Minerals of California, by Adolf Pabst, Associate Professor of Mineralogy, University of California, 344 pages, 1 illustration. Lists all known minerals found in California, and describes their characteristics and occurrences.

Bulletin 114. California Mineral Production and Directory of Mineral Producers for 1936, by Henry H. Symons, 199 pages, 5 illustrations. Gives detailed figures of commercial production of all mineral substances in California for the calendar year 1936.

Bulletin 115. Bibliography of the Geology and Mineral Resources of California, for the years 1931 to 1936 inclusive, by Solon Shedd, librarian of the Branner Memorial (Geological) Library, Stanford University. This bulletin supplements Bulletin 104, the "master bibliography" covering the same subjects from the earliest known writings on California to the end of 1930.

Conclusion

In conclusion we can but reiterate what we have said in previous reports: that California is outstanding in the diversity and economic values and potentialities of her mineral resources; and as the only state agency fostering the economic development of these resources, the Division of Mines deserves generous support for the continued maintenance of its services to the public and these industries.

Respectfully submitted.

WALTER W. BRADLEY,
State Mineralogist.

October 10, 1938.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

There have been no changes of personnel in the Division of Mines to be noted in the past three months.

New Publication

Geologic Map of California. In six sections each 32 inches by 42 inches, each overlapping and carrying separate legend. When assembled as a wall map, it is 6½ ft. by 7½ ft. By combinations of colors, shades and rulings, 80 geologic formations are distinguished. Contains also various charts showing source data, index to topographic maps, index to the township and range system, dimensions and areas of the state and its counties, a rainfall map, geologic time chart, geomorphic map showing submarine contours, mineral chart, and master legend. Highways and roads are shown accurately.

Commercial Mineral Notes (Nos. 184-186 incl.) August, September, October, 1938, respectively. These 'Notes' contain the lists of 'mineral deposits wanted' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to four pages in recent months.

Mail and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

The complete, detailed annual report on the mineral production of California for 1937, with a directory of producers, will be available, as Bulletin No. 116 of the State Division of Mines. The 1937 mineral output was valued at $361,515,951. See July, 1937, issue of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

SOURCES OF GOLD PRODUCED IN CALIFORNIA FROM 1848 TO 1937

Gold came from California as early as 1841 [1] and possibly as early as 1820 [2], having been mined from stream gravels near Los Angeles by the Indians and shipped to the Philadelphia Mint by the way of Mexico. The padres and the rancheros discouraged the quest for gold, so the early small production went practically unnoticed.

The discovery of gold by James W. Marshall in the tail-race of Sutter's sawmill at Colma on the American River, on January 24, 1848, brought about the gold rush which made California a commonwealth of the first rank in a very short period.

The data on the various methods of placer mining and types of ore from which the lode gold was derived, were compiled by James M. Hill [3] in 1928 who gives the placer and lode values of gold in ten-year periods also from 1900 the annual value by sources as well as lode and placer up to and including 1926. The Division of Mines has compiled these data to include 1937 by taking available information from the annual numbers of the U. S. Bureau of Mines, Mineral Resources (1927 to 1931), and U. S. Bureau of Mines Mineral Year Book (1932 to 1938). To Mr. Hill's table such changes and additions were made to give a more detailed break-down of sources as far back as possible.

The first gold produced was by small-scale hand methods of placering where the miner used sluice boxes, rockers, long toms and pans. In 1852 hydraulic mining was started near Nevada City and continued to flourish until the Sawyer decision in 1884, since which this method has been limited.

Drift mining on the ancient buried-river channels started at Forest Hill, Placer County, in 1852 and was an important source of placer gold from 1866 to 1900.

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[1] Hittell, T. H., History of California, Vol. II, p. 312, 1885.

[2] Bancroft, H. H., History of California, Vol. II, p. 417, 1886.

[3] Hill, James M., Historical Summary of Gold, Silver, Copper, Lead and Lime Produced in California, 1848 to 1926, U. S. Bureau of Mines Economic Paper 3, 1928.

Dredge production started on the Feather River in 1898 and by 1903 was the chief source of placer gold and has continued so to date.

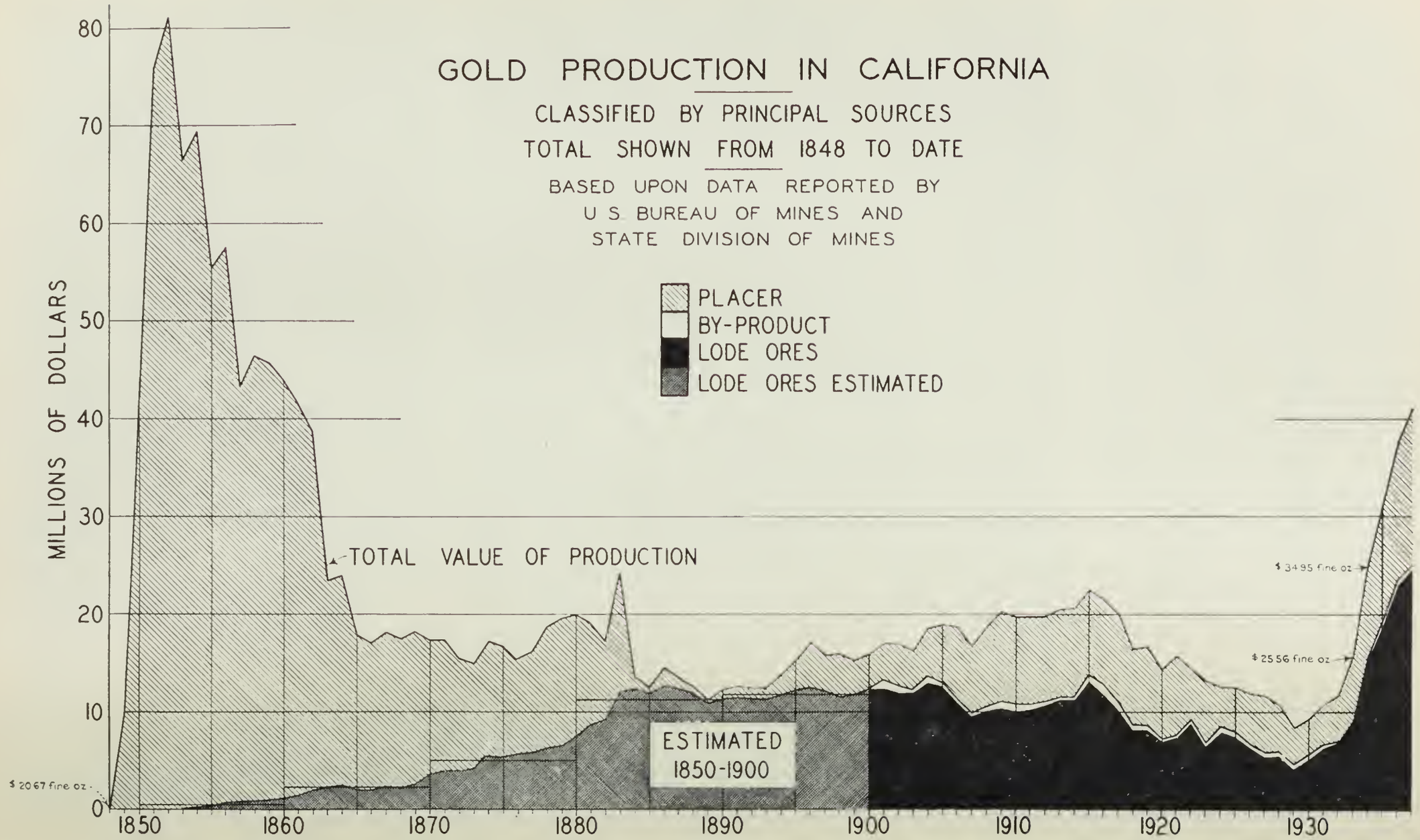
In 1933 when the ounce value of gold was increased it became profitable to work with dragline dredges and power shovels gravel properties which were too small for the standard bucket-line dredges. By 1935 these were an important source of the precious metal.

The lode or deep mines began operation in or about 1851 and by 1885 were the chief source of Californian gold. Prior to 1900 there was no definite segregation of placer and lode-gold statistics but a fairly accurate estimate can be made. An interesting fact is, that the 1937 lode-gold output with the largest lode value in the history of the State undoubtedly has also the largest annual output in ounces from the veins.

The accompanying chart was prepared by the Division of Mines from the annual gold figures and contains many points of interest. In 1852 the high-record annual gold output was achieved by hand-mining methods by the hundreds of thousands of men who rushed to the new El Dorado to make their fortune, also the richest surface placers were being skimmed. From this on till 1880 it was a new industry in a new country, finding its own level through men who came out to mine, but among whom many found other methods of making a living, more profitable or more to their liking. During this same period, also, others were attracted to new gold strikes in different parts of the world. From 1852 to 1885 as the amount of gold coming from the placers decreased the lodes were being developed and were increasing in output. In 1884 the decision by Judge Sawyer brought hydraulic mining to a standstill.

From 1885 on, the trend of business throughout the United States had a direct bearing on the mining of gold in California. During periods of financial prosperity the gold output was down, while during periods of financial depression the gold output increased. From 1888 to 1892 the gold output was down, but business in the United States as a whole was good, owing to the large-scale railroad construction throughout the country. In 1893 the panic increased the demand for gold, until the silver campaign depression of 1897. In 1893, the Caminetti act stimulated placer mining with the hope of the restoration of hydraulic mining.

The first gold dredge made its appearance on the Feather River in 1898 and proved a success, stimulating placer operations. The general merger of business in 1903 increased business in general and gold production dropped off. The panic of 1904 put gold on the upward trend, while the prosperity of 1905 to 1907 brought about a gradual decline in output. The panic of 1907-1909 and the war depression of 1914 all brought increased gold yield. The war prosperity 1915-1918 showed a gradual lessening in gold mining. The post-war depression of 1921 changed the trend for a year while the post-war prosperity and reconstruction period 1924 to 1927 and market boom of 1929 caused the interest in gold to lessen to such a point that the 1929 output was the smallest in the history of the State since 1848. The depression of 1929 stimulated the demand for gold which was further augmented by the increased prices from August 29, 1933, and the Gold Reserve Act of 1934 in effect on January 30, 1934, placing a value of $35 a fine ounce


GOLD PRODUCTION IN CALIFORNIA
CLASSIFIED BY PRINCIPAL SOURCES
TOTAL SHOWN FROM 1848 TO DATE
BASED UPON DATA REPORTED BY
U S BUREAU OF MINES AND
STATE DIVISION OF MINES
PLACER
BY-PRODUCT
LODE ORES
LODE ORES ESTIMATED
MILLIONS OF DOLLARS
80
70
60
50
40
30
20
10
0
TOTAL VALUE OF PRODUCTION
ESTIMATED
1850-1900
$ 20.67 fine oz
$ 34.95 fine oz
$ 25.56 fine oz
1850
1860
1870
1880
1890
1900
1910
1920
1930

on gold. The above act has also made it possible to work low-grade deposits at a profit which at no time previously would pay, at $20.67 per ounce.

The 1937 gold output was the largest in any year from 1861 in value, and 1862 in ounces, with the exception of 1883.

VALUE OF GOLD PRODUCED IN CALIFORNIA, 1848 TO 1937 FROM VARIOUS SOURCES

Period	Placer				
	Dredge	Hydraulic	Surface sluice	Drift	Total
1848-1850					$51 669,767
1858-1860					581,561,868
1861-1870					211,388,439
1871-1880					120,910,077
1881-1890					37,881,328
1891-1900	[6]$426,118				29,416,001
1901	471,762	[8]$1,698,720	[8]$719,078	[8]$1,061,489	3,951,049
1902	867,665	[9]1,256,222	[9]1,234,554	[9]889,161	4,247,602
1903	1,475,749	872,812	798,521	905,679	4,052,761
1904	2,187,038	1,028,183	836,115	933,954	4,985,290
1905	3,276,141	975,140	825,555	815,240	5,892,076
1906	5,098,359	1,054,172	617,577	605,817	7,375,925
1907	5,065,437	909,011	302,864	563,383	6,840,695
1908	6,536,189	743,797	560,656	390,545	8,231,187
1909	7,382,950	605,608	376,078	739,797	9,104,433
1910	7,550,254	635,498	186,114	516,929	8,888,795
1901-1910	39,911,544	9,779,163	6,457,112	7,421,994	63,569,813
1911	7,666,461	675,486	164,680	479,900	8,896,527
1912	7,429,955	689,682	138,034	387,992	8,645,663
1913	8,090,294	329,300	224,045	192,538	8,836,177
1914	7,783,394	702,884	264,623	329,948	9,080,849
1915	7,796,465	420,770	118,427	272,955	8,608,617
1916	7,769,227	390,015	165,118	251,297	8,575,657
1917	8,313,527	267,103	126,641	366,759	9,074,030
1819	7,431,927	213,229	85,203	108,420	7,838,779
1919	7,716,919	184,832	45,984	85,341	8,033,076
1920	6,900,366	66,233	31,089	62,925	7,060,613
1911-1920	76,898,535	3,939,534	1,363,844	2,538,075	84,739,988
1921	7,756,787	162,808	107,818	127,411	8,154,824
1922	4,999,215	158,275	89,739	252,626	5,499,855
1923	6,065,735	111,828	160,249	184,771	6,522,583
1924	4,305,521	60,195	124,088	98,568	4,588,372
1925	4,750,842	175,345	103,434	66,523	5,096,144
1926	4,950,545	69,139	97,483	111,236	5,228,403
1927	5,461,929	141,929	120,832	112,623	5,837,313
1928	4,430,913	153,386	91,512	174,818	4,850,629
1929	3,589,259	84,668	59,732	136,948	3,870,607
1930	3,451,801	62,615	89,403	151,324	3,755,143
1921-1930	49,762,547	1,283,733	1,099,069	1,258,524	53,403,973
1931	3,619,355	111,199	62,556	227,636	4,020,746
1932	3,903,481	205,880	122,876	533,238	4,765,475

Period	Placer							
	Surface placers						Underground placers drift	Total
	Connected-bucket dredges	Drag line dredges	Non-floating[14] washing plants	Hydraulic	Small-scale wet	Hand method dry[14]		
1933[11]	$5,155,716	$1,924	$40,442	$114,890	$928,098	$5,737	$434,036	$6,680,843
1934[12]	6,772,380	121,138	203,810	324,397	1,694,919	6,426	454,098	9,577,168
1935[13]	8,274,130	776,701	416,240	476,809	1,545,153	4,494	599,883	12,093,410
1936	9,671,347	1,748,864	422,079	268,450	1,369,620	11,827	837,618	14,329,805
1937	11,303,635	3,294,970	597,765	161,980	896,420	17,010	258,930	16,530,710
1931-1937	48,700,044	5,943,597	1,680,336	1,663,605	6,619,642	45,494	3,345,439	67,998,257
Grand totals	$215,698,788	$5,943,597	$1,680,336	$16,666,035	$15,539,667	$45,494	$14,564,032	$1,302,539,511

[1] Estimated as 100 per cent from placer mines.
[2] Estimated as 1 per cent from gold-lode mines and 99 per cent from placer mines.
[3] Estimated as 10 per cent from gold-lode mines and 90 per cent from placer mines.
[4] Estimated as 30 per cent from gold-lode mines and 70 per cent from placer mines.
[5] Estimated as 75 per cent from gold-lode mines and 25 per cent from placer mines.

VALUE OF GOLD PRODUCED IN CALIFORNIA, 1848 TO 1937 FROM VARIOUS SOURCES—Continued

Period	Lode					Total value
	Gold ore	Copper ore	Lead ore	Zinc ore	Total	
1848-1850						[1]$51,669,767
1851-1860					$5,874,362	[2]587,436,230
1861-1870					23,487,604	[3]234,876,043
1871-1880					51,818,604	[4]172,728,681
1881-1890					113,643,986	[5]151,525,314
1891-1900					117,664,005	[7]147,080,006
1901	$12,499,743	$421,385	$116,867		13,037,995	16,989,044
1902	12,295,261	361,951	5,506		12,662,718	16,910,320
1903	[10]11,973,291	[10]272,801	[10]1,800		12,247,892	16,300,653
1904	13,136,758	511,108	520		13,648,386	18,633,676
1905	12,772,219	224,650	9,600		13,006,469	18,898,545
1906	11,036,018	318,489	1,020	$1,000	11,356,527	18,732,452
1907	9,532,771	344,421	9,504	537	9,887,233	16,727,928
1908	10,050,853	473,092	6,427		10,530,372	18,761,559
1909	10,433,400	691,062	8,975		11,133,437	20,237,870
1910	10,143,780	658,288	24,577		10,826,645	19,715,440
1901-1910	113,874,094	4,277,247	184,796	1,537	118,337,674	181,907,487
1911	10,317,794	427,789	6,798		10,752,381	19,738,908
1912	10,771,759	293,946	1,717	393	11,067,815	19,713,478
1913	11,222,566	320,939	27,276		11,570,781	20,406,958
1914	11,200,323	343,776	28,548		11,572,647	20,653,496
1915	13,315,559	491,940	23,555	2,625	13,833,679	22,442,296
1916	11,876,291	922,876	35,504	413	12,835,084	21,410,741
1917	10,244,720	669,809	98,945		11,013,474	20,087,504
1918	8,287,599	319,701	82,455	419	8,690,174	16,528,953
1919	8,499,014	126,866	36,887	112	8,662,879	16,695,955
1920	7,158,329	38,459	53,642		7,250,430	14,311,043
1911-1920	102,893,954	3,956,101	395,327	3,962	107,249,344	191,989,332

Period	Lode							Total placer and lode value
	Gold ore	Gold-silver[15] ore	Silver ore[16]	Copper ore	Lead ore	Zinc ore	Totals	
1921	$7,317,692		$184,824	$29,747	$16,681	$1,054	$7,549,998	$15,704,822
1922	8,905,622		105,280	118,632	30,012	10,945	9,170,491	14,670,346
1923	6,438,818		206,284	177,129	34,199		6,856,430	13,379,013
1924	7,933,780		170,661	436,786	16,442	4,134	8,561,803	13,150,175
1925	7,429,269		146,227	342,834	47,083	3,773	7,969,186	13,065,330
1926	6,334,909		84,125	233,612	22,636	19,796	6,695,078	11,923,481
1927	5,411,442		64,806	342,259	8,259	6,939	5,833,705	11,671,018
1928	5,515,916		67,164	345,751	5,855		5,934,686	10,785,315
1929	4,187,591		46,464	414,384	7,657		4,656,096	8,526,703
1930	5,123,653		76,868	485,236	10,262		5,696,019	9,451,162
1921-1930	64,598,692		1,152,703	2,926,370	199,086	46,641	68,923,492	112,237,465
1931	6,450,853	$14,766	17,943	281,291	28,563		6,793,416	10,814,162
1932	6,901,890	227	34,334	32,275	31,525		7,000,251	11,765,726
1933	8,931,465	33,773	93	29,495	6,065	1,341	9,002,232	15,685,075
1934	15,423,796	88,171	2,575	1,269	38,305		15,554,116	25,131,284
1935	18,877,312	634	84,166	95,478	14,033	17	19,071,640	31,165,050
1936	22,842,470	33,985	42,735	449,015	12,075	385	23,380,665	37,710,470
1937	23,401,315	546,000	81,305	539,105	11,445	350	24,579,520	41,110,230
1931-1937	102,829,101	717,556	263,151	1,427,928	142,011	2,093	105,381,840	173,381,997
Totals	$384,195,841	$717,556	$1,415,854	$12,587,646	$921,220	$54,232	$712,380,811	$2,014,920,222

[6] Dredge production first recorded in 1898, $18,887; 1899, $206,302; 1900, $200,929. See U. S. Geological Survey Mineral Resources, Pt. 1, 1914, p. 357, for table to date. Note previous tables gave no production for 1898.

[7] Estimated as 80 per cent from gold-lode mines and 20 per cent from placer mines.

[8] Estimated distribution from information in Annual Report of Director of Mint, 1901, p. 90.

[9] Estimated distribution from information in Annual Report of Director of Mint, 1902, p. 76.

[10] From U. S. Geological Survey tabulation sheets.

[11] Value calculated at an average weighted price of $25.56 a fine ounce; previously $20.6718.

[12] Value calculated at an average weighted price of $34.95 a fine ounce.

[13] Value calculated at $35 a fine ounce.

[14] Prior to 1933 was included with small-scale hand methods wet.

[15] Prior to 1931 under gold ores.

[16] Prior to 1921 under gold ores.

MUSEUM

The museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

20881 DAHLLITE, a carbonated calcium phosphate.
From Manhattan, Nevada.
Donor: W. C. Eyles. August, 1938.

20882 VASHEGYITE (green), a hydrous aluminum phosphate; with LAUBANITE (white), a hydrous calcium-aluminum silicate.
From Manhattan, Nevada.
Donor: W. C. Eyles. August, 1938.

20883 CINNABAR (HgS), mercury sulphide—a piece of float.
From near Cambria, San Luis Obispo County, California.
Donor: M. D. Gaines. August, 1938.

20884 PHARMACOLITE, an acid, hydrous calcium arsenate—$HCaAsO_4.2H_2O$.
From White Caps Mine, Manhattan, Nevada.
Donor: Hatfield Goudey. August, 1938.

20885 TOURMALINE, a complex silicate of boron and aluminum, $HAl_3(B.OH)_2Si_4O_{19}$.
From Lucky Strike Mine, four miles due south of Engle Mine—Sec. 28, T. 29 N., R. 11 E.—Plumas County, California.
Donor: G. L. Holmes. September, 1938.

20886 CHALCANTHITE, hydrous cupric sulphate, $CuSO_4.5H_2O$.
From True Friend Mining Claim, Masonic Mining District, Mono County, California.
Donor: Byron A. Krebs. September, 1938.

20887 WULFENITE, $PbMoO_4$. Lead molybdate crystals in cluster.
From Miess, Yugoslavia. Exchange. October, 1938.

20888 FLUORITE, CaF_2—Calcium Fluoride.
From Afton, San Bernardino County, California.
Donor: Morio Kitagaki. October, 1938.

20889 GYPSUM, $CaSO_4.2H_2O$.
From Santa Monica Cliffs, Los Angeles County, California.
Donor: E. F. Montgomery. October, 1938.

20890 QUARTZ, SiO_2—bull quartz showing zone structure of crystals.
From Shingle Springs, El Dorado County, California.
Donor: V. E. Perish. October, 1938.

20891 ZIRCON, sand first mined commercially in California.
From Kaufield Gold Dredge, Lincoln, Placer County, California.
Laboratory. October, 1938.

20892 CORAL, $CaCO_3$—recent.
From Fiji Islands.
Donor: Walter W. Bradley. October, 1938.

LABORATORY

GEORGE L. GARY, Acting Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one, "Minerals of California," by Adolph Pabst, was published this year by the Division of Mines as Bulletin 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

No. 3—Chalcanthite, a hydrous cupric sulphate from the True Friend mining claim in the Masonic mining district, Mono County.

No. 4—Basanite, silicon dioxide, a velvet black siliceous stone or flinty jasper, used on account of its hardness and black color for trying the purity of the precious metals, from the beach, San Francisco County.

No. 5—Garnierite, a hydrous magnesium and nickel silicate from the Aurora mine, near the New Idria mine, San Benito County.

No. 6—Titanite. A few small envelope shaped crystals of titanite in a pegmatite rock from the Mountain district, eastern Madera County.

No. 7—Psilomelane, a manganese oxide associated with pink rhodonite, a manganese silicate from 12 miles southwest of Soledad and about 4 miles west of Paraiso Springs, Monterey County.

No. 8—Rhodonite, a manganese silicate associated with psilomelane, a manganese oxide from 12 miles southwest of Soledad and about 4 miles west of Paraiso Springs, Monterey County.

No. 9—Satin-spar, a variety of gypsum that is fine—fibrous, with pearly opalescence, from Salinas, Monterey County.

No. 10—Covellite, an indigo-blue cupric sulphide associated with chalcopyrite, from near Groveland, Tuolumne County.

No. 11—Montroydite, mercuric oxide with cinnabar from the Red Elephant mine, near Lower Lake, Lake County.

No. 12—Montroydite, mercuric oxide with native quicksilver and cinnabar, from the Esperanza mine on Sulphur Creek, east of Cloverdale, Sonoma County.

No. 13—Cerusite, a lead carbonate as a heavy yellow concentrate in sands from near Healdsburg, Sonoma County.

LIBRARY

J. C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE ESPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

Professional Papers:

189 A Species and Genera of Tertiary Noetinae.
189 C Pliocene Diatoms from the Kettleman Hills, Calif.
189 E The Force Required to Move Particles on a Stream Bed.
190 Lower Pliocene Mollusks and Echinoids from the Los Angeles Basin, California.

Technical Papers:

582 Methods for the Detection and Determination of Carbon Monoxide.
585 Flotation for Recovery of Scheelite from Slimed Material.
586 Notes on the Sampling and Analysis of Coal.

Water Supply Papers:

810 Surface Water Supply of the U. S. Part 10—The Great Basin.
820 Dwight of 1938. With Discussion on the Significance of Drought in Relation to Climate.

S30 Surface Water Supply of the U. S., 1937. Part 10. The Great Basin, Calif., Idaho, Nevada, Oregon, Utah and Wyoming.
S31 Pacific Slope Basins in California.

Topographic Maps:

Branch Mountain, Advance Sheet.
Goleta Quadrangle, Santa Barbara Co.
Jackson Quadrangle, Calif.
Newman Quadrangle.
Plan and Profile of Kings River, Piedra to Mile 32, California. North Fork to Balch Camp, Big Creek to Mile 4. Reservoir and Dam Sites, 6 sheets.
Plan and Profile of Putah Creek, from a point 2 miles above Winters to Middletown, Calif. Dam sites—6 sheets scale 1:31680.
Sequoia and General Grant National Parks, Calif.
Tobias Peak, Advance Sheet.

Bulletin:

S95 D Geophysical Abstracts 91, October-December, 1937.

U. S. Bureau of Mines:

Information Circulars:

6990 Mining and Milling Methods and Costs at the Summitville Consolidated Mines, Inc., Summitville, Colo. By Jos. R. Guiteras.
7028 Reconnaissance of Placer Mining in Boise County, Idaho. By O. H. Metzger.
7029 Cost of Mining 55 Tons of Copper-Nickel Ore at the Great Eastern Prospect, Bunkerville, Clark County, Nev. By Paul T. Allsman.
7030 List of Respiratory Protective Devices approved by the Bureau of Mines. By H. H. Schrenk.
7031 Natural-Gasoline Plants in the United States, January 1, 1938. By G. R. Hopkins and E. M. Seeley.
7032 Some Observations on Coal-Mine Fans and Coal-Mine Ventilation. By D. Harrington and E. H. Denny.
7034 Petroleum Refineries, Including Cracking Plants, in the United States, Jan. 1, 1938. By G. R. Hopkins and E. W. Cochrane.
7035 Lighting Practices in Coal Mines of the United States. By A. B. Hooker and C. W. Owings.
7036 Necessity for More Extended Use of Safety Equipment in Mining. By D. Harrington.
7037 Some Instruments and Devices That Coal-Mine Officials Should Understand and Use. By G. W. Grove.
7038 A Study of Explosive Accidents Reported to the National Safety Competition, 1925-35.

Reports of Investigations:

3406 Progress Reports—Metallurgical Division, 23. Electrometallurgical Investigations. Electrolytic Manganese. By S. M. Shelton, M. B. Broyer, and A. P. Towne.
Boulder City, Nev., Electrometallurgical Laboratory. By J. Koster and R. G. Knickerbocker.
Pullman, Wash., Unit, Electrometallurgical Section. By H. A. Doerner.
3409 Ball-Mill Grindability Indexes of Some American Coals. By H. F. Yancey and M. R. Geer.
3410 Porosity of the Sundance Sand in the Lance Creek Oil Field, Wyoming. By H. Dale Nichols.
3411 Tests of a Barrier Using Rock Dust in Paper Bags. By H. P. Greenwald and H. C. Howarth.
3412 Ventilation of Manholes: 3. Effect of Wind Velocity on Natural Ventilation. G. W. Jones, E. S. Baker and John Campbell.
3413 National Safety Competition of 1937. By W. W. Adams, T. D. Lawrence, and E. E. Getzin.
3414 Production of Explosives in the United States During the Calendar Year, 1937. By W. W. Adams and V. E. Wrenn.
3416 Truck vs. Rail Haulage in Bituminous-Coal Strip Mines. By Albert L. Toenges and Frank A. Jones.

3417 Survey of Crude Oil in Storage 1936-1937. By Petroleum Economics Division and Petroleum and Natural Gas Division, Bureau of Mines.
3418 Consumption of Primary and Secondary Tin in the United States in 1936 and 1937. By John B. Umhau and M. E. Trought.
3419 Progress Reports—Metallurgical Division. 25. Annual Report of the Metallurgical Division, Fiscal Year 1937-38. By R. S. Dean and others.
3420 Mineral Economics Series. 3. Consumption of Ferrous Scrap and Pig Iron in the United States in 1937. By Robert H. Ridgway, H. W. Davis, and M. E. Trought.
3421 Active List of Permissible Explosives and Blasting Devices Approved Prior to June 30, 1938.
3422 Desalting Crude Petroleum. A Review of the Literature. By L. F. Christianson and Joseph W. Horne.

Bulletins:

405 Copper Mining in North America.
413 Mineral Industries Survey of the U. S., California, Calaveras County, Mother Lode District (South) Mines of the Southern Mother Lode Region, Part I, Calaveras County.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers. New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gemmologist, London.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Sands, Clays and Minerals, Chatteris, England.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.

Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

Books:

American Men of Science—A Biographical Directory, 1938.
The Official Manual of the Cripple Creek District, Colorado. Published by Fred Hills; Donated by R. K. Hutchings, M.D.

John Hays Hammond Library:

Historic Spots in California, Counties of the Coast Range, by Mildred Brooke Hoover.
Historic Spots in California, the Southern Counties, by Hero Eugene Rensch and Ethel Grace Rensch.
Quartz Family Minerals, by H. C. Dake and Ben Hur Wilson.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of California Journal of Mines and Geology, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of California Journal of Mines and Geology.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

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REPORTS

Asterisks (**) indicate the publication is out of print. Price Postpaid

**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks ----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks ----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks ----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks ----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks ----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks $0.75
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr. .75
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. ----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr. ----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr. ----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 ilustrations, 10 maps. William Irelan, Jr. ----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps William Irelan, Jr. 1.50
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford ----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford ----
Chapters of the State Mineralogist's Report, XIV Biennial Period, 1913-1914, Fletcher Hamilton:
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper ----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper .75
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper ----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper ----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper ----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper ----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:
A General report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth ----
Chapters of the State Mineralogist's Report, XV Biennial Period, 1915-1916, Fletcher Hamilton:
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176, pp., paper ----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper .75
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper .75
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper .75

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price Postpaid
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	$1.00
Mines and Mineral Resources of Plumas County, 188 pp., paper	.75
Mines and Mineral Resources of Sierra County, 144 pp., paper	.75
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	2.50
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, **May, June, July, August, September, October, ** November, December, 1922	.40
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.40
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.40
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.40
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.40
**July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	----
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California, Lloyd L. Root. Published quarterly:	
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.40
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.40
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.40
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Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.25
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**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin, 4 pp.	----
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**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	----

MISCELLANEOUS PUBLICATIONS

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**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----

MISCELLANEOUS PUBLICATIONS—Continued

Asterisks (**) indicate the publication is out of print.

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**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper	----
Bulletin. Reconnaisance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper	$0.25
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 (15c annually)	Free

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**Register of Mines, with Map, Butte County	----
**Register of Mines, with Map, Calaveras County	----
**Register of Mines, with Map, El Dorado County	----
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**Register of Oil Wells, with Map, Los Angeles City (1906)	----

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**Map of California, Showing Mineral Deposits (50x60 in.)	----
**Map of Forest Reserves in California	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
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**Geographical Map of Inyo County. Scale 1 inch equals 4 miles	----
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OIL FIELD MAPS—Continued

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DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLDT, DIRECTOR
DIVISION OF MINES
WALTER W. BRADLEY STATE MINERALOGIST
PLATE III.
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425 K-16—Widow Borate
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427 M-10—Williams and Johnson
428 C-2—Wilshire-Bishop Creek
429 I-14—Winter's Borate Deposit
430 I-8—Wittikint Mine
431 O-18—Wonder
432 K-9—Wonder
433 M-13—Wyoming
434 L-9—Yucca
U. S. MINERAL MONUMENTS
No. 2 G-4 | No. 61 N-14 | No. 121 O-20
No. 14 G-6 | No. 62 L-13 | No. 127 J-12
No. 16 L-9 | No. 72 O-17 | No. 130 O-21
No. 27 H-8 | No. 76 M-13 | Inyo I-8
No. 32 B-4 | No. 106 O-11 | No. 131 D-19
No. 34 I-14 | No. 107 N-11 | No. 133 H-14
No. 37 J-16 | Armaugh I-8 | No. 136 N-11
No. 40 J-16 | No. 110 K-16 | No. 138 I-16
No. 43 K-16 | No. 111 L-14 | No. 169 J-8
No. 44 K-18 | No. 113 L-16 | No. 179 O-18
No. 45 L-17 | No. 116 M-13 | No. 181 O-11
No. 46 J-16 | No. 118 M-13 | No. 182 O-18
No. 47 K-16 | No. 119 I-16 | No. 183 F-13
No. 58 I-7 | No. 120 L-16
MAP OF
INYO COUNTY
CALIFORNIA
SHOWING LOCATION OF
PRINCIPAL MINES
ACCOMPANYING REPORT ON MINES AND
MINERAL RESOURCES OF INYO COUNTY
BY W. B. TUCKER AND R. J. SAMPSON
1938
SCALE
0 5 10 15 MILES
• 250 MINES
◉ 62 U.S. MINERAL MONUMENTS
ACCOMPANYING STATE MINERALOGIST'S REPORT XXXIV. OCTOBER 1938.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey

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THE TEMESCAL TIN DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

by

L. R. Page 1910- and T. P. Thayer 1907-

45-13

ILLUSTRATIONS

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Introduction and history of mining

Very small quantities of tin have been found in a large number of tourmaline-rich veins which occur principally in quartz monzonite, in the northeastern and easternpart of T. 4 S., R. 6 W., and in the western edge of T. 4 S., R. 5 W., Southeast of Carona, in Riverside County. The tin-bearing area is south and west of Lake Mathews, a reservoir of the Metropolitan Water District of Southern California, and is served by paved roads from Corona and Arlington. The Cajalco mine in this district is one of the few tin occurrences in the United States that has been productive, although the total yield has been only 125 to 150 short tons of metallic tin.

Tin, in the form of cassiterite, was discovered in the veins about the middle of the last century, probably between 1840 and 1856 1/. In 1860, Don Abel Stearns, owner of El Rancho Sobrante de San Jacinto, leased the tin-bearing area to S. C. Bruce who, backed by the Phelps Dodge Corp., started exploration at the Cajalco mine in September. A vertical shaft (the Robinson) had been sunk 95 feet when the outbreak of the Civil Wat stopped the work. Exploration was resumed in 1868 by the San Jacinto Tin Mining Co. after acquisition of 49,000 acres of the ranch, and in 1869 15.34 tons of ore shipped to San Francisco was said to have yielded 6,895 pounds of tin. According to Craze 2/and Crossman 3/litigation arose in 1869 and little additional work was done before the property was sold to the San Jacinto Estate, an English company, in 1890. The English company began a 6-1/2 mile tunnel in Temescal Canyon to crosscut about 40 of the main veins, but the project was soon abandoned. After refinancing, a mill and smelter were built at the Cajalco mine, 4/, and in 1891-92, production amounted to 125 to 145 tons of tin. Operations were suspended in 1892 and the property was sold to the San Jacinto Land Company.

1/ Bancroft, H.H., The Works of Herbert Howe Bancroft, vol. XXIV, History of California, vol. 7, p. 660. (San Francisco, History Co.), 1860-1890.
Cronise, T.F. The Natural Wealth of California, p. 103 (San Francisco, H.H. Bancroft and Co.), 1868.
Furness, J.W., Tin: Mineral Resources, U.S., 1925, pt. I, p. 68, 1928.
Hanks, H.G., Cassiterite: California State Mining Bureau. State Mineralogist's Report 4, p. 120, 1884.

2/ Craze, Capt. Charles, Private report, June 1888.

3/ Crossman, H.H., Mining and Scientific Press, Sept. 6, 1890 (San Francisco).

4/ Benedict, W. de L., The San Jacinto (California) Tin mines: Eng. and Mining Jour., vol. 50, pp. 450-453, 1890.

Between 1892 and 1927 the Cajalco mine was pumped out and examined several times but no attempt at mining was made until the Temescal Syndicate acquired the mine in 1927. The syndicate was reorganized as the American Tin Corporation in 1928 and an extensive program of development and prospecting was undertaken under the direction of George W. Bryant. The veins near the Cajalco mine were prospected, the Cajalco mine was deepened, and many drifts were driven in search of new ore shoots. Many veins in the district were stripped and thousands of samples were taken; wherever high assays were obtained, shafts or adits were dug. A small mill was set up and runs were made on ore from the higher-grade veins. Every possible attempt was made to develop a mine, but, after spending many thousands of dollars in sampling and exploration, the project was abandoned. The American Tin Corporation was reorganized about 1930 as the Temescal Corporation and again in 1943 as the Tinco Company.

Investigations of the deposits in the last decade have consisted primarily of surface sampling. The veins in the area now covered by Lake Mathews and in the immediate vicinity were extensively sampled in connection with a condemnation suit by the Metropolitan Water District about 1934. In 1943, Dodge Construction, Inc., as agent for the Metals Reserve Company, erected a mill near the Cajalco mine and milled 14 100-ton lots taken from carefully laid out trenches on Cajalco Hill, from veins No. 4 and 5 east of Cajalco Hill, and from a small blowout in the Black Rocks area. These tests showed that cassiterite could not be concentrated from the tourmaline-bearing rock in any appreciable quantities by commercial gravity methods.

The entire production apparently came from a single cassiterite ore body in the Cajalco mine, which was worked at three different periods. As shown in the following table, the main activity was during 1891 and 1892, when 97 to 98 percent of the total tin was mined and the main ore body was mined out. Later efforts to produce tin on a commercial scale have been unsuccessful.

Production of tin from the Temescal district, California

Date	Pounds of metallic tin
Prior to 1890 (probably 1868 - 1869)	6,895[a]
1891	121,108[a]
1892	163,131[a]
1928-1929	1,188[b]
	292,322

a/ Rolker, C. M., The production of tin in various parts of the world: U. S. Geol. Survey 16th Ann. Rept., pt. 3, p. 537, 1895.

b/ Segerstrom, R. J., Tin in California: California Div. of Mines, Jour. Mines and Geology, vol. 37, p. 543, 1941. Production in 1891 and 1892 stated as 56 and 56.2 long tons, respectively.

Field Work and Acknowledgments

The principal tourmaline-bearing veins in the district were mapped in detail by L. R. Page, Theodore Lance, Gordon Bell, and Raymond M. Alf, of the Geological Survey, between October 1940 and February 1941. About 6 square miles in the vicinity of the Cajalco mine and the Black Rocks are was mapped on a scale of 400 feet to the inch with plane table and telescopic alidade, about one-third on a topographic base made at the time, and two-thirds on a base furnished by the Metropolitan Water District. Although most of the underground workings were inaccessible, many of the veins were mapped in detail on the surfaces or in accessible underground workings. Page, assisted by Alf, did additional mapping in April 1943; in August of the same year, T. P. Thayer mapped Cajalco Hill and the Metals Reserve Company trenches in great detail, while the sampling was being done. During the milling, the Cajalco mine was partly unwatered and Thayer and the Metals Reserve Company Engineers went down into the upper part of the old stope. John H. Wiese spent two months in the spring of 1945 on petrographic examination of concentrates.

During the course of the Geological Survey work more than 125 samples of vein material were collected for chemical and microscopic study. Lance, in 1940-1941, crushed about 110 of the samples and separated fractions with heavy liquids in the geological laboratories of the California Institute of Technology, and in the Survey laboratories in Washington. Twenty-two samples were analyzed spectroscopically in 1940 by the Applied Research Laboratories of Los Angeles, and 43 samples or fractions were analyzed in 1945 by Charles Bentley at the Mining Experiment Station, South Dakota School of Mines, at Rapid City. Samples collected by D. F. Hewett in 1938 were examined in detail by J. J. Glass, of the Geological Survey.

George Bryant, who was concerned with all of the properties as engineer and geologist for 20 years, accompanied the writer in the field many times and kindly furnished copies of all of his maps, several of which have been used in this report. The officials of the American Tin Corporation and owners of the other properties supplied maps and other information. The Metropolitan Water District gave permission for use of some of its topographic maps as a base and gave the writer free access to engineering reports on the area.

The field work was done under the general supervision of D. F. Hewett, who first visited the district in 1938, and the report was revised and critically reviewed by T. P. Thayer, D. M. Lemmon, and M. E. Dorr.

Geology

The tin deposits in the Cajalco district are associated with tourmaline rocks in veins and irregular pipe-like masses which cut nearly all the main rock units in the district. The oldest rocks are the Elsinore metamorphic series, 5/probably of Triassic age, which were intruded by the Temescal porphyry 5/and Cajalco quartz monzonite 5/. Three distinct varieties of the quartz monzonite —coarse-grained,

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5/ Dudley, P. H., and Sampson, R. J., Geology of the Perris block, Southern California: California Div. of Mines, Jour. of Mines and Geology, vol. 31, pp. 487-506, 1935.

porphyritic, and fine-grained—were mapped in the field, in addition to closely related pegmatites and aplites. Trachyte porphyry dikes, younger than the veins, occur northeast of the Cajalco mine.

Rocks

Elsinore metamorphic series

The Elsinore metamorphic series, probably of Triassic age, the oldest rocks in the map area (fig. 2), consist mainly of argillites and quartzites, and some mica schist and greenstone. They occur in the southern part of the area.

The metamorphosed sedimentary rocks are dark gray to green or black, are thinly laminated, and have a dense texture. They consist of various proportions of quartz, orthoclase, plagioclase, biotite, and muscovite, with accessory titanite, apatite, zircon, magnetite, pyrite, and tourmaline. The greenstones are dark greenish chloritic rocks, that were probably basalt flows. Near the tin-bearing veins, all these rocks are bleached and are irregularly impregnated with quartz and tourmaline.

Dacite porphyry.

Dacite porphyry crops out along the western edge of the district, about 2,000 feet west of the Cajalco mine. It is an aphanitic to medium-grained, dark gray to greenish porphyry that contains phenocrysts of feldspar and quartz rarely exceeding 1/4 inch in length, in a dark fine-grained to aphanitic ground-mass. Some parts rich in quartz have not been separately mapped because they form dike-like masses which have indefinite contacts and are poorly exposed. Dudley states that the composition of the dacite porphyry averages 38 percent andesine, 24 percent orthoclase, 30 percent quartz, 6 percent biotite, and 1 percent hornblende 6/. The phenocrysts, mainly of andesine, are estimated to constitute 40 percent of the rock. Small amounts of magnetite, ilmenite, apatite, titanite, and rutile are also present. The porphyry is bleached at contacts with younger igneous rocks and veins and contains epidote which gives the rock a variety of yellowish-green colors.

Diabase, diorite, and gabbro.

Inclusions of diabase, diorite, and gabbro occur throughout the quartz monzonite, but none of them are sufficiently large to be shown on the smaller-scale geologic maps. They range from fresh, black, medium-or coarse-grained diorite or gabbro to brownish quartz monzonite. Where cut by tourmaline veins, in which epidote is abundant, these basic rocks are changed to a dark epidote-rich rock. The inclusions are undoubtedly related to the gabbros and other basic rocks mapped to the south and east by Dudley.

Large masses of these basic rocks are exposed in the lower levels of the Cajalco mine and in some of the other workings. The inclusions in places make up 50 to 75 percent of exposures, and are particularly abundant about 2,000 feet

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6/ Dudley, P. H., and Sampson, R. J., op. cit., p. 497.

south of Cajalco mine, in Mine Creek and in Cajalco Canyon for a distance of 1,500 feet below the toe of the Lake Mathews dam. Below an altitude of about 1,150 feet they are fairly common but above that they are widely scattered; their abundance in Cajalco Canyon and Mine Creek suggests that the floor of the quartz monzonite is not far below.

Quartz monzonite.

Three textural varieties of quartz monzonite were mapped in the district, coarse-grained, porphyritic, and fine-grained. The coarse-grained quartz monzonite underlies most of the tin-bearing areas. In some places it appears to grade into a medium-grained pink to brownish porphyritic variety, which in turn grades into the fine-grained quartz monzonite. Where the fine-grained and coarse-grained varieties of the quartz monzonite are in contact, the boundary is usually well defined.

The coarse-grained quartz monzonite is about 35 percent plagioclase (oligoclase-andesine), 35 percent microcline and orthoclase, 20 percent quartz, and 10 percent hornblende and biotite, and contains magnetite, apatite, titanite, zircon, and other accessory minerals. The texture is sub-porphyritic or monzonitic and the grains average about 1/4 inch. The quartz grains commonly are rounded and where the feldspars are completely altered, the rock appears porphyritic. The plagioclase feldspars are conspicuously zoned and have been partly replaced by epidote and a fine-grained aggregrate of granular quartz. The biotite is partly altered to chlorite.

The porphyritic quartz monzonite consists of elliptical grains of feldspar and quartz about the same size as those in the coarse-grained quartz monzonite, set in a fine- to medium-grained groundmass.

The fine-grained quartz monzonite contains less plagioclase than the coarser varieties. It is an even-grained rock in which the minerals average 1 to 2 mm. It crops out as an irregular body in the hills just west of the Lake Mathews reservoir, and also along the east side of the map area (fig. 2). The position of the outcrops strongly suggests that it is the upper part of the Cajalco quartz mass described as monzonite by Dudley. 8/. However, dikes resembling this rock and also the porphyritic variety cut the coarse-grained quartz monzonite.

Aplite and pegmatite.

Irregular masses of aplite and pegmatite are exposed near the contact between the dacite porphyry and coarse-grained quartz monzonite in secs. 3 and 10, T. 4 S., R. 6 W. The largest of these is about 400 feet long and may be as much as 250 feet wide. Narrow dikes of aplite cut all varieties of the quartz monzonite, the dacite porphyry, and the metamorphic rocks. The larger aplitic masses include irregular segregations of pegmatite, in which quartz and feldspar crystals range up to 2 or 3 inches in size. The aplite in most places is a sugary, fine-grained, pink to brown rock composed of feldspar (55 percent), quartz (40 percent), and biotite (5 percent). Some of the aplite dikes appear to grade into fine-grained or porphyritic monzonite and others grade into pegmatite.

8/ Dudley, P. H. and Sampson, R. J., op. cit., pp. 502-503.

Monzonite porphyry

A lenticular body of monzonite porphyry, about 1,000 feet long and 400 feet wide is exposed in the western edge of the Black Rocks area (fig. 4). It is a light gray, very coarse-grained rock composed chiefly of feldspar phenocrysts up to 1 inch long, in a fine-grained matrix containing ferro-magnesian minerals and scattered grains of epidote. An inclusion of coarse-grained quartz monzonite was found in a boulder of this porphyry and at one place aplite appears to intrude it.

Trachyte porphyry

Trachyte porphyry dikes as much as 6 feet wide occur northeast of the Cajalco mine (fig. 3), and one of them follows and cuts vein No. 5 (fig. 3). These rocks are dark grey to greenish-black, finely banded and consist of phenocrysts of white feldspar up to 1/4 inch long in an aphanitic matrix.

Surficial deposits.

Unconsolidated sedimentary material that obscures the bedrock is found in numerous places west and south of Lake Mathews. Placer deposits of cassiterite, rather significantly, are conspicuously absent. West of Lake Mathews the lower parts of the valleys contain remnants, up to a dozen feet thick, of poorly sorted, obscurely bedded arkosic material that apparently represent stream deposits. These, for the most part, have been removed by recent erosion along the main drainage lines.

South of Lake Mathews, well-sorted sands and gravels apparently underlie large flat areas. South and east of the Black Rocks these sediments are very thick, and appear to represent a deltaic deposit the top of which is at an altitude of about 1,540 feet. On the southwest side of the Black Rocks map area, in secs. 13 and 24, T. 4 S., R. 6 W., a shingled beach gravel occurs at an altitude of about 1,400 feet, and gravels containing numerous boulders of vein material are widespread at or below this altitude. These deposits which may be of Pleistocene age or older have been partly reworked by recent streams.

Structural features

The rocks of the Elsinore metamorphic series strike N. 65° - 75° W. and dip 70° - 80° NE toward the quartz monzonite which was intruded into them. Exposures of these rocks are poor, and structural details could not be mapped, but local variations in structure were seen. The contact of the coarse-grained quartz monzonite dips steeply westward under the metamorphic rocks, and seems to flatten to 35° to 55° under the dacite porphyry (fig. 2). The coarse-grained quartz monzonite also appears to dip eastward under the fine-grained quartz monzonite on the eastern side of the Black Rocks area and on the hills north and west of Lake Mathews. The small patch of metamorphic rocks surrounded by quartz monzonite in sec. 13 of the Black Rocks area appears to be a roof pendant. Predominance of fragments of metamorphic rock in the tourmaline breccia in sec. 24 suggests that the Elsinore metamorphic series may be near the surface there.

The tin-bearing deposits occupy well-defined fractures or systems of fractures which consist of closely spaced small en echelon fractures. Many of the

fracture zones can be traced for several hundred feet by the tourmaline in them. Movement along the fractures has probably been slight, for they pass through basic inclusions and aplite dikes without apparent displacement.

The main vein systems are not all parallel, and the dips of the veins vary from place to place. Most of the veins occur in the coarse-grained quartz monzonite in a belt, up to 2,400 feet wide, which extends from the SE¼ sec. 19, T. 4 S., R. 5 W. northwestward to the SW¼ sec. 2, T. 4 S., R. 6 W. Beyond Cajalco Hill, the major veins in quartz monzonite trend northeast over the entire area, though they range in strike from about N. 20° E. to N. 50° E., and dip 50° to 85° NW. The veins in the Black Rocks area in general strike parallel to those west of Lake Mathews, but they dip southeast. The veins in secs. 13 and 18 strike about N. 30° E. and dip about 60° SE. Two systems of fractures, both dipping 60° - 80° SE., are apparent in sec. 19; one system strikes N. 40° E. and the other strikes N. 60° E., and there are several pipelike masses of tourmaline breccia. The veins in dacite porphyry southwest of the Cajalco mine show wider divergence in attitude; some of the larger ones strike N. 35° - 40° E., and dip 65° - 75° NW, but most of them strike nearly north and dip 50° - 70° W. Minor cross-fractures intersect many of the larger veins at various angles, apparently without any system.

TIN-BEARING VEINS AND PIPES

Tin, in the mineral cassiterite and possibly also chemically combined in tourmaline, is associated with veins and pipe-like masses of tourmaline-quartz rock, principally in the coarse-grained quartz monzonite. Although veins cut the other rocks, they are narrow and discontinuous, particularly in the fine-grained quartz monzonite. The only minable ore shoot found in the district was in the Cajalco vein, and except for a few pillars it has been stoped out. Assays of samples from almost any of the veins show 0.03 to 0.1 percent tin, but samples assaying more than 0.1 percent have been found in very few places except the Cajalco Mine.

Four varieties of tourmaline-bearing rock have been recognized and distinguished in the mapping; mottled, porphyritic, fine-grained, and tourmaline breccia. The mottled tourmaline rock is pink, white, grey, or black, depending on the proportions of tourmaline, feldspar, and quartz, and containing radiating clusters or small felt-like masses of tourmaline which have replaced the feldspar. The porphyritic tourmaline rock is characterized by large elliptical quartz grains in a black glassy matrix of fine-grained tourmaline and quartz. The fine-grained tourmaline rock is composed almost entirely of minute black tourmaline needles. The tourmaline breccia consists of angular or rounded fragments of mottled or porphyritic tourmaline rock in a matrix of fine-grained tourmaline. Although some contacts between the varieties are well defined, in most places the different varieties intergrade.

Form, size and structure

The tourmaline rocks of possible economic interest are restricted to veins and blowouts, and tin has been mined only from two shoots in the Cajalco vein. Although the Cajalco vein has been explored continuously over a length of 1,000 feet, and the system which comprises veins No. 7 and 8 is about 4,800 feet long,

most of the veins are 1,000 feet or less in length and are discontinous. The veins are very irregular, for two reasons: (1) they were formed along irregular fractures, and (2) replacement of the country rock was very erratic. The average width of the veins, including spotted tourmaline rock and silicified rock, probably averages 1 - 2 feet, although some of the veins are 6 feet wide, and in places a few are 15 - 20 feet wide. The Cajalco vein was followed to a depth of 690 feet, and was not bottomed; it therefore seems likely that the other veins extend to considerable depths.

The veins are commonly zoned or banded from the center outward. Most veins a foot or so wide are made up entirely of mottled tourmaline rock or silicified rock which represents partly replaced country rock. In the wider parts of the veins where mineralization was more intense and replacement was more complete, the center of the vein is occupied by a streak of fine-grained tourmaline a few inches wide. The fine-grained tourmaline grades into the mottled or porphyritic rock, and never forms more than a small fraction of the entire vein width. In the east end of No. 2 stope of the Cajalco mine, for example, the hanging wall split of the vein is about $5\frac{1}{2}$ feet wide, and the fine-grained tourmaline, which contains the only visible cassiterite, is about 6 inches wide. In a few places white quartz occupies the center of the veins. The veins widen at intersections with cross fractures to form masses similar to blowouts, and a close genetic relation between veins and blowouts seems indisputable. Bryant indicated that the Cajalco vein runs into the Cajalco Hill blowout in the lower levels of the Cajalco mine.

The tourmaline rock pipes or blowouts are irregular pipe-like masses which are known to range in size up to 500 to 600 feet across and some of those which are partly covered may be considerably larger. The blowouts in the Black Rocks area appear to be made up largely of tourmaline breccia, but the Cajalco Hill blowout, as shown in plate 4, consists essentially of mottled and porphyritic tourmaline rock. The blowouts in the Black Rocks area consist of blocks of the old metamorphic rocks as well as of the quartz monzonite, in a matrix of fine-grained tourmaline. Some of the breccias in the vicinity of the Cajalco mine are believed to contain fragments of dacite porphyry.

The veins are clearly related to fractures, which for the most part are well defined, but the structural relations of the blowouts are not clear. Some of the smaller ones appear to be related to interesecting or converging fractures, but many of the larger ones, such as Cajalco Hill and North Black Rocks, apparently are not. The breccia pipes are regarded as probably of explosive origin, and the others appear to have been formed by solutions moving along minute fractures and joints. The borders of the Cajalco Hill blowout grade into quartz monzonite in a distance of a few inches, and the contacts appear to be essentially vertical where not faulted.

Mineralogy

Most of the tourmaline veins and pipes are composed essentially of tourmaline and quartz. The principal vein minerals are black tourmaline, quartz, dumortierite, muscovite, bastnäsite, and epidote, which are associated with quartz, feldspar, biotite, apatite, zircon, and hornblende derived from partly altered country rock. Cassiterite, mostly in very small grains, has been recognized in

hand specimens from veins No. 1, No. 2, and No. 8. and in heavy-liquid concentrates from a number of veins. Minute grains of cassiterite also have been observed in thin sections of vein material. Small quantities of chalcopyrite, pyrite, arsenopyrite, galena, sphalerite, magnetite, limonite, hematite, and malachite are also present. Copper is most abundant in the underground workings of vein No. 5, according to assays made by the American Tin Corporation, and galena and sphalerite were observed only in the vein prospected by adit No. 46. Arsenopyrite was observed in vein material on the Cajalco mine dump and from veins in the dacite porphyry.

Cassiterite.-- The cassiterite is chocolate-brown to red-brown in hand specimen. Specimens of high-grade ore collected by Thayer from pillars in the No. 2 stope of the Cajalco mine, show clusters of grains and crystals which are a millimeter or less in size, scattered through a fine-grained, felted mass of tourmaline crystals. Many of the cassiterite grains are clustered around small vugs into which they project as euhedral crystals. Thin sections show these grains to be twinned and characterized by concentric zones which range from colorless to deep red-orange or yellowish-brown. Some of the cassiterite appears interstitial to the tourmaline and some occurs as small crystals along the edges of quartz grains. Magnetite is interstitial to cassiterite and tourmaline. Some specimens, probably from vein No. 2, show brecciated cassiterite and tourmaline cemented by epidote and quartz. In these specimens, Miss Glass found cassiterite crystals penetrated by tourmaline crystals which themselves were cut by veinlets of cassiterite, suggesting over-lapping periods of deposition of the two minerals. Bell tentatively identified fluorite and axinite associated with cassiterite as inclusions in quartz. Quartz is not abundant in cassiterite-rich parts of the vein.

Tourmaline.-- Tourmaline is the most abundant vein mineral. Although it appears black in hand specimens, in thin section it is commonly zoned and may be colorless, blue-black, indigo, brown, green, blue-green, or greenish-brown. Miss Glass determined the refractive index of the extraordinary ray (E) as ranging from 1.60 to 1.655. Individual crystals are rarely over 3 mm. in length. The mineral usually occurs as a felted mass of crystals with interstitial quartz, but in some veins radiating needles form spherical masses up to $\frac{1}{2}$ inch in diameter. The tourmaline replaces all the original minerals of the wall rocks, and much of it is earlier than the cassiterite and other vein minerals.

Epidote.-- An iron-poor variety of epidote is common in the veins, and is most abundant in those veins that cut inclusions of diabase, diorite, or gabbro. It is apparently later than the tourmaline and probably formed as a result of the alteration of feldspars and other calcic minerals. Veinlets of iron-rich epidote cross the tourmaline-quartz-cassiterite veins and are in turn cut by veinlets of white quartz.

Dumortierite.-- Dumortierite was found in some of the veins southwest of Cajalco Hill, in veins northeast of Black Rocks, and is a prominent constituent of a vein which is well exposed in the road cut just north of the dam across Cajalco Canyon, in the NW$\frac{1}{4}$ sec. 12. This vein is well banded, with a central core of quartz surrounded by dense black tourmaline rock which grades into mottled tourmaline rock containing dumortierite. The parts of the vein richest in

dumortierite are pink to lavender. Miss Glass determined the refractive indices of the dumoritierite to be α= 1.676, β= 1.694, and γ= 1.698. The tourmaline associated with this mineral is blue-black, lavender, or pale yellow in thin section. The dumortierite occurs only in the wall rocks, and was not found in the central parts of veins.

Wall Rock alteration.

The veins and blowouts alike seem to have been formed by processes of replacement in which tourmalinization, saussuritization, and silicification were most important. The hydrothermal solutions which introduced the vein-forming minerals along the fractures penetrated the wall rocks for considerable distances, for alteration may extend several feet beyond the walls of fractures less than one-fourth of an inch wide, and breccia fragments several feet across commonly are almost completely tourmalinized. In some of the pipes the channelways for solutions are obscure.

Tourmalinization:— Tourmalinization is the most prominent wall rock alteration. The degree of alteration differs not only from vein to vein, but also within a single vein. Most veins show small scattered tourmaline aggregates which decrease in number from the fracture outward into the walls. Plagioclase appears to be replaced first, then potash feldspar and, finally, quartz; the texture of the host rock is preserved until all minerals have been replaced. Although quartz probably was deposited shortly after the earliest tourmaline, silicification appears to be dominant only where the feldspars were completely tourmalinized. The mottled tourmaline rock represents the early stages in the replacement process, the porphyritic rock represents the stage at which all but quartz had been replaced, and the fine-grained tourmaline appears to be the end product. Most of the porphyritic tourmaline rock was probably derived from coarse-grained quartz monzonite.

Silicification:— Deposition of quartz accompanied tourmalinization in most places after introduction of the early tourmaline and before deposition of the last tourmaline. Fine-grained aggregates and wormy intergrowths of late quartz replace the feldspars and original quartz and fill the spaces between tourmaline crystals. As a result the host rocks and earlier loose-textured tourmaline rock are changed to hard, grey, glassy rocks. In the Black Rocks area part of the quartz monzonite has been silicified but not tourmalinized. Two veins near the west edge of SE¼ sec. 2, show silicification only, and the vein material resembles white, fine-grained pebble quartzite. The feldspars were completely replaced by a fine-grained granular aggregate of quartz and sericite which surrounds the rounded quartz grains of the original quartz monzonite. The walls of the vein grade into unaltered coarse-grained quartz monzonite.

Saussuritization:— Alteration of the plagioclase in the rock bordering the veins to epidote is best shown where the veins cut basic inclusions. The plagioclase of the quartz monzonite commonly is partly replaced by low-iron epidote, and the rock takes on a bleached appearance, being greenish, buff or dull white. In the basic rocks the epidote is much richer in iron, and in epidote commonly forms veins which cut across and replace the tourmaline-rich vein material. The iron-rich epidote clearly is later than the tourmaline and cassiterite.

Origin

The systematic distribution of the tin-bearing rocks in the Temescal district shows clearly that they were localized along fractures or in brecciated portions of the quartz monzonite and older rocks. The gradational relations of the several varieties of tourmaline rock with each other and with the various country rocks is good evidence that replacement had a dominant part in the process of vein formation, and only a very small part of the vein material shows definite evidence of deposition in open fractures. Although some of the fine-grained tourmaline rock may have been deposited as vein filling, most of it appears to be the end product of the replacement process. The concentration of cassiterite around minute cavities and as veinlets in the tourmaline rock shows that it was formed later than much of the tourmaline, although some tourmaline followed the cassiterite in specimens from the Cajalco mine adds emphasis to the importance of replacement in the process of vein formation.

The deposits are believed to have been formed at great depth soon after the quartz monzonite had crystallized and while it was still very hot, for the association of cassiterite with tourmaline, arsenopyrite, and dumortierite is characteristic of deposits formed under high temperature and pressure. The restriction of the main veins to the coarse-grained quartz monzonite also is evidence that the principal deposition occurred before the vein-bearing emanations reached the cooler rocks surrounding the quartz monzonite.

RESERVES AND GRADE OF TIN BEARING ROCK

Grade of the deposits and recoverability of the tin

The veins in the Temescal district have been thoroughly sampled and their grade is accurately known. The American Tin Corporation collected and assayed thousands of samples; a large proportion of them showed 0.03 to 0.1 percent of tin, a few showed more than 0.5 percent tin, and many were reported as barren. Where assays of 0.5 percent or more were obtained the veins were explored by underground workings, with uniformly discouraging results. Their assays indicate that the average grade of the vein material is between 0.03 and 0.05 percent, or 0.6 to 1 pound of tin per short ton. The results obtained by other private companies and engineers are comparable. The ore mined in the Cajalco vein is said to have averaged about 2 percent tin.

In 1943 the Metals Reserve Company, acting through Dodge Construction, Inc., of Fallon, Nevada, mined and milled about 1,400 tons of tin-bearing rock. The samples consisted of 14 lots of about 100 tons each, from trenches laid out essentially in accordance with recommendations by Bryant, as follows: eleven from various parts of the Cajalco Hill blowout, two from veins Nos. 4 and 5, and one from the blowout on the NW¼ sec. 18, T. 4 S., R. 5 W. The geology of the areas sampled was mapped in detail by T. P. Thayer of the Geological Survey at the request of the Metals Reserve Company (see figs. 5, 6, 7). As the following table shows, the samples represent all the principal types of tin-bearing rock. During the mill tests some of the samples were ground finer than others, and all were concentrated on Deister tables. The company assayer found traces of tin in a few samples, and could find no appreciable difference between the grade of heads

and concentrates. Three samples were analyzed spectrographically in the Geological Survey laboratory with the following results, in percent Sn:

Lot No.	Heads	Middlings	Concentrates
4	0.007	0.01	0.02
6	0.005	0.007	0.01
11	0.006	0.01	0.02

Superpanner tests of screened fractions of the mill products from samples T-2, T-3, and B-7 showed fewer grains of cassiterite in the plus 100 mesh material than in the finer sizes, and the proportion of visible cassiterite in all fractions was very small. Similar tests on tailings from the old mill showed abundant cassiterite grains averaging about 0.02 mm in the minus-200 mesh fraction.

The apparent wide distribution of small quantities of tin in the veins of the district led the Geological Survey to a program of detailed sampling of all the types of vein material and wall rock. In all, 116 samples, some from specimens and from channels, were examined petrographically. From the crushed smaples, 100 gram fractions were taken with a Jones splitter and these fractions were screened. The minus-80 plus-200 mesh material was separated in bromoform (sp. gr. 2.8), and the heavy fraction was separated again in methylene iodide (sp. gr. 3.3). The heavy minerals were separated magnetically, and part of the non-magnetic fraction (about 0.008 g.) taken cut with a Jones-type microsplit was mounted in balsam for petrographic examination.

Cassiterite was identified in 55 of 113 samples prepared in this manner, but none of the slides contained cassiterite equivalent to 0.01 percent tin in the original sample. The results of this work are given in table 2. Concentrates and minus-200 mesh fractions of several samples analyzed by Charles Bentley at the South Dakota School of Mines, Mining Experiment Station, were found to contain only traces of tin -- less than 0.05 percent. Qualitative spectrographic analyses were made of 25 samples, including 9 used in the heavy mineral study, with the results shown in table 3. The analyses, made by M. F. Hasler of the Applied Research Laboratories, Los Angeles, show a range in tin content from 0.04 to 0.25 percent.

Comparison of heavy mineral studies of samples P35, P47, and P48, with spectrographic and chemical analyses suggests that part of the tin may be contained in minerals other than cassiterite. Microscopic examination of grain mounts of the plus-200 mesh fraction of the concentrates revealed only one grain of cassiterite in each, equivalent to less than 0.01 percent tin. The spectrographic analyses of the whole samples, however, indicate 0.08 to 0.25 percent tin. The failure to concentrate the tin in the heavy fractions may be explained in two ways: (1) the tin is chemically combined with the tourmaline, or (2) it is in fine-grained cassiterite which is so intimately intergrown with the tourmaline that it cannot be effectively separated, even with heavy solutions. In view of the impossibility of sampling the veins quantitatively by thin sections, the problem of distribution of the tin where it is present only in small quantities must remain unanswered for the present, but it is obvious that separation of most of the tin from average tourmaline rock is not economically feasible.

The absence of placer deposits of cassiterite in the district is a general confirmation of all the sampling programs. If moderately coarse-grained cassiterite occurred in appreciable quantities in the veins, placers of economic interest would almost certainly have been formed.

Size and localization of ore shoots

The only known minable ore in the Temescal district occurred in two shoots in the Cajalco mine. Maps of the mine (figs. 10 & 11) indicate that the shoots were about 70 and 160 feet, respectively, in strike length, and the larger one had a dip length of about 240 feet. The stopes were inaccessible when most of the Geological Survey mapping was done, but Thayer was able to get into stope No. 2 during the Metals Reserve Company milling tests. He collected some samples of high-grade ore, and made the following observations regarding ore left in the pillars:

"Specimens of high-grade cassiterite were obtained from the smaller of the two pillars shown on Bryant's map in stope No. 2 at the first level. The high-grade streak of coarse-grained cassiterite is 5 to 6 inches wide and was traced about 3 feet down the dip. It is 1 - 1.5 feet from the hanging wall of the vein, which here consists of two splits, the hanging wall split being somewhat over 4 feet wide. The cassiterite is in dense black tourmaline rock which contains scattered clusters of quartz grains and grades into mottled tourmaline-quartz rock along the edge of the vein. The cassiterite lens lies at a slight angle to the main vein, so that the lower end impinges against the mottled rock. Specimens from the lower end show euhedral cassiterite replacing the large quartz grains in the mottled rock. The cassiterite grains are irregularly disseminated and show no evidence of having been deposited along a fracture. Two similar masses of cassiterite an inch or two across were found elsewhere on the same pillar, also in the dense tourmaline rock. The coarser cassiterite commonly forms crystals lining minute cavities, in some of which slender tourmaline needles have grown on the cassiterite.

"Four facts seem clear: (1) the high-grade ore is localized in or near the dense all-tourmaline portion of the vein; (2) the cassiterite is disseminated in the tourmaline rock and was not localized along fractures; (3) cassiterite has replaced the original quartz grains; and (4) it is older than the last tourmaline. The scattered clusters of quartz grains in the tourmaline facies are regarded as incompletely replaced remnants of country rock quartz monzonite. It seems probable that the cassiterite was emplaced simultaneously with the tourmaline where mineralization was most intense, and that the dense tourmaline rock itself was formed by replacement.

"The genetic relation between disseminated cassiterite and that deposited along fractures in tourmaline rock found on the old dump is not known, but it probably is very close. The writer is inclined to believe that the amount of disseminated cassiterite probably far exceeds that deposited along fissures as fillings."

Efforts to find other ore shoots have been unsuccessful, as all concentrations of high-grade material explored by the American Tin Corporation were found to be very small. The factors controlling concentration of the cassiterite are therefore very imperfectly known.

Most of the cassiterite is disseminated in the velvety fine-grained tourmaline which occupies the center of some of the veins. The richest concentrations are in the wider parts of the veins, but they may be scattered anywhere in those parts, and in the absence of obvious structural controls, would be hard to find. The wide parts of veins at intersections with minor fractures do not appear to be especially promising, for they closely resemble the pipes, which have been shown to be essentially barren. Some of the more promising parts of the veins appear to be in northward bends, but the evidence for using this as a guide in the search for ore is meager.

Future of the District

The geologic monotony of the veins over an area of several square miles and a vertical range of 400-500 feet shows that the conditions under which the tin-bearing deposits were formed were not conducive to rapid changes in the character of the veins, and the potentialities of the district as a producer of tin may therefore best be judged by the available surface and underground exposures of the veins.

The lack of minable ore shoots exposed at the surface, despite the thousands of linear feet of exposed veins, is not conducive to optimism about the future of the district. Ore shoots, to be of commercial size in veins of the width encountered in the Cajalco mine, would have to be hundreds of feet in length and depth, and if many were present within reasonable distances of the surface, a few might be expected to crop out. The lack of exposed ore bodies, shown by consistenly low assay values of the veins, and the absence of placer deposits may be interpreted in two ways: (1) the entire vein system is very poor in tin; or (2) the main zone of tin deposits has not yet been reached by erosion and underground exploration. Hope for the district obviously lies in the second alternative.

Tin-bearing quartz-tourmaline veins, where mined elsewhere in the world, have been found to persist through vertical ranges of hundreds or thousands of feet, and the Temescal veins probably also persist downward for long distances. The Cajalco mine workings, however, show that the veins pinch and swell downward as they do horizontally; it would appear, therefore, that the character of the veins does not change appreciably within a few hundred feet of the surface.

The geological structure of the district indicates that the veins now exposed at the surface represent a much greater geological range than the surface exposures would suggest. Since the veins are genetically related to the quartz monzonite, their distance from the original surface of the quartz monzonite mass, rather than their present topographic position, is the controlling factor in predicting their behaviour at depth. The distance erosion has cut into the quartz monzonite cannot be accurately measured, but it may be several thousand feet, for the contacts dip 30° or more under the older rocks, and the quartz monzonite is exposed over a width of two miles in the vicinity of the Cajalco mine 9/. If the contact with the dacite porphyry west of the Cajalco mine be projected eastward at an angle of 45°, the average dip of the contact, it would pass about 2,000

9/ Dudley, P. H., and Sampson, R. J., op. cit., map facing p. 506.

feet above the mine, and would be much higher above the veins to the east. Even if the contact were assumed to flatten toward the east in a broad arch, it would pass many hundred feet above the mine. The contact with the old metamorphic rocks dips much more steeply, and some of the rocks exposed in the Black Rocks area may be much farther below the original surface of the quartz monzonite. It seems probable, therefore, that the veins in the dacite porphyry and near the margins of the quartz monzonite were formed many hundreds or thousands of feet higher in the quartz monzonite than those exposed in the central parts of the mass. The uniformity of the veins, accordingly, is regarded as evidence that they probably will not materially improve in grade with depth.

All the available evidence, geological and otherwise, indicates that although the tourmaline-quartz veins of the Temescal district consistently carry small amounts of tin, the veins are not likely to improve in grade with depth, and their economic possibilities are accurately indicated by the present exposures. The probability of finding minable ore bodies by underground exploration is believed to be slight.

Mines and Prospects

The following description of individual mines and prospects is based on surface mapping by the Geological Survey. Only adit No. 3 and adit No. 9 were accessible at the time the work was done, and information furnished by Mr. George Bryant was used in describing the other underground workings. American Tin Corporation assays and vein widths have been used, except where noted.

Cajalco or No. 1 Vein

(Cajalco mine)

The Cajalco mine is in the NW¼, SW¼, of sec. 2, T. 4 S., R. 6 E, on the Cajalco or No. 1 vein. The workings consist of an adit at an altitude of 1,159 feet*, a vertical shaft (the Robinson) now caved, an inclined shaft (the Williams or No. 1) that extends to a vertical depth of 540 feet, a raise to the surface from stope No. 1, and more than 5,800 feet of drifts and crosscuts on seven levels. The extent of workings on different levels and the range in thickness of vein are shown in table XX, compiled from maps by Bryant.

Table XX. Length of workings and thickness of vein in the Cajalco mine

Level	Altitude	Extent of workings (in feet) Drifts	Cross cuts	Thickness of vein (feet and inches)
1	1,150	480	40	2 in. - 5 ft.6 in.
2	1,080	735	185	2 in. - 4 ft.6 in.
3	1,030	880	780	
4	990	135	40	8 in. - 4 ft.
5	905	425	20	6 in. - 4 ft.2 in.
6	830	880	130	1 in. - 5 ft.10 in.
7½	690	360	735	
		3,895	1,930	

* Bryant's map shows an altitude of 1,150 feet. Geological Survey altitudes are based on altitude of Cajalco dam of Metropolitan Water district.

On the surface, vein material is exposed discontinuously over a length of 550 feet, and ranges in thickness up to 5 feet. The vein is 5 feet thick at the Robinson shaft, pinches out at the road, is 1 foot thick at the portal of the No.1 adit, farther northeast ranges from a few inches to 5 feet, is 2.5 to 3 feet thick at the Williams shaft, and pinches out a few feet beyond. It is composed mainly of mottled tourmaline rock, with a narrow band of black tourmaline in the center. Surface samples taken by the American Tin Corporation assayed 0.08 to 0.20 percent of tin. In the workings of the Cajalco mine, the vein seems to have about the same range in thickness.

In spite of all the workings in the Cajalco vein, only 2 small shoots of ore were discovered, and both of these were above the third level. The larger ore body was removed in No. 2 stope, which had a strike length of about 70 feet and a pitch length of 240 feet. The No. 1 stope had a strike length of 160 feet, and was mostly between levels 1 and 2. The average grade of the ore removed was approximately 2 percent of tin. Samples cut from the walls of these stopes showed commercial ore in only a few places. The remainder of the vein, exposed in thousands of feet of drifts, contains no commericial ore, and the average grade is less than 0.15 percent of tin.

When the mine was partially dewatered in 1943, Thayer examined stope No. 2, and made the following observations. The eastern edge of No. 2 ore body lensed out rapidly. Although the footwall split of the vein is 5.5 feet wide, including 6 to 8 inches of dense tourmaline rock, at the east edge of the stope at the first level, it pinches out completely 50 to 55 feet east in the drift. The hanging wall split, though 3 to 4 feet wide in the edge of the stope, does not extend to the short crosscut 10 feet farther east. Fifteen feet below the floor of level No. 1 the vein pinches from 5.5 feet to 6 inches in a strike distance of 6 feet, partly as a result of minor faulting.

Other workings connected with vein No. 1 include the No. 3 tunnel (fig. 10), 275 feet long, in the pipe called the Cajalco Hill "blowout". This adit is in various types of tourmaline rock cut by a fault zone. Samples taken by the Survey contained only traces of tin (samples TDL-22C to 29C; 40, table 2) though the American Tin Corporation obtained assays of as much as 0.10 percent of tin. The Metals Reserve Company's sampling of the surface of this "blowout" indicated a grade of less than 0.01 percent of tin.

A 50-foot vertical shaft, No. 4, 180 feet south of Shaft No. 1, is on a small vein that may connect with the Cajalco Hill pipe at adit No. 3.

East of the No. 1 shaft, the Cajalco vein pinches out, but another group of veins striking in a more easterly direction and dipping 50 to 55° NW continues for another 600 feet. These are exposed in inclined shaft No. 3 and in a number of trenches.

Vein No. 2

Vein No. 2, 380 feet southeast from Shaft No. 1 (see fig. 3), is opened by 2 inclined shafts 150 feet apart. Shaft No. 5 is 100 feet deep on a 70 degree incline, and from the 85 foot point, it is connected by a drift with

with the bottom of Shaft 6, and by a crosscut with Shaft No. 4 on a different vein. Crosscuts driven south from the Cajalco mine exposed what was believed to be same vein on the No. 3 level and the No. 7½ level. On the No. 3 level (equivalent to 185 Level of Shaft No. 5) drifts in No. 2 vein were extended 125 feet SW and 300 feet NE of the crosscut. The dip of the vein decreased from 70 degrees above the 50-foot level to 53 degrees between the 185- and 520-foot levels.

On the surface, vein No. 2 consists of three lenses connected by thin tourmaline stringers, and appears to feather out about 50 feet southwest of shaft No. 5. The vein strikes No. 50° - 55° E. and dips 65° - 70° NW. At shaft No. 5 it is cut by a normal fault of a few inches displacement that strikes N. 40° E. and dips 60° SE. At shaft No. 6 a normal fault, with 2 feet of vertical displacement, strikes east and dips 65° S. The vein is 2 feet thick at the west edge of shaft No. 5, but narrows abruptly in both directions; the average is about 8 inches. The vein appears to have been brecciated during mineralization and numerous epidote veins cut the tourmaline rock. Silicification is unusually strong; the lenses of fine-grained tourmaline in the center of the vein are very discontinuous and less than 3 inches thick. These pods probably furnished the high grade ore that was mined in 1929 from a pit 50 feet long by 10 feet deep, just northeast of shaft No. 6.

The weighted average of 46 samples taken by the American Tin Corporation on the 50-foot level excluding those mentioned below, was 0.12 percent of tin over a 16-inch width. Three assays showed 1 to 2 percent tin near the shafts and 1 percent at one spot on the 50-foot level. A specimen representing 2 inches of the vein assayed 67.87 percent and a 4-inch sample 4.96 percent. On the 185-foot level, southwest of the crosscut, the vein has an average width of 12 inches and 23 assays are said to have averaged 0.10 percent tin. Northeast of the crosscut the vein was said to be 6 inches thick and 40 samples averaged 0.06 percent of tin. On the 520-foot level the vein was 34 inches thick and assayed 0.08 to 0.10 percent of tin and 0.8 percent of copper (as chalcopyrite).

About 1,200 feet southwest of and in line with, vein No. 2 are two veins which have been exposed by stripping for 200 to 400 feet along the strike. These have been assumed to be part of vein No. 2, and likewise the veins 800 feet to the northeast have been assumed to be part of the same system. Geological Survey samples (P4 and P5) from these veins contained traces of cassiterite.

Vein No. 3

Vein No. 3, 210 feet southwest of vein No. 2, is exposed intermittently for 750 feet; about 370 feet was stripped and it was crossed by two trenches. Shaft No. 7 80 to 100 feet deep on a 65 degree incline, prospects the vein about 50 feet from its southwest end. The vein is also cut, at the 500-foot level, by the crosscut from the No. 7½ level of the Cajalco mine.

On the southwest side of the shaft the vein strikes N. 50° E. and dips 72° NW and on the northeast side it strikes N. 60° E and dips 60° NW. It is cut by a gouge zone that strikes N, 65° E and dips 65° NW. At the shaft the hanging wall

of the vein is aplite and the footwall is coarse-grained quartz monzonite. Southwest of the shaft, the vein consists of 6 to 18 inches of brecciated fine- to coarse-grained mottled tourmaline rock with a one to 3-inch fine-grained tourmaline rock with a one to 3-inch fine-grained tourmaline center, and appears to be faulted off. Northeast of the shaft the 12- to 30-inch vein lenses out within 20 feet and another starts 3 feet to the south. This strikes N. 47° E. and is largely brecciated fine, glassy, tourmaline rock and is up to 4 feet thick.

Of 21 assays from surface samples of this vein half contained no tin, and the others 0.05 to 0.29 percent of tin. The weighted averages of these showed 0.10 percent of tin over an average width of 16 inches. Four samples in the upper 80 feet of the shaft showed 0.08 to 0.18 percent of tin over 20-to 30-inch widths and at the 500-foot level the vein assayed 0.08 percent of tin over 38 inches.

About 1,000 feet to the northeast there is a group of small veins, one of which may be an extension of the No. 3 vein structure. Southwest of shaft No. 7, 1,100 to 1,400 feet and 2,050 to 2,350 feet, veins which may be part of the same vein structure have been prospected by trenches. The vein segment from 1,100 to 1,400 feet southwest of the shaft is 6 to 30 inches thick, and averages about 12 inches.

Assays ranged from nothing to 0.15 percent of tin. The other vein is 2 to 6 feet thick, and seven assays spaced over 300 feet of strike length averaged 0.23 percent of tin over an average width of 15 inches. Individual assays ranged from 0.05 to 0.40 percent.

Veins No. 4 and No. 5

Vein No. 4 extends 950 feet northeastward from a point about 250 feet southeast of Shaft No. 7 (Fig. 3); it crops out again 250 feet to the northeast for a distance of 700 feet. The southwest part of the vein consists of a series of overlapping and interlocking vein segments, individually as much as 15 feet wide, which have been exposed by stripping and by a series of cross trenches. This part of the vein is exposed underground in Shaft No. 12.

On the surface, southwest of Shaft No. 12, Vein No. 4 includes a group of mottled tourmaline veins of irregular strike and dip. Fine-grained tourmaline in the center of these veins is as much as 3 inches thick. The quartz monzonite walls and the vein itself contain abundant epidote probably derived from the numerous basic inclusions which occur in the area. Northeast of the shaft, the veins are more sharply defined although they commonly pinch and swell. In places the mottled tourmaline rock is 15 feet wide, but the fine-grained centers are at most only a few inches wide. Assays of samples taken from the surface on this southwestern part of Vein No. 4 gave the following results:

Southwest of shaft 12 - 0.05 - 0.10 percent tin
1 sample (30" width) - 1.10-1.73% copper

Near the collar of shaft No. 12 - 1.90 percent tin) 24 inch
1.75 percent tin) widths.

Northeast of shaft No. 12 - 1 sample - 0.0 percent tin
3 samples - 0.25 percent tin
2 samples - 0.10 percent tin
1 sample - 0.08 percent tin
1 sample - 0.05 percent tin

Underground, the vein is reported to be from 4 to 24 inches wide. The weighted average of assays of 40 samples was 0.008 percent tin, 4.0 percent copper, 4.0 oz. silver, and 0.05 oz. gold over an average width of 12 inches. Individual assays showed as much as 0.15 percent tin, 8.2 percent copper, and 7.6 oz. of silver. Samples from the shaft where it cut the vein showed from 0.0 to 0.15 percent tin over widths of 6 to 40 inches.

The northeast extension of Vein No. 4 is 6 inches to 3 feet wide. Near its southwest end, at Geological Survey sample P9, the vein is composed of radiating tourmaline needles in quartz monzonite. Fifteen samples across 6- to 40-inch widths showed 0.0 - 0.10 percent tin and Sample P9 contained traces of cassiterite.

Vein No. 5 has been prospected by trenches and by shaft No. 8 (fig. 9). The vein is one to four feet thick but has been split over most of its length by a 2- to 6-foot trachyte porphyry dike. Ten assays from the southwestern 800 feet of the vein show an average of 0.22 percent of tin over an average width of 28 inches. Near shaft No. 8 the vein is up to 3 of 4 feet thick and assayed 0.05 to 0.25 percent of tin over 24-inch widths, though some parts were barren. Samples in the shaft to a depth of 130 feet showed 6 to 36 inches of vein assaying 0.03 to 0.10 percent, and one sample was barren. On the surface the vein appears to contain widths of fine-grained tourmaline rock and malachite stains are common.

Near the common corner of secs. 2, 3, 10, and 11 (fig. 3) two groups of veins are designated as vein No. 5a and No. 5b; they are not extensions of veins No. 4 or 5. Vein No. 5a consists of two segments, each 300 feet long, in the southwest corner of section 2. The eastern segment has been stripped and is 1 to 11 feet wide. The western part, 3 feet thick, strikes N. 68° E. and dips 70° NW. for about 25 feet; widens abruptly to 7 feet for about 30 feet along a N. 25° E. direction; then changes strike to N. 55° E and widens to 11 feet; splits into two parts which rejoin 50 feet farther northeast; and continues with an average thickness of 18 inches to the end of the exposure. According to Bryant, of 40 samples taken across 12 to 60 inch widths, 5 assayed 0.05, 10 assayed 0.02 percent of tin and the rest were barren. A Geological Survey sample (P49) of the fine-grained glassy tourmaline in the wide part of the vein showed less than 0.001 percent of cassiterite in the heavy concentrates of the plus 200 mesh fraction. The western exposure of vein No. 5a has been explored by 6 cross trenches and is 1 to 4 feet thick.

Vein No. 5b, which lies about 200 feet southeast of No. 5a, is a series of en echelon lenses trending N. 50° E., which has been explored by 20 trenches in a distance of about 2,000 feet between the dacite porphyry-quartz monzonite contact and Mine creek. American Tin Corporation assays of samples from these veins show zero to 0.20 percent of tin over widths up to 36 inches. The vein consists mostly of mottled tourmaline rock and attains a width of 10 feet in places. Heavy concentrates of Geological Survey samples P42-48, inclusive,

yielded 2 grains or less of cassiterite per slide, indicating less than 0.001 percent of tin in the plus-200 mesh fraction of the sample. Qualitative spectrographic analyses of samples P47 and P48 showed 0.1 and 0.08 percent of tin respectively.

Vein No. 6

Vein No. 6 is about 520 feet southeast of vein No. 4 and includes a series of about 20 weak, discontinuous mineralized fractures that extend 4,000 feet northeast from the dacite porphyry contact. Although two of the mineralized areas are 30 to 40 feet wide, the individual veins are less than 300 feet long and the intervals between them are as much as 1,200 feet. The rock is mainly mottled tourmaline of which few American Tin Corporation samples assayed as much as 0.10 percent of tin. Workings in the veins consist of two 15-foot shafts and a number of trenches. One Geological Survey sample, P7, contained traces of cassiterite.

Veins No. 7 and No. 8

Veins No. 7 and 8 crop out about 1,950 and 2,150 feet respectively southeast of shaft No. 1. These discontinous vein structures are the strongest in the Cajalco mine area (fig. 3). They appear to converge in the NW. ¼, sec. 11, but a vein continues southwest and converges with vein No. 6 near the dacite porphyry contact. The total length of this structure is 4,800 feet and over at least half the distance there are two distinct veins. About 4,200 feet of the vein has been stripped and it appears to be discontinuous.

These veins are explored underground by shafts No. 13 and No. 14 on vein No. 8 and by adit No. 46 on vein No. 7 southeast of its convergence with vein No. 8. Shaft No. 13 inclined 60° NW., was started where samples 8 to 60 inches long assayed from 1 to 2.10 percent of tin. At 15 feet below the outcrop the vein assayed 1.16 percent over 20 inches and at 30 feet 0.32 percent of tin. Below this part of the vein all but one of the samples assayed less than 0.03 percent of tin. Geological Survey samples L30 to 36 were taken in the area of the high assays but only 4 showed traces of cassiterite. According to Bryant the vein is cut off by a slip that strikes N. 40° E. and dips 140° NW. at the 50-foot level. Shaft No. 13 is 80 feet deep with 50 feet of crosscut at the base. At the 50-foot level drifts were made 65 feet to the southwest and 58 feet to the northeast.

Shaft No. 14, 820 feet northeast, also was sunk in a high-grade cassiterite pod which was exposed in the pit southwest of the shaft. The shaft is 103 feet deep and slopes 78° NW. At the 70-foot level drifts extend about 53 feet to both the northeast and the southwest. In the shaft the vein pinches and swells as it passes quartz monzonite and basic inclusions. Samples taken by the American Tin Corporation from the pit at the surface contained from 0.28 to 1,94 percent of tin over widths of 6 to 26 inches; the weighted average of 8 samples is 0.73 percent for a 12-inch width. Eight samples from the upper 25 feet of the shaft contained between 0.26 and 0.75 percent of tin; the weighted average was 0.43 percent tin over a 14-inch average width. The average weighted assay of 23 samples along the drift on the 70-foot level is 0.13 percent of tin over an average width of 19 inches.

Adit No. 46 prospects vein No. 7 on the southwest side of Mine Creek. The adit follows the vein southwest for 330 feet and at 150 feet there are 75 feet of crosscuts. The vein dips 68° NW at the surface and is from 6 to 60 inches wide. Above the adit it crops out as two separate lenses that pinch out at either end. The vein is largely mottled tourmaline rock with a narrow center of fine-grained tourmaline, but southwest of the adit the center consists of loose-textured tourmaline, fine-grained white mica, and iron sulphides. Galena and sphalerite were picked up on the dump from this vein. With few exceptions, the American Tin Corporation samples contained less than 0.10 percent of tin. Two of the four Geological Survey samples showed less than 0.001 percent of cassiterite in the concentrates, but spectrographic analysis of P-11 showed 0.15 percent of tin.

About 760 feet east of adit No. 46 there are exposures of a vein that has, in the past, been incorrectly correlated with vein No. 8. These appear to be part of a two parallel vein structures, 30 to 150 feet apart, which can be traced intermittently to the dacite porphyry contact, about 2,600 feet southwest. The average grade of these exposures is probably about 0.03 percent of tin.

Veins No. 9 and No. 10

Veins No. 9 and No. 10 crop out southwest of, and above, adit No. 9 which is 2,300 feet southeast of adit No. 46. The two veins are parallel and about 50 feet apart. On surface vein No. 9 is exposed continuously for 400 feet and had been stripped for 325 feet. American Tin Corporation samples from the northern part of the stripped area assayed from 0.30 to 1.60 percent of tin.

Vein No. 10 crops out almost continuously from 180 to 900 feet southwest of the portal of adit No. 9 and has been stripped for 500 feet at its southwestern end. For 300 feet at the southwest end of the trench the vein consists of two splits. It ranges from 8 inches to 6 feet in thickness and shows a large proportion of fine-grained tourmaline rock. That part of the vein from 800 to 1,100 feet southwest of the adit portal is 12 to 100 inches wide. Samples taken by the American Tin Corporation assayed 0.10 to 0.35 percent of tin.

Adit No. 9 prospects this vein. The underground workings include 135 feet of crosscut to vein No. 10, along which a drift was driven for 475 feet. A 6 to 12-inch vein, intersected in the crosscut 32 feet east of vein No. 10, was explored to the southwest by a 20-foot drift. At 400 feet on the main drift, a crosscut was driven 175 feet to the northwest. This cut vein No. 9 at 50 feet, where it was 10 inches thick. Vein No. 10 is irregular in width and consists of a series of lenses that are brecciated by a group of small strike faults. The northeast end of the vein may have been faulted off. The vein rock is largely mottled tourmaline rock, though in the wider parts fine-grained tourmaline, up to 2 feet thick, forms the center of the vein. Most of the assays recorded by the American Tin Corporation along the underground workings are from 0.03 to 0.05 percent of tin, though a 60-foot section of the vein, 175 to 235 feet southwest of the north end of the vein, assayed from 0.10 to 0.18 percent of tin for 18 to 24 inch widths. Vein No. 9 was cut underground, just northeast and below the point where high assays were obtained on surface but on the adit level it assayed only 0.05 percent of tin.

Numerous veins east of No. 9 and No. 10 in sec. 11 have been sampled but most assays show little, if any, tin.

Veins North and West of Cajalco Hill

A group of veins crop out intermittently for about 1,000 feet northeast of a point 2,780 feet north of the corner of secs. 2, 3, 10, and 11. These are similar to others in the district but are more irregular in strike and dip. They are rarely over 1 foot in width and show less than 1 inch of fine tourmaline in the center of mottled tourmaline rock. The northeastern ones show an unusual type of silicification which results in a greenish glassy quartz-rich rock at the edges of the mottled tourmaline rock.

Just west of Cajalco hill a branching vein has been stripped for 250 feet and has been explored by a pit at its northern end (fig. 12). Geological Survey samples P2 and P18-22 showed less than 0.001 percent of cassiterite in heavy concentrates and P22 contained 0.20 percent of tin according to spectrographic analyses. About 520 feet west of this vein is a small exposure in which cassiterite was recognized in hand specimen. Geological Survey samples P23-25 failed to show appreciable cassiterite in concentrates. P23 contained less than 0.0001 percent of cassiterite in the heavy concentrates, but by spectographic analysis contained about 0.1 percent of tin.

About 450 feet south of the branching vein are two other vein exposures. The northernmost and branching vein contains dumortierite with tourmaline. The southernmost vein outcrop is brecciated and veined with epidote. Southwest and west of this exposure a number of short veins in the monzonite have been explored by trenches and one shallow shaft. Only a few of the American Tin Corporation's assays showed as much as 0.10 percent of tin in these outcrops.

Veins in the Dacite Porphyry

The dacite porphyry near the section line between sec. 3 and sec. 10 contains a number of tourmaline veins which strike from N. 20° W. to N. 40° E. and in general dip from 25 to 80 degrees to the west, though a few dip to the east. Ten of these veins have been partly stripped, and three veins have been prospected by two inclined shafts (No. 15 and No. 17) and one vertical shaft (No. 16). Of about 100 samples taken by the American Tin Corporation on these veins, all except 4 taken near incline No. 17, and 9 taken near incline No. 15, contained less than 0.08 percent of tin.

Shaft No. 15, which slopes 15 to 20 degrees to the northwest, is on a 3 to 6 foot vein which differs markedly from the other veins of the district. It is a rubbly-appearing light buff to greenish grey rock in which nodular masses of fine-grained grey tourmaline-arsenopyrite masses up to 6 inches or more in diameter are enclosed in a white to buff talcose and micaceous groundmass. According to Bryant's samples, 12 to 60 inches in width assayed 0.24 to 1.62 percent of tin. One 2-foot channel sample collected by the Geological Survey from the upper part of the vein on the west wall of the shaft at the portal assayed 0.32 percent tin according to Charles Bentley of Rapid City, South Dakota. Spectrographic analyses of samples P34, P34A, and P35 from this vein showed 0.1, 0.2, and 0.25 percent

of tin, respectively. The plus 200-mesh fraction of sample P35 between 2.8 and 3.3 specific gravity, contained 0.20 percent of tin, indicating its presence in minerals other than cassiterite.

Shaft No. 16 was sunk vertically to prospect the intersection of a group of north trending and west dipping veins with the vein followed by shaft No. 15. This was not successful in finding more than traces of tin. Results of microscopic study of Geological Survey samples (P28-33) from veins to the north are given in table 3. A spectrographic analysis of sample P33 showed about 0.25 percent of tin and the presence of cassiterite was confirmed by microscopic studies, though it was less and 0.001 percent of the heavy concentrates.

Shaft No. 17 was sunk on a vein dipping 35° W. which was assumed by Bryant to be the same one encountered in shaft No. 15. There is no evidence to prove that these two are connected. Seven assays of samples taken by the American Tin Corporation along the outcrop are reported to be 0.11 to 0.40 percent of tin. Traces of cassiterite was found in heavy concentrates of Geological Survey samples P38 and P39. Samples P39 contained 0.15 percent of tin according to spectrographic analysis.

Veins in Sections 1 and 12

A group of tourmaline veins in the SW ¼, sec. 1 and the NW ¼, sec. 12 trend about N. 20° E. and for the most part dip 50° to 80° NW. A few veins dip 60° to 65° SE. These veins are well exposed in the road cuts and the spillway of the Cajalco dam. According to Bryant about 210 samples from veins exposed in the NW ¼, sec. 12 contained less than 0.11 percent of tin. However, with but few exceptions the assays showed only 0.03 to 0.05 percent. The thickness of these veins are shown on figure 2. The extension of these veins in the SW ¼ of sec. 1 are of similar grade according to Bryant. Fifteen samples were taken by the Geological Survey and concentrated by means of heavy liquids. Samples P50, 51, 52, 53, 59, 61, and 62, contained traces of cassiterite (probably less than 0.001 percent).

Tourmaline Veins and Pipes of the Black Rocks Area

Three groups of tourmaline veins and pipes occur in the Black Rocks area (fig. 4). One group in the NW ¼ sec. 18, T. 4 S., R. 5 E. is known as North Black Rocks. Another group near the common corner of secs. 13, 24, 18, and 19 has no special designation. The third group in the NW ¼, sec. 19 are known as the South Black Rocks group. The name Black Rocks is derived from the outcrops of these tourmaline pipes which rise prominently above the flat country. The areas between veins are covered by alluvium or sands and gravel.

The Black Rocks Tin Syndicate thoroughly sampled about 40 veins in the NW ¼, sec. 18 in 1927-29. One inclined shaft (No. 8) and a few pits prospect the veins. Only part of this group is shown in figure 2, namely those in the immediate vicinity of shaft No. 8. Additional veins occur to the north, east, and south of those mapped. No mapping was done in sec. 18 east of the road to Black Rocks or inside the Metropolitan Water District fence in sections 12 and 7. Detailed geologic mapping was not carried out west of the area of Elsinore metamorphics in sec. 13.

About 310 samples were taken by the Black Rocks Tin Syndicate and only occasional assays showed more than 0.08 percent of tin. Most of the assays were black, trace, 0.03, or 0.05 percent. The highest was 0.18 percent.

Shaft No. 8 is reported to be about 180 feet deep and is inclined about 72° to the east. The vein is porphyritic tourmaline rock.

The group of veins near the common corner of secs. 13, 24, 18, and 19 lies northeast of a group of tourmaline breccias in sec. 24. A ringshaped and also a lenticular breccia pipe occur in the SW ¼ of sec. 18. The veins range in width from 6 inches to 15 feet in thickness. They strike from north to N. 60° E. Associated with the tourmaline veins are silicified monzonite veins or masses elongated N. 45° W. No cassiterite is visible in any of the outcrops, though these like other veins in the district have narrow seams of fine-grained tourmaline in the center. One of the largest veins is explored by a shallow shaft, inclined 70° SE. in the upper part, and vertical at the base. No assays are available to indicate the grade of these veins, but it would be surprising if they contained more tin than the other veins of the district.

The South Black Rock group of veins and pipes includes two veins that have been prospected by shafts No. 1 and No. 2 and others that were prospected by trenches. The veins strike N. 30° - 60° E. and, for the most part, dip 65° - 80° SE. In places they attain a width of 30 feet and are continuously exposed for as much as 800 feet. They show more branches than most of the veins in other parts of the district, but there is less fine-grained, loose-textured tourmaline rock than in veins No. 1 to No. 10 in the Cajalco mine area. Some of the vein material is breccia similar to that in the breccia pipes. The outcrops of the breccia pipes, as indicated on the maps, probably outline their shape rather closely because the tourmalinized rocks appear to be much more resistant than the surrounding monzonite. However, the intervening areas are in part gravel or alluvium which cover the details of the contacts. One small mottled tourmaline pipe north of the Black Rocks pipe shows about 5 feet of dumortierite rock on its southern contact.

One semi-circular pipe northeast of Black Rocks contains no breccia. It is made up of mottled tourmaline and porphyritic tourmaline rock. (fig. 4) Fractures with more intense alteration appear to have been the channelway for replacing solutions. The outline of this pipe has been mapped, in part, on the presence of float which appears not to have moved appreciable distances.

More than 150 assays of samples taken by the Black Rocks Tin Syndicate at the Black Rocks breccia pipe and the veins to the south and west indicate that the average grade of these veins is probably between 0.03 and 0.05 percent of tin. The upper 30 feet of shaft No. 2, which is inclined 75° SE averages about 0.10 percent of tin over an average width of 56 inches. This is the most promising place assayed.

Table 3 . Qualitative spectrographic analyses of Geological Survey samples [a]

Map No.	Sample No.	Probable Percentages																							
		Al	Fe	Si	Mg	As	K	Na	Ti	B	Ca	Zr	Sn	Ba	Sr	Mn	Cu	V	Bi	Cr	Ga	Co	Ag	Pb	Zn	Ni	Mo
P11	LRP- 660-40	10	10	10	2		.6	2	.6	.5	.4	.04	.15	.1	.02	.1	.1	.001		.06	.001		.002	.6	.02	.0006	.0005
P75	LRP- 700-40	10	10	10	2		.1	1	2	.5	2	.04	.05	.1	.05	.2	.1	.001	.0004	.1	.001		.0002	.001		.001	
P76	LRP- 750-40	8	10	10	2		.1	.5	2	.5		.04	.06	.002	.02	.1	.1	.001	.0004	.1	.001	.0005	.0002	.001		.0006	
P22	LRP- 810-40	10	10	10	4		.4	2	2	.5	1	.04	.2	.002	.02	.2	2	.002	.1	.2	.01	.002	.1	.1	.005	.002	.001
P23	LRP- 820-40	20	10	10	4		2	5	2	.5	.7	.04	.1	.1	.02	.2	.1	.001	.0002	.1	.01	.004	.0004	.002		.0006	.001
P77	LRP- 870-40	12	10	10	4		.2	2	2	.5	1	.04	.05	.2	.02	.1	.1	.004		.1	.002	.0005	.0002			.0006	
P78	LRP- 880-40	20	10	10	10		.4	5	2	1	1	.04	.06	.001	.02	.1	.1	.06		.1	.01	.002				.0006	
P79	LRP- 900-40	10	10	10	4		1	10	2	.5	1	.1	.05	.2	.1	.1	.1	.004		.1	.001		.0001	.001		.0006	
P80	LRP- 910-40	20	10	10	6		.1	5	2	.5	1	.1	.05	.0002	.02	.2	.1	.03		.06	.001	.0005	.0001	.004		.006	
P81	LRP- 920-40	20	10	10	2		2	7	2	.2	2	.04	.04	.3	.1	.1	.1	.004	.0004	.1	.001	.001	.001	.01		.0006	
P33	LRP- 980-40	20	10	10	4	1	2	5	2	.5	.1	.1	.25	.1	.02	.2	.1	.01	.01	.1	.002	.001	.001	.002		.0006	
P34	LRP- 990-40	10	10	10	2	2	2	.5	2	.1	.5	.04	.1	.3	.01	.05	.1	.004	.0004	.1	.001		.0004			.0006	
P34 A	LRP- 990(A)-40	10	10	10	2	1	2	2	2	.5	.5	.2	.2	.05	.02	.1	.1	.03	.006	.1	.002	.001	.002			.0006	
P35	LRP-1000-40	20	10	10	4	2	1	2	2	1	.5	.1	.25	.006	.02	.1	.1	.06	.05	.06	.002	.0005	.01	.002		.0006	
P82	LRP-1030-40	10	10	10	2		.6	2	2	.5	1	.2	.06	.2	.02	.2	.1	.02	.0002	.06	.001	.001	.006	.001		.002	
P39	LRP-1050-40	10	10	10	4	2	2	2	2	1	1	.3	.15	.1	.1	.05	.02	.002	.001	.001	.001	.0005	.0001				
P83	LRP-1080-40	10	10	10	4		.4	1	2	.5	.7	.04	.04	.2	.02	.05	.1	.002		.1	.0005	.0005	.0001	.002		.001	
P84	LRP-1090-40	20	10	10	6		.2	5	2	1	.7	.2	.06	.003	.01	.2	.1	.06		.1	.01	.001	.0001	.004	.005	.01	
P85	LRP-1100-40	10	10	10	2		.2	.3	1	.5	.5	.2	.05	.1	.01	.07	.1	.001		.1	.0005	.0005	.0001	.002		.002	
P86	LRP-1130-40	10	10	10	2		.6	7	2	.1	1	.04	.05	.2	.05	.05	.1	.001	.0002	.01	.0005	.0005	.0004	.002		.0006	
P47	LRP-1160-40	20	10	10	6		1	5	2	1	1	.02	.1	.05	.05	.2	.1	.06	.02	.06	.007	.0005	.0002	.1	.01	.0006	
P48	LRP-1170-40	10	10	10	2		.1	5	1	1	1	.1	.08	.006	.05	.2	.1	.01	.1	.1	.001	.0005	.001	.1		.001	

Map No.	Remarks
P11	Chip sample. Along N. side of 4"-vein. Tourmaline-quartz-mica greisen.
P75	Grab sample across mottled tourmaline rock vein.
P76	14" channel across mottled tourmaline rock vein.
P22	Specimen. Massive fine-grained tourmaline rock with molochite.
P23	14" channel across vein.
P77	Fine-grained tourmaline veins in docite porphyry.
P78	5"-channel at intersection of tourmaline seams.
P79	1'-channel across numerous tourmaline seams.
P80	Specimen sample. Fine-grained 2"-tourmaline vein.
P81	Silicified dacite porphyry between tourmaline seams.
P33	Fine grained tourmaline rock with sulphides and mica.
P34	Vein center at S. wall, shaft No. 15. Tourmaline-arsenopyrite nodules in micaceous matrix.
P34 A	Do.
P35	8" channel. Above P34. Iron stained, vuggy tourmaline rock.
P82	3' channel across tourmaline vein. S. side shaft No. 15. .
P39	Dumortierite and tourmaline in talcose, chloritic matrix.
P83	2" to 3"-vein along dacite porphyry - monzonite contact.
P84	Sample across vein.
P85	Chip sample of 4 sq. ft. Hard, glossy tourmaline rock.
P86	Sample of weathered monzonite on footwall of vein.
P47	Mottled and fine-grained tourmaline rock. Possibly cassiterite.
P48	Lens of vuggy mottled tourmaline rock.

[a] Analysed by M. F. Hasler, Applied Research Laboratories, Los Angeles, California

(NO TABLE 1)

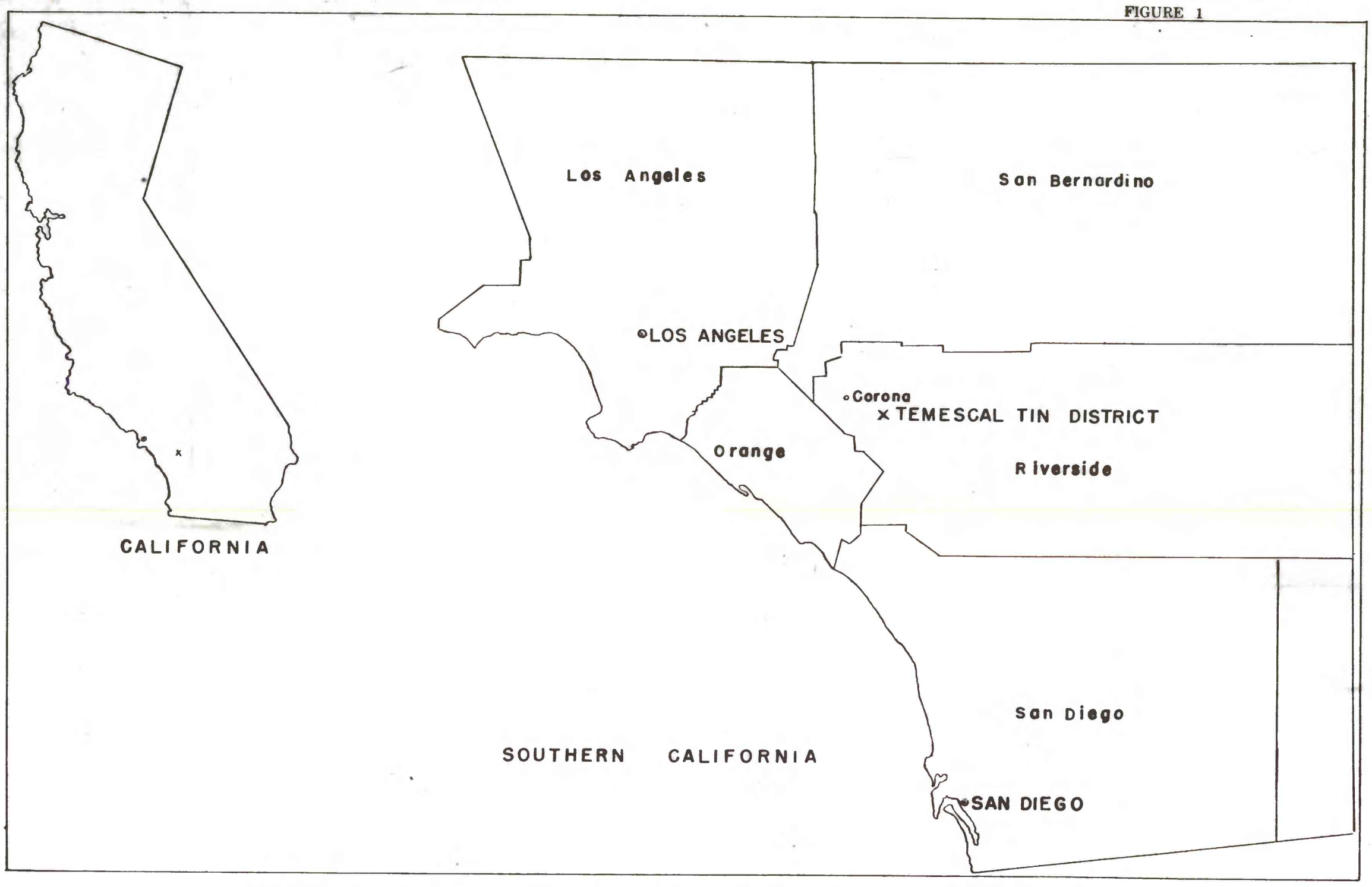
Table 2.--Results of heavy liquid separations on samples from the tin-bearing veins.

Sample number on map (Figs. 2 and 3)	Type of sample	Weight (pounds)	Screen analysis after pulverizing (Weights in grams) 80-200 mesh (used in heavy mineral separations) (grams)	Screen analysis after pulverizing (Weights in grams) -200 mesh (discarded)	Magnetic separations of fraction 3.3 specific gravity Non-magnetic Weight	Non-magnetic Percent of original sample	Grains of cassiterite observed in mount A/	Remarks
P 1	Grab	3.0	54.3	44.4	1.46	3.04	0	Epidotized monzonite.
P 2	Specimen	2.5	53.8	44.7	0.30	0.56	1	Center of vein. Glassy, fine-grained rock tourmaline.
P 3	Specimen	1.8	47.1	52.3	0.21	0.44	0	Epidotized monzonite.
P 4	Specimen	2.0	53.75	42.55	0.21	0.39	20	Vein. Dull, fine-grained tourmaline-quartz rock.
P 5	Specimen	1.25	54.2	43.46	1.30	2.39	4	Three-inch vein. Micaceous, mottled tourmaline rock.
P 6	Specimen	2.0	48.5	41.05	1.25	2.58	0	Felted, fine-grained tourmaline.
P 7	Grab	2.0	48.3	50.7	0.39	.81	1	Average of 12"-vein, fine-grained tourmaline rock.
P 8	Specimen	1.5	54.82	40.0	0.22	0.41	0	Spots of tourmaline in aplite.
P 9	Grab	1.0	39.05	56.1	1.47	3.77	1	Three-foot vein. Radial tourmaline.
P10	Specimen	1.5	59.55	38.4	3.7	6.27	0	Vein zone. Brown, altered feldspar. No tourmaline.
P11	Chip	6.0	59.60	38.3	1.20	2.02	3	Along N. side 4-inch vein. Tourmaline-quartz-mica gneiss.
P12	Chip	3.0	52.6	40.0	0.21	0.40	0	Across 28" on S. wall of vein. Mottled tourmaline rock.
P13	Chip	3.0	45.35	50.8	1.12	2.49	0	Center of vein.
P14	Chip	5.0	47.35	46.9	1.11	2.35	2	Eight inches across N. edge of vein. Vuggy, fine-grained tourmaline rock.
P15	1' channel	3.0	50.9	41.1	0.88	1.73	0	Along 3-inch center of vein. Tourmaline.
P16	1' channel	2.0	59.0	38.75	0.21	.36	22	Across unaltered footwall monzonite and thin tourmaline seams.
P17	1' channel	4.0	54.4	44.2	3.37	6.21	0	Along 6-inch hard, glassy tourmaline vein center.
P18	Chip	5.0	56.74	40.2	1.75	3.41	0	Along 6-inch fine-grained tourmaline vein center.
P19	14" channel	2.5	60.47	36.4	1.98	3.25	0	Across massive, hard, glassy, fine-grained tourmaline vein.
P20	2' channel	5.0	68.05	30.5	0.86	.38	1	Above hanging wall of vein. Slightly tourmalinized.
P21	4" channel	4.0	55.25	43.4	0.41	.75	0	Mottled tourmaline rock.
P22	Specimen	3.0	55.05	44.7	1.25	2.27	---	Massive, fine-grained tourmaline rock with malachite stains.
P23	14" channel	6.5	47.3	51.2	3.02	6.35	2	Across veins.
P24	12" channel	6.0	47.1	46.6	0.84	1.75	0	Across hard, fine-grained tourmaline rock of vein center.
P25	Specimen	2.0	47.0	47.8	0.87	1.86	1	Soft, fine-grained tourmaline rock.
P26	Chip	6.0	34.45	62.0	0.05	.16	0	Across dumortierite vein. Includes 2½" of fine-grained tourmaline rock.
P27	2" chip	6.0	45.55	51.0	0.35	.77	0	Along 15" dumortierite vein. Included fine-grained tourmaline rock.
P28	5" channel	5.0	49.2	48.75	0.29	.59	0	Hangingwall dacite. Some tourmaline.
P29	6' chip	4.5	40.1	58.3	0.54	1.36	1	Along vein. Fine-grained tourmaline rock.
P30	2" chip	4.5	42.95	55.6	0.41	.96	0	Down dip of 3" fine-grained tourmaline vein.
P31	Specimen	6.0	38.0	60.0	0.34	.80	0	Tourmaline seams in dacite porphyry.
P32	Grab	9.6	42.35	56.1	0.88	1.38	0	3' x 5' area. Dacite porphyry; silicified and tourmalinized.
P33	Grab	5.5	42.25	56.1	0.52	1.25	0	3' x 5' area. Dacite porphyry; silicified and tourmalinized.
P34	40" channel	8.0	40.35	57.95	0.59	1.47	2	Fine-grained tourmaline rock with sulphides and mica.
P34	8" specimen	3.5	52.05	46.0	0.06	1.23	3	Vein center at S. wall shaft No. 15. Tourmaline-arsenopyrite nodules in micaceous matrix.
P34a	---	2.0	47.6	50.8	0.82	1.69	1	Same as P34.
P35	8" channel	5.0	40.35	58.1	0.37	.94	0	Above P34, iron-stained, vuggy tourmaline rock.
P36	Specimen	5.0	45.8	52.55	0.36	.79	0	14" brecciated, quartz-mica-tourmaline vein. S. of shaft No. 15.
P37	3" channel	7.0	37.8	59.45	0.21	.57	0	Across tourmaline vein in dacite porphyry.
P38	4' channel	4.0	44.6	53.35	0.14	.32	1	Includes entire tourmaline vein.
P39	Chip	5.0	46.15	52.2	3.56	7.71	1	Dumortierite and tourmaline, in talcose, chloritic matrix.
P40	Chip	4.0	36.8	60.95	0.37	1.26	0	Center vein in brecciated and silicified vein zone.
P41	2" channel	5.5	39.35	54.8	0.25	.75	0	Across fine-grained tourmaline rock vein center.
P-42	1' channel	6.5	51.05	47.7	1.07	2.25	0	Across fine-grained tourmaline rock vein center.
P-43	---	10.0	53.4	39.55			0	Same as P42.
P44	Chip	3.0	56.35	40.0	0.53	.95	1	1½' cut in mottled tourmaline rock in the hangingwall.
P45	1' channel	3.5	49.45	49.45	1.28	2.65	0	Brown, red stained fine-grained and mottled tourmaline rock.
P46	8" channel	5.0	41.75	56.6	0.99	1.45	2	Similar to P45, but finer grained.
P47	Chip	3.0	43.6	58.9	0.62	1.43	1	Mottled and fine-grained tourmaline rock. Possibly cassiterite.
P48	Grab	9			0.83		1	Lens of vuggy mottled tourmaline rock.
P49	Grab				0.69		2	11' mottled and fine-grained tourmaline rock.
P50	18" channel	3.5	63.5	34.2	0.06	.10	1	Across radial tourmaline veins; quartz center.
P51	10" channel	4.5	54.2	36.8			1	Radial tourmaline at outer edge of vein.
P52	1' channel	6.0	49.1	38.3			1	Along 6" quartz center of vein.
P53	Chip	2.5	38.85	21.15			2	20" across W. side of vein at P52.
P54	1' channel	1.5	45.2	23.6			0	1½" zone along S. side of quartz vein center.
P55	Chip	3.0	39.15	31.3			0	Felted, radial tourmaline vein with 2" quartz center.
P56	24" channel	3.5	76.6	34.9			0	Weathered monzonite in hanging wall of vein.
P57	14" channel	3.0	41.7	28.2			0	Dumortierite zone; a few tourmaline seams, below P56.
P58	12" channel	4.0	60.15	34.3			0	Glassy, coarse mottled tourmaline seams, below P57.
P59	18" channel	2.5	41.95	29.1			1	Dumortierite zone; few tourmaline seams, below P58.
P60	6" channel	3.0	75.75				0	Weathered monzonite, below P59.
P61	1' channel	4.5	54.25	30.75			3	Silicified zone 7' above P56. Looks like 30 percent tourmaline pebble quartzite.
P62	12" channel	2.0	58.6	34.9			1	Along 4" vein, 13' W. of P60.
P63	3.5" channel	8.0	39.0	28.2			0	Across dumortierite vein.
P64	18" channel	5.0	36.5	36.2	0.22	.60	0	Dull, fine-grained, micaceous tourmaline vein center.
P65	4.5" channel	5.0	33.2	18.15			0	Mottled tourmaline, 2" vein center omitted.
P66	Grab	6.5	41.0	20.15			0	Tourmalinized (10-15 percent) monzonite.
P67	Specimen	7.0	38.8	22.1	0.19	.51	0	Mottled tourmaline rock.
P68	Chip	5.5	48.8	18.45	0.01	.04	0	White to brown quartz with 20 percent tourmaline.
P69	Chip	2.0	70.7	42.3	0.21	.31	0	Matrix of breccia. Fine-grained glassy tourmaline rock.
P70	Grab	7.5	63.1	38.6	0.04	.07	0	Average of mottled tourmaline rock of "blowout."
P71	Grab	4.0	55.7	52.2	0.02	.03	0	Average of grey tourmalinized monzonite of "blowout."
P72	Grab	8.0	57.4	43.29	0.04	.08	1	Hard, glassy, black tourmaline rock.
P73	Grab	8.5	68.65	36.65	0.04	.06	1	Glassy, fine-grained mottled tourmaline rock.
P74	Grab	5.5	63.95	51.6	0.01	.03	0	Fine-textured tourmalinized breccia.
L 1	1' channel	3.0	163.2	326.7			---	Hard, dull, fine-grained tourmaline rock of 5" vein in monzonite.
L1b	Do	4.5	49.4	49.0			---	Do.
L 2	Chip	7.0	255.75	236.85			3	E. side hanging wall vein at L 1.
L 3	Chip	4.0	252.4	233.6			2	W. side foot wall vein at L 1.
L 4	8" channel		56.3	38.15	0.30	.91	3	Iron stained gouge zone; footwall of fault.
L 5	Chip	6.5	53.5	42.4	0.59	1.11	3	Weathered mottled tourmaline rock; hanging wall of fault.
L 6	5' channel	6.0	51.1	44.1			5	Fine-grained, dark, tourmaline rock.
L 7	Grab	127.3 grams	49.8	69.15	4.54	9.08	0	Red to brown cavity filling in breccia.
L 8	Grab	6.0	271.5	225.0			3	Monzonite from dump of Robinson shaft.
L 9	Grab	8.5	54.3	40.2	1.35	2.39	0	Mottled tourmaline rock; vuggy breccia.
L10	4' chip	10.0	52.3	40.9			---	Do.
L11	3' chip	8.0	52.3	42.7			0	Brecciated, tourmaline breccia.
L12	Grab	10.0	48.8	44.7			0	5 sq. ft. area. Mottled tourmaline rock.
L13	Chip	1.5	48.1	45.7			0	Mottled tourmaline rock.
L14	Chip	8.0	44.7	49.4			0	Mottled tourmaline rock; 40 percent quartz.
L14a	Do	0.5	52.15	41.2			---	Do.
L15	Chip	9.5	54.35	40.35			1 ?	
L16	Chip	8.0	51.6	42.5			---	Coarse mottled tourmaline rock.
L17	Chip	± 827 grams	109.5	138.0			2 0	Dark, tourmalinized breccia fragment.
L18	Chip	8.0	43.7	51.6	0.58	1.33	1	Vuggy, porphyritic tourmaline rock.
L19	10" channel	11.0	51.15	42.7			10	Do.
L20	Chip	3.0	43.7	52.0			0	Vuggy porphyritic tourmaline rock.
L21	6" channel	3.0	280.4	205.7			0	Matrix of tourmaline breccia.
L22	Specimen	3.0	248.35	245.45			2	Mottled tourmaline rock; breccia fragment.
L23	Chip	5.0	229.7	264.95			2	Altered, clayey, monzonite.
L24	Specimen	287 grams	153.8	125.5			0	6" zone of soft, fine-grained tourmaline rock.
L25	Chip	4.5	41.7	53.8	1.51	3.51	2	2' x 4' pocket, fine-grained gouge material.
L26	Specimen	± 2400 grams	636.0	513.0			2	Vuggy, mottled tourmaline rock.
L27	2.5' channel	8.5	90.3	43.8			0	Across vein, south of shaft. Fine-grained tourmaline rock.
L28	6" channel	1.5	56.4	35.2			1	Narrow part of vein. Fine-grained tourmaline rock.
L29	10" channel	6.0	51.2	43.5			5	Weathered wall rock. Some fine-grained tourmaline seams.
L30	2' channel	5.0	53.6	43.0			2	Weathered wall rock. No tourmaline.
L31	15" channel	8.0	58.4	35.1			0	Do.
L32	Chip	8.0	48.8	48.3			0	10" vein of fine-grained tourmaline rock.
L33	2' channel	7.5	50.8	43.7			0	Dull, fine-grained tourmaline rock.
L34	3' channel	4.0	47.3	47.4			2 ?	Mottled and fine-grained tourmaline rock.
L34a	Do	4.5					0	Do.
L35	16" channel	7.0	52.6	45.8			2	Dull, fine-grained and mottled tourmaline rock.
L36	8" channel	1.5	54.8	38.6			3	Felted tourmaline. Same vein as L35.
L37	15" channel	8.0	53.2	41.35			5	Fine-grained tourmaline rock grading into monzonite.
L38	Grab		53.7	42.75			3	Felted tourmaline.

A/ Grain mounts contained 1000-4000 grains. The average weight of sample in each was about 0.008 gm.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

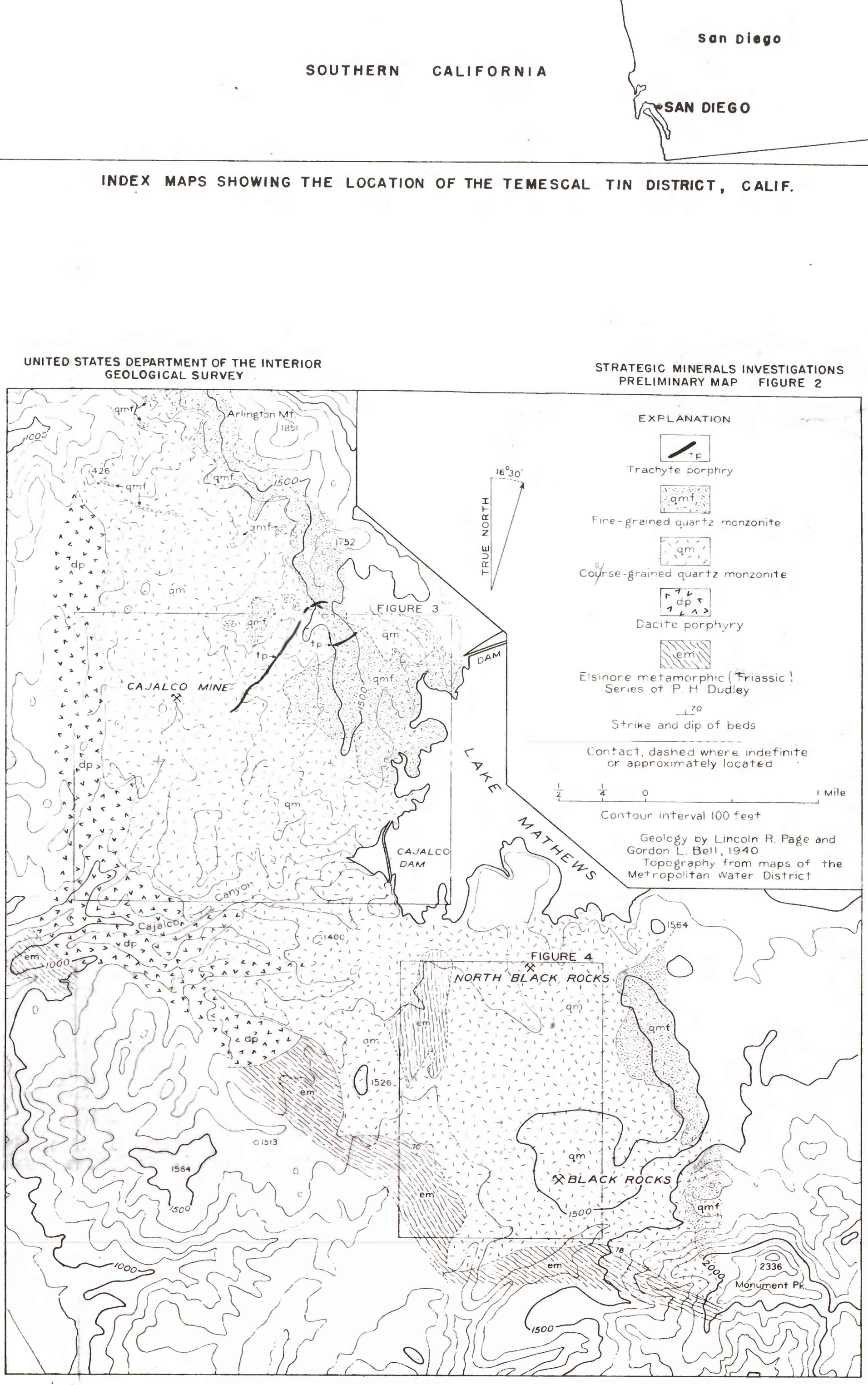
STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 1



INDEX MAPS SHOWING THE LOCATION OF THE TEMESCAL TIN DISTRICT, CALIF.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

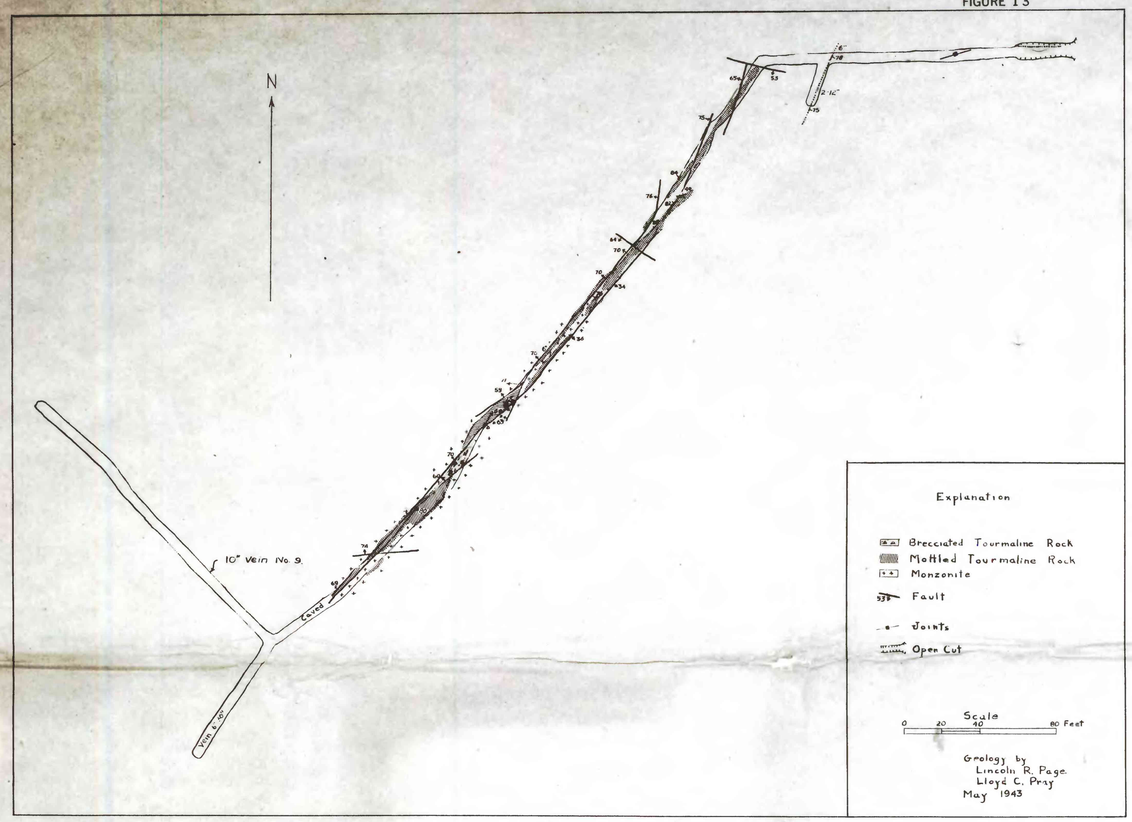
STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP FIGURE 2



GEOLOGIC MAP OF THE TEMESCAL TIN DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 13



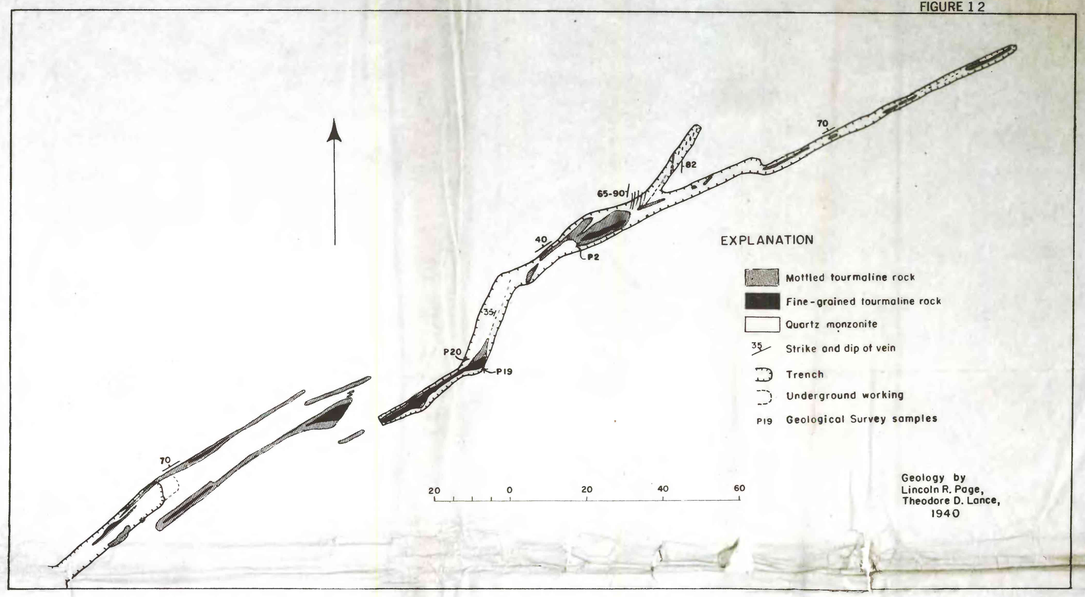
ADIT NO. 9, VEIN NO. 10, TEMESCAL TIN DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

IN BACK OF BOUND VOLUME
PLEASE REMOVE IN DOCKET

4513

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

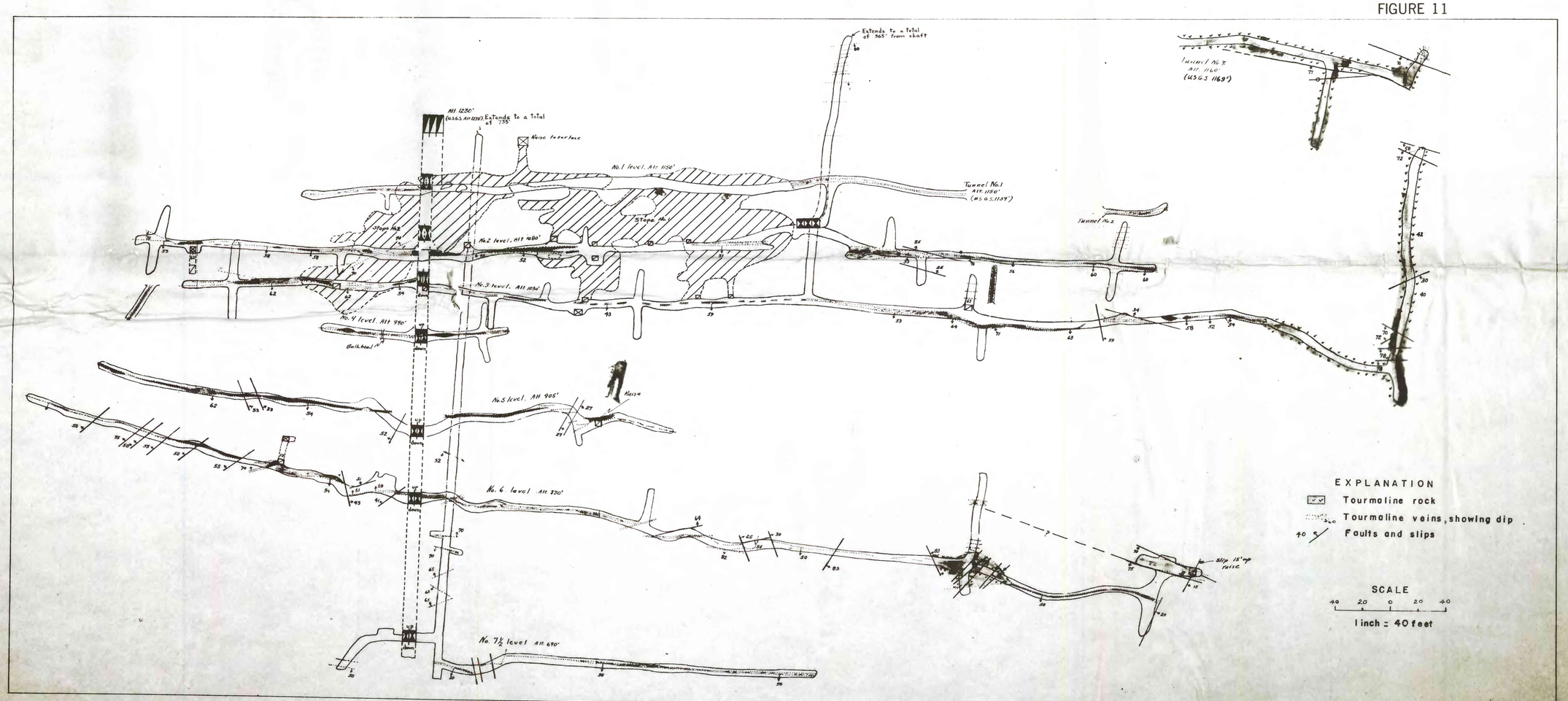
STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 12



DETAILED PLAN OF BRANCHING VEIN WEST OF CAJALCO HILL, TEMESCAL TIN DISTRICT, RIVERSIDE CO., CALIF.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 11



GEOLOGIC MAP OF THE CAJALCO TIN MINE, RIVERSIDE COUNTY, CALIFORNIA

45-13

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP FIGURE 3

CAJALCO MINE

ROBINSON SHAFT

SHAFT NO 1

SHAFT NO 2

SHAFT NO 3

SHAFT NO 4

SHAFT NO 5

SHAFT NO 6

SHAFT NO 8

SHAFT NO 13

SHAFT NO 14

SHAFT NO 15

SHAFT NO 16

SHAFT NO 17

ADIT 159

ADIT 1165

TUNNEL NO 3

ADIT NO 9

VEIN NO 1

VEIN NO 2

VEIN NO 3

VEIN NO 5

VEIN NO 5B

VEIN NO 6

VEIN NO 8

VEIN NO 8B

VEIN NO 9

VEIN NO 10

Faults

Cajalco Creek

Mine

Cajalco Canyon

CAJALCO DAM

LAKE MATHEWS

Spillway

EXPLANATION

Tourmaline rock

Tourmaline vein, showing dip, thickness, and length stripped

TP Trachyte porphyry

Shaft

Adit

Trench or pit

P42 Geological Survey Sample

INDEX TO TOPOGRAPHY

Lincoln R. Page and Gordon L. Bell — Metropolitan Water District — Geological Survey

T. 4 S - R. 6 W

TRUE NORTH 16° 30'

Geology by Lincoln R. Page and Gordon L. Bell, 1940

GEOLOGIC MAP OF THE CAJALCO MINE AREA, TEMESCAL DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

400 0 1600 FEET

CONTOUR INTERVAL – 20 FEET

45-13

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP FIGURE 4

NORTH BLACK ROCKS

SHAFT NO. 8

T. 4 S.
R. 6 W.
R. 5 W.

P 68

P-69-70

P 71-72

P 73

P 74

BLACK ROCKS

SHAFT NO. 2

SHAFT NO. 1

1400

1500

16°30'
TRUE NORTH

EXPLANATION

Tourmaline rock

Tourmaline vein showing dip, thickness, and length stripped

Shaft

Trench or pit

P 74
Geological Survey Sample

Metropolitan Water District

Lincoln R. Page and Gordon L. Bell

INDEX TO TOPOGRAPHY

Geology by Lincoln R. Page and Gordon L. Bell, 1940

GEOLOGIC MAP OF THE BLACK ROCKS AREA, TEMESCAL DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

400 0 1200 Feet

Contour interval 20 feet

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 5

GEOLOGIC MAP OF CAJALCO HILL

T.P. Thayer, September 1943
Revised by J.H. Wiese, 1945

50 0 50 100 150 200 FEET

Contour Interval 10 Feet
Scale: 1 inch = 40 feet

EXPLANATION

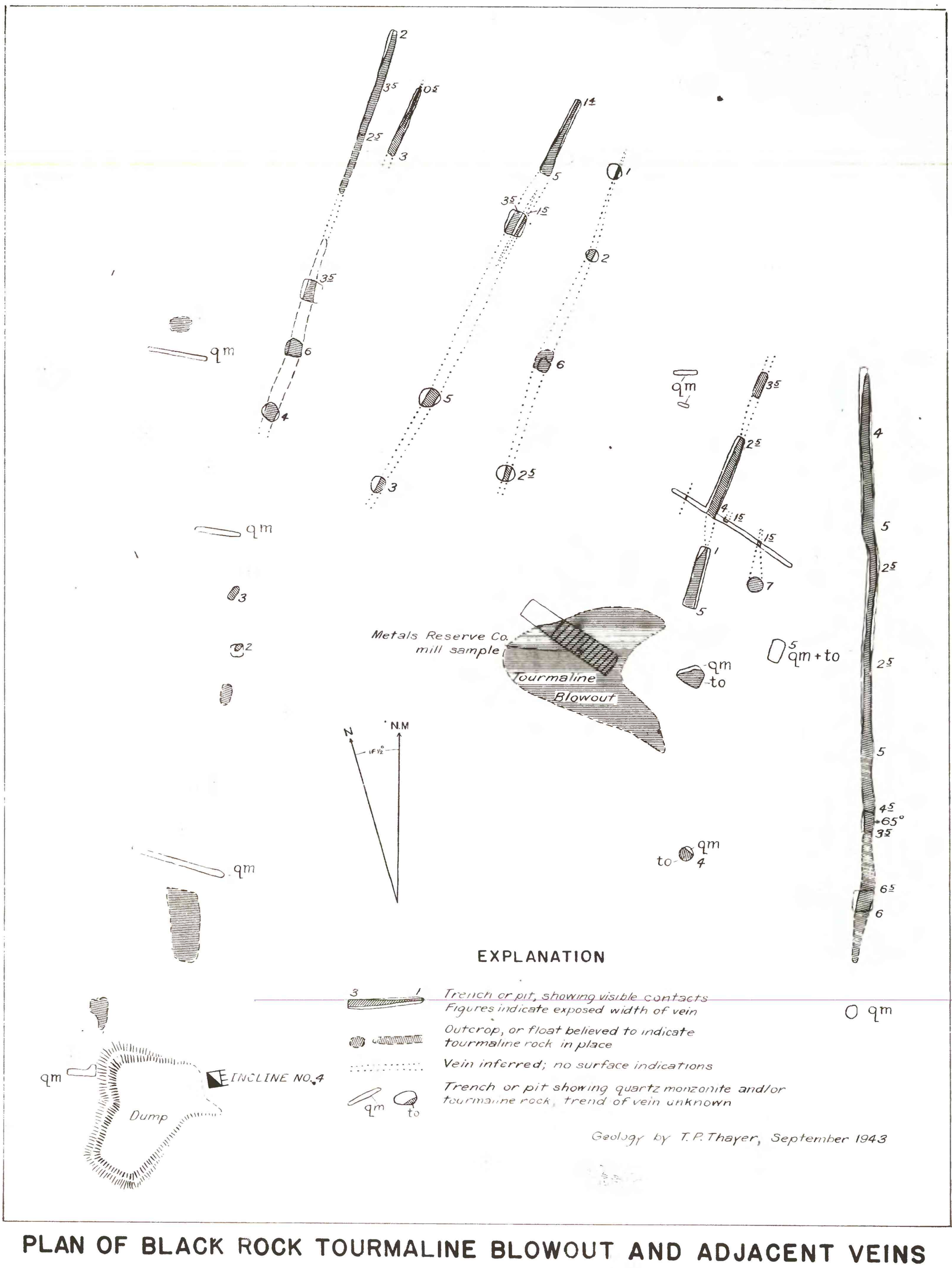
- Tourmalinized breccia
- Porphyritic tourmaline rock
- to — Tourmaline-quartz rock, exposed
- Tourmaline-quartz rock, inferred
- qm — Quartz monzonite, exposed
- Quartz monzonite inferred
- Dark gabbroic rock
- Visible contact
- Indefinite contact
- Concealed contact, location uncertain
- 75° — Visible fault, showing direction and angle of dip
- Fault, location approximate
- Concealed fault, location uncertain
- Sheeting
- Metals Reserve Company sample trench
- Old trench

45-13

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS

FIGURE 6



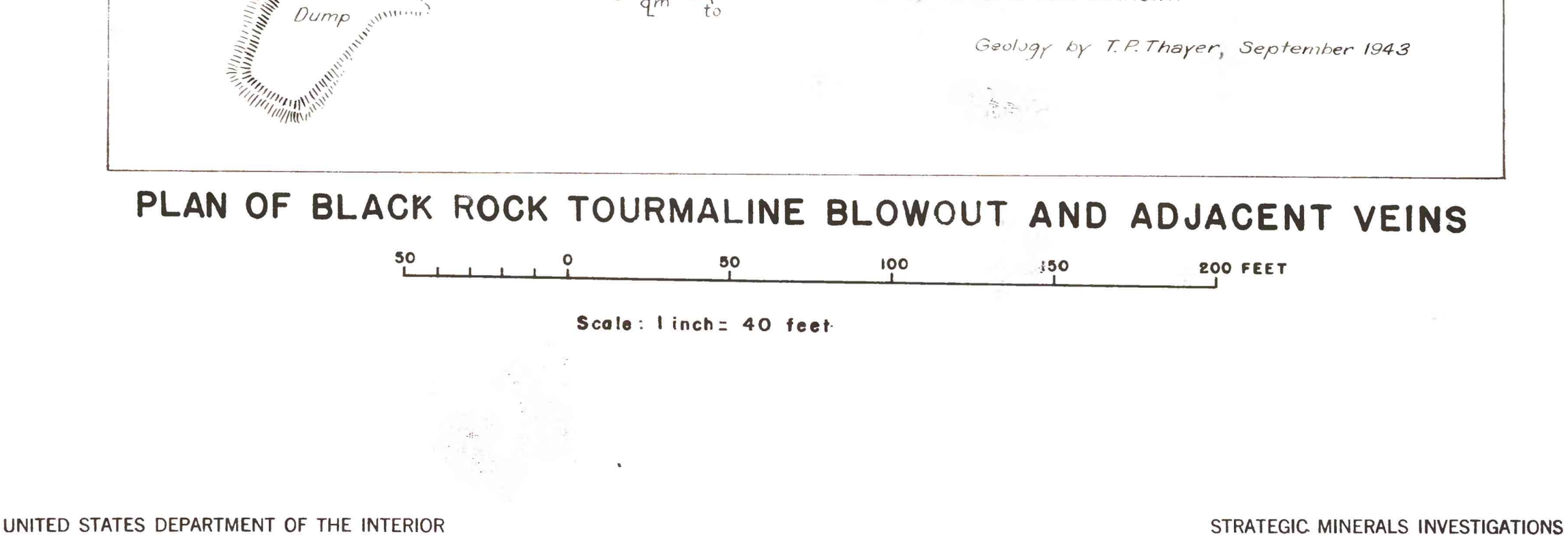
PLAN OF BLACK ROCK TOURMALINE BLOWOUT AND ADJACENT VEINS

50 0 50 100 150 200 FEET

Scale: 1 inch = 40 feet

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 7



Tourmaline veins in Metals Reserve Co. trenches east of Shaft No. 12, Temescal District

40 0 40 80 120

Scale

1 inch = 40 ft.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS
FIGURE 8

45-13

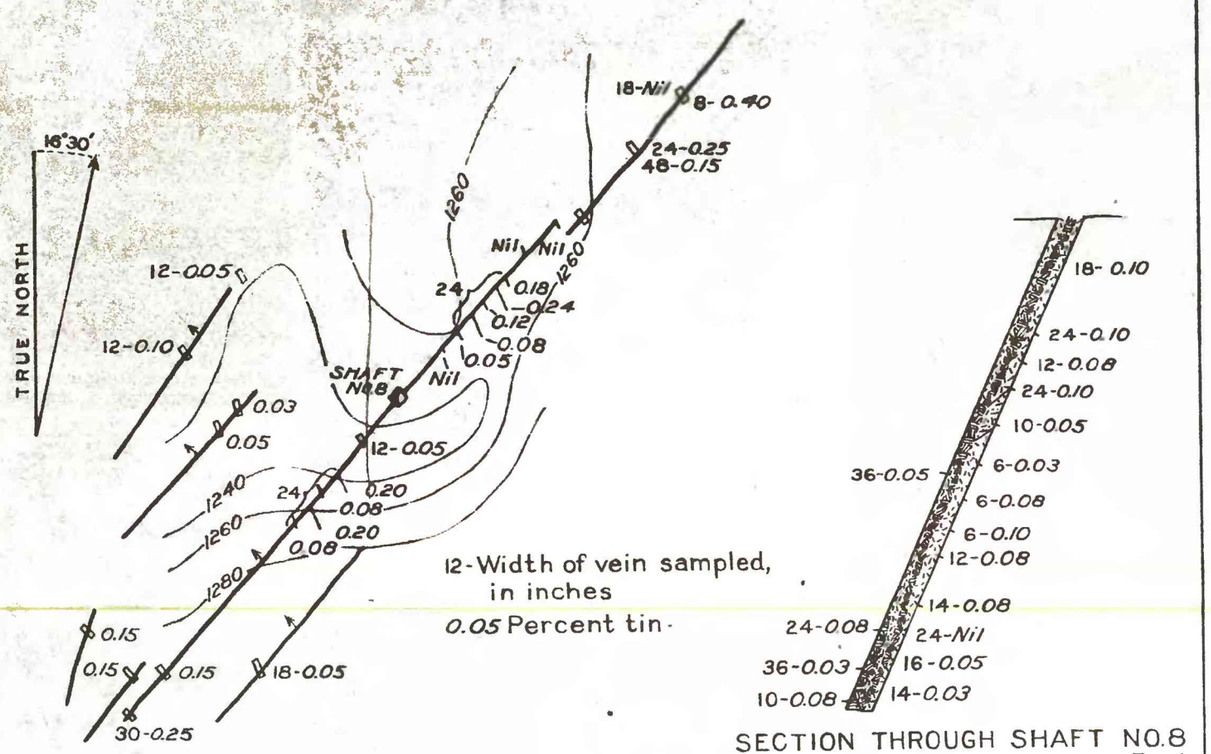
ASSAY MAP OF THE CAJALCO TIN MINE, RIVERSIDE COUNTY, CALIFORNIA

Scale: 1 inch = 40 feet

45-13

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP FIGURE 9



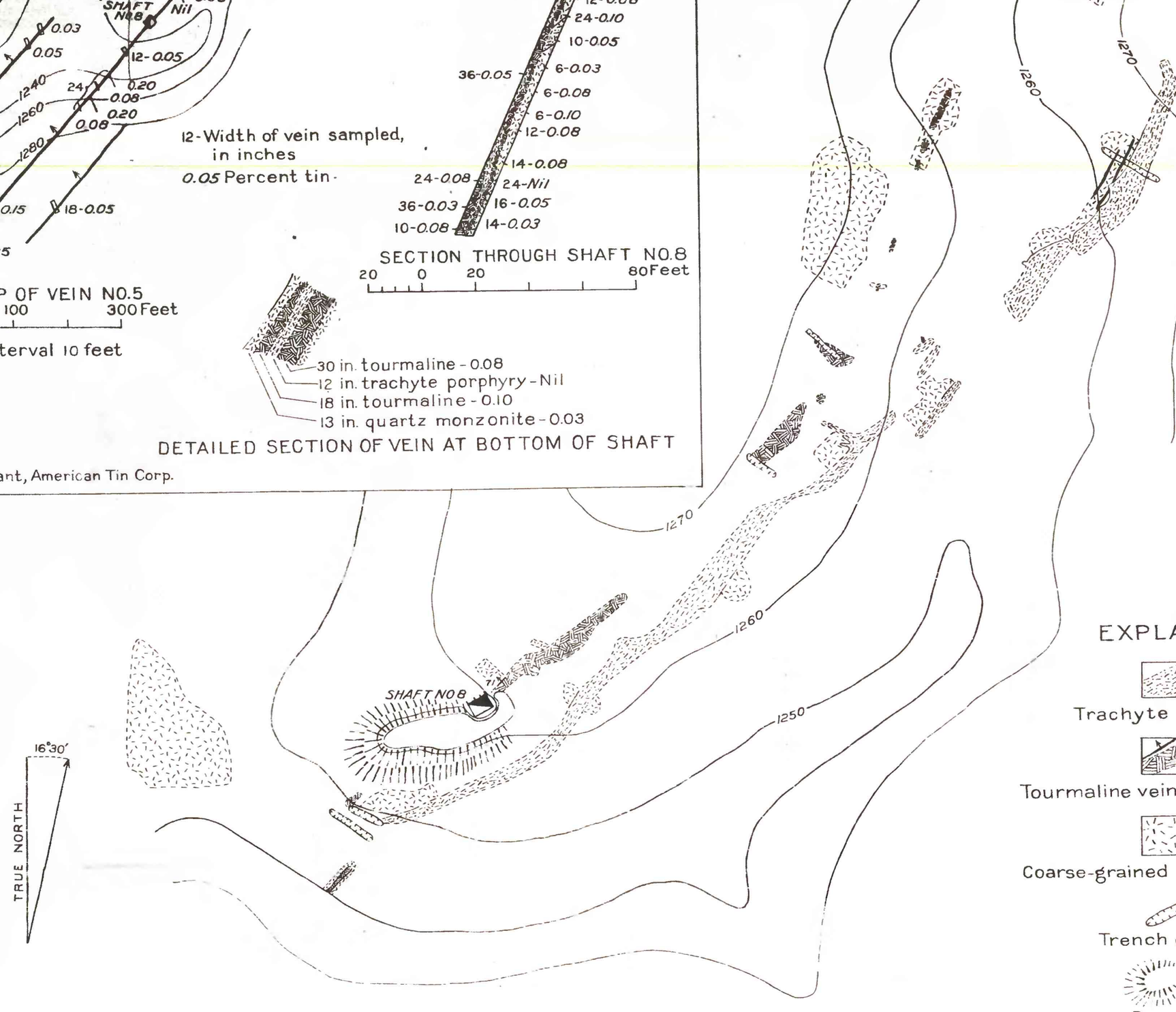
ASSAY MAP OF VEIN NO.5
100 0 100 300 Feet
Contour interval 10 feet

12-Width of vein sampled, in inches
0.05 Percent tin.

SECTION THROUGH SHAFT NO.8
20 0 20 80 Feet

DETAILED SECTION OF VEIN AT BOTTOM OF SHAFT

After G.W. Bryant, American Tin Corp.



Geology and Topography by Lincoln R. Page and Gordon Bell 1941

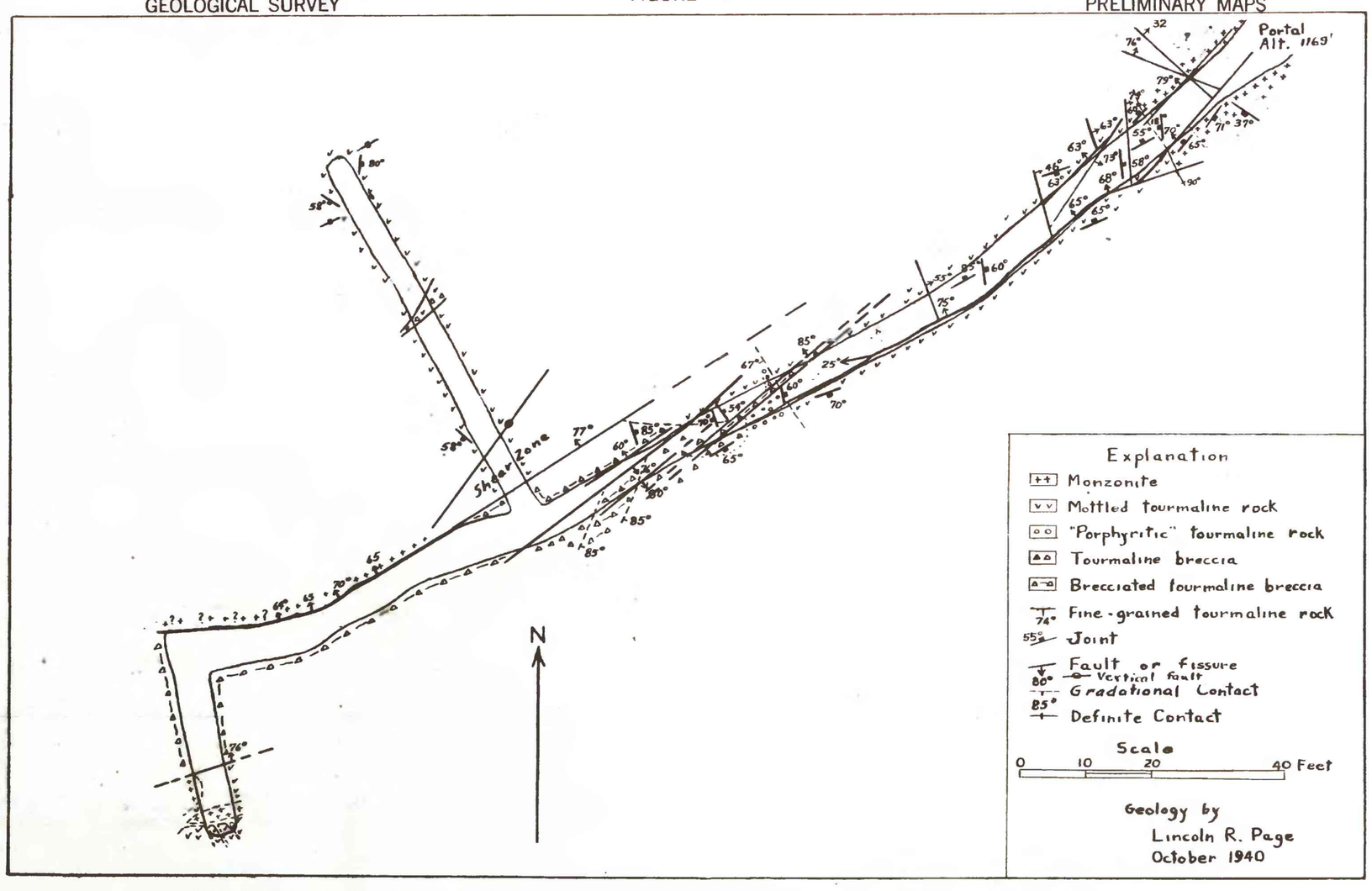
GEOLOGIC MAP OF VEIN NO.5, NEAR SHAFT NO.8 TEMESCAL TIN DISTRICT, RIVERSIDE COUNTY, CALIFORNIA

40 0 80 Feet
Contour interval 10 feet

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FIGURE 10

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAPS



GEOLOGIC MAP OF NO.3 ADIT, CAJALCO TIN MINE, RIVERSIDE CO., CALIF.

(NO TABLE 1)

Table 2.—Results of heavy liquid separations on samples from the tin-bearing veins.

Sample number on map (figs. 2 and 3)	Type of sample	Weight (pounds)	Screen analysis after pulverizing (Weights in grams)		Magnetic separations of fraction 3.3 specific gravity		Grains of cassiterite observed in mount a/	Remarks
			80-200 mesh (used in heavy mineral separations) (grams)	-200 mesh (discarded)	Non-magnetic Weight	Non-magnetic Percent of original sample		
P 1	Grab	3.0	54.2	44.4	1.65	3.04	0	Epidotized monzonite.
P 2	Specimen	2.5	53.8	44.7	0.30	0.56	1	Center of vein. Glossy, fine-grained rock tourmaline.
P 3	Specimen	1.0	47.1	52.3	0.21	0.44	0	Epidotized monzonite.
P 4	Specimen	2.0	53.75	42.55	0.21	0.39	20	Vein. Dull, fine-grained tourmaline-quartz rock.
P 5	Specimen	1.25	54.2	43.66	1.30	2.39	4	Three-inch vein. Micaceous, mottled tourmaline rock.
P 6	Specimen	2.0	48.5	41.05	1.25	2.58	0	Felted, fine-grained tourmaline.
P 7	Grab	2.0	48.3	50.7	0.39	.81	1	Average of 12"-vein, fine-grained tourmaline rock.
P 8	Specimen	1.5	54.92	40.0	0.22	0.41	0	Spots of tourmaline in aplite.
P 9	Grab	1.0	39.05	56.1	1.47	3.77	1	Three-foot vein. Radial tourmaline.
P10	Specimen	1.5	59.55	38.4	3.7	6.27	0	Vein zone. Brown, altered feldspar. No tourmaline.
P11	Chip	6.0	59.60	38.3	1.20	2.02	3	Along W. side 4-inch vein. Tourmaline-quartz-mica greisen.
P12	Chip	3.0	52.6	40.0	0.21	0.40	0	Across 18" on S. wall of vein. Mottled tourmaline rock.
P13	Chip	3.0	45.35	50.8	1.12	2.49	0	Center of vein.
P14	Chip	5.0	47.35	46.9	1.11	2.35	2	Eight inches across W. edge of vein. Vuggy, fine-grained tourmaline rock.
P15	1' channel	3.0	50.9	41.3	0.88	1.73	0	Along 3-inch center of vein. Tourmaline.
P16	1' channel	2.0	59.0	38.75	0.21	.36	12	Across unaltered football monzonite and thin tourmaline seams.
P17	1' channel	4.0	54.4	44.2	3.37	6.21	0	Along 6-inch hard, glossy tourmaline vein center.
P18	Chip	5.0	56.74	40.2	1.75	3.41	0	Along 6-inch fine-grained tourmaline vein center.
P19	14" channel	2.5	60.47	36.4	1.98	3.25	0	Across massive, hard, glossy, fine-grained tourmaline vein.
P20	2' channel	5.0	68.05	30.5	0.26	.38	1	Above hanging wall of vein. Slightly tourmalinized.
P21	4" channel	4.0	55.25	43.4	0.41	.75	0	Mottled tourmaline rock.
P22	Specimen	3.0	55.05	44.7	1.25	2.27	—	Massive, fine-grained tourmaline rock with malachite stains.
P23	14" channel	6.5	47.3	51.2	3.02	6.35	2	Across veins.
P24	12" channel	6.0	47.1	46.6	0.84	1.75	0	Across hard, fine-grained tourmaline rock of vein center.
P25	Specimen	2.0	47.0	47.8	0.87	1.86	1	Soft, fine-grained tourmaline rock.
P26	Chip	6.0	34.45	62.0	0.05	.14	0	Across dumortierite vein. Includes 2½" of fine-grained tourmaline rock.
P27	2" chip	6.0	45.55	51.0	0.35	.77	0	Along 15" dumortierite vein. Includes fine-grained tourmaline rock.
P28	5" channel	5.0	49.2	48.75	0.29	.59	0	Hangingwall dacite. Some tourmaline.
P29	6' chip	4.5	40.1	58.3	0.54	1.36	1	Along vein. Fine-grained tourmaline rock.
P30	2' chip	4.5	42.95	55.6	0.41	.96	0	Down dip of 3" fine-grained tourmaline vein.
P31	Specimen	6.0	38.0	60.0	0.34	.90	0	Tourmaline seams in dacite porphyry.
P32	Grab	5.5	42.25	56.3	0.52	1.25	0	3' x 5' area. Dacite porphyry; silicified and tourmalinized.
P32	Grab	5.5	42.29	56.3	0.52	1.25	0	3' x 5' area. Dacite porphyry; silicified and tourmalinized.
P33	40" channel	8.0	40.25	57.95	0.99	1.47	2	Fine-grained tourmaline rock with sulphides and mica.
P34	8" specimen	3.5	52.05	46.0	0.06	1.23	3	Vein center at S. wall shaft No. 15. Tourmaline-arsenopyrite nodules in micaceous matrix.
P34a	——	2.0	47.6	50.8	0.82	1.69	1	Same as P34.
P35	8" channel	5.0	40.35	58.1	0.37	.94	0	Above P34, iron-stained, vuggy tourmaline rock.
P36	Specimen	5.0	45.8	52.55	0.36	.79	0	14" brecciated, quartz-mica-tourmaline vein. S. of shaft No. 15.
P37	3' channel	7.0	37.8	59.45	0.21	.57	0	Across tourmaline vein in dacite porphyry.
P38	4' channel	4.0	44.6	53.35	0.14	.32	1	Includes entire tourmaline vein.
P39	Chip	5.0	46.15	52.2	3.56	7.71	1	Dumortierite and tourmaline, in talcose, chloritic matrix.
P40	Chip	4.0	36.8	60.95	0.37	1.26	0	Center vein in brecciated and silicified vein zone.
P41	2" channel	5.5	33.35	64.8	0.25	.75	0	Across fine-grained tourmaline rock vein center.
P-42	1' channel	6.5	51.05	47.7	1.07	2.25	0	Across fine-grained tourmaline rock vein center.
P-43	——	10.0	53.4	39.55			0	Same as P42.
P44	Chip	3.0	56.35	40.0	0.53	.95	1	1½' cut in mottled tourmaline rock in the hangingwall.
P45	1' channel	3.5	49.45	49.45	1.28	2.65	0	Brown, red stained fine-grained and mottled tourmaline rock.
P46	6" channel	5.0	41.75	56.6	0.59	1.45	2	Similar to P45, but finer grained.
P47	Chip	3.0	43.6	53.9	0.62	1.43	1	Mottled and fine-grained tourmaline rock. Possibly cassiterite.
P48	Grab	9			0.83		1	Lens of vuggy mottled tourmaline rock.
P49	Grab				0.69		2	11' mottled and fine-grained tourmaline rock.
P50	18" channel	3.5	63.5	24.2	0.06	.10	1	Across radial tourmaline vein; quartz center.
P51	10" channel	4.5	94.2	26.8			1	Radial tourmaline at outer edge of vein.
P52	1' channel	6.0	40.1	19.3			1	Along 6" quartz center of vein.
P53	Chip	2.5	38.85	21.15			2	20" across W. side of vein at P52.
P54	1' channel	1.5	45.2	23.6			0	14" zone along S. side of qartz vein center.
P55	Chip	3.0	39.15	31.3			0	Felted, radial tourmaline vein with 4" quartz center.
P56	24" channel	3.5	76.6	34.9			0	Weathered monzonite in hanging wall of vein.
P57	14" channel	3.0	41.7	28.2			0	Dumortierite zone; a few tourmaline seams, below P56.
P58	12" channel	4.0	60.15	34.3			0	Glossy, coarse mottled tourmaline seams, below P57.
P59	18" channel	2.5	41.95	29.1			1	Dumortierite zone; few tourmaline seams, below P58.
P60	6" channel	3.0	75.75				0	Weathered monzonite, below P59.
P61	1' channel	4.5	54.25	30.75			3	Silicified zone 7' above P56. Looks like 10 percent tourmaline pebble quartzite.
P62	12" channel	2.0	58.6	34.9			1	Along 4" vein, 13' W. of P60.
P63	3.5' channel	8.0	33.0	19.2			0	Across dumortierite vein.
P64	18" channel	5.0	36.5	36.2	0.22	.60	0	Dull, fine-grained, micaceous tourmaline vein center.
P65	4.5' channel	5.0	33.2	19.15			0	Mottled tourmaline, 2" vein center omitted.
P66	Grab	6.5	41.0	20.15			0	Tourmalinized (10-15 percent) monzonite.
P67	Specimen	7.0	38.8	22.1	0.19	.51	0	Mottled tourmaline rock.
P68	Chip	5.5	48.8	19.45	0.01	.04	0	White to brown quartz with 10 percent tourmaline.
P69	Chip	2.0	70.7	42.3	0.21	.31	0	Matrix of breccia. Fine-grained glossy tourmaline rock.
P70	Grab	7.5	63.1	38.6	0.04	.07	0	Average of mottled tourmaline rock of "blowout."
P71	Grab	4.0	55.7	52.2	0.02	.03	0	Average of grey tourmalinized monzonite of "blowout."
P72	Grab	8.0	57.4	45.25	0.04	.08	1	Hard, glossy, black tourmaline rock.
P73	Grab	8.5	69.65	36.65	0.04	.06	1	Glossy, fine-grained mottled tourmaline rock.
P74	Grab	5.5	63.95	51.6	0.01	.03	0	Fine-textured tourmalinized breccia.
L 1	1' channel	3.0	163.2	326.7			——	Hard, dull, fine-grained tourmaline rock of 5" vein in monzonite.
L1b	Do	4.5	49.4	49.0			——	Do.
L 2	Chip	7.0	255.75	236.85			3	E. side hanging wall vein at L 1.
L 3	Chip	4.0	252.4	233.6			2	W. side foot wall vein at L 1.
L 4	8" channel		56.3	38.15	0.50	.91	3	Iron stained gouge zone; footwall of fault.
L 5	Chip	6.5	53.5	42.4	0.59	1.11	3	Weathered mottled tourmaline rock; hanging wall of fault.
L 6	5' channel	6.0	51.1	44.1			5	Fine-grained, dark, tourmaline rock.
L 7	Grab	127.3 grams	49.8	69.15	4.54	9.08	0	Red to brown cavity filling in breccia.
L 8	Grab	6.0	271.5	225.0			3	Monzonite from dump of Robinson shaft.
L 9	Grab	8.5	54.3	40.2	1.19	2.19	0	Mottled tourmaline rock; vuggy breccia.
L10	4' chip	10.0	52.3	40.9			——	Do.
L11	3' chip	8.0	52.3	42.7			0	Brecciated, tourmaline breccia.
L12	Grab	10.0	49.8	44.7			0	5 sq. ft. area. Mottled tourmaline rock.
L13	Chip	1.5	48.1	45.7			0	Mottled tourmaline rock.
L14	Chip	8.0	44.7	49.4			0	Mottled tourmaline rock; 40 percent quartz.
L14a	Do	0.5	52.15	41.2			——	Do.
L15	Chip	9.5	54.15	40.35			1 ?	
L16	Chip	8.0	51.6	42.5			——	Coarse mottled tourmaline rock.
L17	Chip	± 825 grams	109.5	138.0			2 0	Dark, tourmalinized breccia fragment.
L18	Chip	8.0	43.7	51.6	0.58	1.33	1	Vuggy, porphyritic tourmaline rock.
L19	10" channel	11.0	51.15	42.7			10	Do.
L20	Chip	3.0	43.7	52.0			0	Vuggy porphyritic tourmaline rock.
L21	8" channel	3.0	280.4	205.7			0	Matrix of tourmaline breccia.
L22	Specimen	3.0	248.35	245.45			2	Mottled tourmaline rock; breccia fragment.
L23	Chip	5.0	229.7	264.95			2	Altered, clayey, monzonite.
L24	Specimen	287 grams	153.8	125.5			0	6" mass of soft, fine-grained tourmaline rock.
L25	Chip	4.5	41.7	53.6	1.51	3.51	2	2" x 4' pocket, fine-grained gouge material.
L26	Specimen	± 2400 grams	636.0	513.0			2	Vuggy, mottled tourmaline rock.
L27	2.5' channel	8.5	50.5	43.8			0	Across vein, south of shaft. Fine-grained tourmaline rock.
L28	6" channel	1.5	56.4	35.2			1	Narrow part of vein. Fine-grained tourmaline rock.
L29	10" channel	6.0	51.2	43.5			5	Weathered wall rock. Some fine-grained tourmaline seams.
L30	2' channel	5.0	53.6	41.0			1	Weathered wall rock. No tourmaline.
L31	15" channel	8.0	58.4	35.1			0	Do.
L32	Chip	8.0	49.8	45.3			0	10" vein of fine-grained tourmaline rock.
L33	2' channel	7.5	50.0	43.7			0	Dull, fine-grained tourmaline rock.
L34	3' channel	4.0	47.3	47.4			2 ?	Mottled and fine-grained tourmaline rock.
L34a	Do	4.5					0	Do.
L35	16" channel	7.0	52.6	45.8			2	Dull, fine-grained and mottled tourmaline rock.
L36	8" channel	1.5	54.8	38.6			3	Felted tourmaline. Same vein as L35.
L37	15" channel	8.0	53.2	41.35			5	Fine-grained tourmaline rock grading into monzonite.
L38	Grab		53.7	42.75			3	Felted tourmaline.

a/ Grain counts contained 1000-4000 grains. The average weight of sample in each was about 0.008 gms.

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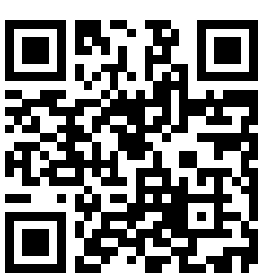

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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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INFORMATION CIRCULAR

MINING AND MILLING METHODS AND COSTS AT THE GLASS-SAND PLANT OF P. J. WEISEL, INC., CORONA, CALIF.

BY

EDMUND SHAW

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DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MINING AND MILLING METHODS AND COSTS AT THE GLASS-SAND PLANT OF P. J. WEISEL, INC., CORONA, CALIF.[1]

By Edmund Shaw[2]

INTRODUCTION

This paper is one of a series being prepared by the United States Bureau of Mines describing mining and milling methods and costs at industrial mineral plants throughout the United States. These papers are designed to disseminate technical information regarding the methods and equipment used. The cost tabulations represent operating expenditures only and not total production costs. It is recognized that publication of total production costs might, in many instances, cause embarrassment to individual producers as well as to the industry as a whole. On the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue.

P. J. Weisel, Inc., with office at La Habra and plant at Corona, Calif., is the only local company that produces sand for the Los Angeles glass factories, although silica sand for other purposes is produced in other parts of southern California and the adjacent portions of Nevada. The deposit at Corona consists of coarse sand imbedded in a whitish clay and differs greatly from the other deposits, which are fine-grained sandstone that must be crushed before it can be screened and washed. The preparation of Corona sand has to be thorough and includes grinding in tube mills, repeated washing and rinsing, removal of dust by air separation, and magnetic separation of iron and other minerals. This requires a plant with a complicated flow sheet. The first plant built did not make a satisfactory glass sand, and many additions and changes were necessary. It is thought that the present flow sheet will remain substantially unchanged until a new plant is built. The design of a new plant would be simpler, but the process would be the same.

Acknowledgment is due G. A. Van Valin, manager, for much of the information contained in this paper and for the explanation of the operation.

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6937."

2/ One of the consulting engineers, U. S. Bureau of Mines.

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HISTORY AND DEVELOPMENT

The deposit was opened and developed by the present owners but under a different management. The plant was erected in 1925. It was not a success commercially because of the cost of experimentation necessary to determine the proper process required to make glass sand from the bank material. Success was attained after the plant was reorganized after many changes in methods and equipment had been made that reduced labor costs.

GEOLOGY

The sand is within an area of marine deposits of Eocene age shown on a geological map of Riverside County (fig. 1), copied from the 25th report of the California State Mineralogist, published in 1929. These marine deposits occupy an area about 25 miles long by an average of 4 miles wide, which extends northwest and southeast. It is bordered on the northeast by the Quarternary plain (through which runs the Santa Ana River) and plutonic rocks (in which there is a granite quarry) and on the southwest side by beds of Triassic limestone.

The deposit is on both sides of a valley through which the State highway from Corona to San Diego has been built. It is assumed that this was once a continuous deposit through which the valley was cut by erosion. The portion now being worked is in a long, low hill, and of this portion an area approximately 1,000 feet long and 800 feet wide has been proved by drilling. Only a very small area in proportion to the whole has been worked. The depth of the present working face is 100 feet, and the floor is in good sand. Drilling has shown that the depth varies with the surface contour from 40 to more than 125 feet. A conservative estimate, made from prospect drilling, places the reserve in this part of the deposit at 700,000 tons of recoverable sand. On the other side of the highway an irregular area, containing approximately 1,000,000 square feet, has been prospected by drilling 100-foot holes, none of which went through the sand. This was reported upon by an outside engineer as containing at least 2,000,000 tons of recoverable sand. There is very little overburden, and if a new plant is built it will probably be in this area across the road from the present plant. Parts of the area now being worked are covered with considerable overburden, but the amount is negligible where the present work is going on.

The deposit is not within the limits of a city or town. There are no houses nearby, and the nature of the operation is such that the nearest neighbor cannot be seriously damaged. The waste water from the plant is used to irrigate an orange orchard, and the solid wastes, mainly clay, pack hard and do not blow around.

The topography is rolling--an area of low hills and rather flat valleys. The mountains of the Santa Ana Range are not far away. Toward Corona the road runs into the flat Quarternary plain and the Santa Ana River valley.

Character of the Material

The deposit consists of small pebbles and sand cemented by a whitish clay Although a good-sized lump can be broken with the fingers, the cementing bond is sufficient to prevent the use of a power scraper for excavating the deposit without

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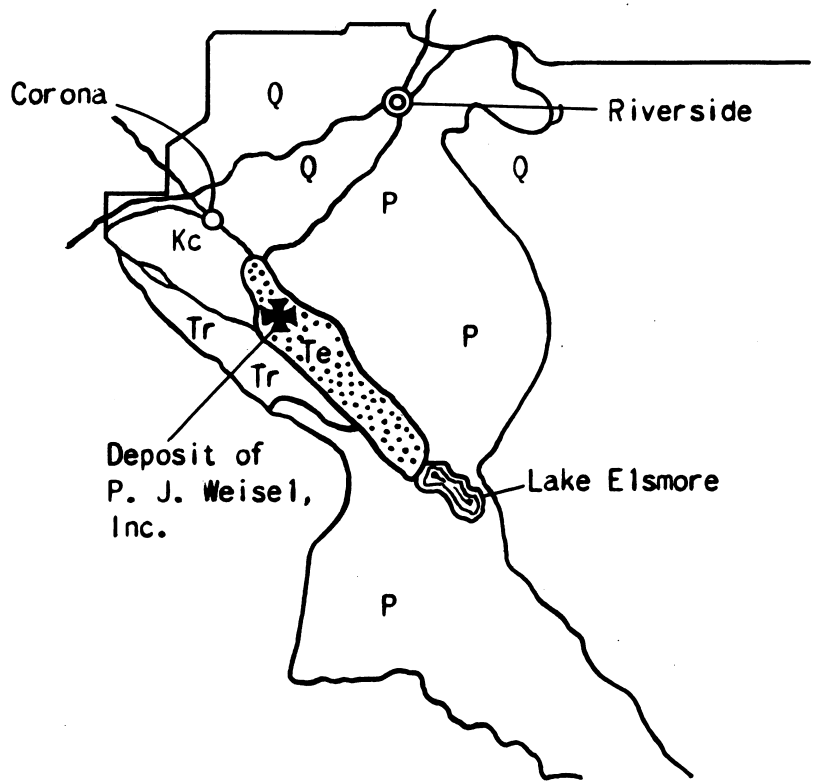

Q Quarternary. Sand, gravel, and clay
Te Eocenic. Marine deposits
Kc Upper Cretaceous. Sandstone, shale, and some lime
Tr Triassic. Heavy beds of limestone
P Plutonics. Granitic rocks

Figure 1.- Western end of Riverside County, Calif.

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first breaking it by blasting. As all excavation, including the floor, is within the deposit, the character of the surrounding rocks does not affect the work in any way.

A mechanical analysis of the bank material is approximately as follows:

Sieve Analysis of Bank Material

	Percent
Clay and fine sand, -200 mesh	30
Sand, +200 to 1/4 inch	62
Pebbles, +¼ inch to -½ inch	8

Pebbles larger than ½ inch diameter occur in negligible quantity.

The sand and small pebbles are almost wholly silica, although grains of feldspar may easily be picked out of the coarser sizes. There is no complete record of a chemical analysis of the bank material, but the finished glass sand has the following composition:

Composition of Glass Sand

	Percent
SiO_2	94.5--96
Al_2O_3	2.5-- 3.5
K_2O and Na_2O, etc.	1.8-- 2.3
Fe_2O_3	.03- .04

The glass factories have set 3 percent Al_2O_3 and 0.05 percent Fe_2O_3 as maximum limits.

The cementing clay dries white and is said to be nearly pure kaolin. The presence of feldspar makes this probable.

PROSPECTING AND EXPLORATION

Prospecting is done by means of a drill rig, designed and built at the plant, of the type generally used for driving water wells. It is set on an automobile chassis, which is jacked up while drilling is going on, so that power can be taken from one of the rear wheels. The bailer, made of a 12-foot length of 6-inch well casing, has a shoe that serves as a bit. The tip is covered with studite (a hard alloy) to take the wear.

In prospecting the unmined area across the road the holes were set about 100 feet apart one way, but not according to any particular pattern. Three were put on the tops of hills, three in valleys, and three on the sides of hills. All were put down 100 feet without going through the sand. No water was found in any of the holes. Every time the bailer was emptied the driller threw in a few buckets of water.

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METHODS OF SAMPLING AND ESTIMATION OF TONNAGE

During prospecting samples were taken from the bailer every 10 feet, and some partial analyses were made on composite samples. No samples of the bank material are taken regularly. Samples of the finished product are taken regularly from the bins and tested for iron in the plant laboratory. The method employed is to fuse with an alkali, make a solution, and compare with a standard color solution. Other determinations are made in commercial laboratories in Los Angeles and Lancaster, Ohio. The dry weight of one cubic foot of bank material is assumed to be 100 pounds, for estimating purposes. Reserves are so large that no record of depletion as a percentage is kept, but occasional measurements are made of the quantity removed in a given time. All sieve testing is done with hand-shaken Tyler Standard testing sieves.

CHOICE OF MINING METHOD

Power-scraper loading was adopted because it was deemed to be the most economical method under local conditions for the tonnage to be handled. Originally the material was loaded and transported to the conveyor belt that fed the plant by scrapers drawn by tractors. This was expensive; the bill for repairs to tractors was about $200 per month, and the labor costs were high. For the comparatively small tonnage (140 tons per day to produce 100 tons of finished sand) the power scraper has been found to be very satisfactory as to both first and operating costs.

Mining is simplified by the fact that there is no dilution with waste and no need for selective mining; everything in the bank goes to the plant. No development is required, and the only plant transportation is by the scraper bucket.

MINING

Holes are drilled by electrically driven coal augers, which penetrate 4 feet per minute. They are set in two rows, at the toe of the bank face, which is 100 feet high and stands nearly vertical. The holes in the lower row are staggered vertically with those in the upper row as shown in figure 2. The lower holes are horizontal and are driven at the level of the floor, but they are slanted 45° from the line of the face. The upper holes are normal to the face, but pointed downward, so that the bottoms are at the floor level. All holes are 16 feet deep.

Augers are made of standard, 1½-inch, twisted steel of 2-inch gage. They are sharpened by cutting the point on the anvil to the right shape and slant without grinding. The points are hardened by heating to a cherry red and then plunging them into water. This has been found to produce the best wearing point.

Sixteen holes are loaded with 40 percent dynamite and shot at one time. No. 6 caps and fuse are almost always used for firing, but when the pit foreman judges that simultaneous firing would be better because of the condition of the face electric detonators and a battery are used. All the details of drilling and blasting are left to his judgment. The consumption of explosives averages 1/10 pound per ton of bank material brought down.

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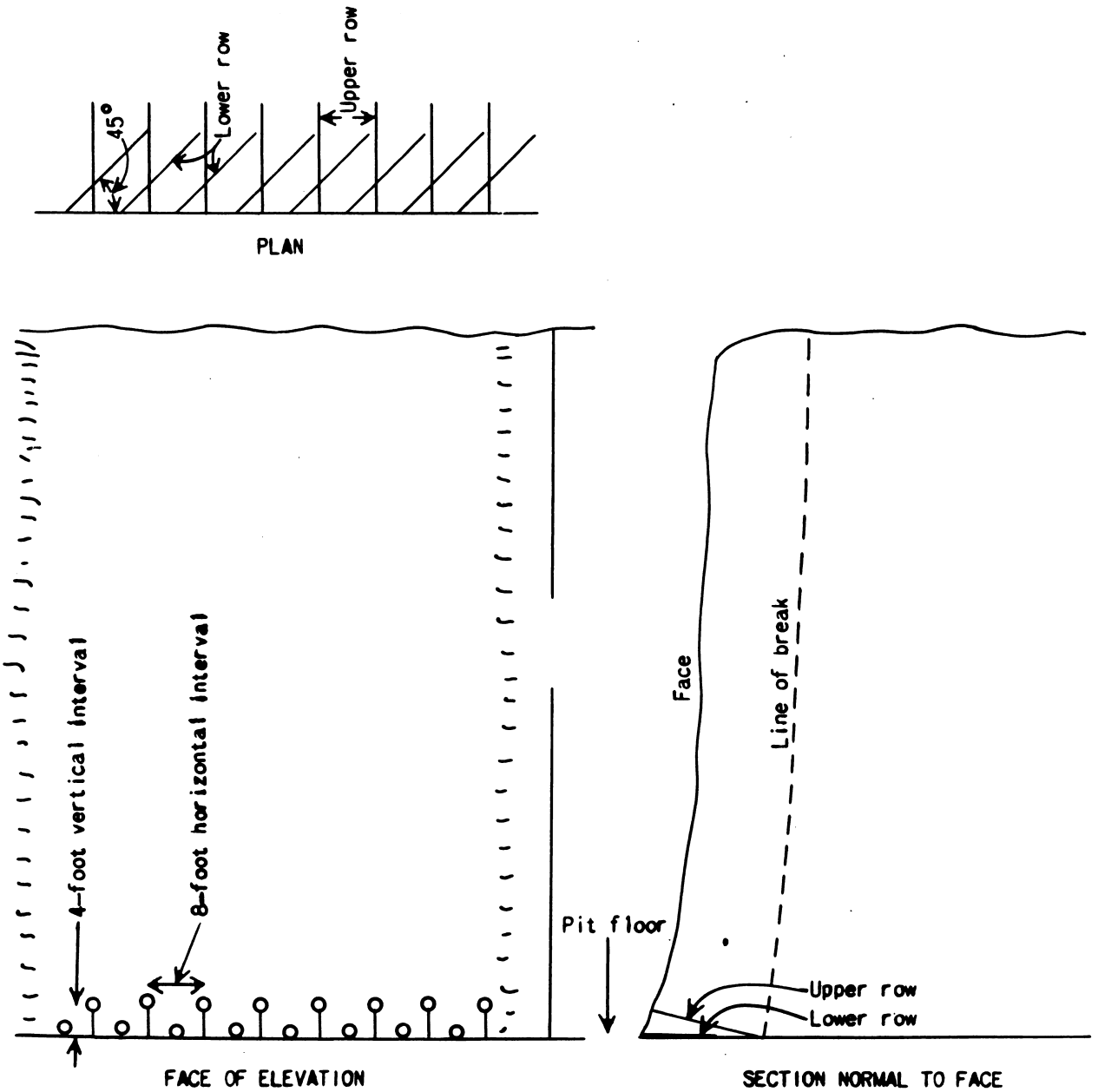

Figure 2.— Position and direction of holes in a 16-hole shot.

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Recently blasting with vertical holes, put down with the prospecting drill rig described, has been tried. Holes were drilled 18 feet apart, 18 feet back from the face, and were 90 to 125 feet deep, all holes being bottomed at the level of the floor. Each hole was loaded with 200 pounds of powder--two-thirds at the bottom and one-third at the center of the hole. The results were so satisfactory that this method may be adopted for regular work, especially if production is increased.

LOADING AND TRANSPORTING TO PLANT

The material shot down is drawn to the belt that feeds the plant by means of a crescent-shaped, $\frac{3}{4}$-yard, power scraper bucket, operated by a hoist with a 50-horsepower, 440-volt, alternating-current, induction motor. The current is supplied by a transmission line carried on poles. The inhaul rope is $\frac{3}{4}$-inch and the outhaul 1/2-inch in diameter. The life of these ropes under present conditions has not been determined, but it is more than 1 year. The speed of the bucket is 300 feet per minute going out empty and 240 feet coming in loaded. The two men who do the drilling and blasting also operate the scraper and do all other necessary work in the pit, except that they may call on others employed in the plant to help change sheaves and for other extra work.

At the inhaul end the scraper is drawn up a 10° incline built of steel rails to discharge into the hopper that feeds the plant conveyor belt. The rails are set 12 inches apart and serve as a grizzly, lumps that will not pass being broken by hand. At present the bucket travels about 200 feet, and the discharge hopper is about 225 feet from the hoist house, the total span being 425 feet.

The plant conveyor, described in detail later, is 250 feet long and has about a 1 to 3 inclination. It discharges into a rod grizzly, the first of the plant machines.

GRINDING

As the material is not closely consolidated it disintegrates in the preliminary scrubbing and washing until everything passes a $\frac{1}{2}$-inch round-hole screen. Hence, no preliminary crushing is required and the necessary reduction can be made in a tube mill 18 feet in length and 6 feet in diameter, outside measurements. The feed is 60 percent solids and 40 percent water by volume. The tube mill is lined with silex blocks, which reduce the inside diameter to about 5 feet and the inside length to about 15 feet. The blocks are imported from Belgium and cost $24 per ton at the plant, freight included. Danish pebbles Nos. 3 and 4, which are approximately 3 and 4 inches in diameter, are used for grinding. The pebble load approximates 23,000 pounds. They cost $20 per ton at the plant, and 200 pounds is added each week. The life of the block lining has not been determined under present conditions, but it is estimated from measurements that it will last for more than 10,000 tons.

Formerly an 8-foot double conical mill was used for this work, but this is now used as a scrubber for blast sand stock and is run without pebbles. Block linings in this mill were worn out after grinding 4,000 to 5,000 tons.

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SCREENS

The screens in this plant are numbered from 1 to 10 on the accompanying flow sheet (figure 3).

Screen 1

This is a trommel that receives the original feed after it has passed a revolving rod grizzly and a revolving scrubber. The trommel is an extension of the scrubber and is on the same shaft. It is 11 feet in length and 4 feet in diameter, and has ½-inch round holes. The oversize is practically negligible in quantity. What little there is consists of clay lumps that fall to the ground and are taken away in a wheelbarrow and thrown into an old working. All that passes this trommel goes to washer 2, an inclined screw, which is followed by a paddle washer, No. 3, and then it goes to screen 2.

Screen 2

This is a 3- by 6-foot, double-deck, flat screen inclined 30°: It is hinged at the lower end and vibrated at the upper end by an eccentric shaft. The upper deck carries 6-mesh cloth and the lower 14-mesh. Oversize (plus 6-mesh) and undersize (minus 14-mesh) are washed in washer 5 and then go to the tube mill. The intermediate sizes (between minus 6- and plus 14-mesh), comprising raw material for blast sand, go to the double conical mill through washer 4.

Screen 3

This is a 3- by 6-foot inclined screen, resting on the ends of flat wooden springs, vibrated by an unbalanced pulley 600 times per minute. It is set at the highest point of the plant and receives the blast-sand stock after it has been washed in washer 6. The feed is lifted to it by elevator 1. The screening medium is 30-mesh wire cloth, and the undersize goes by gravity to one of the glass-sand washers (No. 11) below it. The oversize (blast-sand) goes to a drainage bin and then to the drier if it is to be dried. Some of it is sold in a damp state.

Screens 4 and 5

These are 3- by 6 feet and of the same type as screen 2 except that they are single-deck screens. They are in parallel with screen 6, and all three are covered with 30-mesh wire cloth and are fed from a revolving distributor. These three are the main plant screens for separating the glass sand from the discharge of the tube mill. The oversize, after passing screens 7 and 8, is returned by gravity to the tube mill. Screens 4 and 5 operate at 600 vibrations per minute.

Screen 6

This screen was designed and built by Robert Rawson, the plant foreman, his purpose being to design a screen that had no whipping motion and that would be easier on the screen cloth. In this he was successful, the brass wire cloth having about twice the life on this as on the other screens. When the screen was designed this brass cloth cost $8 per screen and its life was about 10 days.

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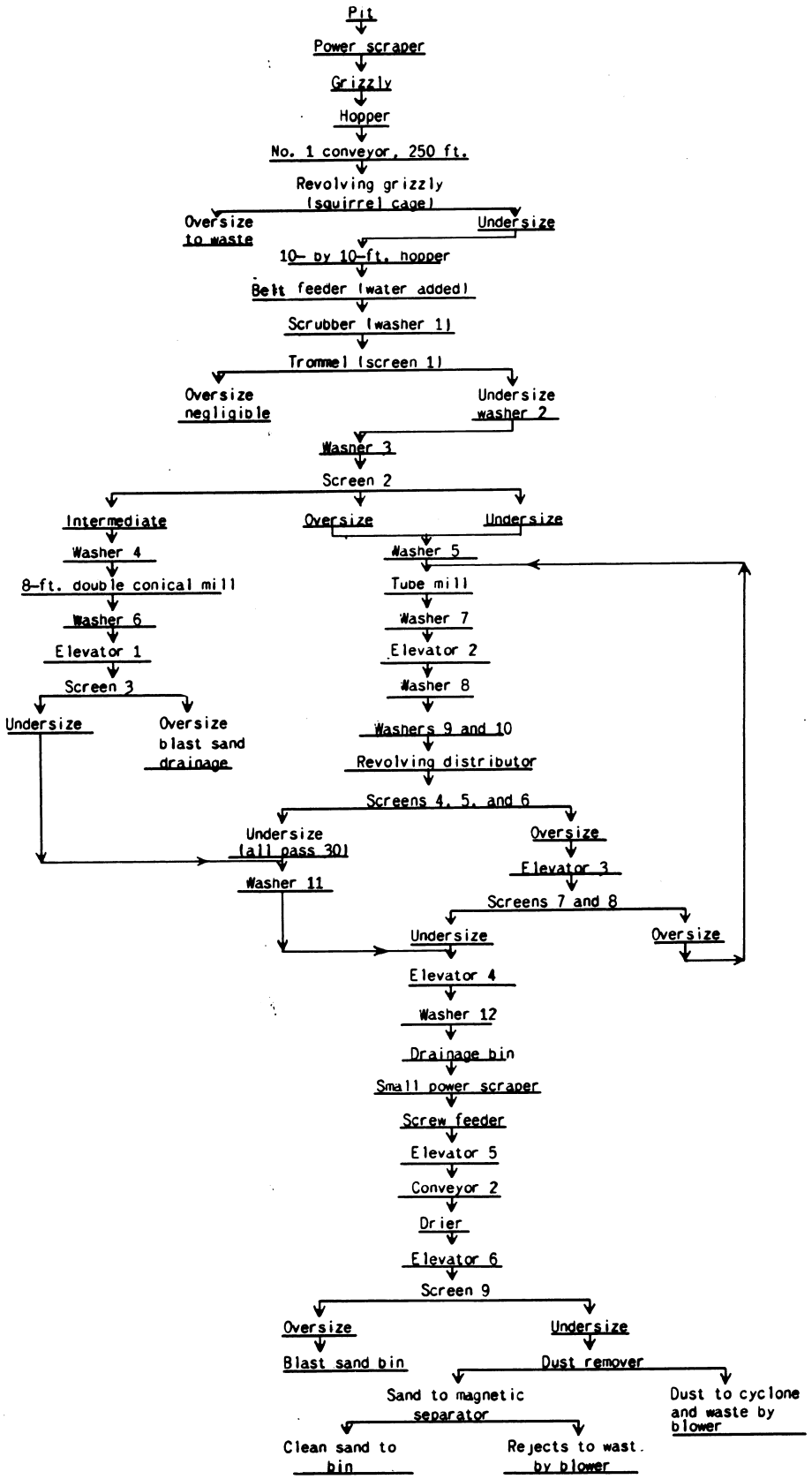

Figure 3.- Flow sheet of silica-sand plant of P. J. Weisel Inc.

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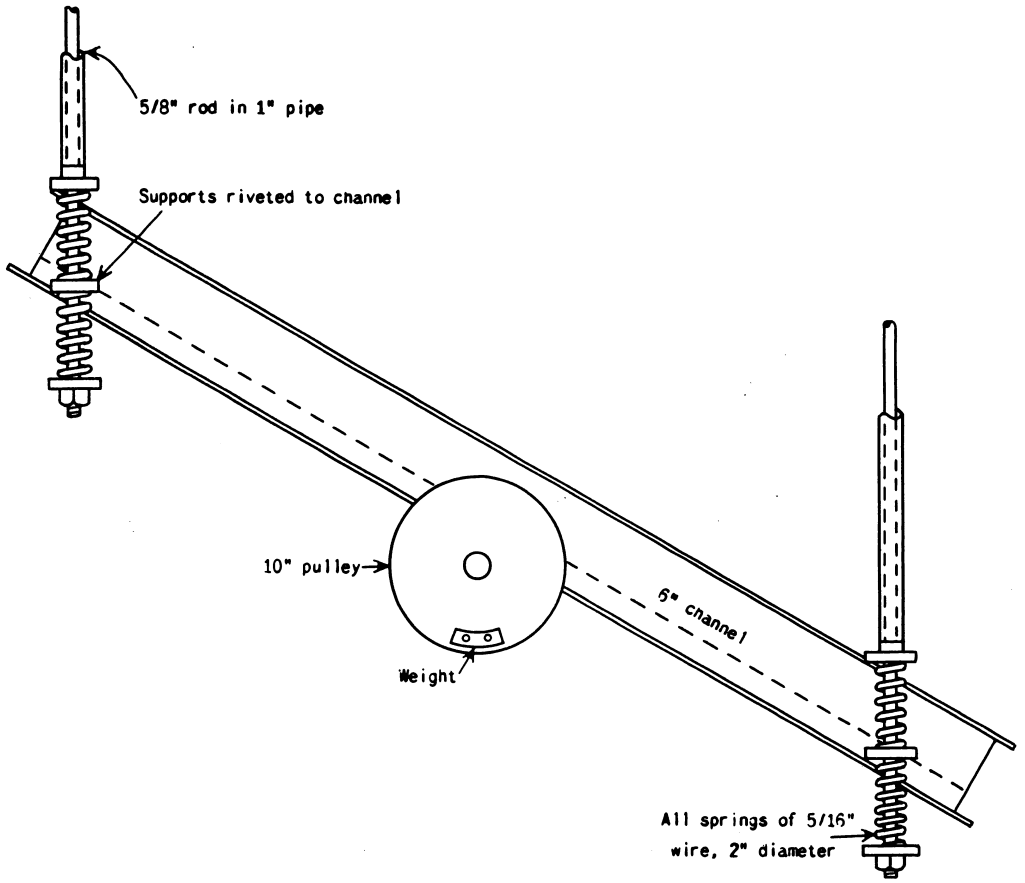
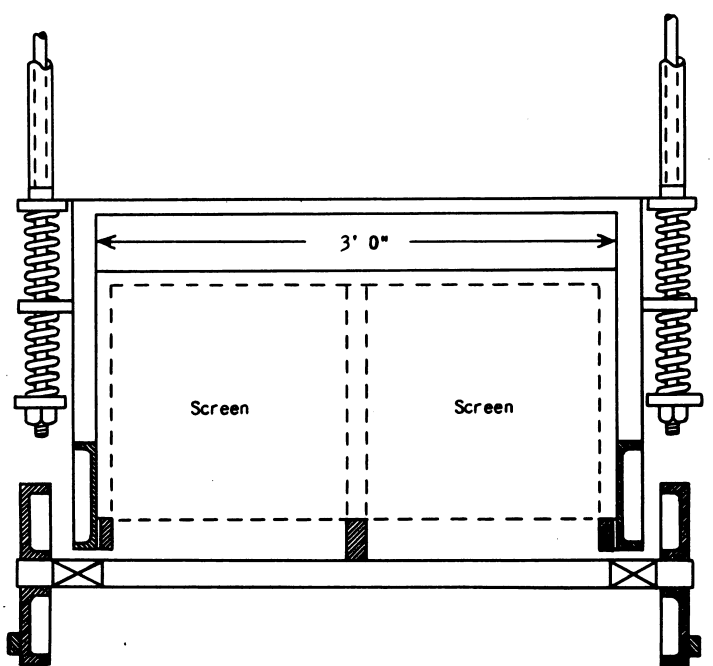


SIDE ELEVATION



SECTION ON CENTER LINE OF PULLEY

Figure 4.- Rawson screen.

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Experiments with stainless-steel cloth have shown it to be much cheaper because its life is more than twice that of the brass cloth. Tests had not been completed when this was written.

The screen is set at the same angle as the others--30° from horizontal. The corners of the frame rest on four spiral springs, which are at the bottoms of the 4 rods by which the screen is suspended. On the same rods are four other spiral springs set to resist upward motion, just as the lower springs resist downward motion. The frame is vibrated 720 times per minute by a belt-driven shaft that carries two unbalanced pulleys. The amount of vibration is varied by changing the weights that throw the pulleys out of balance. The construction of this screen is shown in figure 4.

Screens 7 and 8

These are 3- by 6-foot electrically vibrated screens of the type that vibrates the cloth by a centrally located magnet and armature without vibrating the frame. They are covered with the same 30-mesh wire cloth that is used on screens 4, 5, and 6. Screens 7 and 8 are set in parallel and are fed with the oversize of 4, 5, and 6, which is elevated to them by elevator 3, thus putting these two screens in series with the other three. The oversize goes back to the tube mill by gravity; the undersize joins the undersize of screens 4, 5, and 6 from washer 11 to elevator 4 and is elevated to washer 12.

Screen 9

This is a vibrating screen of the same type as screens 7 and 8. It is fed with the hot material from the drier by means of the chain-and-bucket elevator 6. The oversize always goes to the blast-sand bin, whether blast sand or glass sand is being treated. The undersize goes to the dust remover and magnetic separator and then to the clean-sand bin. The purpose of this screen is only to keep foreign matter and accidental oversize out of the products, so it is covered with a larger-mesh cloth (no.16) than the other screens.

Screen 10

This screen is of the same type as no. 2 and nos. 4 and 5, vibrating 600 times a minute, but it is mounted on a frame that is on wheels so that it can be moved anywhere on the floor below the bins where the trucks are loaded for delivery. The drive is a 2-horsepower induction motor attached to the supporting frame. The undersize goes to an inclined portable belt conveyor, which discharges into the truck, and the oversize, usually small in amount, is shoveled into a wheelbarrow to be wheeled away. The purpose of the screen is to remove foreign matter and accidental oversize, but sometimes it is used to split blast sand into two sizes.

CONVEYORS

There are two belt conveyors in the plant, and a portable conveyor used in truck loading.

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Conveyor 1

This conveyor brings the feed from the pit to the plant. It has a 24-inch belt, is 250 feet long, center to center of pulleys, and runs at a speed of 190 feet per minute. It is supported on a trestle at an inclination of approximately 1 to 3. The lower end takes the feed from the hopper under the rail grizzly, which serves as a track for the power scraper. This is in a pit below the general ground level. The belt passes over the trestle, out of the pit, and discharges to the "squirrel cage" (rod grizzly), which is above the main feed hopper. This belt runs on three-roll troughing idlers with standard, greased, babbited bearings which have been found to give better service than some types of antifriction idlers that were tried and that became filled with sand and locked. Some idlers have been in service 10 years.

Conveyor 2

This conveyor feeds the drier. It is a 12-inch belt, 30 feet long center to center of pulleys, and handles about 6 tons per hour. The feed is drained sand that is lifted to it by elevator 5. The amount of feed is controlled by a screw feeder that discharges into the elevator boot.

Portable Conveyor

This is a 12-inch belt conveyor on a frame that is carried on wheels and is 32 feet long, center to center of pulleys. It is driven by an induction motor mounted on the frame. The type is the ordinary commercial portable conveyor used for loading coal at retail yards and for many other industrial purposes

ELEVATORS

The plant has five bucket-and-belt and one chain-and-bucket elevators. These are numbered from 1 to 6 in the flow sheet. All are of the centrifugal-discharge type. All but no.6 handle pulps with fairly high moisture content.

Elevator 1

This elevator has a 36-foot lift and a speed of 250 feet per minute. The belt is 10 inches wide and the buckets are 6 by 6 by 9 inches. It is inclined about 5° from the vertical; all the other elevators are vertical. Its feed is the blast-sand stock that has been scrubbed in the double conical mill and washer 6, and it lifts this to screen 3.

Elevator 2

This has a 26-foot lift and a speed of 250 feet per minute. The belt is 10 inches wide and the buckets are 6 by 6 by 12 inches. It receives the tube-mill discharge after it has been washed in washer 7 and raises it to washer 8.

Elevator 3

This has a 20-foot lift and a speed of 250 feet per minute. The belt is 10 inches wide and the buckets are 6 by 6 by 9 inches. It lifts the oversize of screens 4, 5 and 6 to screens 7 and 8, for rescreening.

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Elevator 4

This has a 20-foot lift, a speed of 250 feet per minute, and the same size belt and buckets as elevator 3. It lifts the undersize of screens 4, 5, 6, 7, and 8 to washer 12.

Elevator 5

This has the same lift, speed, and sizes of belt and buckets as nos. 3 and 4. It lifts the drained sand, fed to it by the screw feeder, to conveyor 2, which feeds the drier.

Elevator 6

This is a chain-and-bucket elevator of 30-foot lift with 5- by 5- by 5-inch buckets. It lifts the hot sand from the dryer to screen 9. This elevator has a steel housing; all the others have wooden housings.

GRIZZLIES

There are two grizzlies. The first is in the pit and receives the scraper-bucket discharge. It is made of 90-pound rails, 20 feet long, and is set at about 10° from horizontal to provide a track on which the scraper may be drawn above the hopper that feeds conveyor 1. Only the part above the hopper acts as a grizzly, and the sand is allowed to build up to the rails outside of the hopper. This grizzly may be rotated in line with the direction of the scraper's path.

The other grizzly, called a "squirrel cage" in the plant, is a revolving rod grizzly made of old 1½-inch pump rods fastened to circles of flat iron on spiders, by which they are held to a central shaft. The speed is 18 revolutions per minute. The oversize is lumps of clay that go to a waste pit in an old working. Besides taking out these lumps of clay, the grizzly is useful to break up lumps of partly cemented material so that it may be screened and washed in the scrubber-trommel below. The grizzly is 12 feet long and 4 feet in diameter and the rods are set with 4-inch clear spaces. The discharge falls directly into a 10- by 10-foot hopper.

WASHING EQUIPMENT

The Washing equipment includes a revolving scrubber, four "paddle washers" (which are really scrubbers, as they have no overflow), one inclined screw washer, a "monkey-motion" washer, two rake-type classifiers, three drag-belt classifiers, and a 10-foot thickener for washing fine sands.

Washer 1

The first washer is the revolving scrubber, 4 feet in diameter and 5 feet long, inclined 1½ inches per foot and held by spiders on the same shaft as the trommel that follows it and to which it is attached. It is a cylinder of steel plate on which are riveted "lifters" that lift and turn the material as it passes through. The outlet is baffled a little to hold some water and feed in the

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scrubber. The feed comes from the hopper above (below the rod grizzly) through a 12-inch by 6-foot screw feeder. About 150 g.p.m. of water is added, this being the overflow of the 10-foot thickener, which receives the overflows of all the washers in the plant following the tube mill. The regular rate of feed is 140 tons, dry weight, of solids per 8-hour day.

Washer 2

This is a factory-made inclined screw washer, a 16-inch screw conveyor in a trough about 10 feet long, set at 18° from horizontal, and running at 18 r.p.m. It receives the undersize of the trommel (screen 1), which has been washed in the scrubber, and sends it to washer 3. The overflow of this washer contains more clay and fine sand than the overflow of any other washer. It goes to a 16-foot thickener, first passing over a 7-foot cone in which coarser particles settle, to be clarified for use in the mill.

Washer 3

This is one of four paddle washers, all of which were designed and built at the plant. They are something like log washers in appearance but are set horizontally, and have flat blades between the inclined blades that cut through and urge the pulp along (as in a log washer). The purpose of these flat blades is to break lumps of clayey sand that may be formed by the pressure of the screws against the moving mass. All the paddle washers have blades of the same size and type, 13-inch radius, which are set on a 1-15/16-inch shaft. The drive is by a chain and sprocket connection to a jack shaft and pulley and the speed is 65 r.p.m. The length of the paddle washers varies. Washer 3 is 12 feet long. These paddle washers have been found to give better results on this difficult material than any form of washer or scrubber that has been tried. The construction is shown in figure 5.

Washer 4

This is another paddle washer of the same dimensions and speed as washer 3.

Washer 5

This is called the "monkey-motion" washer because the linkage that moves the rakes that pull out the sand and raises them on the return has a peculiar motion. It was designed and built at the plant. The washer is 16 feet long, has 24-inch rakes, and is run at 32 strokes per minute.

Washer 6

This is a factory-built, rake-type washer, 16 feet long, with 32-inch blades. It washes the discharge of the double conical mill (blast sand) and its product goes to elevator 1 and screen 3.

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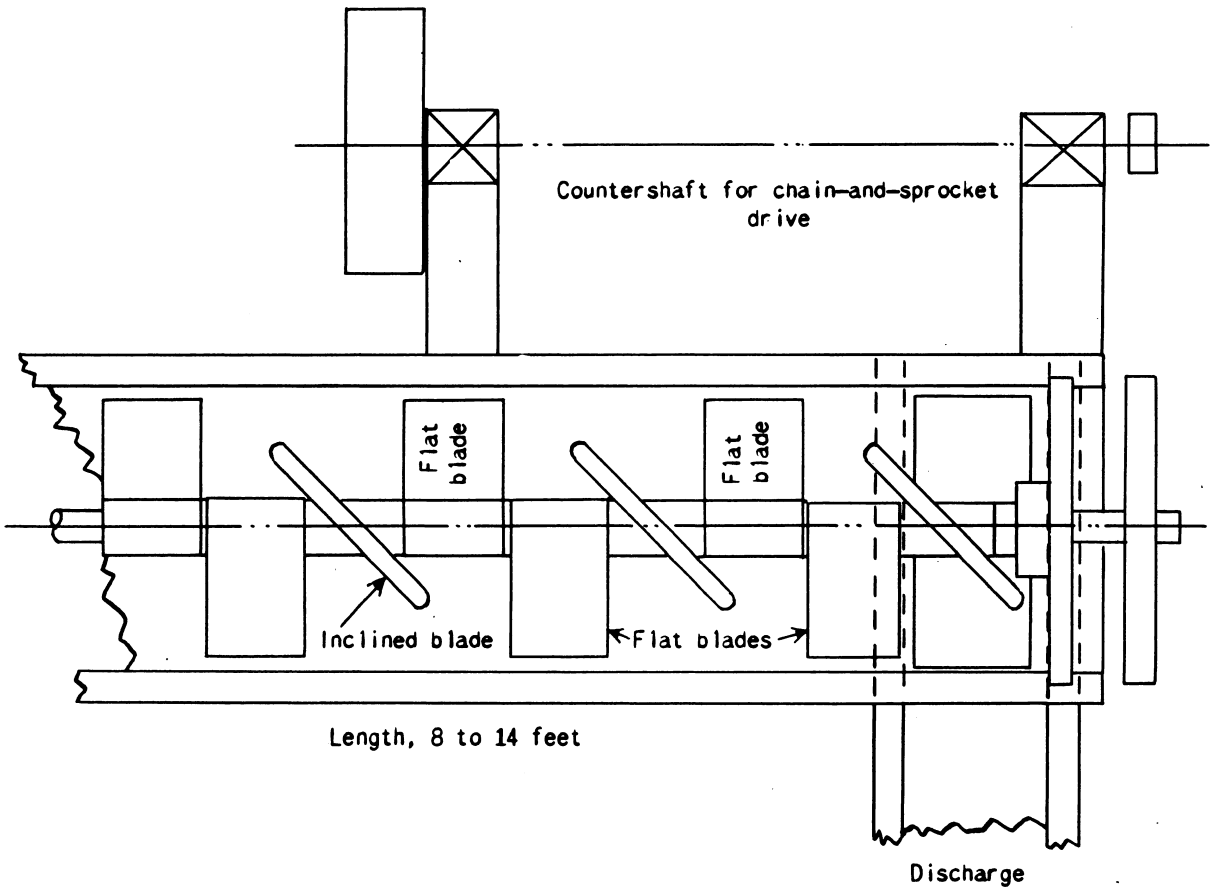
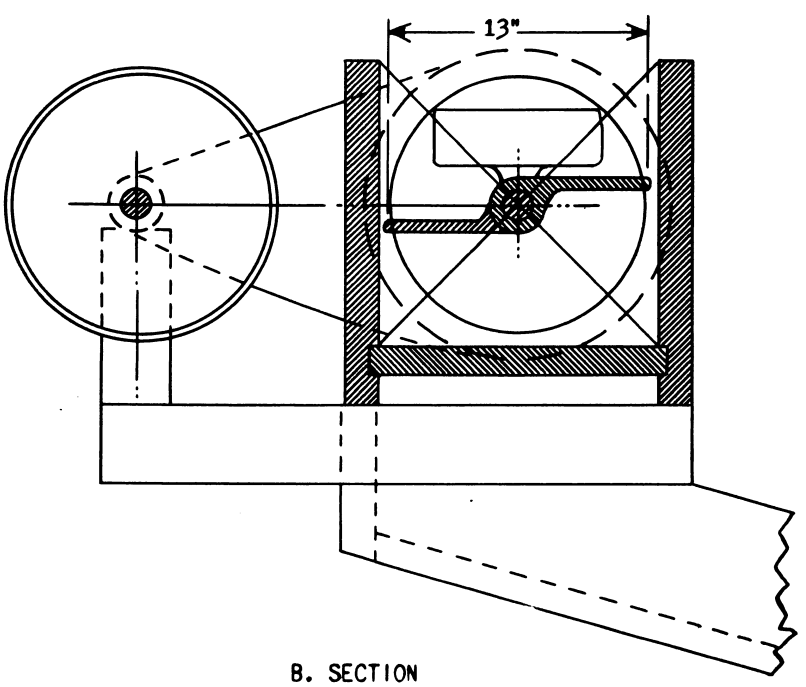


A. PLAN



B. SECTION

Figure 5.- Paddle washer.

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Washer 7

This is a drag belt 16 feet long, the length given for all these washers being that of the box. All drag belts were made at the plant. Both pulleys are set in bearings on the edges of the box so both are out of the water. The tight side of the belt is the digging side, which is not the usual practice in plants where the load is heavy; and the inclination is about 10°, varying with the length of the box. The overflow is at the end and the speed is 48 feet per minute. Washer 7 has a 10-inch belt which carries 18-inch flights. It receives the discharge of the tube mill and its product goes to elevator 2 and is elevated to washer 8.

Washer 8

This is a factory-built, rake-type washer, 16 feet long, with 32-inch rakes, that washes the discharge of washer 7. The discharge from washer 8 goes by gravity to washers 9 and 10.

Washers 9 and 10

These are paddle washers (or scrubbers) of the type described, set in parallel, and 8 and 10 feet long, respectively. The pulp from these is diluted with water at the rate of 10 g.p.m., and then goes to the revolving distributor that feeds screens 4, 5, and 6.

Washer 11

This is a drag belt 14 feet long with a 10-inch belt and 18-inch flights. It takes the undersize of screens 3, 4, 5, and 6 and delivers it to elevator 4, which discharges to washer 12. Washer 11 has overflows on three sides instead of only at the end.

Washer 12

This is a drag belt 14 feet long with a 10-inch belt and 24-inch flights. It is wider than the others to provide a greater settling area because it receives the fine sand from the 10-foot thickener.

The 10-Foot Thickener

This is 4 feet deep and has a flat spiral instead of the usual blades to bring the settled solids to the center discharge. The speed is $3\frac{1}{2}$ r.p.m. Both this and the 16-foot thickener (described on page 12) were originally fitted with rakes, and both have shown better settling and dryer discharge since the spirals were put in. The solids from this 10-foot thickener go to a 5- by 8-inch spiral pump, which lifts them to washer 12. The overflow is pumped by a 4-inch centrifugal pump to the scrubber trommel (washer 1), as described.

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PUMPING

Figure 6 is a flow sheet of the water-supply system.

All fresh water comes from a well 82 feet deep and is raised by a deep well turbine pump of 500 g.p.m. capacity to a 10,000-gallon storage tank, which is 1/2-mile distant from the pump and 1/4-mile from the plant. The usual tank-water level is 117 feet above the lowest floor of the plant.

The water comes to the plant through a 6-inch pipe that terminates in a 6-inch vertical column extending from the bottom to the top of the building. It has the following outlets: A 3-inch line that supplies 20 g.p.m. to the washer that receives the tube-mill discharge; a second 3-inch line that supplies 120 g.p.m. to drag belts 7, 11, and 12 and one rake classifier, no. 8; a third 3-inch line that supplies 500 g.p.m. to the sprays on screens 4, 5, 6, 7, and 8; a 1½-inch line that supplies 10 g.p.m. of water to the revolving distributor; and a 1½-inch line that supplies 50 g.p.m. of water to screen 3.

For clarifying the plant water there are two thickeners, the 10-foot thickener described and a 16-foot thickener, which is 4 feet deep. The latter has a flat iron spiral (instead of rakes), which revolves once in 4 minutes and 40 seconds. This receives the overflows of all the washers that precede the tube mill. They flow to a sump, from which they are pumped by a 5½- by 8-inch spiral pump and pass through a 7-foot cone to remove heavy solids.

The solids from this thickener are mostly clay, with some fine sand and mica. They run by gravity to a settling sump, which is part of an old working. Here the solids settle hard and the water runs to an orange orchard below, where it is used for irrigation. Occasionally the solids are dug out with a small, home-made, cableway scraper and are stacked in a pile. This disposal of the tailings is paid for by the owner of the orange orchard and is not charged to sand production.

The overflow of this thickener goes to a high-speed, 1½-inch piston pump which discharges into the clear water line.

DRYING AND DUST REMOVING

The washed sand from washer 12 goes to drainage bins and is drawn to the boot of elevator 5 by a home-made drag or scraper. This is a flat plank with plow handles. It delivers the sand to a screw conveyor 9 feet long with 9-inch-diameter flights. The trough has an open top and is kept filled by the scraper so that the screw delivers a uniform feed to the elevator, which in turn delivers to the 30-foot conveyor belt that feeds the drier. The feed may be varied by changing the pulleys that drive the screw feeder.

The drier is of the direct-indirect type, 20 feet long and 6 feet in diameter. It uses 33 cubic feet per minute of natural gas and usually delivers 6 tons per hour of dried sand, the output being 75 to 80 tons per day. The remaining production is sold damp for polishing, plastering, and other industrial purposes. There are no available data from which the efficiency of the drier may be calculated. The feed is estimated to contain 8 to 10 percent moisture, and no moisture can be detected in the product by the time it has passed the dust remover and magnetic separator.

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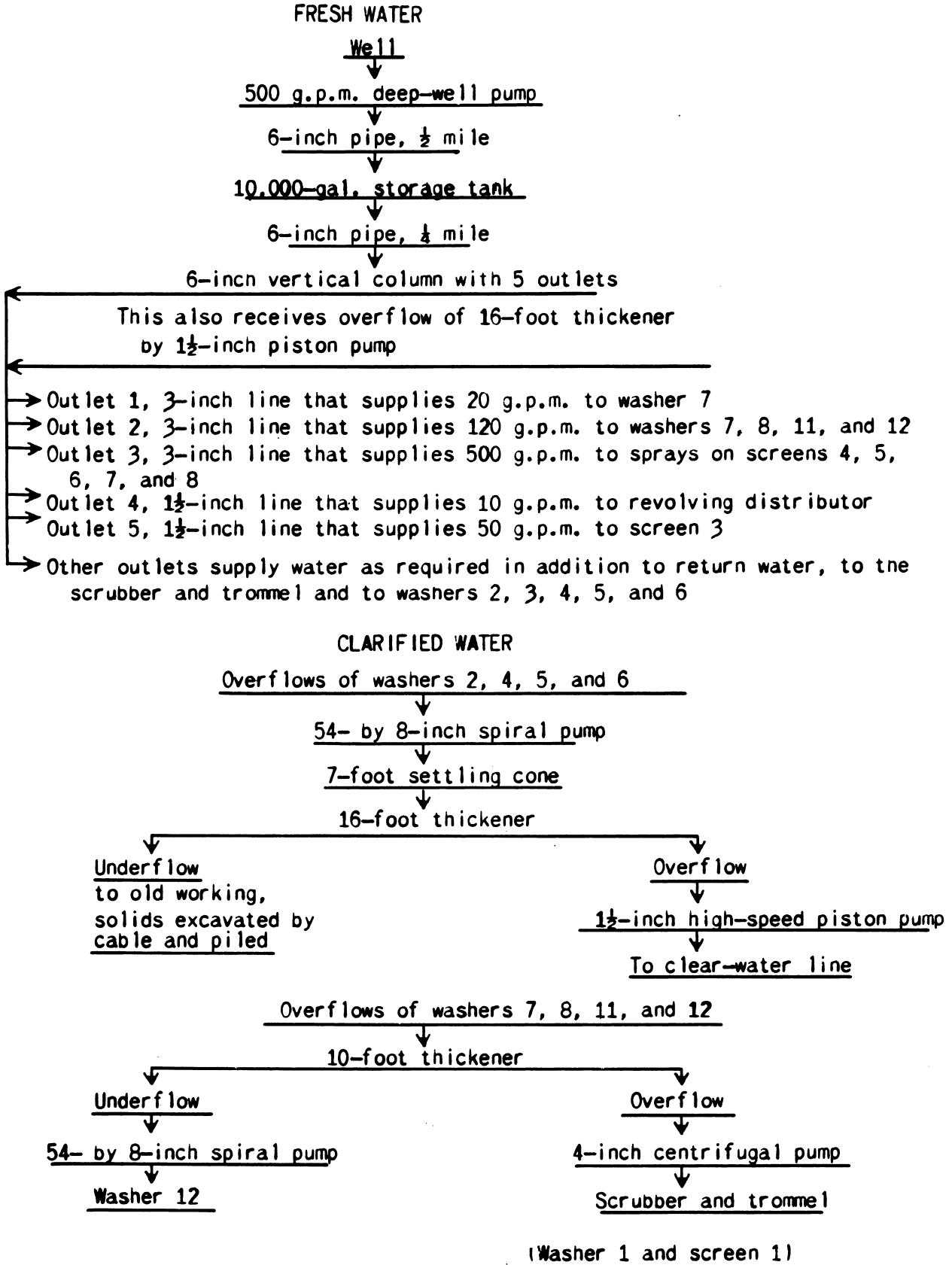

Figure 6.- Water flow sheet.

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The dried sand is elevated by a chain elevator (no. 6) to a 16-mesh, electrically vibrated screen (no. 9), which removes accidental oversize and foreign matter. The undersize goes to the dust remover, which serves also as a cooler. This dust remover was designed by Mr. Rawson, the plant foreman, and was built at the plant. It is a box 6 feet long and 3 feet wide, two pyramidal hoppers forming the bottom. There is a flap between the two that is hinged at the bottom so that it may be thrown over to cover either hopper, according to whether glass sand or blast sand is being dried. Chutes lead from the hoppers to the magnetic separator and blast-sand bins.

The feed comes from elevator 6, which takes the sand directly from the drier, which has its feed controlled by a screw feeder; hence the quantity is kept uniform. It goes into a small hopper over a feed roller that spreads it into a thin sheet. This falls in front of a screened opening in the end of the box. The box is under suction, which draws air through the screened opening and through the falling feed, removing dust and also cooling the sand. The other end of the box is reduced to a point, to which is attached a 4-inch pipe connected to a blower that furnishes the suction and blows the sand to a cyclone above a waste pile.

A sample of the waste, which did not include the finest dust that escaped with the cyclone exhaust, had the following sieve analysis:

Sieve Analysis of Dust Removed

Mesh	Percent
Retained on 30	0.8
Pass 30, on 60	7.5
Pass 60, on 80	7.8
Pass 80, on 100	23.1
Pass 100, on 150	34.3
Pass 150	26.5
	100.0

The sizes above 100-mesh were almost wholly mica, and there was some mica in the smaller sizes.

The glass sand flows by gravity from the dust remover to the magnetic separator. This is a commercial machine of the type that employs a closed magnetic circuit. The electric magnets, set in groups of three, terminate in pole pieces that are grooved to receive soft-iron rollers about 6 inches in diameter. On the other side of these is a soft-iron frame, also grooved at top and bottom to receive the same rollers. Adjusting screws make it possible to vary the gap between the frame and the rolls. This frame acts as an armature and completes the magnetic circuit, making magnetic fields in which the rolls revolve. This magnetizes the rolls, except on the neutral line between the magnets and the soft iron frame. At that point the surfaces of the rolls lose their magnetism until they have passed it and are under the influence of the magnets or the armature frame again. There are three sets of magnets, rolls, and frames set vertically, so that the sand flows from the highest, which serves as a rougher, to the lowest, from which finished sand is discharged.

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The feed flows over the rolls in a thin stream, from which the magnetic minerals are collected by adhering to the rolls. When the neutral point is reached these minerals drop off and go to a box, from which they are drawn by the suction of a blower similar to that used for handling the waste from the dust remover. No cyclone is needed to settle this waste for almost all the dust has been removed. It is allowed to pile up in the open. A sample taken from the pile had the following sieve analysis:

Sieve Analysis of Magnetic Separator Rejects

	Percent
Pass 30, on 40 mesh	24.3
Pass 40, on 60 mesh	45.6
Pass 60, on 80 mesh	10.7
Pass 80, on 100 mesh	10.2
Pass 100, on 150 mesh	6.8
Pass 150	2.4
	100.0

With a pocket magnifier the following minerals were noted in the rejects: Mica, (both biotite and muscovite), garnet, dried clay in fine grains, dark silica grains, and metallic iron that was presumably abraded from the pipes and the parts of washers with which the sand came in contact while passing through the plant.

STORAGE, DELIVERY, AND MISCELLANEOUS

The sands ready for shipment, whether damp or dried, fall by gravity into storage bins, which will hold about 10 days' run. They are supported on posts above a concrete floor that forms a truck driveway. The ordinary way of loading, however, is for the truck to take the undersize of portable screen by means of a portable conveyor. These have already been described.

The truck takes the sand to a railroad siding where the company has hoppers for car loading. Most shipments are made by rail.

PERCENT EXTRACTION

From measurements of the ground excavated and from the shipping weights of the various products sold it is calculated that 70 percent of the bank material extracted is sold as finished product. Of this, from 70 to 75 percent is sold as glass sand and the remainder as blast sand and for other industrial uses.

PAY SYSTEM, SAFETY METHODS, AND ADMINISTRATION

The base pay is $0.50 per hour, and the men work 8 hours a day and 6 days a week. Safety practices comply in all respects with the California laws, but there is no first-aid organization. The only lost-time accident in 5 years was a foot injury that kept a man at home for 6 days.

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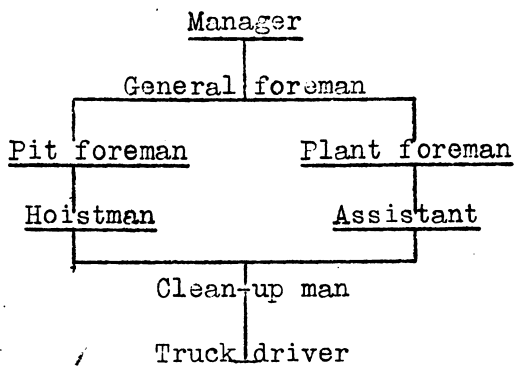
Seven men are employed, including the general foreman. An organization chart is presented below.



COSTS

While the total production costs of the sand actually shipped have been kept carefully, there are no detailed figures. To obtain figures that would represent the costs of the various parts of the operation the totals were divided and allocated according to the judgment of the manager and the general foreman. In this they were guided somewhat by detailed cost figures that were kept several years ago under different operating conditions. The totals were found each month by adding all items chargeable to mining for mining cost and all chargeable to milling to milling cost, and sums of these totals were taken for a period of average production, the results being 16.9 cents for mining and $2 for milling costs.

Mining Costs

Drilling and blasting

	Cents per ton
Labor	4.0
Supervision	1.0
Explosives	1.7
Power	.1
Other supplies	.1
Total	6.9

Loading and transportation

	Cents per ton
Labor	4.0
Supervision	1.0
Power	3.5
Supplies	1.5
Total	10.0

Total cost, per ton of finished product, 16.9 cents per ton.

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Milling Costs

	Cost per ton
Tube-mill grinding	$0.30
Screening	.20
Elevating	.10
Conveying	.05
Scrubbing	.05
Washing	.05
Pumping	.17
Clarifying water	.03
Drying	.40
Hot screening, elevating, and dust removing	.15
Magnetic separation	.15
Storage and trucking, including loading with screen and portable conveyor	.35
Total milling cost	2.00

This cost is per ton of finished product. It is expected that this cost and the mining cost will be considerably lower with increased production, as only one more man is needed to increase the production 50 percent. The power cost will remain the same and the supplies will be increased but not in as great proportion as the production.

Effort is made to keep the average production at 100 tons per 8-hour day. On this basis the man hours per ton would be 0.56. The motor ratings add to 250 horsepower, and on the basis of continuous full-rated load the power consumption would be 2.5 horsepower per ton per day of 8 hours, or 20 horsepower hours per ton.

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ABSTRACT

Riverside, the (4th) largest county in California, comprises 7,179 square miles most of which is arid or mountainous. The population, ~~[more than 300,000]~~ according to the 1960 census, is growing most rapidly in the west half of the county in the city of Riverside and its suburbs adjacent to the urban and commercial complexes of neighboring, more populous coastal counties, and in the agricultural and recreational areas of the Coachella Valley.

Riverside County includes parts of the Peninsular Ranges, the Colorado Desert, the Transverse Ranges and the Mojave Desert.

Abstract

The rocks exposed in the county range in age from Precambrian to Quaternary and represent a diversity of geologic events and processes. The Precambrian, Paleozoic, and most of the early Mesozoic rocks are intensely metamorphosed. Comparable rocks underlie parts of the Peninsular Ranges and most of the Transverse Ranges and mountains of the Mojave Desert. Intrusive, crystalline rocks of the Mesozoic Southern California Batholith underlie most of the Peninsular Ranges and parts of the desert ranges. Upper Mesozoic marine sedimentary rocks flank the northwest end of the Peninsular Ranges. Cenozoic marine and continental sedimentary rocks flank the north end of the Peninsular Ranges and underlie scattered desert areas. Cenozoic volcanic rocks are confined almost entirely to isolated areas in the Mojave Desert.

Much of the geology of the eastern half of the county is concealed beneath quaternary alluvium. The data exposed in the individual ranges suggests a general northwest structural trend. The presence of faults of considerable displacement has been determined in and near some of the intermountain basins but for most alluviated areas little data has been accumulated and less has been published.

The largest, most active faults in Riverside County are the San Andreas, San Jacinto, and Elsinore which trend northwest across the western half of the county. The eastern half of the county is intricately faulted and folded. The Salton Sea sheet of the State geologic map affords a good view of the structural pattern in this area. Here, evidence

of recent movement on range-bounding faults was found; for example, Quaternary alluvium is faulted on the west side of the Chuckwalla Mountains and on the trace of the Porcupine fault at Porcupine Flat in the Hexie Mountains. Locally, late Tertiary gravel is faulted and deformed.

Virtually all of the metalliferous lode deposits except iron ore are in or closely associated with old, inactive faults some of which probably originated during the intrusion of the Mesozoic Southern California Batholith. Such faults are features of the White Tank monzonite in the Joshua Tree National Monument-Chuckwalla Mountains area and the Coxcomb granodiorite in the Coxcomb Mountains. Recent faults such as the San Andreas, San Jacinto, and Elsinore are essentially unmineralized although they have given rise to hot springs and, locally, bound ground-water basins.

During the period 1891-1960, mineral commodities valued at about $1,040,194,201 ~~million~~ were produced in Riverside County. ~~A major part~~ most of this total. ~~comprises~~ the combined values of iron ore, limestone for cement, sand and gravel, stone, gypsum, and clay, comprises

Iron ore is mined, by Kaiser Steel Corporation, from an extensive replacement deposit in pre-Cretaceous rocks in the Eagle Mountains. This is the principal metal mine in the county. Riverside County has had a long history of both noble and base metal mining but until the development of the Eagle Mountain iron in 1948, such mining had been sporadic and on a relatively small scale.

Limestone, for the manufacture of portland cement, is mined from bodies of pre-Cretaceous metamorphic rock in the Crestmore Hills. This is one of the oldest continuous mining operations in southern California.

Exploration and development of raw materials for the clay and glass-sand industries have continued in the Corona-Elsinore area.

Increases in urban and industrial growth are placing a growing demand on the sand and gravel resources of the county and encouraging a young roofing-granule and decorative rock industry.

INTRODUCTION

The early Spanish explorers, de Anza (1774, 1775-1776) and Garces (1776), found the area which now comprises Riverside County sparsely populated by Indians of the Shoshonean and Yuman groups. To this day evidence of the former Indian inhabitants remains in the form of petroglyphs, pictographs, dim trails and scattered artifacts. Since the building of the home of the first ~~(white)~~ settler, that of Leandro Serrano in Temescal Valley in 1824, the population of Riverside County has increased to a 1960 total of ~~300,000~~. This figure represents a ~~71~~ percent increase over the ~~1950~~ census. ~~the largest numerical gain in any 10-year period in the history of the county.~~

Riverside County, the 4th largest in California, was formed in 1893 from parts of San Diego and San Bernardino Counties. The name was originally given to the city of Riverside in the year 1871 and subsequently adopted for the County. Riverside County has an area of 7,179 square miles, 44 percent of which is privately owned.

The principal cities and their 1970 populations are Riverside (140,000), Corona (27,500), Palm Springs (20,900), Indio (14,400), Hemet (12,200), and Banning (12,000).

In 1960 this county ranked ~~8th~~ 7th in value of annual mineral production in California with a total of ~~$36,692,145~~ $41,543,930. In the period 1893-1960 mineral production in Riverside County had a total reported value of ~~$1,040,194,201~~ $1,114,743,231.00. Among those counties not reporting fuels, Riverside County has consistently ranked second only to San Bernardino County.

Cement, iron ore, sand and gravel, stone, and clay accounted for the bulk of the 1960 Riverside County mineral production.

Geography

Riverside County is about 215 miles long from east to west and some 45 miles wide. The north boundary of the county is nearly coincident with the 34° 00' N line of latitude.

The western third of the county has a combination of steppe and mediterranean climates with warm dry summers and mean annual rainfall ranging from less than 10 inches at lower altitudes to as much as 30 inches at high altitudes. The eastern two-thirds of Riverside County is desert, characterized by extreme annual temperature changes and less than 5 inches of precipitation.

The western third of the county is essentially a low plateau bordered on the west by the Santa Ana Mountains and the east by the San Jacinto and Santa Rosa Mountains. The desert areas to the east form a mountainous, gently-eastward-sloping plateau bordered on the west by the Coachella Valley and the east by the Colorado River (see frontispiece).

figure 2

Status of Lands

Figure 3/ and table 2/ supply data pertinent to land use in Riverside County. Topographic maps of the U. S. Geological Survey and Army Corps of Engineers (indexed in fig. 4/) show boundary details of national forests, parks, military reservations, monuments, Indian reservations and land grants.

Records of private lands and mining claims are maintained by the County Assessor and Recorder at the Court House in Riverside. A prospector seeking the status of land not clearly identified on published maps or in the field, will need to resort to these records. Where claim markers are present, it is not advisable to trust the absence or antiquity of field claim notices and affidavits of assessment work as proof of abandonment. Ownership data included in the property descriptions and the tabulated list were current at the time of writing. This data was drawn from County files, claim markers, and the statements of individuals; whichever appeared to be most recent and reliable. These statements are not to be construed as legal documents.

Figure 3

The letters, R.B.S., C.H.G., or J.R.E. that appear with the date of most descriptions are the initials of the author. Descriptions drawn from other sources are so credited.

In March of 1969, Riverside County adopted articles XIIa and XIIb of the zoning ordinance. These articles, which pertain to mineral resources, are included below. Details of their administration should be sought in the office of the County Planning Department; that office can furnish the latest up-to-date copies of the ordinances, which may be changed from time to time.

ARTICLE XIIa

M-R ZONE - MINERAL RESOURCES

SECTION 12.50. USES PERMITTED.

(a) Uses Permitted. Notwithstanding the requirements of Section 12.51, the following uses are permitted on parcels not less than 20,000 square feet in area:

(1) Agricultural use of the soils for crops, orchards, grazing and forage.
(2) Electric and gas distribution, transmission substations. telephone and microwave stations.
(3) Water well and any use appurtenant to the storage and distribution of water.
(4) Riding and hiking trails, recreation lakes, and camp grounds.

(b) Uses Permitted Subject to Plot Plan Approval. The following uses are permitted in conformance with the development and performance standards of this Article, provided a plot plan showing the access from the property onto public streets has first been approved by the Planning Director, and also provided that within 90 days of the establishment of the M-R Zone to the area and continuously thereafter, the outer boundaries of all property to be used for the following purposes have been posted with signs carrying the message, "MINERAL RESOURCE ZONE" in letters not less than 3 inches in height, and the message "THIS PROPERTY MAY BE USED AT ANY TIME FOR THE EXTRACTION OF MINERALS AND RELATED PROCESSING. COUNTY OF RIVERSIDE ORDINANCE NO. 348" in letters not less than 1 inch in height. Such signs shall be posted not more than 1000 feet apart with not less than one sign on each side of the property, except that such signs will not be required along a common boundary line between Zones M-R and M-R-A. Such signs shall be located and continuously maintained so as to give reasonable notice to passersby of the message contained thereon.

(1) Mining, quarrying, excavating, beneficiating, concentrating, processing, and stockpiling of rock, sand, gravel, decomposed granite, clay, gypsum, limestone, metallic ores, and similar materials, and the backfilling of resultant excavations with inert materials in accordance with recognized standards and requirements of public agencies responsible for public health, fire safety, and the protection of water resources.
(2) Rock crushing plants, aggregate washing, screening and drying facilities and equipment, and concrete batching plants.

The uses permitted in this subsection and any accessory use established as a part thereof, shall assume a nonconforming status pursuant to the provisions of Section 18.6 on the date that the mineral resource on the site of such use or structure is depleted.

(c) Accessory Uses Permitted. Premises in the M-R Zone may be used for accessory uses provided such uses are established on the same parcel of land, are incidental to, and do not substantially alter the character of any permitted use, including but not limited to:

(1) Retail and wholesale distribution of materials produced on the site.
(2) Storage of trucks and excavating vehicles.
(3) Storage of materials and machinery used in the operation.
(4) Scales and weighing equipment.
(5) Offices and maintenance shop structures, including use of mobilehomes.
(6) Residences and mobilehomes for caretakers or watchmen and their families provided no compensation is received for the use of any such residence, mobilehome or mobilehome space.
(7) Maximum of two on-site signs, each not over 100 square feet in area, advertising the products being produced on the site.

(d) Uses Permitted by Conditional Use Permit. Where the boundary sign posting provisions of Section 12.50 (b) have not been observed and satisfied, premises in the M-R Zone may be used for the following purposes only if a Conditional Use Permit has first been obtained pursuant to the provisions of Article III of this Ordinance:

(1) Any use permitted in Section 12.50 (b) and (c) of this Article.

The uses permitted in this subsection shall assume a nonconforming status pursuant to the provisions of Section 18.6 on the date that the mineral resource on the site of such use or structure is depleted.

SECTION 12.51. DEVELOPMENT STANDARDS. Premises in the M-R Zone shall be subject to the following development standards.

(a) Lot Area. Not less than five acres gross.
(b) Lot Width. Not less than 200 feet.
(c) Yards. Front, rear, and side, not less than 50 feet for any use permitted, except those uses permitted in Section 12.50 (a); provided further, however, that any structure exceeding 50 feet in height shall have front, side, and rear yard spaces equal to the height of said structure.
(d) Building Height. Maximum height of buildings and structures, 105 feet.
(e) Off-Street Parking. Off-street parking shall be provided and improved as required in Section 18.12.

SECTION 12.52. SPECIAL DEVELOPMENT AND PERFORMANCE STANDARDS. Premises in the M-R Zone used for any mining and quarry operations, rock crushing and aggregate dryers shall be subject to the following standards.

(a) Noise Suppression. All equipment and premises employed in conjunction with any of the uses permitted in the M-R Zone shall be constructed, operated and maintained so as to suppress noise and vibrations which are or may be injurious to persons living on adjoining property.

(b) Roads and Driveways. All roads and driveways shall be kept wetted while being used or shall be treated with oil, asphaltic concrete or concrete, or other palliative to prevent the emission of dust.

(c) Access Roads. All private access roads leading off any paved public street onto property used for any purpose permitted in Section 12.50 (b), (c), and (d) shall be paved to a minimum width of 24 feet with asphaltic concrete or equal, not less than 3 inches in thickness with adequate compacted base material for not less than the first 100 feet of said access road.

(d) Air and Water Pollution. All operations shall be conducted in compliance with the requirements of the Riverside County Air Pollution Control District and the State Water Quality Control Board.

(e) Slopes of Excavations. No production from an open pit quarry shall be permitted which creates an average slope steeper than 1 foot horizontal to 1 foot vertical; provided however, that a steeper slope may be permitted where the soil content or material is such that a vertical-cut excavation is safe in the opinion of the Division of Industrial Safety, Department of Industrial Relations of the State of California.

(f) Landscaping and Fencing. Excavation operations which are located at any time within 500 feet of at least 10 buildings or mobilehomes used or designed for dwelling purposes, shall be screened to a height of at least 6 feet by either landscaping, berms, walls or solid fencing and the outer boundaries of the area being excavated shall be enclosed with a 6-foot high chain link fence, including all necessary gates, except where such a fence would be impracticable as in the bed or flood channel of a wash or watercourse.

(g) Hours of Operation. All uses shall confine operations on the property, other than maintenance, to the hours between 6:00 a.m. and 10:00 p.m. of any day, except those operations that are located not less than 300 feet from the outer boundary of such property.

(h) Insurance. Before commencing operation in any quarry, the owner or operator shall show continuing evidence of insurance against liability in tort in the amount of $300,000.00 arising from the production activities, or operations incident thereto, conducted or carried on under or by virtue of any law or ordinance. Such insurance shall be kept in full force and effect during the period of such operations.

(i) Ponding. Where practicable, all excavation operations shall be conducted in such a manner as to prevent unnecessary ponding or accumulation of storm or drainage water.

(j) Rehabilitation. Any pit resulting from depletion of the mineral resource, or from abandoned or terminated mineral extraction operations shall be

filled to ground level, or such pits or any depleted hillside areas shall be treated in accordance with the following standards:

(1) Filling. On property where the mineral resource thereon is in fact depleted by reason of extraction operations, or on property where the production of any such resource is in fact abandoned or terminated, said property shall be filled as permitted in Section 12.50 (b), (1), or landscaped in accordance with the requirements of paragraph (4) of this subsection. Said filling or landscaping treatment shall be commenced within a period of 5 years from the date of depletion, abandonment or termination of mineral resource production on the property and diligently prosecuted to the completion thereof. The Planning Commission may determine the date of depletion, abandonment or termination if it finds, after hearing the matter that: (a) mineral resource extraction operations have not been conducted on the property involved for a continuous period of 5 years prior to the date of said hearing and (b) the remaining mineral resource on the property involved need not be conserved for ultimate production in the public interest.

(2) Grading. Slopes, overburden stockpiles, abandoned spoil piles and the general premises shall be graded and smoothed so as to control erosion, prevent the creation of potentially dangerous areas and present a neat and orderly appearance. No hillside shall remain with an average grade steeper than 1 foot horizontal to 1 foot vertical with a 10 foot wide terrace for not more than each 50 feet of vertical height, unless a permanent steeper slope, without terraces, is approved by the Director of the Department of Building and Safety.

(3) Water-Filled Areas. Upon termination of operations, all excavations made to a level below the existing ground water table shall be filled with inert materials to a level above the existing ground water table. This requirement shall not apply, however, to any water-filled excavations scheduled to be an integral part of future development of the property. All such water-filled areas remaining shall be continuously treated with effective mosquito control measures.

(4) Landscaping. Within a period of 5 years from the date of depletion of the mineral resource on a particular property, or within 5 years of the date of abandonment or termination of mineral extraction operations thereon, as such date is determinable under the provisions of paragraph (1) of this subsection, trees, shrubs, grasses or other ground cover native to the particular area shall be planted in order to prevent erosion and to restore the property to a natural appearance. However, this requirement will not apply to properties where dense rock slopes make planting impracticable, or within a wash or watercourse, or within an area being filled pursuant to Section 12.50 (b) (1).

ADDED EFFECTIVE: 3-12-69 (Ord. 348.612)

ARTICLE XIIb

M-R-A ZONE - MINERAL RESOURCES AND RELATED MANUFACTURING

SECTION 12.60. USES PERMITTED.

(a) Uses Permitted. Notwithstanding the requirements of Section 12.61 the following uses are permitted on parcels not less than 20,000 square feet in area:
(1) Agricultural use of the soils for crops, orchards, grazing, and forage.
(2) Electric and gas distribution, transmission substations, telephone and microwave stations.
(3) Water well and any use appurtenant to the storage and distribution of water.
(4) Riding and hiking trails, recreation lakes, and camp grounds.

(b) Uses Permitted Subject to Plot Plan Approval. The following uses are permitted in conformance with the development and performance standards of this Article, provided a plot plan showing the access from the property onto public streets has first been approved by the Planning Director and also provided that within 90 days of the establishment of the M-R-A Zone to the area and continuously thereafter, the outer boundaries of all property to be used for the following purposes have been posted with signs carrying the message, "MINERAL RESOURCE ZONE" in letters not less than 3 inches in height, and the message, "THIS PROPERTY MAY BE USED AT ANY TIME FOR THE EXTRACTION OF MINERALS AND RELATED PROCESSING AND MANUFACTURING. COUNTY OF RIVERSIDE ORDINANCE NO. 348" in letters not less than 1 inch in height. Such signs shall be posted not more than 1000 feet apart with not less than one sign on each side of the property, except that signs will not be required along a common boundary line between Zones M-R and M-R-A. Such signs shall be located and continuously maintained so as to give reasonable notice to passersby of the message contained thereon.
(1) Mining, quarrying, excavating, beneficiating, concentrating, processing, and stockpiling of rock, sand, gravel, decomposed granite, clay, gypsum, limestone, metallic ores, and similar materials and the backfilling of resultant excavations with inert materials in accordance with recognized standards and requirements of public agencies responsible for public health, fire safety, and the protection of water resources.
(2) Rock crushing plants, aggregate washing, screening and drying facilities and equipment, and concrete batching plants.
(3) Ore reduction plants, and specialty plants for processing mineral products; and the manufacture of block, pipe, tile, bricks, cement, plaster and asphaltic concrete, provided that such plants and manufacturing operations observe a minimum setback of 300 feet from any zone, other than Zones M-R, M-R-A, M-2 and M-4.

The uses and structures permitted in this subsection and any accessory use established as a part thereof shall assume a nonconforming status pursuant to the provisions of Section 18.6 on the date that the mineral resource on the site of such use or structure is depleted.

(c) Accessory Uses Permitted. Premises in the M-R-A Zone may be used for accessory uses provided such uses are established on the same parcel of land, are incidental to, and do not substantially alter the character of any permitted use, including but not limited to:

(1) Retail and wholesale distribution of materials produced on the site.
(2) Storage of trucks and excavating vehicles.
(3) Storage of materials and machinery used in the operation.
(4) Scales and weighing equipment.
(5) Offices and maintenance shop structures, including use of mobilehomes.
(6) Residences and mobilehomes for caretakers or watchmen and their families provided no compensation is received for the use of any such residence, mobilehome or mobilehome space.
(7) Maximum of two on-site signs, each not over 100 square feet in area, advertising the products being produced on the site.

(d) Uses Permitted by Conditional Use Permit. Where the boundary sign posting provisions of Section 12.60 (b) have not been observed and satisfied, premises in the M-R-A Zone may be used for the following purposes only if a Conditional Use Permit has first been obtained pursuant to the provisions of Article III of this Ordinance:

(1) Any use permitted in Section 12.60 (b) and (c) of this Article.

The uses permitted in this subsection shall assume a nonconforming status pursuant to the provisions of Section 18.6 on the date that the mineral resource on the site of such use or structure is depleted.

SECTION 12.61. DEVELOPMENT STANDARDS. Premises in the M-R-A Zone shall be subject to the following development standards.

(a) Lot Area. Not less than five acres gross.
(b) Lot Width. Not less than 200 feet.
(c) Yards. Front, rear, and side, not less than 50 feet for any use permitted except those uses permitted in Section 12.60 (a); provided further, however, that any structure exceeding 50 feet in height shall have front, side, and rear yard spaces equal to the height of said structure.
(d) Building Height. Maximum height of buildings and structures, 105 feet.
(e) Off-Street Parking. Off-street parking shall be provided and improved as required in Section 18.12.

SECTION 12.62. SPECIAL DEVELOPMENT AND PERFORMANCE STANDARDS. Premises in the M-R-A Zone used for any mining and quarry operations, and related manufacturing shall be subject to the following standards:

(a) Noise Suppression. All equipment and premises employed in conjunction with any of the uses permitted in the M-R-A Zone shall be constructed, operated and maintained so as to suppress noise and vibrations which are or may be injurious to persons living on adjoining property.

(b) Roads and Driveways. All roads and driveways shall be kept wetted while being used or shall be treated with oil, asphaltic concrete or concrete, or other palliative to prevent the emission of dust.

(c) Access Roads. All private access roads leading off any paved public street onto property used for any purpose permitted in Section 12.60 (b), (c), and (d) shall be paved to a minimum width of 24 feet with asphaltic concrete or equal, not less than 3 inches in thickness with adequate compacted base material for not less than the first 100 feet of said access road.

(d) Air and Water Pollution. All operations shall be conducted in compliance with the requirements of the Riverside County Air Pollution Control District and the State Water Quality Control Board.

(e) Slopes of Excavations. No production from an open pit quarry shall be permitted which creates an average slope steeper than 1 foot horizontal to 1 foot vertical; provided, however, that a steeper slope may be permitted where the soil content or material is such that a vertical-cut excavation is safe in the opinion of the Division of Industrial Safety, Department of Industrial Relations of the State of California.

(f) Landscaping and Fencing. Excavation operations which are located at any time within 500 feet of at least 10 buildings or mobilehomes used or designed for dwelling purposes, shall be screened to a height of at least 6 feet by either landscaping, berms, walls or solid fencing and the outer boundaries of the area being excavated shall be enclosed with a 6 foot high chain link fence, including all necessary gates, except where such a fence would be impracticable as in the bed or flood channel of a wash or watercourse.

(g) Hours of Operation. All uses shall confine operations on the property, other than maintenance, to the hours between 6:00 a. m. and 10:00 p. m. of any day, except those operations that are located not less than 300 feet from the outer boundary of such property.

(h) Insurance. Before commencing operation in any quarry, the owner or operator shall show continuing evidence of insurance against liability in tort in the amount of $300,000.00 arising from the production activities, or operations incident thereto, conducted or carried on under or by virtue of any law or ordinance. Such insurance shall be kept in full force and effect during the period of such operations.

(i) Ponding. Where practicable, all excavation operations shall be conducted in such a manner as to prevent unnecessary ponding or accumulation of storm or drainage water.

(j) Rehabilitation. Any pit resulting from depletion of the mineral resource, or from abandoned or terminated mineral extraction operations shall be filled to ground level, or such pits or any depleted hillside areas shall be treated in accordance with the following standards:

(1) Filling. On property where the mineral resource thereon is in fact depleted by reason of extraction operations, or on property where the production of any such resource is in fact abandoned or terminated, said property shall be filled as permitted in Section 12.60 (b), (1), or landscaped in accordance with the requirements of paragraph (4) of this subsection. Said filling or landscaping treatment shall be commenced within a period of 5 years from the date of depletion, abandonment or termination of mineral resource production on the property and diligently prosecuted to the completion thereof. The Planning Commission may determine the date of depletion, abandonment or termination if it finds, after hearing the matter that: (a) mineral resource extraction operations have not been conducted on the property involved for a continuous period of 5 years prior to the date of said hearing and (b) the remaining mineral resource on the property involved need not be conserved for ultimate production in the public interest.

(2) Grading. Slopes, overburden stockpiles, abandoned spoil piles and the general premises shall be graded and smoothed so as to control erosion, prevent the creation of potentially dangerous areas and present a neat and orderly appearance. No hillside shall remain with an average grade steeper than 1 foot horizontal to 1 foot vertical with a 10 foot wide terrace for not more than each 50 feet of vertical height, unless a permanent steeper slope, without terrace, is approved by the Director of the Department of Building and Safety.

(3) Water-Filled Areas. Upon termination of operations, all excavations made to a level below the existing ground water table shall be filled with inert materials to a level above the existing ground water table. This requirement shall not apply, however, to any water-filled excavations scheduled to be an integral part of future development of the property. All such water-filled areas remaining shall be continuously treated with effective mosquito control measures.

(4) Landscaping. Within a period of 5 years from the date of depletion of the mineral resource on a particular property, or within 5 years of the date of abandonment or termination of mineral extraction operations thereon, as such date is determinable

under the provisions of paragraph (1) of this subsection, trees, shrubs, grasses, or other ground cover native to the particular area shall be planted in order to prevent erosion and to restore the property to a natural appearance. However, this requirement will not apply to properties where dense rock slopes make planting inpracticable, or within a wash or watercourse, or within an area being filled pursuant to Section 12.60 (b) (1).

ADDED EFFECTIVE: 3-12-69 (Ord. 348.612)

Acknowledgments

Much of the information included in this report was obtained in the field by the authors but important assistance was furnished by other members of the Division of Mines and Geology. Technical and historic data were gathered from both published and unpublished reports of the Division of Mines and Geology, U. S. Bureau of Mines, U.S. Bureau of Land Management and the U.S. Forest Service. Officials and employees of Riverside County were a generous source of information. The authors are grateful to these agencies and individuals and to the many people in local communities and in the vicinity of mines who volunteered useful information.

In general the authors confined their individual contributions to certain areas. Richard B. Saul covered the western, southern and eastern parts of the county except for the Elsinore, Corona and Riverside areas. Cliffton H. Gray, Jr. supplied information on the Corona and Riverside areas, worked in the Little San Bernardino Mountains, and, in collaboration with James R. Evans, covered much of the western and southern parts of Joshua Tree National Monument. James R. Evans investigated

properties in the eastern half of Joshua Tree National Monument, an area which includes most of the Pinto and Eagle Mountains. The sections on clay and limestone are largely the work of Cliffton H. Gray, Jr. ~~Iron, rare earths, and deposits of~~ Rare earths, and most of the iron deposits radioactive minerals were described by J. R. Evans, ~~except for several minor deposits of iron at the east end of the county.~~

Certain published reports warrant particular acknowledgment. The work of René Engel and Thomas E. Gay, Jr., on the Elsinore quadrangle (1959) supplied many property descriptions including those of the clay deposits near Alberhill and the most productive gold mine in the county, the Good Hope. Descriptions of gypsum deposits in the Little Maria Mountains by Ver Planck (1952) and in the Palen Mountains by Hoppin (1954) were of great value. Much of the historic data was drawn from property reports by Reid J. Sampson and W. Burling Tucker. Unpublished data were supplied by Charles W. Chesterman (descriptions of fluorspar, perlite, and nephrite deposits in the Orocopia, Chuckwalla, and Eagle Mountains); F. Harold Weber, Jr. (unpublished data on a tungsten deposit on Beauty Mountain); and Harold B. Goldman (data on sand and gravel deposits and processing plants). Many other useful suggestions were offered by members of the Division of Mines and Geology.

G E O L O G Y

General Features

Riverside County lies athwart a mosaic of natural provinces (fig. 2/) which from west to east, are: (1) the Peninsular Ranges, (2) the Colorado Desert, (3) the Transverse Ranges, and (4) the Mojave Desert.

In Riverside County the Peninsular Ranges province comprise the northwest-trending Santa Ana, San Jacinto, and Santa Rosa Mountains and include the highest point in the county, San Jacinto Peak, elevation 10,805 feet. The Colorado Desert province includes Coachella Valley, Salton Sea, Mecca Hills and Indio Hills. This is the lowest area in the county, the surface of Salton Sea being 235 (±) feet below sea level. The Transverse Ranges province comprises the Little San Bernardino, Pinto, Hexie, Cottonwood, and Eagle Mountains; these are arid and rugged mountains ranging in altitude from 3,000 to 5,400 feet. The Mojave Desert province is an area of rugged, arid mountain ranges separated by broad alluvial plains. The ranges are the Orocopia, Chuckwalla, ~~Cocks~~ Cox-comb, Granite, Palen, McCoy, Little Maria, Big Maria, Arica, Mule, and Riverside Mountains.

The western half of the county is crossed by 3 major parallel, northwest-trending, right-lateral fault zones -- the San Andreas, San Jacinto, and Elsinore. The most extensive and famous of these is the San Andreas fault, which parallels the eastern margin of the Colorado Desert. The San Jacinto fault lies farther west and bounds the southwest side of the Santa Rosa Mountains (fig. 2/), Thomas Mountain, and the northwest margin of the San Jacinto Mountains. The Elsinore fault is still farther west and is roughly parallel to the southwest boundary of the county where it has formed the shallow, trench-like depression occupied, in part, by Lake Elsinore.

The eastern half of Riverside County contains much local evidence of faulting and faults appear to bound many of the mountain ranges; however, ~~there is no~~ ~~such~~ physiographic evidence of displacement is not spectacular as that of the rifts of the San Andreas, San Jacinto and Elsinore faults in the western half of the county.

Descriptive Geology

The geologic formations in Riverside County are described on plate 3/, and, in addition, some of their known or probable relationships are shown. The ages of these rocks range from Precambrian(?) to Quaternary. Rocks of pre-Cenozoic age comprise the largest area of exposed bedrock in the county, an area which includes most of the desert ranges, the east end of the Transverse Ranges and most of the northern end of the Peninsular Ranges. Exposures of rocks of Cenozoic age are on the north and northwest flanks of the Peninsular Ranges, the margin of the Colorado Desert and in scattered areas in the desert ranges.

At no place in the county do rocks representing all the geologic periods occur in an unbroken sequence. A composite geologic column (plate 3/) illustrates the incompleteness of the record and uncertainty of some age determinations. The older sedimentary rocks are deformed, and with few exceptions, metamorphosed. The Cenozoic rocks are well described and dated but comprise a diversity of local sections.

Precambrian Rocks

Rocks of Precambrian age include the Pinto Gneiss and Chuckwalla Complex.

The Pinto Gneiss was named and described by Miller (1938, p. 424-426) on the basis of rocks exposed in the Pinto Mountains. Additional mapping by Rogers (1954, map sheet no. 24) and Babcock (1961, unpublished thesis) has extended the known area of outcrop westward to the Lost Horse Valley area. This lithologic unit is a heterogeneous mixture of metasedimentary and metaigneous rocks. In the original description Miller implied a Precambrian age for the Pinto Gneiss ~~by suggesting an origin similar to that of rocks of probable Precambrian age in the western San Gabriel Mountains~~ (Miller, 1934, p. 63).

The Pinto Gneiss is the host rock of gold-bearing quartz veins in the Pinto Mountains and Lost Horse Mountain areas and, in Music Valley, contains deposits of rare earth minerals.

The Chuckwalla Complex was named by Miller (1944, p. 16) from extensive ~~typical~~ exposures in the Chuckwalla Mountains. This complex comprises varyingly metamorphosed diorite, granodiorite and granite with minor proportions of metasedimentary rocks and migmatite. Rocks of the Chuckwalla Complex are exposed in the Cottonwood, Little San Bernardino, Orocopia, Eagle, Chuckwalla, Little Chuckwalla, Mule and Big Maria Mountains, and appear to underlie a broad pediment along the east side of the Arica Mountains.

Miller (1944, p. 20-21) regarded the Chuckwalla Complex as early Precambrian in age because of its similarity to other rocks in southern California, which, like it, underlie strata of known or probable Paleozoic age and appear to be older than other less intruded and altered pre-Paleozoic rocks.

The Chuckwalla Complex is host to numerous quartz veins some of which have yielded gold, and copper, tungsten, lead and silver-bearing minerals.

Paleozoic Rocks

Rocks considered to be of Paleozoic(?) age are widely distributed in Riverside County. At the west end of the county rocks identified as Paleozoic by Larsen (1948, p. 16), are exposed in an irregular mosaic of north-northwest-trending pendants in the Mesozoic igneous rocks of the Peninsular Ranges. Here these metasedimentary rocks consist of coarsely-crystalline, quartz-mica schists with local concentrations of amphibole andalusite, sillimanite, garnet and epidote. The section contains, in addition, a thick series of quartzite beds and, (in the Jurupa, San Jacinto and Santa Rosa Mountains) limestone. Where exposed south of Domengoni Valley (south of Winchester) this section has been estimated to be from 12,000 to 13,000 feet thick (Laresn, 1948, p. 17; Schwarcz, 1960, p. 1969).

Uncertainty as to the age of these rocks arises from the fact that they are strongly metamorphosed, having been deformed, and later, intruded by igneous rocks of the southern California batholith. Virtually all fossil evidence has been destroyed, save for a reported occurrence of a Paleozoic coral near Winchester (Webb, 1939, p. 198-201), and some objects of doubtful origin and age found in the Palm Canyon Complex between Bradley and Cathedral canyons near Cathedral City (Miller, 1944, p. 25). These rocks generally have been correlated with Paleozoic sections in nearby regions on the basis of lithologic similarity (Jahns, 1954, chap. II, cont. 3, p. 33), the known age range of overlying sedimentary and volcanic rocks, and the intrusive rocks of the southern California batholith (Larsen, 1948, p. 18, 22, 136). Schwarcz states (1960, p. 1969) that Larsen's "Paleozoic schist" is conformable on the Bedford Canyon Formation (Triassic-Jurassic). Larsen believed that the Paleozoic rocks were in fault contact with the "younger" Bedford Canyon (Larsen, 1948, p. 17).

Although the Paleozoic(?) rocks exposed in the western half of the county contain gold-bearing quartz veins in some localities and are associated with magnesite near Winchester, the principal economic value of these rocks lies in the limestone units. One limestone body is being mined at Crestmore. Others in the San Jacinto, Santa Rosa and Jurupa mountains have been prospected and mined for limestone, and locally, are the host rock for tungsten minerals.

In the eastern half of Riverside County, sedimentary rocks of Paleozoic(?) age comprise the Maria Formation, which was described by Miller (1944, p. 25-28). It consists of gneiss, quartzite, schistose carbonate rock, green schist, gypsum and altered limestone. These rocks are exposed in the Pinto, Eagle, Palen, Little Maria, Big Maria, Arica and Riverside Mountains. In all of these localities the Maria Formation has been deformed, faulted and generally metamorphosed. It is difficult to measure the true thickness or sequence of units in the formation. Ver Planck (1952, pl. 3) suggests a thickness of as much as 3,000 feet for exposures of the Maria Formation in the Little Maria Mountains. In the nearby Big Maria Mountains, Hamilton (1960) has described deformation and repetition by faulting in these rocks.

Miller (1944, p. 28) assigned a Paleozoic age to the Maria Formation because of an apparent unconformity between it and the subjacent Chuckwalla Complex and because of crinoidal remains identified to be "of Paleozoic age, and possibly Silurian". Conversely, Lee (1908, p. 15) noted similar rocks at several localities in northwestern Arizona and considered them to be of probable Precambrian age.

The chief economic importance of the Maria Formation lies in the extensive bodies of iron ore contained in the Eagle Mountains section, and gypsum present in large tonnages in the Palen, Little Maria, Big Maria and Riverside Mountains.

Gold-and-copper-bearing quartz veins of small extent are exposed in and near the various outcrops of the Maria Formation. In the Little Maria Mountains these rocks are host to manganese and fluorite deposits. Wollastonite-rich, altered limestone has been used as decorative rock and tested for the manufacture of rock wool.

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Some of the igneous rocks in the Maria Mountains region are of possible Paleozoic age (Miller, 1944, p. 31). A body of granite porphyry at the north end of the McCoy Mountains appears to be overlain unconformably by the sediments of the McCoy Mountains Formation thought by Miller (1944, p. 51-52) to be of Late Paleozoic or early Mesozoic age. Fault zones in this porphyry have been extensively mined for manganese oxides.

Mesozoic Rocks

The Mesozoic rocks of Riverside County comprise the metasedimentary rocks of the Triassic(?)-Jurassic Bedford Canyon Formation; the Jurassic(?) Santiago Peak Volcanics; probably all or part of the McCoy Mountains Formation; the igneous rocks of the late Jurassic- to mid-Cretaceous southern California batholith and the more isolated but probably related White Tank Monzonite and Cox Cockscomb Granodiorite; the upper Cretaceous sedimentary rocks of the Trabuco and Ladd Formations.

Possibly the oldest Mesozoic rocks in Riverside County are those of the McCoy Mountains Formation. This formation has not yet been adequately described or studied but it appears to consist of mudstone, siltstone, calcareous sandstone, coarse arkosic grit and arkosic conglomerate, pebbly mudstone, chert, and volcanic ejecta characteristic of a marine eugeosynclinal environment. The total thickness of this section has not been measured. Miller (1944) who named and briefly described these rocks, suggested a thickness of "many thousands of feet". The McCoy Mountains Formation underlies all but the northern ridge of the McCoy Mountains, most of the Palen Mountains, the southern one-third of the Cocks comb Mountains, and possibly parts of the Maria, Mule and Riverside Mountains. The age of the McCoy Mountains Formation (late Paleozoic or Triassic) was suggested by Miller (1944, p. 51-52) on the basis of work by Hazzard, Gardner and Mason (1938) and his own observations.

Quartz veins, containing gold, ~~and~~ copper and lead minerals cut the McCoy Mountains Formation at scattered localities. At the south end of the Palen Mountains these rocks are host to several small iron deposits and, along one shear zone, are altered to talc. At the south end of the McCoy Mountains thin crusts and films of secondary uranium minerals are exposed in several shallow prospects. Some of the dense volcanic rocks, which range in color from pink through various shades of gray and green, may eventually prove useful for decorative purposes. Iron-stained and coated quartzite cobbles, derived from the conglomeratic units of the McCoy Mountains Formation, have been gathered from the surface of the alluvium near Palo Verde and marketed as decorative rock.

~~Precambrian(?) Rocks~~

~~Rocks of Precambrian(?) age include the~~ The Orocopia Schist, ~~Schist, Pinto Gneiss and Chuckwalla Complex.~~ once believed to be as old as Precambrian, has been considered Mesozoic by Crowell and Wolfe (1962).

The Orocopia Schist was first described by Miller (1944, p. 21). This formation consists of an undetermined thickness of muscovite and biotite schists interlayered with quartz-feldspar, muscovitic, calcareous and quartzitic schists, and a few thin units of both pure and sandy limestone. ~~(Miller suggested a correlation between the Orocopia Schist and the Pelona Schist of Los Angeles County.)~~ In Riverside County the Orocopia Schist is exposed only in and near the San Andreas fault zone where ~~they~~ it underlies the west end of the Orocopia Mountains and several small areas along the northeast slope of the Mecca Hills.

Thin lenticular bodies of manganese oxides are present in the Orocopia Schist. Several of these have been prospected and a small tonnage of material has been shipped from one claim. In addition, the Orocopia Schist contains an undetermined but probably small proportion of talc-actinolite rocks, one deposit of which has been prospected.

Other early Mesozoic metasedimentary rocks are exposed on the east slope of the Santa Ana Mountains and east and southeastward to Domenigoni Valley. These rocks, the Triassic-Jurassic Bedford Canyon Formation, consist of slate, argillite, quartzite and a few thin lenses of limestone in the Santa Ana Mountains and similar but more metamorphosed rocks to the east and southeast. The Bedford Canyon Formation was once thought to be largely of Triassic age (Larsen, 1948, p. 18-19) but subsequent work (Silbering and others, 1961, p. 1746-1748) has indicated a Jurassic age for much of this formation, at least in the northern Santa Ana Mountains. The Bedford Canyon Formation is only sparingly fossiliferous and those forms that have been recovered are blemished by metamorphism. The total thickness of these rocks is uncertain. Larsen (1948, p. 22) states that the base is not exposed and the top of the formation is an erosion surface.

The rocks of the Bedford Canyon Formation have been mined in a small way for flagstones and building stone, and some have been ground for roofing granules (Engel and others, 1959, p. 103).

The ~~Jurassic~~ Santiago Peak Volcanics intruded and flowed over the deformed and eroded Bedford Canyon Formation. The Santiago Peak Volcanics were named by Larsen (1948, p. 23) who described them as unmeasurable but probably a many thousand-feet-thick accumulation of mildly metamorphosed volcanic rocks, mostly agglomerate, that include some sediments. In Riverside County this formation is confined to scattered outcrops in the Santa Ana Mountains and one small area north of Alberhill (Larsen, 1948, pl. 1).

Larsen (1948, p. 23-24) considered the Santiago Peak Volcanics to be of Jurassic age because they overlie the Bedford Canyon Formation unconformably and are intruded by the crystalline rocks of the southern California batholith.

South of Corona, on the northeast slope of the Santa Ana Mountains, deeply altered rocks of the Santiago Peak Volcanics have been quarried for contained gypsum.

Another rock unit, the Temescal Wash Quartz Latite Porphyry, is probably of Jurassic age (Larsen, 1948, p. 36). This unit underlies several square miles in the hills southeast of Corona and is extensively exposed in the Estelle Mountain area north of Alberhill.

At a quarry in Temescal Canyon the Temescal Wash Quartz Latite Porphyry has been mined since 1888; first for paving materials and, since 1947, for roofing granules (Gray, 1961, p. 93).

The rocks of the Southern California batholith are the most extensively exposed bedrock units in Riverside County. They range in composition from gabbro to granite; The average composition is that of a quartz diorite. The intrusive sequence was: Gabbro, quartz diorite, granodiorite, then granite (Larsen, 1948, p. 137, 138-139).

The southern California batholith comprises the bulk of the Peninsular Ranges the northern end of which underlies the west half of the county. Plutonic igneous rocks of similar age (Jurassic to Cretaceous) are present in the Little San Bernardino, Pinto, Eagle, ~~Cocks~~ Cox comb, Chuckwalla and Orocopia Mountains. One of these, the White Tank Monzonite, which underlies parts of the Pinto, Eagle, Orocopia and Chuckwalla Mountains, has been dated as Cretaceous in age (Jaffe and others, 1959, p. 88) in the Joshua Tree National Monument area.

The Fargo Canyon Diorite, in the Little San Bernardino Mountains, has been considered of probable late Jurassic age (Miller, 1944, p. 60) on the basis of field relationships, and the ~~Cocks~~ Cox comb Granodiorite is of probable Mesozoic age (Miller, 1944, p. 63) because it intrudes the McCoy Mountains Formation. Thus, the central desert area of Riverside County was intruded by plutons which were roughly synchronous, if not contiguous, with the southern California batholith of the Peninsular Range Province.

Much of the evidence of the age of the southern California batholith is outside Riverside County, but, in the Santa Ana Mountains, components of this igneous complex intrude the Triassic-Jurassic Bedford Canyon Formation and the Temescal Quatz Latite Porphyry and are overlain unconformably by sedimentary rocks of late Cretaceous age.

Most of the metal-bearing vein deposits of Riverside County lie in or are closely associated with the rocks of the southern California batholith. Dikes of gray- to green, fine-grained rock of dioritic composition are common in the eastern part of the county. Such dikes cut rocks as young as the White Tank Monzonite and were observed to be a source of copper minerals in several deposits in the Maria and Riverside Mountains. Some of these dikes may be late Mesozoic in age, but some might be as young as and related to Tertiary volcanic rocks such as those in the Little Chuckwalla Mountains. Miller (1944, p. 32) suggested that the replacement iron ore deposits in the Eagle Mountains are of late Mesozoic age through the assumption that they are related to intrusive rocks of that age.

In the west half of the county, pegmatite bodies, associated with the rocks of the southern California batholith, have been a source of quartz, feldspar, and gems and are a potential source of beryllium minerals. In addition, the various rocks of the batholith have been used as decorative and structural material, rip-rap, and, where decomposed, as road base.

In Riverside County, Upper Cretaceous sedimentary rocks comprise the Trabuco and Ladd Formations. These rocks are exposed in a narrow belt along the northeast slope of the Santa Ana Mountains.

The Trabuco Formation consists of 600 feet of non-marine(?) conglomerate which lies unconformably on, or is in fault contact with, the previously described older Mesozoic rocks.

The Ladd Formation is made up of 5,400 feet of fossiliferous, marine conglomerate, sandstone, siltstone and shale. The upper one-third of this formation consists of a 1,400-foot sandstone unit, called the Baker Canyon Member and an overlying silt- to silty clay unit, called the Holz Shale.

Woodring and Popenoe (1942, p. 170) consider the Trabuco Formation to be of early Late or late Early Cretaceous age. The same authors described the Ladd Formation and assigned a Late Cretaceous age (Woodring and Popenoe, 1942, p. 170) on the basis of marine fossils.

The Ladd Formation yields red-burning clay in the Wardlow and Mabey Canyon area about 3½ miles southwest of Corona (Gray, 1961, p. 78-80). The clay is used in the manufacture of common clay products.

Tertiary Rocks

Rocks of Tertiary age are exposed in a few restricted and widely separated areas in Riverside County.

In the west half of the County the Tertiary rocks consist of the Silverado Formation (Paleocene), Santiago Formation (Eocene), Vaqueros-Sespe Formations (Eocene to Miocene), Topanga Formation (Miocene), Puente Formation (Miocene) and undifferentiated Pliocene sedimentary rocks.

The Silverado Formation is made up of approximately 2,000 feet of non-marine and marine clay, clayey sandstone, lignite, and pebble conglomerate. These rocks were originally assigned to the Martinez Formation (Dickerson, 1914, p. 263; English, 1926, p. 19 Sutherland, 1935, p. 76) of "lower Eocene" age on the basis of their relationship to older rocks and fossil evidence. Woodring and Popenoe (1945) proposed the name Silverado.

The Silverado Formation is exposed in a narrow belt northeast of the Elsinore fault parallel and adjacent to the foot of the northeast slope of the Santa Ana Mountains (Gray, 1961, p. 24, pls. 1,3). In the Alberhill area and south of Corona this formation is quarried for clay and glass sand (Gray, 1961, p. 23-29).

The Santiago Formation consists of a band of marine Eocene ~~(?)~~ sandstone, siltstone, and cobble conglomerate, ranging from 200 to 800 feet in width which extends for about 1 3/4 miles eastward from Santa Ana Canyon parallel to the north slope of the Santa Ana Mountains (Gray, 1961, p. 29, pl.3). The age of this formation is based on somewhat indefinite fossil evidence (Gray, 1961, p. 29). It is conformable on the Silverado Formation and overlain unconformably by the undifferentiated Vaqueros and Sespe Formations.

The Vaqueros and Sespe Formations Undifferentiated are sparsely fossiliferous, maroon, red-buff, gray and grayish-green coarse sandstone, conglomerate, with a minor amount of siltstone. These rocks are exposed in the area south of the junction of Bedford Wash and Temescal Wash and in a discontinuous belt east of Santa Ana Canyon and south of Prado Dam (Gray, 1961, pls. 1,3).

Dickerson (1914), English (1926), Loel and Corey (1932, p. 51-60), Woodring and Popenoe (1945), Woodford and others (1954, p. 69), and Gray (1961, p. 29-31) have contributed to the description of the Vaqueros and Sespe Formations and their age and relationship in the Santa Ana Mountains. The Vaqueros and Sespe Formations Undifferentiated have a maximum exposed thickness of 2,300 feet in Riverside County. These rocks are reported to be ~~conformable on Paleocene sandstone,~~ unconformable on the Santiago Formation and unconformably overlain by the Topanga Formation (Gray, 1961, pl ~~30-31~~).

In Riverside County rocks assigned to the Topanga Formation are exposed in an area about one-half ~~of~~ a square mile in extent in the hills south of El Cerrito Village and about 3 miles southeast of Corona (Gray, 1961, pl. 1). Here this formation comprises buff and brown siltstone and shale with subordinate sandstone and conglomerate. Some of the shale is diatomaceous. These rocks are probably 750 to 1,000 feet thick. Their late middle Miocene age is based on fossil evidence and primarily on microfossils (Gray, 1961, p. 31).

At the above locality the Topanga Formation overlies the Silverado Formation unconformably and its upper boundary has been removed by erosion.

The Puente Formation, which in the normal Santa Ana Mountains section lies unconformably on the Topanga Formation, was originally described and named by Eldridge and Arnold (1907). Subsequent workers (English, 1926, p. 33-38; Woodford and others, 1944) divided the Puente Formation into three members: lower shale and sandstone; middle sandstone; and upper shale, conglomerate and sandstone. Later work by Schoellhamer and others (1954) and Gray (1961) has shown the utility of using four members in the southeastern Puente-Chino Hills and in the Santa Ana Mountains. The members are (in ascending order): The La Vida Shale, Soquel Sandstone, Yorba Shale, and Sycamore Canyon. Gray (1961, p. 34, pls. 1,3,4), in mapping the Corona-Prado Dam area, used a basal "undifferentiated" unit in addition to the four members.

All of these units except the La Vida Shale are exposed in Riverside County. They are fossiliferous marine sedimentary rocks. The Puente Formation underlies scattered areas from Temescal Canyon northwest to Santa Ana Canyon in a rough arc around the northeast end of the Santa Ana Mountains.

The Puente Formation, undifferentiated consists of about 1,000 feet of siltstone, shale, diatomite, limy beds and minor sandstone and conglomerate.

The Soquel ~~Sandstone~~ Member consists of 700 feet of sandstone, conglomerate and a minor amount of siltstone. Where its base is exposed, west of the county, it is conformable on the La Vida Member. It is in gradational contact with the superjacent Yorba Member.

The Yorba Member comprises about 1,200 feet of massive to fissile siltstone interbedded with fine sandstone. It grades upwards into the overlying Sycamore Canyon Member.

The Sycamore Canyon Member is made up of approximately 2700 feet of coarse sandstone and conglomerate with interbedded siltstone.

In the Prado Dam area the axis of a syncline (Arena Blanca Syncline) contains about 3,000 feet of marine sedimentary rocks of Pliocene (?) age (Gray, 1961, p. 36, pl. 3) exposed in a belt of about 1½ miles wide at the southeastern end of the Puente-Chino Hills. These rocks are white sandstone, conglomerate, and sandy silt and shale. They are in gradational contact with the underlying Puente Formation. The Pliocene (?) age of these rocks is in doubt because the supporting fossil evidence is inconclusive.

In contrast to the oil and gas bearing Late Tertiary marine sedimentary rocks in the Prado-Corona area, the Tertiary and Quaternary strata exposed to the southeast in the Murrieta-Temecula area, are nonmarine. They consist~~ing~~, in part, of clay, diatomite, and volcanic rocks (plate 3).

These rocks were mapped and described by Mann (1955). They were deposited in or near the zone of the Elsinore fault. All recognized formations are unconformable with the immediately subjacent and superjacent rocks and are probably, in part, a result of tectonic events related to the fault.

The Pliocene (?) Santa Rosa Basalt and the Pleistocene or sub-Recent (Mann, 1955) Nigger Canyon Volcanics are of particular interest. ~~because~~ volcanic rocks so young are unusual in the coastal ranges of southern California and, as Mann points out, they lie along a major structural break, the main feature of which is the Elsinore fault zone.

Fossiliferous, continental and lacustrine beds of Pliocene and Pleistocene age underlie badlands northwest of the San Jacinto Mountains and in the Bautista Creek-Hemet Valley areas. These rocks comprise the Mount Eden Formation (Pliocene), San Timoteo Formation (Pliocene) and the Bautista Beds (Pleistocene).

The Mount Eden Formation was originally named the Eden Beds by Frick (1921) ~~. Because this name was found to be preoccupied, the name~~ and changed to the Mount Eden Formation ~~was proposed~~ by Fraser (1931, p. 512). The Mount Eden Formation includes a lower, generally coarse-grained red-bed unit overlain by interbedded gray, buff and greenish, arkosic sandstone, sandy shale and shaly siltstone. Fraser (1931, p. 512, 513) estimated the thickness of the basal red beds to be 1,800 feet and the overlying sandstone and shale 1,500 feet. The Mount Eden Formation is exposed in the area of Potrero Creek and its tributaries. The Pliocene age of ~~the Mount Eden Formation~~ these beds is based on fossil vertebrate faunas described by Frick (1921), and plant remains (Axelrod, 1937).

The San Timoteo Formation consists of an unknown thickness of alluvial silt, sand, and coarse gravel underlying the San Jacinto-Moreno and San Bernardino valleys and the intervening divide which extends about 18 miles northwest from the foothills of Mount San Jacinto. This formation overlies the Mount Eden Formation unconformably. No contact between the San Timoteo Formation and the younger Bautista Beds has been described. The Pliocene age of the San Timoteo Formation is based upon vertebrate fossils (Frick, 1921).

(Frick, 1921, p. 290)

The Bautista Beds underlie the Bautista Creek badlands which lie north of Bautista Creek and form both banks of the San Jacinto River and Poppet Creek in an area of about 36 square miles 7 miles east of Hemet. Several smaller exposures include Park Hill near Hemet, a six-square-mile area in the Bautista Creek watershed, a three-square-mile area in Cactus Valley, and a ten-square mile area at the southeast end of Hemet Valley (Fraser, 1931, map). ~~This formation was named by Frick, (1921, p. 290).~~ It is made up of poorly indurated silty clay, shale, sandstone and minor conglomerate and calcareous tuff, estimated (Fraser, 1931, p. 515) to be 1,500 to 2,000 feet thick. The Bautista Beds have yielded a rich Pleistocene vertebrate fauna (Frick, 1921).

Along the northeast side of the Coachella Valley the trace of the San Andreas fault is marked by several groups of low, deeply eroded hills, which include the Bat Cave Buttes, Mecca Hills and Indio Hills. In these hills, soft sedimentary rocks of the Mecca and Imperial Formations, the Canebrake Conglomerate, the Palm Spring Formation and the Ocotillo Conglomerate are exposed (Dibblee, 1954).

The Mecca Formation was described by Dibblee (1954, p. 24) as "essentially a basal conglomerate of granitic and metamorphic debris." It is unconformable on the eroded Precambrian rocks exposed in the Orocopia Mountains and overlies the Dos Palmas Rhyolite of Miocene (?) age. In addition to its typically conglomeratic character the Mecca Formation grades laterally and upward into sand, sandstone, and clay. It has an estimated total thickness of as much as 1,000 feet (Dibblee, 1954, fig. 3). The Miocene(?) age of the Mecca Formation is based on its stratigraphic position. It is overlain unconformably by the Imperial and Palm Spring formations.

The Lower Pliocene Imperial Formation was named by Woodring (1931). It is exposed in the northwestern Indio Hills. This formation appears to comprise as much as 300 feet of fossiliferous, marine clay and possibly some sandstone. It is unconformable beneath the Palm Spring Formation and the Ocotillo Conglomerate.

The Plio-Pleistocene Palm Spring Formation (Woodring, 1931) is made up of 3,300 to 4,800 feet of non-marine (?), arkosic sandstone grading upward into increasingly clay-rich beds and including, in its upper 1,500 feet, thick beds of red and green silty claystone. The upper beds are at least in part marine for a specimen of the marine pelecypod genus Rangia was found by the author in this unit, about 4 1/2 miles east of Thermal.

The Palm Spring Formation grades northeastward into the Canebrake Conglomerate of similar age, described by Dibblee as a marginal facies, 0 to 3,000 feet thick (1954, p. 25, fig. 3). The Canebrake Conglomerate is composed of dominantly coarse, poorly sorted, well indurated accumulations of sandy to bouldery, well-rounded igneous and metamorphic debris.

The Palm Spring Formation and Canebrake Conglomerate are overlain unconformably by the Pleistocene Ocotillo Comglomerate. The Ocotillo Conglomerate is an accumulation of granitic and metamorphic debris which forms coalescing alluvial fans derived from the Orocopia and Little San Bernardino Mountains. This conglomerate was described by Dibblee (1954, p. 25) who estimated its thickness to range from 0 to 2,500 feet.

About 300 feet of alluvium, terraces and lake beds cap the Coachella Valley section. The lake beds were named the Lake Coahuila Deposits by Tarbet and Holman (1944, p. 1782) after Lake Coahuila, a former fresh water body, the shore line of which is still visible along the ~~east~~ west side of the valley.

Some exposures of clay-rich units in the Palm Spring Formation have been prospected for clay. Alluvial deposits along the southwest margin of the Mecca and Indio Hills currently are being quarried for sand and gravel.

In the arid ranges of the Mojave Desert in the southern and eastern part of Riverside County, the Cenozoic era is represented by 4,800 feet of marine sediments of Eocene age, more than 5,000 feet of nonmarine Miocene sedimentary and volcanic rocks and marine or brackish water marl, travertine, clay, and sandy gravel, of Pliocene to Pleistocene age. There are abundant late Quaternary alluvial, lake, and eolian deposits.

To the east of the Coachella Valley, on the north flank of the Orocopia Mountains, Eocene rocks have been described by Crowell and Susuki (1959) and named the Maniobra Formation. They state (1959, p. 591): "The Maniobra formation, discovered recently in the Orocopia Mountains north of the Salton Sea, contains a fauna of mollusks, orbitoids and small foraminifera. These marine rocks constitute about 4,000 feet of interbedded sandstone, siltstone, conglomerate, and breccia which were laid down near a rugged shore line." The Maniobra Formation is discontinuously exposed in a narrow, northwest-trending belt about 12 miles long and 2 miles wide in the north-central Orocopia Mountains. Approximately 5,000 feet of nonmarine, Miocene strata overlie the Maniobra Formation. These strata may be equivalent, at least in part, to the Mecca and Imperial Formations exposed in the Coachella Valley (plate 3 /).

The volcanic rocks exposed in the Orocopia Mountains might be roughly synchronous with the Dos Flamas Rhyolite to the west, the volcanic rocks exposed along the south flank of the Little Chuckwalla Mountains and at the south end of the Mule Mountains to the east, and just southwest of Palen Pass at the north end of the Palen Mountains.

Bodies of quartz latite and rhyolite are common in various areas. Miller (1944, p. 65-66) assigned a probable early Tertiary age to a system of quartz latite dikes most prominently exposed in the Desert Center area. One such dike forms the "spine" of a long northeast-trending ridge just south of Desert Center. It is possible that some of the dikes cutting the Chuckwalla Complex in the Chuckwalla Mountains at Graham Pass are Tertiary in age.

Miocene(?) volcanic rocks flanking the south slope of the Chuckwalla and Little Chuckwalla Mountains comprise an undetermined thickness of andesite, rhyolite and basalt flows. Cursory examination of the sequence suggests that the andesite and rhyolite (were the preceded the basalt earlier having culminated in flows of perlitic obsidian. The basalt appears to have followed a period of erosion for, in at least one locality, it is separated from the underlying obsidian by some tens of feet of alluvial material. The volcanic rocks exposed in the Mule Mountains are, as far as was observed, the older rhyolitic types material.

The south slope of the Chuckwalla Mountains, and especially the Coon Hollow area in the Mule Mountains, are noted collecting localities for cryptocrystalline varieties of quartz in the form of septarian nodules (thunder eggs), amygdules, and as fissure fillings.

The youngest volcanic rocks in eastern Riverside County, possibly as young as early Pleistocene, are olivine basalt flows and interlayered basaltic sands, totaling 500 to 700 feet in thickness, which form small mesas in the Eagle Mountains (Miller, 1944, p. 68-69).

Low on the slopes of the Big Maria, Little Maria and Riverside Mountains deposits of calcareous marl, travertine, and lime-cemented alluvium comprise what appears to be remnants of a Pliocene(?) marine or saline lake deposit (Hamilton, 1960, p. 276-277). These deposits are as much as 800 feet above sea level. In some exposures the material is composed of a coquina of calcareous algae, barnacles, and pelecypods. Some slopes are buttressed by masses of dense travertine as much as 50 feet thick (fig.); others are covered by thin veneers. A small tonnage of marl was quarried from one deposit at the south end of the Maria Mountains, but no record of its sale or use was found. Locally, accumulations of manganese oxides in and immediately beneath these cappings have been prospected, but in Riverside County, little if any material has yet been marketed from this source.

Photo 1

The basin in and around which the marl and travertine deposits formed was probably a broad, ~~and~~ shallow, ~~whether it was a lake or an~~ extension of the Gulf of California, ~~has yet to be determined but in either case~~ the basin was filled by Quaternary clay, silt, sand and gravel deposits of the Colorado River flood plain-- the Chemehuevis Gravel (plate 3/).

Lee described the Chemehuevis Gravel (1908, p. 18), as a valley ~~filling~~ fill ~~as much as~~ up to 700 feet thick deposited during an aggrading stage of the Colorado River. Longwell (1936, p. 144) renamed these bel. The Chemehuevi Formation. In eastern Riverside County this deposit now underlies bluffs, badlands, and the Palo Verde Mesa. The deposit is characterized by local changes in the size and composition of sedimentary material. The river bluffs along the east side of the Maria and Riverside Mountains contain much locally derived rock debris. Badlands near Vidal and south of the Palen Mountains are cut in bedded silt and clay resembling lake, bay or estuarine deposits. The Palo Verde Mesa, north and west of Blythe, consists of clay, silt, sand, gravel and fragments of apparently reworked clay.

Near areas of exposed bedrock, where coarse debris is proportionately dominant, the Chemehuevis Formation ~~Gravel~~ has been used for road material and as a source of aggregate. Just north of the county line, near Vidal, clay beds are quarried on a small scale for use in drilling mud. South of the Palen Mountains similar deposits have been prospected but, as of 1961 they had not yet ~~(1961)~~ been developed ~~(Tucker and Sampson, 1945, pl. 35)~~

Mining Districts

In the western mining camps, mining districts were (the result of) individuals "----finding themselves beyond the pale of the law and being so uncomfortable in that nakedness that they concerted to erect a system of law and a machinery of government." (Caughey, 1948, p. 225).

Where competition for mineral ground was keen, mining district boundaries were apt to be well defined and well administered, one of the chief functions being the recording of claims. Conversely, in areas such as Riverside County, where gold and water were less abundant, mining districts appear to have been less formal and to have acquired little or no legal machinery. When disputes arose in such areas they could be settled under federal statutes. Mining districts were not necessary to the staking of claims (Ricketts, 1931, p. 176) but a district office afforded the miner a local authority.

The various areas in Riverside County referred to at one time or another by prospectors or ~~authors of~~ technical reports as "districts" are shown on ~~plate~~ figure 4. With the possible exception of the Temescal and Taquitz (Kenworthy) districts no evidence was found (that) ~~much in the way of~~ formal records ~~were kept in these areas~~. Early

Figure 4

reports use different, and sometimes conflicting, names for similar areas. The Ironwood district, for example, once ~~included~~ covered the eastern third of the county, an area including 8 smaller districts the names of which have been used either in the literature or on claim notices filed with the county authorities. The U. S. Geological Survey has used mining districts for "convenience of reference" (Hill, 1912, p. 114) including some of those shown on ~~plate~~ figure 4/.

The offices of the county assessor and recorder, ~~(both of which) are in the courthouse~~ They in Riverside, CA receive and record notices of claims, records of official surveys, and affidavits of annual assessment work. Old or newly devised district designations are of little service to the accuracy of their records as a means of specifying location and afford the locator a poor legal base for his claim. The asessor maintains records of ownership for tax purposes only.

The recording of a mining claim should be done as nearly as possible with reference to the "Public Land Survey" system. The topographic quadrangle maps published by the U. S. Geological Survey show the lines of this coordinate system and serve as a valuable aid to locators (fig. 5/). The "Public Land Survey" has not yet been completed in some remote or arid areas. In such areas, Mineral or Location Monuments have sometimes been established to afford permanent reference points (Saul, 1962). These markers should be used where available.

figure 5

Mines and Mineral Deposits

Antimony

Mountain Group (Crowell, Mabey Canyon) Deposit

Location: NE¼NW¼ sec. 8, T. 4 S., R. 7 W., S.B.M., Black Star Canyon quadrangle, 7½', 1950; about 4½ miles southwest of Corona on the northeast side of the Santa Ana Mountains in the Cleveland National Forest, along the east side and about 100 feet above upper Mabey Canyon.

Ownership: Robert A. Mattey, Jr., 11359 Biona Drive, Los Angeles 66 (1953). Undetermined (1963).

History: In 1895 this property was known as the Crowell mine and was owned by J. Irving Crowell, South Riverside (Corona). By that date a number of superficial cuts had been made on the claim and several hundred pounds of stibnite had been mined from one cut. The property was idle and the principal workings were caved in 1895. Apparently the property remained idle until 1935 when Joseph Erenreich located the Mountain claim which he developed under the name Erenreich Gold Mines. In May, 1942, Mr. Erenreich first recognized antimony in the area and by December of that year four claims (Mountain 1-4) were under lease to R. A. Mattey, Sr. and a shipment of sorted antimony ore had been made to the Harshaw Chemical Company's smelter in El Segundo. Following this ship-

ment considerable effort was made to develop this deposit under the strategic minerals program and an access road was built, but apparently little, if any, ore was shipped during the remainder of World War II. By 1948 the property consisted of five claims held under a partnership of Robert A. Mattey and others, and was known as Mountain Antimony Mine. In October, 1948, two lots of ore were shipped to the Harshaw smelter. This smelter was shut down in 1949 and dismantled in 1950. Apparently no further shipments were made from the Mountain deposit, but small scale intermittent activity, including the stockpiling of several tens of tons of ore, continued until about 1953. The property has apparently since been idle.

Geology: A mineralized zone about 4 feet thick of altered volcanic rock occurs between two well-marked shear zones in fresh, green hornblende andesite of the (Jurassic(?)) Santiago Peak Volcanics. The shear zones strike north and dip 10°-25° E. Altered rock is exposed along a strike length of about 40 feet and is reddish-brown on weathered surfaces, but is gray on fresh surfaces. This altered zone is cut by numerous thin, randomly oriented veinlets of stibnite. ~~(without apparent orientation.)~~ Disseminated bits of stibnite and small clots of pyrite also occur. ~~(Both)~~ calcite, (and) quartz, (as well as) and brown iron oxide, are associated with most of the stibnite veinlets. Nearly pure stibnite veinlets are as much as 2 inches thick, and the quartz-calcite-stibnite veinlets average 2 to 3 inches thick.

In addition to stibnite, a yellow oxide, which is apparently an alteration of stibnite, also occurs. Tests on one lot of ore that averaged 11.1 percent Sb, made by Harshaw Chemical Company, indicated that antimony was present as mixed sulfide and oxide and that 4.6 percent was Sb_2S_3 (Stibnite) and 6.5 percent was Sb_2O_3 (Cervantite?). Tucker and Sampson (1943, p. 66) reported that cut samples made at intervals along a 50-foot open cut assayed 10-28 percent antimony. Because of dense brush the extent of the deposit was not determined when the property was visited in April, 1958, but Tucker and Sampson (1945, p. 123) reported that stibnite occurs over an area about 200 feet by 500 feet in a series of nearly parallel veins ranging from 6 inches to 2 feet in width, and that on the hillslope above large boulders of stibnite were found in the overburden.

Development: By 1942 workings included a caved lower adit at the creek level driven southeast 140 feet; about 100 feet above was an upper adit 20 feet long and an open cut on the vein for a distance of 50 feet. In 1958 the only working observed was a 10-foot adit driven N. 80°E. from the back of an open cut on a steep hillslope facing Mabey Canyon. The open cut is about 15 feet long, 15 feet wide, and 10 feet deep. A small mill and a "smelter" constructed of brick were located in lower Mabey Canyon at the Grapevine Clay Mine. The mill included a crusher, screens, and two flotation cells. Apparently the mill operated during 1948 but was not satisfactory and has since been dismantled.

Production: Total undetermined. That given below was shipped to the Harshaw smelter and probably includes most, if not all, of the production.

ear	lbs. ore (wet)	lbs. ore (dry)	Assay, Crude Sulfide ore			Total Sb Content Value recovered
			H_2O	Sb	As	
942	792 (sorted ore)		1.0%	38.7%	0.34%	307 lbs. $25.79
948	2,800	2,746	1.91%	34.2%	0.15%	939 lbs. $204.28
948	1,907	1,890	0.90%	11.1%	0.13%	probably not processed
otal	5,499					

References: Crawford, 1896, p. 31; Merrill, 1917 /1919/ p. 524; Tucker, 1921, p. 324; Tucker and Sampson, 1943, p. 65-66; Tucker and Sampson, 1945, p. 123.

C.H.G. 4/26/58.

Arsenic

Shining Star Deposit

This report is based largely on information contained in a recently published description by Engel, Gay and Rogers (1959, p. 75-76).

Location: Sec. 6, T. 6 S., R. 4 W., S.B.M.; ~~U. S.~~ Army Corps of Engineers, Lake Elsinore quadrangle, 15', 1942; on a town-lot building site on the north flank of a small, flat-topped hill just north of Pottery Street at Lewis Street, in the northwest part of Elsinore.

Ownership: Undetermined.

History: In 1929, James Wrench of Elsinore held three claims on the deposit (Engel and others, 1959, p. 61, pl.2).

Geology: The deposit is on a fault between Jurasic quartzite and slate, and Cretaceous diorite and gabbro. Aplitic dikes are present in the gabbro and both rock types are decomposed near the surface, especially near the fault zone.

The fault zone, about 3 feet wide, trends N. 20° W. and dips about 68° SW. as exposed in the shaft collar. Fine-grained (Sugary) siliceous material occupies the fault zone; parallel siliceous veins are reported in the adjacent rocks.

The deposit contains gold and arsenopyrite with traces of black manganese oxide. A sample representative of a 2-foot width of vein was reported to assay $4.80 in gold, 12 percent arsenic, 7 percent sulfur, and 18 percent iron (Tucker, 1929, p. 469).

Development: In 1929 development consisted of 2 near-vertical shafts, 22 and 30 feet deep, and a 75-foot crosscut adit driven southward, its portal about 250 feet northwest of and 150 feet below the collar of the 30-foot shaft. The adit crossed 5 veins from 1 foot to 2 feet wide. In 1955 all workings were boarded but apparently uncaved.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 468-469; 1945, p. 123-124; Engel and others, 1959, p. 61.

R.B.S., from Engle and others.

Asbestos

Charleboix (Percival Asbestos) Claims

Location: Secs. 29 and 32, T. 6 S., R. 5 E., S.B.M., Toro Peak quadrangle, 1941; at the northwest edge of Pinyon Flat near Nightingale, a small resort on State Highway 74.

Ownership: Kenneth Charleboix, Corregador Street, Cathedral City, holds 9 claims. Under lease to Lee Wolfer, Box 80, Mountain Center (1958).

History: Early mining on these claims was by a combination of short adits and open pits (Merrill and Waring, 1917, p. 550-553; Tucker and Sampson; 1929, p. 499). Claims appear to have been located and worked in a small way as early as the turn of the century, but the only period of sustained activity appears to have been in 1930 (Tucker and Sampson, 1945, p. 159). In 1945 (Tucker and Sampson, p. 159) J. Wellman and Jack Harris, Pinyon Flat, were the owners.

Geology: An irregular shear zone cuts gneissic and schistose Paleozoic(?) rocks in an arc roughly 3 miles long, along the west and southwest edge of Pinyon Flat. The width of the zone is difficult to determine because of low relief and overburden. It is as much as 200 feet wide in one exposure but this is probably made up of a series of parallel or en echelon shears. The shearing appears to have occurred along a thin ~~sill~~ dike-like body of ultrabasic rock of uncertain attitude referred to by Tucker and Sampson (1945, p. 158-159) as cortlandite, a basic igneous rock composed largely of hornblende and olivine. Veins and cavities in this body are filled in part with tremolite asbestos. Biotite and chlorite are common as a soft schistose constituent in the shear zone. Much of the material has been sheared, granulated, and altered to a soft, gray, earthy gouge.

The tremolite occurs in veins ranging from a fraction of an inch to as much as 2 feet in thickness. The fresh material is solid and brittle, the fibers being difficult to separate. The weathered tremolite is soft and finely divided.

Development: Remnants of the old workings described by Merrill and Waring (1917, p. 552) still remain (June, 1958) but are unsafe or caved. The present operator plans to use open-pit methods and hopes. ~~It is~~ hoped that several products may be marketed, ~~including~~ (1) three grades of asbestos fiber, (2) biotite, thought to have possibilities as vermiculite, mica, and (3) soil conditioner derived from the soft gouge material.

When visited (June, 1958) a mill was under construction but nothing more than assessment work had been done on the claims.

Production: During the early development of this property an unreported amount of tremolite asbestos was shipped to San Diego for use in mineral paint (Merrill and Waring, 1917, p. 552). In 1930, about 800 tons of asbestos ~~were~~ was shipped to Soto Battery Box Manufacturing Co., Los Angeles (Tucker and Sampson, 1945, p. 158-159).

References: Merrill and Waring, 1917, p. 550-553; Tucker and Sampson, 1929, p. 499; 1945, p. 158-159.

R.B.S. 6/26/58.

Beryllium

Although beryl, the chief ore mineral of beryllium, has been mined in Riverside County for use as a gem (see herein under gems) it has not yet been found in sufficient quantity to warrant mining for its contained beryllium oxide. Indeed, western Riverside County contains some of the most beryl-rich pegmatite dikes in California, yet even these have been shown to contain only a fraction of 1 percent of the mineral (Wright, 1957, p. 75).

Perhaps the most recent (1959) discovery of beryl in Riverside County was in the vicinity of the Garnet Queen mine on the northwest flank of Santa Rosa Mountain, the most northerly peak of the Santa Rosa Mountains (see Santa Rosa Mountain Prospect).

Santa Rosa Mountain Prospect

Location: SE¼SE¼ sec. 19, T. 7 S., R. 5 E., S.B.M., Fallwild quadrangle, 1959; on the northwest flank of Santa Rosa Mountain, adjoining the Santa Rosa Mountain lookout road.

Ownership: In 1960, D. C. Walker, c/o Farmers Insurance Group, 1587 E. Colorado Street, Pasadena, held an undetermined number of unpatented claims on this deposit.

History: Undetermined.

Geology: The geology of the township in which this prospect is located was mapped by Lawrence B. Wright (1945, p. 9-13, pl. 1). Wright's map shows that the prospect is in one of numerous, extensive, west- to northwest-trending pendents of Paleozoic(?) metasedimentary rocks separated by irregular bodies of Cretaceous granitic rock. In the vicinity of the prospect the country rock is cut by poorly exposed, beryl-bearing pegmatite dikes of undetermined number and extent. Exposed fragments of dike rock are as much as one foot thick. The dikes are composed of quartz, albite, muscovite, black tourmaline, and beryl. The beryl crystals are as much as one inch in diameter and four inches long. In surficial material presently exposed the beryl is finely fractured and partially altered. Though the beryl crystals appear to be more

70

abundant here than in pegmatite dikes in the nearby Coahuila area, their relatively small, pencil-like size would make concentration by current (1962) techniques difficult.

Development: By late 1959 a short access road and a shallow prospect pit comprised the only development.

Production: None.

References: Wright, 1946, p. 9-13, pl. 1.

R.B.S. 10/22/59

Bismuth

The only recorded production of bismuth in California was from Riverside County in 1904. In that year 20 tons of bismuth ore were reported (Chesterman, 1957, p. 79) from the Lost Horse mine (see herein under gold). Murdoch and Webb (1956, p. 79) list bismuthinite (Bi_2S_3) as found at the Lost Horse mine, but this occurrence is not documented.

Clay

The southwestern part of Riverside County contains the oldest and most productive clay district of southern California -- the Alberhill-Temescal Valley-Corona district. The clay deposits, of which this district is a major part, crop out discontinuously in Riverside and Orange Counties in an irregular, rather narrow, horseshoe-shaped belt, the ends of which point southeast. In Riverside County the deposits lie in a belt about 20 miles long that extends northwest from Elsinore to Corona along the Temescal Trough. The deposits are parallel to and bounded on the southwest by the Elsinore fault zone along the north east flank of the Santa Ana Mountains. On the northeast the deposits lap up onto the edge of the Gavilan Hills. From Corona the deposits extend around the northwest tip of the Santa Ana Mountains into Orange County and thence southeastward on the south west flank of the mountains across Trabuco Canyon to the Tierra Colorado clay district in southeastern Orange County.

The clays in the district are both residual and sedimentary. Most of the clay probably was originally derived from weathered surfaces of Jurassic(?) or Cretaceous hypabyssal intrusive rocks. Less abundant are clays that have weathered from Triassac and/or Jurassic argillites and slates. Elsewhere in the Santa Ana Mountains Cretaceous shales may have been a source of clay. Residual clays have developed in place by subaerial chemical weathering of aluminum-rich rocks which, in the Alberhill region, include: quartz latite porphyry; quartz latite volcanic breccia; Santiago Peak Volcanics, latite to andesite; mixed gabbro-diorite; and Bedford Canyon Formation slates. These clays are of two general types: white, yellow, buff, gray, and red mottled claystone; and white, yellow, and red pisolitic claystone.

figure 6
figure 7

The sedimentary clays are commonly associated with lignite and are found near the base of the Paleocene Silverado Formation. Apparently they were derived from the residual clays and deposited unconformably on Cretaceous and older rocks, or on the weathered materials derived from them. The sedimentary clays differ from place to place but are of four general types: red and white or yellow and gray mottled claystone; gray to brownish red or yellowish green pisolitic clay (locally called "bone clay" or "bauxite"); gray sandy claystone; and white or gray to black, fine-grained, dense kaolinite with a conchoidal fracture (locally called "flint fire clay", or "fire clay").

In 1963 about 20 pits were active, but some of these are mined only intermittently. From 1894 to 1960 a total of (about) 8 million tons of clay valued at more than (12) million dollars is reported to have been produced in Riverside County (see ~~Fig~~ Table 2). These figures, however, are not complete as prior to 1949 they do not include clay ~~and~~ used to manufacture brick and hollow tile which from 1898 to 1949 was reported either separately or under unapportioned. Almost all of the reported clay production was mined from the Elsinore-Alberhill-Corona area and the greatest portion came from the Alberhill area. In recent years total production of all types of clay from the Alberhill-Temescal Valley-Corona district probably has been on the order of 250,000 tons each year. This region of Riverside County contains the largest known deposits of commercial clay in southern California.

In the desert area of Riverside County several deposits of sedimentary silty clay have been explored, but none have been placed in production. The best known of these are the Red Top deposit a few miles east of Thermal and the Palen Mountains deposit on the southwest flank of those mountains.

Bedford Canyon (Corona) Clay Deposit

Location: N½ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 5 road miles southeast of Corona, on the west side of Temescal Wash in lower Bedford Wash.

Ownership: International Pipe and Ceramics Corporation, 2901 Los Feliz Boulevard, Los Angeles 39 (P.O. Box 578, Corona) own about 160 acres in an irregular shape in the N½ sec. 16.

History: This deposit was discovered in August 1954 by geologists of Gladding, McBean and Company who were engaged in an intensive exploration program. After core drilling the property, construction of a plant for the manufacture of red-burning clay products began in July 1956, and it was placed in operation on January 1, 1958. The plant has since been in continuous operation. In 1962 Gladding, McBean and Company merged with the Lock Joint Pipe Company of East Orange, New Jersey to form the International Pipe and Ceramics Corporation.

Geology: The deposit includes both residual clay and sedimentary clay of the ~~Paleocene~~ Silverado Formation; the two clay zones are separated by poorly indurated arkosic sandstone. The beds appear to strike about N. 20° W. and dip from 8° to 15° southwest. The sequence, as exposed in the pit in October 1955, is given below.

Unaltered, fine-grained, blackish-gray hornblende diorite grades upward through progressively more altered rock, but with igneous texture recognizable, and finally into red mottled residual clay without recognizable igneous texture. This zone is mostly red with some buff colored pods and ranges from 5 to 20 feet in thickness, with an irregular and discontinuous pisolitic zone at the top as much as 4 feet thick. The top of the residual clay is an undulating erosion surface which is overlain by 5 to 15 feet of tawny to buff, medium to coarse, poorly consolidated arkose which contains much mica. The lower part of the arkose contains sparse, irregularly shaped, cobble-sized clasts of red mottled residual clay and a thin, discontinuous basal conglomerate with pebbles and cobbles of quartz.

Overlying the arkose are 10 to 15 feet of red mottled sedimentary clay with some white, gray, and buff colored pods. Bedding is not discernible and the sedimentary clay has the same appearance as the residual clay. In places, a thin zone of altered conglomerate lies at the base of the sedimentary clay. This zone contains light colored angular cobbles of altered igneous rocks and is cemented with a red, sandy, pisolitic clay matrix. The top of the sedimentary clay is a gray to buff or tawny colored pisolitic zone from 1 to 5 feet thick. In places the uppermost part of this zone has been bleached to nearly white. The sedimentary clay is overlain by 10 to 100 feet of buff to gray and white, poorly indurated, fine to medium, arkose which contains abundant grayish-green mica.

Both the red matrix material and pisolitic inclusions of the upper part of the sedimentary clay are chiefly kaolinite as indicated by X-ray diffraction analysis. Most of the deposit is common red-burning clay but the pisolitic material which comprises a small part of the total thickness appears to be a low-grade fire clay. The operator recognizes and blends five or six different pit clays.

Development: About 100,000 cubic yards of overburden were removed in 1955 in developing the exploratory pit. Subsequent mining has been periodic, with sufficient clay being stockpiled to supply the plant for many months. Mining is carried on with bulldozers, rippers, scrapers, and tournapull-type equipment. The pit is about 700 feet long in a north-south direction, 200 to 300 feet wide, and 125 feet deep.

The Bedford clay is blended with clays from the company's Sloan pit at Alberhill and their Harrington and Atlas pits in Temescal Valley, and several filler clays. These include Silverado Formation clay shales from the Thomas Clay deposit (described herein), clay shale and clayey sand of the Sycamore Canyon member of the upper Miocene Puente Formation from the Pomona Brick Company's Strona pit on the northeast flank of the Chino Hills (sec. 1, T. 3 S., R. 8 W., S.B.M.), and waste pond material from the nearby Owens-Illinois ~~rock~~ sand plant.

yes!

In addition to clay used in the manufacture of clay products, the mining operation yields mineral materials for another industry. In recent years buff sand, sandy clay, and pisolitic clay ("bone" clay) from the Bedford Canyon clay deposit have been marketed to several cement companies for use in the manufacture of portland cement.

The plant includes a 420-foot tunnel kiln and 8 periodic or "beehive" kilns. Buildings include bulk clay and grog storage bins; grinding and screening building with two 10-foot grinding pans; a structure housing seven auger presses and 16 horizontal and vertical dryers; laboratories and offices; lunch room and locker building; and main offices. The plant manufactures vitrified clay pipe for sewer lines and storm drains and multiple duct vitrified clay conduit for telephone and power lines.

Production: Initial rated plant capacity was 6,000 tons per month. By 1963 the plant had not undergone any major changes.

References: Stauffer, 1946, map Station 32; Ceramic News, August 1956, p. 17; Ceramic News, November 1956, p. 21-22; Gray, 1961, p. 69-71, 110.

C.H.G. 6/20/63.

Cajalco Pit

Location: N½ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; 5 miles southeast of Corona on the east side of Temescal Wash, south of Cajalco Road along the east side of the railroad.

Ownership: Louis A. Weisel, and others, La Habra, own patented ranch land in this area (1957).

History: Leased and developed by Pacific Clay Products for a short time in the early 1930's. Idle since 1938.

Geology: Residual red mottled clay derived from Bedford Canyon Formation argillites and/or slates; bright brick-red clays about 30 feet thick grade laterally into mottled grayish-green clays and gray clays, thence into unaltered argillites. Overlain unconformably by poorly indurated sandstone (Silverado Formation) and terrace material, 0 to 25 feet thick.

Development: Irregular ~~quarry~~ pit about 100 feet long, 10 to 30 feet high. Old mine rails may mark sites of 2 small adits, now obliterated. This deposit apparently has very little areal extent beyond the quarry pit limits.

Production: Undetermined, but apparently small.

References: Gray, 1961, p. 110.

C.H.G. 9/1/60.

Chocolate Drop Deposit

Location: NW¼NW¼ sec. 17, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3½ miles southeast of Corona at the south margin of the El Cerrito Hills.

Ownership: Francis A. Stearns, Box 262, Corona (1957).

History: Pit opened in 1948 by Liston Brick Company. Intermittently active since then as a source of material used in the manufacture of common red brick by Liston Brick Company.

Geology: Pale gray, diatomaceous, clay shale is mined from a low isolated hill composed of ~~upper~~ middle Miocene shale (Topanga Formation).

Development: Material is scraped from hillslope and stockpiled by International TD9 combination bulldozer-loader; sparse limy concretions are removed by hand sorting; clay shale is loaded on small dump trucks and transported about 1½ miles to Liston Brick Company.

Production: Small tonnage mined each year since 1948.

References: Gray, 1961, p. 110.

C.H.G. 8/15/62.

Conduit Clay Placer

Location: SE¼ sec. 32, SW¼ sec. 33, T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; in the northeastern foothills of the Santa Ana Mountains, 3½ miles southwest of Corona.

Ownership: Two patented placer claims (Conduit Nos. 1 and 2). Riverside Cement Co., P.O. Box 832, Riverside owns Conduit No. 1 (132 acres) and south 40 acres of Conduit No. 2. Ray and Irma B. Overacker, 412 Olive St., Huntington Beach own north 22 acres of Conduit No. 2 (1957).

History: The area was prospected for clay about 1900 and the property was patented in 1917. Apparently there has been little or no mining on these claims but in 1956 Riverside Cement Company extensively explored the property by bulldozer cuts.

Geology: Sandy to very sandy clay shales of the Upper Cretaceous Ladd Formation underlie this area.

Development: Bulldozer cuts and shallow pits.

Production: Apparently none.

References: Gray, 1961, p. 110.

C.H.G. 2/27/61.

Corona Clay Pit

Location: N½SW¼ sec. 26, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 8½ miles southeast of Corona on the northeast side of Temescal Wash at the western margin of the Gavilan Hills; half a mile north of Arcilla Siding.

Ownership: Riverside Cement Company, Division of American Cement Corporation, mill office, P.O. Box 832, Riverside.

History: The Alumina placer mining claim of 74.23 acres was patented to Ira J. Coe in 1917 and acquired by Riverside Cement Company before 1925. The area was prospected for fire clay by means of short adits in the early 1900's and probably a small tonnage of clay was mined for use in cement manufacture at some unknown period before 1945. The property was inactive for many years but in 1960 large scale open pit mining was started by the Riverside Cement Company who also mine the contiguous Atlas pit as part of the same operation. The pit continued to be actively mined in 1963.

Geology: The western part of the property is underlain by Jurassic(?) quartz latite porphyry. The eastern part of the property is underlain by a band of residual claystone derived by weathering of the Triassic(?) Bedford Canyon Formation which is overlain by the Paleocene Silverado Formation ~~(upper part)~~ and capped by Quaternary terrace deposits. The clay-bearing sequence strikes easterly and dips northerly. The sequence exposed in the pit in January 1963 included: basal residual high silica red mottled clay, 130 feet maximum thickness; grades upward into "bone" clay, maximum thickness 30 feet, part of which is high alumina clay; overlain by soft Silverado Formation green clay shale and micaceous arkose; overlain by about 80 feet of sandy conglomerate and bouldery terrace deposits. Sequence dips 15° to 30° northerly in most exposures, but is nearly flat lying in places.

Development: Pit is a side hill cut about 1,500 feet long east-west and 300 feet wide with three main bench levels, each about 50 feet wide with face 20 feet high. Stripping is done with tournapull equipment and bulldozers, clay is then loosened and stockpiled by Caterpillar D-8 equipped with ripper and bulldozer. Caterpillar front-end loader then loads clay directly into truck-trailer units for transport to several plants. "Bone" clay goes to Oro Grande plant of Riverside Cement Company and part of the red mottled clay goes to their Crestmore plant. Red and gray mottled clay from east end of deposit (and contiguous Atlas pit) goes to Corona plant of International Pipe and Ceramics Corporation.

Production: Total undetermined, early in 1963 probably about 200 to 300 tons per day.

References: Dietrich, 1928, plate 10 facing p. 162; Stauffer, 1946, map Sta. 27.

C.H.G. 1/24/63

Corona Placer (Lord?) Deposit

Location: NW¼ sec. 14, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeast margin of the Santa Ana Mountains, west side of Main Street Canyon, 3½ miles southwest of Corona.

Ownership: A. E. Ganahl, 1011 Victoria (P.O. Box 643) Corona (1957).

History: May include at least part of the clay and mineral paint deposits worked by George W. Lord and others about 1900 (Aubury, 1906, p. 223, 339). The property has long been idle, except for annual assessment work.

Geology: The deposits are thin, discontinuous, red mottled and pisolitic "bauxitic" clays of the ~~Paleocene~~ Silverado Formation intercalated with clay shale, arkosic sandstone, and conglomerate. The Silverado beds strike northwest and dip steeply southwest, or are vertical. In general the deposit is believed to be similar to, and an extension of, the adjoining Middlesworth deposit (described herein). Tucker and Sampson (1945, p. 161) reported a bed of "blue fire clay" said to be 20 feet thick with 10 to 20 feet of overburden. However, in 1957 fire clay was not exposed and clay reserves appeared to be small.

Development: By 1914, the property had been developed by two open cuts and two adits, each about 100 (?) feet long. These workings were inaccessible in 1957.

Production: G. W. Lord is reported to have produced gray fire clay, about 1905, which probably was mined from this property and the adjoining Middlesworth deposit. Amount of production is not known, but probably was not large.

References: Aubury, 1906, p. 223, 339; Tucker and Sampson, 1945, p. 161; Gray, 1961, p. 71, 110.

C.H.G. 8/15/62.

Dolbeer and Hoff Mine

Location: Reported to be in the SW¼ sec. 26, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; near the town of Terra Cotta, 3½ miles northwest of Elsinore. Site may have been in the area now known as Terra Cotta Plant Site or Terra Cotta Eight (See in tabulated entries).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles (1959).

History: Coal prospect active in the 18880's (Goodyear, 1868, p. 175). Idle since about 1900.

Geology: Goodyear (1888, p. 175-178) reported a two- to four-foot layer of coal to occur near the bottom of an 80-foot shaft sunk in sand, clay, and sandy clay (apparently Silverado Formation).

Development: By 1887 an 80-foot shaft had been sunk and several hundred feet of workings had been driven from the foot of the shaft. (Goodyear, 1888, p. 175-176).

Production: Undetermined.

References: Goodyear, 1888, p. 174-178; Engel and others, 1959, p. 97, 133.

C.H.G. 1/8/63.

Douglas Pit*

*Adapted from Engel and others, 1959, p. 95.

Location: NE¼ sec. 22, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; north of and adjacent to the West pit of the Alberhill Mines of Pacific Clay Products, half a mile southeast of Alberhill Post Office (see. fig. 7/).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles.

History: Clay deposits in the Douglas pit were first mined in the period 1885-1890. In the early operations, sedimentary fire clay comparable to the Sh-3 clay that overlies the lignite in the West pit (Alberhill Mines) was mined from the Douglas pit. This layer of fire clay was mined out at some time after 1930. Later, and until about 1955, red and white mottled plastic clay was mined from the Douglas pit for use in the production of sewer pipe. Immediate pit area apparently was exhausted in 1955 and the pit has since been inactive.

Geology: Red and white mottled plastic clay, probably consists of both residual material and of sedimentary material near the base of the Silverado Formation. See figs. 6/, 7/, and table 3/ for details. Plate 6 of Engel and others (1959) shows the geology of the area.

Development: Open pit, the northern half of the West pit which is rectangular in shape and about 1,700 feet by 270 feet and 80 feet deep.

Production: Undetermined, but formerly one of the principal pits in the Alberhill area. Inactive since 1955.

References: Dietrich, 1928, p. 176-177; Tucker and Sampson, 1929, p. 501; Sutherland, 1935, p. 75; Engel and others, 1959, p. 95, 131, figs. 6, 7, table 1, plate 6.

C.H.G. 6/20/63.

Table 3

Eagle Canyon (Fraser) (Clay) Deposit

Location: SW¼ sec. 13, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains 4 miles south of Corona, on the west side of Eagle Canyon.

Ownership: T. A. and F. M. Fraser, 718 Howard Street, Corona, own the Eagle group of unpatented placer claims (1957).

History: This deposit is part of the Eagle Canyon gypsum deposit (see herein) which has been mined intermittently for agricultural gypsum since 1913. In 1944 Dr. Leon Katz, San Fernando, shipped several truck loads of "fire" clay to several plants in Los Angeles. This clay was tested for flue tile, but proved to be unsuitable. Apparently the property has been idle since 1944.

Geology: Sandy clays and clay shales of the Paleocene Silverado Formation.

Development: Shallow prospect pits and small open-cuts.

Production: Undetermined, but small.

References: Gray, 1961, p. 111.

C.H.G. 2/27/61.

Elsinore Clay Company (Morton) Clay Deposit

Location: NE¼ sec. 31, T. 5 S., R. 4 W., S.B.M., Elsinore quadrangle, 7½', 1953; astride State Highway 74, 1 3/4 miles north of Elsinore.

Ownership: Elsinore Clay Company, P.O. Box 104, Murietta.

History: Deposit first mined by the Morton Clay Company in the early 1920's, apparently both from shafts and open pits. About 1930 the property was purchased by the Elsinore Clay Company which has intermittently mined the deposit since that time (Engel and others, 1959, p. 92). In recent years this deposit has been a source of red-burning clay for several common brick manufacturers, including the Hancock Brick Company, Highgrove, and Phoenix Brick Company, Phoenix, Arizona.

Geology: Lignite and refractory carbonaceous claystone, and gray to buff clay shale of the Silverado Formation are exposed in the pits. For details see figures 6/, 7/, and table 3/. In January 1963, the sequence exposed in the largest and apparently most recently active pit was 10 to 20 feet of red soil overburden and 25 feet of gray sandy clay with purple mottled clay at base.

Development: Four open pits west of Highway 74. The northernmost pit (Laura Ward pit), apparently inactive since the late 1950's, is elongate triangular in plan about 400 feet by 150 feet and 40 feet deep. The largest pit, opened in recent years and apparently the only pit active in 1963, is in the southwestern part of the property in the area earlier developed by the old no 2 pit. This rectangular pit is about 500 feet long, 300 feet wide, and 50 feet deep. Mining is done intermittently by machine methods and the clay is stockpiled for use as needed. A fifth pit was opened about 1954 east of Highway 74, but has been inactive for several years. Only clay shale and micaceous arkose of the upper part of the Silverado Formation are exposed in this pit.

Production: Undetermined, probably a few thousands of tons each year in recent years.

References: Tucker and Sampson, 1929, p. 501; Sampson, 1935, p. 520; Tucker and Sampson, 1945, p. 161; Stauffer, 1946, map Sta. 5; Engel and others, 1959, p. 92, 130, figs. 6, 7, Table 1.

C.H.G. 1/9/63.

Emsco Pit

Location: SE¼ sec. 33, T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3 miles southwest of Corona, on the east bank of Wardlow Wash.

Ownership: Mrs. Graciosa and Bernard W. De Pipkins, Harvard Street, Los Angeles (1956).

History: The Emsco pit was opened in 1937 by the Emsco Refractories Company, South Gate and a few hundred tons of high refractory clay were shipped to their South Gate plant. Mining ceased about 1940 and in 1956 the remaining adit and dump were destroyed by construction of a pipeline.

Geology: Gray, sandy, carbonaceous high refractory clay of the ~~Paleocene~~ Silverado Formation. Clay zone reported to be about 8 feet thick, dipping 45°± east.

Development: First mined in 1937 from open quarry by power shovel, but open pit mining proved impractical because of steep dip; later an adit was driven N. 50° E. about 250 feet south of the quarry and some clay was mined. In 1950 the clay zone was not found in the quarry and the adit was inaccessible. Lignite, carbonaceous clay, and impure reddish-brown sandy clay were in the dump.

Production: Undetermined, but apparently small.

References: Gray, 1961, p. 111.

C.H.G. 2/27/61.

Findley Feldspar Placer

Location: SE¼ sec. 33, T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 3 miles southwest of Corona, along the west bank of Wardlow Wash.

Ownership: Ray and Irma B. Overacker, 412 Olive Street, Huntington Beach own two patented placer claims (Findley Feldspar nos. 1 and 2) (1957).

History: This may be the location of one of the glass sand deposits noted by Aubury (1906, p. 375) as under development by the Corona Pressed Brick Company, about 1905. The property is said to have yielded a considerable tonnage of clay about 1920 used in brick plants in the Los Angeles area. It has been idle since long before 1938, when acquired by the present (1957) owners.

Geology: Pods and irregular stringers of red, white, and gray mottled, and white and purple mottled clays in a matrix of weak, coarse, white arkose of the Paleocene Silverado Formation with some cobble conglomerate; sandstone beds strike N. 70° E., dip 30° NW.

Development: Explored by several open-cuts; perhaps also by underground workings, now caved.

Production: Undetermined.

References: Aubury, 1906, p. 375; Gray, 1961, p. 111.

C.H.G. 2/27/61.

Findley Graphite Placer Mine

Location: NW¼ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 3½ miles southwest of Corona, north of Wardlow Canyon.

Ownership: Omar Short, Santa Ana owns one patented placer claim (Findley graphite placer) (1957).

History: Explored about 1900 by shallow open cuts and one adit said to have showings of "graphite"; not found in 1956. In the late 1940's, the clay zones were prospected by bulldozer cuts.

Geology: Thin discontinuous zones of impure red and green sandy clays occur in the shear zones in sandstone and conglomerate of the Upper Cretaceous Ladd Formation.

Development: Shallow open-cuts and bulldozer cuts.

Production: Undetermined.

References: Gray, 1961, p. 111.

C.H.G. 2/27/61.

Fire Clay Group

Location: Secs. 4, 5, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, along both sides of Mabey Canyon.

Ownership: Sky Ranch Clay Company (Clifford Tillotson, owner) P.O. Box 237, Corona, owns 3 patented placer claims (Fire Clay no. 1, Fire Clay no. 2, M. & M. placer) (1957).

History: This property was explored for clay before 1910, but production from this period is undetermined. About 1950, the Sky Ranch Clay Company (see herein) mined a small tonnage of clay shale from an open-cut. Idle since about 1950.

Geology: Clay shale of the Upper Cretaceous Holz Shale Member of the Ladd Formation.

Development: By 1910, the property had been explored by 4 short adits and 7 open-cuts. In 1956, the principal, but idle, working was a small open-cut hillslope.

Production: Undetermined.

References: Gray, 1961, p. 78-80, 111.

C.H.G. 2/27/61.

Freeman clay

Location: Undetermined, probably various deposits between Main Street and Hagador Canyons, Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 3½ miles southwest of Corona. (See Middleworth clay deposit and Corona clay placer, herein).

Ownership: Undetermined.

History: G. R. Freeman, Corona, reported some clay production from the Corona area during the 1920's.

Geology: Clay-bearing Paleocene Silverado Formation sandstones and siltstones crop out in this area.

Development: Undetermined.

Production: Undetermined.

References: Gray, 1961, p. 77-78, 111.

C.H.G. 2/28/61.

Gladding, McBean and Co., Corona Plant

Location: NW¼NW¼ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; in lower Bedford Wash near Temescal Canyon, 5 road miles southeast of Corona on State Highway 71.

Description: Manufacturers of vitrified clay pipe and conduit (see Bedford Canyon (Corona) clay deposit herein).

References: Gray, 1961, p. 69-71, 114.

C.H.G. 3/2/61.

Grapevine Clay Mine

Location: SE¼NW¼SW¼ sec. 4 (lot 9), T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3 miles southwest of Corona on the south side of Mabey Canyon.

Ownership: Mrs. Mary A. Mattey, 11359 Biona Avenue, Los Angeles 66 (1957).

History: First active from about 1900 to 1910. In 1906, the California Portland Cement Company removed some "cement rock" and about 30,000 tons are said to have been shipped to their Colton plant. From 1908 to 1910, the Corona Pressed Brick Company is reported to have used clay shale from this deposit in their manufacturing plant located west of Corona. After 1910, the property remained idle except for development work, until about 1950 when Joe Deleo, Jr., Corona, mined some clay shale. Starting in 1953, the Sky Ranch Clay Company began mining this clay shale for use by the Tillotson Refractories Company in Corona. Mining continued through 1955, but by November 1956 the property was inactive and has remained idle.

Geology: The clay occurs as a clay-shale unit in a narrow lens of the Holz Shale member of the Upper Cretaceous Ladd Formation. This lens of Holz Shale, about 3,500 feet long and as much as 500 feet wide, crops out along the abruptly rising south side of Mabey Canyon. The shale strikes about N. 60° W. and dips 65° NE., or is vertical. The Grapevine claim covers only about 1,000 feet of the strike-length along the central part of the shale, the remainder on each end being part of the Sky Ranch Clay Company holdings (described herein).

Development: Several short exploratory adits and open cuts. Three adits were driven during early development operations; one is now caved at the portal, two others are 50 and 60 feet in length. Recent mining was done by benching with bulldozer, ripper, and scraper, the loosened material being pushed into a small storage bunker for loading into small trucks.

Production: About 350 tons per month during 1955. Total production unknown, probably several tens of thousands of tons.

References: Gray, 1961, p. 72-73, 111.

C.H.G. 8/15/62.

Harrington (Emsco) Pit

Location: E½SE¼ sec. 26, NW¼SW¼ sec. 25, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 8½ miles southeast of Corona on the northeast side of Temescal Wash at the western margin of the Gavilan Hills, three quarters of a mile northeast of Arcilla Siding.

Ownership: Stuart Findley, Huntington Park. About 20 acres in the southwest part of the pit area is leased to the Corona Clay Company, 1233 Garretson, Corona; the remainder of the property is leased to International Pipe and Ceramics Corporation, 2901 Los Feliz Blvd., Los Angeles 39.

History: The original Harrington pit area was 81.80 acres in section 26, but in 1963 the area includes an unknown, but apparently small acreage in section 25. As early as 1905 clay was being mined from the Harrington pit area by the Independent Sewer Pipe Company for shipment to Tropico (Los Angeles area). By 1920 the property was under lease to Alberhill Coal and Clay Company, but was idle. Later the pit was leased to the Emsco Clay Company who in 1926-27 were mining from a pit about 100 feet square and 40 to 50 feet deep. At that time the white plastic clay went to the Atlas Fire Brick Company and the other clays were marketed in Los Angeles, chiefly to Gladding, McBean and Company and Pacific Clay Products. Emsco Refractories Company still controlled the pit in 1942, but by 1945 the property was leased to the Temescal Clay Company who also shipped clay to the two above named companies in Los Angeles. By 1945 the pit had been enlarged to about 700 feet in diameter and a depth of 140 feet. Since about 1950 the pit has been operated by the Corona Clay Company and Gladding, McBean and Company (now part of the International Pipe and Ceramics Corporation). The pit was active in 1963.

Geology: Southern part of property is underlain by Triassic(?) Bedford Canyon Formation. Mine area, in northern part of property, is underlain by residual red mottled claystone derived by weathering of Bedford Canyon Formation; white, and red, white and buff mottled claystone with carbonaceous claystone and lignite at base (lower part of the ~~Paleo~~cene Silverado Formation); and green clay shale and micaceous arkose (upper part of the Silverado Formation). Clay sequence is more than 100 feet thick in places. A typical sequence is: overburden, 30-60 feet; "bone" clay, 4-6 feet; pink mottled clay, 10-15 feet; red mottled clay, 2-20 feet; white-gray plastic clay (locally termed select Harrington No. 5), 3-7 feet; red clay (locally termed Red Horse), 40-50 feet. Clay sequence dips gently north or northeasterly.

Development: Pit area is a somewhat L-shaped or semi-circular sidehill cut about 2,000 feet long east-west and 1,000 feet in maximum width with two main irregular bench levels. The north face is about 200 feet high and the south face is about 75 feet high.

International Pipe and Ceramics Corporation mines red mottled clay from their portion of the pit about once each year. Mining is done by contract with an earth-moving company. The clay is stockpiled and later hauled as needed to their Corona plant by the Corona Clay Company. Mining by the Corona Clay Company in their portion of the pit is more or less continuous and utilizes bulldozers, rippers, tournapull equipment, small dipper power shovels, and front-end loaders. Several types of clay including white-gray plastic, dark gray plastic, red, and red mottled are stockpiled separately and are supplied to several manufacturers of clay products in western Riverside County and in the Metropolitan Los Angeles area. The dark gray plastic clay finds an unusual use in the manufacture of artificial fireplace logs. Clay is loaded directly into semi-trailer trucks for transport to market.

Production: 3 to 4 rail cars per day in 1926-27, 35 cars per month in 1945. In recent years and at present (1963) several tens of thousands of tons each year. Total production unknown, but apparently one of the larger clay mines in the Alberhill-Corona region.

References: Aubury, 1906, p. 223; Merrill, 1917 /1919/, p. 568; Boalich and others, 1920, p. 86; Tucker and Sampson, 1925, p. 500; Dietrich, 1928, p. 169-171; Sutherland, 1935, p. 71-72; Sampson, 1935, p. 518; Tucker and Sampson, 1945, p. 162; Stauffer, 1946, map Sta. 28.

C.H.G. 1/24/63.

Hoist Pit*

*Adapted from Engel and others, 1959, p. 95.

Location: NE¼NE¼, and 10 acres in the SE¼NE¼ sec. 26, T. 5 S., R. 5 W., S.B.M., Elsinore quadrangle 7½', 1953; at Durant Siding, 3½ miles northwest of Elsinore (see fig. 7/).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles, owns a 50 acre block. The mine area is in a 10 acre tract which is part of the area known as the Elsinore Joint Property (see tabulated entry herein).

History: The Hoist pit was opened in about 1890. Clay mined here was transported to a plant at Terra Cotta where it was used to make sewer pipe, hollow tile building blocks, and other heavy clay products. This plant and the Hoist pit apparently were owned by the Dolbeer Estate before 1905, then by the California Fireproof Construction Company and by 1912 were owned by the Pacific Sewer Pipe Company which later became part of Pacific Clay Products. The pit was abandoned when the plant was destroyed by fire and the Pacific Sewer Pipe Company closed down in 1912. The property has not been mined since, but in recent years exploration by drilling and bulldozer cuts has been done by Pacific Clay Products. This work is reported to have established additional clay reserves.

Geology: Yellow pisolitic "bone" clay occurs as small lenses overlying red and white mottled plastic residual clay. Overburden is about 30 feet of ~~Paleocene~~ Silverado Formation sandstone. See fig. 6/ and table 3/ for details. Plate 6 of Engel and others (1959) shows the geology of the Hoist pit area.

Development: Irregular, elongate open pit 600 feet by 200 feet and 60 feet deep.

Production: Undetermined.

References: Merrill, 1917 /1919/ p. 570; Boalich and others, 1920, p. 89-90; Dietrich, 1928, p. 178; Tucker and Sampson, 1929, p. 501; Engel and others, 1959, p. 95, 131, figs. 6, 14, table 1, plates 5, 6.

C.H.G. 6/20/63.

International Pipe and Ceramics Corporation

(Gladding, McBean and Co.) Alberhill District*

*Adapted from Engel and others, 1959, p. 92-93.

Location: SW¼ and S½NW¼ sec. 22 and S½NE¼ sec. 21, T. 5 S., R. 5 W., S.B.M.; Alberhill quadrangle, 7½', 1954; an L-shaped strip of land that lies north and east of and adjacent to the clay properties owned by the Los Angeles Brick and Clay Products Company. This strip, which is about half a mile south of the Alberhill Post Office, contains 5 clay pits (see fig. 7/).

Ownership: International Pipe and Ceramics Corporation, 2901 Los Feliz Boulevard, Los Angeles 39.

History: The clay deposits developed by the three northernmost pits, referred to as the old Sloan pits, were discovered as early as 1885, but were most actively mined by the Los Angeles Pressed Brick Company and Gladding, McBean and Company during the period 1920-1929. In 1916 the Los Angeles Pressed Brick Company erected a plant for the manufacture of clay products adjacent to the Sloan pits. The plant was active until about 1930 and was later dismantled. The Los Angeles Pressed Brick Company merged with Gladding, McBean and Company in about 1926 and in 1962 Gladding, McBean and Company merged with the Lock Joint Pipe Company of New Jersey and became the

International Pipe and Ceramics Corporation. The two most southerly pits were opened in the early 1950's and the southernmost pit, now known as the Sloan Pit, is the only one of the group that was being mined in early 1963.

Geology: A regional geologic map is given by Engel and others (1959, plate 5). According to Engel and others (1959, p. 92) similar sequences of clay-bearing units are exposed in all the pits except for minor variations in lithology and thickness. The section contains little or no carbonaceous material, in contrast to Alberhill and Western pits, but all five pits apparently contain both sedimentary clays and sandstone (Silverado Formation) and residual clays. White, yellow, and red, massive, pisolitic bone clay of probable residual origin is exposed in and was mined from the three old Sloan pits. Pink and white mottled plastic residual clay underlies the bone clay in the northernmost of the old Sloan pits. A layer of sedimentary fire clay, which is less than one foot thick, overlies the bone clay in the southernmost of the old Sloan pits and the northernmost of the recent pits. In all of the pits, a layer of red and gray mottled, plastic, sandy, sedimentary clay as much as 50 feet thick overlies the sedimentary fire clay and is called the Sloan Mottle. The sequence exposed in the active Sloan Pit in January, 1963, was: buff sandy overburden, 20-35 feet; red and gray mottled clay, 25 feet; white clayey sand, 5 feet; dark red to brown "bone" clay, 10 feet; red mottled clay, 5 feet; buff sandy clay at pit bottom. See figures 6/, 7/, and table 3/ for details of each pit.

Development: Open pits, see figure 7/ and table 3/ for details. In the early days the Sloan pits were mined by hand methods. Recent mining, however, has been almost entirely by machine methods. Mining is periodic and is done by contract, with large stockpiles prepared from which material is hauled by truck as needed. The active Sloan Pit is rectangular in plan with dimensions of about 500 feet by 600 feet and a maximum depth at the south face of 100 feet. Clay is mined from three bench levels. The Sloan Mottle is being mined for use in the production of heavy clay products at the company's plant at Corona and a considerable tonnage of "bone" clay is sold to various cement companies for use in the manufacture of portland cement.

Production: Total undetermined. In 1963 mining was at the rate of about 50,000 tons of "bone" clay for cement company use, and about 25,000 tons of mottle clay for heavy clay products each year.

References: Aubury, 1906, p. 223; Merrill, 1917 /1919/, p. 574; Boalich and others, 1920, p. 86-89; Dietrich, 1928, p. 171-174; Tucker and Sampson, 1929, p. 500; Sutherland, 1935, p. 70; Engel and others, 1959, p. 92, 93, 130, figs. 6,7, table 1.

C.H.G. 6/24/63.

Jones (Hoffman, Hoag Ranch) Deposit

Location: NW¼ sec. 19, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; 4 miles southeast of Corona, near the head of a small canyon midway between Joseph and Bedford Canyons.

Ownership: Coronita Ranch, c/o D. C. McMillan, 8704 Colima Road, Whittier (1957).

History: The Jones deposit, known in 1892 as Hoffman's coal prospect, was later part of the Hoag ranch. The owner in 1925 was A. E. Jones of Corona; later the property was acquired by Mrs. D. C. Hammond and became part of the Coronita Ranch in 1957. Local residents report the period of greatest activity as about 1900 when clay and coal were mined. The property was idle in 1925 and apparently has since remained idle.

Geology: The mine area, which is covered with dense brush, is along the northeast side of the Elsinore fault. These deposits are part of the nonmarine lower facies of the Paleocene Silverado Formation. The strata now exposed in the mine area are white arkosic sands, sandy buff to gray claystone, cobble conglomerate, and tawny and gray fissile claystones which strike northwest and dip about 30° southwest; the beds are overturned. The commercial clay zone is not exposed but presumably occurs

below the white arkose. Tucker and Sampson (1929, p. 500-501) describe the clay in the workings as a gray, plastic clay bed about 6 to 8 feet in thickness, dipping southwest about 20°. Thin coal seams occurred on both the top and bottom of the clay bed. The coal seam at the outcrop was from 4 to 10 inches thick and is reported to have been 4 feet thick in old workings 90 feet from the surface.

Development: According to Tucker and Sampson (1929, p. 500-501) the principal mine workings were at the head of the canyon and consisted of 4 adits ranging from 70 to 180 feet in length. These adits were driven on the two coal seams. In 1956, all of the workings were badly caved and only several old mine rails and some scattered dump material mark the site.

Production: Undetermined, but probably was small and the coal is said to have been used only locally.

References: Tucker, 1921, p. 325; Tucker and Sampson, 1929, p. 500-501; Sampson, 1935, p. 520; Gray, 1961, p. 73, 112.

C.H.G. 8/15/62.

Jordan Tile Manufacturing Company

Location: 909 Railroad Street, Corona, in the NE¼ sec. 26 (proj.), T. 3 S., R. 7 W., S.B.M., Corona North quadrangle, 7½', 1954; 1 mile northwest of Corona.

Ownership: Mosaic Tile Company, Zanesville, Ohio.

History: Plant built in 1948 has since been in continuous operation.

Description: Three types of tile are manufactured and include: (1) "Vitreous" tile, used to make unglazed ceramic mosaic; (2) "quarry" tile, used on industrial floors and walls; and (3) "Granitex", assembled in sheets and used on floors and walls. The plant has two complete circuits, one for "vitreous" tile and "Granitex", and the other for "quarry" tile, and is the principal supplier of these products in southern California. Mineral raw materials are purchased from a number of suppliers.

Raw materials used in the "vitreous" tile include talc from Gouverneur Talc Company, Inc., New York; feldspar from the Consolidated Feldspar Department of the International Minerals and Chemical Corporation, Kingman, Arizona; silica, feldspar, and silica spar from Del Monte Properties Company, Pacific Grove, California; kaolin from the southeastern states, including Georgia and Florida; and small amounts of stain to produce the desired colors.

"Quarry" tile is manufactured from California raw materials, mostly from nearby quarries in the Silverado Formation. These include white, sandy fire clay from the Sloan pit of Gladding, McBean and Company at Alberhill; red mottled clay from the Harrington and Atlas clay pits 8 miles southeast of Corona along the east side of Temescal Valley; clay shale from the Thomas clay deposit, east pit; and waste clay from the processing of clayey sand at the Corona silica sand deposit. Lesser amounts of fire clay from Lincoln and Ione, California also are used.

"Granitex", a trade name for a tile which is related to both the "vitreous" tile and "quarry" tile, is made of and colored by, natural clays from the Corona area.

References: Gray, 1961, p. 73-74, 114.

C.H.G. 6/20/63.

Kroonen (Keno Group, Dutch Placer) ~~Clay~~ Nonmetal

Location: S½ sec. 4; NE¼ sec. 9; NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3 miles southwest of Corona, west of and adjoins the McKnight mine, between Tin Mine and Mabey Canyons.

Ownership: Mary L. Kroonen, 708 West Eighth Street, Corona, owns eight patented placer claims totaling about 150 acres (1957); John Tillotson, 807 Park Lane, Corona, owns one placer claim (Leo Lorenzo, 20 acres) originally included in the Kroonen group (1957).

History: Probably the early exploration occurred during the same period as that at the adjacent McKnight mine, about 1890-1900. The property had been sufficiently developed so that a patent was applied for in 1914 and was granted in 1917. Periods of activity are unknown but this property probably furnished red-burning clay and perhaps some fire clay to several nearby clay products manufacturing plants which were active about 1900 to 1920. By 1928, this property was idle and apparently since has been idle.

Geology: In the northwest part of the deposit, where most of the mining appears to have been done, red mottled clays with good plasticity and thin lenses of dark gray, dense, kaolinite clays associated with lignite are intercalated with buff clay shales, thin-bedded micaceous sandstone, and conglomerate. The beds, which are part of the Paleocene Silverado Formation, strike northwest and dip vertically to steeply overturned to the southwest. These beds are cut by numerous faults, and form the narrow part of a wedge-shaped fault sliver of Silverado Formation sedimentary rocks. Although the clay beds are poorly exposed, the red mottled clay is estimated to be as much as 10 feet thick and the kaolinite and lignite zones range in thickness from several inches to one foot. The lateral extent of the deposit is not traceable more than several tens of feet. Reserves of clay appear to be small.

Development: Tucker and Sampson (1929, p. 501) report the property was developed by tunnels and open cuts. In 1956, the tunnels were inaccessible by caving and the cuts were slumped, but clay exposures were observed in several open cuts.

Production: Periods and amounts of production unknown, but apparently not large.

References: Tucker and Sampson, 1929, p. 501; Gray, 1961, p. 74, 112.

C.H.G. 8/15/62

Lord Deposit

Location: Undetermined. May be same as Middlesworth clay or part of Corona placer, described herein.

History: George W. Lord, Corona, reported light gray, fine-grained fire clay under development in 1905.

References: Aubury, 1906, p. 223; Gray, 1961, p. 71, 72, 78, 112.

C.H.G. 2/28/61.

Los Angeles Brick and Clay Products Company*

*Adapted from Engel and others, 1959, p. 93-95.

Location: S½, NW¼, N½NE¼, sec. 21, NW¼/NW¼/sec. 22, and NE¼ sec. 28, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; along the northern edge of a group of small hills northeast of the Santa Ana Mountains, one mile south of Alberhill Post Office. Plant located at Alberhill about one mile north of the pits.

Ownership: Los Angeles Brick and Clay Products Company, 2310 East Seventh Street, Los Angeles 23.

History: The Los Angeles Brick Company acquired their clay properties from the former owner, the California Clay Manufacturing Company, and built their plant in 1925. This plant, which has been modernized in recent years, utilizes 18 beehive kilns (inside diameter 30 feet) and three tunnel kilns in the manufacture of fire brick, face brick, sewer pipe, flue linings, and floor tile. It has been in continuous operation since 1925. In 1960 a new plant for the manufacture of common red brick was built just east of the existing plant. This brick plant utilizes modern equipment to form the brick which are fired in field kilns. The common brick plant operates only during the warmer seasons, usually from about April to October, with as many as eight field kilns. Except for the No. 1 pit which was in operation as early as 1890, all of the clay deposits have been developed since 1925. The company

also markets the higher grade sedimentary fire clays as sacked clay products. Most of the clay used in the plant comes from their own deposits, but some clay is purchased from the Alberhill Mines of Pacific Clay Products.

Geology: The commercial clay zone which in this area is as much as 100 feet thick occurs in an L-shaped belt within the area of the operating pits. The west boundary of the zone is defined by north-northeast and west-trending normal faults. Most of the clay exposed in the Company's pits is sedimentary in origin, and a one hundred foot thickness of sedimentary clay and sand of the Silverado Formation is exposed in the No. 1 pit. Figures 6/ and 7/ and table 3/ give details for each pit. Plate 5 of Engel and others, (1959) shows the regional geology and plate 7 of Engel and others (1959) shows the detailed geology of the No. 1 pit.

Four types of clay are mined from the pits. Yellow plastic residual clay which is the lowermost unit in Pit No. 1 is used to make sewer pipe. No. 1 fire clay is a white to dark gray, carbonaceous, refractory clay that occurs as a sedimentary layer in pits No. 1 and No. 23 and is employed in the manufacture of fire brick and flue linings. No. 1 pink is a pink and white mottled, locally sandy, plastic sedimentary clay that is used to make face brick and is mined from pit No. 1 and pit No. 7. No. 2 red which is mined from No. 2 pit is a red to yellow plastic residual and basal sedimentary clay used in the production of face brick, sewer pipe, and tile.

Development: Six open pits mined both by machine and hand methods. The Company does their own mining on a continuous basis. In 1963 most of the mining was by machine methods utilizing tournapull-type equipment, front-end loaders, small power shovels, and dump trucks. The High Power pit has been idle since about 1930 but the other five pits (No. 23, No. 7, No. 2 "Pink Mottle", No. 1, and Green) have all been recently operating. See figures 6/ and 7/ and Table 3/ for pit details.

Production: Total not determined. More fire clay is mined from here than from any other deposit in the Alberhill area and during 1954 about 4,500 tons of clay were used each month in the production of clay products at the Alberhill plant. Mining apparently is continuing at about the same rate.

References: Aubury, 1906, p. 223, Merrill, 1917 /1919/, p. 572, 574; Boalich and others, 1920, p. 85-86; Dietrich, 1928, p. 174-176; Tucker and Sampson, 1929, p. 501; Sutherland, 1935, p. 70; Sampson, 1935, p. 520; Tucker and Sampson, 1945, p. 160-161; Engel and others, 1959, p. 93, 130, 131, figs. 6,7,10,11, 12,13, table 1, plates 5,7.

C.H.G. 6/20/63.

Liston Brick Company

Location: SE Cor. NW¼ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; on State Highway 71 about 5½ miles southeast of Corona, on the east side of lower Bedford Wash.

Ownership: Lionel P. Liston, P.O. Box 7, Corona.

History: Plant established in 1948 and has since been in continuous operation.

Description: Plant manufactures common brick products in both common and commercial sizes. The processing includes grinding and mixing of several raw material components. After pugging, a vacuum pump removes air and the mixture is extruded under pressure. Various brick sizes are cut and placed in a curing yard. After curing about 5 weeks, the bricks are fired in field kilns — the final operation.

The company obtains mineral raw materials from deposits in the Corona area. These materials are furnished from three sources: (1) diatomaceous shale of Miocene age is supplied from the Chocolate Drop deposit (described herein); (2) Owens-Illinois Glass Company provides sandy clay stripping waste material and waste pond material from the Corona silica sand deposit (described herein); and small amounts of local soil and sandy clay from several locations are sometimes used.

References: Gray, 1961, p. 74, 114.

C.H.G. 6/20/63.

McClintock Pit

Location: NW¼SE¼ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3 miles southwest of Corona, on the north side of Mabey Canyon.

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles (1961).

History: In 1952, this property was under development by Earl M. McClintock, who in 1952 furnished a small amount of clay for use in the manufacture of sewer pipe to the Mission Clay Products Corporation, Olive. Later the property was acquired by the Sky Ranch Clay Company, Corona, and the area was prospected in 1956 by bulldozer work. In 1957, the property was purchased by Pacific Clay Products and has since been idle.

Geology: Red mottled sandy clay lenses in Paleocene Silverado Formation sandstone and conglomerate.

Development: Shallow open-cuts and bulldozer cuts.

Production: Undetermined.

References: Gray, 1961, p. 112.

C.H.G. 2/28/61.

McKnight Clay Mine

Location: NE¼ sec. 9; SW¼ sec. 3, NW¼ sec. 10; T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; three miles southwest of Corona between Tin Mine and Mabey Canyons.

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles, owns three patented placer claims (Lucky, Trio, and McKnight), and one unpatented claim (Old Shaft), totaling about 65 acres.

History: Development of the McKnight deposit began about 1885 with the discovery of coal. Coal mining proved to be unprofitable, but attention was soon turned to the associated clay beds and during 1896 J. H. McKnight was shipping 200 tons of clay per month to plants in Corona and Los Angeles. By 1905 the property had been acquired and patented by the Pacific Clay Manufacturing Company, Los Angeles; before 1915 holdings of this Company were acquired by the Pacific Sewer Pipe Company which later became the Pacific Clay Products Company, now known as Pacific Clay Products, the current owner, and the operator for many years. The property has been idle since about the middle 1930's except for small intermittent production of red-burning clay from open pits and occasional sampling. The most recent known mining was about 1952 when several hundred tons of red-burning clay were produced.

Geology: The McKnight deposit is in the sedimentary clay series of the (Paleocene) Silverado Formation, and includes iron-stained clay shale, red mottled clay, and gray fire clay. The clay beds are exposed in several open pits and cuts on a low, brush-covered hill along the south side of Kroonen Canyon. The clay deposit is not completely exposed, but fragmentary exposures and previously published descriptions suggest that the beds at the McKnight mine are similar to those at Alberhill. According to Dietrich (1928, p. 179), the McKnight deposit consisted of two principal layers of commercial clay — an upper layer, 60 feet thick, of red-burning material, used in the manufacture of common clay products; and a lower layer of fire clay, 30 feet thick, used for fire brick. Results of laboratory tests of these two clay types are given by Dietrich (1928, p. 277). The clay is intercalated with sandstone and conglomerate. It is underlain by green, buff, and reddish-brown sandstone and overlain by clay shale which is stained pink or red by iron oxides. According to Sutherland (1935, p. 77), some of this clay shale was used early as red-burning clay, but most of the material mined was a flint-fire clay, which is moderately sandy, well-indurated, and contains various proportions of very fine gray to black, disseminated carbon grains.

The McKnight deposit is in a fault block, triangular in plan, that is about 6,000 feet long, as much as 2,500 feet wide, and is bordered by Upper Cretaceous sandstone, conglomerate, and shale of the Ladd Formation. The structure is complicated by cross fractures and folds which make the clay beds difficult and costly to mine. The ~~Paleocene~~ clays may rest unconformably on and be infolded with Upper Cretaceous rocks, having been subsequently distributed by complex faulting. The Paleocene rocks seem to comprise a fault block. Reserves of fire clay probably are meager and those of the red-burning clay are somewhat more abundant, but no meaningful estimate of clay reserves seems possible from available data.

Development: The McKnight property was mined mostly by underground workings which literally honey-comb the mine area (Sutherland, 1935, p. 79). By 1905, workings included four adits, with level workings totaling about 500 feet and two small open pits. Flint-fire clay was mined in 1919 from a 130-foot vertical shaft and, according to Dietrich (1928, p. 179), fire clay was mined in 1925 through a lower adit 410 feet long and an upper adit 70 feet above and 500 feet to the west. The two adits were connected by a raise; clay was mined by room and pillar methods, dumped into the raise, and drawn off into small mine cars in the lower adit. The rooms were about 15 feet high and connected with an open pit and adit at a still higher level from which red-burning sewer pipe clay was being mined. Extensive workings of a similar character were to the southeast, but the clays there had been exhausted some years before 1925. Mining and loading was by hand methods. By 1945, the main workings were caved and inaccessible. In 1958, several small adits were open but showed little clay; several open pits above the old underground workings partly exposed the clay (deposit) sequence.

Production: Output in 1925 was 50 tons per day each of red-burning and fire clay. Total production is not known, but judging from the extent of workings and fragmentary reports, a large tonnage of both red-burning claystone and fire clay must have been produced over a period of activity spanning nearly 50 years.

References: Goodyear, 1888, p. 505; Crawford, 1896, p. 616; Aubury, 1906, p. 224; Merrill, 1917 [1919], p. 569-570; Boalich and others, 1920, p. 89-90; Dietrich, 1928, p. 179, 277; Tucker and Sampson, 1929, p. 502; Sampson, 1935, p. 520; Sutherland, 1935 p. 75-79; Gray, 1961, p. 74, 77, 112.

C.H.G. 8/16/62.

Middlesworth (Brown Star Claims, Lord?, Freeman?)

(Clay) Deposit

Location: NW¼ sec. 14; SW¼ sec. 11; NE¼ sec. 15, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3½ miles south of Corona along the canyon (Lords Canyon) and intervening ridges midway between Main Street and Hagador Canyons.

Ownership: Josephine Middlesworth, 847 West 9th Street, Corona, holds three unpatented placer claims (Good Luck, Good Hope, Valley Brief) in the NW¼ sec. 14 totaling about 37 acres (1957); William H. Redding, et al., 1008 South Pacific Avenue, San Pedro, own 105 acres of patented ranch land (N½NE¼ sec. 15; SW¼ sec. 11) and one unpatented placer claim (Red Bull No. 1, S½SE¼ sec. 10) of about 80 acres (1957). Patented ranch land totaling 12.5 acres in the N½NW¼NW¼ sec. 14 was owned in 1944 by Mrs. Mabel M. Freeman, Riverside.

History: This property apparently now embraces part of several clay and mineral paint deposits operated as early as 1905 by George W. Lord and later by G. R. Freeman who intermittently produced crude clay from 1918 to 1937. Some of this production may have come from an extension of these clay deposits southeastward to Main Street Canyon (Corona Placer, described herein). By 1944, J. E. Middlesworth, Corona, held four 20-acre placer claims, known as the Brown Star claims; the patented areas were owned by the Freeman interests. In 1943, the Kaiser Steel Corporation took a short-term option on the property and did considerable exploratory work in an effort to develop a source of alumina-rich clays. The property was not put into production, little exploratory work has been done since 1943, and the property remains idle.

Geology: The clays ~~crop out~~ are exposed in bulldozer cuts and pits adjacent to the Elsinore fault in the steeply rising foothills of the Santa Ana Mountains. The clays exposed are sandy clays and semi-plastic clays of the nonmarine part of the Paleocene Silverado Formation, and consist of two principal types — a greenish-brown pisolitic "bauxite", and a semi-plastic red "pottery clay" with a conchoidal fracture. Folding and faulting have deformed the clay beds and the Silverado Formation, (but) ~~the Silverado beds~~ which have a general northwest strike and dip from 50° to 60° NE. in the mine area. However, one bed of "pottery clay" dips about 15° SW., and the largest exposure of bauxitic clay is nearly horizontal. There appear to be three beds of "bauxite" and one bed of the red material, separated by sandy clays. The "pottery clay", the basal unit of the sequence, is reported to be from 20 to 30 feet thick and is separated by about 70 feet of sandy clay from the overlying beds of impure "bauxite" which range from 2 feet to a maximum of about 6 feet in thickness (Tucker and Sampson, 1945, p. 161). The "bauxite" beds, averaging about 3 feet in thickness, are exposed over an area about 300 feet square. The bottom parts of the "bauxite" beds are reported to contain a dense, hard, flinty, non-plastic clay known in the industry as "bone clay". The

average of 107 samples taken from surfaces exposed during the Kaiser investigation in 1943 was 18.9 percent alumina, 57.11 percent silica, and 5.11 percent iron oxide. About 30,000 tons of bauxitic clay averaging above 25 percent Al_2O_3 content were proved, and an additional 30,000 tons of red clay that contains less than 25 percent Al_2O_3 (Draper, 1944).

Development: Early development was by open cuts, shallow shafts and two adits, 150 feet in length. During the Kaiser investigation in 1943 bulldozers removed the brush and overburden and clay was exposed at a number of points; six new cuts were made, nine old cuts were cleaned, and two old adits were reopened. By 1957, these workings were again slumped and brush covered.

Production: Undetermined, but probably not large.

References: Aubury, 1906, p. 223; Draper, 1944, 11 p., map; Tucker and Sampson 1945, p. 161; Gray, 1961, p. 77-78, 112.

C.H.G. 8/16/62.

Oak Park Clay Prospect*

*Adapted from Engel and others, 1959, p. 131

Location: NE¼ sec. 18, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; about 3/4 of a mile southeast of Lee Lake and 1,000 feet south of State Highway 71.

Ownership: Undetermined.

History: In 1946, Stauffer (map station 20) reported an "old clay tunnel or drift in fossiliferous clays"... . The prospect was apparently idle in 1946 and remained idle in 1963.

Geology: Trenches expose 5 to 7 feet of micaceous sandstone and 3 feet of greenish gray, waxy, clayey siltstone (Silverado Formation?).

Development: Two open trenches 60 feet by 15 feet and 15 feet deep.

Production: Undetermined, but apparently only a prospect with no production.

References: Stauffer, 1946, map station 20; Engel and others, 1959, p. 131.

C.H.G. 1/10/63.

Pacific Clay Products Alberhill Mines*

*Adapted from Engel and others, 1959, p. 87-92.

Location: E½ sec. 22, sec. 23, NW¼ sec. 26, and S½ sec. 15, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle 7½', 1954; clay pits are contained in an oval shaped area (in the E½ sec. 22, W½ sec. 23) about one mile long and half a mile wide and lie on the southwest slope of an elongate, northwest-trending hill that is bounded on the west by the Temescal Valley and on the east by Walker Canyon, about half a mile southeast of the Alberhill Post Office (see figure 71).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles holds about 1,500 acres, formerly operated by the Alberhill Coal and Clay Co.

History: From about 1890 to mid-1956 the Alberhill Coal and Clay Company mined coal and clay from their deposits near Alberhill. The company did not manufacture clay products, but supplied large tonnages of high-aluminous clay to ceramic plants in the Los Angeles area. In 1956 Pacific Clay Products acquired exclusive rights to the Alberhill Coal and Clay Company deposits under a long-term operating agreement.and continued the mining operation under the name Pacific Clay Products Alberhill Mines. These deposits provide the principal source of red-burning plastic clay for their plant at Los Nietos (Engel and others, 1959, p. 87-92). Since 1956 mining has been expanded considerably and two new major pits have been opened.

Geology: The regional geology is given by Engel and others (1959, plate 5) and details of the Alberhill Mines area are shown on plate 6 of Engel and others (1959). In general, the commercial clay zone as presently known is confined to the area of the mine pits, shown on figure 1/, and is about 130 feet in maximum thickness. In recent years, however, careful evaluation and drilling have revealed commercial clay in parts of the property previously thought unlikely to be clay-bearing. Thus reserves of usable clay have been greatly enlarged, but as exploration is not yet complete the full extent of the commercial clay zone is unknown. Figure 6/ is a generalized stratigraphic column showing lithologic features of the clay-bearing units in the Alberhill area and table 3/ gives information on each pit. Residual clay formed by weathering of slate (Triassic Bedford Canyon Formation) and volcanic rocks /Jurassic Santiago Peak Volcanics (andesitic) and quartz latite porphyry/ comprises most of the clay exposed in these pits, but both residual and sedimentary clays are produced from the Alberhill Mines deposits. Red and buff burning plastic clay of residual origin, which is used primarily in heavy clay products such as sewer pipe and face brick, occurs in the Pink Mottle pits numbers 1,2,3, and 4 and the No. 4 Plastic pit (fig. 7/). White to cream burning,

high aluminous sedimentary clay (Palocene Silverado Formation) which contains various proportions of quartzose sand, and carbonaceous clay and lignite is found in the West pit, Main Tunnel pit, and the Hill Blue Nos. 1 and 4 pits (fig. 7/). The South Alberhill and Red and Gray Mottle pits, opened in 1961 and 1962, contain sedimentary gray and yellow plastic clays. The Red and Gray Mottle pit also exposes a 3 to 6-foot thick pisolitic lens at the base of the plastic clay. Most of the 32 differently named clays that were sold by the Alberhill Coal and Clay Company can be classified as varieties of the two main types of clay above mentioned (Engel and others, 1959, p. 91). The property in the NW¼ sec. 26 is underlain by green clay shale with interbedded micaceous arkose of the upper part of the Paleocene Silverado Formation. This area has not been mined but recent drilling by Pacific Clay Products is said to have encountered commercial clay at depth.

Development: During the early years of operation high-grade refractory clays were the only clays mined. These clays, which were mined underground by hand methods, were sacked underground and shipped by rail mostly to Los Angeles producers. As late as 1930 underground mining was employed extensively, but by 1945 most of the mining was from open pits. High grade clays continued to be selectively mined by hand methods, however, until the late 1950's. The fire clays of sedimentary origin continue to be selectively mined, but in recent years this has been done by machine methods. These fire clays are sold to various users for use mainly in refractory clay products such as fire brick, furnace lining, and pottery.

In 1963 all of the active clay deposits were being mined by means of large open pits (fig. 7, table 31). Mining is done periodically by contract, usually during a few weeks in early summer. Sufficient clay is stockpiled (150,000-200,000 tons) to last about one year. In June 1963 the Griffith Company was the mining contractor and clay was mined by means of heavy-duty mechanized equipment such as Caterpillar D-8 rippers and bulldozers, Caterpillar DW641 carry-alls (40 ton capacity), and motor graders (used for stockpile work and road work). About 20,000 tons of clay were mined and stockpiled each day. Even though large scale methods are used, and the extent of each clay type is limited, careful supervision of the mining allows

each clay type to be selectively mined and separately stockpiled. Stockpiled material is loaded by rubber-tired front-end loaders as needed for transport to the Los Nietos plant by company-owned truck and trailer equipment.

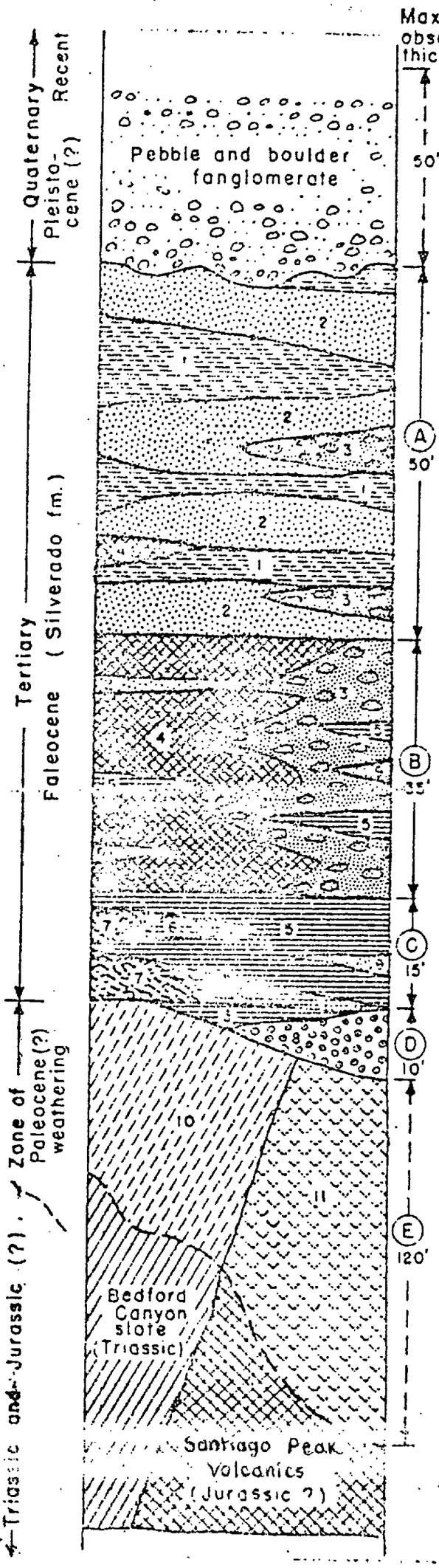
Production: By 1945 the total 50-year output of clay from the Alberhill Coal and Clay Company deposits was estimated at 2,000,000 tons (Tucker and Sampson, 1945, p. 160). In 1945 about 500 tons of clay per day was being shipped from these deposits and by 1963 about 600 tons per day was being shipped.

References: Aubury, 1906, p. 221-222; Merrill, 1917 /1919/ p. 567-568; Boalich and others, 1920, p. 76-85; Hill, 1923, p. 185-210; Dietrich, 1928, p. 161-169; Tucker and Sampson, 1929, p. 500; Sutherland, 1935, p. 51-87; Engel and others, 1959, p. 87-92, 129, plates 5,6, figs. 6,7,8,9, tables 1,2.

C.H.G. 6/20/63.

Riverside Co. Dpt.

Figure 6



EXPLANATION

(A) Green to gray, waxy clay shale (1) interbedded with arkosic, micaceous, coarse-grained sandstone (2); locally contains 1' to 8' thick layers and lenses of sandy, pink and white mottled claystone (3) and sandy white, yellow and gray claystone (4).

(B) Sandy, white, yellow and gray mottled claystone (4) containing lenses of white to gray claystone (fire-clay) (5) and lenses of coarse-grained, angular, clayey quartz sandstone (9). Pink and white sandy, mottled facies of claystone (3) is most abundant in western part of area.

(C) White to gray claystone (fire-clay, (5) interbedded with lignite (7) and dark gray to black, carbonaceous fire-clay (6); contains lenticular layers of clayey pebble conglomerate, and coarse-grained, quartzose clayey sandstone (9).

(D) White, yellow and red pisolitic claystone (8) with white gray claystone (fire-clay) (5); occurs in lenticular bodies in upper part of residual clay.

(E) White, yellow and red plastic claystone of residual origin, derived from slate (10) and volcanic rocks (11).

(Old fig Fi 2)

Figure 6. Generalized stratigraphic columns showing lithologic features of clay-bearing units in Alberhill area. Reprinted from California Division of Mines Bulletin 146, figure 7, page 80.

Riverside Co. Apt. Figure 7

Alberhill Quad. | Elsinore Quad.

117°22'30"

EXPLANATION

Map No. & Name of Pit		Owner (July 1963)
1.	High Power	
2.	No. 23	Los Angeles
3.	No. 7	Brick & Clay
4.	No. 2 (Red)	Products Co.
5.	No. 1	
6.	Green	
7.	New Sloan } Old	International
8.	Red Sloan } Sloan	Pipe & Ceramics
9.	Old Sloan } Pits	Corp. (previously
10.	Brooks (1952)	Gladding, McBean
11.	Sloan	& Co.)
12.	Douglas	Pacific Clay
13.	Hoist	Products
14.	West	
15.	Main Tunnel	
16.	Pink Mottle No. 1	
17.	Pink Mottle No. 4	Pacific Clay
18.	Hill Blue No. 1	Products
19.	Hill Blue No. 4	Alberhill
20.	No. 4 Plastic	Mines
21.	Pink Mottle No. 3	
22.	Pink Mottle No. 2	
23.	South Alberhill	
24.	Red & Gray Mottle	
25.	Alberhill Olive	
26.	Elsinore (Laura Ward, Old No. 3, Morton)	Elsinore Clay Co.
27.	Elsinore (Old No. 2)	
28.	De Guerre Olive (Pits 1-5)	Pacific Clay Products De Guerre Mines
29.	Prospect (name undetermined)	Undetermined
30.	Prospect (name undetermined)	

To Corona

Los Angeles Brick & Clay Products Co. Plant

Alberhill

Alberhill Post Office

WALKER CANYON

A.T.&S.F. R.R.

Terra Cotta

RANCHO LA LAGUNA

To Elsinore

North Elsinore

16 15 14 13 21 22 23 24 28 27 26 25 35 36 34 31

T.5S. S.B.M.

R.5W. | R.4W. S.B.M.

N W E S

0 1/4 1/2 3/4 1

SCALE MILE

Base from portions of U.S.G.S. 1:24,000 topo maps Alberhill & Elsinore quads.

(mid fig G-1)

Figure 7. Sketch map showing location and general outline of clay pits in the Alberhill area. Adapted from California Division of Mines Bulletin 146 Figure 6 pg 78

Pacific Clay Products, De Guerre Mines

Location: N½ and SE¼ sec. 27, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; about 1¼ miles southeast of Alberhill Post Office. The pits are in low hills east of old State Highway 71 in the NE¼ sec. 27. (See fig. 71).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles owns 480 acres in sec. 27.

History: By 1959 the property had been explored only by one small open trench about 60 feet by 10 feet and 6 feet deep in the NE¼ sec. 27, just east of the highway. This trench exposed white clayey sandstone overlain by gray and orange, micaceous shale of the Silverado Formation (Engel and others, 1959, p. 131). Pacific Clay Products acquired the area about 1960 and in 1961 opened a large pit; additional pits were opened in 1962 and 1963.

Geology: The surface is largely covered by Quaternary fanglomerate, but green clay shale and micaceous arkose of the ~~Paleocene~~ Silverado Formation crop out in the central part of the property. Engel and others (1959, plate 5) show the regional geology. The pits expose as much as 20 feet of buff sand, silt, clayey sand, sandy clay, and plastic clay, all apparently in the upper part of the Silverado Formation.

Development: Four principal pits have been opened, with the largest about 500 feet by 300 feet and 20 feet deep (see fig. 7/, table 3/). Mining is by large scale machine methods and is done in connection with the mining of the company's Alberhill Mines. Much of the material mined in 1963 was for experimental purposes, but the sand and sandy clay from the northernmost pit, known as "Sandy Olive" was used as a "flux" in the manufacture of sewer pipe at the company's plant at Los Nietos. In addition to the pits opened east of the old highway, the area west of the highway has been explored by drilling, which is said to have penetrated potential commercial zones.

Production: Undetermined, probably a few tens of thousands of tons have been mined.

References: Engel and others, 1959, p. 131.

C.H.G. 6/20/63.

Pacific Clay Products, Corona Plant

Location: SW¼ sec. 26 (proj.), T. 3 S., R. 7 W., S.B.M., Corona North quadrangle, 7½', 1954; 1150 West 6th Street (State Highway 71), Corona.

History: This plant (described by Gray, 1961, p. 81) began operations in 1941 as the Tillotson Refractories Company and used clay from several deposits in the Temescal Valley-Alberhill area and from the Sky Ranch Clay Company (described herein). Initially the product was insulating fire brick but after 1945 only vitrified clay sewer pipe was produced. In 1957 the plant was acquired by Pacific Clay Products who continued to operate the plant until late in 1960. At that time the Corona plant was consolidated with Pacific Clay Products' Santa Fe Springs plant. After final production runs the Corona plant was dismantled and its machinery moved to the Santa Fe Springs plant.

C.H.G. 8/29/62

Palen Mountains Deposit

Location: Secs. 24, 25, T. 5 S., R. 17 E., and secs. 19 and 30 (proj.), T. 5 S., R. 18 E., S.B.M., Sidewinder Well quadrangle 15', 1952; on the southwest flank of the Palen Mountains.

Ownership: In 1945, Louis Favret and associates, Blythe, held six 160-acre placer claims in this area (Tucker and Sampson, 1945, p. 162). Present (1962) ownership was not determined.

History: Assessment work only appears to have been done.

Geology: The deposit is irregularly exposed by badlands erosion over an area of about one square mile. It is part of an undetermined thickness of inter-bedded, buff-colored silt and calcareous, bentonitic clay of Pleistocene age, which is overlain by a surficial deposit of angular gravel approximately 2 feet in average thickness. Where examined, in a shallow prospect [(photo ~~3~~)], the beds of silt and clay range from one inch to one foot in thickness. A bed of nodular caliche several inches thick lies about 10 feet below the upper surface of the deposit. These strata are essentially flat lying and undisturbed.

Development: The deposit has been explored through several shallow prospect pits and cuts.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 162, pl. 35.

R.B.S. 3/15/62

~~Photo 3~~

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Peterson's Claim

Location: N½ sec. 29, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; northeast flank of the Santa Ana Mountains, about 5½ miles southeast of Corona between Bedford Motorway and McBribe Canyon.

Ownership: Arthur E. Garratt, 3340 Eastern Avenue, Los Angeles owns patented land, formerly railroad section (1957).

History: Some development in this area was as early as 1892 (indicated on U.S. Bureau of Land Management survey map dated 1892). About 1930, the Elsinore Clay Company, Riverside, mined small amounts of clay from open pits. The property has been inactive since the 1930's except that in 1956 bulldozer cuts were made in the NE¼ sec. 29 in an unsuccessful effort to discover glass sand.

Geology: Red mottled clay and sandy gray to white clay with minor pisolitic zones intercalalated in sandstone and conglomerate of the Paleocene Silverado Formation; adjacent to the Elsinore fault on its northeast side. Reserves of clay appear to be very small.

Development: Shallow open pits and bulldozer cuts.

Production: Undetermined, but probably small.

References: Gray, 1961, p. 112.

C.H.G. 3/1/61.

Prospect (name undetermined)*

*Adapted from Engel and others, 1959, p. 130

Location: SE¼ sec. 14, T. 5 S., R. 5 W., S.B.M., Elsinore quadrangle, 7½', 1953; on south face of hill, about 3,000 feet northeast of Walker Ranch (see figure 71).

Ownership: International Pipe and Ceramics Corporation, 2901 Los Feliz Blvd., Los Angeles 39.

History: Undetermined.

Geology: Residual red and white mottled, plastic clay derived from weathering of volcanic rocks is exposed over surface area about 200 feet in diameter.

Development: Caved adit trends northward into hill.

Production: Undetermined.

References: Engel and others, 1959, p. 130, figure 6.

C.H.G. 6/20/63.

Red Top Deposit

Location: Secs. 20 and 21, T. 6 S., R. 9 E., S. B. M., Thermal Canyon quadrangle, 7 1/2', 1956; 4 miles due east of Thermal. The property is reached by unimproved dirt roads which extend eastward to the Mecca Hills.

Ownership: In 1945 Louis Schrim, Los Angeles, was reported to hold 640 acres of patented land in sec. 21 and three 160-acre placer claims in sec. 20 (Tucker and Sampson, 1945, p. 162). Present (1962) ownership was not determined.

History: Assessment work only appears to have been done on these claims.

Geology: Red-brown, buff, and gray, calcareous clay of the Miocene-Pliocene Palm Spring Formation underlie a northwest-trending ridge, about a quarter of a mile wide and 1 1/2 miles long (Photo 4 /). The thickness of the deposit is obscured by folds, faults and a deeply eroded, slope-wash-covered surface, but probably is two or more hundreds of feet. It appears to contain clay-rich units of diverse purity, some of which contain beds of silt and grit. Fracture fillings of gypsum ranging from 0 to 1 inch thick are present, but not common. A few nodular masses of dense, white magnesite, ranging from 1 inch to 4 inches in diameter, were noted in prospects in the ~~SW Sec.~~ southwest corner of the NW 1/4, sec. 21.

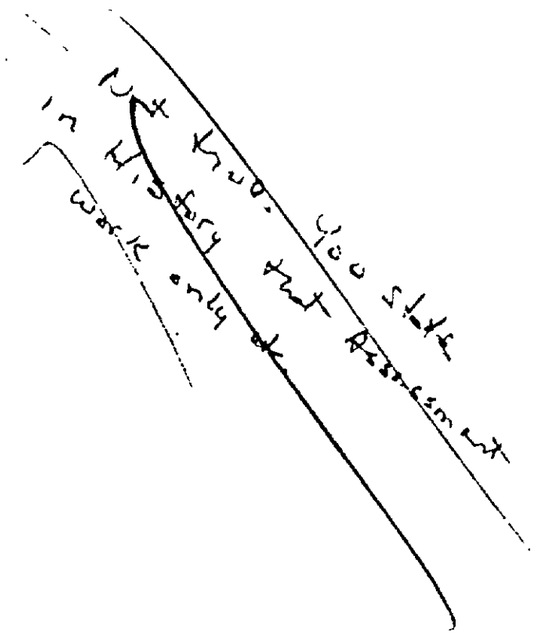
Photo 4

Development: The deposit has been explored through several bulldozer cuts ~~connected by unimproved roads~~.

Production: ~~(Undetermined)~~ None

References: Tucker and Sampson, 1945, p. 162, pl. 35.

R.B.S. 3/15/62



Sievert Clay Prospect*

*Adapted from Engel and others, 1959, p. 131.

Location: SE¼ sec. 36, T. 6 S., R. 5 W., S.B.M., Wildomar quadrangle, 7½', 1953; in the Elsinore Mountains half a mile west of Elsinore Peak.

Ownership: Undetermined.

History: Undetermined.

Geology: Sandy residual clay formed by weathering of granodiorite is overlain by about 10 feet of red to gray buff sandstone and 2½ feet of gray, sandy claystone (Silverado Formation?).

Development: Shallow pit.

Production: Undetermined, probably none.

References: Engel and others, 1959, p. 131.

C.H.G. 1/10/63.

Sky Randh Clay Company Deposits

Location: W½ and SE¼ sec. 4; E½ sec. 5, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3½ miles southwest of Corona along Mabey and Wardlow Canyons and intervening ridges.

Ownership: Clifford and Maude M. Tillotson, P.O., Box 237, Corona, own three patented placer claims totaling 60 acres (Fire Clay No. 1, Fire Clay No. 2, and M & M placer); and three unpatented placer claims (Insight No. 1, Insight No. 2, and French placer, part of which is termed herein Sky Ranch Clay mine, east and west pits). They also own clay-bearing patented ranch land in the area. John Tillotson, 807 Park Lane, Corona, owns one patented placer claim (Leo Lorenzo, 20 acres) formerly part of the Kroonen group which is described elsewhere in this report (1957).

History: Operations in the vicinity of the patented properties began about 1900 but production apparently was small and intermittent. Following a long period of idleness a renewal of activity began about 1945 when Clifford Tillotson began developing sources of red-burning

clays for use at the Tillotson Refractories Company in Corona. The above mentioned properties and also the Susie placer, McClintock pit, and Sky Ranch Clay Mine, west pit (all described herein) were operated collectively by the Sky Ranch Clay Company from 1945 until 1957. At that time Pacific Clay Products acquired the Susie placer, McClintock pit, Sky Ranch Clay mine west pit, and some clay-bearing patented ranch land. The Sky Ranch Clay Company ceased production in 1957, but Pacific Clay Products continued mining their properties until late 1960. The area has since been inactive.

Geology: The Sky Ranch Clay Company deposits are mostly in clay shale and siltstone of Upper Cretaceous age assigned to the Ladd Formation, undifferentiated, but the clay shale on the Fire Clay group belongs to the Holz Shale member of the Ladd Formation. The clay shales, which contain hard, irregular limy beds and concretions, in general strike northwest, dip 40° to 80° northeast and are intercalated with sandy conglomerate and massive sandstone. The principal body of clay shale that was mined crops out in a band about 500 feet wide along the north side of Wardlow Canyon and the shale can be traced northwestward along a strike length of about 1,500 feet. Large areas of the Upper Cretaceous clay shale provide many hundreds of thousands of tons of reserves of red-burning clay shale, but probably only a part of the shale will prove suitable as a constituent for the manufacture of common clay products because of sandy and limy zones and gypsum veinlets.

Development: Open cuts and short adits. The principal quarries were along the north side of Wardlow Canyon. Much of the material was mined by means of a combination bulldozer-ripper which skimmed clay shale from a broad area, rather than opening a discrete quarry.

Production: From 10 to 20 thousand tons of clay shale each year from 1945-1957.

References: Aubury, 1906, p. 223; Gray, 1961, p. 78-80, 112.

C.H.G. 8/31/62

Sky Ranch Clay Mine, East Pit

Location: NE¼SW¼NW¼ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on the north side of Wardlow Canyon.

Ownership: Sky Ranch Clay Company (Clifford Tillotson, owner), P.O. Box 237, Corona (1957).

History: Quarry opened in 1951 and until 1956 steadily furnished a considerable tonnage of clay shale to Tillotson Refractories Company, Corona. Idle since 1956.

Geology: Upper Cretaceous Ladd Formation, siltstone and shale, ~~about 500 feet wide~~ traceable northwestward along strike about 1500 fee

Development: Large open quarry.

Production: Undetermined, probably at least several tens of thousands of tons.

References: Gray, 1961, p. 78-80, 113.

C.H.G. 3/1/61.

Susie Placer (McVicar Pit) Deposit

Location: NW¼ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on a ridge north of Mabey Canyon.

Ownership: Pacific Clay products, 1255 West Fourth Street, Los Angeles owns the patented Susie placer claim (1961).

History: Wm. G. McVicar shipped clay from the Susie claim to the California Clay Manufacturing Company in Los Angeles about 1900. Later the property was acquired by Earl M. McClintock who shipped some clay to Mission Clay Products, Olive, during the early 1950's. In 1954, the Sky Ranch Clay Company (see herein) acquired the property and mined intermittently until September, 1957, when Pacific Clay Products purchased the property. Idle since September 1957.

Geology: A narrow, wedge-shaped fault sliver of Paleocene Silverado Formation sedimentary clay, including red mottled, white, gray, and pisolitic clay with minor associated lignite. Intercalated with Silverado Formation sandstone and conglomerate. The deposit apparently has very little areal extent beyond the pit limits.

Development: Early development was by short adits and open-cuts; recent mining has been from open pits which destroyed the earlier workings.

Production: Undetermined, but apparently small.

References: Aubury, 1906, p. 223; Gray, 1961, p. 78-80, 113.

C.H.G. 3/1/61.

Switzer Deposit

Location: NE¼ sec. 5, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; on the northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, adjoins Findley graphite placer on the east and Sky Ranch Clay Company on the south.

Ownership: Elmo Switzer, 808 West 8th Street, Corona, owns about 50 acres of patented ranch land (1957).

History: About 1945, small amounts of white, sandy clay "ganister" were mined from an open-cut by the Sky Ranch Clay Company for use at Tillotson Refractories Company, Corona. Idle since, except for occasional sampling.

Geology: Buff Upper Cretaceous clay shales of the Ladd Formation underlie the area. A white, sandy clay zone, 2 to 5 feet thick, occurs along a shear zone which strikes N. 50° W., dips 40° NE.

Development: Explored by bulldozer cuts about 1945. Small open-cut on the white, sandy clay outcrop.

Production: Undetermined.

References: Gray, 1961, p. 113.

C.H.G. 3/1/61.

Thomas Clay Deposit, East Pit

Location: NW¼ sec. 33 (proj.), T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3 miles southwest of Corona, along the east side of the major west branch of Wardlow Wash.

Ownership: Charles A. Thomas, P.O. Box 518, Corona, owns this property as part of the 500-acre La Sierra Stock Ranch; about 23 acres are leased to International Pipe and Ceramics Corporation (Gladding, McBean and Company), Los Angeles, who have sublet mining rights to the east pit area to Joe Deleo, Jr., clay supplier and mining contractor, 1233 Garretson, Corona (1957).

History: In 1951 Joe Deleo, Jr. began prospecting activities which led to the discovery of this clay shale deposit on the Thomas property. Mr. Deleo, who operates the Corona Clay Company, began mining during 1953 and each year since 1953 has maintained a small production. This red-burning clay shale is supplied to several manufacturers of common clay products in western Riverside County and in the Metropolitan Los Angeles area.

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Geology: Fissile marine claystone of the Paleocene Silverado Formation. The claystone is buff to light gray in color and contains hard, limy concretionary zones. The claystone has an average strike of about N. 70° W. and dips vertically or steeply eastward. The clay zone being explored, including the adjoining west pit (described herein), has an exposed width of nearly 500 feet and an exposed strike length of about 1,000 feet. It is enclosed by, and may grade both laterally and along the flanks into, sandstone and cobble conglomerate.

Development: Bulldozer cuts and benches, that have formed a sloping quarry face about 200 feet high and as much as 300 feet wide. In early 1963 the main bench was about 30 feet high and 125 feet long. The clay shale is stripped and mined intermittently by means of a combination tractor bulldozer-ripper which stockpiles loose material at the foot of the face. There the clay is loaded by a 1½ cubic yard Lorain dipper power shovel into 12-yard semitrailer dump trucks for transport to the several manufacturers. Irregularly distributed limy concretions are removed at the mine by hand sorting.

Production: Small production of a few thousand tons each year since 1953.

References: Gray, 1961, p. 80-81, 113.

C.H.G. 1/23/63.

Thomas Clay Deposit, West Pit

Location: NW¼ sec. 33 (proj.), T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 3 miles southwest of Corona, along the west side of the major west branch of Wardlow Wash.

Ownership: Charles A. Thomas, P.O. Box 518, Corona, owns this property as part of the 500-acre La Sierra Stock Ranch; about 23 acres are leased to International Pipe and Ceramics Corporation (Gladding, McBean and Company), Los Angeles.

History: Gladding, McBean and Company began development of this property in 1954. Extensive sampling, including core drilling of the clay shale, was done during 1955. The property has not been put into production, but intermittent development work has continued.

Geology: The deposit is on strike with the east pit (described herein) across the canyon and is an extension of the same deposit. In the west pit sufficient cuts have been made to show that the nearly vertical clay shale and siltstone contain intercalated cobble conglomerate and sandstone. These appear to lens out abruptly both along the strike and from side to side. The workings expose a thickness of about 400 feet of continuous clay shale.

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Development: Open cuts and benches on several levels. Mining has been done with bulldozer and ripper.

Production: A few hundred tons were mined in 1955-56 for plant tests. The deposit has not been put into production.

References: Gray, 1961, p. 81, 113.

C.H.G. 1/23/63.

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#13

Wardlow Shale Mine (Sky Ranch Clay Mine, West Pit)

Location: NW¼SW¼NW¼ sec. 4, S½NE¼ sec. 5, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on the north side of Wardlow Canyon.

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles owns the Frenchy placer claim (unpatented, NW¼SW¼NW¼ sec. 4) and 75 acres of patented ranch land in the S½NE¼ sec. 5 (1961).

History: In 1956, the Sky Ranch Clay Company (see herein) opened a quarry in the S½NE¼ sec. 5 and mined several tens of thousands of tons of clay shale for use by the Tillotson Refractories Company in Corona. In September 1957, the property was purchased by Pacific Clay products who continued to mine about 25,000 tons of clay shale each year for their Corona plant (the former Tillotson Refractories Company). Mining was suspended in September 1960, when the Corona plant was dismantled.

Geology: Upper Cretaceous Ladd Formation shale and siltstone. The quarry developed a clay-shale zone which is about 500 feet wide east-west and extends about 1,500 feet northwesterly from Wardlow Canyon.

Development: Open-cut hillslope. Mining was done by a Caterpillar bulldozer-ripper which loosened and moved the shale to a stockpile, where a skip loader loaded the shale on dump trucks for transport to the plant.

Production: 1956-1960, about 100,000 tons.

References: Gray, 1961, p. 78-80, 113.

C.H.G. 3/1/61.

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Wildomar Kaolin Deposit

Location: NW¼ sec. 7 (proj.), T. 7 S., R. 3 W., S.B.M., Murrieta quadrangle, 7½', 1953; 2 miles northwest of Murrieta just east of Chaney Hill.

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles owns 16.98 acres.

History: Deposit was reported by Aubury in 1906 (p. 222) and was opened prior to 1925. It has since been intermittently active but in recent years only a small quantity has been mined. Inactive since 1961.

Geology: According to Sutherland (1935, p. 72) the clays are residual and derived from acid-lava flows. The sequence consists of pumiceous and agglomeratic altered rhyolites and rhyolitic tuffs. The beds strike N. 37° W., and dip 26° S. The clay is non-plastic and is used as a filler in various mixtures. Stauffer (1946, map station 3) described the deposit as "probably a volcanic ash with clays associated".

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~~165~~

Development: By 1925 a shaft had been sunk and there were two shallow open cuts, each about 100 feet long and 50 feet wide. In 1963 the principal working was a slumped open cut trending N. 30° W., 200 feet long, 50 feet wide, with maximum depth of 25 feet. To the northwest several ridges have been cut exposing material similar to that in the main cut along a strike distance of about 350 feet.

Production: Considerable quantities were mined before 1935 (Sutherland, 1935, p. 75) but in recent years only about 150 tons have been mined each year (Mann, 1955, p. 19).

References: Aubury, 1906, p. 222; Dietrich, 1928, p. 180; Tucker and Sampson, 1929, p. 502; Sutherland, 1935, p. 72-75; Stauffer, 1946, map Station 3; Mann, 1955, p. 19.

C.H.G. 1/10/63.

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~~Unknown~~ Pit (Name [illegible])

Location: NE¼ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4½ miles southeast of Corona, on the east side of Temescal Canyon.

Ownership: Temescal Water Company, Corona (1957).

History: Intermittent small scale surface mining of soil by Liston Brick Company during the 1950's. The material was used in the manufacture of red brick in the nearby Liston Brick Company plant. Idle in 1961.

Geology: Soil developed on Triassic (?) Bedford Canyon Formation metasedimentary rocks.

Development: Small, shallow open-cuts were mined by combination bulldozer-loader.

Production: Undetermined, but small.

References: Gray, 1961, p. 113.

C.H.G. 3/2/61.

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~~167~~

~~Unknown~~ Prospect (name unknown)

Location: SE¼ sec. 33, T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern margin of the Santa Ana Mountains, about 3 miles west of Corona, on the west side of Wardlow Wash.

Ownership: P. J. Oertel and others, Corona (1957).

History: Undetermined, but long idle.

Geology: White and pink, mottled, impure, sandy clay of the Paleocene Silverado Formation. Beds strike N. 60° W., dip 45° to 60° NE., overlain by pebble arkose.

Development: Caved pit or shaft 10 feet deep in 1957.

Production: Undetermined, apparently only a prospect.

References: Gray, 1961, p. 113.

C.H.G. 3/2/61.

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Unknown Prospect (name [illegible])

Location: NE¼ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern margin of the Santa Ana Mountains, 2½ miles southwest of Corona, on a flat-topped ridge east of Wardlow Wash.

Ownership: Mrs. Graciosa V. and Bernard W. de Pipkin, Harvard Street, Los Angeles (1956).

History: Undetermined, but long idle.

Geology: Gray and white, brownish-buff, iron-red to limonite-yellow colored mottled clay bed 5-10 feet thick, intercalated with white arkose and conglomerate of the Paleocene Silverado Formation.

Development: Two shallow open-cuts.

Production: Undetermined, but apparently none.

References: Gray, 1961, p. 113.

C.H.G. 3/2/61.

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~~Unknown~~ Prospect (name unknown)

Location: SW¼ sec. 3, T 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3 miles southwest of Corona.

Ownership: Joy G. and Walter T. Jameson, Corona (1957).

History: Apparently a prospect developed in the 1920's (Dietrich, 1928, map facing p. 162). Long idle.

Geology: Reddish-brown pisolitic clay bed strikes N. 50° W., dips 55° NE. Clay bed 3 feet thick is exposed along a strike length of 30 feet. Overlain by clayey reddish sandstone, underlain by 2 feet of white and gray fire clay which grades downward into red iron-stained clayey sandstone and buff arkose. Paleocene Silverado Formation sedimentary rocks.

Development: Several small prospect pits.

Production: Undetermined, but apparently none.

References: Dietrich, 1928, map facing p. 162; Gray 1961, p. 114.

C.H.G.G. 3/2/61.

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unknown

Prospect (Name undetermined)*

*Adapted from Engel and others, 1959, p. 132.

Location: SE¼ sec. 16, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; half a mile northwest of Alberhill Post Office on the north side of Temescal Wash (see figure 71).

Ownership: Undetermined.

History: Undetermined. Long inactive.

Geology: Surface exposes purplish red, plastic residual clay derived from weathering of volcanic rocks of Santiago Peak Volcanics.

Development: Shallow pit.

Production: Undetermined, probably none.

References: Engel and others, 1959, p. 132, figure 6.

C.H.G. 1/10/63.

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Coal

Between the years 1894 and 1902, a total of 51,210 tons of coal valued at $116,573 was reported to have been produced in Riverside County (Tucker and Sampson, 1945, pl. 23). Virtually all of this coal came from a deposit near Alberhill. Here a single coal bed ranging from 4 to 10 feet in thickness was found in the clay-rich sedimentary rocks of the Silverado Formation (Paleocene). The coal was developed by the Elsinore Coal and Clay Co. of Los Angeles (Crawford, 1896, p. 54), but the property is now held by Alberhill Coal and Clay Company.

The coal, a lignite, was used for heating and to fire stationary boilers but it yielded too few Btu's per unit volume for locomotive use (Crawford, 1894, p. 60). The Alberhill lignite soon became unmarketable in competition with more convenient and abundant petroleum. Since 1902 this deposit has not been a source of fuel.

ITC

Alberhill Coal and Clay Company ~~Coal~~ Deposit

(Colliers and Cheney Coal Mine)

Location: NE¼ sec. 22, T. 5 S., R. 5 W., S.B.M., Alberhill quadrangle, 7½', 1954; half a mile southeast of Alberhill post office.

Ownership: Alberhill Coal and Clay Company, Alberhill; leased to Pacific Clay Products, 1255 West Fourth Street, Los Angeles.

History: Coal was discovered in the Alberhill area in 1883 and from 1885 to about 1900 a lignitic variety was mined at the present site of Pacific Clay Products Alberhill ~~operations~~ Mines. Early development was by Cheney and Colliers and later mining was by the Alberhill Coal and Clay Company. Since 1900 very little coal has been marketed from the Alberhill area (Engel and others, 1959, p. 97).

Geology: In the West and Main Tunnel clay pits of the Alberhill Coal and Clay Company a layer of coal as much as 10 feet thick and with an average thickness of about 4 feet is interbedded with fire clay at the base of the Silverado formation. This layer yielded the early production ~~of coal~~ in the area. The coal is a soft, lignitic variety, and in many places grades laterally and vertically into black carbonaceous clay (Engel and others, 1959, p. 97).

Development: The coal was mined by the room and pillar method and with hand tools. It was sacked underground and shipped by rail to Los Angeles. Clay was mined from the same adits as the coal and by 1887 the workings included two adits, each about 350 feet long (Engel and others, 1959, p. 97; Goodyear, 1888, p. 174-178).

Production: Total undetermined. Tucker and Sampson (1945, pl. 23) report 51,210 tons of coal produced in Riverside County from 1894-1902. Apparently most of this coal came from the Alberhill deposits. Judging from early descriptions the most active period of coal mining probably was from 1885 to 1895 and thus production may be several times that reported by Tucker and Sampson.

References: Hanks, 1886, p. 117; Goodyear, 1888, p. 179-178; Engel and others, 1959, p. 97.

C.H.G. 1/8/63.

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Castillo's Prospect

Location: NW¼ sec. 29, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 5½ miles southeast of Corona, on the east bank of Bedford Canyon.

Ownership: Arthur E. Garratt, 3340 Eastern Avenue, Los Angeles owns patented land, former railroad section (1957).

History: A coal prospect at this location is shown on a U.S. Bureau of Land Management survey map dated 1892. Long idle.

Geology: Red mottled clay, claystone, and minor amounts of pisolitic clay and lignite of the Paleocene Silverado Formation are exposed in a narrow, steep canyon.

Development: None observed in July 1956.

Production: Undetermined.

References: Gray, 1961, p. 114.

C.H.G. 3/2/61.

McKnight Deposit

Location: NE¼ sec. 9, SW¼ sec. 3, NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 3 miles southwest of Corona, between Tin Mine and Mabey Canyons.

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles (1961).

History: Attempts were made to mine coal in this area from about 1885 to 1895. Attention soon turned to the associated clay beds (see McKnight Clay mine herein).

Geology: In 1888, a bed of coal was observed to crop out in rocks (Paleocene Silverado Formation) that probably have since been removed in coal and clay mining operations. The coal bed showed a strike of about N. 70° W. and dipped 65° to 70° NE., but was very irregular in thickness and quality. At the surface it was an impure streak from 1 to 2 feet thick, about 50 feet down it widened to 4 feet of rather clean soft coal. Below this it pinched out to only 3 or 4 inches with an irregular dip. (Goodyear, 1888, p. 505).

Development: By 1887, an adit had been driven into the hill about 60 feet and a winze about 170 feet deep sunk from the adit in the search for coal (Goodyear, 1888, p. 505). (See McKnight Clay mine herein for description of later workings).

Production: Undetermined, but probably small for local use.

References: Goodyear, 1888, p. 505; Gray, 1961, p. 74-77, 114.

C.H.G. 3/2/61.

Unnamed
Unknown Prospect

Location: NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, north side of Tin Mine Canyon.

Ownership: Arthur Weirick, Chase and Skyline Drive, Corona (1956).

History: Early day local resident reports there was a caved adit and considerable dump area with lignite at the location in 1907 (personal communication, Mrs. Irene J. Ware, Corona, 1957). This was on the old McKnight ranch, and probably was part of McKnights coal prospect (see herein). No trace of adit or dump were found in 1957.

Geology: Paleocene Silverado Formation sandstone and conglomerate.

Development: Undetermined.

Production: Undetermined.

References: Gray, 1961, p. 114.

C.H.G. 3/2/61.

Copper

Riverside County mineral production statistics first included copper in 1907 (Tucker and Sampson, 1945, pl. 23). By 1959 a total of 420,802 pounds of copper, valued at $65,499 had been produced. Much of this total came from gold mines in which cuprous gangue minerals are common. Most such mines are in the northeastern corner of the county in the Riverside Mountains. ~~Indeed, the distinction between gold and copper mines is, in a few instances, purely arbitrary.~~

Anderson (Hope) Mine

Location: Secs. 11 and 14, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 3½ miles south of New Dale (Site) and about 1 mile east of the Gold Crown mine (~~pl. 3~~ figure 31).

Ownership: Charley Wade, General Delivery, Twenty-nine Palms, owns at least one unpatented claim (March 1960).

History: In 1916 the property consisted of 26 claims, and was owned and operated by Anderson and Co. (Merrill, 1916, p. 525). At this time it was reported that a shaft had been sunk 80 feet and a tunnel driven 100 feet, and considerable other exploration work done. Tucker and Sampson's report (1929, p. 469) indicates that no additional work had been done by 1929. The mine ~~was not in operation on the day of the property visit~~ but is worked intermittently by the present owner.

Geology: North-trending and steeply-dipping quartz veins, ranging from ~~two~~ 2 to 6 feet (?) in width, cut massive Mesozoic quartz monzonite. The ore ~~carries~~ contains copper (azurite and malachite) and a ~~little~~ trace of silver (Merrill, 1916, p. 525).

Development: The shaft is nearly vertical, sunk on the vein, and is now at least 150 feet deep. Probably there are drifts on one or more levels. The other workings were not visited.

Production: Undetermined.

References: Merrill, 1916, p. 525; Tucker and Sampson, 1929, p. 469.

J.R.E. 3/10/60.

Big Horn Group

Location: Secs. 32 and 33 (proj.), T. 3 S., R. 20 E., S.B.M.; Midland quadrangle, 1952; in the Little Maria Mountains about 12 miles, by road, northwest of Inca Siding.

Ownership: Undetermined.

History: In 1929 the property was held by E. E. Schellenger, Blythe. It was idle then and appears to have been so since.

Geology: This deposit appears to comprise several sparsely mineralized shear zones as much as 30 feet wide which dip steeply to the north along a west-trending contact between granite and gneiss of the Precambrian Chuckwalla Complex. The granite is the hanging wall. The original ore mineral probably was chalcopyrite. Subsequent alteration left a residue of iron oxides and thin encrustations and stains of chrysocolla in fractures and cavities in the crushed and altered rocks. The lateral extent of mineralization was not determined but probably does not exceed 500 feet. Iron-oxide-stained quartz veins occur in scattered outcrops in the area, but they have not been explored.

Development: According to Tucker and Sampson (1929, p. 470), this property was developed by 4 shafts. Only 2 shafts and a prospect were seen in 1959. One 50-foot shaft, is near the old camp site, It is timbered and sheathed for 10 feet at the collar and is open and dry for the remaining 40 feet. The other shaft, is 300 to 400 feet to the southwest, It is about 30 feet deep. The collar timber is broken and caving is well advanced.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 469-470; 1945, p. 124.

R.B.S. 1/14/59

Cactus Hill Mine

Location: SE¼NW¼ sec. 17, T. 2 S., R. 5 E., S.B.M., Thousand Palms quadrangle, 1958; south flank of the Little San Bernardino Mountains in the east fork of Blind Canyon, 2½ miles north of Desert Hot Springs.

Ownership: Undetermined (1961).

History: Undetermined. Inactive.

Geology: Pre-Cretaceous gneiss (Chuckwalla complex) intruded by alaskite/aplite forming an irregularly shaped intrusive breccia mass with a maximum diameter of about 1,200 feet. This mass is cut by a northwest-trending fault, and a northwest-trending aplite dike. The mine dump contains dark brown sphalerite, galena, and a trace of scheelite under ultraviolet light (Proctor, 1958, p. 47, 142).

Development: A 20-foot adit located between the northwest-trending fault and dike.

Production: Undetermined.

References: Proctor, 1958, p. 47, 142.

C.H.G. 5/20/61.

Copper Point Mine

Location: Sec. 10, T. 2 S., R. 12 E. (proj.), S. B. M., Dale Lake quadrangle, 1956; Pinto Mountains about 3 1/2 miles south-southeast of New Dale (site) and three-fourths of a mile east of the Gold Crown mine (~~plate 3~~ figure 31).

Ownership: Undetermined.

History: Undetermined. Idle.

Geology: A ~~N~~ north 10° west-striking and 83° east-dipping fault cuts Mesozoic quartz monzonite. The fault is marked by coarsely crystalline quartz veins of undetermined extent which contain specularite, ankerite (?), secondary copper minerals, and possibly gold.

Development: An inclined shaft is sunk in the fault at least 50 feet. ~~There are~~ north-south drifts of undetermined length were driven at about the 30-foot level.

Production: Undetermined.

References: None.

J.R.E. 3/11/60

Eagle Nest (Badger-State Group, Crescent Group) Mine

Location: N½ sec. 30 (proj.), T. 4 S., R. 20 E., S.B.M., Midland quadrangle, 1952; at the head of a narrow, north-trending canyon on the east slope and at the north end of the McCoy Mountains, 10½ miles by road west of Inca Siding.

Ownership: Not determined (1959).

History: During World War II, W. B. Tucker of the State Division of Mines compiled a detailed report on the Eagle Nest mine for the U. S. Government because the operator had applied for an R.F.C. loan. The essentials of that report were printed in the subsequent Riverside County report (Tucker 1945, p. 124-125). Much of the following information is abstracted from that report.

These claims were formerly known as the Badger-State group and Crescent group. They were worked from 1907 to 1909 by E. E. Scheelenger and associates. The Ironwood Mining Company, Riverside, worked the mine from 1915 to 1917. From 1939 to 1945 the owners were Larry Coke, Hermo, and C. R. Combs, Los Angeles.

Photo 5

Geology: The Eagle Nest mine is in an area underlain by sheared and fine-grained faulted granitic rock of Paleozoic(?) age. Ore minerals occupy fissures and fractures as much as 6 inches wide along fault zones and in horses of country rock. They consist of chrysocolla and specular hematite associated with quartz and calcite. Although the faults strike and dip in a random pattern, mineralization appears to be roughly confined to an east-west trending zone about 1½ miles long and half a mile wide. The fault zones are as wide as 6 feet and the fracture pattern in some of the included horses of country rock suggests reverse movement.

Development: Tucker and Sampson's (1945) description of the Eagle Nest mine divides the development into two main areas referred to as the eastern and western workings, some thousands of feet apart (~~the figure of 9,750 feet given in that report is probably too high~~), the western workings being the most extensive, but the eastern having yielded the most ore. The eastern workings were visited in January of 1959. They explore several poorly exposed, en echelon shear zones as follows.

A westernmost crosscut adit was driven about 20 feet north through an east-west trending, 30° N. dipping shear zone as much as 5 feet wide. An 80-foot drift was then driven west and slightly northwest on the copper-bearing zone. At the junction of the adit and drift, a winze follows down the dip of the shear zone about 75 feet from which drifting and stoping opened a chamber roughly 50 feet wide. The 80-foot drift, (referred to above) having run out of ore, turns right to a N. 25° W. bearing and crosscuts barren rock for about 100 feet to another shear zone. A 150-foot drift was driven west on this shear zone which strikes N. 70° W. at the crosscut, N. 70° E. at the face of the drift, and dips 30° to 35° to the northeast and northwest respectively. Only small pockets of ore are exposed along this drift.

About 75 feet east of the west adit portal a 75-foot inclined shaft was sunk on the same shear zone penetrated by the west adit, and the two openings are connected along the surface exposure of the shear zone by a trench and shallow pits. Two short drifts were driven west from the shaft 20 and 35 feet from the collar.

Approximately 400 feet east and slightly upslope from the inclined shaft an adit was driven 100 feet north. At its portal, this adit cuts across a 6-foot mineralized shear zone which strikes N. 60° E., dips 20° NW. and is exposed for about 100 feet. Through its remaining length the adit is in barren rock except for a narrow quartz-calcite vein at the face.

According to Tucker and Sampson, the west workings comprise a 200-foot adit and a 40-foot raise which explore a group of parallel quartz-calcite veins as much as 12 inches wide. These workings were not visited (1959).

Production: During the period 1907 to 1909, 65 tons of selected ore was shipped which assayed 0.40 ounces of gold and 8 ounces of silver per ton and 23.42 percent copper. In 1916, six tons of selected ore were shipped which netted $107.16 per ton. As of 1945 ore valued at ~~a total of~~ $7,000 ~~(worth of ore)~~ had been shipped from the Eagle Nest mine (Tucker and Sampson, 1945, p. 124-125).

References: Aubury, 1908, p. 342-343; Merrill and Waring, 1919, p. 526; Tucker and Sampson, 1929, p. 470; 1945, p. 124-125.

R.B.S. 1/14/59.

Green Hornet

Location: NE¼ sec. 32, T. 7 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 1952; on the northeastern ridge of the Mule Mountains, about 12 airline miles southwest of Blythe.

Ownership: Walter Scott, et al., Blythe Nursery and Florist, 136 N. Broadway, Blythe (1958).

History: Not determined.

Geology: The country rock is sheared and fractured gneissic granite. The area is crossed by west-to northwest-trending quartz veins as wide as 3 feet, which dip steeply to the south. Though most of these veins appear to be barren, one, situated on the south side of a saddle in the northeast corner of section 32, contains local concentrations of copper minerals.

Precambrian

This vein is in a shear zone, as much as 50 feet wide, exposed for about a quarter of a mile. It trends N. 80° W., and dips 45° SW. The quartz vein material is mixed with coarse fragments of country rock and forms pods and stringers in the planes of shearing. The ore is a mixture of chrysocolla, malachite, and oxides of iron and manganese.

Development: Development consists of an adit and an inclined shaft. The adit extends south 20 ± 30 feet across the shear zone. The inclined shaft is roughly located 200 feet up a slope to the southwest. It is about 12 feet deep on the plane of the shearing.

Production: Undetermined.

References: None.

R.B.S. 4/7/58.

Homestake Group

Location: S 1/2 sec. 7 (proj.), N 1/2 sec. 18 (proj.), T. 4 S., R. 19 E., S.B.M., Palen Mountains quadrangle, 1952; on the east slope of the Palen Mountains about 5 miles west-northwest of the north end of the McCoy Mountains.

Ownership: Undetermined (1959).

History: This mine appears to have been idle since the late 1800's. It was reported to have yielded copper, gold, and silver (Aubury, 1908, p. 341-342), but no specific date of location or operation was found.

Geology: The rocks in the area of the Homestake Group are a succession of sediments, rich in volcanic debris, which have been metamorphosed, sheared, and locally mineralized. This is the McCoy Mountains Formation of Upper Paleozoic or Juriassic age (Miller, 1944).

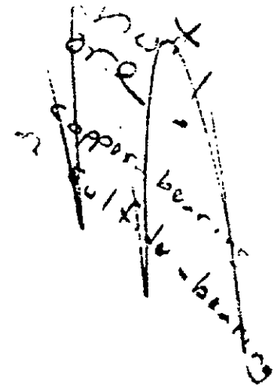
Photo 6

196

The mine is in a steep, west-trending canyon. The (A) unit ~~of~~ is fine-grained, greenish-gray, metatuff as much as 10 feet thick. It is irregularly exposed in the walls of the canyon and through a saddle at the head of the canyon. It strikes roughly west and dips about 30° N. Chrysocolla, malachite, and pyrite, associated with quartz and oxides of iron, fill a boxwork of fractures which is confined to a metatuff unit.

Development: The mineralized ore-bearing unit is explored by shallow prospect pits low on the north side of the canyon and the principal workings, a short adit, an inclined shaft, and several prospects high on the south side. The adit and the shaft are several hundred feet apart, ~~(on the mineralized unit)~~

The adit is the higher of the two main workings. It was driven S. 20° E. about 20 feet, passing through the plane of the ore unit and into a subjacent zone of barren, white, finely-milled fault gouge. ~~It is in the latter material through most of~~ For the rest its length.



no PP

The inclined shaft has a slope length of about 50 feet. It was driven in the footwall and very little of the mineralized tuff appears to have been removed. It is inclined 30° through the ~~first~~ upper 35 feet of its length and steepens to about 40° for the ~~last~~ lower 15 feet.

no PP In addition, there are two shallow prospects on the west-facing slope beyond the saddle at the head of the canyon.

Production: Undetermined.

References: Aubury 1908, p. 341-342; Merrill and Waring, 1917, p. 526; Tucker and Sampson, 1929, p. 470-471.

R.B.S. 2/4/59.

Indian Copper Mine

Location: SW¼SE¼ sec. 18, T. 2 S., R. 5 E., S.B.M., Thousand Palms quadrangle, 1958; south flank of the Little San Bernardino Mountains on the west side of Blind Canyon, 2 miles north of Desert Hot Springs.

Ownership: Undetermined (1961).

History: Undetermined. Inactive.

Geology: ~~Pre-Cretaceous~~ migmatitic gneiss (Chuckwalla complex).

Development: A 50-foot vertical shaft.

Production: Undetermined.

References: Proctor, 1958, p. 142.

C.H.G. 5/20/61.

Little Mountain Claims (Lion's Den Claims)

Location: W 1/2 sec. 7 (proj.), T.4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 15', 1951; about 3 miles east of Midland Road and about 17 miles north of Blythe.

Ownership: California Limestone Products, Blythe (1959).

History: This property was prospected prior to 1945 and was then known as "Lion's Den Copper Claims", but as described at that time (Tucker and Sampson, 1945, p. 126) it apparently was mislocated about a mile to the southeast. It was idle then and appears to have remained so since.

Geology: The Little Mountain Claims are located on an isolated hill in an area underlain by metamorphic rocks, Maria Plutonic Complex of Paleozoic (?) age, which strike N. 10° W., dip 25° SW, Copper mineralization is largely confined to a contact zone as much as 30 feet wide, adjacent to the basic dikes. The copper minerals appear to be sparse coatings and fissure fillings of malachite and chrysocolla. Iron pyrite is present. The other gangue minerals are garnet, epidote, hornblende, calcite, iron oxides, quartz, and a fibrous amphibole.

and which are cut by dikes of granite pegmatite and fine-grained basic rock. The latter strike N 60°-70° W and dip 55°-65° NE.

Development: Development is on 2 levels. The lower level is an adit about 200 feet long driven N. 20° W., roughly along the strike of the country rock. It cuts several narrow dikes and mineralized fractures but exposes no appreciable ore body. The upper workings, about 150 feet up the slope above the adit portal, consist of an open cut, driven 15 feet north into the hillside, joined at its midpoint by a trench as much as 10 feet deep which extends 40 feet east across the slope, and a 20-foot shaft inclined 55° N., 15° W., located about 15 feet west of the cut. The cut crosses a basic dike which strikes N. 60° W. and dips 55° NE. The dike appears to reach a maximum thickness of about 3 feet. The trench cuts a similar dike as much as 2 feet wide striking N. 70° W., and dipping 65° NE. Though the dikes appear to be related to the mineralization they are barren. The cut, the trench, and the shaft are all in the mineralized zone but no strong concentration of ore minerals is exposed in them.

Production: Not determined.

References: Tucker and Sampson, 1945, California Jour. Mines and Geol., vol. 41, no. 3, p. 126; Eric, John H., 1948, in California Div. Mines Bull. 144, p. 293.

R.B.S. 1/12/59.

Nancy Mine

Location: Sec. 3? (proj.), T. 4 S., R. 13 E., S.B.M., Pinto Basin quadrangle, 15', 1943; Eagle Mountains, about 1 1/4 miles southwest of the Iron Chief Mine, and 10 miles northeast of the East Pinto Basin-West Pinto Basin-Cottonwood Pass and Black Eagle mine roads intersection.

Ownership: Kaiser Steel Corporation, P. O. Box 217, Fontana, owns 4 unpatented claims (March 1960).

History: George Lane, Mecca, owned 4 unpatented claims in 1929. At this time a 130-foot shaft was driven with drifts north and south on the 100-foot level.

Geology: Mesozoic (?) granite is cut by a north-trending and 72° west-dipping fault. Work is confined to a vein in the fault plane. It has an average width of 4 feet and contains malachite, azurite, chalcopyrite, gold, and silver, all in minor amounts (Tucker and Sampson, 1929, p. 471).

Development: Apparently little work has been done since 1939.

Production: Samples taken from ore on the dump are said to cary $8 in gold, 6 oz. of silver and 4 percent to 7 percent copper (Tucker and Sampson, 1929, p. 471).

References: Tucker and Sampson, 1929, p. 471; ~~Tucker and Sampson,~~ 1945, p. 126.

J.R.E. 3/17/60

Orphan Boy Mine

Location: SE 1/4 sec. 10, T. 3 S., R. 18 E., S.B.M., Palen Mountains quadrangle 15', 1952; at the west end of Palen Pass about 46 miles, by road, northwest of Blythe and 28 miles by road, northeast of Desert Center.

Ownership: Not determined (1959).

History: In 1908, the property was owned by P. W. McGrath, Los Angeles, who had done little more than discovery work (Aubury, 1908, p. 341).

Geology: The Orphan Boy mine is near the crest of a west-trending ridge composed of limestone of the Paleozoic (?) Maria Formation, underlain by gneiss. These rocks strike N. 45° W. across the ridge and dip about 10° NE. A vertical shear zone as wide as 50 feet strikes northwest across the ridge for a traceable distance of about 700 feet, parallel to the limestone-gneiss contact. In the geniss, shear planes are sparingly mineralized with chrysocolla, malachite, calcite, and oxides of iron in lenses and pods of fractured quartz ranging in width from 0 to 3 feet. Epidote is abundant where mineralization occurs in the limestone.

Development: The shear zone is explored by 2 shallow shafts, a short adit, and a prospect pit. The 2 shafts, one 5 feet deep, the other 10 feet deep, are high on the north slope of the ridge. They are about 30 feet apart and expose narrow mineralized zones near either side of the shear zone. The adit is on the south slope of the ridge and is driven 15 feet into an epidote-rich zone near the limestone-schist gneiss contact.

Production: Undetermined.

References: Aubury 1908, p. ~~341~~ 256; 1908, p. 341, Hopper, 1954, Fig. 3, Pl. 1.

R.B.S. 2/5/59.

St. John Mine

Location: Sec. 32 (proj.), T. 4 S., R. 20 E., S.B.M., Midland quadrangle, 15', 1952; about 9½ miles by road west of Inca Siding, in a narrow valley in the north end of the McCoy Mountains.

Ownership: Proof of labor was filed for 1958 by Hazel Fascio, 3650 Blackwelder, Los Angeles.

History: This property was first worked prior to 1916. By 1917 a 75-foot inclined shaft had been sunk (Merrill and Waring, 1917, p. 527). In 1929 and in 1945 the owner was reported to be R. L. Kennedy of Los Angeles (Tucker and Sampson, 1929, p. 471; 1945, p. 126).

Geology: The low ridge upon which the St. John Mine is located is underlain by schist and metaconglomerate which strike N. 75° E., and dip 75° SE. A shear zone, as much as 20 feet wide striking N. 5° W. and dipping 40° W., is exposed across the crest of the ridge. A boxwork of irregular quartz veins in the shear zone contains a high proportion of chrysocolla and malachite with minor hematite and quartz.

Development: The shear zone has been explored by means of a 75-foot shaft, inclined 25° S. 25° E., driven in the crest of the ridge. About 20 feet below the shaft collar a 15-foot winze descends to the southwest on the dip of the shearing. About 500 feet down the slope of the ridge to the southwest a 25-foot adit was driven S. 85° E. in barren rocks. This appears to have been used for storage.

Production: An undisclosed amount of ore containing 40 percent copper was shipped, probably prior to 1916 (Merrill and Waring, 1917, p. 527; Tucker and Sampson, 1945, p. 126).

References: Merrill and Waring, 1917, p. 527; Tucker and Sampson, 1929, p. 471; 1945, p. 126; Miller, 1944, p. 32-52; Eric, 1948, p. 294.

R.B.S. 1/14/59.

Feldspar and Silica

In the September, 1899 issue of the Mining and Scientific Press (vol. 79, no. 11, p. 289) there appeared the following statement, reprinted from the Riverside Press.

> "In Menifee Valley a paying industry has developed in the shipment of white quartz to Los Angeles, where it is ground and used in the manufacture of fire brick."

This "paying industry" was based upon the exploitation for silica and feldspar, of numerous, rather small pegmatite dikes contained in the rocks of the Southern California batholith. These deposits are exposed in an irregular area extending from Riverside, southeastward to the Lakeview Mountains, to Anza, and south to Elsinore.

The local market for feldspar dwindled in the mid-nineteen thirties when talc largely replaced its use in wall tile manufacture (Wright, 1957, p. 199). Silica is now more economically won from sand deposits such as those near Corona (see herein) and refractory manufacturers are resorting to more extensive and more easily mined bodies such as the exposures of the Eureka quartzite in Inyo County (Clark and Carlson, 1957, p. 464).

Photo 7

Brown Silica (Quartz) Deposit

Location: Sec. 35 (proj.), T. 4 S., R. 11 E., S.B.M., Hexie Mountains quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 3.5 miles north of Cottonwood Spring, and 0.6 mile west of the Cottonwood Pass road.

Ownership: Undetermined.

History: The property was originally operated in 1935 and apparently has been idle since that time. In 1945, the deposit was owned by E. M. Brown, Los Angeles (Tucker and Sampson, 1945, p. 163).

Geology: A tabular body of milky quartz is well exposed as a dip slope on the south side of a northwest-trending hill carved in the Mesozoic White Tank ~~quartz~~ monzonite (fig. 8 /). It is approximately 20 feet thick in an open cut. The quartz is massive, but thoroughly fractured, and coated with red-brown secondary iron oxides along planar zones of crushing. Along the margins of the body, the quartz is more transparent and smoky.

Figure 8

Development: A bench about 15 feet high and 130 feet long has been cut (hacked) in the milky quartz adjacent to its contact with the White Tank ~~quartz~~ monzonite ~~(Fig. 1-A)~~.

Production: In 1935, 300 tons of quartz (98.6% - iron free) was shipped to Gladding McBean Company, Los Angeles (Tucker and Sampson, 1945, p. 163).

References: Tucker and Sampson, 1945, p. 163.

J.R.E. 10/13/59.

Figure 83. Sketch maps showing the location (A) and geology (B) of the Brown Silica (quartz) deposit (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

BROWN SILICA (QUARTZ) DEPOSIT

B

3000

3050

Green basic dike

Aplite dike

Milky quartz

Quartz monzonite

Open cut

Road

West Pinto Basin Road

To Dale Mining District

To Black Eagle Mine

HEXIE MTS

ROAD

PASS

EAGLE MTS

WOD

COTTONWOOD

To Cottonwood Spring - 3½ ± Miles

A

0 264 528

Scale in Feet

0 ½ 1

Miles

By James R. Evans

October 1959

Feldspar - Silica

Bundy-Murrieta Deposit

Location: SE¼SE¼ sec. 17, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle, 7½', 1935; just northwest of the junction of Bundy Canyon Road and Murrieta Road about 10 miles south of Perris.

Ownership: Undetermined.

History: Undetermined.

Geology: A poorly exposed pegmatite dike as much as 15 feet wide cuts deeply weathered Mesozoic diorite. It strikes N. 25° E. and appears to be vertical. The outcrop is traceable for about 230 feet. The dike is composed of quartz and feldspar and minor proportions of biotite and allanite. The quartz forms what appears to be a continuous central zone in the dike surrounding irregular masses of feldspar as much as 3 feet in thickness. Some of the quartz and feldspar occur as graphic intergrowths but much of the material is quite pure. The feldspar appears to be microcline. The quartz is milky and massive. A few fragments of allanite crystals, found on the dump, are weakly radioactive.

Development: The dike was explored by a shaft about 30 feet deep which is partially caved.

Production: Undetermined.

References: None.

R.B.S. 9/21/59.

California Land and Mineral Co. (American Encaustic Tiling Co.) Deposits

Location: Secs. 4 and 5 (proj.), T. 7 S., R. 3 W., S.B.M., Murrieta quadrangle, 7½', 1953; in the northwest corner of the Temecula Land Grant, northwest of Antelope Road, and about 3 miles northeast of Murrieta.

Ownership: Undetermined.

History: In 1929, American Encaustic Tiling Company, 2030 E. 52d St., Los Angeles, was working deposits of feldspar and silica in an 800-acre tract, at the above location, under lease from California Land and Mineral Company (Tucker and Sampson, 1929, p. 502). Operations continued as late as 1931 (Sampson and Tucker, 1931, p. 421).

Geology: The area is underlain by Mesozoic plutonic rocks, that range from gabbro to diorite, which are cut by an undetermined number of roughly lenticular pegmatite bodies as much as 80 feet thick and several hundred feet ~~wide~~ in lateral extent. Four pegmatites were examined. One is in a low knoll in the NE¼ sec. 5, two are exposed on the north flank of a low ridge in the NW¼ sec. 4, and the fourth and largest body is just north of Antelope Road in the NE¼ sec. 4. ~~(On the quadrangle map, the first three deposits are shown as prospects and the last as a mine.)~~

In the ~~above order~~ the ~~first~~ pegmatite body in Sec. 5 is a~~n essentially~~ flat-lying mass with an exposed lateral extent of about 60 feet and thickness ranging from 0 to 20 feet. It consists of an unzoned mixture of quartz and feldspar. The two minerals are present as pure masses as much as 2 feet on a side and in coarse, graphic intergrowth.

Of the two pegmatite bodies exposed on the ridge in sec. 4, the one highest on the slope appears to be the larger. It is about 30 feet ~~in~~ thick~~nese~~ and is exposed through a horizontal distance of about 100 feet. This dikelike mass strikes N. 55° W. and is vertical. It comprises well-segregated masses of quartz and feldspar, the quartz appearing to be the more abundant. Quartz occupies the full width of the body in some exposures but is extensively fractured and iron stained. A mass of quartz-feldspar pegmatite is exposed in the walls of a trench, about 50 feet long and 10 feet deep, lower on the slope of the ridge but the ~~volume~~ dimensions and attitude of this mass were not determined.

The deposit near Antelope Road is exposed in the walls of a quarry, about 120 feet long and 60 feet wide which was flooded to within 8 feet of its rim (October, 1960). The feldspar and quartz lens was reported to be as much as 80 feet in thickness at one point in the quarry and as much as 250 feet in length. Quartz was said to be the principal constituent (Sampson and Tucker, 1931, p. 421). This lens strikes west and appears to be ~~essentially~~ vertical.

Development: The northwest deposit (in sec. 5) was developed through a 30-foot adit (now largely caved) driven west to the bottom of a glory hole about 40 feet long, 20 feet wide and 15 feet deep. In the north wall of the glory hole shallow galleries were driven several tens of feet in the quartz-feldspar body.

The larger mass in the ridge in ~~section~~ 4 was explored through an 80-foot adit (now caved) driven south to the bottom of a glory hole 40 feet deep and 60 feet in diameter.

The main quarry near Antelope Road was reported to have been ramified by crosscuts driven 40 feet north at the 60-foot level, from which were raises ran to the hanging wall where material was removed by top slicing, and by stopes extending 130 feet east from the quarry (Sampson and Tucker, 1931, p. 421).

Production: In 1929, feldspar was being shipped at the rate of 200 tons per month from this property and a cumulative total of about 30,000 tons was reported (Tucker and Sampson, 1929, p. 503). No figure was given for silica. In 1931, 250 tons per month of silica was being shipped but very little feldspar. The cumulative figure for feldspar at that date was 50,000 tons (Sampson and Tucker, 1931, p. 421).

References: Tucker and Sampson, 1929, p. 502-503; Sampson and Tucker, 1931, p. 421; Wright, 1950, p. 160; 1957, p. 196, 197

R.B.S. 10/21/60.

Coahuila Brave (Williamson) Mine

Location: NE¼ sec. 17, T. 7 S., R. 2 E.,S.B.M., Hemet quadrangle, 15', 1957; on the south slope of Coahuila Mountain, 7 miles west of Anza.

Ownership: C. E. Williamson estate (1958).

History: The Coahuila Brave mine was located in 1925. It comprised 5 claims totaling approximately 100 acres. The mine was worked for feldspar during the late twenties (Tucker and Sampson, 1929, p. 503-504).

Because of reduced local demand for feldspar this mine has been idle for many years. The Williamson family is still known in the area and have been intermittent occupants of a dwelling in a canyon below the mine.

Geology: The mine area is underlain by Pre-Cretaceous(?) gneissic rocks which are cut by a group of about 7 roughly parallel pegmatite dikes. The developed dike strikes N. 15° W. to N. 40° W. and dips from vertical to about 35° NE. It is unevenly exposed for half a mile up the southwest flank of a ridge which trends southeast from the main ridge of Coahuilla Mountain. This dike, probably a roughly lense-shaped body,

reaches a maximum width of 40 to 50 feet where exposed in the mine. It is composed of microcline, massive, gray- to rose quartz and prisms of black tourmaline as much as 4 inches in diameter. Graphic intergrowth of quartz and feldspar is common. The dike is roughly zoned, but the proportions of constituents differs in each exposure. The footwall side is composed of an intergrowth of black tourmaline, microcline, and quartz. Toward the middle of the dike the black tourmaline becomes sparse and quartz becomes more abundant. Quartz predominates along the hanging wall. The intergrowth of the constituent minerals would require considerable sorting to furnish a commercial product. The other dikes are of similar mineralogy but narrower and undeveloped.

Development: This deposit was explored by 2 open cuts about a quarter of a mile apart. The lower cut is about 30 feet wide and ~~as many~~ 30 feet long with a 12-foot face on the dike. Here the dike is about 40 feet wide, strikes N. 15° W., and is nearly vertical. The upper workings are cut northwest 100 feet into the side of the ridge along the strike of the dike. The dike is exposed along the southwest side of the cut and in the face, which is about 50 feet high. Here it is 40 to 50 feet thick, strikes N. 40° W. and dips 35° NE.

Production: According to information submitted by the owner in August of 1929, 28 railroad-car loads of feldspar had been shipped as of that date (Tucker and Sampson, 1929, p. 503-504). The mine was idle at the time. It was stated that some quartz had been sorted and shipped.

References: Tucker and Sampson, 1929, p. 503-504.

R.B.S. 6/24/58

Hemet Silica Deposit

Location: SW¼NW¼ sec. 26, T. 5 S., R. 1 W., S.B.M., Hemet quadrangle, 7½', 1953; on the west slope of Hemet Butte about 2 miles south of Hemet.

Ownership: James L. Pool, 1048 Norumbega Drive, Monrovia.

History: Tucker and Sampson (1929, p. 504-505) ~~give~~ list the Hemet Silica Company as the earliest reported operator, followed by San Jacinto Rock Products Company who held it ~~at that time~~ in 1929. The property apparently has been idle for many years. The present owner purchased the land from James Schideler, 609 E. Central, Hemet.

Geology: Hemet Butte is composed of deeply weathered Mesozoic granitic rock. About half way up its west slope a dike is exposed which is as much as 40 feet wide. It strikes N. 25° W., dips 70° SW. and is traceable for about 1,000 feet. The dike ends abruptly at its northwestmost exposure where it attains its maximum thickness. It tapers gradually to the southeast. It is composed primarily of massive quartz, but there are local concentrations of biotite and feldspar. Tucker and Sampson reported (1929, p. 504) that the silica ~~is second-grade because of its~~ has an objectionably high iron content.

Development: Development consists of an open pit about 60 feet wide, 100 feet long, and 40 feet deep; and an adit which enters the slope about 50 vertical feet below the pit and is driven N. 60° E. 100 feet to a point on the footwall of the dike just below the pit. In addition, the southwest wall of the pit is breached by a narrow cut which apparently afforded access.

Production: Undetermined. ~~Idle.~~

References: Tucker and Sampson, 1929, p. 504-505; Sampson and Tucker, 1931, p. 443.

R.B.S. 7/23/58.

Lang Silica Deposit

Location: S½NW¼ sec. 7, T. 8 S., R. 2 E., S.B.M., Aguanga quadrangle, 7½', 1954; on the south side of a low bouldery ridge and about 1,000 feet south of Coahuila Road approximately 4½ miles northeast of Aguanga.

Ownership: Undetermined (1958).

History: The property was described briefly by Tucker and Sampson (1929, p. 505). The owner in 1929 was J. S. Lang, Aguanga.

Geology: The deposit is a poorly exposed pegmatite dike surrounded by deeply weathered Mesozoic granitic rock. The dike strikes N. 20° W., is vertical and is 10 to 30 feet thick. Its outcrops for about 200 feet. It is composed of a coarse intergrowth of feldspar and milky quartz with scattered biotite crystals. The feldspar was reported to be 10 to 11 percent K_2O and the silica of good grade (Tucker and Sampson, 1929, p. 505).

Development: The dike has been opened by two open pits; one 20 feet wide, 40 feet long and 12 feet deep, the other, about 50 feet southeast, is 6 feet wide, 12 feet long and about 5 feet deep.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 505; Sampson and Tucker, 1931, p. 423.

R.B.S. 7/24/58.

Nettleton Deposit

This report is based largely on information contained in a recently published description by Engel, Gay and Rogers (1959, p. 99-100).

Location: Sec. 14, T. 6 S., R. 4 W., S.B.M., U. S. Army Corps of Engineers Lake Elsinore quadrangle, 15', 1942; on the north and east side of a prominent hill about 4 miles southeast of Elsinore and about 1 2/3 miles south of Railroad Canyon dam.

Ownership: M. G. Nettleton, Temecula, holds patent.

History: The deposit has been inactive since about 1930 when an undetermined tonnage of quartz was quarried for unspecified purposes.

Geology: A body of aplitic and pegmatitic leucogranitic rock within granodiorite of probable Mesozoic age contains pods of milk-white quartz, and an uncutlined mass of quartz-sericite rock.

The quartz occurs as an irregular vein-like body, or bodies, in a discontinuously exposed zone that strikes about N. 45° E. and dips steeply southeastward to vertical. As exposed in workings near the top of the hill the zone is 20 to 30 feet wide and at least 300 feet long. Adits several hundred feet farther northwest may reach extensions of the zone underground but quartz is not exposed on the surface. Exposures indicate that individual lenses or pods in the zone are as large as 6 feet wide and 15 feet long, although larger masses may have been removed.

The quartz-bearing zone is much shattered and sheared. Bodies of pure quartz are separated by impure gougy material containing ground quartz, feldspar, mica, chlorite, and iron oxides. Small segregations of muscovite cyrstals, some nearly a half inch across, and a few thin quartz-orthoclase-muscovite veins are present. The quartz zone is faulted cleanly against leucogranite to the south. The fault strikes N. 35° E. and dips 60° NW.

About 300 yards eastward on the same hill a body of soft, fine-grained, quartz-sericite rock occurs, also within deeply weathered leucogranitic rock. As exposed underground, the quartz-sericite rock appears to be mainly confined to a 15-foot wide belt associated with a fault zone that trends N. 15° E. and dips 75° NW.

Development: The main opening is a large sidehill open cut at the southwestern end of the exposure near the top of the hill. This pit is about 30 feet wide and 50 feet long, with a face as high as 40 feet. It was mined in part as a glory hole. An irregular inclined opening, about 8 by 10 feet in plan, leads from the quarry floor through the quartz-bearing zone 50 feet down to a 100-foot haulage adit. A cable-drawn rail tramway was used to move the quartz about 150 yards down the hill to a loading point. Caved portals and substantial dumps at the loading point indicate level workings of undetermined length or purpose.

The eastern quartz-sericite body is explored by a 100-foot crosscut adit driven N. 55° W. through the shattered zone with a 40-foot winze 75 feet from the portal. A 15-foot caved pit exposes the quartz-muscovite rock 50 feet uphill from the adit portal. No stoping was done.

Production: Undetermined.

References: Engel, Gay and Rogers and others, 1959, p. 99-100.

Perris Mining Co. (Blom Mine) Deposit

Location: SE¼SW¼ sec. 16, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle 7½', 1953; just north of Bundy Canyon Road, half a mile west of Murrieta Road.

Ownership: J. B. "Tall" Turley, P.O. Box 608, Perris.

History: According to the present owner this mine is known locally as the old Blom Mine. It was worked, from the World War I period to about 1929, by Ollie Blom. The product was trucked to the Ellis railroad siding near Perris for shipment to Washington Iron Works in Los Angeles for use in the manufacture of porcelain and tile.

Geology: The weathered, Mesozoic diorite country rock is cut by a quartz-feldspar pegmatite dike as much as 30 feet wide, which strikes N. 65° E. and dips 40° SE. The dike is exposed for roughly 100 feet on the north slope of a low knoll.

Massive quartz makes up most of the deposit. Feldspar however, is reported to occur in masses as much as 20 feet in thickness (Tucker and Sampson, 1929, p. 506).

Development: When visited in 1959 the mine was flooded. Consequently, the following description is drawn from Tucker and Sampson (1929, p. 506).

The dike was explored by an inclined shaft driven S. 15° E. for a slope distance of 150 feet. An 80-foot shaft was sunk 50 feet west of the inclined shaft and the two are connected at the 50-foot level by a stope which is open to the surface. A 50-foot drift was driven northwest at the 75-foot level of the inclined shaft. In the face of an open cut about 15 feet deep, 50 feet west of the vertical shaft, an exploratory adit was driven 500 feet east but nothing of value was found.

The products were milled and graded at the mine but the equipment has since been removed.

Production: Undetermined. ~~Idle (1959).~~ Reported to have exceeded 1,000 tons (Wright, 1950, p. 160).

References: Tucker and Sampson, 1929, p. 506; 1945, pl. 35; Sampson and Tucker, 1931, p. 424-425; Wright, 1950, p. 160; R.B.S. 9/22/59. 1957, p. 196, 197.

Southern Pacific Deposit

Location: NW 1/4 of NE 1/4 sec. 31, T. 4 S., R. 2 W., S.B.M., Lakeview quadrangle, 7 1/2', 1953; about 1 1/2 miles southeast of Nuevo.

Ownership: International Pipe and Ceramics Corporation, 2901 Los Feliz, Los Angeles.

History: This quarry was worked for feldspar and silica, during 1916, 1917, and 1918, by the West Coast Tile Company, apparently under lease from the Southern Pacific Company. At an unspecified later date, Southern Pacific sold the property to American Encaustic Tiling Company who worked it for an unreported period (Tucker and Sampson, 1929, p. 503). In 1929, the property was reported (Tucker and Sampson, p. 503) as "formerly operated" by the latter company and "presumably exhausted".

Geology: A funnel-shaped mass of quartz-feldspar rich pegmatite is exposed in an area 130 feet long and 110 feet wide in Mesozoic quartz-hornblende diorite. The long dimension ~~strikes~~ trends N. 40° E. This deposit comprises three distinct, roughly-concentric zones. The outer zone is composed of quartz and feldspar intergrown to a considerable extent as graphic granite. On the southeast side of the quarry, the outer zone contains groups of radiating lath-shaped biotite crystals; individual clusters 20 inches in diameter.

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are common. The intermediate zone is a coarse-grained mixture of quartz, feldspar and black tourmaline. The feldspar was reported to contain 11 percent potash (Tucker and Sampson, 1929, p. 503). The central zone, composed of massive quartz, is now largely removed, the remaining portion being the apex of what was once a cone-shaped mass.

Development: In developing this deposit advantage was taken of its position in the crest of a low ridge. The quartz-feldspar body was explored by an open pit about 40 feet deep and roughly 100 feet in diameter. Additional access was by means of 3 cuts and 2 short adits in the surrounding slopes. (Fig. [redacted])

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 503; Jahns, [redacted], 1954, p. 42, fig. 7.

R.B.S. 10/22/58

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Tully Deposit

Location: E½ sec. 32, T. 4 S., R. 2 W., S.B.M., Lakeview quadrangle, 7.5' 1953; about 3 miles southeast of Nuevo and northwest of Juniper Flat.

Ownership: Undetermined, 1958.

History: This deposit probably was worked in the 1920's. By 1929, the mine was idle (Tucker and Sampson, 1929, p. 507) and appears to have remained so since.

Geology: Several north- to northwest-trending pegmatite dikes in Mesozoic diorite are exposed along low knolls and ridges ~~of diorite~~. The dikes which were mined are confined to the NE¼ of the section. These deposits appear to be as much as 30 feet wide but their boundaries are obscured by brush and ~~regolith~~ soil. To the southwest, in the NW¼ SE¼ of the section a north-trending, westward-dipping dike as much as 30 feet wide is exposed for about 1,000 feet. Black tourmaline and garnets are common in this body.

Development: The northeast dikes were explored by shallow pits and trenches along the outcrop. The southwest dike was opened by 2 small prospect pits. ~~but apparently was not seriously mined.~~

Production: By 1929 this deposit had yielded at least 2,500 tons of feldspar which was shipped to Riverside Portland Cement Company. (Tucker and Sampson, 1929, p. 507). ~~Idle.~~

References: Tucker and Sampson, 1929, p. 507; 1931, Sampson and Tucker, p. 425; 1945, pl. 35; Sampson, R. J., 1935, p. 521; Wright, 1950, p. 160; R.B.S. 10/21/58. 1957, p. 196, 197.

White Prince (Yellow Queen) Deposit

~~Gavilan Deposit~~

Location: NE¼ SW¼ sec. 25, T. 4 S., R. 5 W., S.B.M., Steel Peak quadrangle 7.5; 1953. The deposit forms a low knoll on the north side of Santa Rosa Road.

Ownership: Undetermined.

History: Undetermined.

Geology: A body of quartz-feldspar pegmatite, lenticular in plan and as much as 60 feet wide, is exposed for a horizontal distance of 100 feet. It strikes N. 15° W. and dips 40° SW. The country rock is Mesozoic diorite. Translucent, massive quartz and contained irregular masses of microcline comprise most of the dike. The body also contains sparsely distributed crystals of biotite mica as well as local concentrations of a friable, black mineral. The dike has been sheared. The quartz appears to have been more affected than the feldspar, and the resulting zones of fractures are iron stained.

Development: The deposit has been opened by a single open cut which breaches the northwest slope of the knoll and occupies most of the outcrop area.

Production: Undetermined. ~~Idle (1959)~~.

References: None.

R.B.S. 9/24/59.

Fluorite

~~Optical Fluorite~~

An unspecified quantity of fluorite from the Fluorspar group (see below) was marketed in 1922 for optical purposes (Tucker and Sampson, 1945, pl. 23).

~~Fluorspar~~

Subsequent production of fluorspar (the commercial name for fluorite) for chemical and metallurgical use, was from the Red Bluff deposit in 1944 and the Orocopia deposit in 1955 (see below).

Fluorspar Group

Location: NW 1/4 sec. 10, T. 3 S., R. 18 E., S.B.M., Palen Mountains quadrangle, 15', 1952; at the west end of the Palen Pass about 28 miles by road northeast of Desert Center.

Ownership: Undetermined (1959).

History: In 1908, the Fluorspar Group was mentioned as a copper prospect and the presence of gold, silver, and fluorspar were noted by Aubury (1908, p. 343). This property was mentioned in several subsequent reports, and though ownership changed, it was always reported and continues to be idle (March, 1959).

Geology: A mineralized shear zone is exposed on the southeast flank of a ridge underlain by greenish-gray to brown-weathering Pre-Cretaceous gneiss. The somewhat folded plane of the shear strikes roughly N. 50° W., and dips 35° NE. Exposures are good over an area about 50 feet wide and 300 feet long, but the full extent of the deposit is not evident. Fluorite is the most obvious mineral of potential value. It occurs as seams and veins as much as one foot in thickness. It is colorless to pale lavender when pure, but is generally colored by films and crusts of iron and manganese oxides, malachite, and chrysocolla, which occur in fractures and along cleavage planes. Some calcite is present, but quartz is more abundant.

Development: The deposit has been explored by several shallow prospects and trenches. ~~It is reached by means of a rough trail from the old camp site about a quarter of a mile to the west~~ near the east edge of sec. 9. Near the west end of ~~the~~ a trail several small stockpiles of mined rock still remain. An attempt apparently had been made to separate 3 products; fluorite-rich rock, copper-rich rock, and material heavy with iron oxides ~~presumably containing gold.~~

Production: In the years 1917 and 1918 an unstated quantity of fluorite was taken from this deposit for optical purposes (Murdoch and Webb, 1956, p. 158). In 1922, records show that optical fluorite again was produced in Riverside County, presumably from this deposit (Tucker and Sampson, 1945, pl. 23).

References: Aubury 1905, p. 258; 1908, p. 343; Merrill and Waring, 1917, p. 526; Tucker and Sampson, 1929, p. 470; 1945, p. 164, pls. 23, 35; Crosby and Hoffman, 1951, p. 632-633.

R.B.S. 3/11/59.

Orocopia Fluorspar Claim

The following report is drawn from work by Charles W. Chesterman of the Division of Mines and Geology.

Location: Sec. 25, T. 6 S., R. 12 E. (proj.), S.B.M., ~~U. S. Army Corps of Engineers, Canyon Spring~~ Hayfield) quadrangle, 15', 1944; on a low range of hills in the Orocopia Mountains about 3½ miles southeast of Shaver Summit.

Ownership: 7 claims, of which 3½ are owned by Fluorspar Mining Company, Kenneth Holmes, president, Winterhaven, California, and 3½ claims leased from J. Strum and John Bock, Coachella, California (1955).

History: The deposit is reported to have been discovered and worked in 1955 (Chesterman, 1957, p. 202) but appeared to be idle in 1960.

Geology: The fluorspar occurs as veins in shear and breccia zones in Cretaceous quartz monzonite. The quartz monzonite (~~field identification~~) is coarse grained, medium gray, and underlies much of the area claimed. It is well jointed and, at several places, is cut by dike-like bodies and irregular masses of massive, white quartz.

Figure 9

The fluospar veins, of which at least 10 have been prospected, are more or less parallel, and strike N. 45° E. and dip 75° to 80° SE. The veins range in width from a few inches to 6 feet. Individual veins pinch and swell along their strike. The largest vein has been prospected sporadically along a strike distance of about 500 feet.

The wall rock adjacent to the fluorspar veins consists of brown, silicified, brecciated quartz monzonite. The width of the silicified breccia ranges from a few inches on the narrow veins to several feet along the wider veins.

Fluorite (CaF_2) is the ore mineral. It is white to light gray in color, rarely pale purple, and occurs as crystalline aggregates of medium sized crystals (1/8 to 1/4 inch across) or as finely crystalline masses showing colloform banding and minor brecciation. Impurities appear to consist of silica (Quartz and chalcedony) and calcite. An analysis of mine-run ore gave the following:

CaF_2 = 91.7 percent

SiO_2 = 5.9 percent

CaO = .2 percent

CO_2+H_2O = 2.2 percent

An analysis of a hand picked sample of the fluorspar shows the following:

CaF_2 = 97.83

SiO_2 = 0.93

CaO = 0.65

Development: Development consists of trenching and shaft sinking on the large vein. Figure 9/ shows some of the work that had been done prior to the first of June, 1955. The trench is along the vein, averages about 6 feet wide, is about 150 feet long, and has a maximum depth of about 15 feet.

A shaft had been started at about the mid-point of the trench and had reached a depth of 15 feet.

Production: One carload of about 50 tons of fluorspar was shipped in the late spring of 1955 to Kaiser iron mine in the Eagle Mountains. The fluorspar in the mine run state is considered metallurgical grade and was to be used at the Fontana blast furnaces of the Kaiser Company.

Reserves of at least 5,000 short tons of fluorspar were estimated (1955) on the assumption that the large vein extends to a depth equal to one-third its outcrop length.

References: Chesterman, 1955, unpublished report; 1957, p. 202.

C.W.C.

Red Bluff Deposit

Location: SW¼ sec. 24 (proj.), T. 3 S., R. 20 E., S.B.M., Midland quadrangle, 15', 1952; about 3 miles northwest of Midland.

Ownership: Undetermined.

History: In 1945, the Red Bluff deposit was reported to be owned by Tom Ashby, et al., Rice, California who leased the property to N. A. Anderson, Pasadena, California, and Roy Cornell, Los Angeles. The mine was active in 1944 (Tucker and Sampson, 1945, p. 165, pl.29).

Geology: This deposit is exposed on the west slope of a group of low rounded hills composed of flaggy, Pre-Cretaceous quartzite, gneissic quartzite, and gneiss cut by numerous quartz-feldspar pegmatite dikes. Colorless, crystalline fluorspar is concentrated along 2 roughly-parallel faults one of which is exposed for about 100 feet on a low spur near the south end of the hills; the other is 1500 to 1800 feet to the north where it extends along the side of a wash and up the side of a low ridge for a distance of about 400 feet. The south fault strikes N. 50° W. and dips 70° NE. It contains a vein as much as 2 feet wide of fluorite mixed with country rock. The north fault is filled with a breccia of country rock, as much as 4 feet wide, which carries fluorite and traces of ~~manganese~~ iron oxides. It strikes N. 75° W. and dips 75° NE.

Development: The south fault is explored by a 40-foot vertical shaft, ~~the collar of which is timbered and sheathed and above which an old head frame still stands.~~ About 75 feet southeast of the shaft the fluorite vein is exposed in a 10-foot pit.

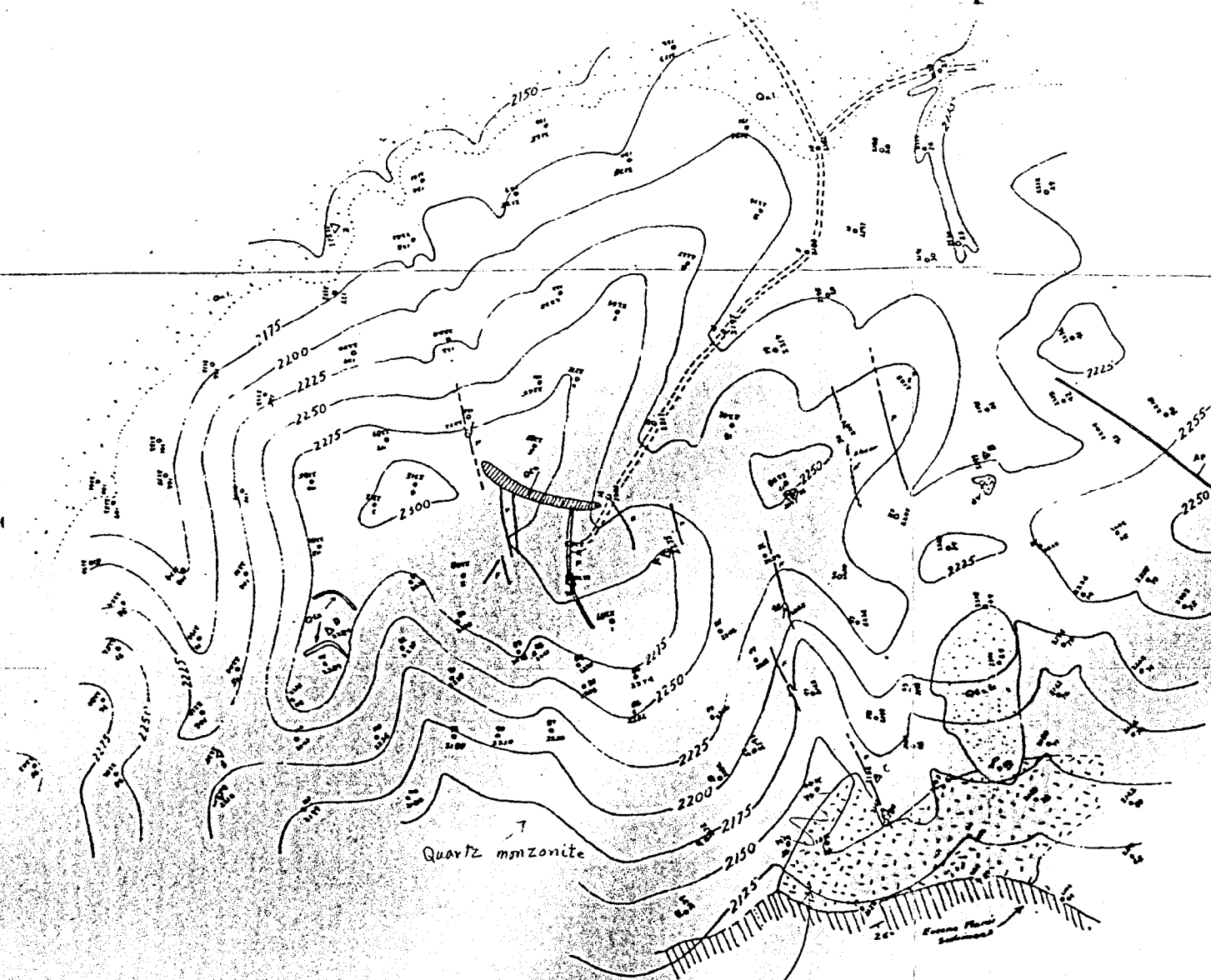
The north fault ~~was entered through~~ is developed by 2 steeply-inclined shafts, 2 trenches, and several prospect pits. One of the shafts is near the wash on the north side of a ravine. ~~It is~~ about 25 feet deep ~~and has a timbered collar and head frame~~. The other shaft is 50 to 60 feet deep and about 260 feet to the northwest, on the slope of the hill. ~~It is 50 to 70 feet deep and has a timbered collar.~~ The 2 trenches lie between the shafts. One is about 10 feet southeast of the west shaft and is small and shallow. The other is about 90 feet northwest of the east shaft. It is 50 feet long and has a maximum depth of 6 feet (Tucker and Sampson, 1945, pl. 29).

Production: During 1944, one hundred and thirty tons of fluorspar were shipped to the National Supply Company, Torrance, California; analysis 87 percent CaF_2, 4 percent SiO_2, 0.47 percent CaO, 2.25 percent Al_2O_3, 0.15 percent Fe_2O_3 (Tucker and Sampson, 1945, p. 165).

References: Tucker and Sampson, 1945, p. 165.

R.B.S. 2/3/59.

Figure 9



Label features —

F = fault

Qtz = Quartz

Ap = Aplite

plus 1 quartz monzonite - delete

OROCOPIA FLUORSPAR

Orocopia Mountains Riverside County

C.W. Chesterman & H.B. Goldman, Jan. 1957

Scale 1 inch = 200 feet Datum Assumed

Feet

True North

Magnetic North

16° 45'

GEMS

Historic accounts of gem mining in California generally stress the discovery of the gem-bearing pegmatite dikes of Riverside and San Diego counties. Colored tourmaline of gem quality was ~~first~~ discovered as early as 1872 on the southeast slope of Thomas Mountain in Southwestern Riverside County (Kunz, 1905, p. 122-123; see Belo Horizonte claim herein). This and subsequent discoveries in the Little Coahuila Mountain area northwest of Anza were mined on a small scale during the late 1800's and early 1900's (Sperisen, 1938, p. 35). The systematic search for gems in these deposits revealed the presence of additional varieties, the most important of which were beryl and kunzite. Gem-bearing pegmatite dikes, much richer, more numerous, and extensive, were discovered in neighboring areas of San Diego County shortly after the opening of the Riverside County deposits. The ~~more southern mines~~ new discoveries soon eclipsed those in Riverside County. However, gem-quality tourmaline, beryl, and kunzite may yet be found by diligent search in the pegmatite dikes of the Little Coahuila Mountain area.

Polished psilomelane is ~~currently in vogue~~ a popular. An abundance of hard, manganese oxides is obtainable from the numerous manganese mines and prospects in the Blythe area (see herein under manganese).

The quartz family minerals, agate, chalcedony, and jasper occur in areas underlain by Tertiary volcanic rocks on the south flank of the Little Chuckwalla and Mule Mountains. The bulk of this material is found as float in the form of nodules, fragments, or water worn pebbles, however, in the Mule Mountains a variety of chalcedony called "fire agate" has, for several years, been mined on a small scale from fissure-fillings in volcanic rocks (see herein under Mule Mountains Fire Agate claims).

In 1960 a newly discovered deposit of nephrite jade was reported in the Eagle Mountains (see herein under Storm-Jade Mountain Nephrite).

Riverside County mineral production statistics for the years 1905 through 1913 show a total value of $7,250 in gems (Tucker and Sampson, 1945, pl. 23). For such gems as tourmaline, beryl, and kunzite this was probably the principal period of production. Since 1913 gem mining ~~and gathering~~ has been sporadic. Although an increasing variety of material is entering the market from Riverside County, until 1961, production statistics included gems in the unapportioned category. ~~The recent paucity of marketing data on gems may have been caused by the fact that in Riverside County, organized gem mining enterprises have been almost entirely replaced by individual mineral collectors and amateur lapidaries who collect for~~ In recent years have been the principal ~~dealers~~ producers of gem minerals in Riverside County.

Anita (Magee) Mine

Location: NW¼ sec. 22, T. 6 S., R. 1 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Hemet quadrangle, 15, 1957; on a north-facing slope opposite the northwest ridge of Red Mountain.

Ownership: Undetermined (1958).

History: According to Mr. Harry Bergman this mine was operated in the early 1900's. Mr. Bergman helped with the early development of this property when it was known as the Magee Mine (personal communication, Harry Bergman, ~~Oct. 20~~ Aguanga, 1958). ~~Idbe.~~

Geology: The Anita mine is at the north edge of a ~~quartz-diorite~~ underlain by mesozoic quartz-diorite. mesa. A pegmatite dike as much as 12 feet in thickness is exposed on a north-facing slope. The dike appears to be either a group of parallel and partially coalesced dikes or a single branching body. It strikes about N. 20° E., dips approximately 25° NW., and is exposed over an area 200 ~~feet~~ by 300 ~~feet~~ area.

Photo 8

Quartz and albite feldspar make up the bulk of the dike. Both form pure crystalline masses but most commonly occur as a graphic intergrowth. The rarer minerals include black, green, pink, and blue tourmaline; lepidolite, biotite mica, and garnet. The tourmaline commonly shows color zonation, some crystals changing from end to end; others are zoned concentric to their ~~c~~ axis. The small quantities of gem-quality material appear to be concentrated in lepidolite-rich zones and in pockets. Because of the confused and littered character of the exposure and the large quantities of material removed from the working, the structure of the dike was not determined. ~~It may be significant~~ ~~that~~ the main development is near the hanging wall of the dike.

Development: The principal workings radiate from an oval pit about 50 feet long and 30 feet wide. They comprise a stope, which extends about 50 feet up the dip of the dike from the south end of the pit, a drift adit about 100 feet long driven into the west side of the pit, and an inclined shaft of undetermined depth descending from the north end. In addition, several shallow pits and trenches were dug in the outcrop.

Production: As much as 10 pounds of clear gem tourmaline was taken from this deposit and several hundred pounds of fractured, pink tourmaline were shipped to China for carving (Harry Bergman, ~~Aguanga~~, personal communication).

References: Wright, 1957, p. 206.

R.B.S. 7/24/58.

Belo Horizonte (Columbia Gem Mine, California Gem Mine, April Fool Mine) Claim

Location: SW¼SW¼ sec. 1, T. 7 S., R. 3 E., S.B.M., Hemet Reservoir quadrangle, 15', 1940; on southeast ridge of Thomas Mountain just northeast of the point where a power line crosses Thomas Mountain Truck Trail.

Ownership: L. E. and L. R. Humiston, 52C Card St., China Lake.

History: ~~According to Dr. George F. Kunz~~ this ~~mine~~ is the oldest tourmaline mine in California (Kunz, 1905, p. 122-123). It was discovered in 1872 by a Mr. Hamilton and held, under the name Columbia Gem Mine, by H. C. Gordon, P. E. Johnson, and William Dyche but other parties are reported to have claimed it under the name April Fool Mine. In 1892, the claim was relocated by Frank H. Jackson, et al. under the name California Gem Mine. A patent was applied for by this interest but was rejected. They appear to have held the property until about 1917 (Merrill and Waring, 1917, p. 576-577; old mineral survey map). Long abandoned, the mine was relocated by the present owner in 1957.

Geology: The mine workings explore a pegmatite dike which appears to be one of several such dikes ~~which are~~ poorly exposed on both the north and south flanks of the ridge crest. Their general strike is N. 60° E. and their dip is near vertical. The dikes appear to pinch and swell, ranging from 0 to several tens of feet in thickness. In the mine area a dike underlies the crest of a ridge on the north slope. It is exposed for several hundred feet. Both the dike and the surrounding dioritic country rock are fractured. They are probably of Mesozoic age.

Quartz and feldspar are the chief dike minerals. The quartz is largely the clouded, crystalline type with local concentrations of the rose variety. The feldspar is mainly albite and microcline. A few fragments of pale-green amazonstone were found by the writer. Lesser quantities ~~proportions~~ of muscovite, biotite, and tourmaline are present. The tourmaline is primarily black but fragments of colored material were found, ranging through various shades of pink and green, and combinations of the two colors, in zones both concentric with the long axis and parallel to the base.

The dike does not appear to be strongly zoned but this might better be determined with deeper development.

Development: The dike was opened by means of an open pit about 40 feet long and 20 feet wide and an adit about 20 feet long was driven through its northeast wall. The pit is partially filled with debris, thus its depth was not determined. In addition the dike has been prospected by a shallow trench and pit about 100 feet down the ridge to the northeast.

The present owner is reopening the adit with the apparent intent of mucking out the pit in preparation for further development.

Production: In 1917 Waring wrote -- "it is said that $10,000 worth of gems were taken out about 1894. Some pink, green, and dark red tourmaline is said to have been taken out also. It is said that $300 worth of rose quartz has been taken out recently." (Merrill and Waring, 1917, p. 577).

Although rose quartz is present on the Belo Horizonte Claim, field observations suggest that most of the rose quartz mined in the area came from various shallow pits in pegmatites exposed about one-quarter mile distant on the south slope of the ridge in the northeast corner of Sec. 11. These pits may be reached by following the power-line fire break south from Thomas Mountain Truck Trail.

References: Kunz, 1905, p. 122-123; Merrill and Waring, 1917, p. 576-577.

R.B.S. 10/22/59.

Fano (Simmons) Mine

Location: E½ sec. 33, T. 6 S., R. 2 E., S.B.M., Hemet quadrangle, 1957; 1½ miles northwest of Tripp Flat Ranger Station on a ridge just north of Cahuila Mountain.

Ownership: Undetermined.

History: This mine originally comprised four claims located in 1902 and developed by Bert Simmons (Kunz, 1905, p. 28, 121-123). Subsequently it was owned by E. A. Fano, of San Diego who continued mining possibly as late as 1917 (Merrill and Waring, 1917, p. 576). By 1945, the property consisted of two patented claims owned by Clark and Campbell, Coahuila (Tucker and Sampson, 1945, p. 165). The property appears to have been long inactive.

Figure 10

Geology: The ridge included within the two Fano claims is underlain by mixed igneous and metamorphic rocks which trend northwest and dip steeply southwest. The former probably are of Mesozoic age, the latter Pre-Mesozoic. These rocks are cut by several tabular pegmatite dikes, the most extensive of which is exposed along the crest of the ridge through a lateral distance of about 1300 feet and is as much as 20 feet ~~in~~ thick~~ness~~ (~~fig~~. Photo 9/). The dikes strike N. 45° W. and dip 10° NE. The principal dike pinches and swells laterally and the proportion of the various constituent minerals changes along the strike so that in one exposure rose quartz is the principal constituent, whereas in another microcline and black tourmaline predominate. The dike has yielded such minerals as kunzite, variously colored tourmaline, beryl, lepidolite, and amblygonite. In addition, quartz crystals and possibly some mica were marketed (Merrill and Waring, 1917, p. 576). Two much thinner dikes underlie the southeasternmost exposure of the main dike. The three dikes are parallel and several tens of feet apart (~~fig.~~). As suggested in figure 10/, the trend of these dikes might persist for some distance to the southeast.

Photo 9

Development: The large dike was explored through 7 shallow prospect pits; 2 trenches 25 to 30 feet long; and an open-cut 60 feet long, 40 feet wide, and 10 feet deep. A crosscut adit 176 feet long was reportedly driven through the deposit (Merrill and Waring, 1917, p. 576). The open cut may mark the now caved portal. The two smaller dikes were opened by several prospect pits.

Production: In 1917 Merrill and Waring (p. 576) gave the following account:

"The output so far has been 25 pounds of kunzite, white; 1 pound of kunzite, pink; and 25 pounds of all classes of tourmaline, mostly blue and green; about 250 pounds of beryl have also been taken out but only 5% of it is available for gem purposes. Two hundred pounds of very fine quartz crystals also have been sold, and about a ton of lepidolite and 30 to 40 pounds of amblygonite; also flake mica has been discovered large enough for commercial purposes."

No subsequent record of production was found.

References: Kunz, 1905, p. 58, 121-123; Merrill and Waring, 1917, p. 576; Tucker and Sampson, 1929, p. 508; 1945, p. 165; Wright, 1957, p. 206.

R.B.S. 4/17/61.

Juan Diego #1

Location: NW¼ sec. 5, T. 7 S., R. 2 E., S.B.M., Hemet quadrangle, 15' 1957; on the northwest side of Juan Diego Flat and about 1½ miles northwest of the peak of Coahuila Mountain. (Figure 10)

Ownership: Undetermined.

History: Undetermined. The name Juan Diego #1 is here applied to this deposit for the sake of convenience.

Geology: A pegmatite dike as much as 20 feet in thickness is exposed for about 300 feet along the crest of a low ridge. It strikes N. 34° W., and dips about 45° SW. The country rock is deeply weathered gneiss of possible Mesozoic age.

The dike is composed of a coarse intergrowth of quartz and feldspar through which local pockets of undetermined average size containing garnet, muscovite, and green and black tourmaline are irregularly distributed.

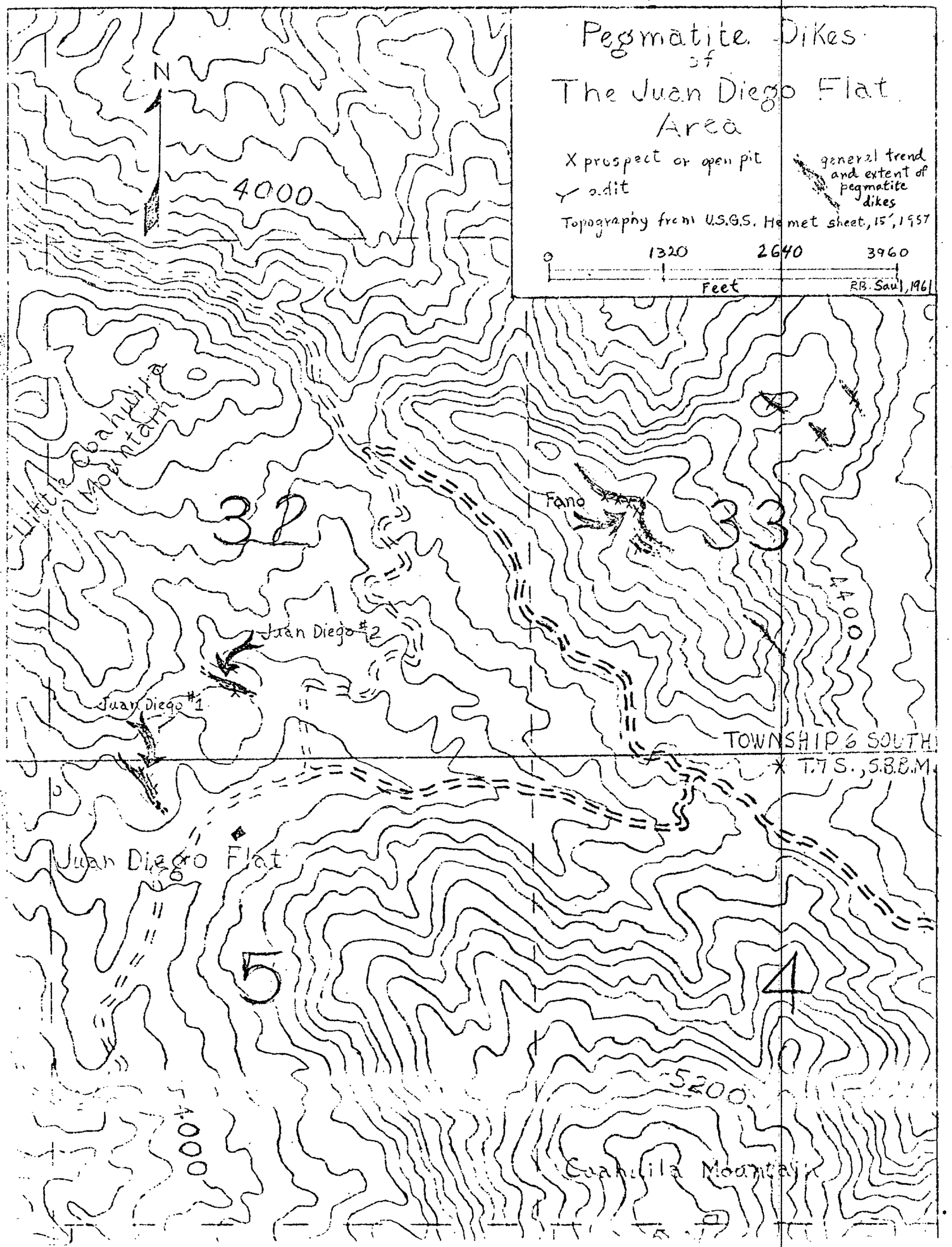
Development: Three shallow pits, grouped within 100 feet of each other, explore the dike high on the northeast slope of the ridge.

Production: Undetermined.

References: None.

R.B.S. 6/25/58.

Figure 10.


Pegmatite Dikes
of
The Juan Diego Flat
Area
X prospect or open pit
adit
general trend and extent of pegmatite dikes
Topography from U.S.G.S. Hemet sheet, 15', 1957
0
1320
2640
3960
Feet
R.B. Saul, 1961
N
4000
Little Coahuilla Mountain
32
33
Fano
4400
Juan Diego #2
Juan Diego #1
TOWNSHIP 6 SOUTH
T.7 S., S.B.B.M.
Juan Diego Flat
5
4
5200
4000
Coahuilla Mountain

Juan Diego #2 Deposit

Location: SW¼ sec. 32, T. 6 S., R. 2 E., S.B.M., Hemet quadrangle, 1957; about a quarter of a mile north of Juan Diego flat. (Figure 10)

Ownership: Undetermined.

History: Undetermined. The name Juan Diego #2 is here applied to this deposit for the sake of convenience.

Geology: A pegmatite dike 300 to 400 feet long, and about 10 feet thick crops out on the southwest side of a low ridge of gneissic, ~~metamorphic~~ of possible Mesozoic age rock. The dike is obscured by talus and heavy brush. It strikes N. 55° W., dips 30° NE., and consists mostly of graphically intergrown quartz and feldspar. Rose quartz is present in irregular masses. Black tourmaline crystals and clots of biotite (as much as an inch in diameter) are common.

Development: A thirty-foot drift adit is driven north at a point near the southeast end of the outcrop.

Production: Undetermined.

References: None.

R.B.S. 6/25/58.

Mule Mountain Fire Agate Claims

Location: Secs. 26, 27, 34, and 35 (proj.), T. 8 S., R. 20 E., S.B.M., Palo Verde Mountains quadrangle, 15', 1953; in an area which includes Coon Hollow, at the south end of the Mule Mountains, about 4 miles, by road, southeast of Wileys Well.

Ownership: Numerous markers indicate that many claims have been filed on at one time or another in the area. L. L. Fenn, Ramona, California, Ervine E. Spiers, et al., 123 N. Main St., Blythe, and O. F. Wright, P.O. Box 1062, Blythe, are among the current (1958) claim holders.

History: Undetermined.

Geology: ~~The rocks in~~ the area ~~are~~ is underlain by volcanic rocks of probably Tertiary age. The most common rock type is a red-brown rhyolite which is interbedded with tuffaceous agglomerate and dark, amygdaloidal, flows of dacite. The strike is roughly north; the dip is generally to the east.

Chalcedony occurs as cavity and fissure fillings throughout most of the area. White opaline silica is common as surface coatings on chalcedonic and crystal quartz surfaces. Some of the vein-filling chalcedony contains thin interlayerings of hematite. It is the latter material which is most sought by gem and mineral collectors and which has come to be known as fire agate because of the iridescence of the included hematite.

Development: Shallow pits and trenches have been dug on various claims. Such excavations generally have been on veins and fissures in rhyolite but much satisfactory material may be found in the alluvium derived from the gem-bearing area. When visited (November, 1958) four men were working in a pit on unclaimed ground south of Coon Hollow.

Production: Though gem material appears to have been obtained from this area for a number of years, the total yield is impossible to estimate accurately.

There appears to be a ready market for good material from this deposit but good specimens are sometimes hard to recognize in the rough. The finished gems command a fair price and good uncut material is in demand by amateur lapidaries.

References: None.

R.B.S. 11/18/58).

Olinger Deposit

Location: NW¼ sec. 1, T. 7 S., R. 2 E., S.B.M., ~~U.S. Army Corps of Engineers~~ Hemet Reservoir quadrangle, 15', 1940; on the east side of Tripp Flat about 3½ miles northwest of Anza.

Ownership: This deposit is on the ranch of A. P Olinger, Anza.

History: Undetermined.

Geology: This deposit consists of a granite pegmatite ~~dike which cuts~~ in the low ~~granitic~~ hills of Mesozoic granitic rock east of Tripp Flat. The dike is poorly exposed through a distance of about 500 feet ~~but is~~ being covered in many places by brush and soil. It strikes N. 65° W., dips about 20° NE., and appears to be as much as 30 feet ~~in~~ thickness. Its principal constituents are milky and rose quartz. Perhaps 30% of the dike ~~is~~ consists of orthoclase crystals intergrown with the quartz. Individual feldspar crystal faces reach a maximum length of 3 feet. (Photo 7) Black tourmaline crystals as much as an inch in diameter are present as a minor constituent ~~of the dike~~. The tourmaline and feldspar appear to be concentrated along the hanging wall ~~of the dike~~.

Development: The dike has been explored near the northwest end of its outcrop by two open pits about 300 feet apart. The principal material removed appears to have been rose quartz, an undetermined ~~volume~~ quantity of which remains in the deposit.

Production: Undetermined.

References: None.

R.B.S. 7/23/58

Schindler (Beryl Crystal, Silica-Beryl) Claims

Location: Sec. 29, 30, 32, 33, T. 6 S., R. 2 E., S.B.M., Hemet quadrangle, 1957; along the northeast slope of the ridge which extends northwest from the Tripp Flats area to Red Mountain, a distance of some five miles.

Ownership: Charles W. Schindler, P.O. Box 562, Hemet (1958) holds four unpatented lode claims.

History: This property was described in 1945 (Tucker and Sampson, p. 165). No earlier report was found, but considering the history of adjoining, patented property (see Fano mine herein) it is probable that these claims were prospected as early as the turn of the century.

Geology: The Schindler claims are in an area in which numerous, discontinuous pegmatite dikes, ranging in width from a fraction of an inch to as much as 30 feet, are exposed. Most of the dikes are roughly concordant with the northwest-striking structural grain of the enclosing mixed igneous and metamorphic (Mesozoic - Pre-Mesozoic?) country rocks. The dikes appear to be very poorly zoned where visible in the outcrop and in shallow workings. Quartz, feldspar, mica and black tourmaline comprise the principal dike-forming constituents. Presumably, beryl, pink and green tourmaline, rose quartz and columbite, reported from these claims, are present in local concentrations. The economic future of these deposits seems speculative, but the area should long remain of interest to gem and mineral collectors.

Development: Except for a 20-foot adit in a dike in the N½ sec. 30, the dikes exposed on these claims are explored only through shallow trenches and prospect pits.

Production: In 1945, 200 pounds of beryl, 10 pounds of pink and green tourmaline, 50 pounds of black tourmaline, 500 pounds of quartz crystals, and 100 pounds of rose quartz were reported to have been taken from these claims. No subsequent record was found.

References: Tucker and Sampson, 1945, p. 165, pl. 35.

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Storm-Jade Mountain Nephrite

Location: N½ Sec. 4, T. 4 S., R.13 E., (proj.), S.B.M., (~~U.S. Army Corps of Engineers, Eagle Tank~~ Pinto Basin) Quad., 15', 19~~6~~3; 7½ miles south-southeast of Mission Well near the Black Eagle Mine Road.

Ownership: Eleven unpatented mining claims are owned by Barry Storm, Chiriaco Summit, via Indio, California. (November 1961).

History: Prior to the discovery of nephrite on this property, a green epidote rock had been quarried from an open cut and sold as roofing granules (see Storm sulfide deposit, this report). The first occurrence of nephrite was noted in the middle of 1960-61 on No. 2 claim. Further prospecting disclosed the presence of additional nephrite bodies on adjacent property and this necessitated the staking of claims Nos. 3 through 10.

Geology: Nephrite occurs associated with magnetite, epidote, chlorite, and garnet in irregular contact metamorphic zones between Mesozoic quartz monzonite and dolomitic limestone of possible Paleozoic age. The quartz monzonite is light colored and contains dikes of a dark, dense basic rock. The dolomitic limestone is light bluish gray in color and locally it was converted to ophicalcite, a mottled buff and light greenish dense rock consisting of calcite marble and irregular masses and layers of serpentine. The purest grades of nephrite-bearing rock are dark olive green color and occur as lens like masses in the contact rock.

Development: Workings consist of several shallow prospect pits in places where the nephrite rock is best exposed.

Production: Undetermined.

References: None.

Gold

The earliest seemingly reliable account of gold discoveries in the southwest is that of placer deposits in the "Carga Muchacho" mining district in 1775 in what is now Imperial County (Hanks, 1884, p. 217-218). Although reports dating earlier than 1870 are scarce for the Riverside County area, it is safe to assume that prospecting and mining had been accomplished well before that date. Indeed, reference to prior Mexican development is encountered both in the literature and in the reminisences of older residents of the mining districts. The following quote from Merrill and Waring (1917, p. 527) will serve as an illustration. It refers to the Perris region.

"Miners who worked here 40 years ago say that, at that time, in Cottonwood Canyon, was an old arrastra bottom in which was growing an elder tree 12 inches in diameter. On Redtop Mountain, in T. 6 S., R. 3 W., was found a location notice dated 1857."

Photo 10

264

In 1893, when Riverside County was created, gold dominated its mineral industry. Reported production of the yellow metal reached an all-time high in 1895 with a value of $285,106 (@ $20.67 per ounce). As small as this figure is, when compared even with individual mines of the Mother Lode, gold remained the county's most valuable commodity until 1902 in which year it was exceeded by brick. Gold rose to a position of importance again during the 1930's depression when, in 1936, the total value was $216,125 (@ $35.00 per ounce). ~~The difference in price (which means that the 1895 figure represents a considerably greater weight of gold) is the result of an increase included in the gold reserve act of 1934 (Henderson, 1934, p. 30).~~ The total reported value of gold mined in Riverside County is $2,623,473.

Of the many gold mines in the county (pl. 1/) few are reported to have yielded more than 1,000 ounces although actual production may well exceed reported production, ~~for many mines because of confusion arising from~~ changing ownership ~~and the several different agencies,~~ private interests, ~~and individuals involved in marketing~~ the metal. The Good Hope mine, with a reported yield of as much as $2,000,000 in gold, appears to have been the most productive mine in Riverside County. Other mines such as the Brooklyn, Desert Queen, Gold Crown, Lost Horse, and Santa Rosa show good reports for some years but in general the gold mines of the county have been small operations, ~~where individuals or small groups of men have found subsistance.~~

Most of the gold mined in Riverside County has been obtained from quartz veins, or mineralized bodies of rock, lying in the planes of faults or less clearly defined shear zones in both granitic and metamorphic rocks. Most of the ore is free milling, the gold being associated with pyrite and chalcopyrite or the secondary iron and copper minerals resulting from their weathering. Deep weathering of the veins is common in the desert areas where water tables are generally low. Unaltered sulfides are, by the same token, generally encountered within one or two hundred feet of the surface in the Perris-Elsinore area. In both areas exceptions to this generality exist, but commonly, alteration of metal-bearing minerals has been facilitated because of fracturing of the vein material, during or following its deposition, by continued movement of the host rocks.

Placer gold has been mined in the Perris-Elsinore area (Merrill and Waring, 1917, p. 527) on land now largely ~~(inaccessible to mining because of~~ privately owned. ~~ownership.~~ Deposits of gold-bearing gravel occur in the Chuckwalla Spring area (see herein) and some of the areas in and about lode-mining districts have yielded some placer gold. ~~to the intelligent prospector.~~

In past years the greatest number of individual placer operations in the county were situated in the desert area of its eastern half but the largest single yield was the 1895 total of 2,176.87 ounces from the Briggs and Hancock holdings (location and extent not determined) in the Perris area.

Some individuals turned to placer mining during the 1930's and early 40's, but fortunes were meager for the reported total yield from all operations came to only 2,993 ounces of gold; just 816.13 ounces in excess of that yielded by the Briggs and Hancock holdings alone.

Mostly Gold

Figure 19.

MINERAL DEPOSITS OF THE GOLD PARK AREA, RIVERSIDE COUNTY

To Twentynine Palms

SAN BERNARDINO CO
RIVERSIDE CO

MUSIC VALLEY

JOSHUA TREE NATIONAL MONUMENT

UTILITY AREA

Gold Park

Boss Mine
North Star Mine
Atlanta Mine
Shannon Mine
Pinto Mine
Carlos Jr. Mine
Silver Spoon Mine
Hornet Group
Carlos Jr. Mine
Anaheim Mine
Adox Claims
Uranus 2
Uranus 4
Uranus 6
Smith Brothers #4 Claim
Nuisance Group
Thunderbird Group
Smith Brothers #1 Claim
Baby Blue Prospect
Hanson 2
Smith Brothers #8 Claim
U-Thor Deposit

3600 3200 3400 3800 4200 4000

34°00'

116°00'

Topography from U.S.G.S. Twentynine Palms (1955) and Valley Mtn. (1956) quads.

#3 Gold (Gold Park Consolidated) (#) Mine No.)

R* Rare-earths (* Denotes holdings of Peerless Nuclear Metals Inc.)

0 1/2 1
Scale in Miles

By James R. Evans, 1960

SAN BERNARDINO COUNTY

RIVERSIDE COUNTY

Approximate Mean Declination, 1956

15°

Gold Crown Road

Brooklyn Mine

Los Angeles Mine

Gold Standard Mine

Gold Rose Mine

Rose Of Peru Mine

Helicross Mine

Pinto Chief Mine

Oehl Mine

MONUMENT

Moose Mine

Goldenrod Mine

Stella Mine

Gold Crown Mine

Copper Point Mine

Anderson (Hope) Mine

Meek Mine

Desert King Mine

Rusty Gold Mine

Schaffers Camp

Gold Crown Mine

Pinto Mine

Standard Mine

Duplex Mine

Dendrite Deposit

North Star (Sunset) Mine

Mission Mine

Golden Egg Mine

Louise Mine

Sabothy Camp

Frank Hill (Star) Mine

Dalton Mine

Sinock Mine

Unknown Mine

Trail

Sunrise Mine

To Zuki Queen and Outlaw mines

JOSHUA TREE NATIONAL

Sunrise (Mission) Mills

Qvb

BASIN ROAD

To Zulu Queen and Outlaw mines

Gold Rose - Los Angeles - Brooklyn Mines Mill

Mission Well (Huff - Lane)

Sunrise Well

Gold Rose Well

To Mystery (Mirtry) Mine

PINTO MOUNTAIN

△ 3982

EAST PINTO

PINTO BASIN

Qoal

qm

ms

di

Qvb

2884

2983

3182

2848

2534

2861

1958

2108

2030

3590

2500±

2000

1500

By James R. Evans
~~1960~~ (Geology modified from an anonymous source)
1960

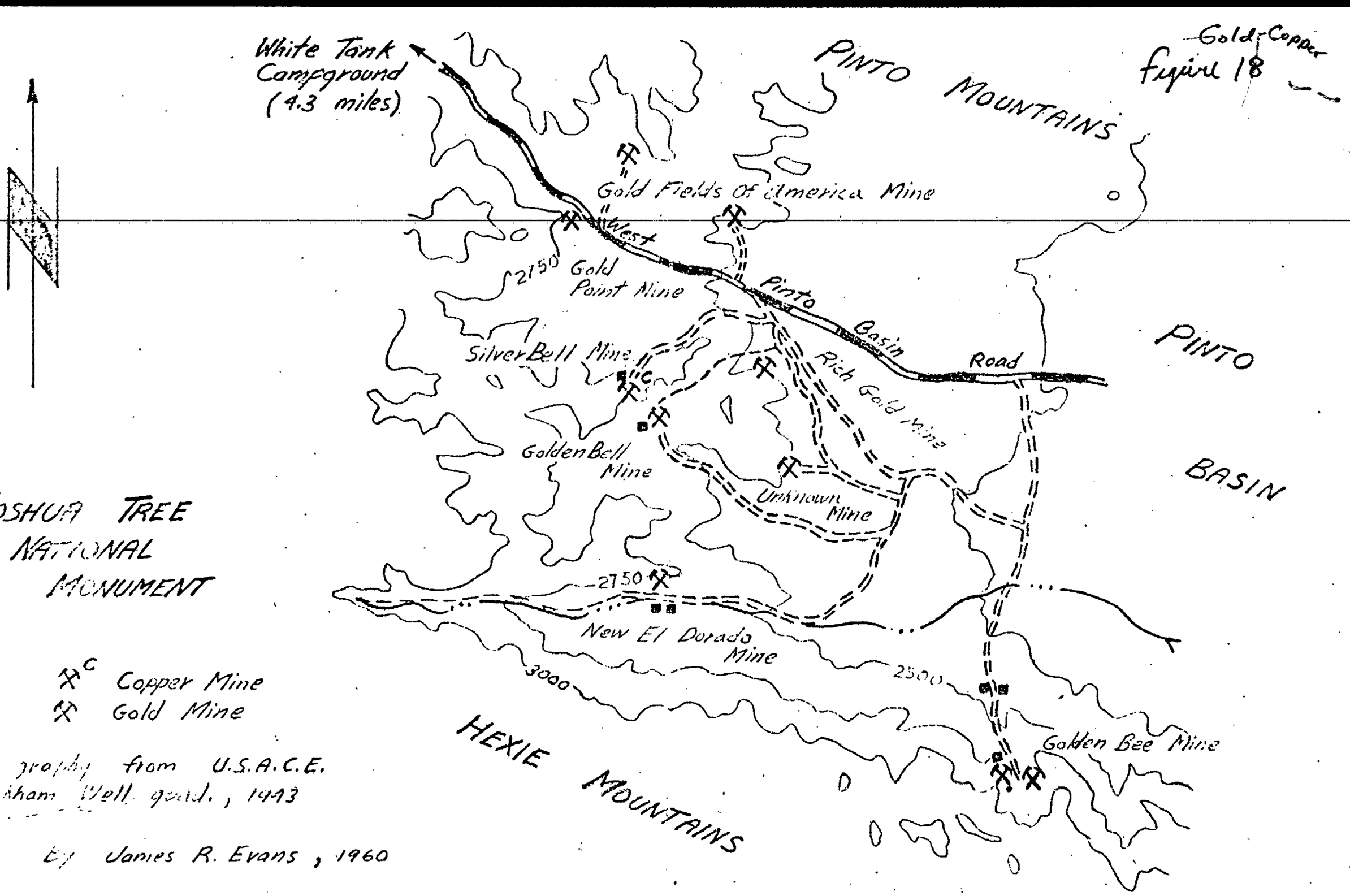
0 ½ 1
Scale in Miles

Contour Interval 500'

116°00 115°45 115°30
34°15
34°00
33°45

Valley Mtn. | Dale Lake
Pinkham Well | ~~Eagle Tank~~
Hexie Mts. | Pinto Basin

Diagram showing quadrangles covered by this map



MINERAL DEPOSITS OF THE WEST PINTO BASIN AREA RIVERSIDE COUNTY

PLATE 2L

Gold

Figure 42

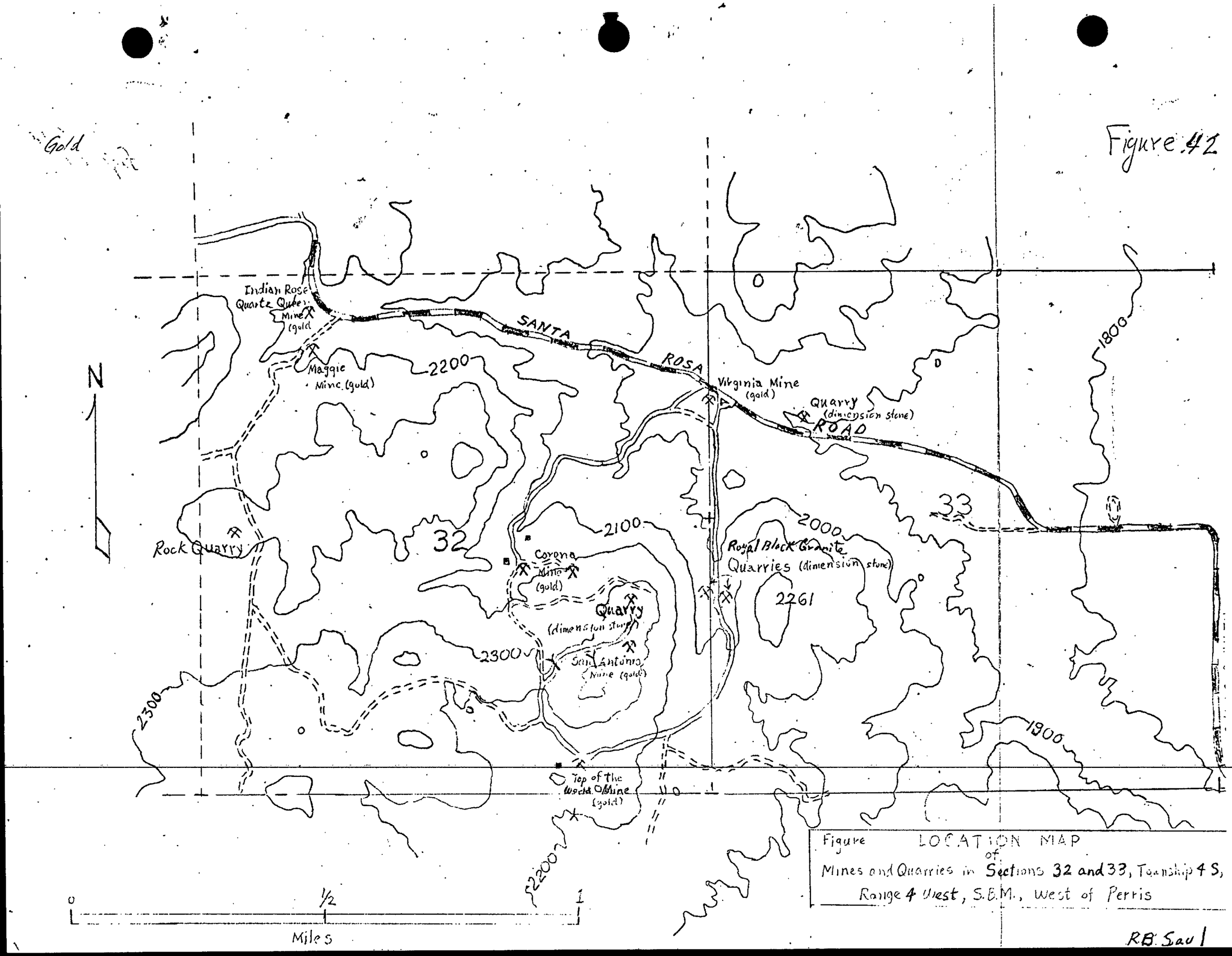


Figure LOCATION MAP of Mines and Quarries in Sections 32 and 33, Township 4 S, Range 4 West, S.B.M., West of Perris

R.B. Saul

Alice Group

Location: Sec. 25 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 15', 1950; about 4½ miles south of Vidal in low foothills at the north end of the Riverside Mountains. Tucker and Sampson (1945, p. 127) reported 12 patented claims in this group.

Ownership: Undetermined (1958).

History: According to Merrill and Waring (1916, p. 544) these claims were once known as the Pipinco Group, but by 1914 the name Alice Group had been adopted. They state that the owner at that time was one B. L. Vaughn, Needles. Tucker and Sampson (1945, p. 127-128) state that for the period from 1933 to 1939 the claims were owned and operated by the Reliance Consolidated Mining Company, E. P. Warner, president, and P. N. Warner, secretary, Banco-American Building, Los Angeles. U. S. Bureau of Mines records indicate that the Alice was active during the years 1927, 1928, 1932-34, 1937 and 1942 and list Clara Blandix, Hollywood, California, as owner and Fredrick Frie, Los Angeles, the operator, as of 1942, the last recorded date of operation.

Frederick Frie installed a 50-ton concentration and flotation plant and operated the mine until October, 1942 when operations were suspended as ~~an affect~~ a result of War Production Board Order L-208.

Geology: The rocks in the mine area, which are of Precambrian age, comprise gneiss and schist interlayered with thin beds of quartzite. They strike about N. 10° W., and dip 20° NE., but are locally contorted. Mineralized faults, which trend N. 55° W. and dip steeply to the northeast, crop out irregularly across most of the claims of the Alice group. Mafic dikes of undetermined age, roughly parallel the faults.

The ore bodies pinch and swell and are as much as 4 feet thick. The vein material is composed of iron and manganese oxides, malachite, chrysocolla, barite, and calcite.

Development: The following description is taken in part from Tucker and Sampson (1945, p. 127-128).

The mine workings are entered through 2 adits, both on the east side of the canyon. The lower adit is near the base of the slope. It was driven 490 feet southeast on a vein which is 1 to 2 feet wide at the portal. The upper adit is about 200 feet up the slope southeast of, and about 120 feet higher than the lower adit. It was driven 250 feet southeast on the same vein. An ore shoot was developed between the adits by a raise with an inclined length of 125 feet. It joins the lower and upper adits at points estimated to be about 210 feet and 50 feet from their respective portals. The shoot is exposed in the lower adit for about 125 feet with an average width of 30 inches. Ore was stoped to the upper adit, and a narrow stope was driven from there to the surface. From the lower adit, ~~there is~~ a winze 225 feet deep ~~in depth.~~ ~~This~~ was not examined, but it probably explores the same ore shoot.

When visited in 1957, the Alice workings were open and dry. The road was passable. All machinery had been removed and the buildings destroyed or in poor repair. However, ore loading bins near the lower adit were still in fair repair.

The only other development noted on the Alice Group is a vertical shaft of unknown depth on the Lucky Boy claim, NE ¼ NW¼ sec. 25, T. 1 S.,R. 23 E., about three quarters of a mile northwest of the workings described above.

Production: The Alice group was worked intermittently from as early as 1914 to 1942. From 1927 to 1942 approximately 200 tons of ore were shipped to American Smelting and Refining Company's smelter at Hayden, Arizona. From these shipments about 170 ounces of gold, 42 ounces of silver and 15,400 pounds of copper were recovered.

References: Merrill and Waring, 1917, p. 544; Tucker and Sampson, 1929, p. 472; 1945, p. 127-128.

R.B.S. and C.H.G. 12/20/57.

Alice Mine

Location: At the center of the SW 1/4 sec. 24, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle, 7½', 1953; about 8 miles south of Romoland.

Ownership: Undetermined.

History: The Alice Mine was located early in the 1890's by J. R. Cheatham, L. M. Wilson and L. Crain (Mining and Scientific Press, 1895, vol. 70, p. 106). In 1894 development was reported under way, a shaft having been started in the hanging wall (Crawford, 1894, p. 221). In 1895 the mine passed into the possession of a stock company the principal members of which were J. M. S. Egan, W. H. Griffith and M. Cantan. A 5-stamp mill was installed, the shaft was reported to be down 85 feet, and 500 tons of ore were said to be ready for milling with enough in sight in the mine to keep the mill running two years (Mining and Scientific Press, 1895, vol. 70, p. 106). In 1896 all operations were reported suspended and the estate of J. M. S. Egan, Perris was the owner (Crawford, 1896, p. 310). Subsequent reports show no further activity and the Egan Estate remained the owner as late as 1945 (Tucker and Sampson, 1945, p. 127, pl. 35).

Geology: The Alice Mine is on a low, featureless, cultivated mesa of Mesozoic gabbroic rock. A fractured quartz vein as much as 15 feet in thickness is exposed for a strike distance of roughly 300 feet. The vein strikes N. 80° W., and dips about 35° NE. The quartz contains heavy concentrations of hematite, magnetite, and hair-like, black- to gray-green tourmaline crystals. Chalcedony is present as fissure and cavity fillings. This ore was reported to yield about $30 per ton in gold (Mining and Scientific Press, vol. 70, p. 106).

Development: At present all former workings, including the 85-foot shaft, are caved or partially filled. ~~As previously stated, the development consisted of a shaft some 85 feet deep and shallow surface work.~~

Production: Undetermined.

References: Mining and Scientific Press, 1894, vol. 69, p. 394; 1895, vol. 70, p. 106; Crawford, 1894, p. 221; 1896, p. 310; Merrill and Waring, 1917, p. 534; Tucker and Sampson, 1929, p. 472; 1945, p. 127, pl. 35; Sampson, 1935, p. 508.

R.B.S. 10/19/59.

Property of
Arizona Bureau of Mines
Tucson, Arizona

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Anaheim Mine

Location: SW¼ sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), ~~U. S. Geological Survey~~ Valley Mountain quadrangle, 15' 1956; Pinto Mountains, Gold Park, 9 miles S. 30° E. of Four Corners, Twentynine Palms (see ~~pl. 1~~ Figure 19).

Ownership: Undetermined.

History: The mine was active in 1929 and 2 men were employed. It was idle in 1945 but still owned by Edward Harman, Garden Grove (Tucker and Sampson, 1929, p. 472 and 1945, p. 128).

Geology: Gold Park gabbro-diorite, and hornblende granite intrude the Pinto gneiss. These Precambrian rocks are cut by several steeply-dipping faults. Pegmatite dikes, fine-grained green basic dikes, aplite dikes, and gold (?) -quartz veins have all been exposed, and are strongest in and adjacent to fault zones (fig. 11/).

Development: A short adit, and several shafts, 2 at least 100 feet in depth, have been sunk in steeply-dipping fault planes. Shallow prospects dot the landscape in the vicinity of the major workings (fig. 11/). The mine is idle.

Production: Undetermined, April 1959.

References: Tucker and Sampson, 1929, p. 472; Tucker and Sampson, 1945, p. 128.

J.R.E. 4/13/59.

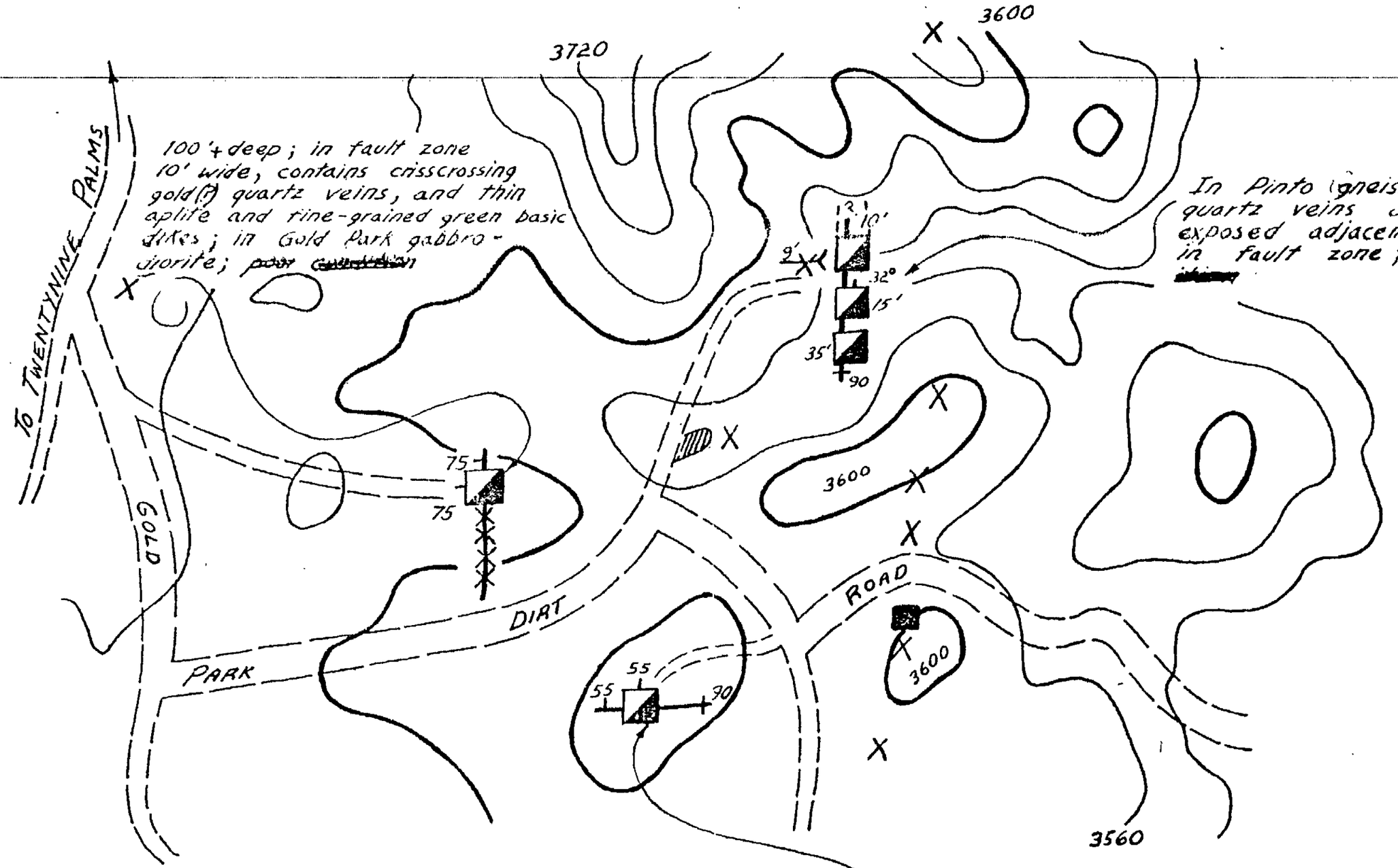
Figure 17

Fig. 11. Sketch map showing the workings of the Anaheim mine and their areal distribution (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Figure 11.

Gold

Anaheim



By James R. Evans
April 1959

~~Contour~~ ~~Interval~~ ~~25'~~

Anna Bell Mine

Location: Sec. 24 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 15', 1951; on the southwest side of a northwest-trending canyon in the Big Maria Mountains. The mine is 25 miles, by road, north of Blythe. The last 7 miles is an unimproved dirt road and jeep trail which extends westward from U.S. 95.

Ownership: Undetermined (1958).

History: Undetermined.

Geology: Two shear zones are exposed in a steep ravine. The lower shear strikes N. 35° W., is vertical, is as much as 10 feet wide and exposed for about 100 feet along its strike. The upper shear zone is about 100 feet slope distance farther up the ravine. It strikes roughly east, dips 25° - 30° S., is as much as 12 feet wide and exposed for about 60 feet on the surface. The country rock is Precambrian gneiss, gneissic granite and Paleozoic (?) carbonate rocks which have been altered in part to calc-silicate minerals. A general attitude, taken near the upper shear zone is N. 55° W., 55° SE. The heaviest concentration of mineralization is at the junction of the upper shear zone and a limestone unit. The gangue minerals are pyrite and iron oxides. Both shear zones contain small amounts of secondary copper minerals which probably are alteration products of chalcopyrite. No information was obtained on the gold content of the deposit.

Development: The lower shear zone is explored by a single vertical shaft about 30 feet deep which is untimbered. The ore shoot in the upper shear zone is explored by an adit driven west about 30 feet. A winze about 12 feet deep is 15 feet from the portal. The adit and winze are open, dry and untimbered.

Production: Undetermined.

References: None.

R.B.S. 12/16/58.

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Arlington Tunnel

Location: Sec. 13 (proj.) T. 4 S., R. 5 W., S.B.M., Steel Peak quadrangle, 7½', 1953; about one mile south of Cajalco fire station.

Ownership: H. D. Goetze, Route 1, Box 81, Perris.

History: In the late 1800's, the area to the south of this development, known as Gavilan Flat, was held by San Jacinto Estate, Limited, an English firm. It was planned to develop the various gold claims systematically and to drain the entire group through a common adit.

"There will be three main shafts sunk, called the Washington, the Gavilan and the Hoag, (see herein) and an adit level will drain all of them." (Mining and Scientific Press, 1891, vol. 63, p. 132).

It is generally agreed, by older residents in the area, that this, the Arlington Tunnel, was to be that proposed "adit level". Apparently it was never finished. To have done so would have required an adit length of nearly 2 miles.

Geology: The country rock is sheared and jointed Mesozoic diorite. No well defined vein is exposed at or near the portal.

Development: A single adit was driven S. 25° W. for an undetermined distance. The large dump suggests that local reports of a length as great as 2,000 feet might be correct. At present (1959) the adit is sealed about 100 feet from the portal and serves as a source of water for an adjoining ranch.

References: Mining and Scientific Press, 1891, vol. 63, no. 9, p. 132.

R.B.S. 6/16/59.

Atlanta (Ronnie B) Mine

Location: NE¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 15' 1956; Pinto Mountains, Gold Park, 8.3 miles S. 28° E. from Four Corners, Twentynine Palms (see pl. 1 / figure 19).

Ownership: Carlos J. Bassler, Jr., and Francis E. Bassler, 2112 Cedar St., Alhambra, own one unpatented claim (February 1959).

History: The mine was originally located as the Atlanta and in 1920 was owned by the Gold Park Consolidated Mining Company ~~(W. C. Winnie, president, J. E. Schweng, secretary, C. W. Roach, manager; Offices 1021 Black Building, Los Angeles)~~ (Tucker, 1921, p. 347). At this time the Atlanta claims included the present site and what workings as there were, of the North Star gold mine. J. Klugh of Pasadena owned the mine in 1929. It was located as the North Star group (Tucker and Sampson, 1929, p. 472). In 1945 the property was owned by the Floyd Mining and Milling Company ~~(Harl F. Skadan, president, G. C. Zimmerman, secretary, Norco,)~~ and was known as the North Star group of mines (Tucker and Sampson, 1945, p. 140). Since 1956 the workings in the extreme northwest corner of sec. 6, T. 2 S., R.10 E., (proj.) have been called the North Star mine, and the shaft and prospects just east of the Gold Park road on a small knoll (NE¼ sec. 1, T. 2 S., R. 9 E., (proj.) have been called the Atlanta (Ronnie B. mine (~~pl. 1~~ / figure 19).

Geology: Milky quartz veins, as much as 2 feet thick, occur along a N. 20° W.-trending and 75°-80° W.-dipping fault in thoroughly weathered, Mesozoic hornblende granite. The quartz contains pyrite and gold (?) and is highly discolored by brownish-red iron stains. The area in the immediate vicinity of the mine is ~~much~~ many intruded by thin pegmatite dikes and fine-grained green basic dikes.

Development: A nearly vertical 2-compartment shaft, well timbered and in good condition, has been sunk at least 75 feet in the fault zone. Several shallow pits and trenches have been dug along the fault over a distance of about 1,500 feet. The mine is idle.

Production: Undetermined.

References: Tucker, 1921, p. 347; Tucker and Sampson, 1929, p. 472; Tucker and Sampson, 1945, p. 140.

J.R.E. 2/10/59.

Augustine Mine

Location: S½ sec. 8 (proj.), N½ sec. 17 (proj.), T. 8 S., R. 17 E., S.B.M., Chuckwalla Spring quadrangle, 15' 1953; just west of Augustine Road and 1½ miles northwest of Chuckwalla Spring. The property is reached by ~~Augustine Road~~, an unimproved dirt road, ~~shown in part as a trail on the map~~, which extends west and southwest ~~from the road~~ to Chuckwalla Spring.

Ownership: Undetermined: Mr. George C. Mieding, 8815 Klindale, Pico Rivera, is considering (April, 1961) developing this mine in association with a number of other individuals.

History: Undetermined.

Geology: The Augustine Mine as here described includes a group of developments on an undetermined number of unpatented claims lying on the southeast and east slopes of a ridge of gneissic Precambrian rocks. ~~(fig.)~~

The deposits are controlled by faults and shearing in the gneiss. They differ in their mineralogic makeup and are probably of different ages.

The most northeasterly deposit ~~(fig.)~~ lies along a poorly exposed vertical fault striking N. 65° - 80° E. across the southeast slope of a low ridge. A quartz vein as much as 6 inches wide carries local concentrations of galena across its full width. The galena contains ~~silver~~ which probably is associated with lesser proportions of pyrite and is altered in part to cerussite. ~~It probably carries silver.~~

The southwest deposit comprises 2 quartz veins, a lower one in shear planes of the gneissic country rock, and an upper vein in the plane of a normal fault, which cuts and displaces the gneissic structure. The lower vein is exposed on the southeast slope of the ridge, where it strikes N. 15° E., and dips 30° NW. The upper vein strikes N. 85° E. in an oblique angle across the ridge just northeast of the highest peak, and dips 70° north-northwest.

The lower vein consists of discontinuous, lenticular bodies of quartz up to 2 feet thick in a zone of differential movement between layers of the gneissic country rock. The upper vein has been crushed and attenuated by continued movement on the containing fault plane. The vein forms lenticular bodies up to 4 inches thick.

These southwest veins are of similar mineral content, but the upper deposit appears to be the richer. It carries oxides of iron, secondary copper minerals, pyrite, chalcopyrite, and gold.

The lower vein yields scattered, small bunches of galena. Galena was not identified in the upper vein, but may have been altered owing to the shattered condition of the rock.

Development: The northeast vein is explored by a 12-foot shaft from which a 20-foot drift extends southwest. about 300 feet to the southwest of the 12-foot shaft there is an inclined shaft at least 80 feet deep near which is a 30 foot vertical shaft.

The southwest veins are explored as follows. The lower vein was opened by an inclined shaft about 75 feet deep and is exposed in shallow prospects along its outcrop northeast and southwest of the shaft through a distance of roughly 1000 feet. The upper vein was opened by 2 short adits several hundred feet apart, one driven 10 feet southwest from high on the southeast slope of the ridge and the other 12 feet northeast from the northwest slope.

Production: Undetermined.

References: None.

R.B.S. 1/20/60.

Aztec and Rainbow Claims

Location: Sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 15', 1952. Eight miles of unimproved road, named Dupont Road on the topographic map, extends southwest to the mine from merged U. S. Highways 60 and 70 at a point 17 miles east of Desert Center.

Ownership: J. Dupont, Desert Center (1959).

History: Mining was started on this property in 1936 and has continued, on a small scale to the present.

Geology: Several poorly exposed quartz veins, as wide as 4 inches, lie along west-trending vertical faults which cut a low ridge of gneiss. The veins are offset along a barren, fault zone which strikes N. 35° W., along the crest of the ridge and dips about 80° NE.

Minerals associated with the quartz veins are: oxides of iron, pyrite, galena, chrysocolla, cerussite and wulfenite. Free-milling gold is unevenly distributed through the veins.

Development: The most recent development comprises several shallow prospects and trenches on the crest of the ridge. The older workings consist of an adit and open trenches. The adit portal is low on the west slope of the ridge. It was driven 90 feet east on a fault zone up to 4 feet wide. The trenches are at the base of the slope ~~and~~ about 300 feet south of the adit and were the site of the earliest work on the claims.

Production: In 1936, 4 to 5 tons of high-grade ore was shipped to U. S. Smelting and Refining Co. at Midvail, Utah. This ore was taken from veins exposed in the old trench workings. It yielded $400 in gold (J. Dupont, personal communication).

References: None.

R.B.S. 4/28/59.

Barrel Tanks Placer

Location: Sec. 10 (proj.), T. 3 S., R. 13 E., S.B.M. (proj.). ~~U. S. Army Corps of Engineers~~ Eagle Tank quadrangle, 15' 1943; along the north slope of the Eagle Mountains, in the vicinity of, and may be the same as, the Mystery Mine (see herein), about 6 miles southeast of Mission Well. Not confirmed, May 1961.

Ownership: Ivan C. Winter and Ray Severence, Box 1271, Twentynine Palms, 1961.

History: William S. Wayne operated and prospected this property on a small scale from 1936 to 1960.

Geology: Placer gold in alluvium.

Development: Undetermined. Reported to be a small-scale hand-operated dry washing operation (personal communication W. S. Wayne, 1958).

Production: Compiled by the U. S. Bureau of Mines.

Year	Yardage Handled	Gold ounces
1936	150	15.19
1938	157	5.00
1939	32	2.00
1940	68	4.00
1942	66	4.00

References: None.

C.H.G. 5/16/61.

Beal Mine

Location: Sec. 13 (proj.) (19), T. 7 S., R. 15 (16) E., S.B.M., U.S. ~~Corps of Army~~ Engineers Chuckwalla Mountains quadrangle, 15', 1945 (63); on the south slope of the Chuckwalla Mountains, one mile west of Black Butte and 2 miles north (northwest) of Gulliday Well.

Ownership: Undetermined.

History: Undetermined.

Geology: The Beal Mine workings explore a shear zone ranging from 15 to 50 feet in width between Mesozoic granite and Precambrian gneiss. The shear zone strikes N. 15°- 20° E. and ~~its~~ dip ~~ranges~~ from vertical to 60° NW. A fractured and altered basic dike lies in the zone and pods and stringers of crushed, finely crystalline quartz, ~~ranging from 0~~ to 2 feet ~~in~~ thickness, are contained in a soft micaceous gouge. The quartz is seamed and pocketed with iron oxides containing traces of free gold.

Although the contact zone appears to be exposed for several miles, the Beal mine explores an outcrop only about 300 feet long in a shallow south-trending ravine ~~(Fig. 1)~~.

Development: The shear zone was explored by means of 2 adits and several prospects. The upper adit is about 45 feet long and appears to have been driven along irregular shear planes within the larger zone. The lower adit is caved at the portal, but the small amount of dump material suggests that it is not extensive.

Production: Undetermined. ~~Idle. (1960)~~.

References: None.

R.B.S. 2/9/60.

Bill Rush Claims

Location: Center sec. 19, T. 2 S., R. 10 E., S.B.M., (proj.), U. S. ~~Army Corps of Engineers (Pinkham Well)~~ Hexie Mountains quadrangle, 15', 1963; southwestern part of the Pinto Mountains, Joshua Tree National Monument, 2½ miles east of White Tank Campground.

Ownership: Undetermined.

History: Undetermined. Apparently long idle.

Geology: Altered felsite dike 20 feet wide trends N. 30° W., in Precambrian Pinto gneiss. The dike shows sparse maroon to yellow-brown iron oxide stain and contains a few pyrite cubes altered to iron oxide. The workings explore a vertical shear in the dike containing very white, smooth, clay gouge material.

Development: Adit driven S. 30° E. on the dike, size of dump suggests at least 100 feet of workings. Several shallow prospect pits and short adits explore the dike over a distance of several hundred feet to the southeast.

Production: Undetermined.

References: None.

C.H.G. 5/16/61.

Black Butte (Gold Tiger) Mine

Location: NE¼ sec. 10, T. 2 S., R. 8 E., S.B.M., Twentynine Palms quadrangle, 1955; Joshua Tree National Monument, 1 mile north of Sheep Pass in low hills between Lost Horse and Queen Valleys.

Ownership: Dr. H. W. Milo, 224 El Camino Real, Vallejo owns 1 lode claim, the Black Butte (1960).

History: No record of this property was found, but the workings are old and may date from the 1890's. It was formerly held by W. F. Keys and known as the Gold Tiger, but apparently Mr. Keys never operated the mine.

Geology: A sheared, altered, mafic dike in ~~gneiss~~ Precambrian (Pinto gneiss) strikes N. 68° E., is vertical, ranges from 1 to 3 feet in thickness, and is discontinuously exposed at the surface for at least 1,100 feet. The sheared zone contains thin quartz veins and where best exposed in an open-cut in the southwest part of the claim the quartz vein is 2 to 4 inches thick at the northwest margin of the shear.

Development: The mafic dike has been explored along its entire length by almost continuous shallow open-cuts, (and) shafts, and drift adits, now largely caved. The principal workings apparently were the "Gold Tiger Tunnel" toward the east end of the outcrop, and the "Ironclad Shaft" in the central part. The extent of these workings was not determined.

Production: Undetermined.

References: None.

C.H.G. 1/27/60.

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Black Warrior (Gold Master?, Paymaster?) Mine

Location: Center of NW¼ sec. 20, T. 2 S., R. 10 E., ~~S.B.M.~~ (proj.), ~~U. S. Army Corps of Engineers~~ (Pinkham Hexie Mountains Well) quadrangle, 15', 1953 (previously reported in sec. 16, T. 2 S., R. 9 E., S.B.M., Tucker and Sampson, 1929, p. 476); southwestern part of the Pinto Mountains, in Joshua Tree National Monument, 3¼ miles east of White Tank Campground.

Ownership: William F. Keys, Joshua Tree (1929), undetermined (1961).

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History: The Black Warrior mine was discovered before 1900, and is said to have been located by Bill McHaney (W. F. Keys oral communication, 1960). By 1918 it was ~~one of~~ and the most southerly of a group of 52 claims owned by the Gold Park Consolidated Mines Company. At this time the workings consisted of a 200-foot shaft with 150 feet of drifts and crosscuts; two men were employed in development work; ore was hauled to Twenty-nine Palms, but by 1918 very little ore had been treated; and the workings became filled with water below the 70-foot level. ~~(surface water which seeped in through an old shaft in the adjacent canyon bottom).~~ Also in 1918 the dump was said to contain 2,200 tons of ore that assayed $14.00 per ton (Tucker, 1921, p. 348). In 1929, William F. Keys was listed as owner, the workings were described the same as in 1918, and the mine was idle (Tucker and Sampson, 1929, p. 476). Apparently Mr. Keys held 2 claims known as Paymaster South Extension, and Paymaster North Extension. During the 1930's the property was leased and much of the dump material was hauled away by truck and milled. The property has since been idle and was renamed the Gold Master in recent years (oral communication, W. F. Keys, 1960).

Geology: Irregular shear zone in banded diorite gneiss (Pinto gneiss) of Precambrian age. At the surface at the west edge of the shaft the shear zone is about 8 feet wide with 5 feet of red-brown iron oxide stained sheared country rock and a 3-foot wide crushed quartz zone with considerable iron gossan. The quartz-filled shear zone appears to be very irregular, it strikes N. 50° W. and is vertical at the shaft, but in the adit below strikes about N. 10° W. Tucker (1921, p. 348) described the mine as follows: "Mineralization occurs along a shear zone in altered granite. The hanging (wall) is a gneiss with a well defined talc wall. General trend of the ore body is N. 10° W. with a dip to the west---The quartz in the vein matter is highly oxidized and contains considerable iron and lime. Its black appearance, due to iron and manganese stains, gives it its name. The vein is different from others of the district, containing considerable pyrite and some arsenopyrite."

Development: Vertical shaft, may be joined to a drift adit, 50 feet south and 35 feet below the shaft, and driven north from the edge of a narrow canyon. The adit has been extensively stoped. According to Tucker (1921, p. 348) "The shaft is vertical to 70-foot level, from this point sunk on an incline of 65° east. On 70-foot level a drift runs 100 feet N. 45° W., exposing an ore body 60 feet in width. Mineralized zone made up of quartz and brecciated wall rock. On 150 foot level a crosscut was run 60 feet west, and is said to be entirely in ore." In 1929 Tucker and Sampson (p. 476) reported the shaft to be 200 feet deep. The adit is not mentioned in the old reports and may be work done subsequently in the 1930's.

Production: U. S. Bureau of Mines records credit the following production to a Paymaster Mine located in sec. 15, T. 3 S., R. 10 E., S.B.M., and operated by W. N. Thompson, Box 397, La Habra. This may be the same as the Black Warrior Mine for which no record of production was found inasmuch as the years listed are about the time the Black Warrior is said to have last been active and no mine is known for sec. 15.

Year	Crude Ore (tons)	Recoverable Metals (ounces) Gold ~~(ounces)~~	Silver ~~(ounces)~~
1935	160	22.9	1
1936	240	55.66	16
1940	46	30.00	3

References: Tucker, 1921, p. 348; Tucker and Sampson 1929, p. 426; ~~Tucker and Sampson~~, 1945, p. 128.

C.H.G. 5/16/61.

Bonanza Lode

Location: NE¼ sec. 26(?), T.3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15', 1958; Joshua Tree National Monument, 1 mile southwest of Pinyon Well, north slope of the Little San Bernardino Mountains. This location is from patent plats and Tucker and Sampson (1945, pl. 35, No. 24), but no trace of mining activity was found at this location in 1960. This may be an erroneous location and the property could be in the NW¼ sec. 26.

Ownership: In 1923 the New Eldorado Mining Company held one patented claim (Bonanza) of 20.54 acres. Undetermined (1960).

History: According to patent records the Bonanza claim was ~~first~~ located in 1905, amended in 1921, surveyed for patent in 1921, and the patent issued in 1923. At time of patent the map shows road to the property, cabin, well, and 10-foot discovery shaft. Survey no. 5600, Patent No. 911384.

Geology: The NE¼ sec. 26 is entirely underlain by Mesozoic coarse-grained quartz monzonite (White Tank quartz monzonite). In the NW¼ sec. 26 the quartz monzonite contains quartz veins which strike northwest and dip steeply southwest.

Development: No mine workings were observed in the NE¼ sec. 26. In the NW¼ sec. 26, however, quartz veins have been explored by pits and shafts (See Hansen Mine herein).

Production: Undetermined.

References: Tucker and Sampson, 1945, pl. 35, No. 24.

C.H.G. 1/26/60.

Boss (Goat or Goat Basin) Mine

Location: NE¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 15, 1956; Pinto Mountains, Gold Park, 8.1 miles S. 27° E. of Four Corners, Twentynine Palms (~~see pl. 1~~ figure 19).

Ownership: Undetermined.

History: In 1921, the mine was owned by the Gold Park Consolidated Mines Company, W. C. Winnie, president, ~~V. E. Schweng, secretary, C. W. Roach, manager;~~ Offices 1021 Black Building, Los Angeles, and consisted of a 132-foot shaft with about 1,000 feet of crosscuts and drifts at that level; including a 200-foot north drift (Tucker, 1921, p. 347). In 1929, the mine was idle, all equipment had been removed and apparently no work was done in the interval of time between 1921 and 1929 (Tucker and Sampson, 1929, p. 476). W. F. Keyes, Banning (present address - P.O. Box 114, Joshua Tree) was the owner.

Geology: Tan colored Mesozoic quartz monzonite and hornblende granite intrude the Precambrian Pinto gneiss. Locally, segments of gneiss have been engulfed and occur as xenoliths and perhaps roof pendants. The mine area is intensely faulted and aplite dikes, green basic dikes, and thin veins of gold (?) bearing quartz, transecting all other rock units, are strongest in these fault zones (~~fig. 1~~ Figure 12).

Figure 12

Development: The main workings consist of the previously-mentioned 122-foot shaft with the associated drifts and crosscuts. Four other shafts of varying depth, have been sunk adjacent to and about 1,000 feet west of the main workings ~~(fig. 1/)~~. About 30 feet above the main shaft an adit is driven 40 feet south along the plane of a west-dipping fault ~~(fig. 1/)~~. The mine is idle.

Production: Undetermined.

References: Tucker, 1921, p. 347; Tucker and Sampson, 1929, p. 476.

J.R.E. 2/10/59.

Figure 12. Sketch map showing the areal distribution of workings (A); and a geologic sketch map (B) of the Boss (Goat or Goat Basin) mine (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Figure 12.

Gold

Boss (Goat or Goat Basin) Mine

X9

To Twenty nine Palms

3680

3640 3600 3560 3520

A

0 330 660

Scale in Feet

Shaft; sunk vertically at least 50' in hornblende granite

Caved

Shaft; opens in older alluvium, then sunk in hornblende granite; reportedly 122' deep with 200' drift north at the bottom

NARROW DIRT ROAD

Shaft; sunk 5' vertically in Pinto Gneiss

Shaft; sunk 15' vertically in Pinto Gneiss

55

Open cut; 30'; leads into adit driven 40' in hornblende granite crosscut by aplite dikes and thin veins of gold(?) bearing quartz

Open-cut; in Pinto Gneiss

60

90

63

Trench; shallow, 50' long; fine-grained green basic dikes & aplite dikes exposed along fault in hornblende granite

Shaft; sunk vertically about 50'; in fault zone; opens in Pinto Gneiss

Quartz vein 1' in maximum width; along fault

B

By James R. Evans
February 1959

Brooklyn, Los Angeles, and Gold Rose Mines

Location: Sec. 1, T. 2 S., R. 12 E., and sec. 36, T. 1 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 2½ miles southeast of New Dale (Site) and about 5 miles north of Mission and Sunrise Wells. The Brooklyn mine is probably in San Bernardino County ~~(see pl. 3)~~ figure 3) and the ~~The~~ Brooklyn-Los Angeles mines have been previously included in reports on San Bernardino County.

Ownership: The Brooklyn and Los Angeles mines are owned by the Brooklyn Mining Co., c/o Clifford Coy, 2032 Genevieve St., San Bernardino (March 1958). The Gold Rose mine is owned by Bonnie H. and Dean H. Oehl, 777 E. 9th Ave., San Bernardino (March 1958).

History: A gold-bearing quartz vein was discovered in 1893 by Ames and Walter Yager on the present site of the Brooklyn mine. They worked the vein intermittently until 1901. From 1902 to 1916 the mine was developed by the Brooklyn Mining Co., San Bernardino, and known as the Brooklyn mine. The mine apparently was not again in operation until the 1930's when together with the Los Angeles and Gold Rose (?) mines it was consolidated under one ownership and operated by the Brooklyn Mining Company. all t The mines were shut down in 1941. Previous to 1930 water was secured at the Supply mine in San Bernardino County, and hauled southeast over the mountains on 5 miles of ~~dirt roads and trails~~. Because the water problem apparently outweighed the convenience of milling the ore in the area, a new mill was built at Gold Rose Well, which ~~This mill, built~~ in the late 1930's, is about 5 miles south of the Brooklyn mine and 1 mile east of Mission and Sunrise Wells.

Geology: The country rock is Mesozoic quartz monzonite cut by diorite dikes and ~~five~~ five parallel quartz veins, about 1000 feet apart. Two gold-bearing quartz veins, one known as the Brooklyn, the other the Los Angeles, ~~have been~~ are the most extensively developed. They strike northwest, dip 70° NE., range in thickness from 2 to 6 feet, and are locally stained with secondary iron and copper minerals.

Development: The Brooklyn vein is proven 1500 feet on the surface and is developed by a drift adit driven 550 feet northwest in the vein about 100 feet below its outcrop. About 300 feet from the portal, a winze has been sunk on the vein to a depth of 200 feet. Level workings extending from the winze at 60 (?), 110, 160, and 200 feet below the adit level have developed two ore shoots; one was 175 feet long, the other 260 feet long, and both had an average width of 4 feet. The shoots had a reported value of $15 a ton. In the early 1930's there was a 3 (750-pounds stamps) stamp mill and a 30-ton rod mill on the property.

The main shaft at the Los Angeles mine is sunk 750 feet on the vein. About 540 feet northwest of the main shaft another shaft is sunk 250 feet in the vein. A drift on the 120-foot level connects these two shafts. Level workings extend from the main shaft at 52, 120, 320, 420, and 685 feet below the surface, and have developed two ore shoots; one was 275 feet long, the other 300 feet long, both had an average width of 5 feet. The shoots had a reported value of $12 per ton. In the early 1930's there was a 3 (250-pound stamp) stamp mill on the property.

The workings at the Gold Rose mine are of much less extent and consist mainly of 5 nearly vertical shafts with depths ranging from 25 to at least 250 feet. One or both of the veins explored contained copper carbonate and small masses bunches of galena. The masses of clots of galena occurred sporadically along the vein and contained values in both gold and silver (Tucker and Sampson, 1930, p. 238). The mine is now being worked intermittently by Dean Oehl (Karl Schapel oral communication, 3/8/60).

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owners.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lbs.)	Lead (lbs.)
		Brooklyn Mine			
1900		174			
1901		145			
1902	1,600	1,209			
1903	350	435			
1904	500	484			
1905	1,200	406	1,418		
1906	1,200	387	1,324		
1907	700	188	77		
1908	130	35	13		
1909	150	34	13		
		Brooklyn - Los Angeles - Gold Rose (?) Mines			
1931	300	138	59		
1934	1,350	208	466	1,371	
1935	?	216	655	1,564	
1938	189	33	20		
1939	90	52	68		
1940	233	197	292	94	258
1941	344	257	3		
~~Total~~					
		Gold Rose Mine			
1939	135	55	2		
1941	432	133			

References: Cloudman, Huguenin, and Merrill, 1919, p. 802; Eric, 1948, p. 291, 300; Newman, 1923, pp. 221-222; Tucker and Sampson, 1930, pp. 227-229 and p. 238; Tucker, 1930, unpublished Field Report No. 331; Tucker and Sampson, 1931, pp. 289-290; Tucker and Sampson, 1934, p. 321.

J.R.E. 3/8/60

Brown (Hillside Group) Mine

Location: NW¼ and SW¼ NW¼ sec. 7 (proj.), T. 2 S., R. 20 E., S.B.M., Rice quadrangle, 15' 1954; east slope of the Arica Mountains, 6½ miles southwest of Rice.

Ownership: Undetermined (1958).

History: In the early 1900's the Brown claims comprised two separate groups, a north group of claims held by Mrs. Floyd Brown (see herein under Brown Mine North) and this, the southern group, which included the main camp and 3-stamp mill, under the ownership of Mr. Floyd Brown, a resident of Blythe (Merrill and Waring, 1917, p. 542). The Brown claims appear to have been most active during the twenties. They were reported idle in 1929 (Tucker and Sampson, p. 476) and in 1945, by which time they had been relocated as the Hillside Group by T. H. Mulhall, Tecopa (Tucker and Sampson, 1945, p. 128).

Geology: The Brown Mine explores gold-bearing quartz veins in two shear zones which cut hornfelsic and gneissic metasediments of ~~probable~~ Precambrian age which underlie southeast slope of the Arica Mountains. The rocks strike about N. 50° W. and dip 45° SW. The shears appear to be en echelon. One, striking N. 5° W. and dipping 60° W., is exposed for several hundred feet at the north end of the property, the other strikes N. 50° W., dips 70° SW. and crops out irregularly for roughly half a mile at the south end of the property.

Development: The north shear zone is explored by a single drift adit about 40 feet long from which two short stopes extend to the surface and below which a winze extends to a depth of 12 feet. Though these workings appear to explore an ore shoot, the vein is little more than a foot wide at the portal. Papers found near ~~these workings~~ this development indicate that it was located (or relocated) by T. H. Mulhall, in 1944, as the Dewey No. 5. Presumably, it was part of the old Brown group.

the adit a

Development of the south vein consists of a vertical shaft of uncertain depth, a 100-foot shaft inclined 60° southwestward on the vein, a 30-foot (short) adit, and extreme southern workings marked as an adit on the topographic map but not visited.

The inclined shaft, situated about 100 feet up the slope west of the old camp site, and the vertical shaft about 300 feet to the northwest, appear to have been the principal sites of activity on these claims. A contorted and fractured quartz vein as much as one foot thick is exposed in the walls portals of these shafts. An old tripod head frame still stands at the collar of the inclined shaft and light timbering is intact within it (1958). The extent of the underground workings was not determined. a 30-foot prospect— The short adit was driven in the south side of a shallow canyon just south of the old camp site. It is about 30 feet deep and appears to be little more than a prospect.

Undetermined.

Production: Statistics were not found for these claims, but the vein material resembles that of the nearby Lua-Gray and Mountain Queen mines.

References: Merrill and Waring, 1919, p. 82; Tucker and Sampson, 1929, p. 476-477; 1945, p. 128-129, pl. 35.

R.B.S. 4/11/58.

Brown Mine North

Location: NW¼NE¼ sec. 1, T. 2 S., R. 19 E., S.B.M., Rice quadrangle, 15' 1954; east slope and at the north end of the Arica Mountains, 6 miles southwest of Rice.

Ownership: Undetermined.

History: The name of this mine is inferred from an early report (Merrill and Waring, 1917, p. 542) which referred to "Mrs. Floyd Brown's mine--located north of the Gray Mine." (See herein under Brown Mine).

Geology: A gold-bearing quartz vein lies in a shear zone in Precambrian gneissic metasedimentary rocks. The shear zone strikes approximately north and dips about 50° W. It is traceable for about 500 feet along the strike, but talus obscures the exposures.

The quartz vein ranges from 1 to 18 inches in thickness. It is fractured and sparsely mineralized with iron and manganese oxides, and chrysocolla.

Development: The vein was explored by 4 inclined shafts. An adit was driven west in the side of a steep ravine, for a distance of about 40 feet. It is at the end of the road and may have been used for storage as there is no clearly defined vein where it enters the slope. The 4 inclined shafts are about 200 vertical feet up the slope to the west of the adit. The southernmost shaft is inclined 45° SW. and is 12 feet deep. Immediately north the other 3 shafts are spaced unevenly along the shear through a distance of about 300 feet. The strike of the shear swings to the east so that the southern two shafts bear due west and the somewhat isolated northernmost shaft bears northwest. All three are inclined from 50° to 60°, coincident with the shear zone. From south to north these shafts are respectively 60, 12 and 60 feet deep. Though a small amount of drifting and stoping appears to have been done, the exact extent was not determined. The ore was transported from the site of the shafts to a loading point lower on the slope by means of a tramway about 400 yards long.

Production: Undetermined (1958).

References: Merrill and Waring, 1917, p. 542; Tucker, 1929, p. 476-477; Tucker and Sampson, 1945, p. 128, pl. 35.

R.B.S. 4/11/58.

Bryan Mine

Location: SE 1/4, sec. 30, T. 6 S., R. 16 E., (proj.), S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; 7 1/2 miles southeast of Desert Center, and 1 1/2 miles southwest of Corn Spring.

Ownership: Undetermined (1959). This claim was patented by James M. Huston, in 1915 (U.S. Bureau of Land Management records). In 1945, J. M. Huston of Los Angeles, was reported to be the owner (Tucker and Sampson, p. 129).

History: The Bryan mine was operated from 1898 to 1900 by Adams and Pickering. The ore was processed in a two-stamp mill at Corn Springs (Merrill and Waring, 1919, p. 539). In a report of 1945 (Tucker and Sampson, p. 129), the Bryan and Dottie Wellborne claims were included under the name Bryan. The Dottie Wellborne (see herein) is in the next township to the west.

Geology: Several en echelon shear zones and associated quartz veins are exposed for about 1,800 feet down a ridge. They strike north to N. 30° ~~east~~ E, and dip 50° ~~west~~ W and ~~northwest~~ NW. The veins range from fine stringers a fraction of an inch wide, to as much as 3 feet in width.

The country rocks are Mesozoic porphyritic granite, and lenticular bodies of intrusive rocks of dioritic-to gabbroic composition, and fine-grained basic dikes of later, probably Tertiary, age.

The quartz veins are heavily stained and pocketed with iron oxides. There are smaller proportions of pyrite and stains and thin crusts of copper minerals.

Development: The property was developed at three levels, spaced at roughly equal intervals up the ridge.

The lower level is a 30-foot adit driven S. 30° W. on a vein as much as 2 feet wide. The middle level consists of an adit driven 280 feet S. 30° W. through sheared and jointed granite. About 130 feet from the portal, a short drift was driven 35 feet to the right, and from the end of the adit a 45-foot drift extends left. This level appears to have been exploratory; no veins are exposed.

The workings at the upper level appear to consist of an inclined shaft about 40 feet deep from which a drift extends southwestward along the vein. The vein is stoped to the surface for 50 feet southwest of the shaft. Ore was moved from the upper workings to the canyon below by means of a cable tramway.

Production: No production data were found for this mine. The ore was reported to have milled $7 per ton (Tucker and Sampson, 1945, p. 129). Most of the mining probably was done between 1898 and 1900.

References: Merrill and Waring, 1919, p. 539; Tucker and Sampson, 1929, p. 477, 1945, p. 129; Saul, 1962, p. 7.

R.B.S. 3/13/59

Cactus Group of Mines (?)

Location: Secs. 22, 27, T. 3 S., R. 13 E., S.B.M. (proj.), ~~U. S. Army Corps of Engineers (Eagle Tank)~~ Pinto Basin quadrangle, 15', 1946; northwestern part of the Eagle Mountains, 6½ miles southeast of Mission Well, astride Cactus Gulch.

Ownership: Undetermined.

History: The Cactus group was located prior to 1900. The property was surveyed for patent in 1900 (Survey No. 3830) and 3 claims (Cactus, Hustler, Short Horn) totaling 31.06 acres were patented in 1903 to The Eagle Mountain Gold Mining Company. Remains of a camp site suggest the property was active during the 1930's. Idle.

Geology: Shear zone in metasedimentary rocks of possible Mesozoic age intruded by Mesozoic quartz monzonite. The shear zone strikes N. 10° W., is about 10 feet wide, and contains a vertical brecciated quartz vein. The sheared rock is stained red-brown by iron oxide.

Development: The shear zone is explored by a drift adit of undetermined length driven N. 10° W. About 500 feet to the northwest of the portal is a crosscut adit. About 3/4 mile to the south a 75-foot vertical shaft explores a copper-stained shear zone in quartz monzonite.

Production: Undetermined.

References: None.

C.H.G. 5/16/61.

Captain Jinks (Jenks) Mine

Location: Sec. 1 (N), T. 4 S., R. 10 E., S.B.M. (proj.), ~~U. S. Army Corps of Engineers Pinkham Well~~ Hexie Mountains quadrangle, 15', 1963; southeastern Hexie Mountains, Joshua Tree National Monument, in rugged hills north of upper Porcupine Wash.

Ownership: Undetermined.

History: This property is said to have been discovered and worked by a Captain Jinks or Jenks in 1874. About 1900, it was held by C. A. Pinkham. In 1951, it was relocated as the Phyllis Silver by W. F., Frances M., and Phyllis Ann Keys (personal communication, W. F. Keys). Apparently the property has been long idle.

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Geology: The mine area is underlain by a Precambrian(?) igneous-metamorphic complex (Chuckwalla Complex?) including hornfels, quartzite, biotite schist, quartz biotite gneiss, and diorite. Two nearly parallel quartz veins, about 300 feet apart, have been explored. The east vein strikes N. 15°-20° W., dips 60° NE., is 1 to 2 feet wide at the main shaft and crops out intermittently southeasterly from the shaft at least 1,500 feet. The footwall is quartzite and biotite schist and the hanging wall is a weathered diorite dike and quartz biotite gneiss. The west vein crops out in a shear zone which can be traced for several thousand feet along the east side of a ridge. The vein strikes N. 25° W., dips 80° NE., is 1 to 2 feet wide, and consists of black to red-brown and yellow-brown iron-stained quartz with sparse green and blue green copper coatings. No sulfide minerals were observed. The footwall is hornfels and the hanging wall is sheared hornfels and quartzite 10 to 15 feet wide.

Development: The east vein is explored by a deep, steeply inclined shaft at its north end. About 175 feet to the southeast and 100 vertical feet below is a caved drift adit, which may have once joined the shaft. Several pits, trenches, and steeply inclined shafts explore the vein about 1,500 feet farther southeast.

The west vein is explored by 2 deep vertical shafts about 300 feet apart. An open-cut about 10 feet deep and 100 feet long extends northwest along the vein from the northern shaft.

Production: Undetermined.

References: None.

C.H.G. 5/18/61.

Carlos Jr. Mine

Location: SE¼ sec. 1, T. 2 S., R. 9 E., and the W½ sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, about 8.7 miles S. 29 E. of Four Corners, Twentynine Palms (see pl. 1 / Figure 19).

Ownership: Carlos J. Bassler, Jr., 2112 Cedar Street, Alhambra, owns several unpatented claims (April 1959).

History: Work apparently has been done as long ago as 1945, and every year since. Most of it appears to have been done in the past 14 years although one shaft may be much older.

Figure 13

Geology: In the SE 1/4 of sec. 1, about 1/4 mile southwest of the Silver Scorpion gold mine, Mesozoic granite cross cut with fine-grained green basic dikes, as much as one foot thick, and tan to brown Mesozoic White Tank quartz monzonite intrude the Precambrian Pinto Gneiss. The same rock types occur in the W 1/2 sec. 6, T. 2 S., R. 10 E., about 1,000 feet northeast of the Silver Scorpion gold mine ~~(figs. 6 and 7)~~. In addition, the Mesozoic Gold Park gabbro-diorite is exposed in a southeast-trending adit. This area is intensely faulted, ~~and~~ hematite and gold(?) bearing milky quartz veins are prevalent in the fractured zones. Thin pegmatite dikes, and fine-grained green basic dikes have been exposed in most of the major workings and in nearly every prospect.

Development: Southwest of the Silver Scorpion gold mine, a boarded-over shaft is sunk to an unknown depth in hornblende granite. Immediately south of the shaft is an adit driven east about 15 feet ~~(fig. 7)~~. Northeast of the Silver Scorpion gold mine are 2 shafts, 3 adits, a few wooden and brick dwellings, and 13 prospects.

Production: Undetermined.

References: None.

J.R.E. 2/11/59 and 4/13/59

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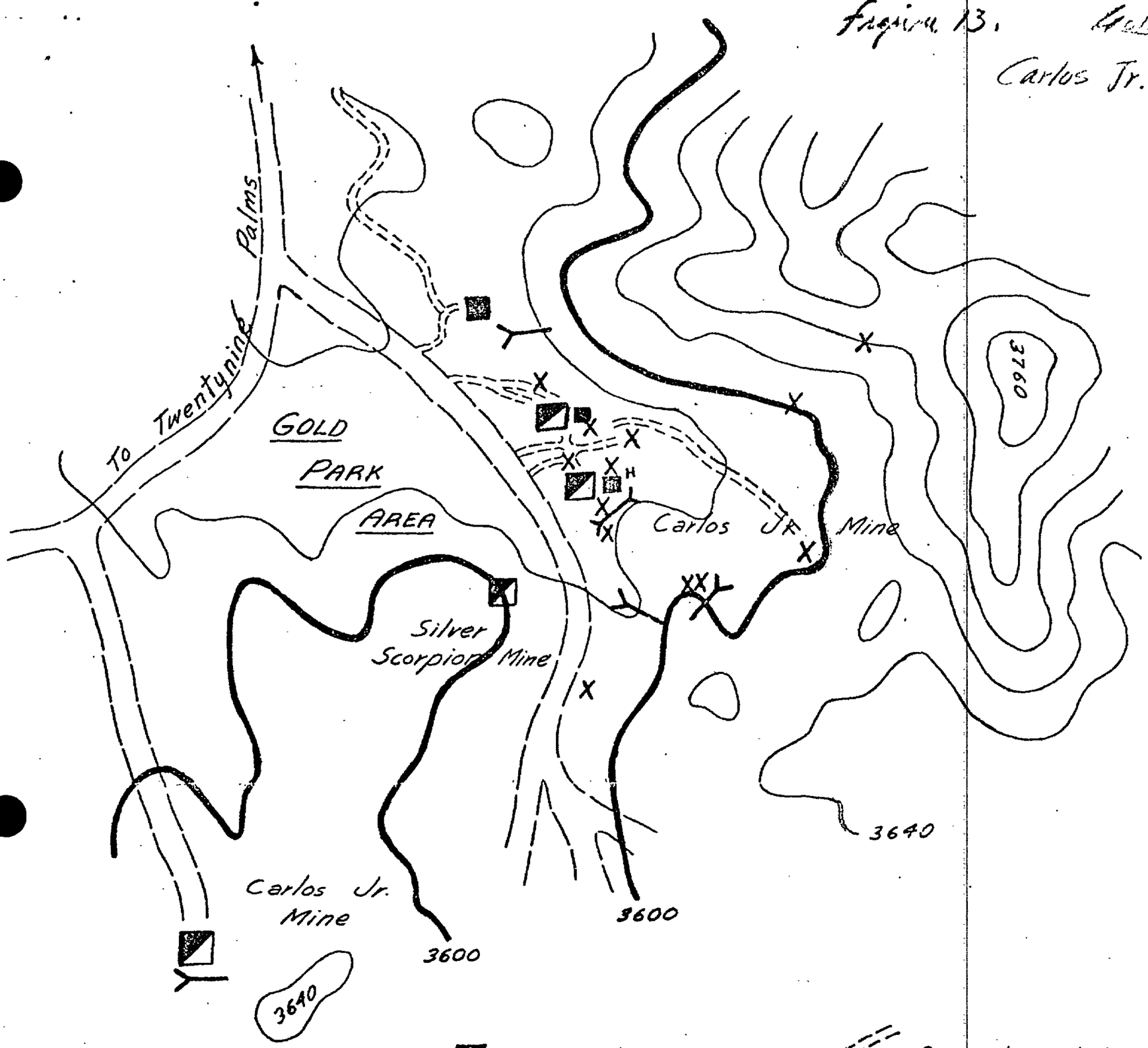
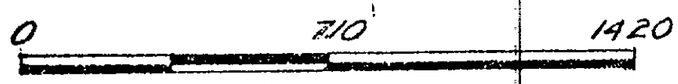
Figure 13. Gold Carlos Jr.



Shaft
Adit
Prospect pit
Trench
Secondary dirt road
Dirt road
Cabin
Hoist house



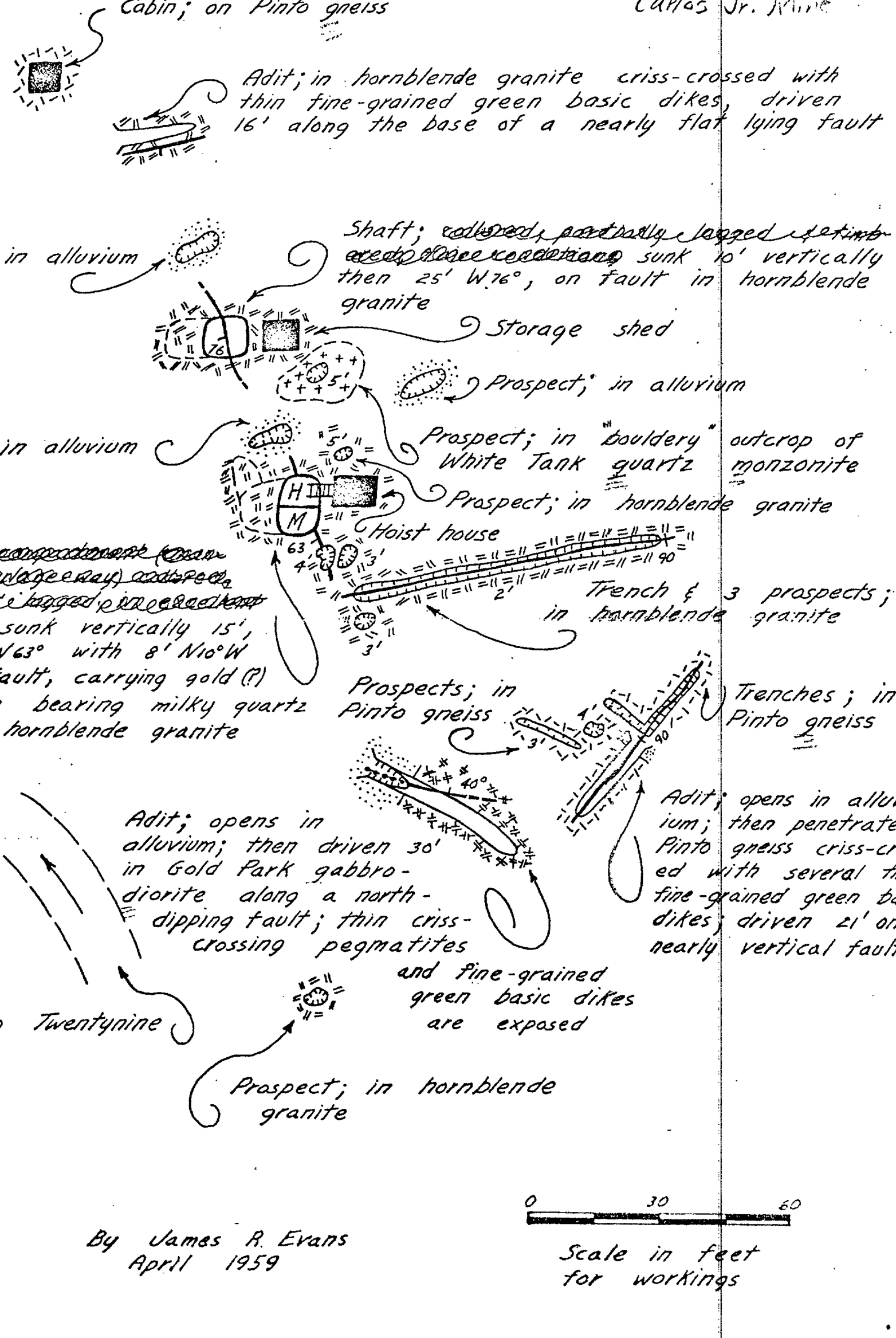
Scale in Feet
Contour Interval 40'

By James R. Evans
April 1959

Figure 13. Sketch map showing the location and distribution of the workings of the Carlos Jr. gold mine (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Project 13.

Carlos Jr. Mine



By James R. Evans
April 1959

Figure 13. Geologic sketch map of a part of the Carlos Jr. gold mine.

Cathy Jean Mine

Location: NW¼NW¼ sec. 25 (proj.), T. 1 S., R. 23 E. S.B.M., Vidal quadrangle, 15' 1950; in a shallow ravine on the extreme northern margin of the Riverside Mountains 4 miles south-southwest of Vidal.

Ownership: Undetermined (1958).

History: Undetermined.

Geology: The ~~rocks in~~ area of the Cathy Jean Mine is underlain by ~~are~~ rocks of the Precambrian Chuckwalla Complex hornfelsic-to gneissic. They are cut by a mineralized fault and a basic dike, which ~~The dike~~ appears to have been intruded along the fault; both strike N. 75° W. and dip 85° NE. In addition to the dike, veinlets and lenses composed of iron oxides, chrysocolla, malachite, barite, and quartz, form a vein or zone, which reaches a maximum width of 6 feet in the plane of the fault.

Development: Two inclined shafts of undetermined depth were sunk to the northeast at angles of 70° to 80° in search of gold. The lower shaft enters the vein near the bottom of the ravine. The vein is about a foot wide at the collar and appears to pinch out to the southeast. The upper shaft follows the same vein to an unknown depth. It is about 300 feet northwest of the lower shaft, and about 50 feet higher, on the west side of the ravine. At the collar of this shaft the vein is exposed in its maximum thickness. It appears to pinch out in a few tens of feet to the northwest but it is not well exposed. In the lower shaft the basic dike forms the foot wall of the vein and in the upper shaft it forms the hanging wall. Though the relation of the dike to the ore was not determined, mineralization resembles that of other mines in the area in which no basic dikes are associated with the ore bodies.

Though a road is open to the mine, no structures or equipment are present. The shafts are open and dry but dangerous to enter.

Production: Undetermined.

References: None.

R.B.S. and C.H.G. 12/18/56.

Chuckwalla Spring Placers

Location: Secs. 9, 10 and 16 (proj.), T. 8 S., R. 17 E., S.B.M., Chuckwalla Spring quadrangle, 1953; 12½ miles southwest of the junction of Blythe-Niland Road and U. S. Highways 60 and 70, a point 25 miles west of Blythe.

Ownership: An undetermined number of unpatented claims are, or have been, held in this area but most of them appear to be abandoned (1959). ~~The Lost River (figure ~~ and ~~Old Channel~~ claims are currently (1959) held by Ben I. Brewer, 4920 Druid Street, Los Angeles 32. These claims are in sec. 9, near the road to Chuckwalla Spring.

History: According to local residents these gravels were worked by small-scale, hand methods during the 1930's. Since then activity has been sporadic. Mr. Brewer has held his claims since 1956.

Photos 11 and 12

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Geology: (This) gravel (deposit overlies) ~~the shelved or~~ (pedimented) north edge of the Chuckwalla Mountains. ~~Over most of this~~ irregular bedrock surface the gravel appears ~~to range from 0 to as much as 100 feet in thickness~~. In local, small areas the gravel is much thicker. Both the gold-bearing gravel and the underlying bedrock have been trenched by water courses heading in the range to the southwest ~~(fig.)~~. The fault bounding the north slope of the range is exposed in the walls of a northeast-trending wash in section 10. Northeast of this fault the gravels dip more steeply into a down-faulted basin of undetermined depth. To the extent that the gold is concentrated on the bedrock this fault is a natural northeast limit for the deposit. According to Mr. Brewer ~~however~~ there are many layers of hardpan in the gravel and gold has been found on these "false bedrock" surfaces. Presumably such layers extend northeast across the fault. The gravel is a poorly sorted mixture of subrounded fragments of igneous and metamorphic rocks in sizes ranging from silt to boulders several feet in diameter. Flat, flag-like fragments are common and commonly lie in a shingled arrangement. Relatively unworn nodules of chalcedony are present in fair profusion on the surface of the deposit, apparently having been derived from volcanic rocks to the southwest.

Local residents report that this is not a rich deposit except for but some spots. ~~have payed well.~~ The presence of silt and clay-sized material makes a clean separation of the contained gold difficult but this may be overcome in part by working the loose, relatively clean reworked material in the present water courses.

Development: ~~Mining of~~ this deposit is cut by numerous has consisted of shallow pits and shafts, short adits, and trenches. ~~(what miners would call coyoting or gophering)~~ In addition shallow benches have been cut on favorable streaks exposed in gullies (~~fig. 4~~). The gold has been recovered ~~concentrated~~ by a variety of small dry-washing devices in the absence of a dependable water supply. Accurate figures on the abundance of the metal in the gravel are lacking.

Production: Undetermined. Idle, 1958.

References: None.

R.B.S. 11/19/59.

C.O.D. Mine

SE 1/4

Location: Sec. 23 (proj.), T. 6 S., R. 15 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Chuckwalla Mountains quadrangle, 15', 1945; about 1 mile south of Aztec Well and 6½ miles south of Desert Center, in the Chuckwalla Mountains. ~~The~~ An unimproved road ~~which~~ extends southwest from U. S. Highways 60 and 70 to the Corn Spring-Aztec Well area.

Ownership: C. E. Squires, P.O. Box 437, Desert Center.

History: In ~~the years~~ 1939-40 and 1940, the C.O.D. mine was operated by Carl De Vaul, Desert Center. The present owner has been cleaning out and timbering the old shafts ~~and installing timber and sheathing~~ as assessment work.

Geology: Crushed quartz veins ~~ranging from~~ up to 2 feet ~~in thickness~~ lie in a fault zone as wide as 4 feet. The strike is N. 20° W., the dip is vertical. The veins are poorly exposed for a strike distance of about 500 feet. They contain pockets and fissure fillings of iron oxides which bear free-milling gold. Pyrite is present but largely confined to the extreme southeast end of the outcrop.

Development: Development consists of 2 vertical shafts sunk on the fault zone about 15 feet apart at the northwest end of the outcrop. They are 25 and 30 feet deep. To the southeast the deposit has been probed through 5 shallow prospects.

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Production: According to U. S. Bureau of mines records (published with permission of the owner) (in) in 1939 and 1940, 10 tons of ore were shipped from which 5 ounces of gold and one ounce of silver were recovered.

References: None.

R.B.S. 4/29/59.

Combination Quartz Mining Claim No. 1

Location: NW¼ sec. 12 (?), T. 4 S., R. 10 E., S.B.M. (Prov.), U. S. Army Corps of ~~Engineers Pinkham Well~~ Hexie Mountains quadrangle, 15', 1963; southeastern Hexie Mountains, Joshua Tree National Monument, at the north edge of upper Porcupine Wash.

Ownership: Chester A. Pinkham and Charles W. Landford (1935). Undetermined (1961).

History: Claim located by Pinkham and Landford in July 1935. Apparently some development work was done in the 1930's. Idle.

Geology: Shear zone in fine-grained quartz monzonite of Mesozoic age. The shear zone contains an iron-stained quartz vein as much as 2 feet wide which strikes N. 55° W. and is vertical.

Development: The quartz vein is explored by means of a vertical shaft 15 feet deep joined at the bottom to a southeast-trending drift of unknown length. Two shallow pits have been opened on shears about 25 and 75 feet up hill from the shaft.

Production: Undetermined.

References: None.

C.H.G. 5/18/61.

Part 2

Copper Giant (?) Mine

Location: SE¼NW¼ sec. 28, T. 4 S., R. 9 E., S.B.M., Lost Horse Mountain quadrangle, 15, 1958; in the Little San Bernardino Mountains at the east edge of Rockhouse (Fargo) Canyon, 11 miles northeast of Indio.

Ownership: Undetermined.

History: Locally said to have been worked by Herman Price, Desert Center, who did the last work in 1915. Apparently long idle.

Geology: Banded quartz-biotite gneiss and quartz monzonite gneiss with biotite schist layers (Precambrian Pinto gneiss). Banding trends N. 45° E., dips 40° SE. No evidence of mineralization or shearing was observed at the adit portal. A few pieces of vein quartz 2 to 6 inches thick with very sparse iron oxide stains were found on the dump.

Development: Adit driven N. 70° E. Size of dump suggests several hundred feet of underground workings.

Production: Undetermined.

References: None.

C.H.G. 5/20/61.

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Corona (Peggy) Mine

Location: NW 1/4 SE 1/4 sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7 1/2', 1953; about 6 miles west of Perris (see Figure 42).

Ownership: Undetermined.

History: U.S. Bureau of Mines records indicate this mine operated in 1939, at which time it was owned by John Seipel, Perris. No other record of ownership was found.

Geology: A poorly-exposed quartz vein crops out of the north slope of a ridge underlain by rocks of Mesozoic age, for a distance of roughly 500 feet. The vein strikes S. 75° E., dips 25° SE. and is as much as 4 inches thick. It is sparsely stained and pocketed with iron oxides and contains scattered flakes of biotite.

Development: The vein is explored by one short adit and two inclined shafts grouped within 100 feet of each other.

The adit is about 15 feet long and is boarded up for storage space. The two inclined shafts, the middle and east shaft, are near a dirt road extending west from the adit. The middle shaft is inclined 20°, S. 65° E. to an inclined depth of 60 feet. Although a vein 3 inches wide is exposed at the collar, no similar body was seen in the shaft. The east shaft was sunk S. 35° E. at a 10° inclination for a distance of 30 feet on the vein.

Production: In 1939, 25 tons of ore yielded four ounces of gold and two ounces of silver. ~~Idle (1959).~~

References: U. S. Bureau of Mines files, San Francisco.

R.B.S. 6/19/59.

Cow Bell Mine

Location: Secs. 2 and 10, T. 2 S., R. 11 E., S.B.M. (proj.), Valley Mountain quadrangle, 15' 1956; Pinto Mountains, about 7 miles south of Old Dale, on the Twentynine Palms Highway.

Ownership: Undetermined.

History: Undetermined.

Geology: In the mine area Mesozoic quartz monzonite is cut by several steeply dipping minor faults of random orientation. The faults contain discontinuous pods and stringers of chalcopyrite and gold-bearing quartz. The largest observed stringer was about 1-foot wide. At location 1, figure 14, where older alluvium has nearly obscured the bedrock, a shaft is sunk at least 100 feet in a N. 10° W.-striking and 75° SW.-dipping fault. At location 2, a shaft is sunk at least 50 feet in a N. 60° E.-trending and 75° SE.-dipping fault zone as much as 3 feet wide. The shaft at location 3 is only 15 feet deep and is sunk in a sinuous but generally northwest-trending and 70° SW.-dipping fault. At location 4 a shaft is sunk about 30 feet in a north-trending vertical fault.

Development

Figure 14

Development: The 100-foot plus shaft at location 1, figure 1/ probably contains drifts on several levels in the fault plane. Shallow pits and trenches have exposed the fault several tens of yards along its surface course. Workings total an estimated 200 to 300 feet. The 50-foot plus shaft at location 2, has a drift about 20 feet southwest on the 10-foot level, and probably has drifts at lower levels in the fault plane. Total workings are estimated to be about 400 feet. Here also shallow pits and trenches have exposed the fault several tens of yards along its course. Shafts at ~~locals~~ locations 1 and 2 are readily accessible but for those at 3 and 4, foot travel is necessary. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/28/60

Cow Bell

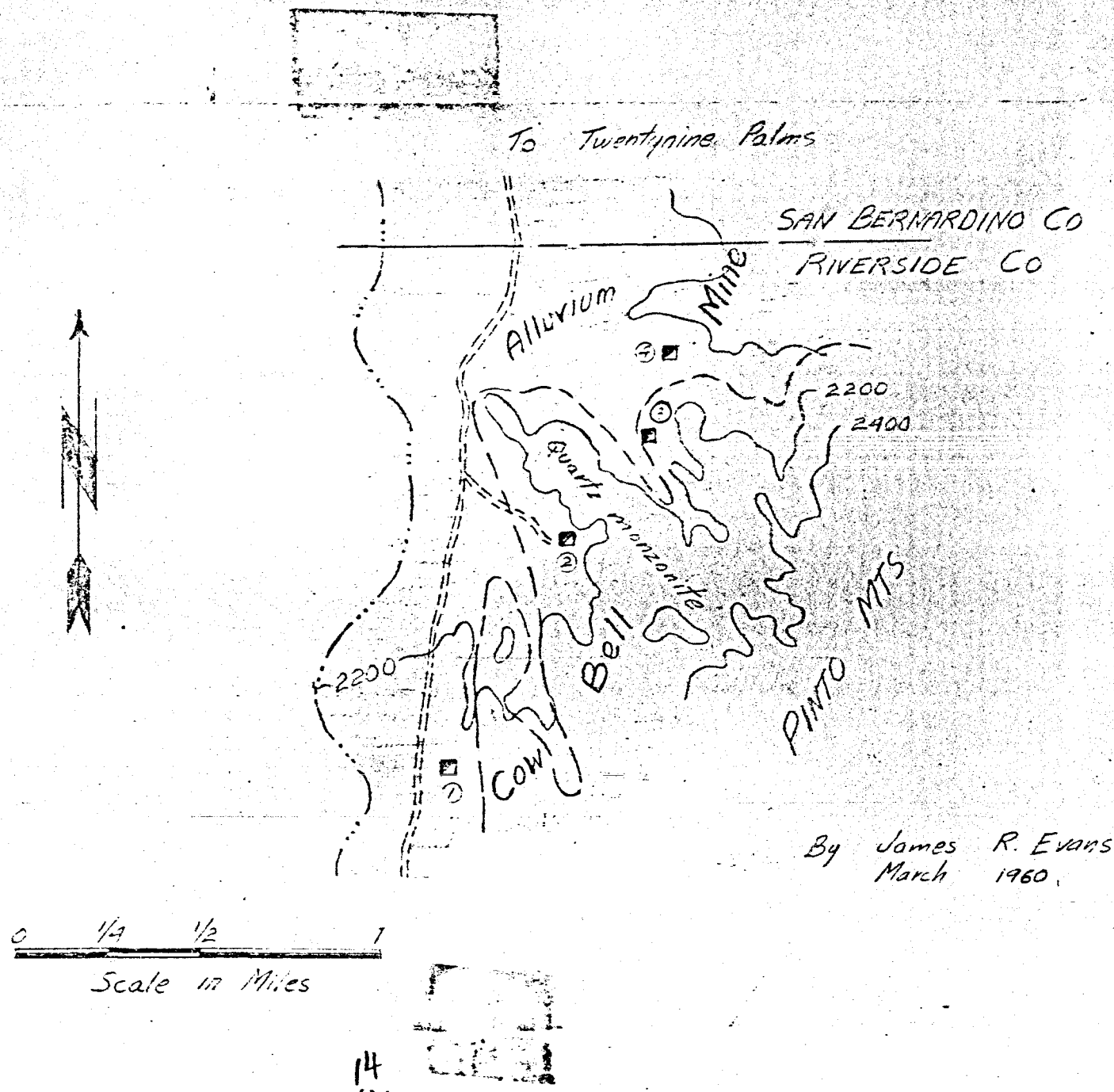

Figure 14. Geologic sketch map showing the location and distribution of the workings at the Cow Bell Mine.

Crescent (Baumonk) Mine

Location: Sec. 17 and 18 (proj.), T. 7 S., R. 15 E., S.B.M., ~~U.S.~~ Army Corps of ~~Engineers~~ Chuckwalla Mountains quadrangle, 15', 1963; on the southwest edge of the Chuckwalla Mountains about 10 miles, by dirt road, south of U.S. Highways 60 and 70. The Baumonk mine is marked on the topographic map but this site appears to be a former well, reservoir, and/or mill site.

Ownership: Joe B. McNeil, and others, 11704 S. Vermont, Los Angeles (1959).

History: The Crescent mine is a new development, located in 1954 in search of uranium minerals, at the site of the old Baumonk gold mine. The older mine seems never to have been described in the literature. According to the owner of the Crescent mine, who talked with the aging Mr. Baumonk, the Baumonk mine was worked late in the 19th century. The ore was shipped from San Diego to England to be smelted.

Geology: The Crescent mine explores a fault zone the erosion of which (has formed) underlies shallow ravines on opposing sides of a low ridge of Precambrian gneissic rocks. This zone of fractured rock is as much as 18 feet in width. It strikes N. 15° E. and is vertical. Because of (dust in the workings and regolith on the surface) poor exposures the nature of the mineralization was not clear. According to Walker and others, (1956, p. 26) -- "Radioactivity was noted in a zone of iron- and manganese-stained altered rock that is 12 feet thick and traced for 150 feet. Radioactivity 10 times background count is concentrated in a zone 2½ feet thick within the zone of altered rock. Samples collected by the U. S. Atomic Energy Commission assayed as high as 0.094 percent equivalent uranium."

The owner states that autunite has been identified in samples from this deposit.

The Baumonk claims covered an undetermined number of quartz veins poorly exposed for about 300 feet across the slope adjacent to and northwest of the Crescent mine. These veins are as much as 2 feet in width. They strike N. 40° E. and their dip ranges from vertical to 50° NW. Oxides of iron occur as small pockets and veinlets in the quartz as with most of the free-milling gold ores of the Chuckwalla Mountains.

Development: The Crescent mine is entered through an adit driven 100 feet northeast on the fault zone. About 50 feet from the portal a raise extends to the surface; 60 feet from the portal there is a 40-foot winze.

The principal development on the Baumonk mine is a vertical shaft of undetermined depth about 35 feet west of the adit portal of the Crescent mine. The remaining development comprises a 10-foot shaft, a 30-foot inclined shaft and an open pit 15 feet deep. These openings are grouped in a broad triangle about 150 feet west of the deep shaft.

Production: No shipments have been made from the Crescent mine (June 1959). The tonnage shipped from the Baumonk mine was not determined. Some of the gold ore is reported to have been rich but ore presently accessible in the shallow workings averages about $18 per ton in gold (J. B. McNeil, personal communication).

References: Walker, and others, 1956, p. 12, 26.

R.B.S. 4/30/59.

Dalton Mine

Location: Sec. 24 (?), T. 2 S., R. 11 E. (?) and sec. 19 (?), T. 2 S., R. 12 E., S.B.M. (proj.), ~~U. S. Army Corps of Engineers Pinkham Well~~ Hexie Mountains quadrangle, 15', 1943; Pinto Mountains, about 3½ miles southwest of the Gold Crown mine and 2 3/4 miles northeast of Pinto Mountain (~~see pl. 3~~ figure 31).

Ownership: Undetermined.

History: Apparently the mine was discovered and operated during the 1930's.

Geology: The main workings of the mine are near the head of a small northwest-trending box canyon and high on the northeast slope of the adjacent ridge. In this area the country rock is Mesozoic quartz monzonite cut by a major north-northeast-trending and 65°-70° west-dipping fault containing a chlorite-rich quartz vein 1½ feet in average thickness. The fault cuts the canyon at nearly right angles and is visable in both ridges on either side of the canyon, a distance of about ~~1/10 of a mile~~ 530 feet.

Development: The main shaft is sunk on the vein at least 100 feet. Judging from the size of the dump there must be drifts on one ~~side~~ or more levels. Total workings are estimated to be at least 1000 feet. An adit opens directly northeast of the shaft and is driven in the plane of the fault about 200 feet into a northwest-trending ridge. A few yards past the hill crest the adit has been stoped 18 feet to the surface over a distance of nearly 35 feet. The adit ends 18 feet below the ground surface in a shaft sunk on the vein at least 80 feet. There are several minor shafts and adits about 3/4 of a mile southeast of the main workings near an abandoned campsite. Principal among these is a north-trending drift driven in a 80° west-dipping fault. The drift was not entered but is estimated to be 200 to 300 feet long. Narrow, and in many places, steep roads provide access to the mine area.

Production: Undetermined.

Reference: None.

J.R.E. 3/30/60

Desert King Mine

Location: Sec. 14 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 3 miles north-northeast of Mission and Sunrise Wells (Figure 31/).

Ownership: Apparently Wilbur E. Cummings, et. al., Los Angeles, still own 2 patented claims; the Big Cross and the Desert King.

History: The Big Cross claim was located June 12, 1897, and the Desert King claim January 1, 1897. Most of the work was done prior to 1900, when the survey for patent was made, but the mine was active briefly in 1938.

Geology: Massive quartz monzonite of Mesozoic age is probably cut by faults containing quartz veins. No field visit was made to the property and nearly all information given here comes from the patent plat (fig. 15/).

Development: The main workings consist of an adit driven west about 150 feet. Other work is of minor extent and restricted to shallow shafts and prospects (fig.). The mine is idle.

Production: U.S. Bureau of Mines records show that in 1938, 18 tons of ore yielded 3 ounces of gold and 1 ounce of silver.

References: None.

J.R.E. 1/1960

Fig. 15

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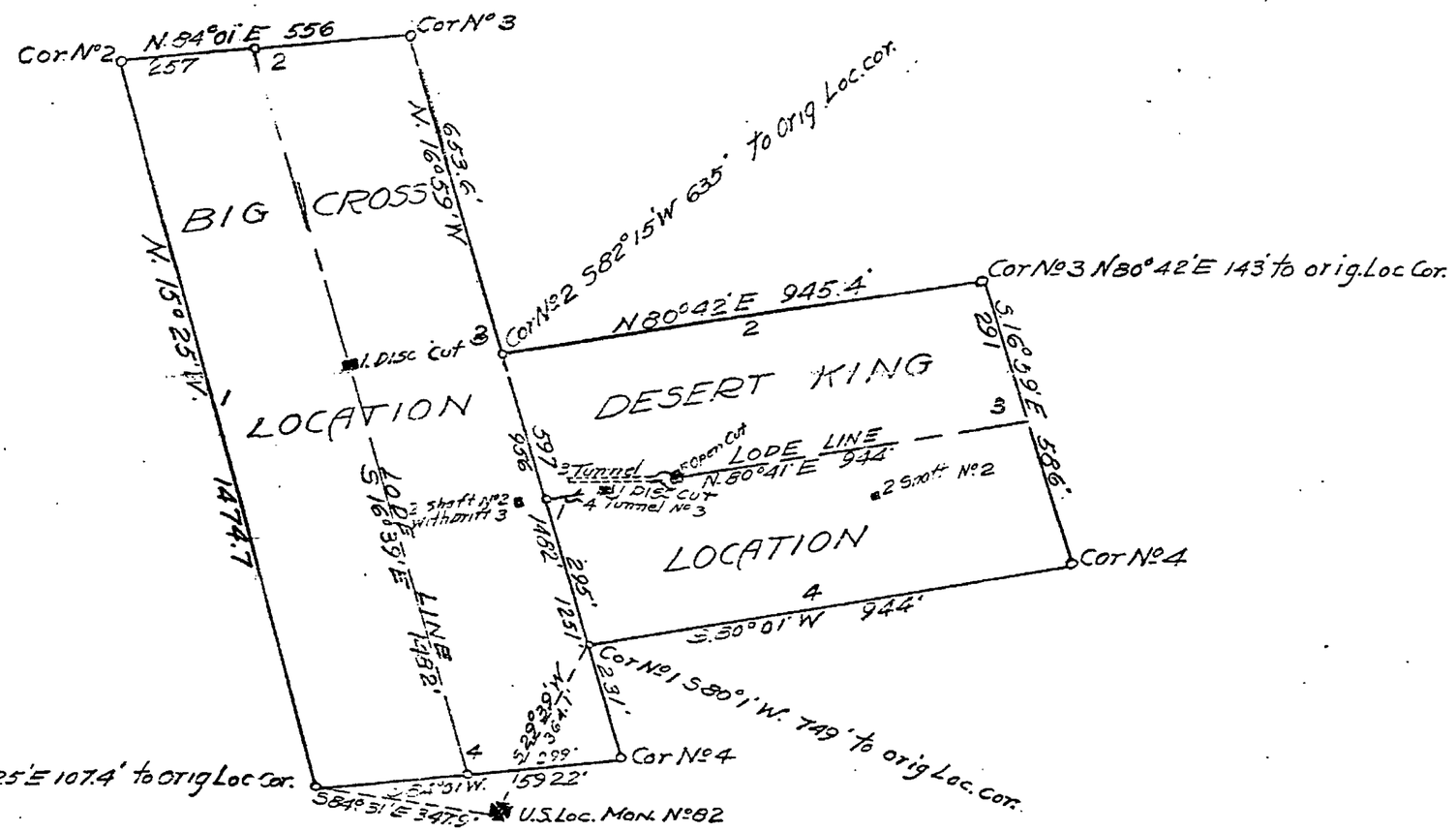
Figure 15. G.L.O.
Desert King

Figure 15. Plat of the Desert King and Big Cross lode claims (Survey No. 3831; surveyed in December 1900; patent No. (vol. 365, pp. 341-344) issued March 17, 1903).

N

T. 2 S. R. 12 E.
S. B. M.
(Unsurveyed)



U.S. Location Monument N°82

A Granite rock in place 20x11 ft. 4 ft high above the general surface. chiseled cross (+) at initial point. and U.S.L.M. N°82.

0 300 600
Scale of Feet

14

Desert Queen (McHaney) Mine

Location: SW¼ sec. 5, and SE¼ sec. 6, T. 2 S., R. 9 E., S.B.M.; Twentynine Palms quadrangle, 15', 1955; Joshua Tree National Monument, about 7.8 miles S. 7° W. from Four Corners, Twentynine Palms and 1.4 miles northwest of Split Rock.

Ownership: William F. and Francis Keyes, P. O. Box 114, Joshua Tree, own 8 unpatented claims and a 5-acre mill site. Six of these claims have been submitted for patent (March 1959).

History: The mine has a recorded production as long ago as 1895. ~~Near and at the end of the 19th century,~~ through 1900 production of 3,701 oz. of gold is recorded. In 1895 Jim McHaney loaded about 200 pounds of gold "matte" worth #40,000, processed by amalgamation at a 2-stamp mill at Pinyon Well, aboard a horse drawn wagon and transported it to San Bernardino (William F. Keyes, oral communication, 3/18/59). The gold-quartz ore was taken from the "Rats Nest", a natural opening at first, and ran $1 a pound (William F. Keyes, oral communication, 3/18/59). A small force of men was employed at this time (Crawford, 1896, p. 310). The mine was active from 1912 through 1914 and again in 1923.

a few tons of ore was mined

From 1932 to 1941 (the mine was in nearly con-
each year
tinuous operation. During the early part of the 20th
From to
century ~~1912-1914~~ the gold-quartz ore was processed
in
~~by means of~~ a 5-stamp mill ~~(which included a Blake jaw~~
crusher, 20-ton Herman Ball mill and a Wilfley table.
~~The plant was driven by a 12-h.p. Lambert gas engine~~)
(Tucker and Sampson 1929, p. 477). ~~It~~ which was ~~located~~ at
the present site of the Keyes ranch, about 6 miles N.
75° E. of the mine. In the 1930's and early 1940's the
ore was processed in a 2-stamp mill built by W. F. Keyes.
It is about 4 miles N. 75° E. from the mine in the SW¼
sec. 34, T. 2 S., R. 8 E., SBM.

Geology: The mine workings are near the top of a
Mesozoic
steep northwest-trending ridge cut in the White Tank
~~quartz~~ monzonite, and just south of a sharp contact
Granite (Precambrian)
with the Palms ~~quartz monzonite~~. A steep N. 70° E.-
trending canyon is cut along the contact between the
16
two rock types (fig. ~~8~~).

Gold-bearing quartz veins and pockets, and pegmatite, aplite, and green basic dikes occur locally and are extensively explored by mine workings.

Development: Ore has been mined from at least 8 adits and 6 shafts at an elevation of about 4400 feet. The principal workings are at and near the top of a steep ridge (figs. 16 and 17). Several closely spaced nearly vertical shafts, sunk on a natural opening ("Rats Nest") in the country rock, extend down 60 to 75 feet to the main adit level. The area surrounding these workings is extensively blasted and caved and they are actually near the center of a large open cut. A few tens of feet northwest of these shafts is an adit, in poor condition which probably contains a winze sunk 50-75 feet to the main adit level, ~~for~~ of which a geologic sketch map has been prepared (fig. 16). The main adit level consists of at least 1,000 feet of drifts, crosscuts, raises, winzes, and stopes. Part of the workings have been backfilled with gangue.

Figure 16

Traveling north and up the jeep trail to the main adit, over a distance of about 300 feet, one passes by an adit driven east about 75 feet, a shaft inclined 45° E. and sunk to a depth of approximately 80 feet, and another shaft inclined 45° NE. and sunk to a depth of approximately 60 feet (~~fig. 1~~). Below and 200 to 300 feet northeast of the main adit are Two adits driven northeast about 60 feet each. Across the canyon to the northwest an adit is driven north and across a gulch to the east two adits are driven southwest (~~fig. 1~~). (~~These workings were not visited.~~) The mine is idle.

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Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable Metals Gold (ounces)	Silver (ounces)
1895	-	1,209	-
1896	-	2,419	-
1900	-	73	-
1912	39	48	23
1913	5	7	2
1914	7	23	4
1923	1	2	1
1932	5	5	2
1933	5	4	1
1934	6	11	3
1935	5	2	1
1937	145	28	46
1938	2	5	1
1939	10	5	2
1940	8	2	1
1941	5	2	-

References: Crawford, 1896, p. 310; Tucker and Sampson, 1929, p. 477.

J.R.E. 3/18/59

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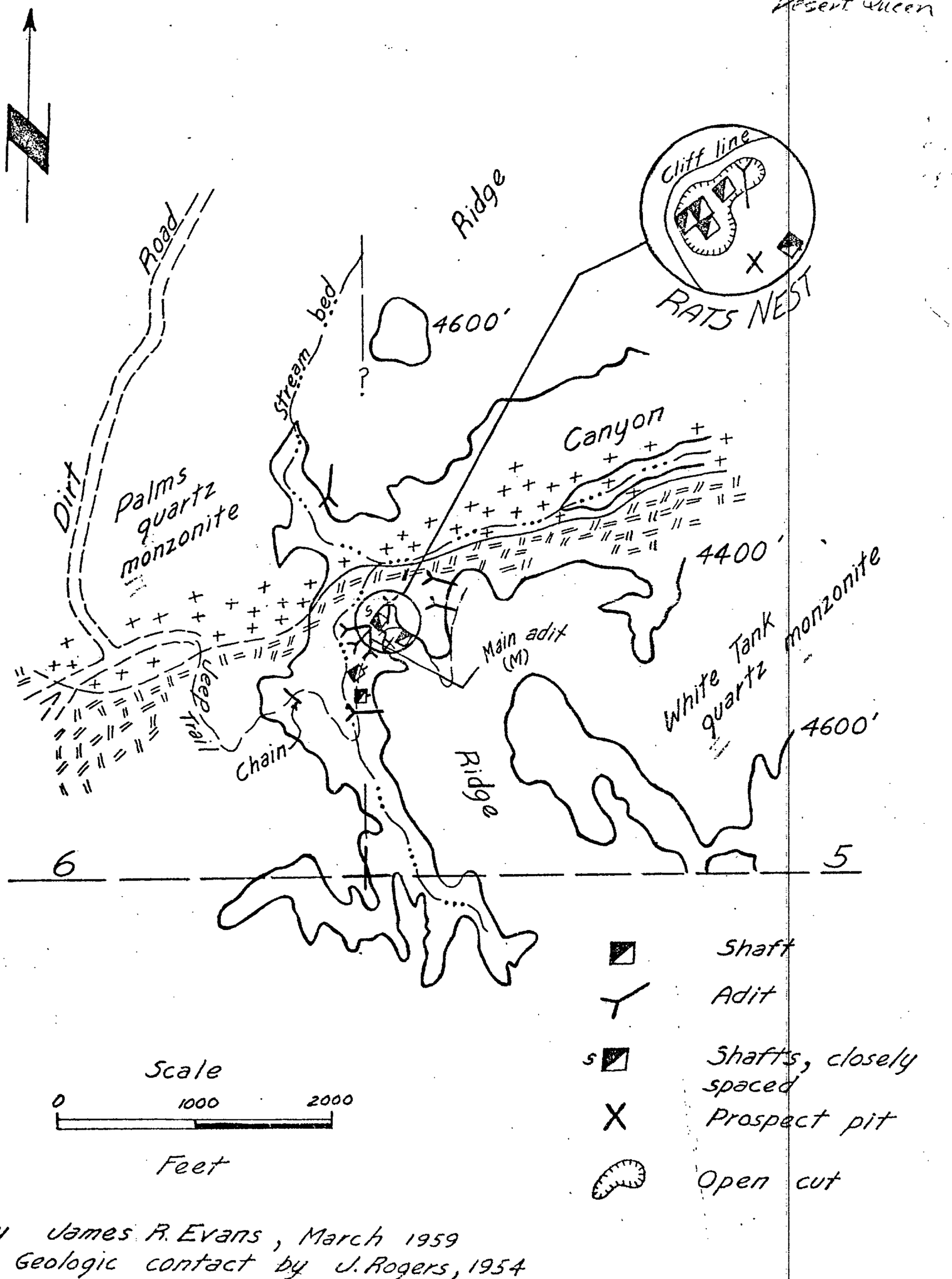
Figure (1) Geologic map showing the location and areal distribution of the workings of the Desert Queen mine, (topography and land grid from U.S.G.S 15' Twenty-nine Palms quadrangle, 1956).

Figure 16

Gold

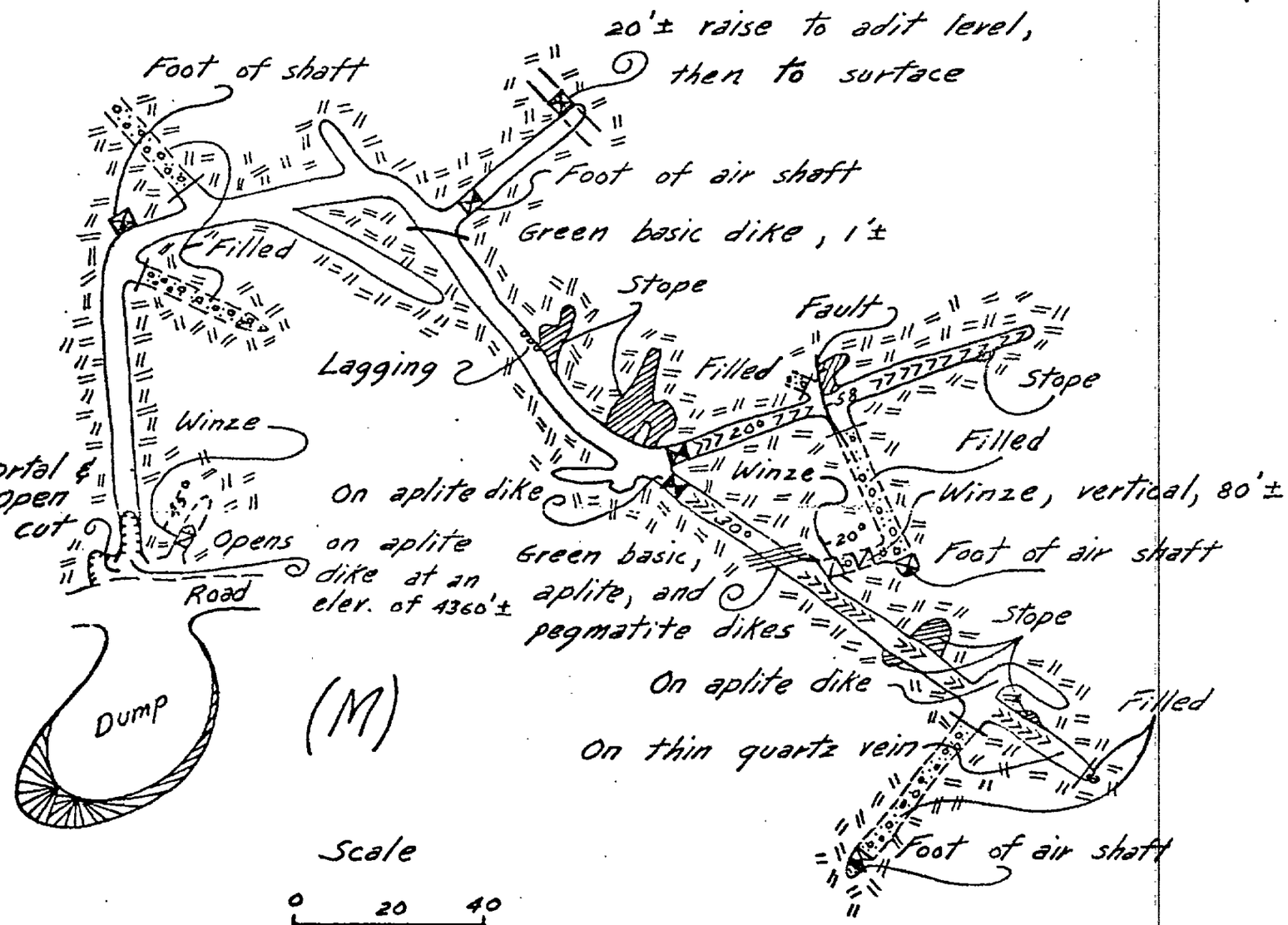
Desert Queen



By James R. Evans, March 1959
Geologic contact by J. Rogers, 1954

Figure 16. Geologic sketch map of the main adit level, Desert Queen mine.

Figure 16.



By James R. Evans
3/18/59

White Tank quartz monzonite

Dr. Musick Mine

Location: NW¼ sec. 19 (proj.) T. 4 S., R. 4 W., S.B.M., Steel Peak quadrangle, 7.5', 1953; about 6 miles west of Perris and three-quarters of a mile north and east of the Gavilan Mine.

Ownership: H. A. Martin, Route 2, Box 95B, Perris (1959).

History: This mine was leased at one time by a man named Dr. Musick, whose name it now bears. According to the present owner the mine has changed hands several times but the dates and periods of active mining were not determined.

Geology: A quartz vein strikes N. 5° W., across the northeast side of a shallow ravine cut in diorite and dips about 70° SW. The vein ranges from an inch or two up to a foot in thickness but it is poorly exposed and its lateral extent was not determined.

Development: An 80-foot shaft was sunk on the vein. According to the owner there are two 100-foot drifts but these were not accessible because of water which has flooded the mine to within 30 feet of the surface.

Production: Undetermined.

References: None.

R.B.S. 6/16/59.

Dos Palmas (Black Jack Claim) Mine

Location: Secs. ~~16 (?)~~ 22 and 23, T. 7 S., R. 12 E., S.B.M., U. S. Army Corps of Engineers ~~Canyon Spring~~ Hayfield quadrangle, 15', 19~~44~~ 63; 3½ miles northwest of Clemens Well, on the south slope of the Orocopia Mountains. The mine is reached by an unimproved dirt road up a wash which drains to the south. ~~(leaves the range near the triangulation station marked Can 890 on the topographic map.)~~

Ownership: Undetermined. The claims were held in 1955 by John C. Brinton, Eileen Brinton and George W. Robinson, under the name Black Jack Claims.

History: This property was first described in 1894, by which time there was a 90-foot and a 190-foot adit ~~(one adit was 90 feet long, and one 190 feet long)~~ (Crawford, 1894, p. 221). Subsequent reports add nothing that suggests activity later than the 90's.

Geology: The country rock is Precambrian gneiss. A quartz vein lies in the plane of a fault which strikes N. 55° E., and dips 50° - 55° NW. The fault zone is as much as five feet wide and contains a soft gouge of chlorite schist. It is well exposed for several thousand feet across several ridges and intervening canyons. The full northeasterly extent of the fault was not determined but to the southwest it is truncated by a wide, northwest-trending fault zone which probably is part of the San Andreas system.

The quartz vein pinches and swells, ranging from 0 to 4 feet in thickness. It is fractured. Contained pyrite is altered almost completely to iron oxides which have filled fissures and cavities. Small amounts of secondary copper minerals and calcite are present. Several samples of ore contain visible traces of gold, but no assay data were found.

Development: The vein was explored by means of adits driven northeast on 3 levels in the southwest slope of a ridge immediately north of a mill and camp site (fig. 17). The adits are joined by stopes which appear to be as much as 30 feet wide. The ground stands well, being only slightly caved at the portals. The adits are untimbered. The stopes are timbered with stulls. Ore was milled at the mine but water was probably in short supply.

Production: Undetermined.

References: Crawford, 1894, p. 221; Merrill and Waring, 1917, p. 541; Tucker and Sampson, 1929, p. 477; 1945, pl. 35.

R.B.S. 2/25/60.

Figure 17

Dos Palmas Mine

a sketch of the workings in the plane of the ~~ore deposit~~

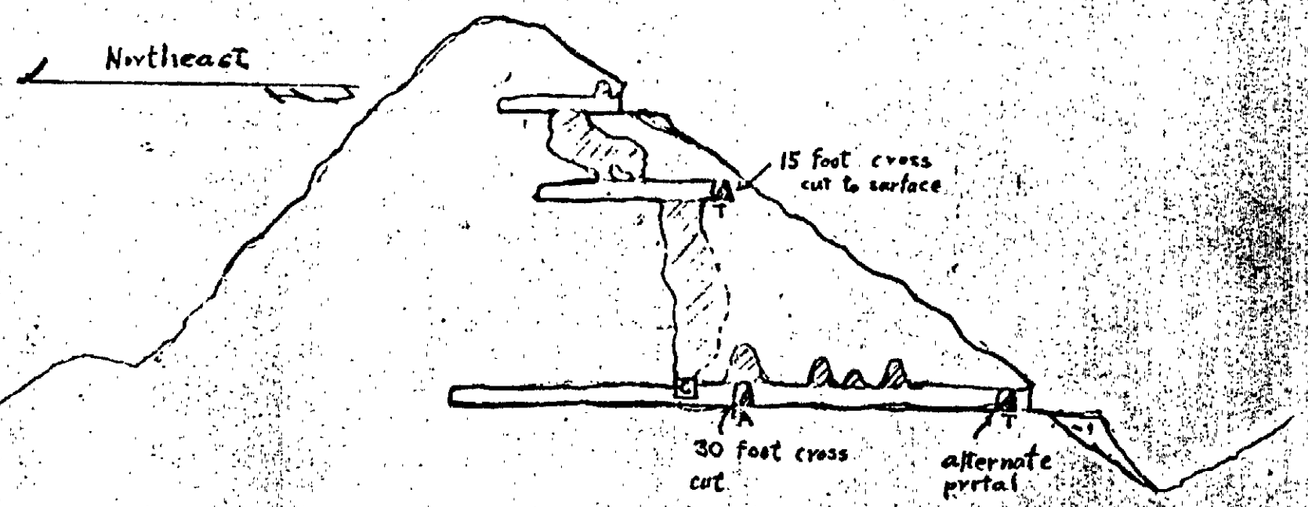
Scale

1 inch equals 100 feet

0 50 100 200 300

Symbols

- ore chute
- cross cut
- T = Toward, A = away
- Stope



R. K. Saul 3/25/60

Figure 14.

Fold

Dos Palmas

Dottie Welborn Claim

Location: SE¼ Sec. 30, T. 6 S., R. 15 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Chuckwalla Mountains quadrangle, 15', 1953; just east of the mill site labeled Red Cloud Mine on the quadrangle map, and about 8 miles by dirt road southeast from a point on U. S. Highways 60 and 70 about one mile west of Skylark Ranch (fig. 39).

Ownership: Undetermined.

History: A patent was issued on the Dottie Welborn claim in 1904, to the Red Cloud Mining Company. No published reference to this claim was found.

Geology: The country rock is contorted Precambrian gneiss cut by pegmatite dikes ranging from 0 to 4 feet in thickness. As far as could be determined, no gold-bearing deposit is exposed on the surface or in the workings, a possible exception being the northwest end of the claim where a zoned pegmatite dike as much as 3 feet wide has been opened by a prospect pit. The dike strikes N. 45° W. and dips 65° NE. The walls of the dike comprise zones of quartz and feldspar as much as one foot wide. The uneven central zone is translucent quartz pocketed with oxides of iron derived from the alteration of sulfides.

Development: Exploration was centered at the southeast end of the claim near a campsite and the road. It consists of a 50-foot vertical shaft in gneiss on the north side of the canyon and an adit driven 20 feet southeast into the south wall of the canyon. (The claim appears to have been used primarily as a camp site and possibly as a mill site.)

Production: Undetermined. (1960).

References: None.

R.B.S. 2/8/60

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Double Jack Claims

Location: W½ sec. 19, T. 6 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15' 1952; at the south end of the McCoy Mountains, on the west slope of a north-trending ridge.

Ownership: J. J. Rakocy, 527 N. Kenmore Ave., Los Angeles (1960).

History: The Double Jack Claims were located recently (probably in 1959) but appear to include parts of older claims for which no data were found.

Geology: The area is underlain by schistose Mesozoic (?) metasedimentary rocks which strike N. 25°-35° W., dip 10°-15° NE. and are cut by mineralized faults. Two systems of faults appear to be present. One comprises faults which strike N. 60°-70° W. and cut the planar structure of the country rock at high angles. The other system faults appear to be essentially parallel to the structure of the country rock. The two systems differ in mineral content, the faults which cut across the trend of the country rock contain lenticular bodies of massive quartz as much as 5 feet in thickness containing minor proportions of specular hematite, calcite, and chlorite. Those faults which parallel the structure contain, in addition to the above minerals, small pockets and crusts of secondary copper minerals, but appear not to be as wide as those of the other system and have more irregular boundaries.

Development: The claims have been developed through an adit (shown on the topographic map), a 10-foot, vertical shaft, and several shallow prospects.

The adit is driven about 25 feet southeast, on a vertical quartz vein as much as 2 feet wide, exposed on the slope of the ridge. This opening is part of an earlier period of development. The 10-foot shaft is new work and explores the alluvium near the base of the slope at a point about 1,000 feet south of the adit. (The presence of a discovery in the shaft could not be determined from the collar.)

Production: Undetermined.

References: None.

R.B.S. 10/17/60.

Duplex Mine

Location: Sec. 14 ~~XX~~, T. 2 S., R. 12 E., S.B.M. ~~(proj.), U. S. Army Corps of Engineers Eagle Tank~~ Pinto Basin quadrangle, 15', 1943; Pinto Mountains, about 3 miles north-northeast of Sunrise and Mission Wells (~~see pl. 3~~ figure 31)

Ownership: Earl and Rose Geiger, 2109 N. Durfee, El Monte own at least 1 unpatented lode claim (March 1958).

History: Apparently part of the Standard-Duplex Group owned in 1933 by J. F. Darling, Indio, and Wesley McGrath, Los Angeles (Tucker, 1933, unpublished Field Report No. 122). At this time little more than assessment work had been done.

Geology: A north-northwest-striking and 77° SW.-dipping fault cuts Mesozoic quartz monzonite. The fault zone is 1 foot in average thickness and contains thin quartz stringers near the ground surface.

Development: A shaft is sunk at least 100 feet in the fault plane. There are probably drifts at one or more levels. Total workings are estimated to be about 400 feet. ~~(The mine was not in operation on the day of the property visit.)~~

Production: Undetermined.

References: Tucker, 1933, unpublished Field Report No. 122.

J.R.E. 3/10/60.

(Lucky Boy)

Elton Mine

Location: SW¼ sec. 8, T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 15', 1955; Joshua Tree National Monument, about 8.7 miles S. 5° W. from Four Corners, Twentynine Palms and 0.7 of a mile west of Split Rock.

Ownership: Mr. Grinnell, one 20-acre claim (1941). Undetermined (1959).

History: Undetermined.

Geology: The mine workings are in gray to brown, medium-grained massive Mesozoic quartz monzonite which is intruded by numerous aplite dikes, as much as one-foot thick, and a few thin veins of milky quartz.

Development: Four very old vertical shafts, all at least 50 feet deep, have been sunk in the quartz monzonite over a southwest-trending, rectangular area about 500 by 200 feet at an elevation of 3,320 feet. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 2/13/59

Gold

Eureka Group

Location: Sec. 3 (6 7 (proj.), T. 7 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; in a narrow canyon in the southwest margin of the Chuckwalla Mountains about 12 miles, by dirt road, southeast of U. S. Highways 60 and 70.

Ownership: Richard T. Ransdell and others, 1680 Main Street, Brawley (1959).

History: Undetermined.

Geology: These claims appear to lie along a poorly exposed fault zone which cuts contorted gneissic rocks. It strikes N. 45° W. and dips shallowly to the southwest. An alignment of saddles and ravines suggest that this fault might be traced as far as (2) miles to the northwest and (1) mile to the southeast of the claims. The fault zone contains lenses and stringers of fractured vein quartz associated with chalcopyrite, oxides of iron, malachite, chrysocolla, calcite, and an undetermined (percentage) of free-milling gold. The quartz veins appear to be as much as a foot in width.

About a quarter of a mile west of the above described fault another fault is exposed for about 300 feet on a ridge at the mouth of the canyon. Here, two quartz veins as much as a foot wide contain small concentrations of galena, lead carbonates, chrysocolla, malachite, and oxides of iron. These veins strike west and dip 30° south. Here too, the country rocks are gneiss.

Development: Development on the Eureka group of claims comprises a discovery shaft at the southeast end of the property and access roads and bulldozer cuts.

Development of the western veins appears to represent activity on an older claim, which may not be part of the Eureka group. It consists of two inclined shafts, both 25 feet deep. One is on what appears to be the most extensive vein and the other, some 60 feet farther east and about 40 feet up the slope to the south, explores a more poorly exposed, parallel vein.

Whether or not the western group is part of the holdings of the Eureka group was not determined.

Production: Undetermined.

References: None.

R.B.S. 4/30/59.

Frank Hill (Star) Mine

Location: Sec. 13 (?), T. 2 S., R. 11 E. ~~(?)~~ V, S.B.M. ~~(proj.), U. S. Army Corps of Engineers) Pinkham Well~~ Hexie Mountains quadrangle, 15', 1953; Pinto Mountains, about 3½ miles west of the Gold Crown mine and close to 3 miles northeast of Pinto Mountain ~~(see pl. 31)~~. figure 31

Ownership: Alice and Vincez Zimmerman, 19078 Slover, Bloomington own 4 unpatented lode claims (March 1958).

History: Apparently the mine was originally located in the early 1930's by the Frank Hill Mining Company, Frank Hill, president, ~~R. Gfeller, secretary,~~ Twentynine Palms (Tucker and Sampson, 1945, p. 130). The mine was active in 1936, but was then owned by Vincez Zimmerman who had renamed it the Star mine.

Geology: Tucker and Sampson (1945, p. 130) report a 4-foot quartz vein in granite (quartz monzonite) which strikes north and dips 40° W. Probably the vein occurs along a fault.

Development: A shaft is sunk on the vein to a depth of 225 feet. There are drifts on the 50, 100, and 200-foot levels (Tucker and Sampson, 1945, p. 130). On the day of the property visit the mine was not being worked and the shaft was locked. As a result no new information can be added concerning either the geology or the workings. The mine access road is narrow and in large part in poor condition.

Production: A record of production for only one year was found, but judging from the reported extent of the workings there may well have been more. The record was compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)
1936	5	2	1

References: Tucker and Sampson, 1945, p. 130.

J.R.E. 3/30/60

(4T In 1936 five tons of ore yielded two ounces of gold and one ounce of silver.

Gavilan Mine

Location: SE¼ sec. 19 (proj.), T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 6 miles west of Perris.

Ownership: Mrs. Orva Nelson, Hillcrest Road, Perris.

History: The Gavilan is an old mine which (It) was reported (Merrill and Waring, 1919, p. 528) to have been worked by Mexicans, probably during the early or middle Eighteen hundreds. There followed a period of operation under American ownership. When, in the late Eighteen hundreds, the Gavilan Mine became the property of the San Jacinto Estate, Ltd., of London, it had been idle for many years. Between 1890 and 1892 it was operated, under lease, by an American company. By 1917 the mine was again idle, the machinery having been sold. When visited in 1959 the property appeared long idle.

Geology: A quartz vein, which appears to lie along a fault, is exposed for about 50 feet on the northwest side of a low outcrop of Mesozoic diorite. The vein strikes N. 70° W., dips about 50° SW., and is one to two feet wide. Free milling gold occurs with iron oxides in fractures and cavities in the vein. The vein in the nearby Ida-Leona mine (see herein) was reported to carry, in addition, pyrite and galena (Tucker and Sampson, 1945, p. 136). It is probable that the same minerals are present at depth in the Gavilan mine.

Development: The mine is caved and inaccessible. It was reported (Tucker and Sampson, 1945, p. 135) to have been entered through a shaft 485 feet deep on the vein. The size of the dump suggests extensive development.

Production: Undetermined.

References: Goodyear 1888, p. 527; Storms 1893, p. 366-367; Crawford 1894, p. 221; 1896, p. 311; Merrill, and Waring, 1919, p. 528; Sampson 1935, p. 508; Tucker and Sampson, 1945, p. 135-136; Larsen, 1948, p. 310.

R.B.S. 6/15/59.

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Gold Crown (Bon Ton) Mine

Location: Secs. 10 and 15, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 15' 1956; Pinto Mountain, about 3 miles south of New Dale (Site) and about 4½ miles south of the Supply mine (Figure 31 ~~pl. 3~~). ~~The information given under~~ History, Geology, and Development is taken largely from previous descriptions of the mine by Tucker and Sampson, (1945, p. 130 and 1929, pp. 478-479).

Ownership: H. G. Frydenlund, Box 704, Twentynine Palms, owns 3 unpatented claims; the Bon Ton, Gold Crown No. 12; and the San Bernardino (March 1958).

History: Denny Pardu, San Bernardino, located the San Bernardino claim in 1896 (Tucker, 1934, unpublished Field Report No. 123). In 1926 the property comprised 25 claims and was owned by the Gold Crown Mining Company, George A. Novell, president, Monrovia. The Gold Crown Mining Company operated the mine intermittently from 1926 to 1938. A 50-ton cyanide plant was built on the property in the early part of 1935 (~~fig. 1~~), and treated ore from the Gold Crown and Nightingale (San Bernardino County) mines until 1938, when the mill and all other equipment was moved to the Supply and Nightingale mines 6 miles to the north, in San Bernardino County. By this time ore had been depleted to a depth of 400 feet, and the claims were abandoned. The present owner operated the mine in 1940 and 1941.

Photo 13 362

Geology: The Gold Crown quartz vein trends N. 20° W., dips 75° W., and cuts Mesozoic quartz monzonite. It ranged in thickness from 4 to 8 feet and had an average value of $12 per ton. There is also a series of parallel quartz veins striking N. 50° E., that intersect the Gold Crown Vein north of the main shaft. These veins range in thickness from 1 to 2 feet. About 2000 feet southeast of the Gold Crown shaft on the San Bernardino claim, the quartz monzonite is cut by a vein that strikes N. 15° W., dips 80° E., and ranges in thickness from 1 foot to 1½ feet in ~~thickness.~~ The average value was reported to be $15 per ton in gold. The Gold Crown and San Bernardino veins both occur in shear zones and contain chalcopyrite, hematite, and free gold.

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Development: At intervals along the outcrop, the Gold Crown vein is developed by 4 shafts ranging in depth from 75 to 640 feet. The principal development work is confined to the double-compartment Gold Crown shaft. (Fig. 2). It is sunk 640 feet on the vein with extensive drifts run at 100-foot intervals to and including the 600-foot level. Total work is about 6000 feet. Several ore shoots, which ranged from 75 to 100 feet in length and had an average thickness of 6 feet, were developed. Ore was stoped from the 400-foot level to the surface. Although 600 feet of drifts were driven on the 600-foot level, no commercial ore bodies were developed. About 100 feet north of the Gold Crown shaft, a second shaft is sunk on the vein to a depth of 100 feet. Apparently a raise from the drift on the 200-foot level [illegible] of the Gold Crown shaft connects with this shaft.

A shaft is sunk on the San Bernardino vein to a depth of 220 feet. Short drifts are run on the vein, both north and south, on the 40, 80, and 130-foot levels. About 30 feet west of these workings there is a parallel vein 6 inches thick which has been exposed by means of a shaft 20 feet deep.

Water was obtained from a well at Old Dale 9 miles north of the mine on the Twentynine Palms Highway. A concrete storage tank at the mine had a capacity of 18,000 gallons.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Gold Crown and Nightingale (?) Mines

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lbs.)
1935	6,089	1,666	1,740	11
1936	10,706	4,254	5,761	
1937	14,653	5,001	5,023	
1940	53	47		
1941	5	2		

References: Tucker, 1934, unpublished Field Report No. 123; Tucker and Sampson, 1929, pp. 478-479; Tucker and Sampson, 1945, p. 130.

J.R.E. 3/11/60.

Gold Crown (San Diego) Mine

Location: NW¼ sec. 4 (proj.), or NE¼ sec. 5 (proj.), T. 6 S., R. 15 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Chuckwalla Mountains quadrangle, 15', 1945 63; about 3 miles southwest of Desert Center.

Ownership: Chuckwalla Uranium Inc., c/o J. Rakocy, 527 N. Kenmore Ave., Los Angeles (1959).

History: In 1894 this mine was mentioned as a new prospect under the name San Diego Mine. E. E. Bowles, San Diego, was the owner. By 1896 a small amount of development work had been done (Crawford 1894, p. 224; 1896, p. 313-314), but by 1917 the San Diego Mine had been abandoned (Merrill and Waring, 1917 p. 540). Between an undetermined date, probably sometime in the late twenties, and 1949, the Gold Crown mine was held by the owners of the Granite mine which is immediately north of it. In 1949 the present owner bought the Gold Crown mine from Henry K. Hennigh.

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Geology: A vertical fault, mineralized with gold-bearing quartz veins as wide as 4 feet, strikes northwest down a granite ridge. It is exposed for about 300 feet. The southwest slope of the ridge is cut by northeast trending shears which dip 80° NW. and are only sparsely mineralized. Vein quartz and included cavity and fracture filling iron oxides are the chief minerals in this deposits. The owner stated (personal communication, J. Rakocy, Mar. 3, 1959) that the better ore runs as high as $600 per ton in free-milling gold but did not describe the sampling technique employed.

Development: The former owner explored the north end of the main fault outcrop through 2 shallow adits driven southeast. The lower of these adits is 30 to 40 feet long, the upper about 10 feet long. The present owner has prospected the vein outcrop several hundred feet farther up the ridge. Two adits were driven into the west slope with the object of crosscutting the vein.

Photo 14

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The lower of these 2 adits follows the crushed footwall zone of a fault for about 170 feet without reaching the vein. A 20-foot winze is located about 20 feet from the portal. About 130 feet from the portal a crosscut extends 90 feet southeast. At the end of the adit an 18-foot crosscut was driven southeast and a 12-foot one northwest. The upper adit is about 100 feet up the slope and is about 55 feet long. A crosscut is driven 35 feet northwest from its face. Except for a narrow shear, exposed near its portal, the upper adit and appended crosscut are in barren rock.

Production: Undetermined.

References: Crawford 1894, p. 224; 1896, p. 313-314; Merrill and Waring, 1917, p. 540; Tucker and Sampson, 1929, p. 487.

R.B.S. 3/10/59.

Gold Cup Group

Location: Sec. ~~23 (X)~~ 24 (proj.), T. 6 S., R. 13 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Hayfield ~~Canyon Spring~~ quadrangle, 15', 19~~44~~ 63; on the northeast slope of the Orocopia Mountains, on the south side of a west-trending canyon, 2½ miles south of U. S. Highways 60 and 70.

Ownership: Undetermined.

History: This mine was held in 1945 by E. G. Sweeney, 355 Norton St., Long Beach. At that time it was idle. (Tucker and Sampson, 1945, p. 130-131, pl. 35). No previous or subsequent ~~history~~ record of activity was found.

Geology: The Gold Cup Group is in an area underlain by granitic rock. The 5 claims include a north-trending ridge cut by two faults which contain quartz veins. One fault strikes along the ridge N. 10° E. and appears to dip about 60° east-southeast. This fault is truncated by a second fault which strikes N. 60° W. through a saddle in the end of the ridge (~~fig. ___~~) and dips 55° SW. The northwest-trending fault is exposed for about 450 feet across the ridge, and the northeast-trending fault is well exposed for about 100 feet southwest of the junction. Irregular quartz veins lie in the planes of both faults. ~~The~~ quartz in the northwest-trending fault vein appears to be as much as 10 feet wide, and in the northeast-trending fault vein reaches a maximum thickness of about 20 feet near the junction of the faults and narrows to a foot or less to the southwest.

The quartz veins have been fractured and crushed, crushing being most pronounced near the hanging wall of the northwest-trending fault. Jasper, chalcedony, iron oxides, and traces of secondary copper minerals have partially recemented the broken quartz. Some of the iron oxide occurs as pseudomorphs after pyrite. The crushed vein material in the northwest-trending fault was reported to carry $48 per ton in gold and a streak immediately against the hanging wall $320 per ton. These data were not checked.

Development: The deposit is opened by a shallow cut in which is a partially caved shaft filled to within 10 feet of the cut surface. In addition, some exploration has been done by bulldozer. cuts have been made across the saddle, up the ridge, and down the west slope (fig.).

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 130-131, pl. 35).

R.B.S. 2/11/60.

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Gold Dollar Mine

Location: SW¼ sec. 36 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 15' 1950; on the north slope of the Riverside Mountains 5¼ miles south of Vidal.

Ownership: John H. Ware, 408 N. 9th Street, Santa Paula (1958).

History: The earliest record of the Gold Dollar mine is a brief statement by in the Fifteenth Report of the State Mineralogist (Merrill and Waring, 1916, p. 84) which gives ing the original number of claims, the location, the fact that only assessment work had been done at that time and the owners; "Messrs. Ware and McMillan, of Calzona". In 1929 the owner was Riverside Gold Mining and Milling Company, J. W. Ware, president, 363 Orizaba Avenue, Long Beach, California (Tucker and Sampson, 1929, p. 479). The Gold Dollar was reported idle in 1945 (Tucker and Sampson, 1945, p. 131). The last known activity on this property was in 1950 under lease to P. E. and Joe Borg and Lynda Development Co.

Geology: The country rock in the Gold Dollar mine area is contorted Precambrian gneiss interlayered with abundant thin quartzite units. A mineralized shear zone is exposed for about 1,000 feet down a steep ravine.

It strikes N. 15° W. and dips 65° NE. A gold-bearing vein, as wide as 8 feet fills the shear zone. The vein material is largely oxides, carbonates, and silicates of iron and copper. Hematite is the most abundant gangue mineral. Malachite and chrysocolla are intimately associated with the hematite, apparently having a common origin in chalcopyrite, small quantities of which remain unaltered in some of the ore. Quartz, barite, calcite, and manganese oxides, are also common in the vein.

Development: The mine was developed through 2 adits, one near the head of the ravine and the other about 300 feet down the slope. The upper adit was driven southeast about 65 feet to an ore body from which point a drift follows the vein S. 50° W. for a distance of 250 feet. At a point on the drift 80 feet from the adit a winze was sunk 60 feet on the vein. This work exposed an ore shoot 2 to 8 feet wide and 100 feet long. The vein is faulted at the southeast end of this shoot. The lower adit, which was 500 feet long in 1945 (Tucker and Sampson,1945, p. 131) was driven S. 10° E. on or near the vein. The differing attitude of the deposits exposed in the upper and lower workings suggests mineralization on more than one fault.

Ore was transported down the ravine to the camp by means of an aerial tramway, now inoperable. The adits are reached by a steep trail from the camp-site below and were open and dry when visited (1957).

The road to the site follows the bed of a wash for most of its length and is in poor repair.

Production: The best year for this mine was 1932 during which it yielded 59 tons of ore from which 48.24 ounces of gold, 10 ounces of silver and 1,691 pounds of copper were refined. In 1950, O. W. and Joe Boring and Lynda Development Co. removed 8 tons of ore from which 8 ounces of gold, 6 ounces of silver and 451 pounds of copper ~~was~~ were recovered (U. S. Bureau of Mines records published with permission of the owner).

References: Merrill and Waring, 1917, p. 544; Tucker and Sampson, 1929, p. 479; 1945, p. 131.

R.B.S. and C.H.G. 12/20/57.

Gold Fields of America

Mine

Location: Sec. 5, T. 3 S., R. 10 E., S.B.M. (proj.), (U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; Pinto Mountains, Joshua Tree National Monument, about 4.3 miles southeast of White Tank and 0.5 mile north of the Pinto Basin road (see pl. 2).

Ownership: Undetermined.

History: In 1945 the property comprised 12 claims and was owned by Goldfields of America, Ltd., Otto Notterman, president, Frank Notterman, secretary, San Bernardino (Tucker and Sampson 1945, p. 131).

Geology: Both the mine and mill site areas are underlain by Pinto Gneiss, criss-crossed by minor faults containing iron-stained gold (?)-bearing milky quartz veins (fig.). In the mill site area the gneiss is intruded locally by White Tank Quartz Monzonite.

Development: One-quarter mile northeast of the Gold Point mine in the mill site area, Southeast half a mile an adit is driven 200 feet southwest through a 57° southeast-dipping shaft at the 25-foot level ( ) The shaft continues about 90 feet below this level on the same inclination. The mine is idle.

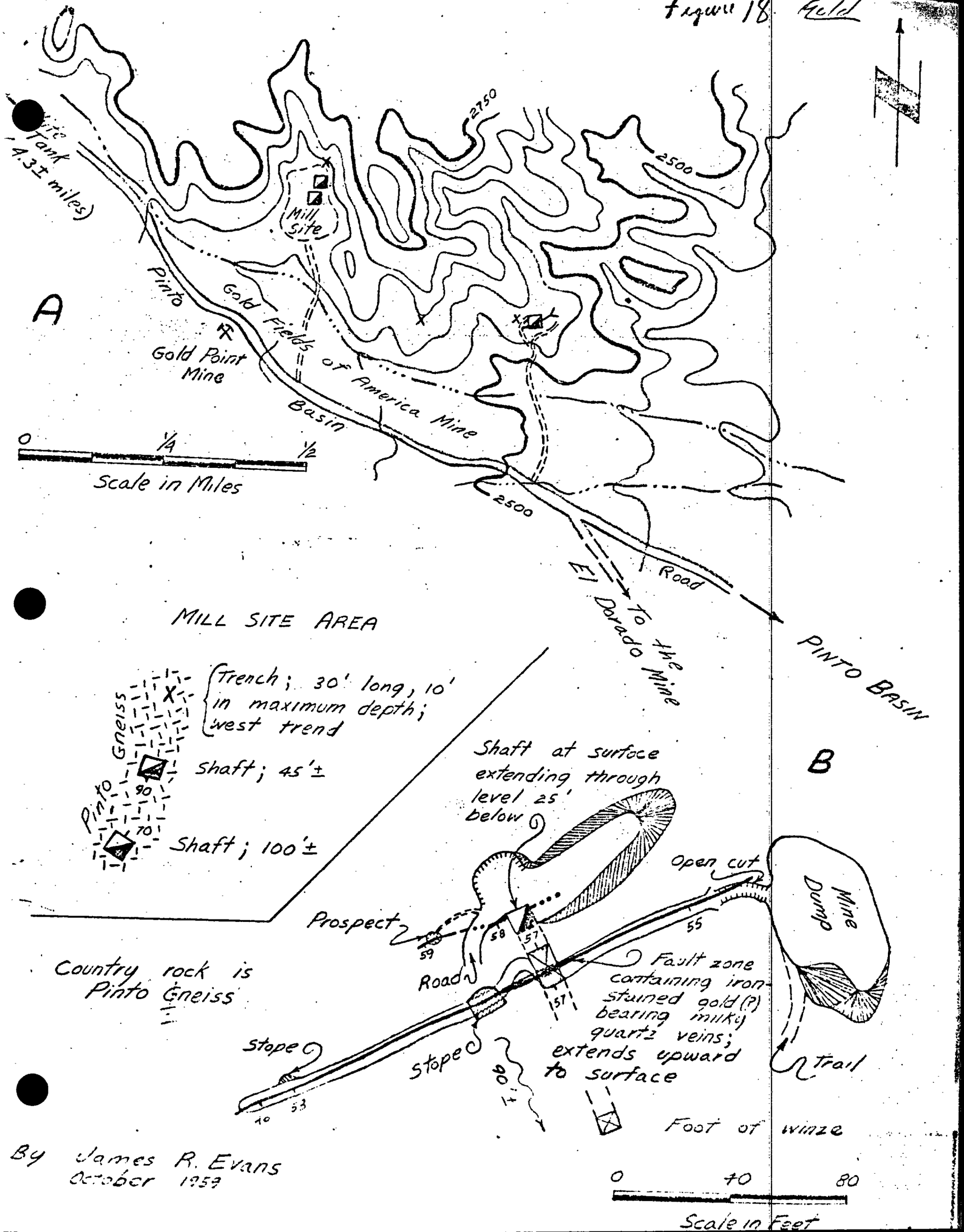
Production: Undetermined.

References: Tucker and Sampson, 1945, p. 131.

J.R.E. 10/15/59

Figure 18. Sketch map showing the areal distribution (A), and a geologic sketch map (B) of the Gold Fields of America mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

Figure 18. Gold



By James R. Evans
October 1959

Gold Galena (Gold Coin) Mine

Location: W½ sec. 9, NE¼SE¼ sec. 8, T. 3 S., R. 9 E., S.B.M., Lost Horse Mountain quadrangle, 15', 1958; Joshua Tree National Monument, south face of the Hexie Mountains 1½ miles east of Squaw Tank.

Ownership: Undetermined (1960).

History: The Gold Galena mine was discovered about 1900. In 1914 the Gold Galena Mining Company owned the property which is reported to have included nine claims in secs. 4, 8, and 9, T. 3 S., R. 9 E., S.B.M., with workings down 70 to 100 feet; no mill was on the property and no bullion had been produced (Merrill, 1917 (1919) p. 538). By 1917 the mine was apparently idle (Brown, 1923, p. 99). In 1920 W. F. Keys, Joshua Tree, located two claims (Pleasant Valley, Jackson) which cover the area most extensively explored. Mr. Keys does some intermittent development work.

Geology: The Hexie Mountains are underlain mostly by banded quartz-biotite gneiss (Precambrian Pinto gneiss). In the mine area an irregular body of granite, half a mile wide and a mile or more long, and three pods of coarse-grained hornblende gabbro (all of probable Mesozoic age) crop out. An east-west shear zone is intermittently exposed across the mine area for more than half a mile. Where exposed in mine workings this shear zone strikes N. 60° W. to N. 80° E., dips 20° to 35° northward, is 2 to 15 feet wide, and contains thin discontinuous quartz stringers ranging from 6 inches to 3 feet in thickness. In most exposures the quartz is fractured, stained red, brown, and black by iron oxides, contains pyrite cubes altered to iron oxide, and shows some green copper stains. A fine-grained, gray aplite (quartz monzonite?) dike is associated with the shear zone. The aplite contains sparse iron sulfides and the dike forms either the hanging wall or footwall in most workings that have explored the shear zone. According to Merrill (1917, (1919), p. 538 the mine explored a vein which contained galena carrying gold.

Development: The Gold Galena mine workings explore the shear zone-aplite dike contact over an east-west distance of half a mile. There are 8 inclined shafts of undetermined extent, numerous shallow pits and cuts, and 2 vertical shafts 50± feet deep. The most extensive workings are in the west part of the area where the largest inclined working is boarded over. Merrill (1917, (1919), p. 537) reported that in 1914 the workings were down from 70 to 100 feet. Although the deeper workings could not be entered in 1957 they apparently have not been much changed since the depths reported by Merrill.

Production: Undetermined (1960).

References: Merrill, 1917 [1919] p. 538; Brown, 1923, p. 99; Tucker and Sampson, 1929, p. 479; Tucker and Sampson, 1945, map, no. 44; Goodwin 1957, p. 603.

C.H.G. 6/29/57.

Gold Park Consolidated (?)

Mine No. 1

Location: SE¼ sec. 2, T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 15' 1955; Pinto Mountains, Joshua Tree National Monument, about 8.5 miles S. 21° E. from Four Corners, Twentynine Palms. (see ~~pl. 1~~ Figure 19).

Ownership: Undetermined.

History: Undetermined.

Geology: Precambrian Pinto gneiss is cut by numerous thin veins of hematite-pyrite-gold (?) bearing milky quartz, and a few pegmatite dikes. The quartz veins are stained yellow and red from oxidation of the iron minerals and are strongest along pre-existing faults.

Development: A 50-foot shaft, inclined 80° west, is sunk on a north-trending quartz vein. About 12 feet below the surface is a westerly excavated 5-foot stope. A trench, ranging in depth from 0 to 2 feet is dug from a point 40 feet east of the shaft to the collar of the shaft. About 350 feet northeast of the shaft, and at nearly the same elevation, are 2 adits accessible through the same portal. One adit is driven N. 50° W. along a nearly vertical fault, for a distance of 66 feet, and the other is driven N. 25° W. for a distance of 54 feet (~~fig. 17~~ figure 20). It is idle.

Production: Undetermined.

References: None.

J.R.E. 2/12/59

Figure 19

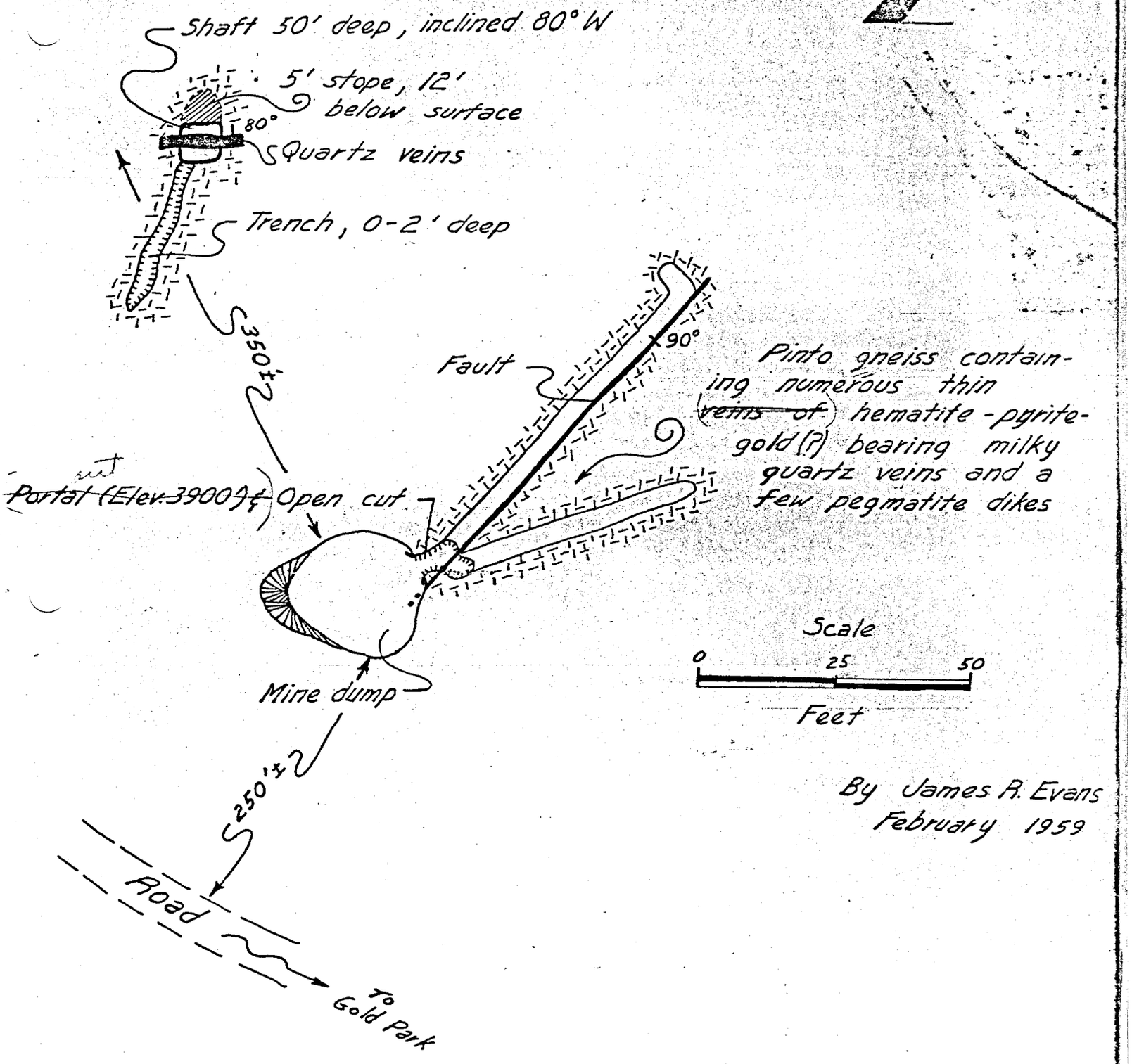
377 Figure 20

figure 20.

Gold

Gold Park Cons.

#1



By James R. Evans
February 1959

Fig. 20. Geologic sketch map of the Gold Park Consolidated (?) Mine No. 1.

Gold Park Consolidated (?)

Mine No. 2

Location: SW¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.) Valley Mountain quadrangle, 15' 1956; Pinto Mountains, Gold Park, 8.3 miles S. 23° E. from Four Corners, Twentynine Palms (see Figure 19).

Ownership: Undetermined.

History: Undetermined.

Geology: A nearly vertical fault strikes N. 60° W. in Mesozoic coarse grained hornblende granite. Criss-crossing gold (?) quartz veins, as much as 1-foot thick occur in the granite and are strongest along the fault plane.

Development: An adit is driven S. 60° E. approximately 45 feet along the strike of the fault. Immediately in front of the portal and centrally located in an open cut that leads into the adit is a shaft sunk vertically about 35 feet in the fault plane.

Production: Undetermined.

References: None

J.R.E. 2/12/59.

Gold Park Consolidated (?)

Mine No. 3

Location: SW¼ sec. 1, T., 2 S,, R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, 8.3 miles S. 25° E. from Four Corners, Twentynine Palms. (see ~~pl. 1~~ figure 19).

Ownership: Undetermined.

History: Undetermined.

Geology: Numerous thin gold-bearing (?) quartz veins, dense green basic dikes, and aplite dikes as much as 1-foot thick occur in Mesozoic monzonite (?) porphyry and hornblende granite. The highly graditional contact between the two rock types is well exposed about midway along a trench connecting two adits, (~~fig. 17~~ figure 21). Both rock units are highly weathered and undergoing granular disintegration.

Figure 21

Development: Two shafts, about 120 feet apart, are sunk in hornblende granite (fig. 1). The southernmost one is inclined 75° W. and is sunk to a depth of at least 50 feet. The other shaft is inclined 65° W. and is 12 feet deep. About 170 feet northwest is a shallow, nearly north-trending trench connecting two short adits (fig. 1). The northernmost adit, a few tens of feet from the road, is driven northwest about 6 feet in monzonite (?) porphyry. The more southerly adit is driven southeast about 12 feet in hornblende granite. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 2/12/59.

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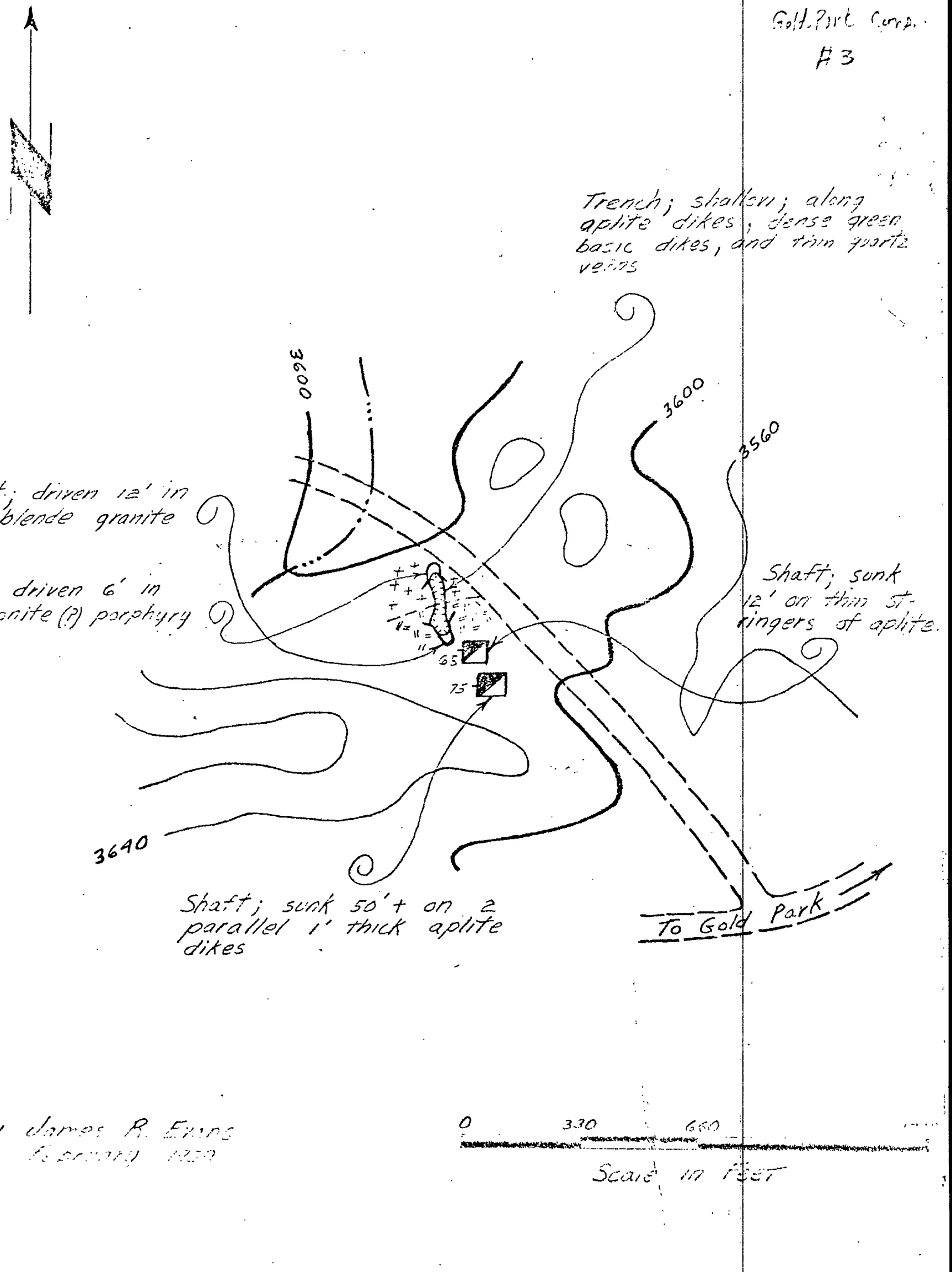
Figure 21. Sketch map of the Gold Park Consolidated (?) Mine No. 3 (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

figure 21.

Gold

Gold Park Corp.

#3



By James R. Evans
February 1959

Gold Park Consolidated (?)

Mine No. 4

Location: SW¼ sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 9.2 miles S. 33° E. of Four Corners, Twentynine Palms (see pl. 1 ~~1~~, Figure 19).

Ownership: Undetermined.

History: Undetermined.

Geology: A north-striking and steeply east-dipping fault cuts the Pinto gneiss. A persistent clayey gouge zone about 1-foot thick occurs in the fault plane. No mineralization was observed (fig. 22).

Development: An open cut leads into the portal of an adit-driven north 140 feet along the strike of the fault. At 136 feet a winze is sunk vertically about 18 feet in the fault plane (fig. ~~11~~). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/19/59.

Figure 22

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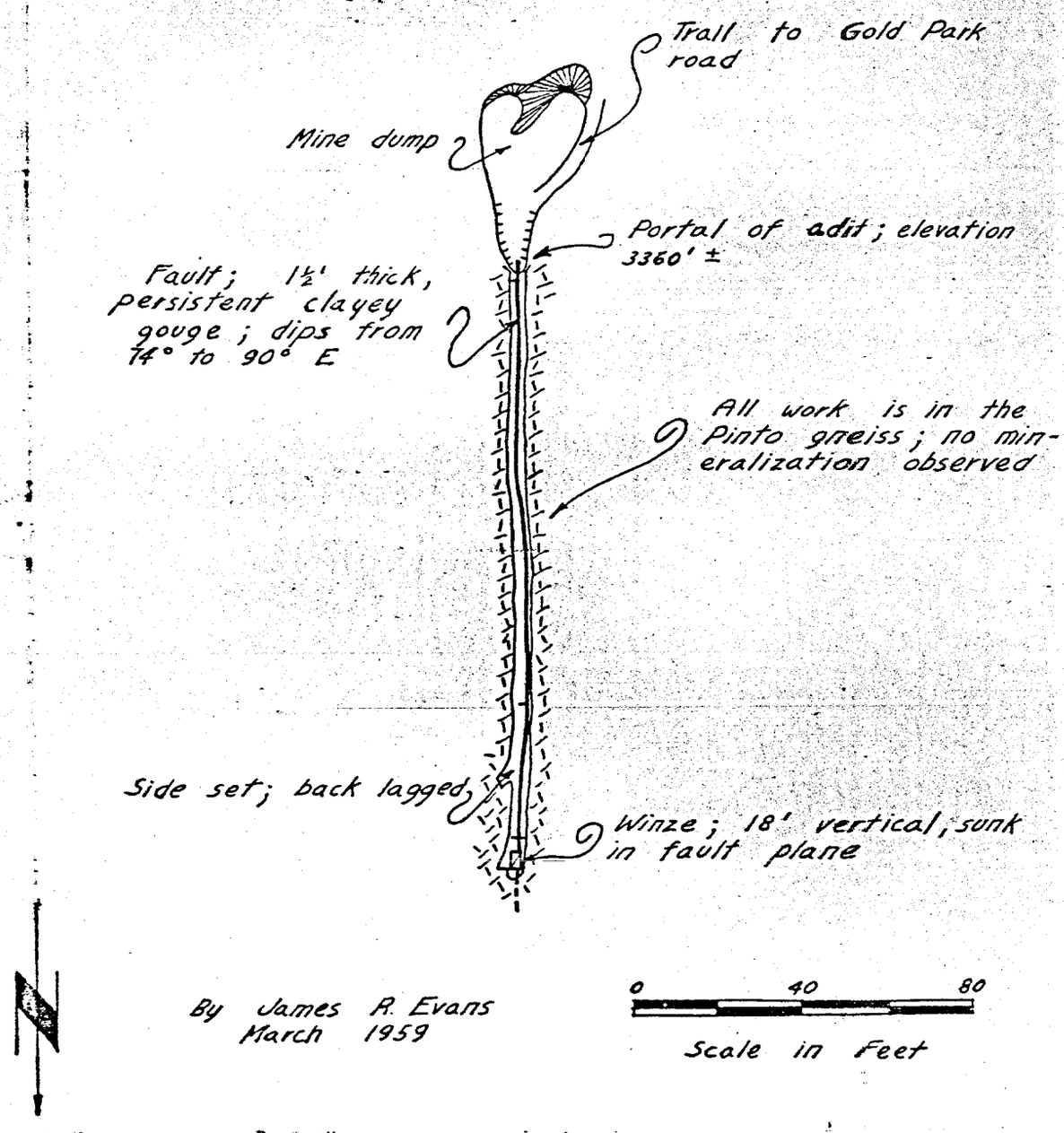
Figure 22. Gold

Gold Park #4

Figure 22



By James R. Evans
March 1959

Figure 22. Geologic sketch map of the Gold Park Consolidated (?) mine No. 4.

Gold Park Consolidated (?)
mine no. 5

Location: NE¼ sec. 12, T. 2 S., R. 9 E., S.B.M. (proj.), U. S. Geological Survey Valley Mountain quadrangle, 15' 1956; Pinto Mountains, Gold Park, 9.4 miles S. 26° E. of Four Corners, Twentynine Palms (see pl. 1 / Figure 19).

Ownership: Undetermined.

History: Undetermined.

Geology: Mesozoic Hornblende granite and White Tank quartz monzonite intrude the Precambrian Pinto gneiss along the lower west, and south flanks of a roughly triangular-shaped hill. The area is ~~much~~ cut by many minor faults. Thin gold (?) bearing veins, and fine-grained green basic dikes transect all three rock types (fig. 1 /).

Development: Three shafts, 4 prospect pits, 2 trenches, and an open cut constitute the mine workings. A majority of the work is shallow, but one older shaft is sunk 52° east at least 100 feet (fig. 23 /). An arrastra has been constructed on a flat cleared off area several tens of feet downslope from this shaft (fig. 20 /). It served as a rude drag-stone mill for pulverizing gold (?) quartz material. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/20/59.

Figure 23

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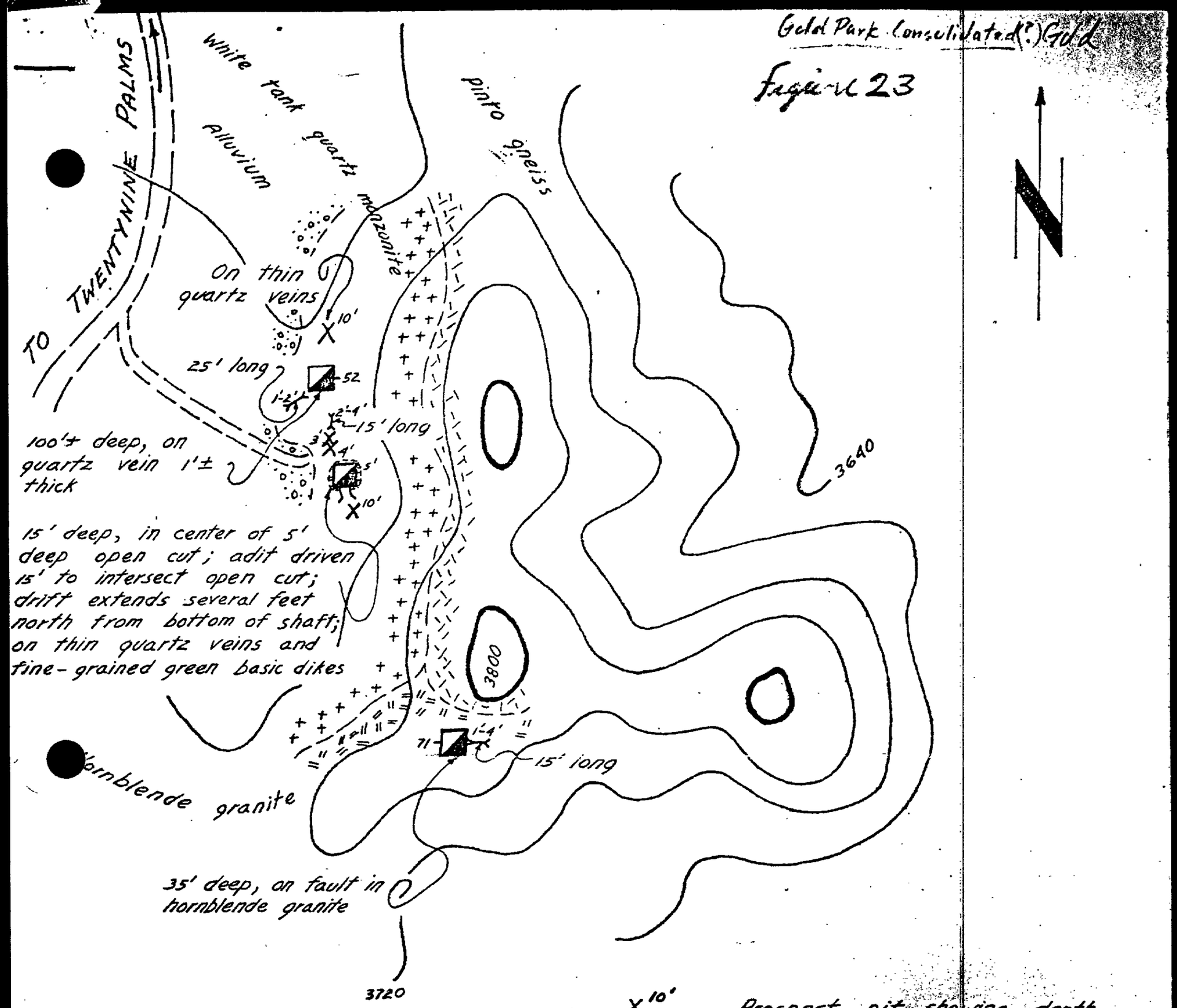
Gold Park Consolidated(?) Gold

Figure 23



By James A. Evans
March 1959

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Fig. (1)/. Geologic sketch map of the Gold Park Consolidated (?) Mine #5 (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Gold Point Mine

Location: Sec. 5 (proj.), T. 3 S., R. 10 E., S.B.M., Hexie Mountains quadrangle, 15', 1963; Hexie Mountains, Joshua Tree National Monument, about 4.5 miles southeast of White Tank adjacent to the Pinto Basin Road (see Fig. 18/).

Ownership: William F. Keys, P. O. Box 114, Joshua Tree, owns at least one unpatented claim (October 1959).

History: In 1935, the Gold Point mine was owned and operated on a small scale by Leon M. Campbell, Twenty-nine Palms.

Geology: Medium- to coarse-grained Precambrian Pinto Gneiss, is cut by a northwest to west-trending and 60° southwest-dipping fault, ~~is intruded by Mesozoic Gold Park gabbro-diorite.~~ Thin, highly oxidized quartz stringers in the fault plane probably contain minor amounts of gold.

Figure 24

Development: Three shafts, ranging in depth from about 30 feet to 50 feet, are sunk in Pinto Gneiss in the plane of the fault (fig. 24). The mine is idle.

Production: In 1935, 46 tons of crude ore yielded 23 oz. of gold and 7 oz. of silver (compiled by the U. S. Bureau of Mines and published with the permission of the mine owner).

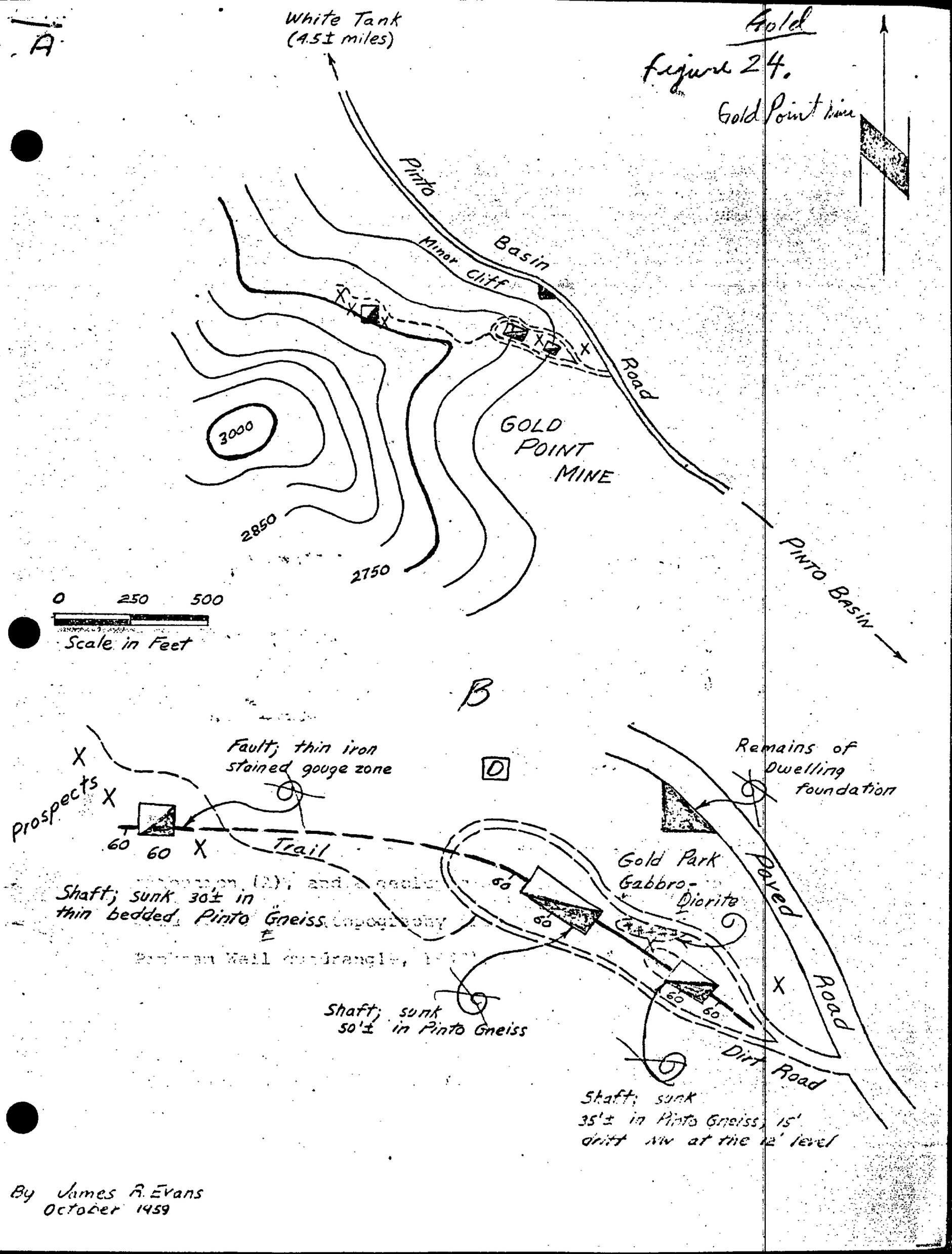
References: None.

J.R.E. 10/15/59.

Figure 24. Sketch map showing the areal distribution (A), and a schematic geologic sketch map (B) of the Gold Point Mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

Gold

figure 24.



By James R. Evans
October 1959

Gold Rice Mine

Location: NW¼ NW¼ sec. 12 (proj.), T. 2 S., R. 33 E., S.B.M., Vidal quadrangle, 15' 1950; on the west slope of the Riverside Mountains, 7 miles south of Vidal.

Ownership: Undetermined.

History: According to Jack Stewart of Parker, Arizona, this is one of the older gold mines of the district, though it is little more than a prospect.

Geology: The area of the Gold Rice mine is one of contorted and faulted gneissic rocks of probable Precambrian age which contain a few thin lenses of carbonate rocks. A mineralized zone about 3 feet wide lies along a fault which trends due north and dips 20° W. Minerals identified in the zone are calcite, barite, fluorite, iron oxides, and malachite.

Development: A single adit about 20 feet long has been driven south on the fault.

The road shown on the quadrangle map was joined by a new road from the south and extended to a point just northeast of the Gold Rice Mine in the process of the recent (1958) development of the nearby Riverside Mountains Manganese Deposit (see herein).

Production: Undetermined.

References: None.

R.B.S. 12/17/57.

Gold Shot Mine

Location: NW¼ SW¼ sec. 28, T. 6 S., R. 4 E., S.B.M., Idyllwild quadrangle, 15' 1959; in Penrod Canyon, 2½ miles east of Kenworthy Guard Station, in the San Jacinto Mountains.

Ownership: G. Charles Munz, 11472 College Ave., Garden Grove, holds the Gold Shot and three adjoining claims, the Golden Libra, Big Jim and Triangle (1958).

History: The Gold Shot Mine was located about 1927. It was acquired by Gold Shot Mines Inc. in 1929 and operated for two or three years. With the dissolution of the corporation (date not known), the present owner and a Mr. Gibson assumed ownership. Mr. Gibson died in 1948 leaving Munz the sole owner. Because of the low tenor of the ore the mine has not shown a profitable yield (personal communication, G. C. Munz, June 1948).

Geology: The area of the Gold Shot mine is underlain by granodiorite cut by pegmatite dikes as much as 18 inches in thickness. A fault strikes N. 65° W. across the claim and dips 75° NE. Finely disseminated, free milling gold is reported to be associated with iron oxides in a fractured quartz vein 3 to 4 inches wide which lies in the plane of the fault. The vein averages about $6 per ton with some ~~"high grade"~~ assays as high as $14. It is traceable for about 200 feet. The pegmatites, ~~which~~ consists mainly of quartz with subordinate black tourmaline, feldspar, and mica, ~~are according to Munz, barren of gold.~~ In one of the thicker dikes, a few tens of feet northeast of the mine, the quartz is colored a pale rose. (personal communication G.C. Munz, June 1958)

Development: The gold-bearing quartz vein is explored by a 10-foot vertical shaft, a 100-foot shaft inclined on the dip of the fault, and an 80-foot drift adit. A short drift runs northwest from the inclined shaft at the 50-foot level. The owner is resuming operations. (June 1958) ~~The 10-foot shaft represents progress made on a new inclined shaft being sunk 25 feet southeast of the old one. The latter is abandoned as unsafe. The adit, which is 25 feet northwest of the old shaft, is also abandoned as unsafe. The owner intends to install a small ball mill~~

and use mercury amalgamation. A lack of water is the chief problem. In addition it was found that, during previous operations, the mineral content of the water coated the amalgamation plates, inhibiting concentration (personal communication, G. C. Munz).

Production: Undetermined.

References: Tucker and Sampson, 1932, p. 5-6, pl. 1; 1945, p. 131, pl. 35.

Gold Shot Mine

Location: NW¼ SW¼ sec. 28, T. 6 S., R. 4 E., S.B.M., Hemet Reservoir quadrangle, 15', 1941; in Penrod Canyon, 2½ miles east of Kenworthy Guard Station, in the San Jacinto Mountains.

Ownership: G. Charles Munz, 11472 College Ave., Garden Grove, holds the Gold Shot and three adjoining claims, the Golden Libra, Big Jim and Triangle (1958).

History: The Gold Shot Mine was located about 1927. It was acquired by Gold Shot Mines Inc. in 1929 and operated for two or three years. With the dissolution of the corporation (date not known), later, the present owner and a Mr. Gibson assumed ownership. Mr. Gibson died in 1948 leaving Munz the sole owner. Because of the low tenor of the ore the mine has not shown a profitable yield (personal communication, G. C. Munz, June 1958).

Geology: The area of the Gold Shot mine is underlain by Mesozoic granodiorite cut by pegmatite dikes as much as 18 inches in thickness. A fault strikes N. 65° W. across the claim and dips 75° NE. Finely disseminated, free milling gold is reported to be associated with iron oxides in a fractured quartz vein 3 to 4 inches wide, which lies in the plane of the fault. The vein averages about $6 per ton and locally as high as $14. It is traceable for about 200 feet.

Development: The gold-bearing quartz vein is explored by a 10-foot vertical shaft, a 100-foot shaft inclined on the dip of the fault, and an 80-foot drift adit which is 25 feet northwest of the 100-foot shaft. A short drift runs northwest from the inclined shaft at the 50-foot level. The owner is resuming operations. (June 1958) The 10-foot shaft represents progress made on a new inclined shaft being sunk 25 feet southeast of the old ~~one~~ shaft.

390

Because of the low tenor of the ore, the mine has not shown a profit~~able field~~ (Personal communication, G. C. Munz, June 1958).

Production: Undetermined.

References: Tucker and Sampson, 1932, p. 5-6, pl 1; 1945, p. 131, pl. 35.

R.B.S. 6/23/58

Gold Standard Mine

Location: SE¼(?) sec. 9, SW¼(?) sec. 10, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, 4½ miles southeast of Ryan Campground on the southwest margin of Lost Horse Mountain.

Ownership: Dr. H. W. Milo, 224 El Camino Real, Vallejo, holds the Gold Standard claim and the Desert Queen Mill site, 6 miles to the northwest in the NW¼NE¼ sec. 34, T. 2 S., R. 7 E., S.B.M., at Stubby Spring.

History: The Gold Standard claim was first located by Johnny Lang in 1902. Later the claim was relocated by William F. Keys and subsequently sold to Dr. Milo about 1955. Intermittent development work has been done for many years, but apparently the property never was an operating mine.

Geology: The mine workings explore thin quartz veins in banded quartz-biotite gneiss (Precambrian Pinto gneiss). At the shaft a quartz vein in sheared gneiss strikes N. 30° W., dips 80° SW. to vertical, and is ½- to 1-foot thick. The quartz is deeply stained with yellow and reddish-brown iron oxides and contains large bleached mica plates. Vein quartz, trending about N. 10° W., crops out discontinuously for about 500 feet north of the shaft. This quartz is red to black iron stained and shows sparse green copper coatings. Sulfide mineralization was not observed. In biotite schist 50 feet northeast of the shaft a 2-foot-wide quartz vein strikes N. 40° E. and dips 40° SW.

Development: The quartz veins have been explored chiefly by a 40-foot vertical shaft with windlass; by 6 open-cuts, 5-10 feet deep and as much as 25 feet long; and by a number of shallow pits and trenches.

Production: Undetermined.

References: None.

C.H.G. 6/20/57.

Gold Standard Mine

Location: Sec. 1., T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 15' 1956; Pinto Mountains, about ½ mile south of the Brooklyn mine and about 3 miles southeast of New Dale (Site). ~~See pl. 3~~ figure 31.

Ownership: Berton L. Schwab, 5438 Delta St., San Gabriel, owns 3 unpatented lode claims (March 1958).

History: The first record of mine activity shows a small production in 1939. F. E. Kerby, Twentynine Palms, was the mine owner. In 1956, the mine was again active, and a small production was recorded by the present owner.

Geology: A quartz vein of undetermined thickness and extent is contained in a northwest-trending and steeply-dipping fault which parallels, and is adjacent to a northwest-trending ridge carved in Mesozoic quartz monzonite.

Development: A crosscut adit is driven about 600 feet northeast and into the side of the hill. It ~~connects~~ joins the 200-foot main shaft, which is sunk in the vein higher on the hill slope, at the 160-foot level. The adit was driven in order to transport ore from northwest and southeast drifts of undetermined length on the 160-foot level (Karl Schapel oral communication, 3/8/60).

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)
1939	8	4	
1956	15	3	1

References: None.

J.R.E. 3/8/60.

SYMBOLS

- Pinto Gneiss
- Crushed and granulitized zone
- Felsite (rhyolite ?) dikes
- Adit
- Shaft
- Prospect
- Open cut
- Dump
- Cabin
- Ore bin
- Trail
- Jeep road

2500

2750

3000

Golden Bee Mine

Main shaft

0 1000 2000

Scale in Feet

⑦

Brecciated and stained gouge

Iron zone

Shaft sunk 20' in fault plane

90°

Fault zone contains thin iron-stained quartz veins

⑥ Rotate 90° clockwise !

Fault

Winze ?

Crosscut at 25' level

Fault ?

Drift at 5' level

Shaft; sunk 70'

Crosscut at 65' level

Shaft; open to 25' level

Drift at 25' level

Fault zones contain thin iron stained quartz veins

③

Faults

Quartz veins as much as 6" wide in fault plane

Stope

Raise 25' to surface

②

Adit driven on minor quartz vein

④

Faults

Fault zones contain thin quartz veins

Main shaft (150'+ deep)

30' level

Winze

10' level

Labyrinth of passageways in crush zone containing veins and pockets of milky quartz

①

⑤

Surface outcrop of an irregular mass of iron-stained milky quartz

0 40 120

Scale in feet

Golden Bee Mine

Location: Sec. 16, T. 3 S., R. 10 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 7 miles southeast of White Tank, and about 1½ miles south of the Pinto Basin Road (see pl. 2 A).

Ownership: Undetermined.

History: In 1935, the mine was owned by E. Auclair, Twentynine Palms; in 1936, by Ira Bond and E. Auclair; in 1937 by Edward H. Fishmer, 3551 Birchwood Street, Riverside; in 1938 by Gold and Vanadium Producers, Inc., Twentynine Palms; from 1939-1942 by E. Auclair, Twentynine Palms; and in 1945 by Golden Bee Mines, Ltd., E. Auclair, president and manager, Guy Pierson, secretary, San Bernardino (Tucker and Sampson, 1945, p. 132). The first record of gold-silver production was in 1935, and the last in 1942. Ore shipments made to Burton Brothers, Inc., Rosamond, Kern County, and the Gold Crown Mining Company's mill at Dale, San Bernardino County, are reported to have been from 1 to 6 ounces in gold per ton (Tucker and Sampson, 1945, p. 132).

Geology: The major workings are in Precambrian Pinto gneiss which is cut by a north-trending major fault marked by a zone of gouge and breccia as much as 100 feet thick (~~fig. 1~~). The crushed material is cut by irregular bodies of iron-stained milky quartz containing minor amounts of gold. Most of the other workings are along minor faults containing narrow quartz veins. About 175 feet east of the main shaft is a persistent light gray felsite ~~(rhyolite)~~ dike, ranging in thickness from 20 to 50 feet, trending slightly northwest and dipping east (fig. 25).

Development: The main shaft is sunk at least 150 feet in the fault zone. It is open on the surface and down to the 30-foot level. About 80 feet southwest, two minor shafts are sunk to the 10-foot level. A drift extends from them 45 feet northeast to a winze which leads down to the 30-foot level. From here a drift leads northeast to intersect the main shaft at this level, (~~fig. 1~~). The area adjacent to the main shaft, from the surface down to at least 30 feet, is honeycombed with narrow and irregular passageways. The rest of the workings compose about 500 feet of adits, shafts, drifts, crosscuts, and stopes (~~fig. 1~~). The mine is idle.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable Metals Gold (ounces)	Silver (ounces)
1935	30	5	
1936	207	345	44
1937	145	15	8
1938	101	30	8
1939	22	12	
1940	18	9	
1941	267	99	3
1942	23	7	3

References: Tucker and Sampson, 1940, p. 48-49; Tucker and Sampson, 1945, p. 132.

J.R.E. 12/10/59.

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Figure 1. Geologic sketch maps of the Golden Bee Mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

Bee Mine

SYMBOLS

- Pinto Gneiss
- Crushed and granvalitized zone
- Felsite (rhyolite ?) dikes
- Adit
- Shaft
- Prospect
- Open cut
- Dump
- Cabin
- Ore bin
- Trail
- Jeep road

500

2750

3000

Main shaft

Golden Bee Mine

N

0 1000 2000
scale in feet

Brecciated and iron stained gouge zone

⑦

Shaft sunk 20' in fault plane

90

Fault zone contains thin iron-stained quartz veins

⑥ Rotate 90° clockwise !

Fault

Shaft; open to 25' level

Drift at 25' level

Winze ?

Crosscut at 25' level

Fault

Drift at 5' level

Shaft; sunk 70'

Crosscut at 65' level

Faults

Quartz veins as much as 8" wide in fault plane

Stope

Raise 25' to surface

③

Fault zones contain thin iron stained quartz veins

②

Adit driven on minor quartz vein

Faults

Fault zones contain thin quartz veins

④

Main shaft (150'+ deep)

30' level

Winze ?

10' level

Labyrinth of passageways in crush zone containing veins and pockets of milky quartz

①

Surface outcrop of an irregular mass of iron-stained milky quartz

⑤

0 40 120
scale in feet

Golden Bell (Blue Bell) Mine

Location: Sec. 8 (?), T. 3 S., R. 10 E., S.B.M. (Prof.), U. S. Army Corps of Engineers Pinkham Well) Hexie Mountains quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 4 miles southeast of White Tank, and about ½ mile southwest of the West Pinto Basin Road. (see pl. 2 / Figure 18).

Ownership: George W. Dooley, 844 Valley St., Burbank owns 1 unpatented claim. (January 1960).

History: The mine was active from 1934 to 1937 and from 1939-1941. During this period of time (1934 to 1941) it was owned by M. A. Rogers of Twentynine Palms. C. A. Benito, Twentynine Palms, owned the mine from 1954 to 1957. He performed cleanup work in 1954.

Geology: Pinto gneiss (Precambrian) is cut by a 80° SW.-dipping and N. 60° W.-trending fault zone as much as 4 feet wide. The zone is exposed for 500 feet and is composed of finely crushed material containing thin but highly oxidized gold-bearing milky quartz veins and stringers (fig. 26).

Development: The main workings consist of an inclined shaft sunk at least 80 feet in the fault plane and a drift adit extending 435 feet northwest from the shaft collar. The adit has been extensively overhand and underhand stoped.

Figure 26

105 feet from the portal.

A winze extends down 20 feet to a second level of undetermined extent. A 70-foot shaft sunk in the fault connects to the main level 170 feet from the portal. Two minor drift adits are driven in the fault about 80 feet above the main level. ~~(see fig. 1)~~. About 450 feet N. 60° W. from the collar of the main shaft another shaft is sunk at least 75 feet in the fault plane. The collar is close to 120 feet above the main shaft. On the surface the fault trace has been locally trenched and excavated. ~~(fig. 1)~~.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable Metals	
		Gold (ounces)	Silver (ounces)
1934	117	118	29
1935	36	29	7
1936	100	36	11
1937	5	6	1
1939	60	24	4
1940	3	1	
1941	21	4	
1954	1	1	1

References: None.

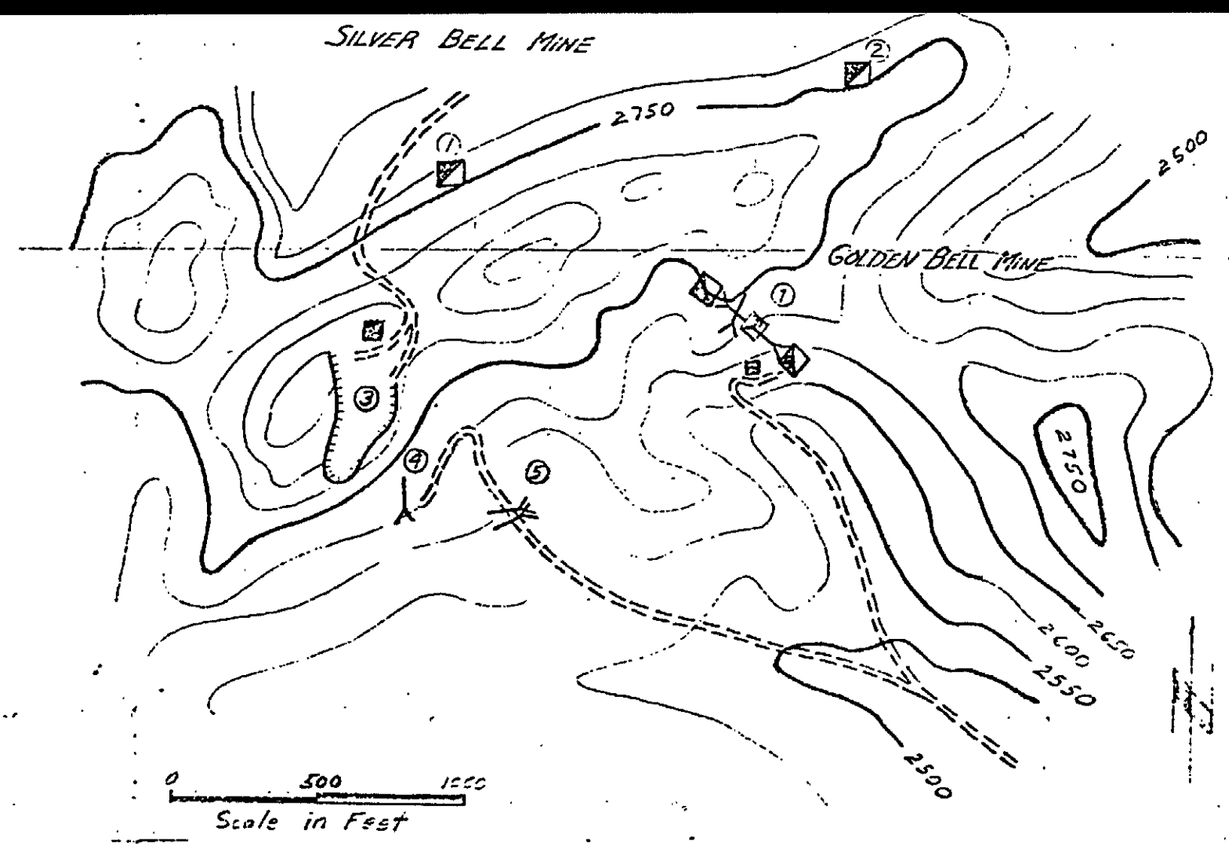
J.R.E. 1/25/60.

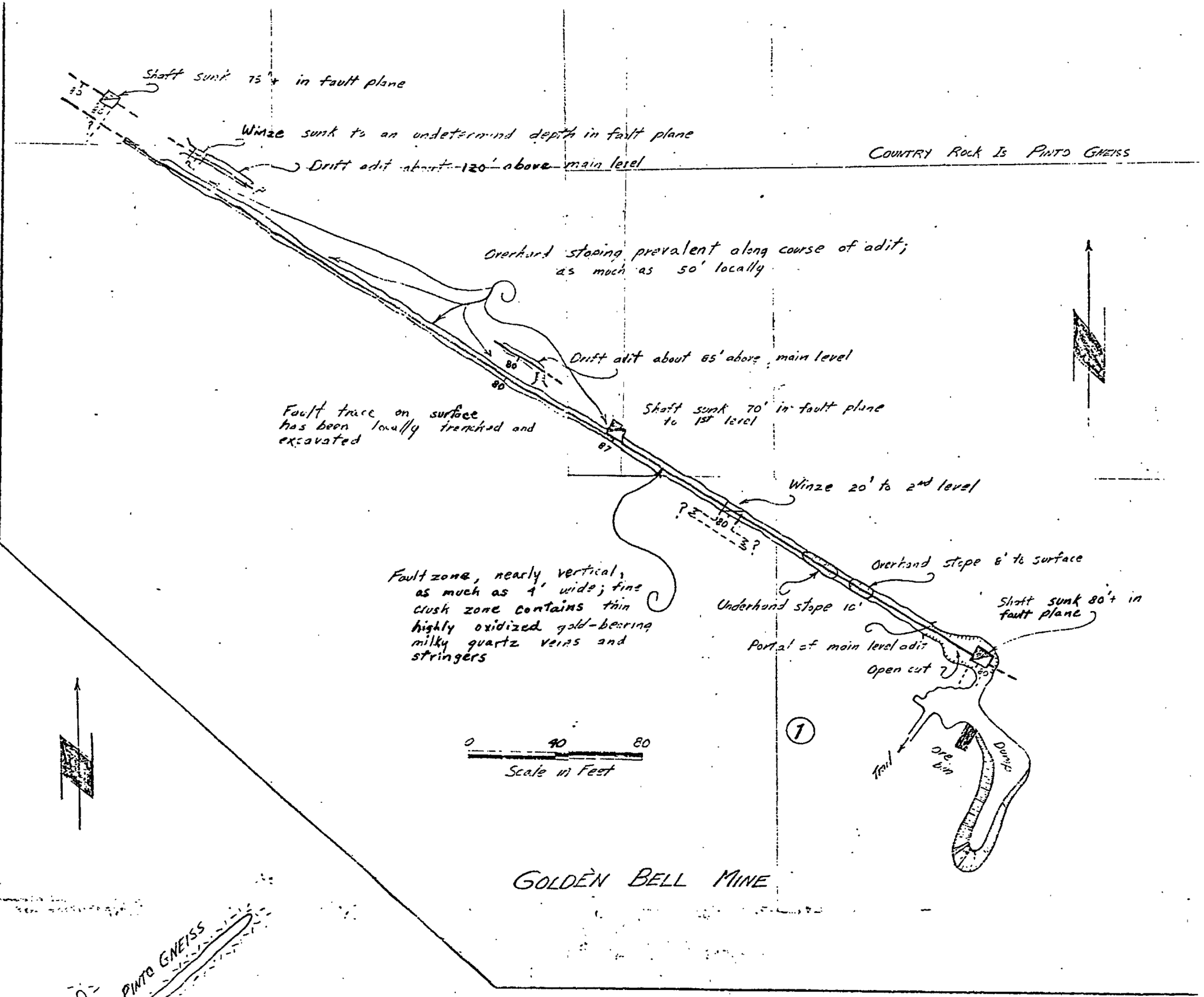
400

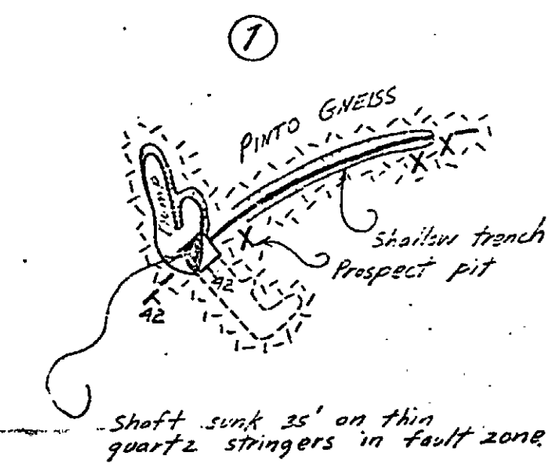
26

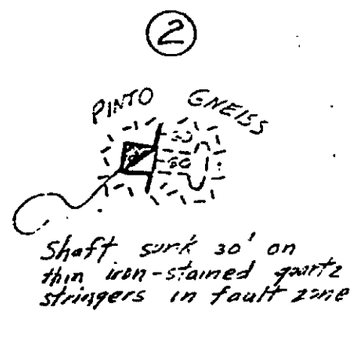
Figure 17. Sketch map showing the areal distribution, and geologic sketch maps of the workings at the Golden Bell (Blue Bell) and Silver Bell Mines.

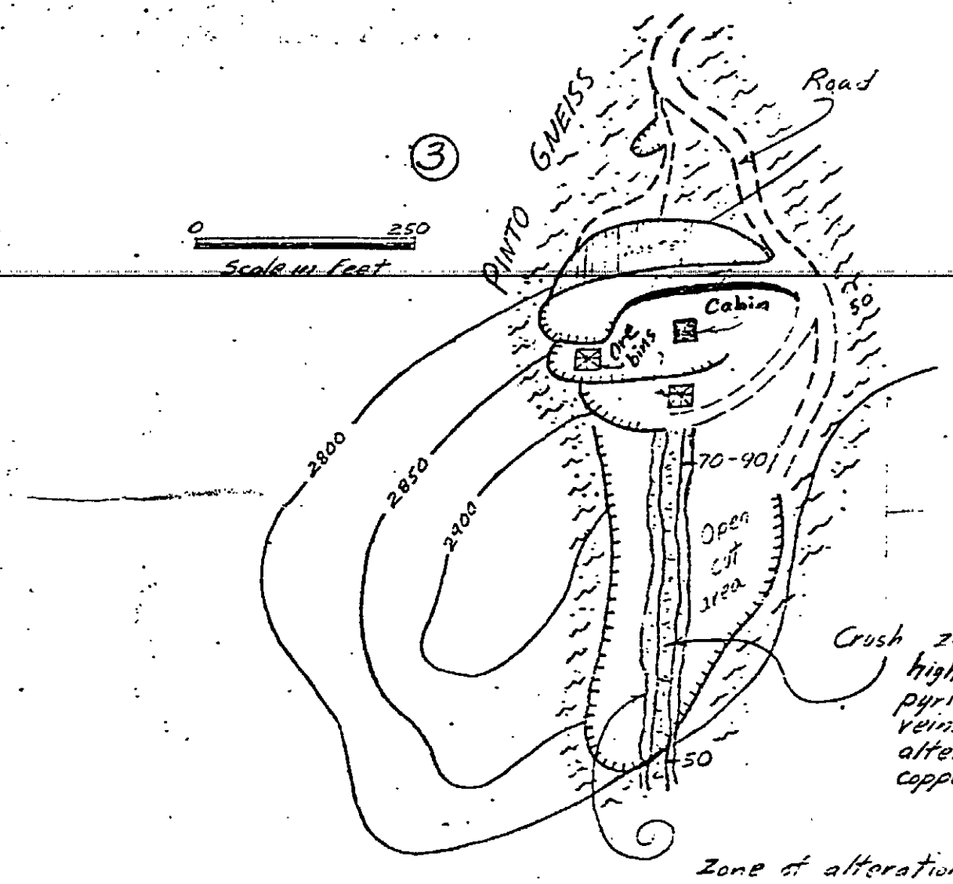
SILVER BELL MINE

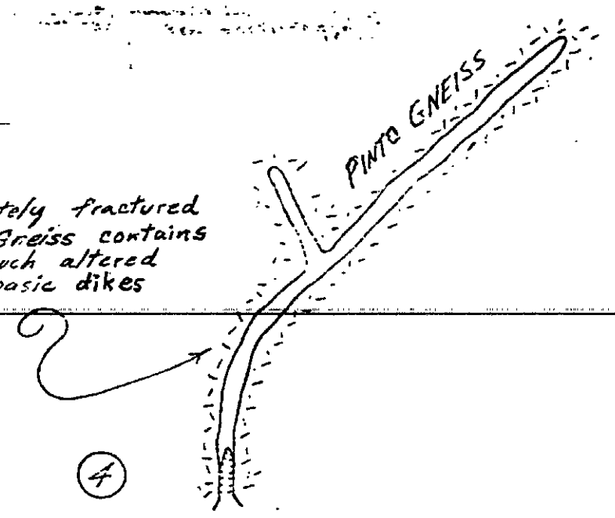


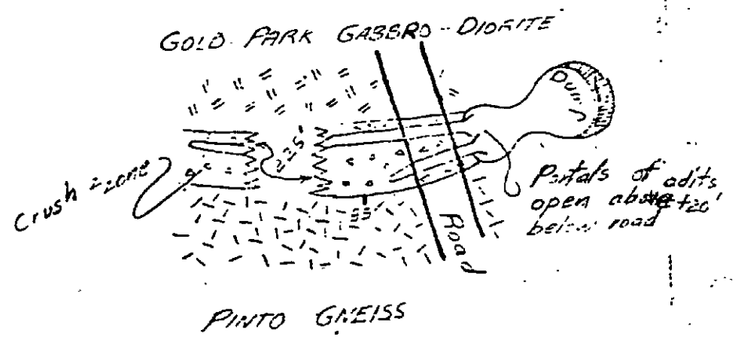












5

By James R. Evans
1960

0 40 80
Scale in Feet

SILVER BELL MINE

Golden Bird Claim

Location: NW¼NW¼ sec. 28, T. 1 S., R. 22 E., S.B.M., Vidal quadrangle; 15' 1949; on the east side of the most westerly foothill of the West Riverside Mountains, 3 miles south of Grommet.

Ownership: Undetermined.

History: Undetermined.

Geology: The country rock is strongly jointed, gneissic Mesozoic granite. A poorly exposed shear zone strikes north and dips 50° W. A vein as much as 4 inches wide lies in the plane of the shear. It consists of a central zone of quartz containing grains and bunches of galena and chalcopyrite. The central zone is bounded by layers of quartz and the same sulfides in generally finer grained, discontinuous laminae. The chalcopyrite is largely altered to oxides of iron, chrysocolla and malachite, the fine-grained bounding material having been most completely affected. Assay data were not found for this deposit, but when panned, a small sample of crushed vein material showed free gold.

Development: The vein is explored by a single 15-foot, inclined shaft.

Production: Undetermined.

References: None.

R.B.S. 11/17/59

401

Golden Charlotte (Golden Chariot) Mine

Location: NE¼ sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; about 6 miles west of Perris. The Golden Chariot Mine is south of and adjacent to the Santa Rosa mine.

Ownership: Undetermined (1959).

History: The earliest report of the Golden Chariot Mine (Crawford, 1894, p. 311) includes a photograph (following page 310) which shows the relative positions of the Santa Rosa Mine and the Golden Chariot Mine. The Golden Chariot mine is in the foreground; the view is to the north. This report (Crawford, 1894, p. 311), though brief, is the most complete, subsequent reports being a series of successively shorter abstracts of it. Charles L. French, Redlands, was then the owner of the mine.

Geology: The Golden Chariot Mine explores a poorly exposed quartz vein which strikes N. 10° W., dips 45° to 55° SW., and was reported to be an extension of the vein explored by the Santa Rosa Mine (Crawford, 1894, p. 311).

Development: According to Crawford (1894, p. 311) the shaft of this mine is 310 feet deep with a single drift of unspecified length near the bottom. The shaft is inclined about 30° at the collar. When inspected in 1959 the mine was flooded to within about 50 feet of the surface. ~~The shaft is timbered and open. Sheathing at the collar is in good condition.~~ Idle.

Production: Undetermined.

References: Crawford 1894, p. 311; Merrill and Waring, 1917, p. 529; Tucker, 1929, p. 479; Sampson, 1935, p. 509.

R.B.S. 6/15/59

Golden Eagle Mine

Location: NE¼ Sec. 23 (proj.), T. 5 S., R. 13 E., S.B.M., ~~U. S. Army Corps of Engineers~~, 15' Hayfield ~~Canyon Spring~~ quadrangle, 1944; 2 3/8 miles northeast of Hayfield Pumping Station. The mine is on the north slope of a low foothill as the southern margin of the Eagle Mountains. The most southerly workings are visible from the power-line road which extends eastward from the Hayfield plant.

Ownership: Undetermined: Mr. George Mieding, 8815 Klinedale, Pico Rivera, is considering (April, 1961) developing this property in association with several other individuals.

History: Although this property probably was located many years ago, no report of its early history was found. The mine was held in 1941 by W. H. Wolcott, Riverside and its location was shown on the mines map in the 1945 county report by Tucker and Sampson (1945, pl. 35).

Geology: The country rock is granitic and of probable Mesozoic age. Two en echelon shears are exposed through a distance of about 350 feet from the top of a hill down its north slope to a wash. They range in strike from N. 40° E. to N. 70° E. and dip 45° SE. The planes of both the shears are marked by a quartz vein ranging from 0 to 5 inches in thickness. Fractures and cavities in the quartz are filled with oxides of iron which carry traces of free gold. A sample taken from the mine shaft by George C. Mieding in 1961 contains chalcopyrite and secondary copper minerals in bunches as much as an inch in diameter.

Development: The veins were worked by means of an inclined shaft, one short cross cut adit, 3 short drift adits and two prospect pits. The inclined shaft is at the foot of the slope near the wash (~~Figure 2~~). It appears to be about 75 feet long and is on the vein but it is partly caved and unsafe to enter. One of the short drift adits is about 45 feet up the slope and southwest of the shaft. It was driven 10 feet southwest. In a shallow ravine about halfway up the slope the crosscut adit was driven south 45° west in barren granite. It appears to explore the essentially unmineralized zone of overlap between the feathered edges of the two shear planes. The remaining two drift adits are driven into the north and south slopes of the hill near its top. One extends 10 feet northeast, the other 40 feet southwest. They could be connected by 15 or 20 feet of drifting. A stope extends to the surface from the 40 foot adit; an inclined distance of about 40 feet. Only light timber, mainly stulls, was used.

Production: U. S. Bureau of Mines records show that in 1941, one ton of ore yielded one ounce of gold. No other records were found.

References: Tucker and Sampson 1946, pl.35.

R.B.S. 1/20/59

Golden Egg Mine

Location: SW/4, Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), Pinto Basin (~~U. S. Army Corps of Engineers Eagle Tank~~) quadrangle, 15', 1943; Pinto Mountains, about 4½ miles south-southeast of New Dale (Site) and 1½ miles southeast of the Gold Crown mine (figure 31) (~~pl. 3~~).

Ownership: Karl Schapel, Box 113, Twentynine Palms, owns 2 unpatented lode claims.

History: Originally owned by Jack Meek as long ago as 1940, when a small tonnage of ore was processed. In recent years the mine has been owned and worked by Karl Schapel.

Geology: Mesozoic quartz monzonite is cut by a N. 10° W.-trending and steeply east-dipping fault. The fault zone is locally at least 3 feet wide and contains a strongly oxidized gold-quartz vein ranging in thickness from 6 inches to 2 feet (fig. 27 ~~14~~).

Development: The main shaft is sunk 100 feet in the fault plane. North drifts on the 17-foot, 27-foot, 67-foot, and 88-foot levels join to it. A cross cut adit is driven east 130 feet to intersect the 345-foot drift on the 88-foot level (~~see fig. 14~~).

Figure 27

Gold
Golden Egg
Figure 27.

Fault ; containing dense green dikes and brecciated quartz vein stained with secondary iron and copper minerals

Winze ; 12'

Side set

Fault zone ; 5'+ wide ; contains strongly oxidized gold-quartz vein with minor amounts of chalcopyrite

DRIFT

Fault

82

77

83

81

88

67' level
27' level
17' level

Shaft ; 68' to surface

Shaft ; 125' to surface

Country rock is massive dark-gray quartz monzonite

CROSS - CUT

Fault

50

GOLDEN EGG MINE

Trail to Cabin and Mill

Open cut

0 20 40 80

Scale in Feet

Track

Dry Wash

By J.R. Evans
March 9, 1960

Figure 27. Geologic sketch map of the Golden Egg mine.

About 240 feet north of the main shaft a second shaft is sunk 125 feet to the drift on the 88-foot level. There is a small mill on the property, and it is nearly complete and ready to process ore from the mine. It contains a primary jaw crusher, and a ball mill, and to amalgamation plates. The mine is operated by the owner who is presently extending the drift on the 88-foot level.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)
1940	16	15	3

References: None.

J.R.E. 3/9/60

Golden Nuggett Lode Claim

Location: SW¼SE¼ sec. 34, T. 5 S., R. 10 E., S.B.M., Cottonwood Spring quadrangle, 15', 1958; south margin of the Cottonwood Mountains 2 miles northeast of Cactus City on the east side of Pinkham Wash.

Ownership: Golden Nuggett Mining Co., Otto and Leo Katz, 12180 Sunset Blvd., Los Angeles 49.

History: Located by Otto and Leo Katz in June 1956.

Geology: Irregular thin shear zone in banded quartz biotite gneiss (Precambrian Pinto gneiss) cut by White Tank ~~quartz~~ monzonite. The shear zone strikes N. 40° W., and dips 35° NE. No vein quartz or other mineralization observed.

Development: Open cut connected to 15-foot drift adit on the shear zone.

Production: Undetermined.

References: None.

C.H.G. 5/15/61.

Golden Nugget Mine

Location: NW¼ sec. 30, T. 4 S., R. 4 W., S.B.M. Steele Peak quadrangle, 7.5', 1953; about 6 miles west of Perris and half a mile southwest of the Ida-Leona Mine.

Ownership: Undetermined (1959).

Geology: A quartz vein of undetermined attitude, thickness, and extent occurs in diorite near the edge of a flat.

Development: A single vertical shaft of undetermined depth appears to be the only development. It is flooded to within 15 feet of the collar. ~~(A head frame and timbered collar are in fair repair.)~~ Idle.

Production: Undetermined.

References: None.

R.B.S. 6/16/59.

409

Golden Rod Mine

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.). Dale Lake quadrangle, 15', 1956; Pinto Mountains, about 4 miles southeast of New Dale (Site) and 2 miles south of the Brooklyn mine (see ~~pl. 3~~ figure 31).

Ownership: Undetermined.

History: The mine was apparently discovered in the middle 1930's and worked intermittently until 1939 by the O.K. Mining Company, Joseph Ingersoll, president. Tucker and Sampson (1940, p. 49) report the mine was under lease in 1940 to the Pinto Basin Mining Company, Indio. A record of production in 1940, 1941, and 1942 shows the mine was active during this time. In 1951 and 1953 the mine was again active and was owned by the Pinto Basin Mining and Milling Company, 7940 Sunset Blvd., Los Angeles. ~~The property was not in operation the day of the visit.~~ Idle.

Geology: A north-striking and 80° W.-dipping quartz vein occurs in Mesozoic quartz monzonite and ranges in thickness from 2 to 4 feet (Tucker and Sampson, 1940, p. 49).

410

Development: A shaft is sunk 350 feet on the vein. North and south drifts extend from the shaft on the 40, 80, 130, 200, 250, and 350-foot levels to develop an ore shoot 75 to 100 feet in length and 4 feet in average thickness. In 1940, there was a small mill (10 tons capacity) on the property, but the ore was hauled to the Gold Crown mine mill for treatment (Tucker and Sampson 1940, p. 49). As water had to be hauled from Mission and Sunrise Wells 3½ miles to the southwest, it was probably more convenient to haul the ore to another mill than to process it on the property.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owners.

Year	Crude ore (tons	Gold (oz.)	Silver (oz.)
1935	7	2	1
1936	109	39	15
1937	625	213	80
1938	300	101	37
1939	306	302	
1940	337	329	46
1941	109	68	33
1942	15	4	1
1951	350	4 (est.)	3 (est.)
1953	12	2	1

411

References: Tucker and Sampson, 1940, pp. 49-50; Tucker and Sampson, 1945, p. 132.

J.R.E. 3/8/60

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Golden Rule Group of Claims

Location: Reported to be in sec. 30, T. 2 S., R. 10 E., S.B.M. (proj.), south of Twentynine Palms, in the Pinto Mountains by Tucker and Sampson (1929, p. 480). Not confirmed, and all the information below is from the previously mentioned reference.

Ownership: Undetermined.

History: In 1929 the mine was active and the 2 claims were owned by Dr. Francis Coltrin, E. C. Miles, and John Stull, Fullerton.

Geology: A vein striking N. 30° W. and dipping 80° W. occurs in gneissoid granite. It ranges in width from 1 to 2 feet. A diorite dike occurs along the footwall.

Development: A shaft is sunk 75 feet on the vein. At the 50-foot level there is a drift 35 feet south.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 480.

Good Hope Mine

This report is based largely on information contained in a recently published description by Engel, Gay and Rogers (1959, p. 63-67 ~~75-76~~).

Location: NW¼ sec. 15, T. 5 S., R. 4 W., S.B.M., and part of a claim extending northeast into section 10, ~~U. S. Army Corps of Engineers~~, Elsinore quadrangle, 15', 1942; about 5 miles northeast of Elsinore on the northwest side and about 200 feet northwest of Highway 74. Patented claims include 160 acres (Engel and others, 1959 p. 63).

Ownership: Mrs. Velna L. Teater, 500 South Occidental, Los Angeles.

History: The Good Hope mine was the most productive gold mine in Riverside County. Between the years 1875 and 1941 it yielded a reported 17,759 ounces of gold and 3,552 ounces of silver. The history of the Good Hope mine began about 1874 when Mexican placer miners and a Frenchman named Mache first located the Good Hope vein zone. It apparently had been the original source of much of the placer gold mined for years prior to 1874 in the arroyo east of the mine. The Good Hope vein zone was found as a "blind lead" through systematic prospecting at the upstream limit of gold-bearing gravel. The vein was opened in numerous places along its course and the

ore milled in arrastres, remnants of which remain in the arroyo south of the present mill. The north end of the vein was developed first, and was known as the San Jacinto claim. This operation soon consolidated with the Good Hope operation on the same vein about 1,000 feet to the south. The mine's main period of activity was from 1889 to 1894. This work connected the San Jacinto and Good Hope workings underground, established the continuity of the vein zone and completed almost all the workings. ~~(shown on figure ___)~~.

About 1893 the property was bought by a Haverhill, Massachusetts, corporation. In 1894, a 20-stamp mill was built. Litigation, which began about 1895, tied up the property for the next 10 years during which time it was worked each year by different lessees. Shortly after 1900, a cyaniding operation was installed. Mill tailings were treated and ore bodies already outlined were removed. Little exploration or maintenance work was done, and the mine became flooded and unsafe.

From 1903 to 1932 the mine was in bad condition and virtually inactive. Machinery was removed or destroyed and workings were largely inaccessible due to flooding and caving. In 1919, the mine was purchased by J. F. Hook for $450 at a tax sale and the inoperative machinery sold as junk.

About 1923, the present owner acquired the property but it remained inactive until about 1932 when the mine was leased and reopened by Good Hope Development Company. A 20-ton capacity mill used amalgamation, leaching, and flotation methods to treat both the dump and new ore. Financial difficulties and mine safety regulations caused the closing of the mine in 1936.

The most recent attempt to open the mine was that of the Panamint Mining Company, which leased the property from 1947 to 1953. No operative machinery remains, and all workings below about 50 feet are flooded and presumably largely caved.

Geology: The Good Hope mine is in an area underlain by deeply weathered granitic rocks. In the mined area the country rock is strongly chloritized and kaolinized. Mineralized zones are delimited by seams of gouge, talcose materials, and clay. Felsitic dikes and porphyritic basic dikes, from a few feet to as much as 30 feet wide are traceable on the surface in the vicinity of the mine. One east-trending basic dike appears to mark the northern limit of gold deposition.

The Good Hope system of quartz veins strikes about N. 12° E., dips about 60° NW., and is discontinuously exposed in pits and shaft collars along the strike for more than 3,300 feet. At the surface, the Good Hope vein system is about 100 feet wide, and consists of several quartz seams of subparallel strike, from 3 to 20 feet apart, that appear to unite about 200 feet below the surface. In depth the quartz seams appear to form an irregular mineralized zone that ranged in width from 3 to 10 feet, and locally splits into two or more zones. The main ore shoot, which averages 18 inches in width in a vein 5 feet wide, pitches to the south at 45 degrees to 75 degrees down to the 350-foot level (Engel, 1959, p. 65).

Development: The main period of development of the Good Hope mine was during the late eighteen hundreds, as ~~summarized in fig. 4~~. In 1932, the main shaft was cleared and retimbered to the 350-foot level and more than 200 feet of level workings driven on the 95-foot and 166-foot levels by the Good Hope Development Company. During the 1947 to 1953 lease of the Panamint Mining Company, the main shaft was again reopened to a depth of 115 feet and a 50-foot shaft was sunk near the south end of the property. In 1955 all shafts were inaccessible and had badly caved collars.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

The entries for the period 1902 to 1941 probably represent the processing of dump material.

Year	Crude ore (tons)	Recoverable Metals Gold (ounces	Silver (ounces)
1895		4,160.25	
1896		3,628.12	
1897		2,418.75	
1898		1,161.00	
1899		2,418.75	
1900		1,112.62	1,613
1901		967.62	1,667
1902	1,880	767.25	
1903	1,100	483.75	
1912	390	247.49	104
1928		2.45	1
1932	5	4.41	1
1933	35	29.42	14
1934	504	125.64	69
1935	846	35.70	18
1936	552	183.92	64
1939	15	1	
1940	9	10.00	
1941	25	1.00	1

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References: Goodyear, 1888, p. 527; 1890, p. 151; Storms, 1893, p. 106; Crawford, 1894, p. 221; 1896, p. 311; Merrill and Waring, 1919, p. 532-533; Tucker, 1925, p. 480; Sampson, 1935, p. 509-511, Engel and others, 1959, p. 63-67.

R.B.S., from Engel and others.

Granite Mine

Location: NW¼ sec. 4 (proj.), T. 6 S., R. 15 E., S.B.M., ~~U. S. Army Corps of Engineers~~ Chuckwalla Mountains quadrangle, 15', 1945; about 3 miles southwest of Desert Center.

Ownership: Henry K. Hennigh, Box 468, Desert Center (1959).

History: According to the present owner, the Granite mine was first located in 1860 by two men, named Hurst and Smith, ~~who~~ started to work the deposit in 1894. A 10-stamp mill was built and operated for an undetermined period. In 1917, the mine was reported to have changed hands several times. It was held, at that time, by Silas Marsters, Riverside (Merrill and Waring, 1917, p. 540). In 1920, the Granite mine was owned and operated by Chuckawalla Mining and Milling Company. In 1929, (Tucker and Sampson, p. 480) it was still in the same hands but idle. A 10-ton ~~Harding~~ Hardinge ball mill was installed in 1930 when the mine was reopened with financial support from a Mr. Osborn, Pasadena, and the present owner. Capacity was increased, in 1932, by use of a 24-ton Denver ball mill. The gold was recovered by amalgamation, table, and cyanide. Operations were terminated in 1932 because of the low grade of the ore. H. K. Hennigh has retained ownership to the present time and is currently doing exploration. (Personal communication, H. K. Hennigh).

Photo 15

Geology: A mineralized fault strikes N. 10° - 20° W. along a low ridge of Mesozoic granite and dips 40° - 55° SW. It is exposed in the mine for a strike distance of about 350 feet and to a maximum depth of 100 feet. Quartz veins ranging from 0 to 3 feet thick lie in the fault plane. Through the northern half of this exposure the fault branches. The two principal breaks thus formed are roughly 55 feet apart where exposed in the north end of the workings. Here, in addition, the granite is cut by basic dikes as much as 3 feet in thickness. Both the dikes and the quartz veins along the faults have been fractured since their emplacement. The fault zone is cut off at the south end of the workings by another fault.

The ore consists of fractured vein quartz containing oxides of iron, manganese oxides, and minor copper minerals. Fine, free-milling gold occurs in the iron oxides. Silver is reported as a product of the mine, but its ore mineral was not identified. Some parts of the mine have yielded radioactivity measurements as high as ten times background and samples analyzed by the U.S. Geological Survey laboratories contained thorium and were graded (percent) at (0.45eU) 0.034 U (Walker and others, 1956, p. 12, 37).

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Development: The old 1894 discovery shaft, at the south end of the workings was sunk 100 feet on and near the fault. At the 50-foot level a 130-foot drift was driven northwest and a 40-foot drift southeast to a short crosscut. There are several stopes near the shaft. Crosscuts extend 70 feet southwest and 70 feet northwest from the bottom of the shaft. The north workings comprise a 330-foot crosscut adit. A drift extends roughly 300 feet southwest on a level 30 feet down the dip of the fault from the 50-foot level of the south shaft with which level it is connected by two raises. An additional 100 feet of drifts explores a branch of the fault in the north workings. Ore bodies as thick as a foot were stoped in a 10-foot-wide shear zone north and south of the junction of the faults.

When visited in 1959, activity was centered in the exploration of a narrow northwest-trending vein exposed on the east slope of the ridge 200 to 300 feet southeast of the crosscut adit. A 30-foot shaft had been sunk on the vein. A gently inclined shaft, being driven west from a point 50 to 75 feet lower on the slope to crosscut the vein was about 40 feet long and had not reached the vein.

. Production: The yield of the Granite mine was not determined. The owner stated that the ore ~~runs~~ contains about $10 per ton in gold and $6 in silver.

References: Merrill and Waring, 1917, p. 540; Tucker and Sampson, 1929, p. 480; 1945, p. 133-134; Walker and Others, 1956, p. 12, 37.

R.B.S. 3/9/59.

Grandaddy Mine

Location: NE¼ sec. 5 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15' 1952; about 1,000 feet northeast of peak 1195, in the Mule Mountains, and about 13 miles by road west of Ripley. The Grandaddy Mine is accessible by ~~a quarter of a mile of narrow~~ foot trail ~~which extends southwest~~ from the nearby Grubstake Mine.

Ownership: Carlo M. Micalizio, 529 N. Broadway, Blythe (1958).

History: Undetermined.

Geology: The country rock is Precambrian gneissic granite. A fault, which strikes N. 40° W. and dips 85° NE. crosses the claim. A basic mafic dike as much as 3 feet wide, and a quartz vein, lie in the fault zone. The dike is the footwall of the vein and both the dike and the quartz vein are complexly fractured. The vein is exposed for about 100 feet and is as much as 3 feet in width. It resembles the vein at the Hodges Mine a quarter of a mile to the east and probably is a part of the same vein system.

Hematite and chlorite ~~were the principal~~ fill ~~minerals observed in~~ fissures and vugs in the vein.

Development: The vein has been explored by shallow trenches along the full length of its outcrop. ~~Idle.~~

Production: Undetermined.

References: None.

R.B.S. 4/8/58.

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Grubstake Mine

Location: NE¼ sec. 5 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 1952; in the Mule Mountains about 13 miles, by road, west or Ripley.

Ownership: Carlo M. Micalizio, 529 N. Broadway, Blythe (1958).

History: Undetermined.

Geology: The country rock is Precambrian gneissic granite. In the mine area a fault is exposed for about 100 feet. It strikes N. 70° W., and dips 35° SW. The fault is marked by a zone of gouge 3 to 4 feet thick which includes a shattered and contorted quartz vein as much as 1 foot in thickness. The vein contains seams and pockets of hematite which according to the present owner ~~this material yields $49.00 per ton in~~ gold.

A zone of contorted gneissic rocks as much as 5 feet wide crops out about 500 feet northwest of the mine. This zone contains crushed ~~lenses and~~ thin lenses and veins of quartz with associated ~~with~~ calcite, chrysocolla, chlorite, and hematite. It strikes N. 60° E., and dips 35° SE. This fault zone apparently is unrelated to the one at the mine.

(on the N.70°W.-striking fault)

Development: The main workings consist of 2 inclined shafts about 100 feet apart and 40 feet deep driven on the dip of the fault. The shear zone to the northwest was opened by a trench and a 15-foot adit -- Mr. Micalizio states that this work was done at some unknown time before he acquired the property and shows little to warrant further work.

Production: Undetermined.

References: None.

R.B.S. 4/8/58.

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Hansen (Hensen) mine (Hensen Well)

Location: NW¼ sec. 26, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 1958; Joshua Tree National Monument, about 1½ miles southwest of Pinyon Well, north slope of the Little San Bernardino Mountains.

Ownership: William F. and Frances M. Keys, Box 114, Joshua Tree, hold the pinyon group of claims (White Hills, Mountain View, Pinyon, Grand View) in sec. 26. Mr. Keys reported (oral communication January 1960) that the "Hansen shaft" is on the Grand View claim.

History: The early history of the Hansen mine is unknown, but it may have been part of the Pinyon (Tingman-Holland) mine about half a mile to the southeast. The nearby Hensen Well was an important source of water to early-day miners. According to Brown (1923, p. 273) "The well is in a little flat in a very narrow canyon and is high up near the summit of the Little San Bernardino Mountains. Near it (in 1918) are the ruins of an old arrastre and the remains of one or two small stone buildings. ---the water was siphoned to the Eldorado mine with that of Pinyon Well." In 1960, the exact site of the well was not found, but a largely caved vertical shaft and foundations for several buildings, one of which apparently was once a mill, were noted in the NW¼ sec. 26.

Geology: The NW¼ of sec. 26 is underlain by light gray to buff coarse-grained quartz monzonite (Mesozoic White Tank quartz monzonite). The "Hansen shaft" explores thin quartz stringers in a shear zone which strikes N. 55° W., is vertical, and exposed at the surface for a strike length of about 1,000 feet. A second quartz vein crops out about 1,500 feet to the east. This vein strikes about N. 50° W., is vertical or dips steeply southwest, is 2 to 3 feet wide, and exposed at the surface for about 750 feet. Along the same strike, about 600 feet to the southeast, vein quartz again crops out. Here the vein area is as much as 16 feet wide, is exposed for about 600 feet, strikes N. 50° W., and dips steeply southwest.

Development: In the NW¼NW¼ sec. 26 a vertical shaft ("Hansen shaft") is sunk on quartz stringers in a shear zone. The workings are inaccessible but the size of the dump suggests at least 100 feet of workings. To the east in the NE¼NW¼ sec. 26 the second quartz vein is explored by several short adits.

Production: Undetermined.

References: Brown, 1923, p. 273.

C.H.G. 1/26/60.

Happy Jack Group

Location: NE 1/4 sec. 30 (proj.), T. 6 S., R. 16, E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; about 1 1/2 miles southwest of Corn Spring and 7 miles southeast of Desert Center.

Ownership: Not determined (1959).

History: These claims were operated in the years 1896 to 1898 by the Happy Jack and Chuckwalla mining companies (Merrill and Waring, 1919, p. 540).

Geology: A quartz vein as much as 3 feet wide is exposed for about 300 feet down the north side of a low ridge and for 200 feet on a rise to the north across a narrow ravine. The vein lies along a shear zone in Mesozoic granitic rock. It strikes N. 30° E. and dips 45° NW.

The vein quartz carries pockets and stains of iron oxides. Pyrite is present, but uncommon.

Development: On the ridge south of the wash the vein is explored by 2 inclined shafts, 50 and 100 feet deep, and a drift-adit driven southwest about 125 feet. The 50-foot shaft is about 20 feet northeast of the adit portal. The 100-foot shaft is 100 feet southwest of the adit portal and connects to the adit at the 30-to 40-foot level. Between the shaft and portal the vein is stoped through a distance of about 30 feet, ~~at a point near~~ the shaft, and up the vein about 20 feet. A 15-foot winze lies below the stope. The adit extends about 25 feet beyond the 100-foot shaft. Though partially caved, it probably connects with a raise to the surface. The workings below the adit level were not examined.

On the rise north of the ravine two inclined shafts, 80 feet apart, one 50 feet deep and the other of undetermined depth, are sunk on the vein and join with an undetermined amount of level workings. About 100 feet south of the shafts a 12-foot inclined shaft is sunk on a shear which strikes N. 10° E. and dips 40° NW. From the bottom of the shaft a drift extends 50 feet to the northeast on a vein 1 to 2 feet in thickness.

According to Merrill and Waring (1919, p. 540) development on these claims reached a depth of 300 feet.

Production: Undetermined.

References: Merrill and Waring, 1919, p. 540; Tucker and Sampson, 1929, p. 481.

R.B.S. 3/13/59.

Helicross Mine

Location: SE¼ sec. 3 (?), T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, Dale District, 8 miles south of Dale Lake, half a mile east of San Bernardino Wash. (figure 31)

Ownership: Undetermined.

History: Undetermined, probably active during the 1930's. Idle.

Geology: Shear zones containing quartz stringers in massive Mesozoic quartz monzonite (fig. 28). Shears strike west to N. 20° W., dip 70° SW. to vertical. At the east working the vein quartz is stained yellow brown to red brown by iron oxide and contains a few fresh pyrite cubes and some pyrite cubes altered to iron oxide.

fig 28

Development: Two areas have been explored. The west group of workings lies adjacent to the valley in low hills and consists of a 30-foot shaft inclined 80° SW., a 25-foot vertical shaft at the end of a 20-foot open-cut which joins a 110-foot adit, and a 60-foot adit driven east from a 35-foot open cut ~~(Fig. A-4)~~. The second area lies half a mile to the northeast and 600 feet above. Here an adit of undetermined length is driven N. 20° W. The size of the dump suggests several hundred feet of workings. A truck-loading bunker remains below the adit.

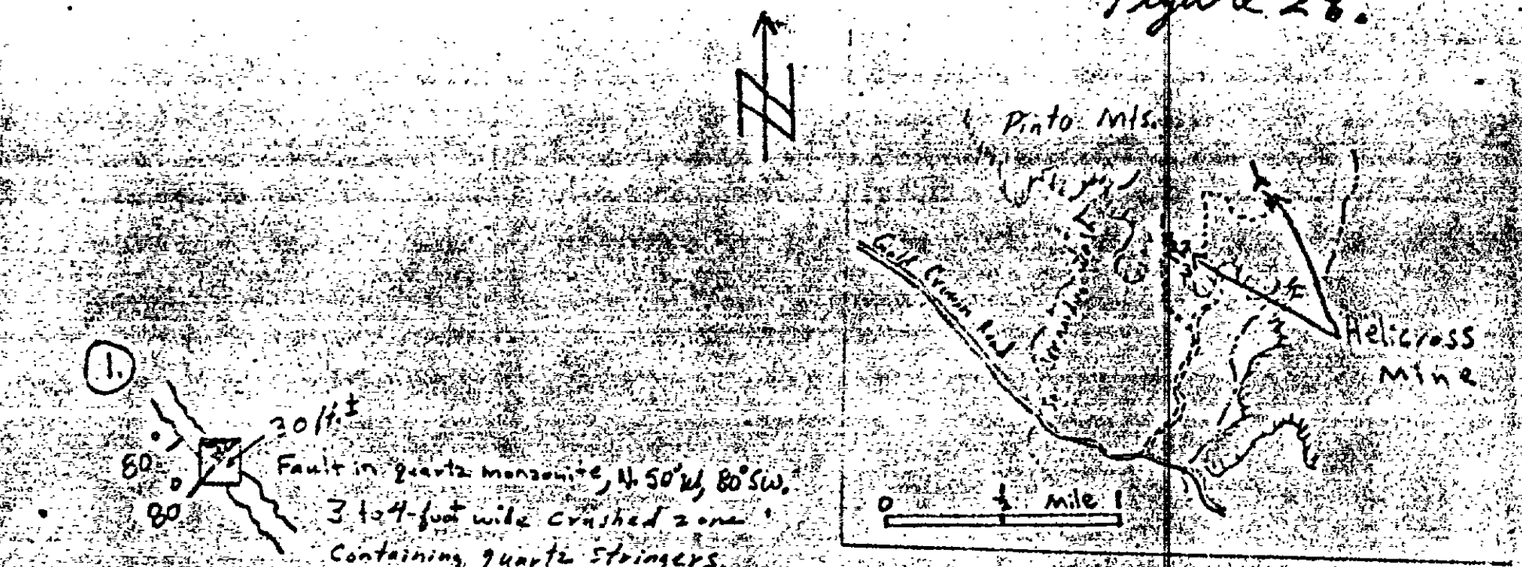
Production: Undetermined.

References: None.

C.H.G. 5/16/61.

Gold

Figure 28.



Scale 1 inch = 40 feet

Sketch map of Helicross Mine

figure 28.

Hemet Belle Mine

Location: E 1/2 SE 1/4 sec. 29, T. 6 S., R. 4 E., S.B.M., Hemet Reservoir quadrangle, 15', 1940; 2 miles east of Kenworthy Guard Station, in the San Jacinto Mountains.

Ownership: D. C. Mayne, 159 South Columbia Street, Hemet (1958).

History: The Hemet Belle mine is one of the old mines of the area. In 1917, one E. E. Chilson of Kenworthy (a town which no longer exists) was reported to have been working this mine. It was equipped with a 5-stamp mill (Merrill and Waring, 1917, p. 535). In 1929, the Hemet Belle was reported idle and listed as a part of the Chilson Estate (Tucker and Sampson, 1929, p. 481). It was relocated and renamed by the present owner in 1951.

Geology: The New Hemet Belle mine explores a gold-bearing quartz vein in the plane of a fault which is traceable for about 500 feet up a ridge on the east side of Hemet Valley. The fault strikes N. 55° E. and is vertical. The quartz vein is as much as a foot wide. Iron oxides fill vugs and fractures in the quartz. According to Merrill and Waring (1917, p. 535) the ore yielded $15 to $20 per ton in gold with some pockets of richer ore.

Development: The workings consist of a 300-foot adit, a 100-foot vertical shaft and several prospect pits. The adit enters the ridge in barren rock on a bearing of N. 50° E. At 100 feet, it turns right, goes 20 feet to the vein, turns left, and follows the vein for 200 feet to the bottom of the shaft.

The present owner was building a new road to the mine in 1958. In 1961, Norman Sanders reported that the road had been completed, and that the adit had been extended to 400 feet.

Production: Undetermined.

References: Merrill and Waring, 1917, p. 535; Tucker and Sampson, 1929, p. 481.

R.B.S. 6/24/58

Hexahedron (Hexie) Mine

Location: SE¼NE¼ sec. 11, T. 3 S., R. 9 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, at the south crest of the Hexie Mountains, 4 miles east of Squaw Tank.

Ownership: Undetermined (1960).

History: The Hexahedron Mine was under development as early as 1894 when Ed. Holland and A. G. Tingman, Indio, were the owners (Crawford, 1894, p. 223). Development work and prospecting in the area continued through 1896 (Crawford, 1896, p. 311). The mine was still active in 1914 (Merrill, 1917 (1919) p. 536) and was owned by the Indio Mining and Milling Company, but by 1918 was inactive and the mill had been dismantled (Tucker and Sampson, 1929, p. 481). No written description of the mill was found, but tailing debris and old foundations in the N½NE¼ sec. 14, T. 3 S., R. 9 E., S.B.M. mark a former mill site. The Hexie mill is said to have been a 5-stamp mill and the largest in the area. In 1960, the road to the mine from Pleasant Valley was impassable and the workings appeared long inactive.

Geology: Banded quartz-biotite gneiss (Pinto gneiss) underlies the mine area. The mine workings explore an altered felsite dike which strikes N. 35° W., dips 40° NE., and is 10 feet wide at the surface. The dike contains thin quartz stringers, local concentrations of pyrite cubes thoroughly altered to iron oxide, and much red to red-brown iron oxide. Dark green mafic dikes, thoroughly weathered, cut the felsite and gneiss irregularly. Crawford (1894, p. 223) described the ore shoot as 75 feet long, 15 to 20 feet in thickness, and dipping 45° N.

Development: The principal working is a 300-foot drift adit driven S. 35° E. with one 30-foot crosscut at 210 feet driven S. 40° W. Above the adit level are 3 open cuts, each about 50 feet long and 30 feet deep. Many shallow prospect pits have been opened in the area.

Production: U. S. Bureau of Mines records list placer production from the Hexahedron of 116.68 ounces of gold in 1893 by H. E. Fallant, Indio.

References: Crawford, 1894, p. 223; Crawford, 1896, p. 311; Merrill, 1917 (1919) p. 536; Tucker and Sampson, 1929, p. 481; ~~Tucker and Sampson,~~ 1945, p. 135.

C.H.G. 1/29/60.

Hidden (Ensperation, Lost Mine Parallel) Mine

Location: SW¼ sec. 7, T. 3 S., R. 8 E., S.B.M., SE¼ sec. 12(?), T. 3 S., R. 7 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, on the south face of the Little San Bernardino Mountains, 3/4 mile southwest of Keys (Salton) View.

Ownership: John and Margaret Samuelson, 656 Staple Street, Compton (1936). Undetermined (1960).

History: This property is said to have been discovered by the Sellers brothers who used the name Lost Mine Parallel. During the 1930's William F. Keys operated the mine. Ore was packed by mules up the steep face of the Little San Bernardino Mountains to Keys (Salton) View above. From there the ore was trucked to Keys Ranch, where it was milled in a 2-stamp mill (Oral communication W. F. Keys, 1960). Long idle.

Geology: The mine area is underlain by resistant, fine- to medium-grained, Mesozoic granite (assigned to the Fargo Granite* by Babcock, 1961, p. 37 and pl. 1). The irregularly shaped granite mass is surrounded by a halo of altered rock which Babcock (1961, p. 39 and pl. 1) mapped as granitized metadiorite. Both the granite and metadiorite are cut by mineralized faults which strike N. 15°-20° W., and dip steeply east. The mineralized areas are marked by iron gossan and the narrow veins contain pyrite, chalcopyrite, quartz, magnetite, and presumably gold. The mine workings chiefly explore two northwest-trending faults, about a quarter of a mile apart. The west fault, which dips about 80° E., has been prospected along its strike for about 500 feet, and the east fault for about 300 feet.

Development: Numerous prospect pits, shallow shafts, and short adits of undetermined extent.

Production: Undetermined.

References: Babcock, 1961, p. 37-40, 74, pl. 1.

C.H.G. 6/21/57.

* Unpublished, informal name.

Hidden Treasure (American Flag Mine) Claims

Location: E½ sec. 13 (proj.), T. 8 S., R. 20 E., W½ sec. 18, T. 8 S., R. 21 E.; Palo Verde Mountains quadrangle, 1953; on the east slope of the Mule Mountains, 13 miles west of Ripley.

Ownership: Ned Hyduke, Star Route, Palo Verde (1960).

History: This property was worked in 1910 under the ownership of Frank Steunchfield, Palo Verde. It was then named the American Flag Mine. In 1917 a list of properties known to be located in the area included the name American Flag M. and M. Co., owned by C. A. Ludden, Pomona, but no details were given (Merrill and Waring, 1917, p. 541). The literature contains no subsequent report on this mine. A mine called the American Flag mine was shown by Tucker and Sampson (1945) on their plate 35, but it ~~appears to be mislocated~~ was in a different location.

Geology: These claims are in an area of low hills formed in foliated gneissic rock of northerly ~~structural~~ trend. A shear zone is exposed through a distance of about 1,000 feet on the east slope of a ridge. It strikes N. 10° W., dips 30° SW. and is as much as 3 feet wide. A fractured quartz vein ranging from 0 to 6 inches in thickness lies along the foot wall. The vein quartz contains seams and bunches of iron oxides with lesser proportions of calcite, specular hematite, chlorite, sericite, pyrite, and traces of secondary copper minerals. Free-milling gold is unevenly dispersed through the above gangue minerals with a probable concentration in the iron oxides.

Development: When visited (January 1960) activity centered at the old shaft which was about 100 feet deep on the dip of the vein. Debris had not been cleared from the bottom of the shaft but some ore had been removed from near the collar. A drift adit was being driven northwest from the end of the ridge about 100 feet south of the shaft. It had reached a length of about 60 feet along the shear zone and should reach the shaft in another 30 to 40 feet. This will afford access to the shaft at about the 50-foot level (fig.). Northwest of the shaft the vein is exposed in 5 shallow prospects through a horizontal distance of about 170 feet.

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Similar veins in the immediate vicinity have been sampled but as yet have remained undeveloped.

Production: According to U. S. Bureau of Mines records, in 1910 the mine yielded 40 tons of ore from which 18 ounces of gold and 11 ounces of silver were recovered. Though the current work is mainly developmental the owner hopes to install a small mill on his ranch near Palo Verde in anticipation of future production.

References: Merrill and Waring, 1917, p. 541; Tucker and Sampson, 1945, pl. 35 (~~mislocated~~).

R.B.S. 1/18/60.

Hoag Mine

Location: NE¼ NW¼ sec. 24 (proj.), T. 4 S., R. 5 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 7 miles west of Perris and roughly 1,000 feet east of Hartford Springs.

Ownership: Undetermined (1959).

History: The first report on the Hoag Mine was by ~~R. J.~~ Sampson in 1935 (p. 512). According to ~~Sampson~~ him this property was worked by an unnamed operator from 1884 to 1886, again starting in January 1932, by H. M. Harford, Perris, and ~~that at the time of his report~~ in {1935}, the mine was flooded and the dumps were being worked.

Geology: Like the neighboring Washington Mine, the Hoag Mine is in an area of low hills and ridges composed of deeply Mesozoic weathered diorite. The vein explored ~~by~~ in the mine is poorly exposed. According to Tucker and Sampson, 1945 (p. 135) it strikes northwest and dips 40° SW. ~~He~~ They state, in addition, that the ore occurs in lenses ranging from a few inches to 2½ feet in thickness and is of limited extent both on the strike and dip.

Development: The Hoag Mine was entered through three vertical shafts and one inclined shaft. When visited in 1959 all four openings were either caved or caving and were unsafe to enter. The maximum depth attained in the workings was 300 feet and roughly 400 feet of drifts were driven at various levels (Sampson, 1935, p. 512). The shafts are arranged in a rough diamond about 270 feet in its longest dimension. ~~This suggests that part of the subsurface work must consist of exploratory cross cuts.~~

Production: U. S. Bureau of Mines records show that from 1934 to 1937, 3,657 tons of ore yielded 231.79 ounces of gold and 110 ounces of silver.

References: Sampson 1935, p. 512; Tucker and Sampson, 1945, p. 135.

R.B.S. 6/16/59.

Hodges Mine

Location: W½ sec. 4 and 5 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15' 1952; on the east slope of the Mule Mountains about 8 miles west of Ripley.

Ownership: Undetermined (1958).

History: This mine was formerly operated early in the present century by Hodge Bros., who had a 3-stamp mill at Palo Verde. It was taken over at an unreported date by Mr. Ludden of Pomona, who added 2 stamps and moved the mill to the mine. Water was pumped from a well in the valley 3½ miles away. Operations continued until 1913 (Tucker and Sampson, 1929, p. 481.) Idle.

Geology: The rocks at the Hodges mine are gneissic Precambrian granite cut by quartz veins. The veins form a generally west-trending system but a few strike from N. 70° W. to N. 70° E. Dips range from 60° southward ~~through vertical~~ to 60° northward. Most of the veins have exposed lengths ranging from 50 to 100 feet and are of irregular thickness, rarely exceeding one foot. The veins are fractured and largely recemented with iron oxides which appear to have been derived from the alteration of sulfides. Free-milling gold occurs in fissures or is finely disseminated in limonite the oxides.

Development: The workings are in a narrow canyon and on a steep ridge immediately to the northwest of the old camp site. Development consists of 3 vertical shafts and 3 adits which are apparently joined by an undetermined amount of drifting and stoping. A depth of a least 100 feet was attained at the adit levels, Mining seems to have been systematic, as evidenced by a long haulage adit driven north from the floor of the canyon through barren rock, to facilitate drifting and stoping on the veins in the ridge. Little timber was used except a stulls in the stopes. No equipment remains on the property, but the walls of a 3-room stone house are still standing near the mouth of the canyon. When visited (Feb., 1958) the mine was open and dry. Access was good.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 481.

R.B.S. 2/21/58.

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Hornet Group

Location: SW¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, about 8.5 miles S. 22, E. from Four Corners, Twentynine Palms. (see pl. 1 / Figure 19).

Ownership: Undetermined.

History: I. N. Lish and B. E. Lish, 8465 Cottonwood, Fontana, located the Hornet Group in May 1956.

Geology: A low elongate south-trending ridge is carved in the Pinto gneiss. Along the crest of this ridge the gneiss is intruded by fine-to medium-grained hornblende granite, thin veins of gold (?)-bearing milky quartz, and narrow green basic dikes.

Development: Several pits, trenches and bulldozer scrapes have exposed the veins and dikes along the ridge crest over a distance of 0.2 of a mile (fig. 29A). Near the Gold Park road there is a 20-foot trench dug to join a vertical shaft sunk 12 feet in a fault (fig. 1 /). At the bottom of the shaft a drift is driven 15 feet south. The claims are apparently not being worked.

Production: Undetermined.

References: None.

J.R.E. 2/12/59.

figure 29

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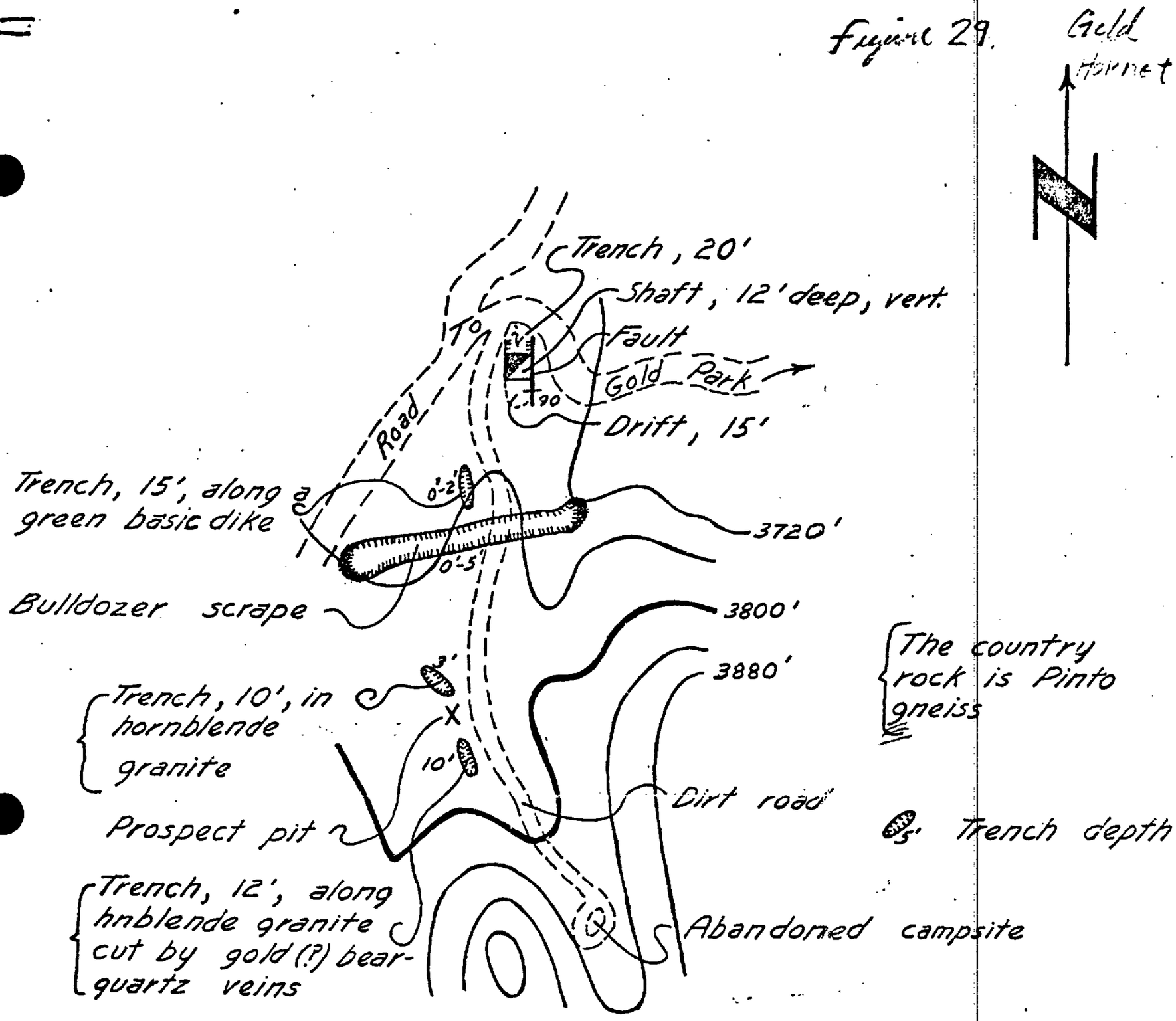
Figure 29.



By James R. Evans
February 1959

Figure 29 (1) Sketch map of the Hornet group (topography from U. S. G. S. 15' Valley Mountain quadrangle, 1956).

Ida-Leona Mine

Location: NE¼ sec. 30, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 6 miles west of Perris.

Ownership: Mrs. Orva Nelson, Perris.

History: Formerly the Ida-Leona mine was described with the older Gavilan mine (Tucker and Sampson, 1945, p. 135-136) which is about 400 feet north of it. The Ida-Leona mine was most active during the 1930's. It was closed in 1942 ~~because of the gold closing order L-208~~ and has since remained idle.

Geology: The country rock is Mesozoic quartz diorite. A quartz vein ranging from 1 to 4 feet in width strikes N. 65° W., and dips 60° SW. It is exposed for about 250 feet. Free-milling gold is associated with iron oxides, pyrite, and galena in small pockets and fissure fillings in the quartz.

Development: When visited in 1959 three inclined and caved shafts were found. ~~They were caved and their extent was not deteremined.~~ ~~In 1945~~ the workings were reported in 1945 (Tucker and Sampson, 1945, p. 135-136) to consist of a 2-compartment shaft 350 feet deep with drifts of unspecified extent at the 100, 150, 250, and 300 foot levels. This shaft was probably the most southeasterly ~~one observed by the writer.~~ of the three. The other two openings may have been raises, ventilation shafts, or exploratory shafts.

Production: A reported (Tucker and Sampson, 1945, p. 136) $50,000 in gold was won from an unstated tonnage of ore said to assay $25 to $50 per ton. Although some high-grade ore was reported, in 1945, to have been shipped to U. S. Smelting Company, Salt Lake City, Utah, the bulk of the ore was milled at the mine.

References: Sampson 1935, p. 508-509; Tucker and Sampson, 1945, p. 135-136; Larsen, 1948, p. 130.

R.B.S. 6/15/59.

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Indian Rose Quartz Queen (Indian Queen) Mine

Location: NW¼ sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 6 miles west of Perris. (figure 42).

Ownership: Frank Koehn, Rt. 2, Box 94, Perris (1959).

History: The old Indian Queen mine was reported as a new prospect in 1896. ~~Equipment consisted of a small steam hoist, a 5-stamp mill and a 4" cornish pump.~~ The owner was J. B. Dennis, Perris (Crawford, 1896, p. 311). By 1899 the mine appears to have changed hands, and was reported as "--developed into a promising property by Mr. Anderson." (Mining and Scientific Press, 1899, vol. 79, p. 750). U. S. Bureau of Mines records show that for the year 1899 the mine was operated by Indian Queen mining Co., Perris and for the years 1900 and 1901 production was credited to Anderson and Morris of Perris. In 1917 the property was held by a party named Morrison, Goldfield, Nev. (Merrill and Waring, 1917, p. 531). ~~Save for assessment work,~~ the mine appears to have been inactive since 1917.

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Geology: The country rock is weathered Mesozoic diorite. The mine is in poor repair (1959) and the features described in former reports could not be confirmed. The vein was reported to strike northwest and dip 70° SW. (Merrill and Waring, 1917, p. 531). This vein is at the west end of the claim. A second vein is exposed in workings near the north side of the claim. It strikes west, dips 50° S. and consists of broken and pulverized quartz lying in the plane of a shear zone little more than an inch wide where exposed. The quartz is stained and pocketed with iron oxides.

Development: The old workings, which appear to have comprised three shafts, are now caved. They were reported to have been 65 feet deep (Merrill and Waring, 1917, p. 531). The west-trending vein is explored by a 6-foot shaft, now caved. ~~(from which a 20-foot drift was driven east (personal communication, Frank Koehn).)~~ In addition ~~this~~ the west-trending vein is exposed in an excavation near the junction of Santa Rosa Road and a dirt road which extends southward to Rancho El Nido.

Production: In the period 1896 to 1901, 850 ounces of gold and 806 ounces of silver were credited to this mine (U. S. Bureau of Mines records). ~~No figures were found for the tonnage of ore removed.~~

References: Crawford, 1896, p. 311; Mining and Scientific Press, 1899, vol. 79, p. 750; Merrill and Waring, 1917, p. 531; Tucker and Sampson, 1929, p. 482; Sampson, 1935, p. 512.

R.B.S. 9/24/59

Iron Chief Mine

Location: Sec. 36, T. 3 S., R. 13 E., S.B.M. (proj.), Pinto Basin quadrangle, 15', 1953; Eagle Mountains, about 1½ miles southeast of the Black Eagle mine and 11 miles northeast of the East Pinto Basin-West Pinto Basin-Cottonwood Pass and Black Eagle mine roads intersection.

Ownership: Kaiser Steel Corporation, P.O. Box 217, Fontana, own at least 6 patented claims - The Gray Eagle Group (March 1960).

History: Tucker (1924, p. 192) reports that the property was originally located by William Stevens and Thomas Dolfflemeyer of San Bernardino. In 1897, the mine was reportedly sold to Charles Lane of San Francisco, who installed a small mill and operated the mine for several years. The property reverted to who Mr. Lane did not complete payments on the property and the original owners took over the installation of and ed a 50-ton cyanide plant, operating the mine and mill until about 1902 (Tucker, 1924, p. 192). From 1902 to at least 1909 the Southern Pacific Railroad Company apparently owned and worked the mine (Tucker, 1924, p. 192). Production was recorded in 1900 and 1901. Apparently little if any work beyond assessment work has been done since 1909 and 6 claims (Gray Eagle Group) were patented in 1915.

Paleozoic(?)

Geology: The mine is in a contact area between Mesozoic calcitic dolomite and quartz monzonite (~~see fig. 1~~). An oxidized zone composed mainly of hematite and quartz, 12 feet in maximum width and 6 feet in average width, contained $10 per ton of gold to a depth of 100 feet, where a sulfide zone containing chalcopyrite and pyrite was encountered. The mine operated at a profit in the oxidized zone but closed down when the sulfide zone was reached. The oxidized zone trends N. 70° W. and dips 45° N. (Tucker and Sampson, 1929, p. 482).

Development: A vertical shaft is sunk 140 feet deep on the contact ~~of~~ between quartz monzonite and dolomite and is intersected at the 100-foot level by a crosscut adit driven 500 feet south to intersect the oxidized zone. At this level there is at least 500 feet of drifting in the oxidized zone which has been stoped to the surface over a length of 300 feet (Tucker and Sampson, 1929, p. 482). In 1924, about 20,000 tons of tailings assaying 90¢ per ton in gold were disposed in the gulch, immediately south of the mine (Tucker, 1924, unpublished Field Report No. 83). About 8000 tons of tailings were still on the property as late as 1945 (Tucker and Sampson, 1945, p. 136). The mine is now filled in, boarded over, and of course inaccessible. It is at an elevation of 2500 feet and adjacent to the Black Eagle mine dirt road.

Figure 30

Production: The U. S. Bureau of Mines records show a production in 1900 of 142 ounces of gold extracted from 3,012 tons of crude ore, and in 1901 of 1,667 ounces of gold extracted from 2,515 tons of crude ore. Tucker and Sampson (1929, p. 482) report a value of $150,000 for total production.

References: Tucker, 1924, pp. 191-192; Tucker, 1924, unpublished Field Report No. 83; Tucker and Sampson, 1929, p. 482; Tucker and Sampson, 1945, p. 136.

J.R.E. 3/17/60

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Figure 30. Geologic map of the Iron Chief gold mine and adjacent area. The quartzites and dolomite are part of a series of old metasedimentary rocks intruded by quartz monzonite, and dikes of intermediate composition. The contact rocks and replacement iron bodies are a result of the intrusion of quartz monzonite into calcitic dolomite.

Gold

figure 30

ds

qm

ds

cr

q

d

d

ds

d

Cr

d

IRON CHIEF MINE

i

cr

qm

20

d

q

i

vq

qm

Quartz monzonite

ds

Intermediate dikes

i

Iron ore

cr

Contact rock

d

Dolomite

q

Quartzite

vq

Vitreous quartzite

Geologic contact

Mine shaft

20

Dip and strike of beds

Intermittent stream

0 250 500

Scale in Feet

Geology after E.C. Harder and J.L. Rich, 1912

Figure 1/. Geologic map of the Iron Chief gold mine and adjacent area. The quartzites and dolomite are part of a series of old metasedimentary rocks intruded by quartz monzonite, and dikes of intermediate composition. The contact rocks and replacement iron bodies are a result of the intrusion of quartz monzonite into calcitic dolomite.

Jean (Postmaster) Mine

Location: N½ sec. 35 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 15' 1950; on the northwest slope of the Riverside Mountains 5 miles south-southwest of Vidal.

Ownership: Undetermined (1958).

History: The Jean mine is so named on the Vidal quadrangle map ~~but this name was not found in the literature. The mine was~~ and it is identified as the Postmaster mine by Danny G. Figueroa (personal communication), ~~but this name has also escaped previous reports.~~ It is probable that this ~~is~~ was the property being worked by Bethel Mining and Lasing Company in 1929 (Tucker and Sampson, 1929, p. 473), which, ~~In 1930, that company recorded~~ was credited with gold production from a claim named "Rattler" (U.S. Bureau of Mines file), ~~located in the same area and possibly the same mine.~~

Geology: The rocks in the mine area are contorted Precambrian gneisses, quartzite, schist, and hornfels cut by quartz veins and mineralized faults. The veins and faults strike from N. 20° E. to N. 30° W. and dip about 40° NW. or SW. ~~A barren vein of massive white quartz 2 to 4 feet wide crops out on these claims near the main camp site. However,~~ few of the veins that have been mined are more than 2 feet wide. Most of the veins actually consist of numerous closely-spaced veinlets. Minerals noted associated with the quartz are chalcopyrite and hematite and less commonly, calcite and barite.

Development: Though the underground extent of the mine was not determined, at least 2 veins have been exploited from the surface.

Development consists of 1 inclined shaft, 1 vertical shaft, 2 adits and prospect pits. The principal shaft is inclined 45° NW. and extends to an undetermined depth on a shear zone mineralized with quartz stringers and veins. About 150 feet northeast of the inclined shaft is a vertical shaft of unknown depth. These 2 shafts are in the area of the main campsite. About 600 feet north of the campsite an inclined adit extends 20 feet southwest on a 12 to 18 inch-wide quartz vein striking N. 10° E. and dipping 40° SE. in platy schist. Up the slope to the east of the campsite about 1,000 feet is an adit driven southeast a reported distance of 1000 feet from which stopes extend 100 or more feet northeast to the surface (Danny G. Figueroa, personal communication). This adit explores a fault zone 12 to 18 inches wide striking N. 20° W. and dipping 35° SW. At the portal an 8 inch quartz vein is exposed from which veinlets branch over a width of about 2 feet. The vein narrows to a width of 2 to 6 inches where exposed in a stope, opening to the surface several hundred feet northeast of the adit portal.

Production: U. S. Bureau of Mines records show that in 1930, 12 tons of ore taken from the "Rattler" (probably the Jean mine) yielded 26.89 ounces of gold and 9 ounces of silver.

References: Tucker and Sampson, 1929, p. 473.

R.B.S. and C.H.G. 12/18/57

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John's Camp

Location: SE¼SW¼ sec. 4 (proj.), T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 15', 1955; Joshua Tree National Monument, 8 miles south of Twentynine Palms.

Ownership: Undetermined.

History: Undetermined; old mill foundations at site are dated 1931. Apparently long idle.

Geology: Shear zones in coarse-grained Mesozoic quartz monzonite (Palms quartz monzonite of Rogers (1954)). The principal adit on the east side of a narrow canyon explores a shear and gouge zone 1 to 2 feet thick, which strikes north and is vertical to steeply east-dipping. Several hundred feet up the hill a second shear zone trends N. 45° E.

Development: A drift adit, of undetermined extent, is driven on the north-trending shear zone, and the zone has been opened by minor trenches above. The northeast-trending zones above have been explored by 4 short drift adits and shallow pits. To the west, across the canyon, is another adit, and there are several caved adits several hundred yards to the east.

Production: Undetermined.

References: Rogers, 1954, map sheet 24.

C.H.G. 5/19/61.

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Jumbo Mine

Location: SE¼ sec. 30, NE¼ sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 6½ miles west of Perris. The claim lies athwart a low ridge just south of Santa Rosa Road (figure 7).

Ownership: Undetermined.

History: The Jumbo Mine was reported active as early as 1896 at which time it was owned by M. E. Bethrum, Perris (Crawford, 1896, p. 312). Although subsequent reports add nothing to the 1896 description, the present condition of the property suggests considerable activity since 1896. U. S. Bureau of Mines files show that the Jumbo mine was active as late as 1900 and that S. T. Crawford, and a party named Stanford, both of Perris, held the mine in the years 1899 and 1900 respectively.

Geology: A poorly exposed shear zone as much as one foot wide contains thin, discontinuous veins and pods of crushed quartz ranging from 0 to about 2 inches in thickness. The shear zone strikes N. 10° W. across a ridge of deeply weathered diorite and dips about 80° SW. The crushed vein quartz is stained and pocketed with iron oxides. It has yielded gold and silver but assay data are lacking.

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Development: The earliest reported development consisted of a 50-foot shaft (Crawford, 1896, p. 312) but inspection of the property revealed that, in addition, at least one adit and several other shafts or deep prospect pits were opened. A foundation suggests that a mill had been installed. When visited (1959) the workings were caved and inaccessible.

Production: During the four reported years, 1896, 97, 99 and 1900, U. S. Bureau of Mines records show that a total of 1,382.10 ounces of gold and 477 ounces of silver were won from an unreported tonnage of ore. These figures seem high but they might constitute an unapportioned total resulting from the milling of ore from a number of small nearby mines.

References: Crawford, 1896, p. 312; Tucker and Sampson, 1929, p. 482; 1945, pl. 35; Sampson, 1935, p. 512.

R.B.S. 9/23/59

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Lane Mine

Location: S. 1/2, Sec. 10 (proj.), T. 6 S., R. 15 E., U. S. Army Corps of Engineers) Chuckwalla Mountains quadrangle, 15', 1945 63, in the Chuckwalla Mountains, 3 3/4 miles south of Desert Center. This mine is accessible only by means of faint trails from the Aztec Well area and from the Granite mine.

Ownership: Undetermined (1959).

History: Early reports barely mention the Lane mine but their dates, 1896 (Crawford, p. 312) and 1919 (Merrill and Waring, p. 540) mark the times of its early development, and, at the later date, after operations had ceased.

Geology: A shear zone with a maximum width of 5 feet is exposed for about 500 feet along the south slope of a (granite) ridge underlain by Mesozoic granitic rock. It strikes N. 50° W. and dips 45° NE. Contained within the shear zone is a crushed quartz vein as much as 2 feet wide which is unevenly mineralized with oxides of iron and traces of secondary copper minerals.

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Development: The vein has been explored by means of a 50-foot shaft, 3 shallow shafts 10 to 20 feet deep, and an open cut. The shafts are inclined on the dip of the vein. In addition, there is a shallow pit which appears to be the collar of a caved shaft.

Production: Undetermined.

References: Crawford, 1896, p. 312; Merrill and Waring, 1919, p. 540.

R.B.S. 4/29/59.

by 1

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Langdon Claim

Location: SW¼, sec. 10 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 15' 1951; about 6 miles by dirt road and trail east of Midland Road and 3 miles northeast of Black Hill.

Ownership: Undetermined (1958).

History: According to Mr. George Ringwald, Blythe, (personal communication 1/12/59) this property was worked from 1932 to 1934 by a man named Langdon.

Geology: The country rock, Precambrian gneiss cut by quartz-feldspar pegmatite dikes, is faulted. The faults are poorly exposed. One fault, explored by the north workings, is vertical and strikes N. 45° E. Another, in the southern workings, strikes N. 85° W. and dips 80° NE. Gold-bearing quartz veins of undetermined extent lie in the fault planes. They range from a fraction of an inch to as much as a foot in thickness. Fractures and pockets in the veins are filled with iron oxides.

Development: The north workings comprise a 20-foot drift adit from the end of which a 17-foot raise was run to the surface. The south working, in a narrow ravine about 1,000 feet to the southeast of the north adit, consists of a 50-foot inclined shaft.

Production: Not determined.

References: None.

R.B.S. 12/19/58.

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Last Chance Mine

Location: ~~Sec. 20 (XX), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers~~ SE1/4, 23 \ 3 (proj). Chuckwalla Mountains quadrangle, 15', 19~~45~~63; in the Chuckwalla Mountains about one mile south of Aztec Well and 3 miles west of Corn Spring. This property is ~~about a quarter of a mile~~ a short distance southeast of the C.O.D. mine and probably lies along the same fault zone.

Ownership: Not determined (1959).

History: Last held, in 1948, by E. M. White.

Geology: A vertical fault zone as wide as 4 feet, which strikes N. 20° W., is poorly exposed for about 200 feet on a low granite ridge. Quartz veins and lenses as much as 5 inches wide are unevenly distributed in the fault plane. The veins are stained and pocketed with iron oxides. Calcite is present but not common.

Development: The fault zone on the nose of the ridge has been explored by means of a 20-foot adit. A 10-foot prospect pit in the fault zone lies about 75 feet up the slope from the adit.

Production: Not determined.

References: None.

R.B.S. 5/1/59.

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Leon Mine

Location: NW¼ NW¼ sec. 18, T. 6 S., R. 2 W., S.B.M. Romoland quadrangle, 7½', 1953; about 6 miles south-southeast of Romoland.

Ownership: Hans Christensen, Romoland, one patented claim.

History: According to early reports the Leon Mine was opened in the late 1800's (Crawford, 1894, p. 223). By 1917, it was still being referred to as "a promising prospect" (Merrill and Waring, 1917, p. 534-535). The actual amount of gold taken from the property was not recorded. According to U. S. Bureau of Mines records, during the years 1950 to 1953 the property was worked by W. A., M. E., and R. H. Obarr, 1541 Freeman Ave., Long Beach.

Geology: A shear zone as much as 3 feet wide strikes N. 55° W. and dips 70° N.E. across the southwest slope of a hill underlain by Mesozoic metasedimentary and metavolcanic rocks. Quartz vein material of undetermined average thickness is distributed unevenly in the shear zone. The shear is exposed for about 1,500 feet.

Photo 16

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Development: Two vertical shafts, a shallow pit, and a trench explore the vein. The collars of the shafts are on the vein and about 200 feet apart, the northwesterly one being higher than the other by about 50 vertical feet. The northwest shaft, now caved, was once reported to be 150 feet deep (Crawford, 1896, p. 312). ~~A small sheet iron shack, which housed the hoisting machinery, still stands near it.~~ The southeast shaft is open but ~~and untimbered as far down as could be observed from the~~ partially caved at the collar. Its depth was not determined. The pit and trench lie between the two shafts, ~~and are simply shallow prospects~~ on the shear zone.

Production: In 1950, 3 tons of ore yielded 1 ounce of gold and 1 ounce of silver (U. S. Bureau of Mines records, published ~~with permission of the owner~~). retet

References: Crawford, 1894, 223; 1896, p. 312; Tucker and Sampson, 1929, p. 483.

R.B.S. 10/22/58.

Lost Angel (Laseter, Sippi?) Mine

Location: SW¼ sec. 35, T. 3 S., R.8 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument in a narrow canyon high on the southwest slope of the Little San Bernardino Mountains, 2 3/4 miles southwest of Pinyon Well. This mine previously, and apparently erroneously, was reported in sec. 22, T. 3 S., R. 8 E., S.B.M. (Tucker and Sampson, 1945, p. 137).

Ownership: Clyde Jones, P.O. Box 1678, Indio (1957).

History: The Sippi mine, which probably is the Lost Angel mine, is said to have been worked by a Mr. McFarland in the 1890's. The Lost Angel mine was owned many years ago by W. H. Laseter, Twentynine Palms. The property was leased to C. L. Woods, Indio, from 1937-1945 when the mine comprised 8 claims. A. F. Perry acquired the holdings in 1945 and subsequently sold them to Clyde Jones in 1956. Apparently the mine has not been worked since about 1937.

Geology: The mine workings explore a 5-foot wide shear zone in biotite-diorite gneiss and biotite schist (Precambrian Chuckwalla complex) on the west side of the canyon. The shear zone strikes N. 80° W., is vertical, and contains discontinuous quartz stringers as much as 1 foot wide.

Development: Tucker and Sampson (1945, p. 137) reported a 75-foot shaft and a 150-foot adit on the vein, and a 5-stamp mill on the property. In June 1957 the shaft was not found, the adit on the west side of the canyon was about 50 feet long, and no trace of the mill remained.

Production: U. S. Bureau of Mines records show 2 tons of crude ore produced in 1937 yielded 2 ounces of gold and 1 ounce of silver.

References: Tucker and Sampson, 1945, p. 137.

C.H.G. 6/29/57.

Lost Horse Mine

Location: SW¼NW¼ sec. 3, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, 3 miles southeast of Ryan Campground and Lost Horse Well, on the east side of a small valley high in the central part of Lost Horse Mountain.

Ownership: Leanta Stafford Ryan, 242 E. Center, Covina holds one patented claim of 13.5 acres.

History: The gold-bearing vein developed at the Lost Horse Mine, was worked as early as 1894 when ore was hauled to the Pinon Mountain mill (apparently located at the present El Dorado patented mill site at Pinyon Well). During this early development Lang, Holland, and Tingman, of Indio were the owners of 2 claims (Crawford, 1896, p. 223). The area was surveyed for one 13 acre claim for patent in 1895 and a patent was issued in 1897 to Nathan Ryan and others. Apparently the mine was in almost continuous operation from 1895-1908, but under several operators: 1896-98, Thos. C. Ryan; 1899-1900, Lost Horse Mining and Milling Company; 1901, 1905, S. M. Kelsey; 1906, 1908, Lost Horse Mining and Milling Company.

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By 1896 a 2-stamp mill had been built several miles north of the mine, probably at Lost Horse Well. Workings included a 80-foot drift adit, 50-foot winze, 50-foot drift from the bottom of the winze, and a 235-foot vertical shaft with a horse-whim (Crawford, 1896, p. 312). In 1929, Tucker and Sampson (p.483) reported the shaft was 500 feet deep and a 10-stamp mill was at the mine. Water was piped to the mine from Lost Horse well.

After being idle for about 20 years the mine was reopened in 1931 under lease by Gen'l Mining and Development Company who mined pillars of ore from the upper levels and milled in the 10-stamp mill. The last activity apparently was in 1936 when J. D. Ryan processed 600 tons of tailing. The operation during the 1930's yielded only a few hundred ounces of gold and local residents report the vein was faulted off at depth and drifting failed to find the vein. Apparently long idle.

Geology: The mine area is underlain by dark well-foliated thin banded quartz-biotite gneiss (Pinto gneiss). Precambrian The banding strikes north to N. 40° W. and is steeply dipping to vertical. According to Merrill (1917 p. 536) the principal workings explore a quartz vein which strikes east, dips 85° N., ranges from 6 inches to 5 feet in width, and is exposed on the surface at several points for about 800 feet. In June 1957, the vein could not be observed in the main shaft because of timbering, but the dump material contained iron-stained vein quartz, gneiss, and black mica schist. Twenty feet east of the shaft a 4-inch quartz vein strikes N. 20° E., and is vertical. Two shallow shafts, 300 and 500 feet to the east on the ridge explore east-striking vertical, thin, iron-stained quartz veins in shear zones in gneiss. Where best defined in the upper shaft the shears strike N. 15° W., and dip 70° SW.

Development: The Lost Horse mine workings consist chiefly of a 500-foot vertical shaft with a small amount of drifting on the vein on the 100, 200, 300, and 400-foot levels (Tucker and Sampson, 1945, p. 137). About 100 feet west of the main shaft an adit is driven N. 80° E. along a 5-foot wide shear zone. Apparently this is the adit described by Merrill (1917, p. 536) as being 80 feet long with a 50-foot winze and a 50-foot drift east driven from the bottom of the winze. The vein also has been explored by 2 shallow shafts, 300 and 500 feet east of the main shaft, and by several pits. In 1957, a vertical headframe, several partially collapsed wooden and stone buildings, and a largely dismantled 10-stamp mill remained on the property.

Production: This property has been credited (Chesterman, 1957, p. 79) with the only production of bismuth in California and the 20 tons of bismuth ore produced in 1904 are listed as being from the Lost Horse, formerly the Lang copper mine. It appears this report is erroneous as a long time local resident, Mr. William F. Keyes, states the bismuth ore came from the Sulphide Bismuth mine (see herein) in the early 1900's, when the property was known as the Lang Copper mine, but Mr. Lang also apparently was a partner in the Lost Horse mine. No evidence of copper or sulfide mineralization was observed at the Lost Horse mine.

Tucker and Sampson (1945, p. 137) report the total value of gold from the Lost Horse mine as $350,000. This is in rough agreement with the more than 10,000 ounces of gold and 16,000 ounces of silver reported (U.S. Bureau of Mines records) to have been recovered from an undetermined tonnage of ore and 600 tons of tailings (produced) yielded by the Lost Horse mine from 1895 to 1936.

References: Crawford; 1894, p. 223; Crawford, 1896, p. 312; Mining and Scientific Press, 1900 (May, vol. 80, no. 18) p. 494; Merrill, 1917 [1919] p. 536; Tucker and Sampson, 1929, p. 483; Tucker and Sampson, 1945, p. 137; Chesterman, 1957, p. 79.

C.H.G. 6/28/57.

Lost Pony Mine

Location: Sec. ~~24~~ 19 (proj.), T. 6 S., R. ~~14~~ 15 E., S.B.M., ~~U. S. Army Corps of Engineers~~ 15', Chuckwalla Mtns. quadrangle, ~~1945~~ 1963; on the southwest slope of the Chuckwalla Mountains 6 3/4 miles southwest of Desert Center. The mine is marked on the quadrangle map.

Ownership: Undetermined.

History: The Lost Pony mine appears to be an old property, but its date of location was not determined. In the early 1940's the mine was owned by Dell Barnum, Desert Center. In 1940, Desert Center Mining Company leased and operated the property for an undetermined period (Tucker and Sampson, 1945, p. 137).

Geology: The country rock is gneissic Precambrian granite cut by aplite and pegmatite dikes as much as 3 feet wide. The gneissic structure has a general strike about N. 10° W. A fault zone, traceable for about 1100 feet, strikes west nearly at right angles to the structure of country rock and dips 50° S. A fine-grained, basic dike ranging from 5 to 30 feet in thickness lies in the fault zone. Quartz veins ranging from 0 to 1 foot in thickness lie along the footwall of the fault zone.

The veins and the dike are fractured, probably by recurrent movement on the fault. The most pronounced shearing followed the footwall creating irregular masses of gouge as much as 3 feet wide in which a large proportion of the vein quartz was dragged and crushed. Minerals observed in the ore are calcite, siderite, chlorite, magnetite, hydrous iron oxides, and scattered stains and thin crusts of chrysocolla. No data on the gold content of the deposit were obtained.

Other quartz veins strike parallel to the fault and crop out 50 to 100 feet south of it. These veins appear to be barren. In addition a second basic dike, 40 feet wide, is exposed 75 feet north of and parallel to the fault but it does not appear to be associated with a fault or vein.

Development: Two shafts, 50 and 80 feet deep, were sunk in the hanging wall. These shafts probably connect with workings serviced by 6 inclined shafts driven on the vein but because of the poor condition of the mine no entry was made to check the extent of development. The mine was reported to be at least 200 feet deep with drifts on the 50, 100, and 200 foot levels (Tucker and Sampson, 1945, p. 137). In addition there is a trench and several prospect pits and, near the west end of the outcrop, ~~there is~~ a 50-foot crosscut adit in the hanging wall from which a drift runs 60 feet east on the vein. A 60-foot shaft explores the dike, exposed to the north of the fault, with apparently negative results.

Production: Desert Center Mining Company made a number of shipments of high-grade ore to American Smelting and Refining Company's smelter, Garfield, Utah but the tonnage and grade ~~was~~ were not reported (Tucker and Sampson, 1945, p. 137). Idle (1959).

References: Tucker and Sampson, 1945, p. 137, pl. 35.

R.B.S. 11/16/59

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Louise Mine

Location: Sec. 17, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1948; Pinto Mountains, about 1½ miles west of the Gold Crown mine and 4 miles southwest of New Dale (Site). (See pl. 3).

Ownership: Emmett Bethurum, Box 111, Amboy, owns 2 unpatented lode claims (March 1958).

History: The mine was originally located in the late 1920's by Jack Meek and E. V. Evans, and was active in 1929 (Tucker and Sampson, 1929, p. 483). Emmett Bethurum owned and operated the mine from 1937 to 1939.

Geology: Quartz monzonite is cut by a north trending and nearly vertical fault containing a quartz vein 2 feet in average thickness. Tucker and Sampson (1929, p. 483) report that the vein is mineralized with galena, chalcopyrite, and shows free gold.

Development: The main shaft is sunk vertically on the vein to an undetermined depth. Probably drifts extend from the shaft at one or more levels. Other workings of minor extent consisting mainly of shallow shafts and surface trenches are randomly distributed about 350 feet south along the fault trace from the main shaft.

Figure 31
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Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lbs.)	Lead (lbs.)
1937	38	13	27		
1938	67	19	24	209	1,292
1939	3	3			

References: Tucker and Sampson, 1929, pp. 483-484.

J.R.E. 3/30/60

Lucky Boy (Walker Claim) Mine

Location: SE¼ sec. 9, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle, 7½', 1953; about 9 miles south of Perris, in a cultivated area between two low, rounded hills.

Ownership: Undetermined.

History: This deposit was discovered in 1892. Development proceeded slowly under the ownership of Sam Walker, Menifee (Storms, 1893, p. 385; Crawford, 1894, p. 223-224; personal communication, John D. Walker). In 1917 the owner was reported dead (Merrill and Waring, 1917, p. 534) and, since that date, the mine has remained idle.

Geology: The country rock at the mine is deeply weathered Mesozoic diorite. The whole outcrop is barely 100 feet long and brush, soil, and the caved state of the mine obscure the deposit. The vein appears to strike about N. 55° W. and, according to John Walker, son of the original owner, it is vertical. It was reported to range from 4 inches to one foot in thickness and to be faulted in two places (Storms, 1893, p. 385). The vein is fractured and the quartz is recemented and pocketed with iron oxides. There appears to be no report on the gold content except some high grade estimated by Storms to run about $65 per ton. Pyrite is present in the ore below the water table (personal communication, J. D. Walker).

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Development: The workings are filled or caved but formerly two shafts, 50 and 60 feet deep respectively, were sunk on the vein. Water was reported to be the principal problem (Crawford, 1896, p. 312).

Production: Undetermined. ~~Idle (1959).~~

References: Storms, 1893, p. 385; Crawford, 1894, p. 223-224; 1896, p. 312; Merrill and Waring, 1917, p. 534; Tucker and Sampson, 1929, p. 484; 1945, pl. 35; Sampson, 1935, p. 513.

R.B.S. 10/20/59.

Lucky Dollar Mine

Location: Sec. 24 (proj.), T. 5 S., R. 13 E., S.B.M., U. S. Army Corp of Engineers, 15', Hayfield quadrangle, 1944; about 3 miles east-northest of Hayfield Pumping Station and a little more than half a mile east-southeast of the Golden Eagle Mine, at the south edge of the Eagle Mountains.

Ownership: Undetermined.

History: Papers found at the mine show that it was claimed in 1940 by C. H. Kelly. No records for other years were found.

Geology: A quartz vein, ranging from 0 to 3 inches in thickness, lies along the hanging wall of a fault zone, as much as 4 feet wide, which is poorly exposed on the crest of a narrow granite ridge. The fault strikes N. 45° E. and dips 45° SE. Voids and fractures in the vein contain oxides of iron which has probably formed from the weathering of sulfides. Gold, where present, is a free-milling residue as with other ores in the area.

Development: The outcrop is penetrated by a 12-foot inclined shaft. A crosscut adit was driven southeast from a point about 100 feet down the slope to the west. It appears to be at least 100 feet long but whether or not it reaches the vein was not determined.

The tonnage yield reported for the year 1940 suggests that the vein was reached and worked, but little vein material was found on the dump.

Production: U. S. Bureau of Mines records show that in 1940 the Lucky Dollar mine yielded 9 tons of ore from which 10 ounces of gold and 4 ounces of silver were recovered.

References: None.

R.B.S. 11/20/59

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Lucky Lady Claim

Location: SE¼ sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 15', 1952; southwest of the Aztec and Rainbow Claims. It is at the northeast base of a ridge and is reached by a side road off Dupont Road.

Ownership: Undetermined.

History: This property was developed during the 1930's and worked for a period of short but unrecorded duration (J. Dupont, personal communication).

Geology: Undetermined. The property was not visited but probably resembles the nearby Aztec and Rainbow Claims, which are on northwest-trending, gold-bearing quartz veins in gneissic country rock.

Development: The deposit was explored by a single shaft, 75 feet deep.

Production: Undetermined. Mr. J. Dupont stated that some ore of good grade was taken from the claim.

References: None.

R.B.S. 4/28/59.

Lucky Strike (Ophir) Mine

This report is based largely on information recently contained in a published description by Engel, Gay and Rogers (1959, p. 67-68).

Location: Sec. 21, T. 5 S., R. 4 W., S.B.M., U.S. Army Corps of Engineers Lake Elsinore quadrangle, 15', 1942; at the northeast base of a low hill just southeast of Highway 74, about 3 miles northeast of Elsinore.

Ownership: R. S. Fisher and R. L. Read, Elsinore (1945) own an undetermined area of patented land (formerly railroad land) including the mine.

History: The Lucky Strike was reported active in 1917 (Merrill and Waring, p. 529).

Geology: The country rock is deeply-weathered, Mesozoic quartz diorite. A quartz vein, about 15 inches wide at the surface, strikes N. 80° E., and dips 45° S. in the collar of the main shaft, but apparently turns to strike N. 55° E. and dip 55° SE. where exposed 100 feet to the east. The vein is discontinuously exposed for several hundred feet across the hill. At the surface, the vein quartz is strongly stained with iron oxides and has a well-defined clay selvage. A second, more northerly vein, not exposed on the surface, is reported also to strike east, but to dip 35° and intersect the main vein at the 50-foot level. The veins contain free gold, silver, marcasite, pyrite, arsenopyrite, and copper oxide stains; the north vein has the higher silver content. On the 50-foot level the vein is reported to range from 2 to 24 inches in thickness with an average thickness of about 10 inches. On this level the oreshoot is reported to be about 85 feet long. Some of the ore was reported to bear 25 ounces of silver and $8 in gold per ton (Sampson, 1935, p. 513).

Development: Mine openings include the main shaft, inclined 45° along the main vein and 150 feet deep, and a second inclined shaft of undetermined depth about 100 feet to the east. In 1955, both shafts were caved at a depth of about 30 feet and inaccessible. Past reports indicate the existence of a 100-foot drift to the north (presumably east) of the main shaft on the 50-foot level, and a 150-foot drift in the same direction on the 150-foot level. In 1935, the lower level, though under water, was reported to have exposed a 30-inch-width of sulphide ore.

Production: Undetermined.

References: Crawford, 1896, p. 313; Merrill and Waring, 1918, p. 529; Tucker and Sampson, 1929, p. 486; 1945, p. 137-138; Sampson 1935, p. 513; Engel and others, 1959, p. 67-68.

R.B.S., from Engel and others.

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Lum Gray (Arica, Gray, Long Shot, Priest) Mine

Location: NE¼ NE¼ sec. 12, T. 2 S., R. 19 E., S.B.M., Rice quadrangle, 15' 1954; west of the main ridge of the Arica Mountains in a shallow valley 6½ miles southwest of Rice.

Ownership: Undetermined (1958).

History: According to Tucker and Sampson (1929, p. 481), this mine was worked by Assets Realizing Company from 1909 to December 1912, at which time operations were suspended. These authors state that the property was subsequently relocated by one E. E. Schellenger as the Arica claim. Merrill and Waring (1917, p. 541-542) reported that, when visited in November of 1914 the Gray Mine was leased (owner not specified) to "Assets Realizing Mines Company".

Edward W. Rowe, Rice, the last reported owner, operated this property under the name Long Shot #1 during the years 1950, 51, and 53 (U. S. Bureau of Mines records).

Geology: The country rock consists of contorted and sheared metasedimentary rocks of Paleozoic(?) age comprising schist and limestone. They strike N. 70° W. and dip 70° SW. in the mine area. Ore minerals form deposits along a shear zone which roughly parallels the structure of the rocks. The shear zone is exposed unevenly for about 1,000 feet along the strike. It contains quartz veins as much as one foot in thickness. Much of the wall rock near the veins contains chrysocolla and iron oxides in fissures and shears. Much of the quartz vein material is brecciated. The ore minerals in the vein and enclosing rock are hematite, limonite (in part as pseudomorphs after pyrite), chrysocolla, malachite, pyrite and manganese oxide.

The vein is reported to carry approximately 0.75 ounces per ton in gold and to be free milling down to 150 feet. Below that depth pyrite becomes abundant (Tucker and Sampson, 1945, p. 138).

Development: The shear zone is explored by one vertical shaft, 700 to 800 feet to the northwest of which is a shaft inclined 60° SW., and an undetermined amount of sub-surface work. According to Tucker and Sampson (1945, p. 138) the vertical shaft was said to be 990 feet deep. In an earlier report (Tucker and Sampson, 1929, p. 481) it is stated that there are 700 feet of drifts and crosscuts at the 300-foot level and that a winze descends from that level to a depth of 229 feet from which there are 300 feet of drifts and crosscuts at various levels. A stope reaches the surface 40 to 50 feet south of the inclined shaft. This may be the work referred to by Tucker and Sampson (1945, p. 138) as having been done from a drift off a 175-foot shaft, possibly the inclined shaft noted above.

When visited in April, 1958, the shafts were open and dry and well timbered. The stope was still open and the stulls sound. Nothing remains of former mine buildings but the foundations. The shafts have no head frames but access is good and portable frames could easily be installed.

Production: During its intermittent development in the years between 1912 and 1950 the Lun Gray mine yielded as much as 1,200 tons of ore from which 1,100 ounces of gold, 534 ounces of silver, 6,911 pounds of copper and 920 pounds of lead were recovered.

References: Merrill and Waring, 1917, p. 541-542; Tucker and Sampson, 1929, p. 481; 1945, p. 138, pl. 35; Goodwin, 1957, p. 604.

R.B.S. 4/11/58.

Maggie (Little Maggie) Mine

Location: NW¼ sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle 7.5', 1953; about 6 miles west of Perris (see figure 42).

Ownership: Charles Hess, 4427 Larchwood Place, Riverside (1958).

History: This mine was located prior to 1894. By that year an arrastra had been built and development was proceeding under the ownership of J. M. Hasson, Perris (Crawford, 1894, p. 223). The mine was idle in 1896 (Crawford, 1896, p. 312). Activity was next reported in 1935 at which time a Chilean mill was being used. The owner was Chas. Lanhorn, Box 152, Perris (Sampson, 1935, p. 512). The mine was worked in 1940 by Charles Hess, Riverside, probably under lease (U. S. Bureau of Mines records). In 1945 it was reported idle (Tucker and Sampson, 1945, p. 136-137, pl. 35).

Geology: This mine area is underlain by deeply weathered Mesozoic diorite. A narrow shear, rarely exceeding 4 inches in width, strikes N. 85° W. and dips 50° SW. The shear contains crushed and pulverized vein quartz material reported to be as much as 8 inches wide (Tucker and Sampson, 1945, p. 136). It has an indistinct surface exposure of about 100 feet.

Development: The vein is explored by 4 inclined shafts now in poor repair. One is flooded below the 50-foot level. Two others are partially filled with debris and are about 30 feet deep. The fourth shaft is about 40 feet deep. At these depths only a small amount of drifting and stoping was done. Three of these shafts were reported to be 175 feet, 75 feet and 75 feet deep respectively (Tucker and Sampson, 1945, p. 136), but were not identified because of the flooded or filled condition of the mine. An old ball mill was still on the property when it was visited (1959).

Production: The only recorded production from the Maggie Mine was two tons of ore for the year 1940, which yielded 1 ounce of gold (U. S. Bureau of Mines records).

References: Crawford, 1894, p. 223; 1896, p. 312; Mining and Scientific Press, 1895, vol. 70, p. 106; Merrill and Waring, 1917, p. 531; Tucker and Sampson, 1929, p. 483; 1943, p. 136-137, pl. 35; Sampson, 1935, p. 512.

R.B.S. 9/24/59

Mammoth Group

Location: NW¼ SW¼ sec. 8, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle, 7.5, 1953; about 10 miles south of Perris.

Ownership: John Rostas, Route 1, Romoland.

History: According to U. S. Bureau of Land Management records, this group, comprising the 2 claims, Edith and Mammoth, was patented by F. A. Stephens, et al., in 1896. At that time development of the mine was already well advanced (Crawford, 1896, p. 312). The claims were owned by A. A. Adair, Riverside, in 1917, (Merrill and Waring, 1917, p. 534) but there was no report of activity then or since.

Geology: A lenticular body of quartz is well exposed on the southeast slope of a low granodiorite ridge through a horizontal distance of about 250 feet (fig. 32). The vein strikes northeast, dips about 15° northwest and is as much as 7 feet thick. Fractures and fissures in the quartz are filled or lined with iron oxides. In addition, the vein contains free-milling gold and pyrite. No assay data were found.

Photo 17

Figure 32

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Development: The deposit has been explored by means of a 50-foot shaft, an inclined shaft, an adit, and two open-cuts, ~~arranged as shown in figure 4~~. In addition there are several shallow prospects.

The inclined shaft is reported to be 200 feet deep and to join with the vertical shaft through a crosscut drift (Crawford, 1896, p. 312). The portal of the inclined shaft is at the face of an open-cut as much as 8 feet deep and 60 feet long, cut in the broad, west lobe of the vein outcrop. The cut and shaft bear N. 40° W. The tapering, east end of the outcrop is explored by the adit and second open-cut. The adit extends N. 40° W. for 60 feet. The open-cut, 40 feet farther east, is parallel to the adit and is 30 feet long. At the adit portal the vein appears to have divided into three roughly parallel veins as much as 6 inches thick separated by tabular bodies of country rock 1 to 2 feet in thickness.

Production: Undetermined. Idle (1959).

References: Crawford, 1896, p. 312; Mining and Scientific Press, 1899, vol. 78, no. 10, p. 267; Merrill and Waring, 1917, p. 534; Tucker and Sampson, 1929, p. 484; 1945, pl. 35; Sampson, 1935, p. 513.

R.B.S. 9/21/59.

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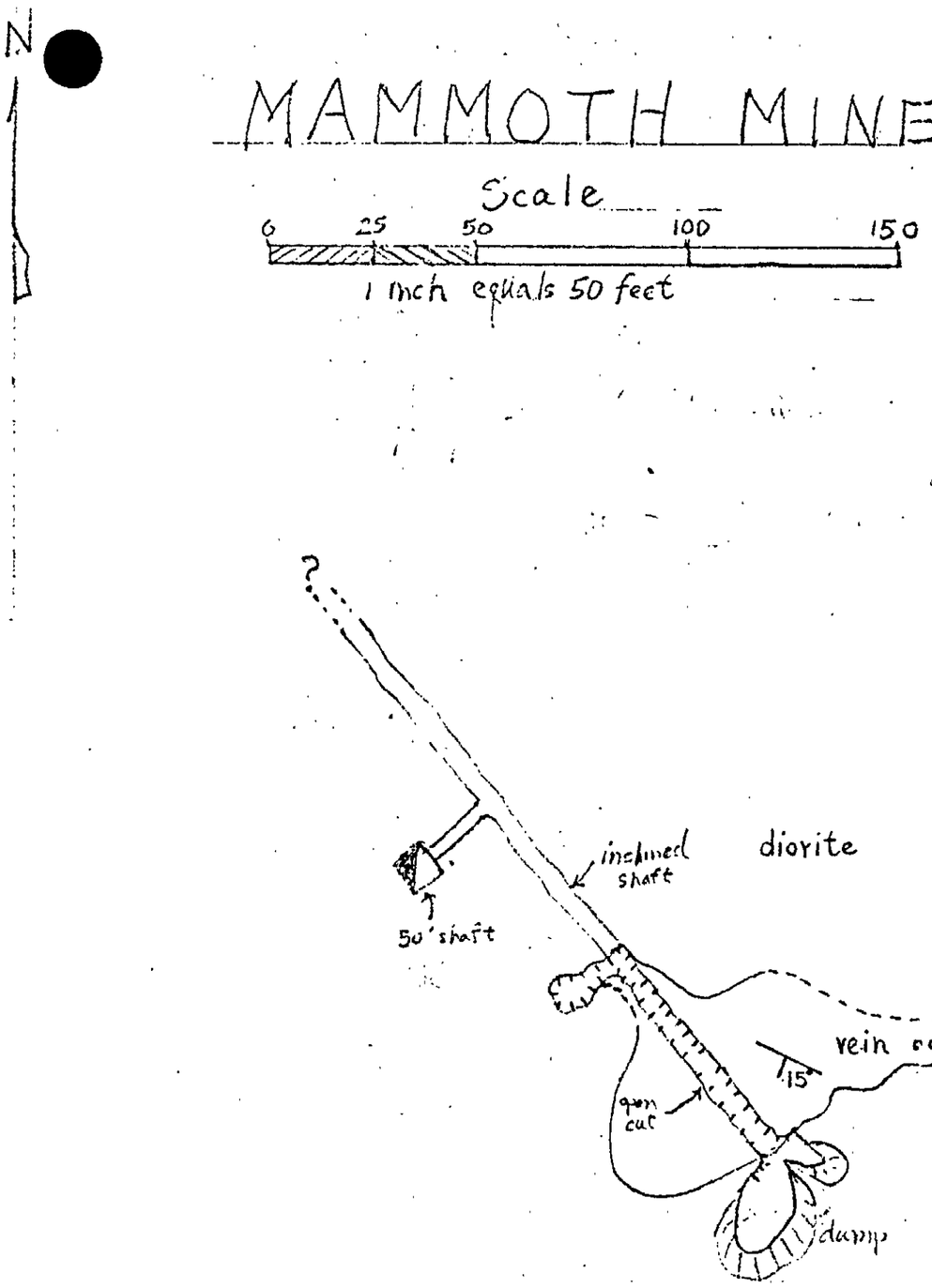
MAMMOTH MINE



Caption?

Gold
Figure 32.

Gold

Mastodon Mine

Location: SE¼ sec. 14, SW¼ sec. 13, T. 5 S., R. 11 E., S.B.M., Cottonwood Spring quadrangle, 15' 1958; Cottonwood Mountains, Joshua Tree National Monument, about 0.8 miles southeast of Cottonwood Spring.

Ownership: Harold E. Haulsey, P.O. Box 1124, Cortez, Colorado owns 1 lode claim (March 1958).

History: In 1945, the mine was owned by George W. Hulsey (Haulsey?), Indio (Tucker and Sampson, 1945, p. 138).

Geology: At the main workings a northwest-trending and 40° NE. dipping fault cuts White Tank quartz monzonite (fig. 33). The fault zone contains thin iron stained gold quartz veins. About 400 feet to the west is a northwest-trending and 60° NE.-dipping quartz vein no more than 1-foot wide.

Development: The main shaft is sunk 75 feet in a fault plane. About 400 feet west, another shaft is sunk to an unknown depth on the 1-foot wide quartz vein. It is caved at the 10-foot level. (fig. [illegible]). Material was hauled from the mine along a narrow dirt road to the Winona Spring (Cottonwood Spring Custom) mill. The mill had a capacity of 40 tons a day and processed material from other mines in the Pinto Basin area (Tucker and Sampson, 1945, p. 129). The mill is in ruins and the mine is idle.

Figure 33
500

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 129, (and p.) 138.

J.R.E. 12/11/59.

Figure 33 (1). Sketch map showing the location (A), and a geologic sketch map (B), of the Mastodon mine (topography from U.S.G.S. 15' Cottonwood Spring quadrangle, 1958).

TWENTYNINE PALMS
40 MI

3200

Winona Spring

Millsite

Cottonwood

Cottonwood Spring

Canyon

Wood Spring

Gravel Pit

Trail

MASTODON MINE

Figure 3

0 2000 4000

Scale in Feet

A

B

Quartz vein; 1'± thick

60

60

Road

Prospect pit

Shaft; cared at 10'

400'

By J.R. Evans
December 1959

Road

Trail

Ore bin

WHITE TANK QUARTZ MONZONITE

Wall

Shanty

Dump

Dirt Tank

Headframe

Shaft; sunk 75' in fault zone containing thin iron stained gold quartz veins

Meek (Thelma and Desert Gold Group) Mine

Location: Sec. 14 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 4 miles south-southeast of New Dale (site) and 1 mile southeast of the Gold Crown mine (Figure 31).

Ownership: H. G. Frydenlund, Box 704, Twentynine Palms, owns at least 2 unpatented lode claims (March, 1958).

History: Jack Meek owned the property in 1929, and at this time had performed only exploration work consisting of a few shallow shafts sunk on different veins (Tucker and Sampson, 1929, p. 488). Jack Meek owned and intermittently operated the mine on a small scale until his death in the early 1950's.

Geology: The Thelma group is located on a series of generally west-striking quartz veins, ranging in thickness from 1 to 2 feet. The Desert Gold group is located on north-trending and steeply-dipping quartz veins ranging in thickness from 1/2 to 2 feet. The veins cut Mesozoic quartz monzonite and locally are heavily mineralized with hematite showing free gold.

Development: Tucker and Sampson (1945, p. 144) reported that several shafts ranging from 20 to 70 feet in depth were sunk on veins.

Two shafts, which now constitute the main workings are sunk on steeply-dipping and generally north-striking faults. The shaft nearest the house ~~(1)~~ is at least 100 feet deep and drifts connect to it at one or more levels. There is an estimated total of about 400 feet of work. The other shaft, about 500 feet east and higher on the hillslope, is at least 120 feet deep and drifts join it at one or more levels. Total work here is estimated to be about 700 feet.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 488; Tucker and Sampson, 1945, p. 144.

J.R.E. 3/11/60

Menifee Mine

Location: SE¼SE¼ sec. 5, T. 6 S., R. 3 W., S.B.M., Romoland quadrangle, 7½', 1953; about 8 miles south of Perris.

Ownership: Ora Rhodes, P.O. Box 915, Perris.

History: Though its date of discovery was not determined, by 1885 the Menifee Mine was well developed and a five-stamp mill was being constructed ~~to avoid the continued shipment of concentrates to San Francisco via San Diego~~ on the property (Mining and Scientific Press, 1885, vol. 51, p. 120). The mine appears to have been operated continuously through 1896 at which time it was owned by H. N. McGready et al., Menifee (Crawford, 1896, p. 312). In 1899, the mine was idle and had passed into the hands of a Chicago interest (Mining and Scientific Press, 1899, vol. 79, p. 750). U. S. Bureau of Mines records show that in 1900 G. S. Allen, Perris, operated the mine, followed in 1901 by W. F. Bray, Perris and in 1903 by Morrison and Anderson, Perris. These men may have been lessees. Tom Chaffin owned the Menifee Mine in 1917 (Merrill and Waring, 1917, p. 533) and as late as 1935 (Sampson, 1935, p. 513). The claim is now part of Rhodes Ranch.

Geology: The vein is no longer exposed but according to an old report it appears to lie along a diorite-schist contact. It strikes northeast and dips 80° NW. to a depth of 40 feet below which it flattens to 65° NW. The vein was reported to range from one foot to 30 inches in thickness and to yield about $24 per ton in gold. Traces of pyrite were reported present (Storms, 1893, p. 385). Fragments of ore on the old dump resemble the ore from near by mines in that the fragments are fractured vein quartz with coatings and pockets of iron oxides.

Development: The vein was explored through 4 shafts 30, 55, 100, and 125 feet deep from which drifting and stoping had been accomplished (Mining and Scientific Press, 1899, vol. 79, p. 750; Sampson, 1935, p. 513). ~~At present (1959),~~ In 1959, the shafts ~~are~~ were filled and the mine long abandoned.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable metals Gold (ounces)	Silver (ounces)
1900	-	29.02	282
1901	-	41.12	
1903	45	21.77	

References: Mining and Scientific Press, 1885, vol. 51 no. 7, p. 120; 1899 vol. 79, no. 27, p. 750; Storms, 1893, p. 385; Crawford, 1896, p. 312; Merrill and Waring, 1917, p. 533; Tucker and Sampson, 1929, p. 484; 1945, pl. 35, no. 86; Sampson, 1935, p. 513.

R.B.S. 9/22/59.

Mission Sweet Mine

Location: Sec. 34 (proj.), T. 3 S., R. 13 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Eagle Mountains, about 3 miles southwest of the Black Eagle mine and 9 1/2 miles northeast of the East Pinto Basin-West Pinto Basin-Cottonwood Pass and Black Eagle mine roads intersection. (Figure 56)

Ownership: Undetermined.

History: Undetermined.

Geology: Mesozoic hornblende granite is cut by several minor north-trending and steeply-dipping faults that contain gold-bearing quartz veins and stringers. The veins are thin and discontinuous; the thickest one observed was about 8 inches. The hornblende granite is intrusive into old sedimentary rocks, and near the top of a hill about 1,000 feet northeast of the printipal development work it is intrusive into calcitic dolomite. No mineralization was observed in the short adit driven into the contact zone.

Development: The principal workings consist of a few shallow shafts with short drifts. The deepest shaft observed was 18 feet, with 20-foot drifts driven north and south at the bottom in a fault plane. The mine is at an elevation of about 2,200 feet and is idle.

Production: Undetermined.

References: None.

J.R.E. 3/17/60

Mission (Huff-Lane) Mine

Location: Secs. 14 and 21 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15 ', 1963; Pinto Mountains, about 2 miles north-northeast of Mission and Sunrise Wells (Figure 31).

Ownership: L. P. Clause, Box 85, Indio, owns 7 unpatented claims and 2 mill sites (March 1958).

History: The mine was discovered by George Lane, Mecca, in 1887, and was owned by him and E. C. Huff in 1929 (Tucker and Sampson, 1929, p. 481). Apparently little work was done until the 1930's. From 1933 to 1936, the mine was owned and operated intermittently by E. C. Huff, 823 South Bonnie Brae Street, Los Angeles. The Mission Gold Mines Company, Mecca, owned and intermittently operated the mine from 1939 to 1942. The present owner, representing the Mission Mining Company, operated the mine in 1951 and 1955.

Geology: Massive, Mesozoic quartz monzonite is cut by a series of semi-parallel quartz veins containing pyrite, chalcopyrite, hematite, gold, and secondary copper and iron minerals. The three principal veins are known as the Water Well, Verde, and Lone Star. The Water Well vein has been the most extensively worked.

It strikes N. 20° W., dips 75° - 80° E., is 2 feet in average width, and has a proven surface length of 3000 feet (Tucker 1934, unpublished Field Report No. 124). The Lone Star and Verde veins are of undetermined extent.

Development: Work began on the Water Well Vein in 1931 and by 1946 a 600-foot shaft had been sunk. On the 125-foot level a drift is driven 533 feet north and 191 feet south. At a point 388 feet from the shaft along the north drift, there is a 120-foot raise on the vein to the surface. These workings developed an ore shoot 2 feet wide and 60 feet long, and ore milled from a stope in this shoot was reported by Tucker and Sampson (1945, p. 139) to have had an average value of $25 per ton in gold. Other work consists of drifts driven north 100 feet, south 120 feet on the 400-foot level; north 325 feet, south 100 feet, on the 600-foot level. The 325-foot north drift was driven to develop an ore shoot 2 feet wide and 200 feet long. Four shipments of ore from this shoot to the Gold Crown Mining Company mill are reported to have averaged $43 per ton in gold (Tucker and Sampson, 1945, p. 139).

In 1934, the Verde shaft was reported to be 350 feet deep, and the Lone Star shaft 50 to 70 feet deep (Tucker 1934, unpublished Field Report No. 124). During certain periods of time in the 1930's and early 1940's it is probable that ore was milled at the Sunrise Mine (Mission) mill about 2 miles south of the mine ~~(pl. 2)~~. Certainly ore was milled here in 1951 and 1955. ~~Neither the mine or the mill was in operation on the day of the property visit.~~

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lbs.)
1933	20	11	7	
1934	132	33	6	
1936	100	36	7	
1939	189	187		
1941	632	568		
1942	213	277	158	589
1951	122	26	16	
~~1952~~ 1955	10	3		

References: Tucker and Sampson, 1929, pp. 481-482; Tucker, 1934, unpublished Field Report No. 124; Tucker and Sampson, 1945, p. 139.

J.R.E. 3/8/60.

5/1

Model (Chuckwalla and Model) Mine

Location: Sec. 2, T. 7 S., R. 14 E., ~~(proj.)~~, S.B.M., Chuckwalla Mountains quadrangle, 15', 1963. The Model mine is reached by about 7½ miles of dirt road extending south of U.S. Highways 60 and 70 from a point 9 miles west of Desert Center.

Ownership: William R. McGowen, Box 461, Desert Center (1959).

History: This property was described as the Chuckwalla and Model group of mines by Tucker and Sampson (1945, p. 129). Fifteen claims were then held by Mrs. A. R. Enloe, Los Angeles, and Leslie Waldrip, Indio. U.S. Bureau of Mines records show that this mine's best years were in 1902 and during the thirties. The most recent activity was in 1947 to 1949 (Personal communication, Wm. R. McGowen, March 30, 1959) but no record of production was found for that period.

Geology: A fault zone as much as 3 feet wide is exposed for about 200 feet along the north slope of a low granite ridge. It strikes N. 40° E. and dips 70° NW. Irregular bodies of crushed vein quartz lie along the fault zone and reach a maximum thickness of one foot. Both the vein matter and the enclosing gouge and wall rock are stained and veined with iron oxides. The fault appears to split, forming two distinct zones through the southwestern half of its exposed length.

Development: The fault is explored by a 50-foot inclined shaft and several trenches 20 to 50 feet long and as much as 10 feet deep. Because no copper or lead minerals were noted in these developments, and those metals are reported from this mine, it is probable that undescribed mine openings are present on other claims of this group.

Production: Compiled by the U.S. Bureau of Mines and published by permission of the owner.

Year	Crude ore	Recoverable Metals Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)
1902	150	72.57			
1934	64	56.40	208	311	1,270
1935	46	25.82	85	179	1,465
1936	10	2.57	1		
1940	75	21	14		
1941	20	25			
1946	3	3	3		

References: Tucker and Sampson, 1945, p. 129; Goodwin 1957, p. 601.

R.B.S. 4/30/59

Moose Mine

Location: Secs. 11 and 12 (proj.), T. 2 S., R. 12 E., S.B.M., Dale Lake quadrangle, 15', 1956; Pinto Mountains, about 4 miles north of Mission and Sunrise Wells and 2 miles east of the Gold Crown mine (figure 31).

Ownership: Walt Rose, General Delivery, Twentynine Palms, owns at least 1 unpatented claim (March 1960).

History: The Moose mine is one of the 3 mines owned and operated by Sunrise Mines Incorporated, San Diego, in the 1930's. In 1933, the property consisted of the Moose group of 3 claims (Tucker, 1933, unpublished field report No. 121). Willard H. Allen owned and operated the mine in 1939. Earl Geiger owned and operated the mine in 1941 and 1942 (see Sunrise mine description).

Geology: A north-trending and 68° W.-dipping fault cuts Mesozoic quartz monzonite, and contains a gold-quartz vein 6 feet in average width (Tucker, 1933, unpublished field report No. 121).

Development: The main workings consist of an inclined shaft sunk 203 feet in the fault plane. There is a 50-foot drift driven north, and a 90-foot drift driven south, on the 70-foot level to develop the 70-foot ore shoot. At the shaft collar level a drift adit is driven south on the vein about 90 feet. A lower adit is driven south 200 feet on the vein. The mine is worked intermittently by the present owner.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Gold (oz.)	Silver (oz.)
1932	100	58	23
1939	3	1	
1941	75	32	7
1942	75	35	15

References: Tucker, 1933, unpublished Field Report No. 121.

J.R.E.

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Morning Star Mine

Location: Sec. 30 (proj.), T. 6 S., R. 16 E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; about 1 1/2 miles southwest of Corn Spring and 7 miles southeast of Desert Center.

Ownership: Undetermined (1959).

History: This mine was worked in the late 1920's by the Morning Star Mining Company (Tucker and Sampson, 1929, p. 485).

Geology: The Morning Star mine explores a mineralized aplite dike which strikes N. 35° E., along the east slope of a ridge cut in Mesozoic granite. The dike is about 6 feet wide and vertical. It is one of a system of brown-weathering, generally porphyritic dikes of granitic composition in the north-central part of the Chuckwalla Mountains. These dikes are usually barren. They have been identified as quartz latite porphyry (Miller, 1944, p. 20, 65).

The dike on the Morning Star claims appears to have been shattered, and the resulting boxwork of fissures filled by quartz and pyrite. The pyrite has altered to oxides of iron. Free-milling gold was observed in a specimen of the dike. No published assay data were found.

Development: A 50-foot shaft was sunk on the dike. About 500 feet down the slope to the northeast a 160-foot adit was driven northwest to cross-cut the dike, but work was suspended before the dike was reached.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 485; Miller, 1944, p. 20.65.

R.B.S. 3/13/59.

Morning Star (Jackknife, Morgan) Mine

Location: ~~This group of seven claims is in the~~ NW¼ NW¼ sec. 6, T. 2 S., R. 24 E., and SW¼SW¼ sec. 31, T. 1 S., R. 24 E., S.B.M., Vidal quadrangle, 15′ 1950; 6 miles south of Vidal in a high valley about half a mile southwest of the Mountaineer Mine and accessible by trail from that property (fig. 34).

Ownership: Benjamin M. Stansbury, P.O. Box 315, La Canada (1960) owns seven claims.

History: According to Jack Stewart, a resident of Parker, Arizona, the Morning Star mine used to be known as the Morgan claims. Though no record of activity was found under that name, a report on the old Jackknife claims was included in the Fifteenth Report of the State Mineralogist in which Cal Morgan and H. D. Bradley are given as owners (Merrill and Waring, 1917, p. 83). In 1929 ~~it was reported~~ Tucker and Sampson (1929, p. 482) reported that C. W. Mitchell, Parker House, Boston, Massachusetts had acquired the Jackknife along with the Calzona and Steece properties. The name Morning Star was used by the Morning Star Mining Co. which held the property in 1945 (Tucker and Sampson, p. 139). There appears to have been little activity since that date.

Photo 18

519

Geology: The rocks of the area are limestone, dolomite and gypsum interbedded with schists. They strike N. 50° -60° E., dip 45° - 50° NW. and are cut by a system of northeast-trending, low-angle faults and shear zones and northwest-trending high-angle faults. The valley trends northeastward along the strike of the rocks. A contorted gypsum unit as much as 100 feet in thickness crops out along the valley floor and the base of the northwest slope. Faulting and shearing appear to have occurred roughly parallel to, and in part within, this unit. At the northeast end of the valley this shear zone is crossed by a northwest-trending fault. Mineralization is extensive in and about the junction of the fault and the shearing forming an ore shoot which plunges 30° to the northwest (rig[illegible]). Gold occurs in a gangue composed of iron and manganese oxides, limestone, schist, barite, chalcopyrite, secondary copper minerals, and quartz. The copper minerals are chrysocolla and malachite. The ore is in pockets, veins, and zones of fault breccia.

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Development: A 100-foot vertical shaft was sunk on the northwest-trending fault. At the 60-foot level a raise was driven S. 80° E. at about 30°. The raise explores a tabular ore body, reported to have been as much as 6 feet in thickness (Tucker and Sampson, 1945, p. 139). The ore body strikes N. 80° E. and dips 35° NW. It appears to lie parallel to the bedding of the country rock. The raise is about 100 feet long and was broadened, by irregular stoping, to a maximum width of about 30 feet ~~(fig.)~~. At its upper limit the raise opens to the foot of a 30-foot shaft from the surface. At the foot of the raise a 15-foot drift was driven N. 50° W. and a 40-foot drift S. 50° E., on the fault, from a chambered area adjoining the 100-foot shaft. The upper limit of the ore body is exposed in shallow working on the southeast side of the valley about 100 feet northeast of the main shaft ~~(fig.)~~. Here it occupies a 3 to 4 ~~foot~~ feet thick breccia zone. As exposed in the workings the lower terminus of the ore body is at the vertical fault although thin stringers lie in the fault zone. It is possible that the mineralized zone extends southwest of the fault at a lower level but the lower 40 feet of the main shaft shows no ~~proof~~ evidence of this.

When visited in 1957, all former buildings and the head frame of the vertical shaft had been destroyed by fire. The mine was revisited in April, 1961, by which date a new head frame, collar and ladder had been installed on the main shaft. Remains of a tramway still stand on saddles to the northeast along the trail to the Mountaineer mine.

Production: By 1932, an estimated $100,000 in ore averaging $60 per ton in gold and copper had been taken from these claims.

References: Merrill and Waring, 1917, p. 543; Tucker and Sampson, 1929, p. 482; 1945, p. 139; Mitchell, 1932.

R.B.S. and C.H.G. 12/19/57

R.B.S. 4/20/61

Morris Washington Deposit

Location: S 1/2 sec. 22, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7 1/2', 1953. The deposit is on the Morris Washington Ranch, about 3 miles northwest of Perris.

Ownership: Undetermined.

History: Undetermined.

Geology: A pegmatite dike as much as 3 feet wide is exposed on the southeast slope of the hill. It strikes north and dips 30° W. Milky- to vitreous quartz is the chief constituent of the dike; the other components, feldspar and biotite mica, are localized in pockets and along the margins of the body. The dike is fractured and in an irregular central zone of the fissures and cavities are filled with oxides of iron. Some of the stains resemble altered, lath-shaped biotite crystals.

A post-dike system of fractures and faults strikes N. 20° - 30° W., and dips 70° - 75° SW., cutting the country rock and the dike. These breaks range from a fraction of an inch wide to shear zones 20 feet in width; they are filled with granular carbonate.

The presence or percentage of gold, or other precious metals in the deposit, was not detected.

Development: The principal workings are a 30-foot shaft inclined 30° W. and a partially caved drift adit about ten feet long which terminates at the collar of a second shaft of undetermined but probably shallow depth. These two openings are about 10 feet apart in the face of a cut on the east slope of the hill. They explore the pegmatite dike.

Two open cuts, one on the northwest slope and one on the south slope, explore northwest-striking faults. The one on the northwest slope follows a shear zone 20 feet wide which contains veins and lenses of calcium carbonate as much as 3 feet wide. The south cut explores a shear zone about 6 feet wide. Pegmatite dikes with a maximum width of 2 inches are exposed in the cut. Here carbonate veins a fraction of an inch wide form a coarse boxwork in the deeply weathered country rock. A 10-foot drift extends beyond the face of the cut and terminates at a 5-foot winze.

Production: Undetermined.

References: None.

R.B.S. 6/16/59.

Moser (Gold Flake (?), Patches (?)) Claims

Location: Secs. 17 and 20 (proj.), and SW 1/4 sec. 21, T. 2 S., R. 16 E., S.B.M., Coxcomb Mountains quadrangle, 15', 1963; on the east slope of the Coxcomb Mountains.

Ownership: Five unpatented claims, Leo, Maxie, Jenny, Moser, and Bamby are held by Carl Moser, 1732 West Rosecrans, Gardena, and Edward-Severson, 2302 West 154 Street, Gardena.

Mr. Moser holds the Leo, Maxie, and Bamby claims and a half interest in the Jenny and Moser claims. In 1959, the Leo claim was under lease to Wright Randall. Mr. Severson holds half interest in the Jenny and Moser claims and leases Moser's half interest.

History: This deposit is probably the site of the old Gold Flake and Patches claims which were shown by Tucker and Sampson (1945, pl. 35). The history of those claims is unknown. Mr. Moser first held the property in 1944.

Geology: The Moser claims are in an area underlain by Mesozoic granodiorite and complexly intruded pendants of metamorphic rocks of probable early Mesozoic age. A quartz vein ranging in thickness from several inches to as much as 5 feet is unevenly exposed for about 7,000 feet. The vein strikes N. 40° W., dips 65° SW, and lies in the plane of a fault. The vein quartz is strongly fractured and the contained metal-bearing minerals are largely altered by meteoric water. The vein contains irregular masses of pyrite, iron oxides, and, locally, stains and thin crusts of copper carbonates. Galena is present but is largely altered to earthy cerrusite and anglesite. The gold is free milling and is most abundant in concentrations of lead minerals. Silver is present in the galena and possibly in unidentified secondary minerals.

Photo 19

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Development: When visited in 1959 development was proceeding on the Jenny and Moser claims. On the Jenny claim an inclined shaft had been sunk about 130 feet on the vein. About 110 vertical feet down the slope a crosscut adit extends 200 feet southwest to the vein. From the face a drift was run 50 feet northwest on the vein and joins with the inclined shaft about 20 feet northwest of the adit. Another drift, being driven southeast on the vein, has been carried a distance of 450 feet, well on to the Moser claim. In this southeast drift it is hoped to cross a downward extension of reported rich ore found in the outcrop.

The former owners worked the deposit through several shallow prospects and short adits to the southeast of the present (1960) development and probably were responsible for much of the work on the aforementioned inclined shaft, (fig.).

On the Leo claim there is an old shaft 20 feet deep at the bottom of which is a 12-foot crosscut, and an open cut just southeast of the shaft. An ore shoot is exposed in a prospect near the end of the road and close to the boundary between sections 17 and 20.

Production: No sustained production has been reported from these claims. In 1947 and 1948, a total of 18 tons of select(?) ore was shipped for smelting. According to the owner, this ore yielded $125 per ton in gold and silver.

References: Tucker and Sampson, 1945, pl. 35.

R.B.S. 11/17/59

Mountain Queen Mine

Location: NW 1/4 NW 1/4 sec. 7, T. 2 S., R. 20 E., S.B.M., Rice quadrangle, 15', 1954; on the east slope of the Arica Mountains.

Ownership: Undetermined (1958).

History: This property was located (date unknown) as the Juanita No. 5 claim, however, U.S. Bureau of Mines records show that in 1938 it was called the Mountain Queen. The owner at that time was H. C. Wiley, Rice. By 1945, it had become one of the Lum Gray claims (Tucker and Sampson, 1945, p. 139-140).

Geology: The Mountain Queen mine explores two gold-bearing shear zones in a homoclinal section of schist and carbonate rocks exposed on the east slope of the Arica Mountains. In the mine area, the bedding and schistocity of the rocks strike N. 60° W. and dip 50° SW. One shear zone is exposed high on the slope for a distance of about 500 feet. It dips and strikes about the same as the country rocks. This zone is roughly 3 feet wide and is mineralized with lenses, pods, and veins of iron-stained quartz as much as one foot thick. The other shear zone is about 1,000 feet to the northeast and roughly 100 feet lower on the slope. It strikes N. 20° E., dips 55° NW., and contains a fractured quartz vein as much as 6 feet wide.

The quartz of both shear zones is stained and pocketed with oxides of iron and manganese and traces of malachite.

Development: The upper shear zone was developed from 2 drift adits entering opposite sides of the ridge. One adit was driven S. 50° E. for an undetermined distance. The other adit enters the south slope of the ridge and trends N. 65° W. In 1945 this adit was reported to be 100 feet long and from it a winze descends at an inclination of 50° to 200 feet (Tucker and Sampson, 1945, p. 139-140). It might connect with the other adit through underground workings, ~~but this was not proven.~~ Within the first hundred feet of the portal the vein was stoped to the surface. ~~The stope was timbered with stulls but the adits are untimbered.~~

Development on the lower shear zone consists of a 30-foot vertical shaft and 2 shafts, about 200 feet apart, inclined on the dip of the vein. One of the inclined shafts is 25 feet deep--the other of undetermined depth.

Production: According to U. S. Bureau of Mines records, (published with permission of the owner) in 1938 this mine yielded 187 tons of ore from which 74 ounces of gold and one ounce of silver were recovered.

References: Tucker and Sampson, 1945, p. 139-140.

R.B.S. 4/11/58.

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Mountaineer (Calzona) Mine

Location: S½ sec. 31, T. 1 S., R. 24 E., S.B.M., Parker Quadrangle, 15′ 1950; on the east slope of the Riverside Mountains, 36 miles north of Blythe.

Ownership: Hugh Gordon, 727 West 7th Street, Suite 7, Los Angeles.

History: This group of claims was owned and worked by Calzona Mines Company from 1898 to 1920 (Merrill and Waring, 1917, p. 542-543). In 1920, the property was acquired by Mountaineer Mining Company who held it until October 1935. In 1935, a 50-ton flotation plant was installed on the property. Water for operating the mine and mill was pumped 1½ miles from the Colorado River (Tucker and Sampson, 1945, p. 140). Early in 1960, the property was leased and worked briefly by Figueroa Mines, P.O. Box 453, Blythe, who shipped a 21-ton lot of select ore to American Smelting and Refining Co., Hayden, Arizona.

Geology: The country rock is sheared and contorted limestone, dolomite, and schist which strike northeast and dip 40°-50° NW. The mine explores a mineralized zone at and near the junction of two faults (fig. 34). One fault is parallel to the bedding of the country rock and is exposed on the southeast side of a narrow, northeast-trending canyon. The other fault strikes N. 25° W., dips from vertical to steeply northeast and is exposed on both sides of the canyon.

Figure 34

Gold occurs in a gangue of quartz, barite, chalcopyrite, malachite, chrysocolla, and oxides of iron and manganese. The ore forms irregular lenticular bodies ranging from 0 to 10 feet in thickness and a few tens of feet in lateral and vertical extent. The ore bodies appear to have formed both by fissure filling and replacement. One of the two principal ore bodies was encountered at the 150-foot level. It is a mass of altered and mineralized country rock, as much as 10 feet in thickness and of undetermined lateral extent, lying on the fault parallel to the bedding of the country rock and extending northeastward from the junction of the two faults. The other ore body was discovered on the northwest-trending fault between the 150-foot level and the northwest adit, (fig. 4). The thickness and extent of this body was not determined, the workings being inaccessible.

The Mountaineer mine has been examined as a prospective source of manganese but no manganese production has been reported (Wilson, 1943, p. 184). Samples of Mn oxides, taken from the Mountaineer and the neighboring Morning Star mines, are reported (personal communication, Danny G. Figueroa) to contain as much as $19 per ton in gold.

Development: The mine has been worked from a west drift adit ~~(the west adit)~~ driven 150 feet northwest into the northwest side of the canyon on the northwest-trending fault and a 150-foot shaft inclined 50° northwest on the fault junction, driven from low on the southeast side of the canyon. A manway was sunk from the collar of the shaft to a point 30 feet southwest of the shaft at the 80-foot level and the ~~two~~ manway and shaft were connected by a drift. The manway appears to follow a barren shear zone which might be the same fault as that extending northeast of the junction. At about the 115-foot level on the shaft a short drift was driven northeast from which a winze was sunk, at about 40°, which crosses above the shaft to a gallery just above its base. From the base of the shaft a gallery was driven northeast into ore which was stoped from the gallery and explored through a 65-foot winze. A 190-foot drift extends northwest from the base of the shaft. A raise connects the drift to the northwest adit and an additional raise extends from the adit to the surface. An undetermined amount of stoping was done adjacent to the raises. Figure 34 shows the principal features of the mine and orientation of the workings on the faults.

Production: Compiled by the U.S. Bureau of mines and published with permission of the owner.

Year	Crude ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)
1915	50	92.01	10	7,656
1916	46	28.69		4,050
1934	1,495	81.35	12	
1935	(45 (12 concentrates)	80.48		1,273

The 21-tons of ore shipped in 1960 yielded $62.70 in gold (@ $32.3185 per ounce) and $32.34 in copper (@ $0.30725 per pound) per ton.

References: Merrill and Waring, 1917, p. 542-543; Tucker and Sampson, 1929, p. 477; Wilson, 1943, p. 184; Tucker and Sampson, 1945, p. 140, pl. 35).

R.B.S. 4/20/61.

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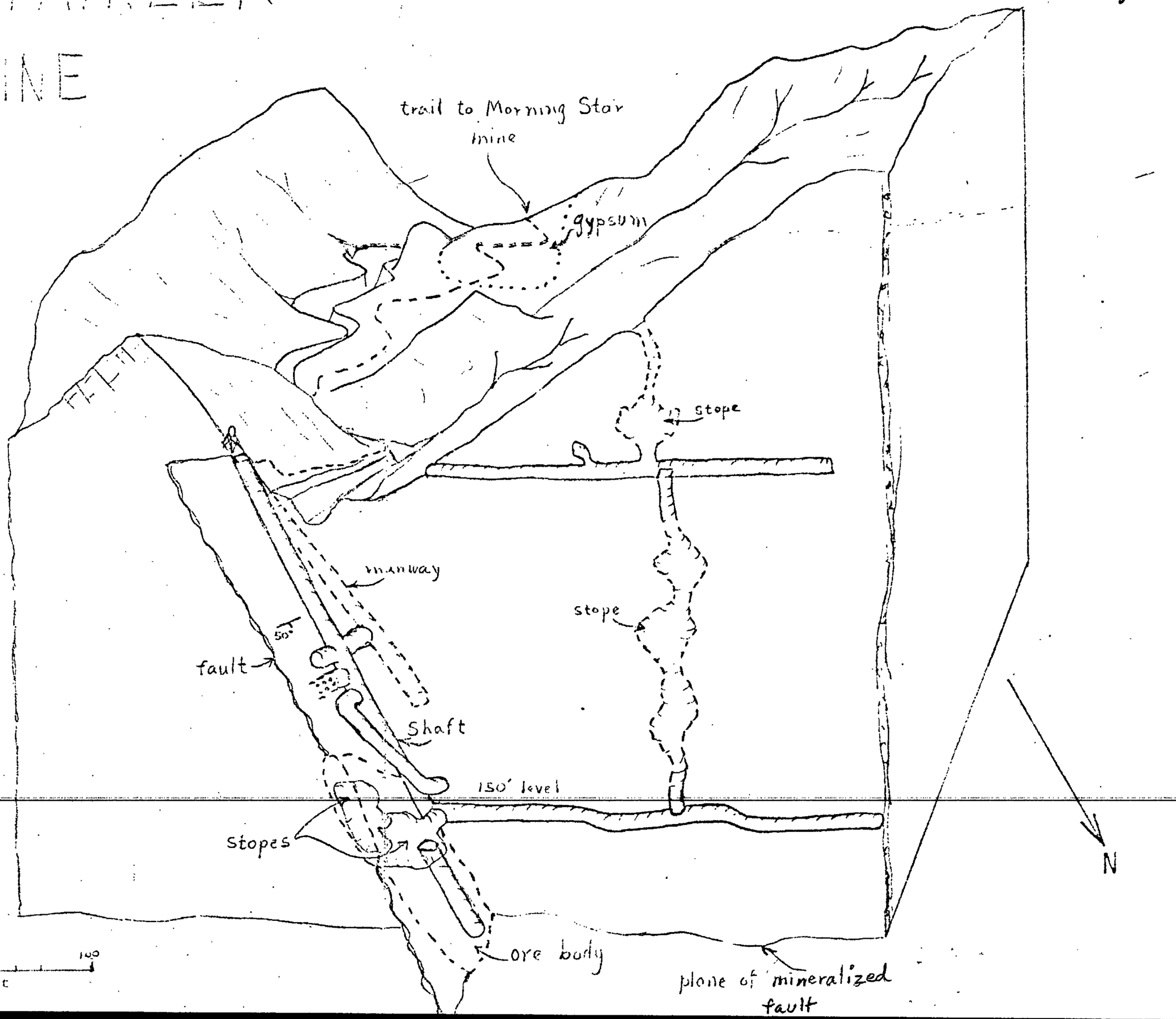
MOUNTAINEER MINE

Riverside Count

Figure



GKK

Mystery (Mirtry) Mine

Location: Sec. 15½, T. 2 S., R. 13 E., S.B.M. (proj.), U. S. Army Corps of Engineers ~~Eagle Tank~~ Pinto Basin quadrangle, 15', 1963, at the base of the north slope of the Eagle Mountains, Joshua Tree National Monument, about 6 miles southeast of Mission Well (Figure 31). Not confirmed, January 1960.

Ownership: Undetermined, 1960.

History: A small scale gold placer operation carried on from 1933 to 1936 when L. L. Benthall, Indio owned the ~~project~~ property.

Geology: Alluvium was processed by placer methods for gold.

Development: Undetermined, but was reported to be a small scale hand operation (U. S. Bureau of Mines records).

Production: Compiled by the U. S. Bureau of Mines.

Year	Yardage handled	Gold ounces
1933	185	9
1934	250	6
1935	500	13
1936	100	4

References: None.

J.R.E.

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New El Dorado (El Dorado) Mine

Location: Secs. 16 and 17, T. 3 S., R. 10 E., S.B.M. ~~(proj.)~~, U. S. Army Corps of Engineers ~~Pinkham Well~~ Hexie Mountains quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 5 miles southeast of White Tank, and about 1 mile southwest of the West Pinto Basin Road ~~(see pl. 24.~~ Figure 35

Ownership: The New El Dorado Mining Company, 308 Orange Grove Ave., Alhambra, owns a patented millsite in sec. 24, T. 3 S., R. 8 E., S.B.M. (Pinyon Well site) located August 31, 1921, and 3 patented lode claims in secs. 16 and 17, T. 3 S., R. 10 E., S.B.M. (proj.) located April 5, 1906.

History: Originally located by Fred Vaile, Indio, in 1911 as the El Dorado Mine. The first record of production of gold-silver ore was in 1911, and the last in 1938. In 1929 the mine was operated by John White, San Bernardino, who leased from Fred Vaile, Los Angeles. Workings consisted of a 500-foot shaft connected by north drifts on the 100, 200, 300, 450, and 500-foot levels (Tucker and Sampson, 1929, p. 485).

Figure 35

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Geology: A major fault striking N. 20° W. and dipping 76° E. cuts the Precambrian Pinto Gneiss which here has been carved into an elongate east-trending ridge (figure 36). Oxidized milky quartz in a vein as much as 4 feet thick, mineralized with gold, silver, and galena occurs along the fault.

Development: At least 2,000 feet of drifts, shafts and minor crosscuts have been worked in and adjacent to the plane of the fault. The main shaft is inaccessible below the 90-foot level which contains about 800 feet of drifts and minor crosscuts (figure 36). An indistinct jeep road leads west about 5 miles from the mine, into the Pleasant Valley, and then southeast about 4 miles to the Pinyon Well millsite. The mine is idle.

Figure 36

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Production: Compiled by the U. S. Bureau of Mines and published with permission of the owners.

Year	Crude ore (tons)	Recoverable Metals Gold (ounces)	Silver (ounces)	Lead (pounds)
1911	18	9	4	
1912	53	22	7	
1913	739	564	147	
1914	1,033	464	119	
1915	1,072	331	73	
1916	549	172	29	
1930	260	83	18	
1931	3	4	10	2,041
1935	200	30	9	
1936	400	108	23	
1937	1,000	190	121	
1938	75	30	31	

The "Eldorado (New Eldorado) mine" has been described (Brown, 1923, p. 266) as a source of vanadium, the ore mineral being vanadinite, but no formal report of vanadium production appears to have been made.

References: Brown, 1923, p. 266; Tucker and Sampson, 1929, p. 485.

J.R.E. 12/9/59

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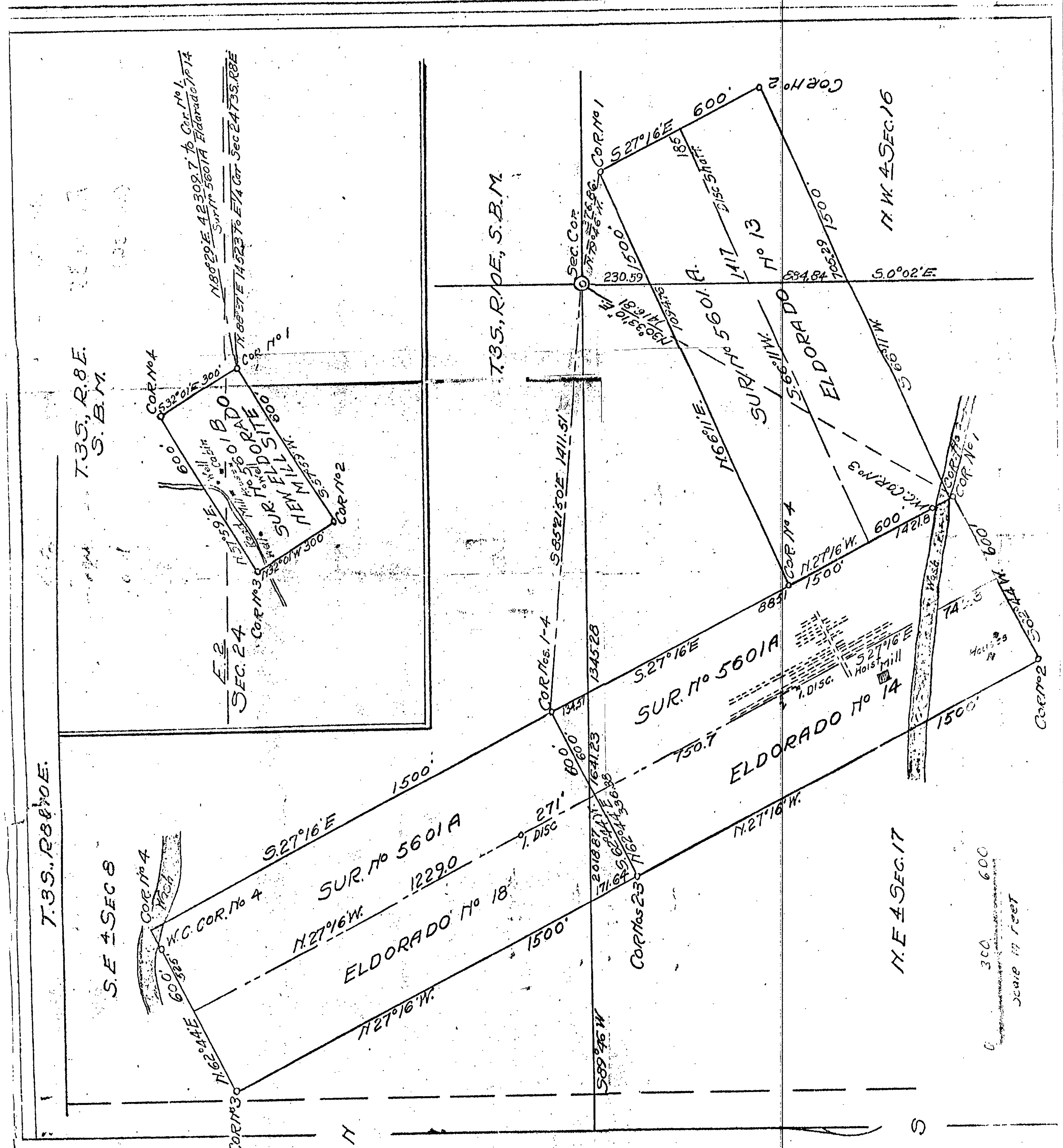
Figure 10/. Plat of the lode claims and mill-site of the New Eldorado Mining Company (Survey No. 5601- A-B; surveyed October 25-30, 1921; patent no. 919797 issued October 10, 1923).


T.3S., R.8E.
S.B.M.
T.3S., R.10E., S.B.M.
T.3S., R8&10E.
E 1/2 SEC. 24
S.E 1/4 SEC 8
N.W. 1/4 SEC. 16
N.E 1/4 SEC. 17
SUR. No 5601 B
ELDORADO
MILLSITE
NEW
COR No 1
COR No 2
COR No 3
COR No 4
S.32°01'E 300'
N.32°01'W 300'
N.57°59'E.
S.57°59'W.
600'
Mill
Well
Cabin
Road
N.86°29'E. 4230.7' to Cor No 1 Sur No 5601A Eldorado No 14
N.88°57'E 14523' to E 1/4 Cor Sec 24 T3S. R8E.
Sec. Cor.
N.79°46'W. 376.86'
230.59
884.84
S.0°02'E.
SUR. No 5601 A.
ELDORADO No 13
S 27°16'E
600'
1500'
185
Disc Shaft
1417
N.30°33'10"E. 1416.81
N.66°11'E.
S.66°11'W.
705.29
W.C. COR. No 3
COR. No 3
COR. No 1
1421.8
N.27°16'W.
COR. No 4
8851
S.85°21'50"E 1411.51'
COR. Nos. 1-4
1345.28
134.51
1641.23
SUR. No 5601A
ELDORADO No 14
S.27°16'E
Hoist
Mill
1. DISC.
750.7
Wash
Houses
S.62°44'W.
COR. No 2
1500'
N.27°16'W.
2018.87
S.62°44'E 336.38
N.62°44'E
171.64
COR. Nos 2-3
271'
1. DISC
1229.0
SUR. No 5601 A
ELDORADO No 18
S.27°16'E
N.27°16'W.
W.C. COR. No 4
COR. No 4
Wash
325
60.0'
N.62°44'E
COR. No 3
S.89°46'W
N
S
300 600
Scale in Feet

New Eldorado (Pinyon Well) Millsite

Location: N½SE¼ sec. 24, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 1958; Joshua Tree National Monument, on the south side of Pushawalla Canyon trail at the east margin of the Little San Bernardino Mountains.

Ownership: Fred Vaile, Los Angeles (1929). Undetermined (1960).

History: Pinyon Well was the only water supply for mines operated at different times in this region in the 1890's. In 1895, ore from the Desert Queen mine is reported to have been milled here in a 2-stamp mill (W. F. Keys, oral communication January 1960). In 1918, the wreck of a 2-stamp mill, 2 deserted cabins, several abandoned shafts, and 2 wells marked the spot (Brown, 1923, p. 267). In 1921, the New Eldorado millsite of 4.13 acres was located at Pinyon Wells. Patent was issued in 1923 and the wells supplied water through a pipe line to the El Dorado Mine, about 9 miles east, in the 1920's. The wells have not been used for many years, probably not since the Eldorado mine closed in the late 1930's.

Geology: The Pinyon well site is underlain by coarse-grained White Tank ~~(quartz)~~ monzonite of Mesozoic age. A shear zone strikes N. 70° W., dips 70°-75° NE., and has been explored, apparently for water, by 3 shafts over a distance of about 400 feet.

Development: In 1923, patent plats indicated 3 wells, 2 cabins, and a mill building on the property.

References: Brown, 1923, p. 267.

C.H.G. 4/7/58.

Figure 36/21. Sketch map showing the location (A), on the 90-foot level (B), and a geologic ~~sketch map~~/of the New El Dorado mine (Topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

North Star Mine

Location: NW 1/4 sec. 6 (proj.), T. 2 S., R. 10 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, about 8.3 miles S. 30° E. from Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: The North Star mine was originally located as the Atlanta, and in 1920 was owned by the Gold Park Consolidated Mines Company, with offices at 1021 Black Building, Los Angeles. By 1929, J. Klugh of Pasadena owned the mine and it was known as the North Star group (Tucker and Sampson, 1929, p. 472). By 1945, the property was owned by Floyd Mining and Milling Company, Earl F. Skadan, president; G. C. Zimmerman, secretary, Norco (Tucker and Sampson, 1945, p. 140).

Geology: Mine workings are in quartz veins in a north-trending, nearly vertical fault zone which cuts the (Precambrian) Pinto Gneiss. The mineralized fault zone is exposed through a distance of 660 feet by the mine workings (fig. 37/). Veins are post-faulting and are strongest where fluids have crossed zones of weakness. Accordingly, the quartz veins are as much as 2 feet thick in the fault zone. The quartz veins contain disseminated grains of pyrite, altering to limonite, and possibly contain gold.

Development: All mine workings are in the fault zone and have exposed it nearly continuously along a north-south line for a distance of 660 feet (fig. 37). The uppermost shaft is sunk 20 feet vertically in a gouge zone 1-foot thick. About 140 feet south another vertical shaft is sunk 25 feet to the fault. A trench, from 0 to 6 feet deep, extends north about 80 feet from this shaft. Approximately 80 feet further south is a 7-foot deep trench, 55 feet long and ending in a burrow-like adit that opens south and extends inward 15 feet. About 165 feet south of the mouth of the burrow an adit is driven north at least 140 feet. A raise is driven to the surface 135 feet from the portal. It opens a few tens of feet downslope from the burrow. Next in sequence, 110 feet south, is an adit driven 250 feet N. 5° W. (fig. 37). About 110 feet south of lower adit, is what appears to be the discovery shaft. It is the most ancient of all workings and is sunk vertically at least 50 feet. The mine is idle.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 472; Tucker and Sampson, 1945, p. 140.

J.R.E. 2/10/59.

Figure 37

North Star (Sunset) Mine

Location: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), ~~U. S. Army Corps of Engineers~~ ~~Eagle Tank~~ Pinto Basin quadrangle, 15', 1943; Pinto Mountains, about 2½ miles north of Mission and Sunrise Wells ~~(pl. 3)~~ figure 3!.

Ownership: Mr. Ross and Mr. Carpenter, 4401 Keystone Ave., Culver City, own at least one unpatented claim (March 1960).

History: Undetermined.

Geology: Massive quartz monzonite is cut by a north-trending vertical fault containing quartz veins as much as 6 inches wide.

Development: A vertical shaft is sunk 100 feet in the plane of the fault. The mine is worked intermittently by the owners.

Production: Undetermined.

References: None.

J.R.E. 3/9/60.

North Star
Trench
figure 37.

T.1S.
T.2S.

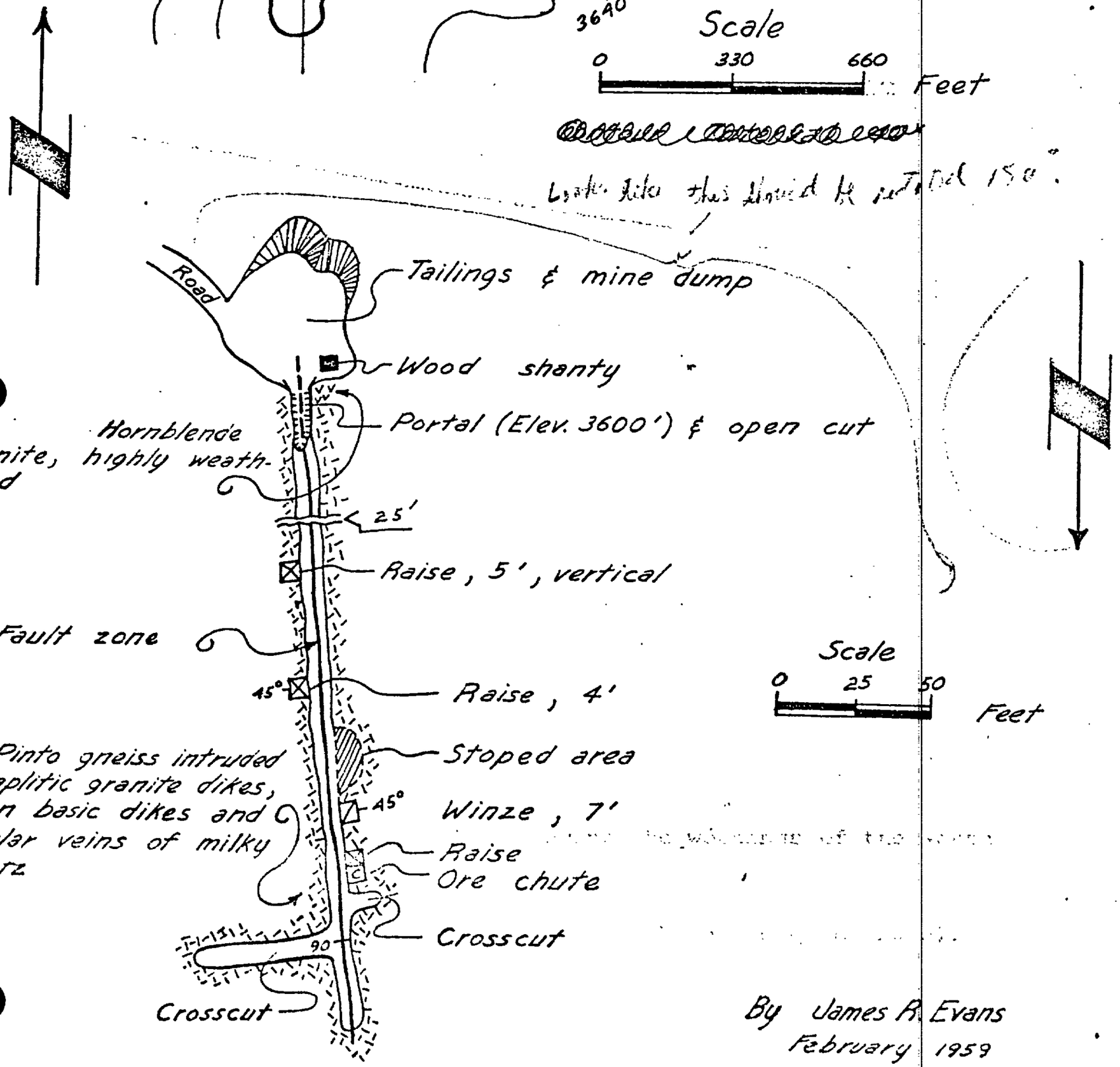
3600
3810
3760
3640

1
6

Y Shaft
Adit
Road
Shanty
R Raise

Scale
0 330 660
Feet

Locate like this should be noted 15a.



Scale
0 25 50
Feet

By James R. Evans
February 1959

Figure 31. Map showing the workings of the North Star mine and a geologic sketch map of the lower adit level (topography from U.S.G.S. 15' Valley Mountain quadrangle).

Nuisance Group

Location: NE 1/4 sec. 12 (proj.), T. 2 S., R. 9 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park area, 9¼ miles S. 25° E. of Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: Virginia Downs filed on the property November 1, 1955.

Geology: Thin veins of gold (?)-bearing quartz occur in Pinto Gneiss. They are strongest along and in the plane of a fault which trends north, and dips 20° west.

Development: An inclined, but partly-caved shaft has been sunk to an undetermined depth in the plane of the fault. The shaft is in the central part of a shallow open cut, which is in the north part of a larger roughly circular open cut that leads into the portal of an adit. The adit has been driven south about 40 feet in the fault plane.

Production: Undetermined.

References: None.

J.R.E. 3/20/59

Oehl Placer Claim

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 3/10 mile south of the Rose of Peru mine and 4½ miles northeast of Mission and Sunrise Wells (see ~~pl. 3~~ figure 31).

Ownership: Bonnie H. and Dean H. Oehl, 77 E. 9th Ave., San Bernardino own 1 unpatented claim.

History: The mine was discovered and worked in the 1930's. No work has been done in recent years.

Geology: The mine is in a low mound of older quaternary alluvium composed of clasts ranging in size from boulder to silt. A few tens of yards to the north the alluvium thins and feathers out on quartz monzonite. Because of the subordinate amount of fine-grained matrix the deposit would appear to be a poor source of gold.

Development: The principal work consists of a 70-foot burrow-like adit driven north and west into the small hill of fairly well indurated older alluvium. Several tens of yards to the southeast a shaft is sunk vertically about 20 feet in a relatively flat surface of the alluvium.

Production: Undetermined.

References: None.

J.R.E. 3/8/60

Oro Copio Mine

Location: Reported to be in sec. 6, T. 2 S., R. 10 E., and sec. 12, T. 2 S., R. 9 E., S.B.M. (proj.); about 9½ miles southeast of Twentynine Palms in the Pinto Mountains, Gold Park area, by Tucker and Sampson, 1929, p. 486. Not confirmed in 1959. This mine may include part or all of the mine workings ascribed herein to the Gold Park Consolidated (?) gold mine #5.

Ownership: Undetermined.

History: The mine was apparently active in 1921 and was owned by the Gold Park Consolidated Mines Company (Tucker, 1921, p. 348). By 1929 the mine was idle (owner, Ellsworth Nichols, Santa Ana) but between 1921 and 1929 additional work was done (Tucker and Sampson, 1929, p. 486).

Geology: Narrow quartz veins, striking N. 10° E., follow a shear zone in granite, ~~which is here altered to~~ gneiss (Tucker, 1921, p. 348).

Development: Three shafts, 50, 75, and 100 feet deep ~~respectively~~ are sunk on the quartz veins (Tucker and Sampson, 1929, p. 486).

Production: Undetermined.

References: Tucker, 1921, p. 348; Tucker and Sampson, 1929, p. 486.

Outlaw Mine

Location: Sec. 1 (?), T. 2 S., R. 13 E., S.B.M. (proj.), Dale Lake quadrangle, 15' 1956; Pinto Mountains, Joshua Tree National Monument, about 9 miles northeast of Sunrise and Mission Wells ~~Well~~, and 2½ miles northeast of the Zulu Queen mine. (Figure 31)

Ownership: Undetermined.

History: The Outlaw mine may have been part of the holdings of the Sunrise Mines Inc., San Diego, which included several mines in the eastern and northern part of the Pinto Basin that were operated by this company in the 1930's (see the Sunrise mine description).

Geology: The mine is on a small outlying hill which is on the northeast side of a southeast-trending wash that drains the south slope of the Pinto Mountains. The hill is carved in quartz monzonite cut by a major N. 50° W.-trending and 70° NE.-dipping fault. A zone of crumbled and red-stained altered rock about 20 feet in average thickness marks the fault trace and is well exposed on the surface over several tens of feet. Locally the fault zone contains thin, discontinuous, and highly oxidized quartz veins.

Development: A shaft is sunk at least 100 feet in the altered zone. The upper 35-foot segment of the shaft is at an inclination of 70° westward, but below this it begins to flatten. Water was obtained at Sunrise Well about 9 miles southwest.

Production: Undetermined.

References: None.

J.R.E. 3/10/60

Pinto (Calidonia) Mine

Location: NE 1/4 sec. 1 (proj.), T. 2 S., R. 9 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, 8.4 miles S. 27° E. of Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: In 1918, the mine was owned and operated by the Gold Park Consolidated Mines Company, W. C. Winnie, president, J. E. Schweng, secretary, C. W. Roach, manager; offices 1021 Black Building, Los Angeles (Tucker and Huguenin, 1918, p. 1).

Geology: Mesozoic hornblende granite, locally crosscut with thin stringers of epidote, intrudes the (Precambiran) Pinto Gneiss. The area is cut by many faults and most of the workings are in a north-trending and steeply west-dipping fault zone. Both the gneiss and the granite are cut by veins of gold (?)-bearing milky quartz as much as 3 feet wide.

Development: Five shafts, one 45 feet deep, have been sunk (fig. 38). Four of these are in a north-trending and steeply west-dipping fault zone which is trenched out to a shallow depth along the strike for a distance of 145 feet. Two adits have been driven; one southeast 120 feet to intersect the northermost shaft in the fault zone; the other southwest 45 feet. The latter mentioned adit has a total of 55 feet of drifts; the north drift probably intersects the southernmost shaft in the fault zone. The mine is idle.

Production: Undetermined.

References: Tucker and Huguenin, 1918, p. 1.

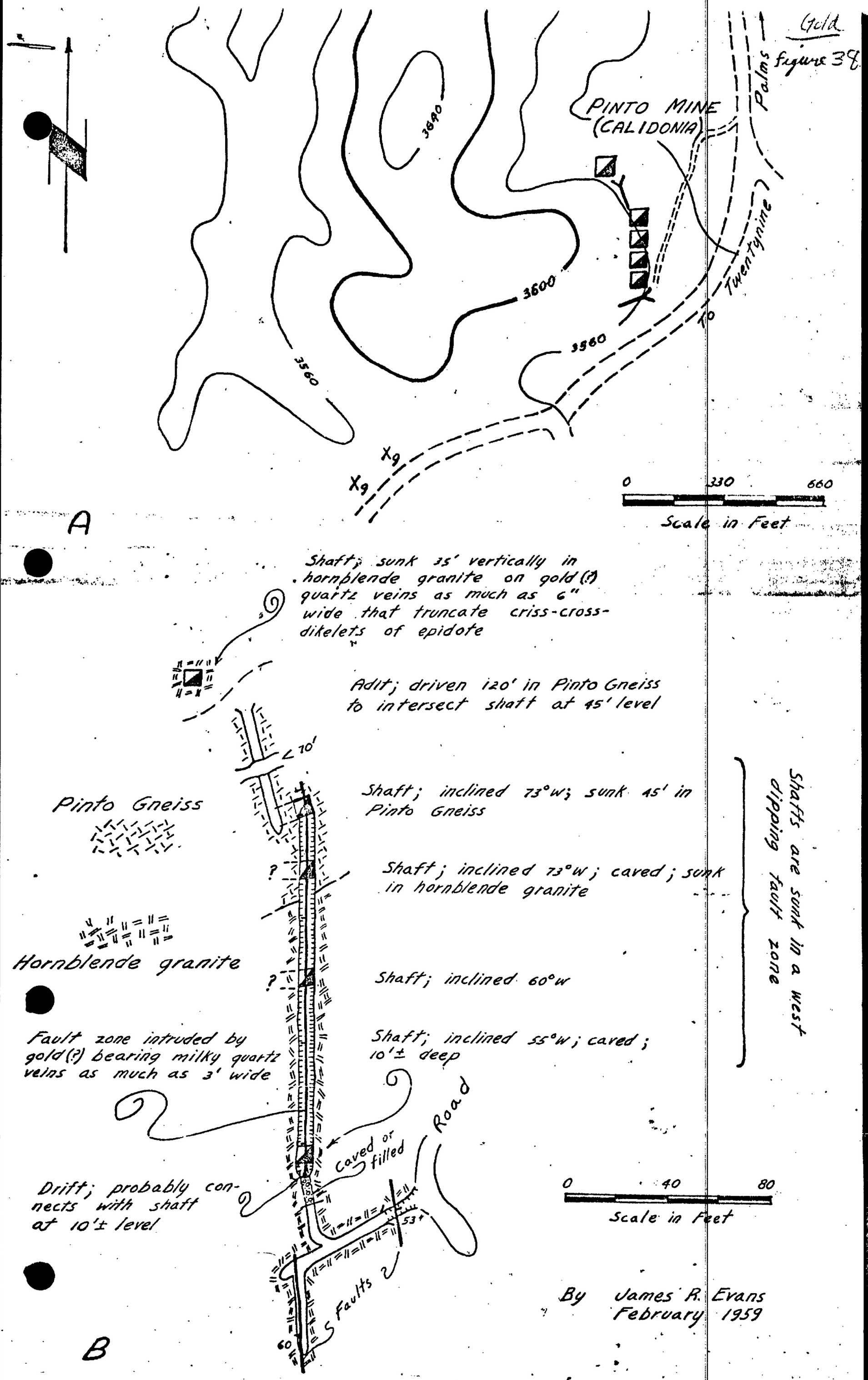
J.R.E. 2/11/59

Figure 38

38

Figure (1). Sketch map showing the areal distribution (A); and a geologic sketch map (B) of the Pinto (Calidonia) mine (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Gold
figure 38.



Pinto Chief Mine

Location: Sec. 1 (proj.), T. 2 S., R. 12 E., S.B.M., Dale Lake quadrangle, 15', 1956; Pinto Mountains, 1 mile south of the Brooklyn mine and 3 1/2 miles southeast of New Dale (site). See figure 31.

Ownership: Undetermined

History: An old property, dating at least from the 1930's.

Geology: A northeast-trending and nearly vertical fault cuts quartz monzonite of Mesozoic age. The fault contains quartz veins of undetermined thickness and extent (Karl Schapel, oral communication, 1960).

Development: A shaft is sunk 300 feet in the fault plane, and is joined to 150 feet of drifts on the 300-foot level (Karl Schapel, oral communication, 1960). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/8/60

Pinto Mine

Location: Sec. 14 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 3 miles north-northeast of Mission and Sunrise Wells (figure 31).

Ownership: Undetermined.

History: Mr. Olsen and Mr. Jenson, Hollywood, owned and operated the mine in 1932.

Geology: Massive, Mesozoic quartz monzonite is cut by a southwest-trending and steeply-dipping fault which contains quartz veins of undetermined length and width (Karl Schapel, oral communication, 1960).

Development: The main shaft is sunk at least 200 feet in the fault. There are southwest and northeast drifts of undetermined extent on at least two levels (Karl Schapel, oral communication, 1960). The mine is idle.

Production: Compiled by the U. S. Bureau of Mines.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)
1932	14	6	3

References: None.

J.R.E.

Pinyon (Tingman-Holland) Mine

Location: S½ sec. 26, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, 1½ miles southwest of Pinyon Well along the crest of the Little San Bernardino Mountains.

Ownership: William F. and Frances M. Keys, P.O. Box 114, Joshua Tree hold the Pinyon group of claims (White Hills, Mountain View, Pinyon, Grand View) in sec. 26.

History: The Pinyon mine was worked as early as the 1890's by A. G. Tingman and Ed Holland, Indio, who by 1891 are said to have been operating two mills in The Blue Cut, several miles north of the mine. The mine was active as late as 1907 when it was operated by W. F. Wilkinson, Indio. Subsequently the property was inactive for many years and was relocated by Mr. Keys in the 1920's. Apparently the mine has remained inactive since the 1920's

Geology: The mine area is underlain by ~~light~~ gray to buff, deeply weathered, coarse-grained quartz monzonite (White Tank ~~quartz~~ monzonite of Mesozoic age). The principal workings explore a quartz vein in a shear zone. The quartz vein is 2 to 4 feet wide at the surface, strikes N. 55° W., dips steeply southwest or is vertical, and is exposed on the surface, at several points in bold outcrops, for about 2,200 feet. About 1,000 feet to the west a parallel quartz vein crops out for about 700 feet.

Development: A drift adit has been driven southeast on the principal vein and may have connected with ② two vertical shafts above on the vein. These workings are largely caved and inaccessible, but the amount of dump material suggests extensive underground workings. Crawford (1894, p. 224) reports the deepest work on the veins was 70 feet from the surface. In addition the vein has been explored by numerous short adits and prospect pits, also caved. The vein to the west has only been explored by shallow pits.

Production: U. S. Bureau of Mines records credit the "Pinon" mine, Tingman and Holland, Indio, with 483.75 ounces of gold in 1896 and, in 1907, 20 tons of ore yielding 7.74 ounces of gold.

References: Crawford, 1894, p. 224; Crawford, 1896, p. 313; Merrill, 1917 [1919], pp. 535-536.

C.H.G. 1/27/60.

Poulson Claim

Location: NW¼ sec. 29, T. 6 S., R. 4 E., S.B.M., Hemet Reservoir quadrangle, 15' 1940; 1½ miles northeast of Kenworthy Guard Station.

Ownership: Undetermined.

History: Undetermined.

Geology: The geology of this deposit was not determined owing to the inaccessible state of the mine and lack of exposure of the vein. The country rock is granitic. ~~The orientation of the mine buildings and cuts suggest that the vein strikes northeast.~~

Development: The mine, now boarded over, appears to have been entered through a shaft. Judging from the size of the mine dump, the number of structures and apparently large investment in equipment, considerable effort was expended. If ore was mined it appears to have been taken elsewhere for milling ~~(figure 1)~~.

Production: Undetermined. Idle (1959).

References: None.

R.B.S. 10/23/59.

Prospector Claims

Location: SE¼ sec. 18, T. 2 S., R. 24 E., S.B.M., Poston quadrangle, 7.5', 1955; on the southeast slope of the Riverside Mountains, about a quarter of a mile west of U.S. Highway 95 and 10 miles, by road, south of Vidal.

Ownership: Trust lands of the Colorado River Indian Reservation, administered by U. S. Bureau of Indian Affairs.

History: A notice found on the property indicates that in 1925 it was held by Arthur W. Williams and H. F. Wilson of Vidal. An unrepaired, bulldozed road suggests more recent activity but no record of such was found. The mine appears long unworked.

Geology: The mine workings explore mineralized zones in faulted and fractured limestone of Paleozoic(?) age which appears to trend northeast and has an irregular but generally shallow dip. At the mine, the limestone caps two north-trending ridges about 600 feet apart, upon which it appears to be as much as 50 feet thick. The limestone is underlain by fractured granitic rocks of Precambrian age. The more easterly ridge is cut by a vertical fault zone striking N.65°E. which contains pods and thin veins of hydrous iron oxides, specular hematite, chrysocolla, calcite, and quartz. The western ridge contains a body of contorted and sheared limestone of undetermined extent. It appears to be an essentially horizontal, tabular mass, at least 6 feet thick where exposed, which is complexly divided by shears and fractures. The shears and fractures are mineralized as are those in the eastern deposit except that secondary copper minerals appear to be more abundant.

Development: A 50-foot, vertical shaft penetrates in the eastern ridge collar surrounded by rotten timber and caving dump material. Several shallow prospect pits lie to the northeast, and within 50 feet of the shaft. In the west ridge an adit driven 20 feet N.60°E. to the base of a 20-foot shaft which opens to the surface. At the base of the shaft is a winze, filled to within 10 feet of its collar by debris caved from the shaft above, and a 20-foot drift driven N.30°W.

Production: Undetermined.

References: None.

R.B.S. 3/16/62

Ragsdale Claim

Location: NE¼ sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 15' 1952; on the east slope of the Chuckwalla Mountains. The property is a quarter of a mile north of the Aztec and Rainbow claims and accessible by a short side road from Dupont Road.

Ownership: Undetermined.

History: Undetermined.

Geology: The country rock is Precambrian gneiss cut by dioritic porphyry dikes. A shear zone, which strikes S. 65° W. and dips 75° NW., is poorly exposed for about 100 feet on the east slope of a low ridge. The zone contains a quartz vein ranging from 0 to 6 inches in thickness. Pyrite and galena appear once to have been abundant in the vein but are now largely altered, the pyrite to iron oxides and traces of secondary copper minerals, and the galena to cerussite and wulfenite. Fractures in the vein are partially filled with crystalline quartz and chalcedony.

Development: The deposit has been developed by means of a single 35-foot drift adit and two prospect pits.

Production: Undetermined. Idle (1960).

References: None.

R.B.S. 2/24/60.

Rainbow Mine

Location: NW 1/4 sec. 7 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15', 1952; on the western ridge of the Mule Mountains approximately 4 miles northeast of Wiley Well, and about 1,000 feet northeast of the Roosevelt mine.

Ownership: O. F. Wright, P. O. Box 1062, Blythe (1958).

History: The Rainbow mine was formerly described with the Roosevelt mine in a common group of 8 claims which had once been called the Santa Fe mine (Tucker and Sampson, 1945, p. 142-143).

Geology: The Rainbow mine is in an area underlain by sheared Precambrian granite. A vein, which pinches and swells from 0 to 2 feet in thickness, is exposed for about 500 feet on a west-to-northwest-trending ridge. The vein strikes west, dips 60° N., and is thoroughly shattered. Fissures and vugs contain iron oxides, malachite, and chalcopyrite. Tucker and Sampson (1945, p. 143) state that the ore averages $12 per ton in gold.

560

Development: A drift adit was driven about 130 feet westward on the vein from a point low on the ridge. The vein quartz has been stoped above the most westerly 100 feet of the adit and has been stoped to the surface at several points.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 142-143.

R.B.S. 2/19/58

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Red Cloud Group (Red Head Group)

Location: Secs. 32 and 33 (proj.), T. 6 S., R. 15 E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; on the northeast side of a northwest-trending canyon, 9 miles by dirt road southeast from U.S. Highways 60 and 70, and 8 miles south-southwest of Desert Center.

Ownership: J. D. Huston, Indio.

History: The Red Head, White Wings, Great Western, and Dottie Welborn, patented claims (see herein), (fig. 39/), were located prior to 1886. Possibly the earliest report of the property was published in 1886, but no details were given (Mining and Sci. Press, 1886, vol. 52, p. 100). The claims were worked by the Red Cloud Mining Company, Salton, from 1899 to 1901. The Red Cloud group appears to have been idle from 1901 to 1932. In 1932, it was worked by Red Cloud Mines, Los Angeles, and from 1935 to 1940 by S. and W. Mine Development Company, 2250 Crenshaw, Los Angeles (U. S. Bureau of Mines records).

Figure 39
Photo 20

562

Fig 39

Claim Data Represent A Close Approximation of Patent Survey Maps

Contours Enlarged and Simplified from Chuckwalla Mts. Quadrangle 1945

Road Data from Field Observations

Dottie Webster

Great Western Mill Site

Red Head

White Wings

2750

Red Head Mill Site

Great Western

U.S. Location Monument #80

N

GROUP

Red Head
White Wings
Great Western
Mill Site

Contour Interval 250 feet

Geology: The Red Cloud group is in an area underlain by Precambrian gneissic rocks, the foliation of which have a northwesterly trend. A quartz vein as much as 15 feet thick is well exposed in an outcrop about 4,500 feet long. It strikes N. 20° to 40° W. and dips 60° NE. The vein appears to lie in the plane of a fault on which subsequent movement has sheared both the vein and the surrounding country rock. The resulting zone of broken and mixed material reaches a maximum width of 10 feet on the Red Head claim. The hanging wall has been altered through a zone as much as 200 feet wide. It forms a bold outcrop of buff-colored, iron-stained rock in which the gneissic banding is still evident. As with the fault zone, this alteration is most extensive on the Red Head claim. The shearing and alteration of the country rock yields an uneven mixture of gangue material, but the vein appears to consist primarly of quartz-containing pockets and veinlets of iron oxides and pyrite. Fluorite is common in the dump on the Red Head claim, but its distribution throughout the body of the deposit was not determined. Small proportions of secondary copper minerals form crusts and stains in the vein matter. Scheelite has been reported present in the deposit (Elmer E. Tubbs, personal communication). The ore contains free gold, but both amalgamation and cyanide were used to achieve maximum returns.

Photo 24

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Development: The workings on the Red Cloud Group comprise three inclined shafts ~~(one on each of the claims.)~~ from which considerable drifting and stoping was accomplished (fig. 40/). The crosscut adit, shown below the White Wings Adit was intended to run extend northeastward some 600 feet from the Red Head Mill Site ~~(this adit)~~ to serve in part as a drainage channel extended but it was only about 200 feet ~~long when operations ceased.~~

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable Metals Gold (ounces)	Silver (ounces)	Copper (lbs.)	Lead (lbs.)
1899		43.54			
1901		96.75			
1932	212	17.33	6		
1935	788	430.76	142	984	
1936	1,033	403.16	93		
1937	1	2	1		
1938	2,064	386	166	306	300
1939	185	71	17		
1940	57	19			

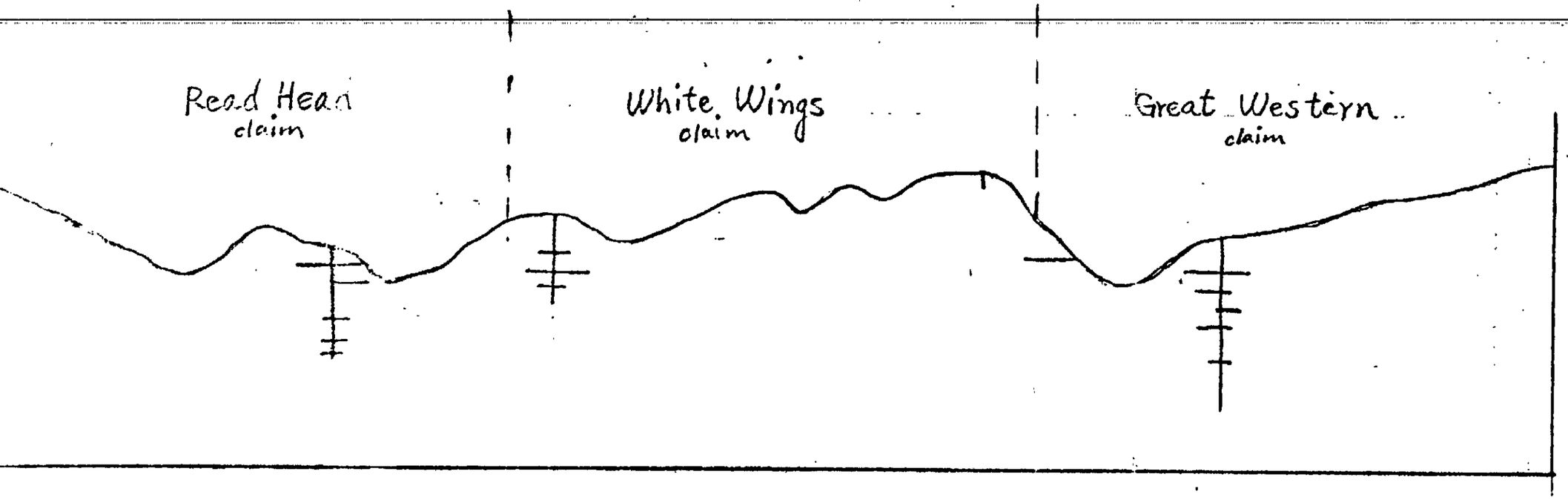
References: Mining and Sci. Press, 1886, vol. 52, p. 100; Orcutt, 1890, p. 900-901; Merrill and Waring, 1917, p. 539; Tucker and Sampson, 1929, p. 486-487; 1940, p. 51-52; 1945, p. 141-142.

R.B.S. 1/21/60.

figure 40

RED CLOUD GROUP

Old figure 40.



sketch

A diagramatic view of the underground development on the claims of the Red Cloud Group in the plane of the vein. Adapted from an unpublished sketch by W. B. Tucker.

Red Streak Mine

Location: Sec. 22 (proj.), T. 6 S., R. 15 E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; 5 3/4 miles south of Desert Center and 2 miles west of Aztec Well.

Ownership: Undetermined.

History: Undetermined.

Geology: The Red Streak mine is high on the north slope of a peak underlain by a complex of Precambrian metamorphic rocks cut by dikes of granitic and basic igneous rock. A shear zone is exposed in an outcrop about 130 feet long on a slope at the head of a narrow ravine. It strikes N. to N. 10° E. and dips 35° west-northwest. A quartz vein, 0 to 1 foot thick lies in the shear zone. The vein is fractured and contains iron oxides as discreet masses of limonite pseudmorphs after pyrite and as fracture fillings. The gold content of this material was not determined.

Development: Near the southern extreme of the outcrop the shear zone is opened by a forked, open-cut one arm of which lies on the vein, the other on an apparently barren zone along the footwall of a basic dike striking southwest. The arms of the cut are 10 to 15 feet long and short 10 to 12-foot adits extend beyond their faces. About 30 feet downslope to the north a short adit cuts S. 10° W. through sheared granite on the footwall of another basic dike but the vein was not encountered. The remaining development comprises 4 shallow prospects downslope to the north.

Production: Undetermined. Idle, 1960.

References: None.

R.B.S. 2/24/60.

Red Top Mine

Location: Sec. ~~34~~ 15 (proj.), T. 6 S., R. 15 E., S.B.M., ~~(U. S. Army Corps of Engineers)~~ Chuckwalla Mountains quadrangle, 15', ~~1945~~ 1963, about 5 miles south of Desert Center and 2 miles west of Aztec Well.

Ownership: J. M. De La Garza, P.O. Box 453, Desert Center (1959).

History: U. S. Bureau of Mines files show activity on a claim of this name during 1940 and 1941 under the ownership of Wiley Brothers, Blythe.

Geology: A quartz vein as much as one foot ~~in width~~ wide is poorly exposed for about 500 feet along the west side of a low granite ridge. It strikes N. 45° W. and dips 25° NE. Free-milling gold occurs in the vein. Oxides of iron, small pockets and stains of chrysocolla, and scattered ~~bunches~~ small masses of galena are present.

Development: Three shafts have been driven down the dip of the vein. They are nearly equally spaced near the northwest end of the outcrop. The deepest, a 30-foot shaft, is on the east side of a shallow ravine, a 10-foot shaft lies about 65 feet to the southeast of it and a 20-foot shaft 100 feet farther southeast on the outcrop.

Production: According to U. S. Bureau of Mines records (published with permission of the owner) the Red Top yielded 64 tons of ore, during the period 1940-42, from which 33 ounces of gold and 7 ounces of silver were obtained.

References: None.

R.B.S. 4/28/59.

Renrut-Neerg (Alveston) Claim

Location: SW¼ sec. 29, T. 6 S., R. 4 E., S.B.M., Idyllwild ~~(Hemet Reservoir)~~ 15' 59 quadrangle, 1948; about 2 miles east of Kenworthy Guard Station.

Ownership: E. K. Turner, Route 1, Box 32, Mountain Center.

History: California Division of Mines files indicate that this property was patented in 1896 by Rueben B. Alves as 2) Two claims, one placer and one lode, under the name Alveston.

Geology: This property includes the sandy floor of a shallow canyon and an adjoining ridge of jointed and weathered granitic rocks to the northwest. Fine gold is disseminated in what appears to be a shallow alluvial deposit in the canyon and in a vein cutting the ridge. The vein is as much as 4 inches wide. It lies in the plane of a shear zone about 4 feet wide which strikes N. 35° E. The dip is vertical at the surface but flattens to about 75° NW. at a depth of 20 feet. This deposit is poorly exposed for about 100 feet on the crest of the ridge. The gold is contained in oxides of iron which pocket and stain the vein quartz. The owner stated that the vein averages $17 per ton in gold and that samples taken from thin veins in the walls of the shear zone, assayed $5 to $8 per ton.

569

Development: The owner has won small quantities of gold from the placer deposit in the canyon by means of a sluice box, however, the water supply is seasonal, and difficult to regulate or conserve.

The vein is explored by a shaft about 60 feet deep. At the bottom drifts extend 20 feet southwest and 50 feet northeast. The backs of the drifts have been overhand stoped as much as 12 feet up dip.

Production: Undetermined. ~~Idle (1959).~~

Reference: Tucker and Sampson, 1945, pl. 35.

R.B.S. 10/23/59.

Rice Claims

Location: S 1/2 sec. 31, T. 7 S., R. 1 E., S.B.M., Sage quadrangle, 7 1/2', 1954; 4 1/2 miles south of Sage, in the mountains.

Ownership: Undetermined (1958).

History: No work appears to have been done on this property for many years. According to Harry Bergman, a long-time resident in the area, this mine was operated in the early 1900's by two men named William Rice and Manny Ridge. Bergman (personal communication, 1958) said that these men made meager wages in gold.

Geology: The workings of this mine are spaced irregularly along a poorly exposed contact between mica schist and Mesozoic diorite. The contact strikes approximately N. 45° W. along the southwest side of a low ridge. It is traceable for about three quarters of a mile. The planes of schistosity are vertical and roughly parallel to the contact. Pods, stringers, and veins of quartz as much as 2 feet wide parallel the schistosity.

Development: Development comprises 5 vertical shafts and one drift adit. A sixth shaft, indicated on the Sage quadrangle, at the northwest end of the property, was not examined.

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The drift adit is at the southeast end of the property. It is about 50 feet long and bears N. 45° W. on a quartz vein which ranges in width from 0 to 2 feet. The portal is partly caved. One of the vertical shafts, of undetermined depth, is situated immediately in front of the adit portal. This shaft appears to explore the junction of the northwest-trending vein and a vertical shear zone bearing N. 20° E. The shear zone is filled in part by a quartz vein with a maximum width of one foot. The dump material and workings were examined briefly, but no recognizable ore minerals were found.

Two shafts, about 50 feet apart, are situated approximately 1,000 feet northwest of the adit. These shafts are on a shear trending N. 40° E. The northeast shaft is vertical to a depth of about 40 feet, below which point it slopes steeply to the northeast to an undetermined depth. No vein is exposed near the collar. The southwest shaft is vertical for an estimated depth of about 100 feet, below which point it is flooded to an undetermined depth. A quartz vein as much as four inches wide follows the plane of a shear where it is exposed at the collar.

572

The remaining 2 shafts are about 800 feet farther northwest and are about 200 feet apart along a line drawn northeast between them. The northeastern-most shaft is about 75 vertical feet higher than the southwest shaft. It is about 100 feet deep to water. the collar is in barren schist, however, the dump material indicates the presence of vein quartz at depth. ~~Though some timber remains at the collar, entry was not possible.~~ The southwest shaft is also about 100 feet deep to water. There is no vein exposed at the collar. The dump consists largely of dioritic material with minor amounts of vein quartz. One small crystal of molybdenite was found in a fragment of quartz. The shaft is untimbered and the collar is surrounded by a light wire fence (July, 1958).

contains probably obtained

Production: Undetermined.

References: None.

R.B.S. 7/25/58.

Rich Gold (Gold Crown #2) Mine

Location: Sec. 8 (proj.), T. 3 S., R. 10 E., S.B.M., Hexie Mountains quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 4 miles southeast of White Tank, and about 1/4 mile south of the West Pinto Basin Road.

Ownership: Undetermined.

History: Originally located as the Gold Crown No. 2. Relocated as the Rich Gold mine July 1, 1931, by S.B. Trujillo and Loyd E. Kinder, 1223 West Fifth Street, San Bernardino.

Geology: Pinto Gneiss is cut by west-trending minor faults and a northwest-trending pegmatite dike. The faults contain thin specularite-hematite-chalcopyrite (?)-bearing quartz veins.

Development: Two shafts, one 25 feet and the other possibly 100 feet deep, are sunk in the plane of a west-northwest-trending fault (fig. 41 /, locs. 3 and 4). At locality 2, a ~~15-foot~~ shaft is sunk 15 feet in a west-trending fault. The pegmatite dike is exposed in a shallow 20-foot long northwest-trending open cut. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 1/25/60

Figure 41

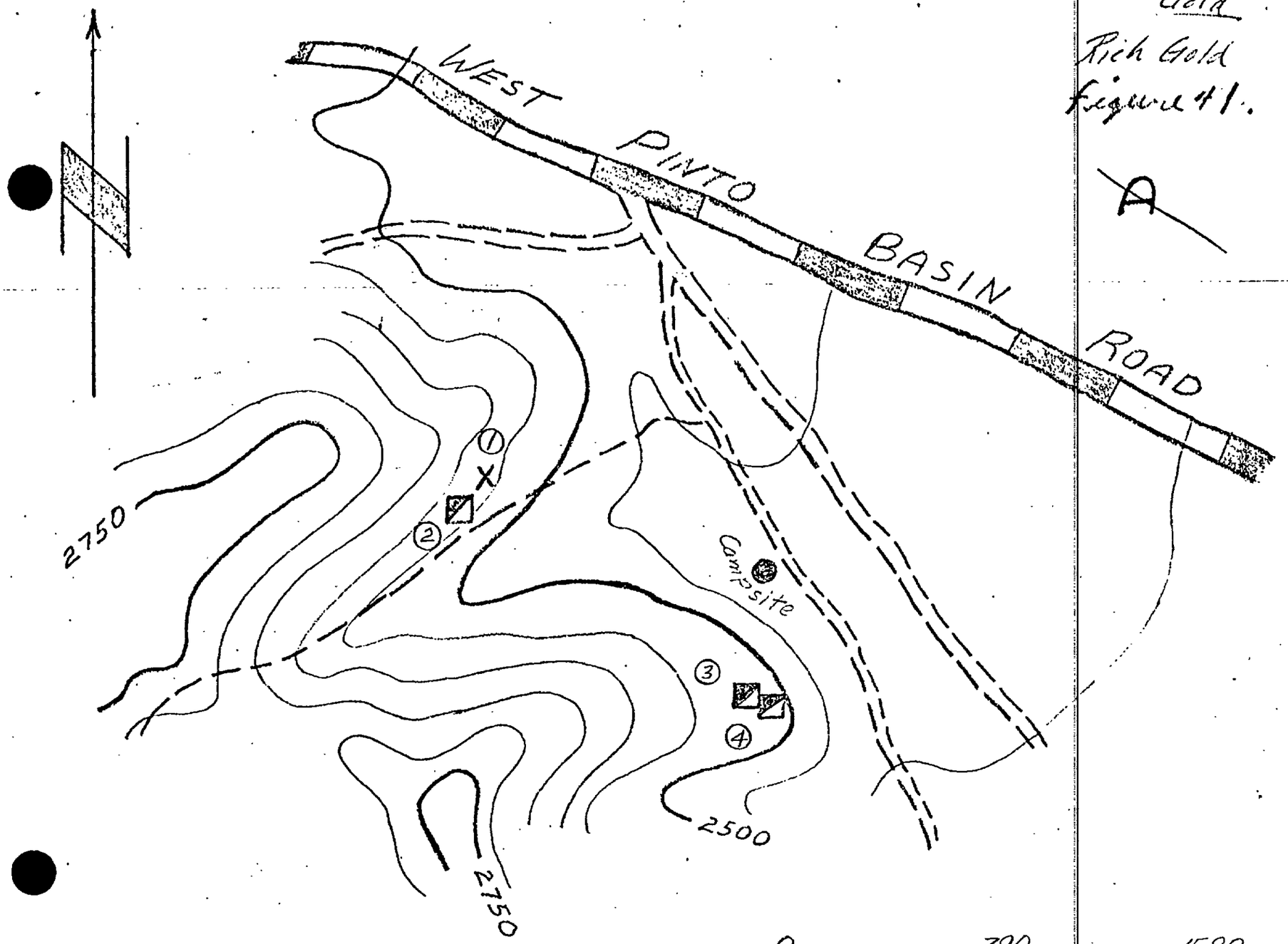
574

Figure 41. Sketch map showing the areal distribution of the workings (A), and a schematic geologic sketch map (B) of the Rich Gold (Gold Crown #2) mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

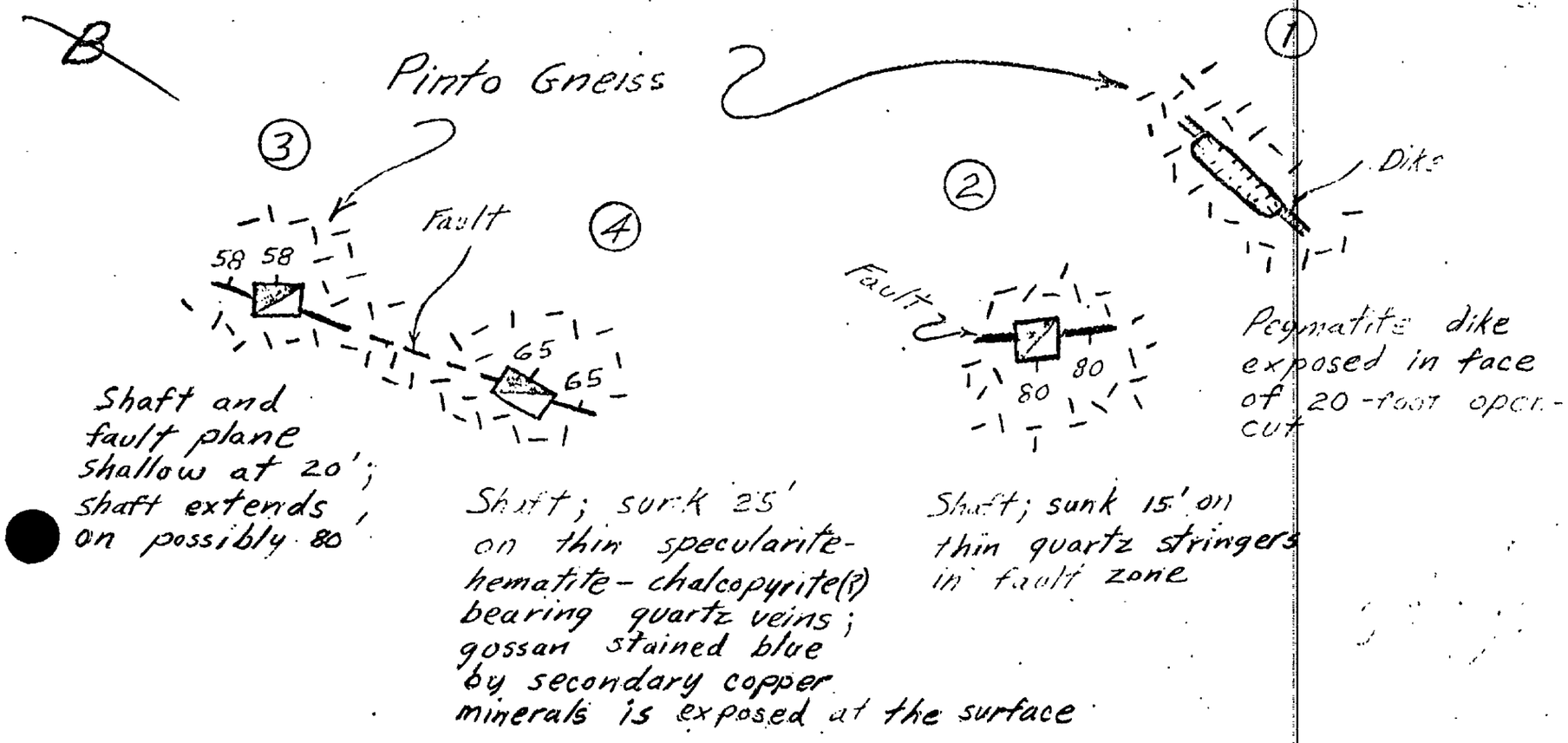
Gold

Rich Gold

Figure #1.



By J.R. Evans
January 1960



Pegmatite dike exposed in face of 20-foot open-cut

Shaft; sunk 15' on thin quartz stringers in fault zone

Shaft; sunk 25' on thin specularite-hematite-chalcopyrite(?) bearing quartz veins; gossan stained blue by secondary copper minerals is exposed at the surface

Shaft and fault plane shallow at 20'; shaft extends on possibly 80'

Romoland Group

Location: SW¼ sec. 23, NW¼ sec. 26, T. 5 S., R. 3 W., S, B.M., Romoland quadrangle, 7.5', 1953; 2 miles south of Romoland.

Ownership: Undetermined.

History: Undetermined.

Geology: The Romoland Group is on a short, north-trending ridge of dioritic rocks of Mesozoic age on the north side of an unnamed group of hills. Narrow, poorly exposed quartz veins lie on shear planes which strike N. 25° E. to N. 25° W. and dip 50° SE. to 70° NE. as exposed in the workings. The quartz is unevenly mineralized with clots and fissure fillings of iron oxides/a sample of which, when panned, showed traces of gold. Where observed, the veins range from a fraction of an inch to 2 inches in thickness.

Development: A shear ~~The fault~~ was explored on the north slope of the ridge by a partly caved, 15-foot shaft inclined S. 20° E. at about 45°. On the east slope a second shaft was sunk about 50 feet on the 70° dip of a vein. In a shallow ravine on the west side of the ridge an adit was driven S. 85° E. in apparently-barren diorite. The portal is partially caved but the adit appears to be at least 100 feet long.

Production: Undetermined.

References: None.

R.B.S 6/18/59

Roosevelt (Roosevelt and Rainbow, Sante Fe) Mine

Location: NW¼ sec. 7 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15' 1952; on the western ridge of the Mule Mountains about 4 miles northeast of Wiley Well.

Ownership: Undetermined (1958).

History: In 1945, Tucker and Sampson (p. 142-143) reported that the Roosevelt Mine was part of a group of 8 claims which included the nearby Rainbow Mine. The Roosevelt and Rainbow mines were formerly known as the Santa Fe mine.

Geology: The country rock is ~~highly~~ sheared granite. A fault trace is poorly exposed along the floor of a narrow canyon where it strikes N. 50° - 60° E. and dips about 50° SE. The fault zone contains irregular bodies of sheared vein quartz material which, according to Tucker and Sampson (1945, p. 143), forms a talcose gouge, mineralized with free gold, which assays from $8 to $100 per ton.

5771

Development: The mine comprises 2 inclined shafts about 100 feet apart. The western shaft slopes about 60° near the collar, flattening to approximately 45° at a depth of about 50 feet. The eastern shaft appears to slope similarly. The depth of these shafts was not determined. According to Tucker and Sampson, in 1945 the western shaft was about 135 feet deep. At 60 feet below the collar of the shaft a 50-foot drift extended westward and a 20-foot drift eastward. No reference is made to any drifting from the eastern shaft.

When visited (1958) the timbering in the collars of the shafts was in fair condition. An ore bin, in good repair, still stood near the west shaft. The road to the mine was passable.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 142-143.

R.B.S. 2/19/58.

Rose of Peru

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 15' 1956; Pinto Mountains, about 3 miles southeast of New Dale (Site) and about 1 mile south of the Brooklyn mine. (Figure 31, ~~(pl. 34)~~)

Ownership: Bonnie H. Oehl, 777 East 9th Ave., San Bernardino owns 2 unpatented lode claims (March 1960).

History: Originally owned and operated by Karl Schapel, Box 113, Twentynine Palms, from 1939 to 1941.

Geology: Generally north-trending and steeply-dipping quartz veins of undetermined extent occur in massive quartz monzonite.

Development: The main shaft, adjacent to the road, is 300 feet deep and sunk 70° E. on a vein. There are 600 feet of north and south drifts on the 200-foot level (Karl Schapel, oral communication, ~~3/8/60~~ 11/19/60). About a quarter of a mile northeast of the main shaft another shaft is sunk 100 feet on a north-trending and steeply-dipping vein. This shaft is joined to 125 feet of drifts on the 100-foot level (Karl Schapel, oral communication, ~~3/8/60~~ 11/19/60). Other workings are of minor extent and consist of shallow shafts, short adits and prospects. The mine is worked intermittently by the owner.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)
1939	33	33
1940	10	6
1941	12	17

References: None.

J.R.E. 3/8/60.

Ruby Lee Claim and Millsite

Location: The mill site is in sec. 10, T. 4 S., R. 11 E., S.B.M. (proj.), ~~U. S. Army Corps of Engineers~~ Pinkham Well quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, bordering the Pinto Basin, about 4 miles northwest of the West Pinto Basin - Cottonwood Pass - East Pinto Basin road intersection. The claim was not found but ~~there are~~ several small prospect pits exist in section 9 about 1 mile west of the millsite. A Jeep road leads west from the millsite to the prospects.

Ownership: A. A. Dietemann, 874 North Beverly Glen, Los Angeles 24, owns 1 unpatented claim and 1 millsite (March 1958).

Geology: The mill site and prospects are underlain by massive but strongly jointed hornblende granite.

Development: At the millsite a cabin and a few sheds house miscellaneous equipment (elevation 3,000 feet). A jeep road leads east from the millsite to a junction with the West Pinto Basin Road about 3 miles northwest of its junction with the east Pinto Basin Road and Black Eagle mine road.

Production: Undetermined.

References: None.

J.R.E. 10/14/59

Rusty Gold (Summit or Sunset Group) Mine

Location: Sec. 16 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 1 mile southwest of the Gold Crown mine and close to 3 1/2 miles south of New Dale (site). See figure 31.

Ownership: Undetermined.

History: Originally located as the Sunset group of 7 claims in the 1920's by Jack Meek, Twentynine Palms. By 1929, only exploration work had been done and the property was idle (Tucker and Sampson, 1929, p. 488). From 1929 to 1944, several shafts ranging in depth from 10 to 20 feet had been sunk and in 1945 the property was again reported idle. Jack Meek, however, was still the owner (Tucker and Sampson, 1945, p. 144) but had apparently relocated the claims as the Summit group. A. T. Roy, Twenty-nine Palms, worked the claims in 1956 and recorded a small production of copper. The mine was not being worked on the day of the property visit.

Geology: A series of west-trending vertical quartz veins as much as 2 feet thick occur along minor faults in Mesozoic quartz monzonite.

NEW EL DORADO MINE

Shaft
Adit
Prospects
Main
Ore bin
Open cut
Tanks
Dump
Tailings
Adit
Cabin
Cabin
Pleasant Valley
To West Pinto Basin Road
2750
2500

A

0 500 1000
Scale in Feet

① Fault
Pinto Gneiss

② Fault
Pinto Gneiss

③ 90
Sunk vertically 25' in Pinto Gneiss

Filled Raise 30' to surface
Fault zone as much as 4' wide
Ore chutes
Main shaft at surface
C W
76
90'
Winze
Stope
Raise
Pinto Gneiss
Filled
Raise to surface
Shaft inaccessible below 90' level
Oxidized quartz vein 4' thick exposed
Dense green rock

B

0 40 80
Scale in Feet

90-foot level - NEW EL DORADO MINE
By James R Evans
December 1959

Development: The main shaft is sunk vertically 35 feet in a fault containing a hematite-gold quartz vein, one foot in average thickness. There appears to be short drifts in the fault plane at the 15-foot level. There are several other shallow prospects from 10 to 20 feet deep, sunk on quartz outcrops and veins; all near the main shaft.

Production: Compiled by the U.S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Copper (lbs.)
1940	5	5	
1956	15		237

References: Tucker and Sampson, 1929, p. 488; Tucker and Sampson, 1945, p. 144.

J.R.E. 3/30/60

San Antonio Mine

Location: SE 1/4 sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7 1/2', 1953; about 4 miles west of Perris (fig. 42/).

Ownership: Lillian P. Enloe, 3120 East 2nd Street, Long Beach, and Ricardo Montijo hold this patented claim and several surrounding unpatented claims.

History: U.S. Bureau of Mines files show that this claim was worked in 1935 by Ralph Mellor, Perris, and by Dick Montijo from 1938 through 1940.

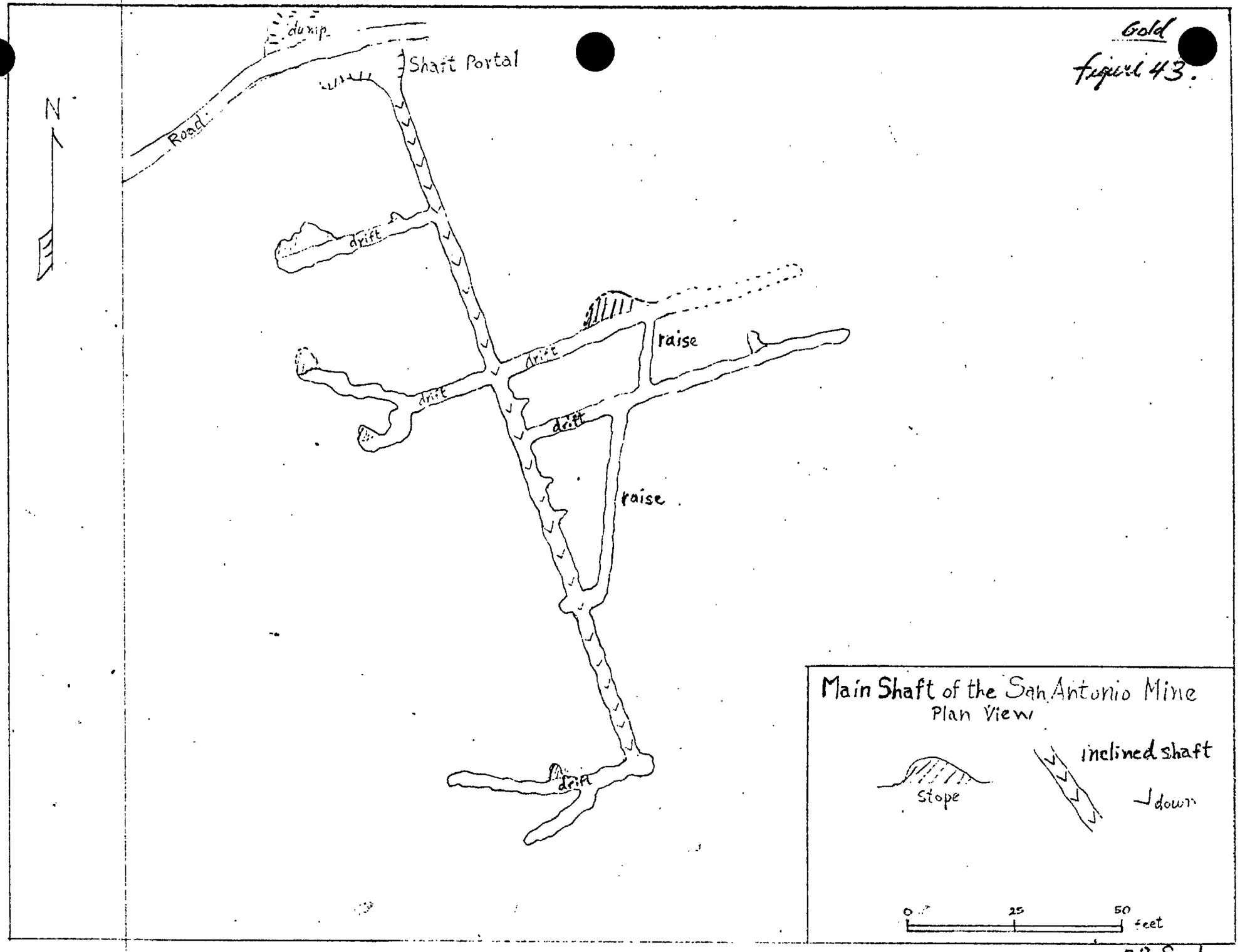
Geology: The San Antonio claim lies high on the northwest slope of a ridge composed of deeply weathered dioritic rock of Mesozoic age. The claim includes the outcrop of a poorly exposed quartz vein as much as one foot wide which strikes N. 70° E. and dips about 25° SE. The lateral extent of the vein appears to be about 1,000 feet. The vein quartz contains veinlets and pockets of iron oxides which carry free-milling gold.

Development: The vein has been explored through six inclined shafts, five adits, and an open cut. The most extensive of these workings, inclined shaft No. 6, is shown in greater detail in Figure 43/.

Figure 42

Gold

figure 43.



Main Shaft of the San Antonio Mine
Plan View

Stope

inclined shaft

down

0 25 50 feet

R.B. Saul

In addition to gold ore, residual boulders of the dark, blue-gray country rock have been quarried on this claim. These dense, homogenous masses yield an attractive product called "black granite" (see section on ~~decorative stone~~ dimension stone).

Production: Published by permission of the U. S. Bureau of Mines.

Year	Crude ore tons	Recoverable Metals Gold(ounces)
1935	14	2.97
1938	2	1.00
1939	4	1.00
1940	3	1.00

References: None.

R.B.S. 6/17/~~69~~ 5

Figure 43

Santa Fe Group

Location: NW 1/4 sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7 1/2', 1953; about 6 miles west of Perris.

Ownership: Undetermined (1959). Three patented claims, the Adyar, Florence, Goldbug, and Adyar Millsite.

History: The Santa Fe group was first worked prior to 1881 (Goodyear, 1888, p. 527), but was idle in that year. Activity was renewed briefly in 1893 under the ownership of Phelps, Judson, and others, Pasadena, (Storms, 1894, p. 224). F. M. Woods and others, having brought in a 5-stamp mill from the Temescal tin mine, worked the Santa Fe group from 1894 to 1896 (Mining and Scientific Press, 1894, vol. 69, p. 394; Crawford, 1896, p. 314). There is no subsequent report of activity on these claims.

Geology: The Santa Fe group is on the north slope of a low ridge composed of deeply weathered Mesozoic diorite. The poorly exposed vein strikes N. 70° W. and dips about 45° SW. The vein is probably less than a foot wide. The vein material on the surface consists of two types; quartz-tourmaline material, and quartz-containing pockets and fractures filled with oxides of iron. The ore, presumably the latter of the above, was reported in 1895 to be on a par with that found elsewhere in the district (Mining and Scientific Press, 1895, vol. 70, p. 106); about $30 per ton in gold.

Development: The indistinct outcrop of the vein was explored by an inclined shaft and closely-spaced pits and shallow shafts along a strike distance of about 300 feet. An adit was driven into the ridge about 100 vertical feet below the outcrop. It was reported to have extended 700 feet southwest and to have cut the vein 500 feet from the portal (Crawford, 1896, p. 314). ~~The adit and the inclined shaft were boarded up when the property was visited and the upper workings were in bad repair.~~

Production: Undetermined, (1959).

References: Crawford, 1894, p. 224; Mining and Scientific Press, 1894, vol. 69, p. 394; 1895, vol. 70, p. 106, 382; Crawford, 1896, p. 314; Merrill and Waring, 1917, p. 530; Tucker and Sampson, 1929, p. 487; Sampson, 1935, p. 514.

R.B.S. 9/23/59.

Santa Rosa (Rosario, Northern Belle) Mine

Location: SE 1/4 sec. 30 and NE 1/4 sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7 1/2', 1953; about 6 miles west of Perris.

Ownership: Undetermined (1959).

History: The Santa Rosa mine was located about 1879 by Mexicans who recovered the gold in arrastres (Mining and Scientific Press, 1894, vol. 69, p. 394). W. A. Goodyear (1888, p. 527) referred to the property as the Rosario or Northern Belle mine and gave its location and a brief description of the vein and the rocks in the area. In 1893 (Storms, p. 384), the name Santa Rosa had been adopted and the mine was reported active. By 1893, a mill building had been erected on the property, and a 20-stamp mill was installed (Crawford, 1894, p. 224-224; Sampson, 1935, p. 514).

In 1959, the Santa Rosa was idle and all structures and machinery were gone.

Geology: The vein explored by the Santa Rosa mine, was reported to be as much as 3 feet wide (Sampson, 1935, p. 514), but is poorly exposed on the surface. It strikes N. 10° W. and dips 45° SW. (Crawford, 1896, p. 314). The country rock is Mesozoic diorite.

Development: The vein was explored to a depth of 200 feet by inclined shafts and trenched along its strike for about 1,000 feet (Crawford, 1894, p. 224-225; Sampson, 1935, p. 514). The workings are now caved.

Production: During the years 1895-1901, the Santa Rosa mine yielded 6,745.40 ounces of gold in an unreported tonnage of ore (U.S. Bureau of Mines records).

References: Goodyear, 1888, p. 527; Storms, 1893, p. 376; Crawford, 1894, p. 224-225; Crawford, 1896, p. 314; Merrill and Waring, 1917, p. 592; Tucker and Sampson, 1929, p. 487; 1945, pl. 35; Sampson, 1935, p. 514.

R.B.S. 6/15/59.

589

Schellenger Mine

Location: Sec. 18 (proj.) T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 15', 1951; on the west slope of a hill, about 1 1/2 miles north of Black Hill in the Big Maria Mountains.

Ownership: Undetermined (1958).

History: In 1929, Tucker and Sampson (p. 487) reported that 6 claims were held by E. E. Schellenger, Blythe, but only assessment work had been done on them. By 1945, (Tucker and Sampson, p. 143) development had progressed to essentially the present state, and the mine was idle. T. A. Ashby, Rice, and M. A. Anderson, Pasadena, owned the claims in 1945. When visited in December, 1958, the Schellenger mine appeared long idle.

Geology: Gneissic, Precambrian country rock is cut by granitic pegmatite dikes as much as 6 feet wide which strike northwest. A fault trends east and dips 85° N. The fault fissure is filled by a quartz vein as much as 18 inches wide. Layers of chlorite 1-2 inches thick lie along both the foot and hanging walls. The vein is fractured and the chlorite is slickensided, suggesting post-mineralization movement. The ore minerals in the quartz vein, pyrite and oxides of iron, are reported to carry $15 per ton in gold (Tucker and Sampson, 1945, p. 143).

Development: A lower and an upper adit are driven east on the vein. The lower adit is about 70 feet long, and contains a narrow raise extended a few feet up the vein from the face. The upper adit is roughly 30 feet higher on the vein, about 50 feet farther east, and is 30 feet long.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 487; 1945, p. 143.

R.B.S. 12/19/58

591

Shannon Mine

Location: NW 1/4 sec. 1 (proj.), T. 2 S., R. 9 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park area, 8.1 miles S. 23° E. from Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: Undetermined.

Geology: Mesozoic hornblende granite is cut by thin aplite and pegmatite dikes and contains gold (?)-bearing milky quartz veins as much as 1 1/2 feet thick. Minor, nearly vertical faults occur locally. A fissure filling of vein quartz is exposed in the adit nearest the road.

Development: The workings consist of an adit driven northeast 38 feet, an adit driven southwest 25 feet, a 100-foot shallow trench, a prospect pit, and a 30-foot shaft inclined 60° E. The mine is idle.

Production: Undetermined.

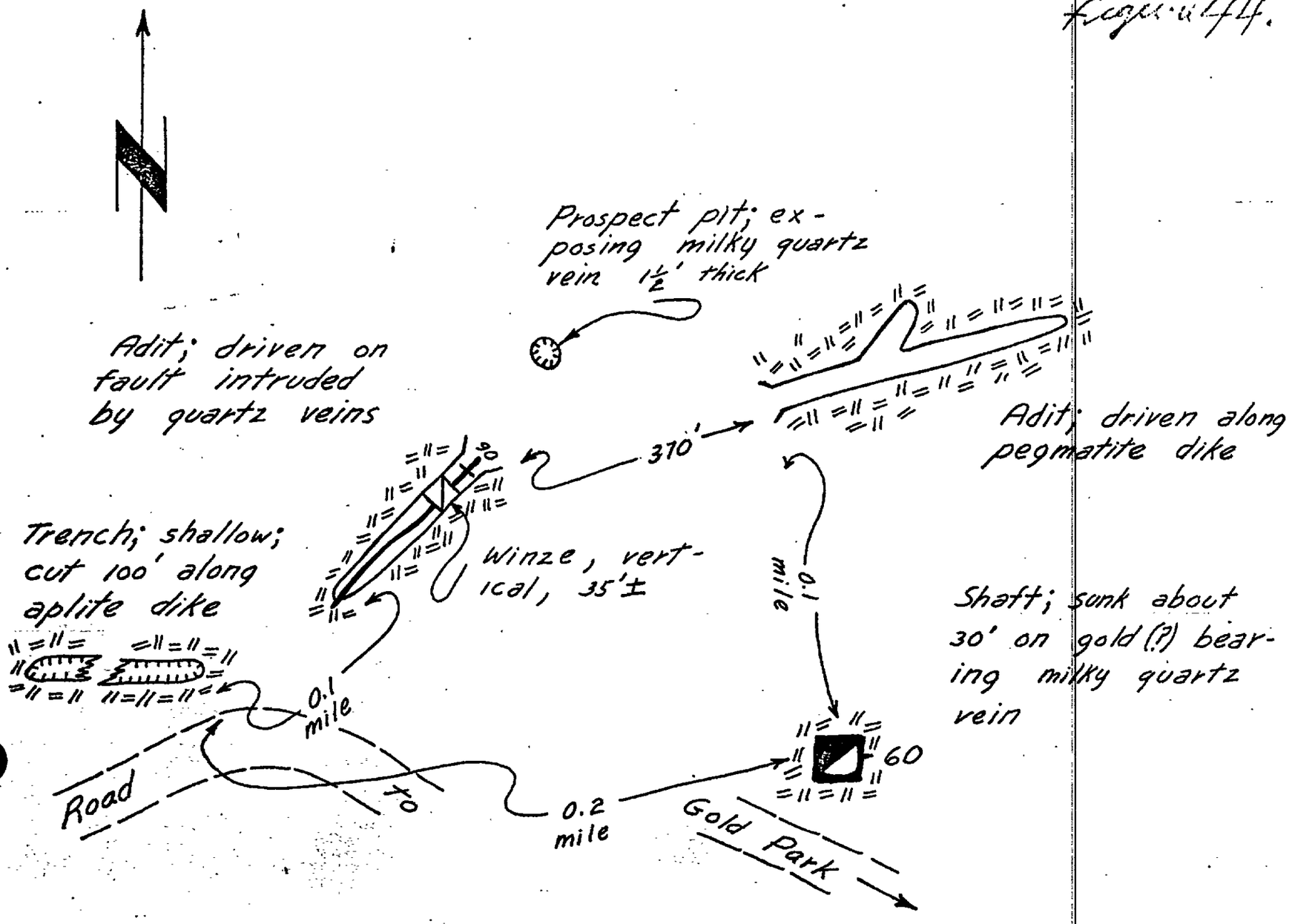
References: None.

J.R.E. 2/12/59

Figure 44

G-44

Salmon
Keyser 454.



Hornblende granite

By James R. Evans
February 1959

~~Elevation 3600'±~~

Figure 44 (1). Geologic sketch map of the Shannon mine.

Silver Bell Mine

Location: Sec. 8 (proj.), T. 3 S., R. 10 E., S.B.M., Hexie Mountains quadrangle, 15', 1963; Hexie Mountains, Joshua Tree National Monument, about 4 miles southeast of White Tank, and about 1/2 mile southwest of the West Pinto Basin road.

Ownership: Undetermined (December 1959).

History: Originally owned by W. F. Keys, P. O. Box 114, Joshua Tree. Prospected for gold during the 1930's, then idle for many years. Latest exploration was for copper in the mid-1950's. In 1956, the property was sold to Farrington Mann, 9207 South Lakewood Boulevard, Rivera.

Geology: Pinto Gneiss is cut by two major faults, several minor faults, and is intruded locally by thin, highly altered, basic dikes. A zone of crushed material containing highly oxidized chalcopyrite, and pyrite with specularite and gold in quartz is well exposed in the open cut along a north-trending and steeply east-dipping fault. The wall rock is highly stained and altered, and contains secondary copper (chrysocolla, azurite, and malachite) and iron (limonite, hematite) minerals.

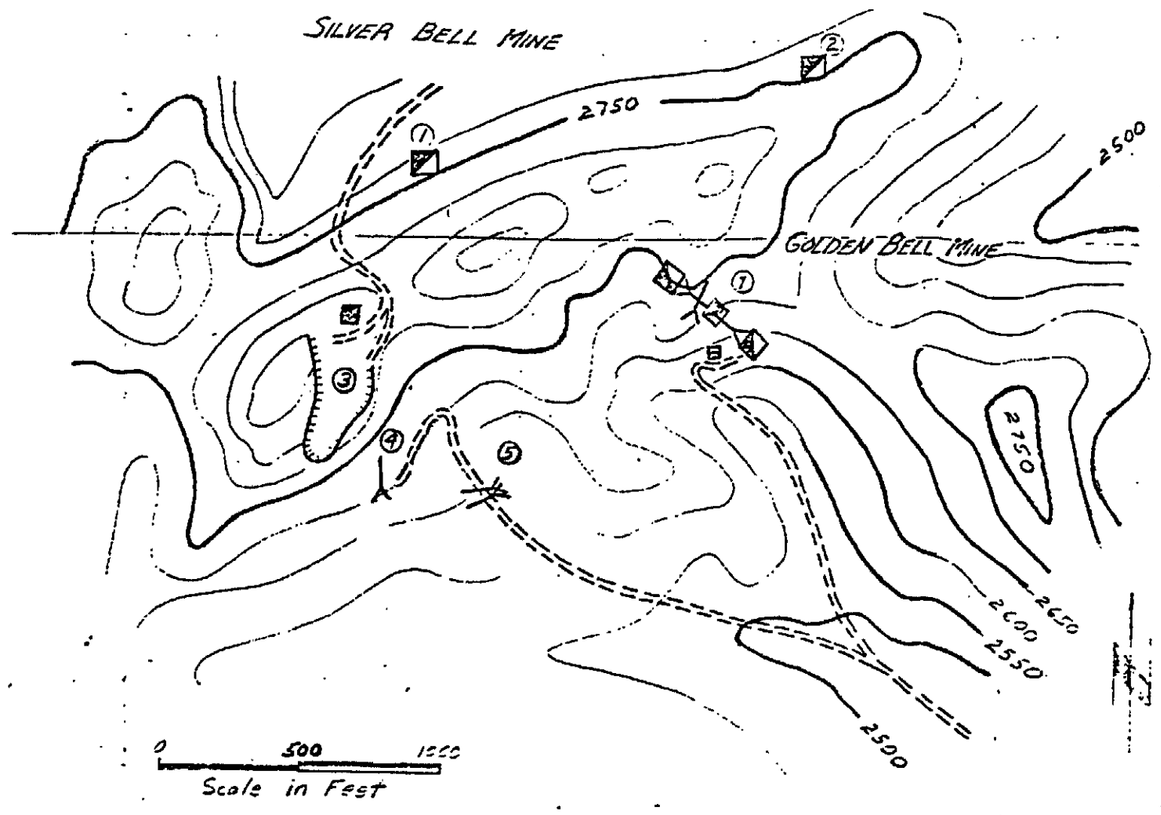
Nearly 500 feet southeast of the open cut a west-trending and steeply-south-dipping fault zone, as much as 20 feet wide and at least 200 feet long, separates Gold Park gabro-diorite from Pinto gneiss. No mineralization was observed in this gouge zone. The minor faults contain thin quartz stringers and veins (see fig. 1).

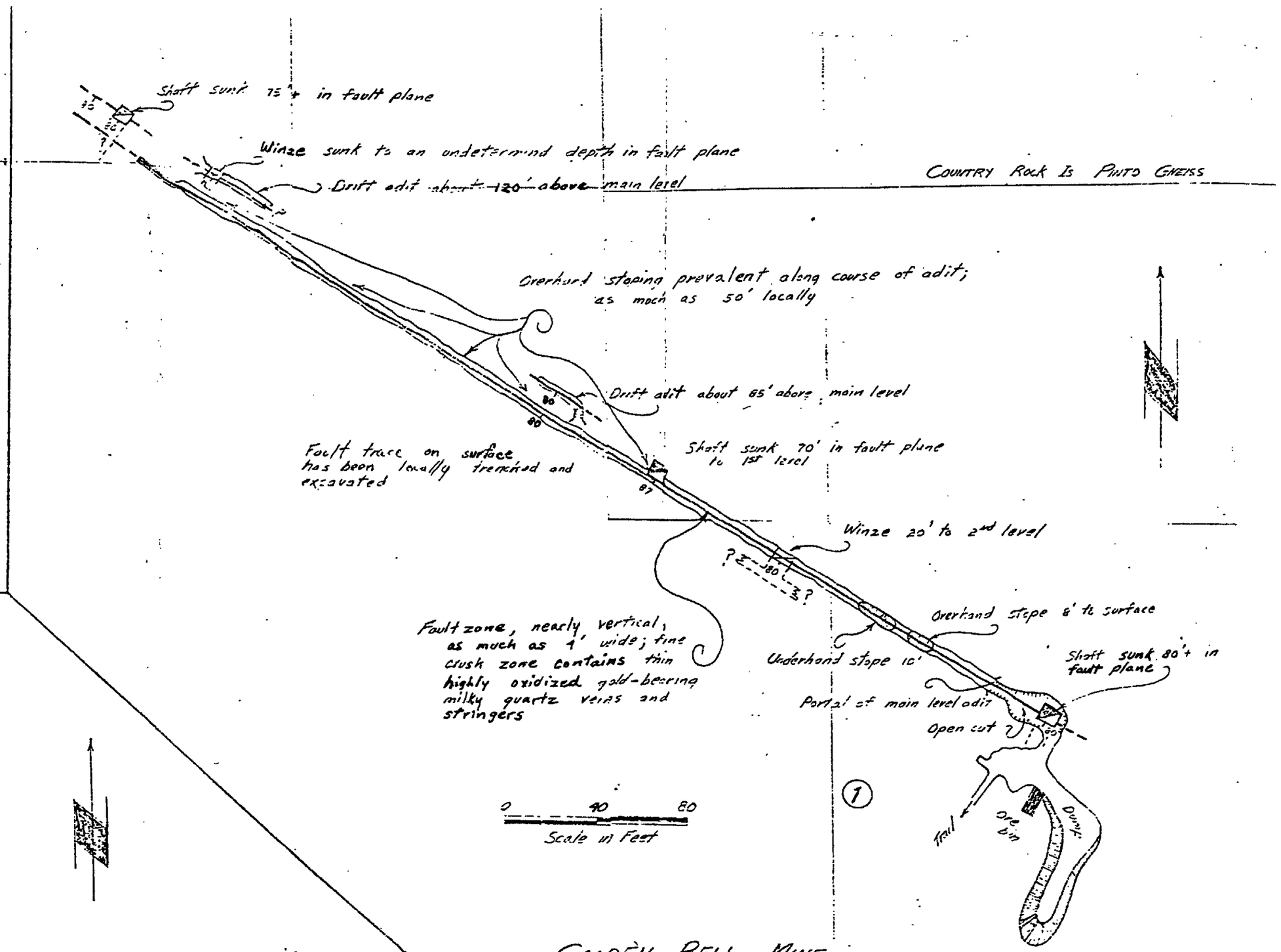
Development: Older work along the northwest slope of a northeast-trending ridge consists of 2 shallow shafts sunk on quartz veins contained in minor faults. Mining of the copper-bearing crushed and altered zone has involved the shaving off of the east slope of a small knob-like hill. About 500 feet southeast of the cut, 2 narrow and relatively old burrows have been driven into a west-trending gouge zone; one about 280 feet, the other 25 feet. About 400 feet west of the burrows an adit is driven about 160 feet in fractured Pinto Gneiss.

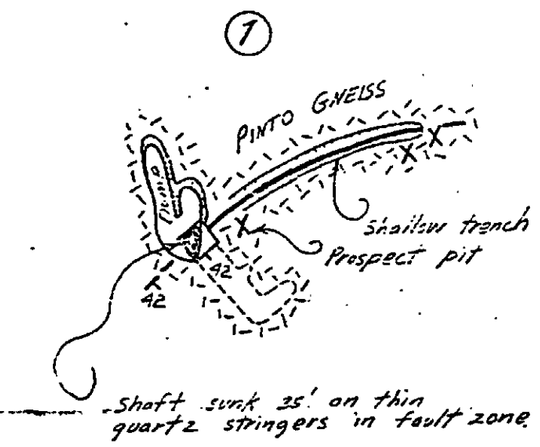
Production: Several tons of material was processed for copper in the mid-1950's at a mill in sec. 16, T. 1 N., R. 9 E., S.B.M., San Bernardino County, about 2 1/2 miles north of Twentynine Palms on Utah Trail. Concentrates produced were not marketed.

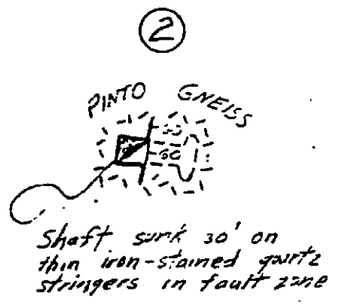
References: None.

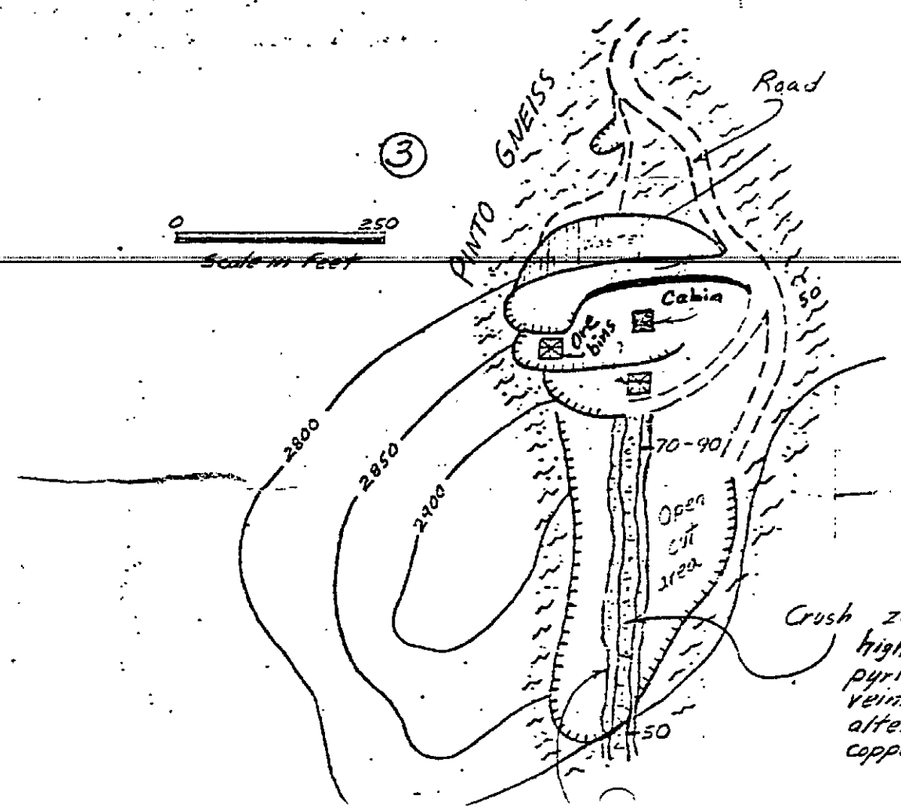
J.R.E. 12/11/59

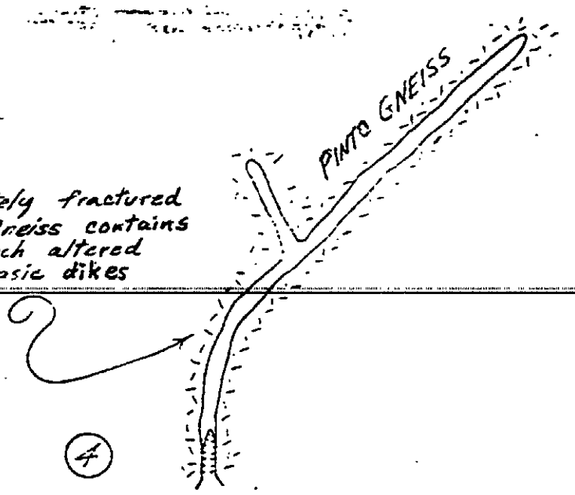


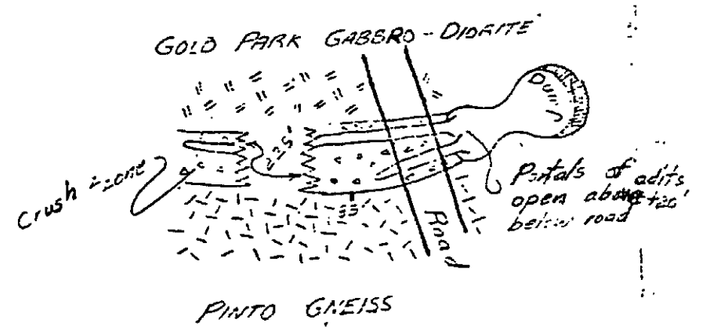


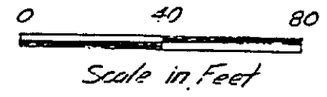












SILVER BELL MINE

By James R. Evans
1960

Silver Scorpion Mine

Location: SE 1/4 sec. 1 (proj.), T. 2 S., R. 9 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, 8.7 miles S. 28° E. of Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: Carlos J. Bassler, Jr., and Francis E. Bassler located the property October 16, 1953.

Geology: Epidote-rich Gold Park gabbro-diorite has been injected by hornblende granite which is cut by a northwest-trending fault. Thin stringers of aplite, and tabular gold (?)-bearing milky quartz veins occur in the immediate area, but are strongest in the fault zone.

Development: A 20-foot shaft is sunk on a 56° SW. inclination in the plane of a northwest-trending fault. The shaft is near the center of a trench that has exposed the fault nearly continuously along a 50-foot line. At 20 feet, a drift extends southeast for an unknown distance paralleling the fault line exposed on the surface. It is idle.

Production: Undetermined.

References: None.

Sinock Mine

Location: Sec. 17 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 3 1/4 miles northwest of Mission and Sunrise Wells (figure 31).

Ownership: Undetermined.

History: Probably a mine active in the 1930's. It does not appear to have been worked in recent years.

Geology: The mine is in massive quartz monzonite of Mesozoic age cut by steeply-dipping faults of random orientation. One shaft is sunk on a north-trending and 70° E.-dipping fault; the other is sunk on a N. 70° E.-trending and 80° W.-dipping fault. Both faults undoubtedly contain quartz veins, but the quartz does not crop out.

Development: The main shaft, sunk in the north-trending fault, is at least 80 feet deep and probably is joined to drifts at several levels. Total workings here are estimated to be 400 to 500 feet. Several tens of yards southwest of the main shaft another shaft is sunk at least 100 feet in the plane of the N. 70° E.-trending fault. Work done here totals perhaps 200 to 300 feet.

Production: Undetermined.

References: None.

J.R.E. 3/30/60

Smith Brothers Claims

Location: Smith Brothers No. 1 claim is in the SW 1/4 sec. 8, Smith Brothers No. 4 claim is in the NE 1/4 sec. 7 (proj.), T. 2 S., R. 10 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, about 10 miles S. 30° E. of Four Corners, Twentynine Palms. Smith Brothers claim No. 8 is in the NE 1/4 sec. 19 (proj.), T. 2 S., R. 10 E., S.B.M., Pinkham Well quadrangle, 15', 1943; Pinto Mountains, 11.2 miles S. 25° E. of Four Corners, Twentynine Palms.

Ownership: Undetermined.

History: John Uland, Milton B., and Albert H. Smith located the claims in 1955.

Geology: The country rock at claim No. 1 is Precambrian Pinto Gneiss and at claim No. 4, (Mesozoic) Palms granite. Country rock is cut by minor faults, and intruded by fine-grained green basic dikes as much as 2 feet thick. Secondary copper mineralization is in evidence at one prospect ~~(fig. 77)~~. At No. 8 claim, hornblende granite is cut by a steeply-south dipping fault in which occur hematite-chalcopyrite-gold (?)-bearing milky quartz veins.

Development: A shallow prospect characterizes No. 1 claim, while 4 prospects and a shaft sunk 35 feet vertically comprise the workings at No. 4 claim (fig. 45/). At No. 8 claim, a shaft has been sunk vertically 14 feet on a fault trending N. 75° E. Short drifts extend out from the foot of the shaft in nearly east and west directions.

Production: Undetermined.

References: None.

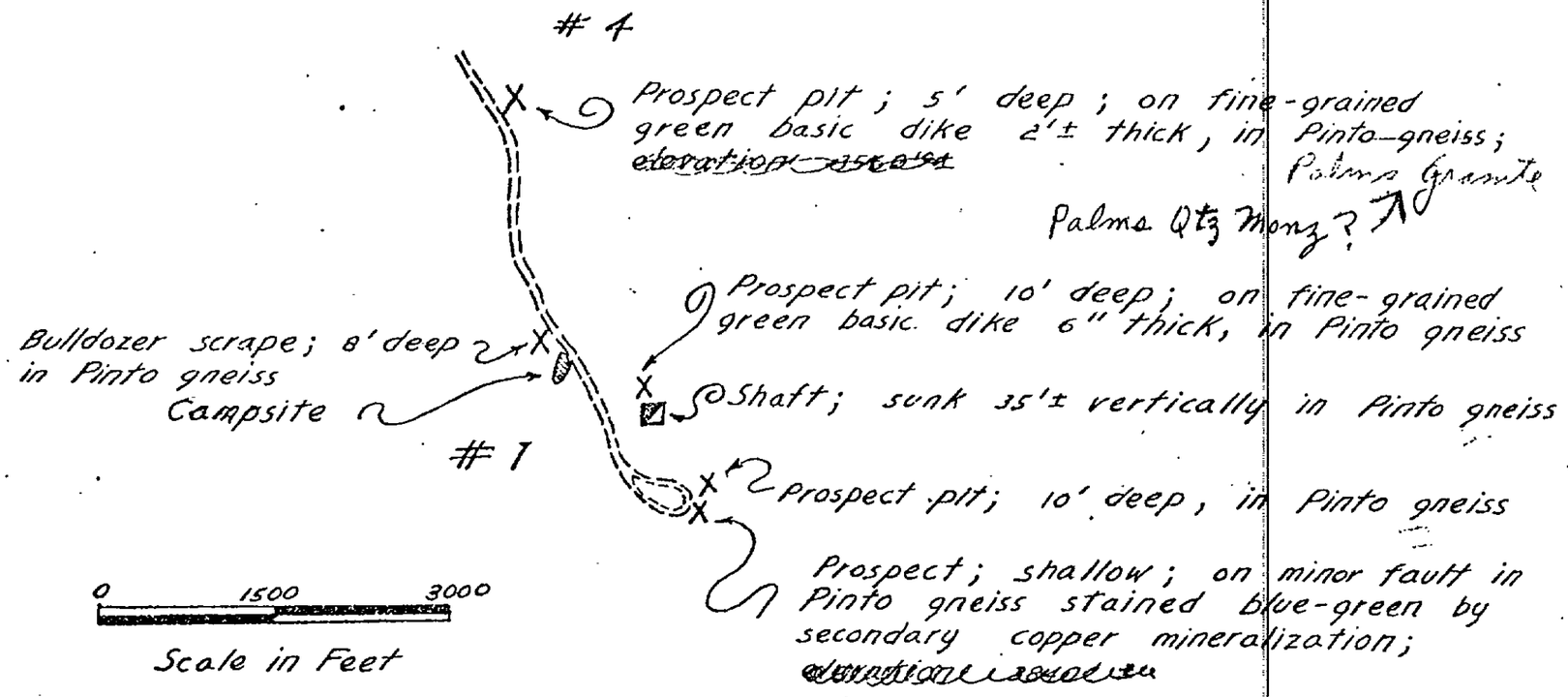
J.R.E. 3/17/59

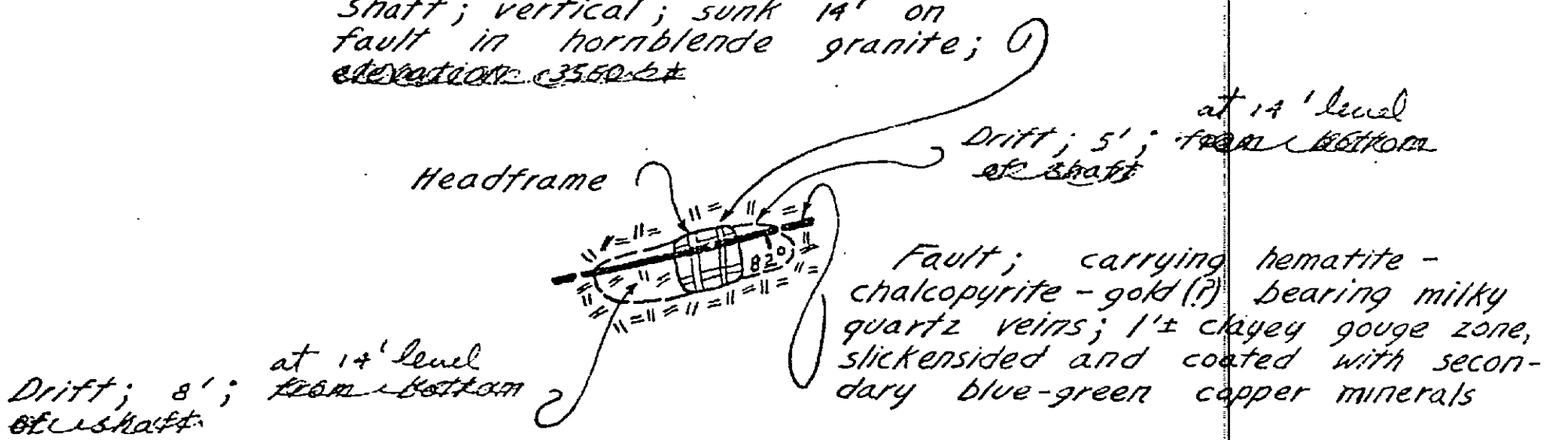
Figure 45

600

Figure 45 Gold

Smith Brothers claim





By James A. Evans
March 1959

45

Figure ~~1~~. Sketch maps of the Smith Brothers claims (1 ~~- 1~~).

Location: Sec. 6, T. 5 S., R. 10 E., S.B.M., Hexie Mountains quadrangle, 15', 1963; Cottonwood Mountains, about 6 miles northwest of Cactus City in Pinkham Canyon.

Ownership: Clifford S. Coy, 2032 Genevieve Street, San Bernardino, owns 3 unpatented lode claims (January 1960).

History: In 1935, the mine was active and J. P. Coy, W. L. Secomb, and C. S. Coy, Highland, were the owners.

Geology: (Precambrian) Pinto Gneiss underlies the southwest slope of a northwest-trending ridge. The gneiss is cut by a fault which trends north and dips 80° E. A well-developed gouge zone 1 to 3 feet thick contains an oxidized milky quartz vein.

Development: A tunnel is driven 90 feet south in the fault plane, through a small projecting ridge, to intersect a 40-foot shaft. The shaft is sunk 80° E. in the fault plane; from which point it flattens and extends possibly another 100 feet. The vein has been overhand stoped ~~at several places~~ to the surface from the floor of the tunnel along its course to the shaft intersection.

at several places

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable metals	
		Gold (ounces)	Silver (ounces)
1935	35	47	8

References: None.

J.R.E. 1/28/60.

Standard Mine

(proj.)

Location: Sec. 13, T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, Joshua Tree National Monument, about 3 miles north-northeast of Mission and Sunrise Wells (fig. 31).

Ownership: Undetermined.

History: See Duplex mine. The mine was owned and operated by Willard Allen and Joe Geiger, Twentynine Palms, from 1938 to 1941.

Geology: Massive Mesozoic quartz monzonite is cut by a southwest-trending fault which contains gold-quartz veins of undetermined length and width (Karl Schapel, oral communication, 3/8/60).

Development: A drift adit comprises the main workings and is driven at least 300 feet southwest in the plane of the fault. Other work is of relatively minor extent and consists mainly of shallow shafts and prospects, although one shaft is at least 50 feet deep (Karl Schapel, oral communication, 3/60). The mine is idle.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude Ore (tons)	Gold (oz.)	Silver (oz.)
1938	104	60	13
1939	89	47	9
1940	238	494	4
1941	287	30	20

References: Tucker, 1933, unpublished field report No. 122.

J.R.E.

Stanford Mine

Location: NE¼ sec. 9, T. 5 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; on the west slope of a narrow north-trending ridge 1 mile southeast of Steele Valley.

Ownership: Undetermined.

History: By 1894, the Stanford Mine had been developed to essentially its full extent and a small, 5-stamp mill installed under the ownership of Hearn Bros. of Perris (Crawford, 1894, p. 225). In 1896, the mine was idle (Crawford, 1896, p. 314) and no report of subsequent activity was found.

Geology: The Stanford Mine penetrates a dip slope underlain by fractured, phyllitic rocks which strike north and dip 35° W. These rocks are cut by a poorly-exposed fault which strikes N. 25° W. and dips 45° - 75° SW. The sheared zone comprises an irregular body of sheared rock as much as 3 feet wide containing crushed, iron-stained quartz veins as much as 1 foot in thick~~(ness)~~ and what appears to be a thin porphyry dike.

Development: The fault is explored by an inclined shaft, reported by Crawford (1894, p. 225) to be 125 feet deep, a 50-foot crosscut and a drift of undetermined length. The crosscut cuts the fault 35 feet from the portal and 15 feet north of the shaft. The drift extends south from the crosscut to and beyond the shaft a distance of at least 50 feet, it being impossible to cross the shaft to determine its southern extent. The drift crosses the shaft about 40 feet below the collar. ~~When visited (October, 1960) the mine was untimbered, open and dry.~~

Production: Undetermined.

References: Crawford, 1894, p. 225; 1896, p. 314; Merrill and Waring, 1917, p. 532; Tucker and Sampson, 1929, p. 487.

R.B.S. 10/21/60.

Stanford Mine, Small Prospects Near

Location: SW¼SE¼ sec. 5, T. 5 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; at the southwest edge of Steele Valley about 5½ miles southwest of Perris. Some prospects probably are in the SW¼ of the section.

Ownership: Undetermined.

History: This area was being prospected and mined in a small way in 1893 and 1894 (Crawford, 1894, p. 225) but the lack of any other reference makes the duration of these operations uncertain.

Geology: The country rock, granodiorite, has been eroded to an irregular pattern of low knolls and swales. A shear zone as much as 10 feet wide is exposed for about 300 feet. It strikes N. 15° W. and dips 85° NE. Quartz ~~, both massive and finely crystalline,~~ forms stringers and veins ranging in width from 0 to 4 inches ~~wide~~ in the sheared country rock. The quartz is pocketed and stained with iron oxides and was reported (Crawford, 1894, p. 225) to be rich in gold in some spots.

Development: The main development is a caved shaft of unknown original depth but now about 30 feet deep. A short crosscut appears to have been driven east at the 15-foot level but ~~his~~ this, too, is now caved. The shaft is at the southeast end of the outcrop. To the northwest the trend of the shear zone is pock marked by numerous shallow prospect pits, now largely filled and grown over by brush. Just south of the shaft, and near the dirt road which traverses Steele Valley, is an old arrastra pit, ~~is still discernable~~.

Production: Undetermined.

References: Crawford; 1894, p. 225.

R.B.S. 9/25/59.

608

Steece (Black Canyon) Group

Location: Sec. 1, T. 2 S., R. 23 E., and sec. 6, T.2 S., R. 24 E., S.B.M., Parker quadrangle, 15' 1950; on the eastern slope of the Riverside Mountains 6 miles south of Vidal.

Ownership: Desert View Mines Inc., c/o Grace M. Tucker, Shattock Hotel, Berkeley 4. This owner holds the unpatented Silver Dome, Fraction, Gossen, Jackknife, Ernie, and Melvill lode claims and the adjacent, patented Black Canyon, Barnes, Buena Vista, Triangle, Emerald Copper, Green Gobbler Copper, Ruby Copper, Soda Basin Copper, and Washington lode claims (1957).

History: The Steece Group was first described ~~reported on~~ in 1917 (Merrill and Waring, p. 543) at which time it was owned by Richard Silliland and Ed Arnold of Calzona. At that time the main shaft was 500 feet deep. In a 1929 report the mine was said to be idle but soon to be reopened under the ownership of C. W. Mitchell, Parker House, Boston, Massachusetts (Tucker and Sampson, 1929, p. 487-488). Subsequently, according to the old Glendale Land Office records (1938), these claims had passed into the ownership of the Vidal Mining Co. and were reported as the "Black Canyon Group."

Geology: The Steece mine is in a geologically complex area. A folded and contorted succession of Paleozoic (?) limestone and cherty dolomite about 700 feet thick is separated from underlying Precambrian schists along a shear zone which strikes roughly east-west, dips 10° N. and is exposed along the base of the mountains for about half a mile. The shear zone is mineralized with gold-bearing veins as much as 20 feet ~~in~~ thickness composed of quartz, hematite, barite, malachite, and chrysocolla.

Development: The extent of underground development was not determined but it appears to have explored downward along the shear zone. The mine is entered through several inclined shafts and adits. Ore appears to have been trammed down the several hundred feet of steep slope to stock-piling and loading points in a canyon which cuts west through the foothills and up which a road leads to the mine.

The ~~final~~ depth of the mine is reported to be 900 feet (Jack Stewart, Parker, Arizona, personal communication, ~~Feb. 18,~~ 1958).

Production: Undetermined.

References: Merrill and Waring, 1917, p. 543; Tucker and Sampson, 1929, p. 487-488; 1945, pl. 35.

R.B.S. and C.H.G. 12/19/57.

Stella Mine

Location: Sec. 10, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 15' (1) 1956; Pinto Mountains, about 3 miles south of New Dale (Site) and approximately 1/10 mile north of the Gold Crown mine (see Figure 31 ~~pl. 3~~).

Ownership: Ivan C. Winter, Box 1271, Twentynine Palms, owns 4 unpatented lode claims and a millsite.

History: The property was discovered in the late 1950's and has been worked intermittently since that time. A gold quartz mill was in a nearly complete stage of assembly on the day of the property visit.

Geology: Thin and discontinuous quartz veins intrude massive quartz monzonite and are strongest along pre-existing minor faults. The largest vein observed was about 6 inches in average thickness.

Development: Four shallow vertical shafts are sunk in minor faults. The deepest shaft is 15 feet.

Production: None as of March 1960.

References: None.

J.R.E. 3/10/60

Sterling Mine

Location: SW 1/4 sec. 20 (proj.), T. 6 S., R. 14 E. S.B.M., Hayfield quadrangle, 15', 1963; on the northeast slope of the Orocopia Mountains, 3 1/2 miles south of U. S. Highways 60 and 70 and 1 1/2 miles southeast of the Gold Cup group, in a southwest-trending canyon.

Ownership: Undetermined.

History: This group of claims was located prior to 1896. During 1896, the property was being worked and a 10-stamp mill under construction by the Sterling Mining Company, Los Angeles (Crawford, 1896, p.314). The Sterling mine was once reported to have been a part of the Red Cloud group (Merrill and Waring, 1919, p. 539) but its distance from that group makes this seem unlikely. The same report states that the mill had been moved to the Lost Horse mine in the Pinon District, so presumably, the mine was idle. The appearance of the mine and camp sites suggests subsequent operation but no record of this was found.

Geology: The Sterling mine workings explore two faults which lie athwart a quartz monzonite-gneiss contact (fig.). One fault strikes east across a low ridge. On the ridge crest it dips vertically but flattens to about 80° N. where exposed in the workings. The other fault converges from the southwest. It strikes N. 80° E. across a ravine just west of the ridge and dips vertical to steeply southeast (fig.).

Discontinuous quartz veins, ranging from 0 to 5 inches in thickness, lie in the planes of the faults. In addition, the fault in the ravine has been intruded by a basic dike. Locally the veins contain heavy concentrations of porous iron oxides in an irregular central zone. Voids in the oxides commonly contain yellow, tabular crystals of wulfenite as much as half an inch across. No information was obtained on the gold and molybdenum content of the veins.

Development: The vein in the ridge is explored by an adit, a 10-foot shaft and several shallow prospects. The adit was driven S. 70° E., 50 feet on a barren shear zone. A crosscut was then extended 33 feet N. 35° E. to the vein on which a drift was driven 40 feet east. The shaft was sunk where the vein crosses the ridge, about 100 feet up the slope from the adit portal.

The vein in the ravine has been prospected by at least 12 shallow pits~~, but no deeper work was done~~.

Production: Undetermined. Idle (1960).

References: Crawford, 1896, p. 314; Merrill and Waring, 1919, p. 539.

R.B.S. 2/11/60.

Stone House (La Rica) Mine

Location: NE 1/4 NW 1/4 sec. 4 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15', 1952; on the crest of the Mule Mountains and half a mile northeast of the Hodges mine. Access is by trail.

Ownership: Joe Hannah, Jr., et al., c/o Melvin Wehe, 121 West Charter Way, Stockton (1955), were the last known owners.

History: The Stone House mine is one of an undetermined number of old lode claims. Papers in the area indicate at least eleven claims were held in 1955 under this name, by the above noted owners. Judging from an old description, it is possible that this is the old La Rica mine (Tucker and Sampson, 1929, p. 483).

Geology: This mine apparently was opened in the search for gold in a fault zone that cuts gneissic granite. The fault zone is about 10 feet in average width and can be traced for about 200 feet up the slope at the head of a steep canyon. It strikes N. 45° W., and dips 45° SW. The mineralization appears to be confined to the quartz veins which are as much as one foot thick and thoroughly fractured. Hematite is common in fissures and vugs along with small amounts of chrysocolla, present as stains and coatings. Calcite and chlorite occur as scattered masses about an inch in average size.

Development: Two short adits and two shallow prospect pits explore the fault. The adits are driven northwest just below a saddle at the head of the canyon and the two prospects are a few tens of feet above them near the saddle. The lower adit is about 40 feet deep. The upper adit, 50 feet higher on the same vein, is 15 feet deep. ~~Both adits are untimbered, and were open and dry in February, 1958.~~

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 483.

R.B.S. 2/21/58.

616

Sunrise Mine

Location: Sec. 26, T. 2 S., R. 12 E., S.B.M. ~~(proj.)~~ U. ~~S. Army Corps of Engineers~~ (Pinto Basin ~~Eagle Tank~~) quadrangle, 15', 1943; southeastern tip of the Pinto Mountains, one mile north of Mission Well. Figure 31

Ownership: Howard M. Fox, 810 N. Whittier Drive, Beverly Hills.

617

History: The Sunrise mine is said to have been discovered about 1900 and apparently was intermittently active until the mid-1930's. In 1929, it was acquired by Sunrise Mines, Incorporated, 416 Electric Building, San Diego. In 1933, the Sunrise group consisted of 15 claims and was operated by Sunrise Mines Incorporated along with the Zulu and Moose groups (see herein) and the Cortez group of 3 claims whose location is undetermined. Sixty five gallons of water per minute were pumped from Sunrise Well, one mile to the south. In 1939, the Sunrise mine was under lease to Pinto Basin Mining and Milling Company which was remodeling the mill to do custom work (Tucker and Sampson, 1940, p. 52-53). This lessee treated custom ore until closed by War Production Board order L-208 in 1942 (Tucker and Sampson, 1945, p. 143-144). The mine was idle in 1945 and by 1958 all buildings and equipment had been removed from the vicinity of the Sunrise shaft.

Mesozoic

Geology: Quartz veins in sheared quartz monzonite. Just south of the shaft a well defined fault strikes north to N. 20° W., is steeply dipping, and is exposed for a strike length of several hundred feet. At the shaft no vein material was observed, but in 1940 Tucker and Sampson (p. 52, 53) reported "A series of parallel quartz veins in granite; strike N. 20° W., dip 70° SW.; width 2 to 4 feet."

Development: By 1933 the Sunrise shaft had been sunk to a depth of 300 feet on an inclination of 79°, with levels at 100, 200, and 300 feet. In 1940, (p. 52-53) and again in 1945 (p. 143-144) Tucker and Sampson reported these workings with no additions. The shaft is boarded over (1961) and timbered so the vein is not visible; but the inclination is due west. All surface equipment has been removed.

Production: U. S. Bureau of Mines records credit Sunrise Mines, Inc. with 67.51 ounces of gold and 28 ounces of silver from 218 tons of ore in 1933 and 71 tons of ore in 1941 yielding 15 ounces of gold. Whether this production was from the Sunrise shaft, or from other operations of the Sunrise Mines Inc. is not known.

References: Tucker and Sampson, 1940, p. 52, 53; Tucker and Sampson, 1945, p. 143-144.

C.H.G. 5/16/61.

620

Top of the World (Victor, La Plomo, Steele) Mine

Location: SE¼ sec. 32, T. 4 S., R. 4 W. and NE¼ sec. 5, T. 5 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; on the north edge of Steele Valley about 5 miles west of Perris (figure 42).

Ownership: Nolan F. Fultz, P.O. Box 175, Perris.

History: The Top of the World Mine was first developed prior to 1888 but the date of location was not determined. By 1888, much of the present development had been accomplished under the ownership of H. C. Steele (Goodyear, 1888, p. 527). The mine was idle when reported on in 1894 (Crawford, 1894, p. 225) ~~still owned by H. C. Steele, the "Victor Mine" was again reported idle~~ and in 1896 (Crawford, 1896, p. 314). The Top of the World Mine was reported active in 1935 when Calbert and Fultz were the owners (Sampson, 1935, p. 514-515). Apparently the mine was worked on a small scale from 1933-1938 but by 1945 the mine was again idle (Tucker and Sampson, 1945, p. 144, pl. 35). ~~At present (1959)~~ In 1959, only assessment work is being done.

Geology: The workings of the Top of the World mine lie athwart a low ridge (fig.) underlain by Mesozoic diorite and a small pendant of quartz-mica schist which strikes N. 10° W. and has a generally vertical dip. At least 2 aplite dikes cut both the diorite and schist.

Judging from the arrangement of the workings and some of the older reports, it appears that the vein lies at or near the diorite-schist contact for at least part of its explored extent. It is poorly exposed at the surface, but appears to strike about N. 20° E. and dips about 45° NW. The vein is reported to range in thickness from 9 to 3 feet and is composed of quartz containing unvenly distributed gold and silver-bearing galena. Ore from one shoot (fig.) has assayed as high as $1,000 in gold and twenty-five ounces of silver per ton (Goodyear, 1888, p. 527; Storms, 1893, p. 384), however, an average based on 1933-1938 production figures, would be roughly $48 in gold and 2.4 ounces of silver per ton (U.S. Bureau of Mines files).

Development: The mine (plate ~~____~~ /) was developed through a main inclined shaft 175 feet deep and three shallower inclined shafts, two of which are now (1959) largely filled. Lateral development was accomplished on the 60, 120, and 175-foot levels. The lowest level opens to an adit driven north from the south slope of the ridge to ventilate and drain the mine. An ore shoot was stoped between three raises at the southwest end of the 60-foot level. An inclined shaft in the hanging wall was sunk by the present owner to avoid the caved upper part of the old main shaft.

Production:

During the years 1933 to 1938 the top of the World mine yielded about 46 tons of ore from which about 24 ounces of gold and 12 ounces of silver were recovered.

References: Goodyear, 1888, p. 527; Storms, 1893, p. 384; Crawford, 1894, p. 225; 1896, p. 314; Merrill and Waring, 1917, p. 531-532; Tucker and Sampson, 1929, p. 489; 1945, p. 144, pl. 35; Sampson, 1935, p. 514-515; Goodwin, 1957, p. 607-608.

R.B.S. 9/24/59.

624

Triangle (Pilot) Mine

Location: Sec. 6, T. 7 S., R. 16 E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; in the Chuckwalla Mountains at the mouth of a canyon which drains the north slope of Pilot Mountain, about 2 1/2 miles south and east of Aztec Well.

Ownership: Not determined (1959).

History: The Triangle mine was reported in 1929 to be owned by William B. Krosse, J. M. Halloway, and C. A. McGraw, who lived at Aztec Well (Tucker and Sampson, 1929, p. 489).

Geology: A fault in gneissic granite is exposed for about 200 feet along the east flank of a ridge. The fault zone is as much as 3 feet wide and is mineralized by a quartz vein as much as 2 feet wide. Fractures and pockets in the vein are filled with oxides of iron and traces of secondary copper minerals. The fault strikes N. 45° E., and dips 40° NW.

Development: The Triangle mine workings consists of 3 inclined shafts, 2 open-cuts, and an adit. The shafts are about 70 feet apart spaced at intervals along the exposed extent of the vein. The northwest shaft is roughly 100 feet deep, the middle shaft is 35 feet deep, and the southeast shaft is blocked by caving at a depth of 20 feet. The two open-cuts adjoin the portals of the northwest and central shafts. In addition, a drift ~~has~~ extends 30 to 40 feet southeast from the central shaft. Two short raises connect this drift with the surface. The adit was driven to crosscut the vein from a point about 40 feet down slope and northeast of the middle shaft.

Production: The total yield of the Triangle mine was not determined. Tucker and Sampson (1929, p. 489) stated that one ton of sorted ore was treated in an arrastra at Aztec Well and that $125 in gold was recovered.

References: Tucker and Sampson, 1929, p. 489; Tucker and Sampson, 1945, pl. 35 (mislocated).

R.B.S. 5/1/59.

No.

Twin Buttes #1 Mine

Location: SE¼ sec. 18, T. 5 S., R. 2 W., S.B.M., Winchester quadrangle, 7.5', 1953; about one mile southwest of Homeland at the northwest end of a shallow, southeast-draining canyon.

Ownership: Undetermined.

History: This was one of seven unpatented claims located in 1935 by Don F. Hays. Previously this claim had been held by Menifee Wilson who did most of the development.

Geology: Two en echelon shear zones, which strike east and dip 80° N., are exposed through a distance of about 200 feet on a knoll underlain by diorite. The planes of these shears contain lenticular bodies of milky vein quartz ranging from 0 to 4 feet in thickness. The quartz is highly fractured and sheared and resulting fissures and cavities are filled with oxides of iron.

Development: The west vein is explored by a 6-foot pit, a 60-foot shaft, is crossed by a trench 60 feet long, and, at its eastern extreme, by a prospect pit and a second shallow trench. The east vein is explored by a 60-foot shaft joined at the 15-foot level by a 30-foot adit driven west on the shear.

Production: Undetermined. Idle (1959).

References: None.

R.B.S. 9/22/59

627

No.

Twin Buttes #2

Location: SE¼ sec. 18, T. 5 S., R. 2 W., S.B.M., Winchester quadrangle, 7½', 1953; one mile southwest of Homeland. This unpatented claim lies in a saddle where a trail (see quadrangle map) crosses a northeast-trending ridge.

Ownership: Mrs. Mayme J. Hays, Route 1, Box 193, Romoland.

History: This is one of seven claims located by Don F. Hays in 1935. The date of its development was not determined.

Geology: A vertical shear zone as much as 4 inches wide strikes N. 40° W. across the diorite ridge. Though poorly exposed, the shear zone appears to converge with an aplite dike about 15 feet wide which strikes N. 70° W. and which is well exposed on the ridge. A thin vein of iron-stained quartz lies in the shear zone. It carries free-milling gold. As presently exposed the vein exceeds an inch in thickness in only a few places.

Development: A 50-foot drift adit follows the shear zone to within an estimated 30 feet of its junction with the dike.

Production: None.

References: None.

R.B.S. 9/22/59.

628

Prospect (Name Undetermined)

Location: Sec. 16 (proj.), T. 2 S., R. 12 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Pinto Mountains, about 3 miles northwest of Mission and Sunrise Wells.

Ownership: Undetermined.

History: Possibly part of the work was done by the Sunrise Mines Inc., San Diego, during the 1930's (see Sunrise Mine description).

Geology: Several steeply-dipping quartz veins, as much as a foot thick, cut massive quartz monzonite. In the prospect area the veins are semi-parallel and trend generally west.

Development: A few shallow shafts, one about 20 feet deep, are sunk on the veins. The mined quartz has been piled near the pits and apparently contained no values.

Production: None.

References: None.

J.R.E. 3/30/60

629

Mine (Name Undetermined)

Location: Sec. 8 (?), T. 3 S., R. 10 E., S. B. M., Hexie Mountains quadrangle, 15', 1963; Hexie Mountains, Joshua Tree National Monument, about 4 1/2 miles southeast of White Tank, and about 1/2 mile south of the West Pinto Basin Road.

Ownership: Undetermined.

History: Undetermined.

Geology: Blue-gray quartzite and quartz-muscovite schist of the Pinto Gneiss are cut by a northwest-trending and 65° southwest-dipping fault. The fault is marked by a 2- to 5-foot wide breccia-gouge zone which contains thin quartz stringers.

Development: A drift adit is driven 100 feet northwest in the fault plane. Forty feet from the portal, a winze is sunk to the 30-foot level in the plane of the fault. From this point, a drift extends northwest 18 feet. A few tens of feet west of the adit portal a pegmatite body and thin quartz stringers have been explored by means of a 20-foot vertical shaft. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 1/25/60

630

Mine (Name Undetermined)

Location: NW cor. sec. 34, T. 2 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15', 1958; Joshua Tree National Monument, 1 3/4 miles southeast of Ryan Campground in a valley between Lost Horse Mountain and Ryan Mountain.

Ownership: Undetermined (1960).

History: Undetermined, but apparently a very old working and long idle.

Geology: Aplite dikes in thin banded, Precambrian quartz-biotite gneiss (Pinto Gneiss). Where exposed in the shaft, the dikes strike N. 10° E. and are vertical. The largest dike is 10 inches wide at the surface but is 6 inches wide at a depth of 20 feet; a second dike is 4 inches wide at the surface, and there are several thinner dikes. The dikes are not exposed at the surface beyond the shaft.

Development: One vertical shaft of unknown depth.

Production: Undetermined.

References: None.

C.H.G. 1/28/60

631

Mine (Name Undetermined)

Location: NE 1/4 NE 1/4 sec. 4, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15', 1958; Joshua Tree National Monument, in the central part of the Lost Horse Mountains on a ridge half a mile northwest of the Lost Horse mine.

Ownership: Undetermined.

History: Undetermined. Probably the exploratory work was in connection with the Lost Horse mine (see herein) in the 1890's.

Geology: Quartz veins occur in shear zones in banded, Precambrian quartz-biotite gneiss (Pinto Gneiss). Two principal quartz veins have been explored: one strikes N. 20° W., dips 70° NE., is solid, and one foot thick; 50 feet to the northeast is a 5- to 6-foot wide sheared vertical quartz vein which strikes north. The vein quartz shows very little iron oxide stain and no sulfides.

Development: The vertical vein is explored by an adit, now caved, and an inclined shaft is sunk on the inclined vein. The shaft apparently is shallow, but the adit, as indicated from the size of the dump, may have at least 100 feet of workings.

Production: Undetermined.

References: None.

C.H.G. 6/20/57

632

~~Unknown~~ Mine (name undetermined)

Location: NE¼NE¼ sec. 33, T. 2 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 15' 1958; Joshua Tree National Monument, 1½ miles south of Ryan Campground and Lost Horse Well, on the northeast slope of the Lost Horse Mountains.

Ownership: Undetermined.

History: Undetermined, apparently long idle.

Geology: Quartz veins in gneissic quartz monzonite (Pinto gneiss). One vein, exposed in an open trench near the crest of the hill, strikes N. 60° E., dips 65° NW., and has been trenched laterally for about 50 feet. A second vein, exposed at the portal of the adit below, strikes N. 45° W., dips 70° SW., and is as much as 3 feet wide. Other thin quartz stringers intersect the trend of this vein at right angles. The dumps contain small amounts of yellow-brown iron oxide stained vein quartz.

Development: The quartz vein near the hilltop has been explored by a narrow trench about 50 feet long and 10 to 15 feet deep, and a shaft inclined 65° NW. is sunk from the bottom of the trench. About 300 feet to the southeast and 175 feet below the trench and shaft an adit is driven N. 45° W. The size of the dumps suggests several hundred feet of underground workings, and the shaft and adit may join. The workings are reached by ~~means of a quarter of a mile of foot trail from the end of the Jeep road in the valley to the east.~~

Production: Undetermined.

References: None.

C.H.G. 5/19/61.

634

Vidal Lime Claim

Location: NW¼ SW¼ sec. 19, T. 1 S., R. 24 E., S.B.M., Vidal quadrangle, 1950; at the north end of the Riverside Mountains, 2 3/4 miles south of Vidal.

Ownership: Jack Stewart, General Delivery, Parker, Arizona; 8 claims, leased to Jack Gordon, Wendon, Arizona (1957).

History: This ~~mine~~ claim was operated for a short time during 1957 by H. G. Smith, Box 416 Buckeye, Arizona; possibly under lease from the present owner.

Geology: The rocks in the area of the Lime ~~mine~~ claim are platy Precambrian gneisses. The slopes near the mine are partially covered by thin deposits of travertine. A mineralized fault, bearing gold and rich in copper minerals, strikes N. 60° - 80° W. across the claims and dips 65° NE. Because of the travertine deposits and the irregular distribution of the ore, the fault is not traceable for more than a few tens of feet in any exposure. Minerals identified are chrysocolla, malachite, quartz, and hematite. They occur in pods and lenses as much as 6 feet wide. ~~in width.~~

635

Development: This deposit is explored by 2 shafts of undetermined depth. One is inclined steeply along the fault and the other, a few feet away, is vertical, apparently affording access to the inclined shaft. An adit of unknown length has been driven northwest into the side of a shallow canyon just south of the main site, and a shallow prospect trench is cut in the north-facing slope at the main site.

Production: During 1957, this mine was reported to have yielded 116 tons of ore from which 4 ounces of gold, 5 ounces of silver, and 1,479 pounds of copper were recovered.

References: None.

R.B.S. and C.H.G. 12/20/57

636

Virginia (Missing Link, Virginia Shay) Mine

Location: NE¼ sec. 32, NW¼ sec. 33, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; at the junction of Santa Rosa Road and an unimproved dirt road which extends southward to Steele Valley. This point is about 5½ miles, by road, west of Perris. (see figure 42).

Ownership: Undetermined.

History: The Virginia mine was first reported under development in 1893 (Storms, p. 385). Active mining was first noted by Crawford (1894, p. 225), a shaft 200 feet deep having been sunk by the owner Jerry Shey, a resident of Perris. The mine was idle in 1895 and 96 at which time it was owned by J. B. Dennis, Perris (Crawford, 1896, p. 313), and appears to have remained inoperative through 1929 (Merrill, 1917, p. 532; Tucker, 1929, p. 485) having then passed into the ownership of Hugh Duff, 626 Wesley Roberts Building, Los Angeles. From 1930-1931 the property was leased to H. L. Musick, 2336 Whittier Boulevard, who sunk a shaft on a new vein (Tucker, 1945, p. 138-139). Frank W. Kitchen, 230 E. 3rd Street, Perris, who worked in the mine during that period, states that this shaft was sunk to explore a vein which had been discovered by core drilling. The drill had cut the vein at a low angle giving a false measure of its thickness.

Geology: Deeply-weathered Mesozoic diorite is cut by two quartz veins, each as much as 3 feet wide. The spatial relationship of the veins is not evident on the surface, but judging from the position of the shafts they are as much as 200 feet apart and roughly parallel. Attitudes given by Tucker (1945, p. 138-139) are N. 75° E., 56° SE. for the north vein, and N. 50° E., 60° SE. for the south vein. They average from $8 to $10 per ton in gold.

Development: The old shaft is on the south vein. It is low on a slope on the south edge of the property and is reported to be 200 feet deep. According to Mr. Kitchen, the shaft which was sunk to explore the north vein is 240 feet, and there is a 75-foot drift northeast at the 50-foot level, and a 150-foot drift at the 175-foot level. Operations were terminated owing to an excess of water.

Production: Undetermined.

References: Storms, 1893, p. 385; Crawford, 1894, p. 225; Merrill, 1917, p. 532; Tucker, 1929, p. 485; Sampson, 1935, p. 513; Tucker, 1945, p. 138-139.

R.B.S. 6/18/59

638

Washington Mine

Location: NE¼ sec. 24 (proj.), T. 4 S., R. 5 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; 7 miles west of Perris and a quarter of a mile southeast of Hartford Springs.

Ownership: Undetermined.

History: Last reported activity was in 1940 and 1941 by Vern W. Decker, Perris (U. S. Bureau of Mines files).

Geology: Deeply-weathered Mesozoic diorite is cut by a fault which strikes N. 10° W., and dips 40° SW. The fault plane comprises a shear zone as wide as one foot sparsely mineralized with quartz veins ranging from a fraction of an inch up to 4 inches in thickness. Fractures and small cavities in the quartz contain iron oxides and free-milling gold. The vein is poorly exposed on the surface.

Development: The fault is explored by two inclined shafts approximately 70 feet apart. The more northerly shaft is timbered and open to 50 feet, below which it is flooded. Its total depth or lateral development was not determinable. The other shaft is caved.

Production: According to U. S. Bureau of Mines records, during 1940 and 1941 this mine yielded 31 tons of ore from which 2 ounces of gold and one ounce of silver were obtained.

References: None.

R.B.S. 6/16/59.

640

Zulu Queen Mine

Location: Sec. 15 (proj.), T. 2 S., R. 13 E., S.B.M., Dale Lake quadrangle, 15', 1956; Pinto Mountains, Joshua Tree National Monument, about 6 miles northeast of Mission and Sunrise Wells. (Figure 31)

Ownership: Undetermined.

History: The Zulu Queen mine is one of 3 mines owned by the Sunrise Mines Inc., 726 Electric Building, San Diego, in the 1930's. In 1933, the property consisted of the Zulu Group of 11 unpatented claims (Tucker and Sampson, 1945, p. 143). The mine was worked intermittently from 1933 to 1938 (see Sunrise mine description).

Geology: A major shear zone as much as 12 feet wide cuts Mesozoic quartz monzonite. The shear zone trends north, is vertical, and contains gold-bearing quartz veins and lenses that range in thickness from a few inches to 18 inches.

Development: A vertical, 2-compartment shaft is sunk 100 feet in the shear zone. On the 50-foot level, there is a drift 175 feet south, and on the 100-foot level there is a drift 75 feet south (Tucker, 1933, unpublished field report No. 121). Directly south of the headframe of the shaft, and at the same elevation, an adit is driven 110 feet southward in the shear zone. A vertical winze connects to the 50-foot level about 85 feet from the portal. At 110 feet, another nearly vertical winze extends to the 50-foot level. Water was obtained from Sunrise Well, about 6 miles southwest.

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Production: Compiled by the U. S. Bureau of Mines and published with permission of the owners.

Year	Crude ore (ton)	Gold (oz.)	Silver (oz.)
1934	19	24	5
1935	18	3	1
1936	28	4	1
1938	47	7	

References: Tucker, 1933, Unpublished Field Report No. 121; Tucker and Sampson, 1945, pp. 143-144, pl. 35.

J.R.E. 3/10/60.

643

Gypsum

The principal source of gypsum ($CaSo_4 \cdot 2\ H_2O$) in Riverside County has been the upper (Paleozoic (?)) Maria formation exposed in the Riverside Mountains, Big Maria Mountains, Little Maria Mountains, and the north end of the Palen Mountains in the eastern part of the County. In all the above areas except the Little Maria Mountains, there has been essentially no gypsum mining, although each area contains deposits of potential commercial grade.

From 1925 to 1940, the United States Gypsum Company plant in the Little Maria Mountains was the largest single source of gypsum products in California. Production ~~has since~~ to 1966 when work at that site was stopped remained about the same, ~~but the~~ That operation had been overshadowed by the exploitation of deposits in other parts of California (Ver Planck, 1952, p. 13).

Gypsiferous material for use as a soil conditioner has been taken from the deposit in the Little Maria Mountains (Ver Planck, 1952, p. 105) in Riverside County, but most of such gypsum (gypsite) has been mined in the western part of the county.

~~Gypsum (Gypsite)~~ In the form of

Gypsite, an earthy mixture of very small gypsum crystals with clay and sand or other impurities, has been mined in an area that lies along the northeast flank of the Santa Ana Mountains about 4 miles south and southwest of Corona. There a narrow, irregular belt, averaging about 500 feet in width but as much as 3,000 feet wide containing rather low-grade gypsite extends for about 3½ miles in a northwesterly direction between Joseph and Tin Mine canyons. The gypsite comprises a mixture of altered volcanic rock (hornblende andesite of the Jurassic Santiago Peak volcanics) and gypsum. Although the gypsum content is only between 20 and 30 percent, the material ~~carries~~ contains enough iron and lime to make it of value as a soil conditioner (Ver Planck, 1952, p. 58). Exploitation of the Corona deposits has been sporadic and most of the mining took place from 1909-1934, with most of the material used locally by orchardists. Production of gypsite from the Corona area for agricultural use is hindered because agricultural gypsite must generally contain more than 50 percent gypsum.

Small quantities of gypsite ~~are said to~~ may have been taken from fluvial deposits at the south end of the Palen Mountains for use in the Blythe area (see herein under Iron Cap and Iron King claims).

Barth (Prizer) Deposit

Location: Undetermined (1961). Ver Planck (1952, p. 124) lists the property in sec. 2, T. 4 S., R. 7 W., S.B.M., ~~This is a doubtful location because section 2~~ which is wholly covered with older alluvium. This location may have been ~~for~~ a grinding or storage site area; the gypsum probably was obtained from the Eagle Canyon-Tin Mine Canyon gypsite belt in the nearby Santa Ana Mountains.

Ownership: Undetermined (1961).

History: Operation was by H. A. Prizer in 1909 and W. C. Barth in 1914.

Geology: Undetermined.

Development: Undetermined.

Production: Small production of gypsite for agricultural use was reported in 1909, 1914, and 1917.

References: Merrill, 1917 [1919], p. 579; Ver Planck, 1952, p. 124-125; Gray, 1961, p. 115.

C.H.G. 3/2/61.

Big Chief (Freeman-Nonhof, White Gypsum Group, Ware) Deposit

Location: SE¼ sec. 9, SW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on the south side of Tin Mine Canyon.

Ownership: P. E. Coleman, 301 Fruit Street, Santa Ana, owns the Big Chief placer claim of 20 acres (1957).

History: In 1923 G. R. Freeman and E. R. E. Nonhof, Corona, did some development work. The property was leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando in 1943 when bulldozer cuts were made and some sampling was done. In 1947, the property was held by Howard S. and Irene J. Ware, 219 East Olive Street, Corona. Mr. Coleman located the property in 1954 and in 1956 limited trenching and sampling were done. This area was formerly part of the White Gypsum Group (see herein).

Geology: See White Gypsum Group herein.

Development: Several short adits 10 to 30 feet long and shallow open cuts.

Production: See White Gypsum Group herein.

References: Gray, 1961, p. 115.

C.H.G. 3/3/61.

Eagle Canyon (Frazer) Gypsum Deposit

Location: Lots 1 and 2, SW¼ sec. 13; N½NW¼ sec. 24, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles south of Corona along both sides and west of the mouth of Eagle Canyon.

Ownership: T. A. and F. M. Frazer, 718 Howard Street, Corona, own three unpatented placer claims: Eagle Group, Eagle Group No. 2, and Eagle Group No. 3, totaling about 150 acres (1957).

History: The Eagle Canyon deposit was mined for agricultural gypsum from 1913 to 1917. Other than assessment work the property has apparently since been idle except during 1943-44 when Dr. Leon Katz mined about 1,000 tons of gypsite. This material was used only for testing and experimental purposes. A small crushing plant was also installed in 1943-44 but proved unsatisfactory and was removed in the early 1950's.

Geology: Gypsite occurs as a network of narrow, closely spaced, satin spar veinlets in zones of hydrothermally altered dacites and andesites of the Jurassic(?) Santiago Peak Volcanics. The gypsiferous zones strike about N. 70° W. and lie along or near the Elsinore fault zone. The gypsite belt, which is as much as 500 feet wide, occurs on both sides of Eagle Canyon and crops out sporadically for a lateral distance of nearly 1,500 feet across the ridge to the next small canyon to the west (Manning Canyon). Tucker and Sampson (1945, p. 168) report the gypsum content ranges from 15 to 25 percent. However, Dr. Katz reports that most of the material has a gypsum content of only about 15 percent (Gray, 1961, p. 83).

Development: Short adits, shallow open cuts, and prospect pits. On the west side of Eagle Canyon an adit is driven west 80 feet; about 200 feet south of this adit there is an open cut 70 feet in length; on the west side of Manning Canyon an adit has been driven west 100 feet (Tucker and Sampson, 1945, p. 168). The most recent development was done in 1943-44 along the east side of Eagle Canyon and consisted of an adit driven southeast 20 feet and an open cut 60 feet in length and 15 feet in depth.

Production: Small recorded production of gypsite, 1913-1917.

References: Merrill, 1917 [1919], p. 579; Tucker and Sampson, 1945, p. 168; Ver Planck, 1952, p. 58, 125, 132; Gray, 1961, p. 83-84, 115.

C.H.G. 8/17/62.

650

El Cerrito Ranch

Location: Undetermined.

Ownership: Undetermined.

History: A small tonnage of gypsite is reported to have been produced in the period 1915-1917 for private agricultural use. This gypsite probably was mined from the Eagle Canyon - Tin Mine Canyon gypsite belt about 3 miles south and southwest of Corona in the Santa Ana Mountains.

References: Merrill, 1917 /1919/, p. 579; Ver Planck, 1952, p. 135; Gray, 1961, p. 115.

C.H.G. 3/3/61.

651

Elki Claims

Location: SW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on the south side of Tin Mine Canyon.

Ownership: George S. Jones, 3262 Santa Ana Street, South Gate (1957).

History: Mr. Jones located three claims (Elki 1-3) in 1956. Formerly part of White Gypsum Group (see herein).

Geology: See White Gypsum Group herein.

Development: Open trenches and one 30-foot adit.

Production: See White Gypsum Group herein.

References: Gray, 1961, p. 115.

C.H.G. 3/3/61.

652

Hagador Canyon Gypsum Deposit

Location: NW¼ sec. 15, S½SW¼ sec. 10; NE¼ sec. 16, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles southwest of Corona, along Hagador Canyon and the ridges on both sides of the canyon.

Ownership: W. R. and Virginia Adams, 301 Fruit Street, Santa Ana, own two unpatented placer claims located in 1952: Farmer's Friend Nos. 1 and 2 (1957). In 1956, Orrin M. Pierce, 1607 North Flower Street, Santa Ana located two placer claims, Alpha and Omega in secs. 9, 10, 15, 16; and A. F. Bullard and William Redding, 1008 South Pacific Avenue, San Pedro also located two placer claims, Red Bull No. 2 (S½SW¼ sec. 10) and Red Bull No. 3 (N½NW¼ sec. 15).

History: The earliest recorded operation was in 1910 and the deposit was later mined in 1915, 1916, 1924, and 1926-34. During the 1926-34 operation by E. R. E. Nonhof a crushing and screening plant with a reported capacity of 40 tons per day was erected in upper Hagador Canyon. Collapsed remains of this plant remained on the property in 1956, but there is no known production since 1934.

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Geology: The gypsum occurs in hydrothermally altered metavolcanic rocks of the Jurassic(?) Santiago Peak Volcanics, and is similar to the Eagle Canyon deposit (described herein). The gypsum-bearing zone strikes northwestward and lies along the southwest side of the Elsinore fault in rugged, brush-covered foothills of the Santa Ana Mountains. Along Hagador Canyon the gypsum-bearing zone is about 3,000 feet wide, but to the northwest narrows to about 1,500 feet on the south side of Tin Mine Canyon, where it apparently terminates. Tucker and Sampson (1945, p. 169) report that the gypsite beds are about 200 to 300 feet in width and about 750 feet in length in secs. 10 and 16 astride Hagador Canyon, with the principal exposure on the west side of the canyon. To the southeast, along the east side of Hagador Canyon, Tucker and Sampson (1945, p. 166) report an exposure of clay (probably altered volcanic rock along a shear zone) that contains 25 to 37 percent gypsum. This gypsum-bearing zone is about 600 feet wide and 1,500 feet long. To the southwest, along the west branch of Hagador Canyon in the NE¼ sec. 16, is exposed a gypsite body several hundred feet thick.

Development: Several large adits and open cuts and trenches, together with a number of shallow open cuts and short adits. In 1956, the open cuts and trenches were caved and the principal adits were inaccessible because of standing water and caving. The area is overgrown with brush so that the gypsite-bearing zones are very poorly exposed.

Production: Undetermined, but this property probably has been the principal source of agricultural gypsite in the Corona area. The output was sold as a soil conditioner to growers in southwestern Riverside County.

References: Merrill, 1917 [1919], p. 579; Symons, 1928, p. 269; Symons, 1935, p. 279; Tucker and Sampson, 1945, p. 168-169; Ver Planck, 1952, p. 57-58, 126, 132, 142, 149; Gray, 1961, p. 84-85, 115.

C.H.G. 8/17/62.

Jameson Deposit

Location: Sec. 3(?), T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954. Location of deposit, given by Ver Planck (1952, p. 126) as sec. 3, is doubtful because the only gypsum found there today is a very minor amount associated with clay shales of the Paleocene Silverado Formation.

Ownership: Undetermined.

History: W. H. Jameson Company, Corona, is reported to have produced a small amount of gypsite in 1915 for private use on orchards. Probably the gypsum was mined from the Eagle Canyon-Tin Mine Canyon gypsite belt, about 3 miles south and southwest of Corona in the Santa Ana Mountains.

Geology: Undetermined.

Development: Undetermined.

References: Merrill, 1917, [1919], p. 579; Ver Planck, 1952, p. 126, 138; Gray, 1961, p. 115.

C.H.G. 3/3/61.

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Main Street (Gypsum) Canyon Gypsum Deposit

Location: S½NE¼ sec. 15; N½S½ sec. 14, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles south of Corona along Main Street (Gypsum) Canyon and adjoining ridges.

Ownership: Mrs. Josephine Middlesworth, 847 W. 9th Street, Corona, owns one unpatented placer claim (Morning Star) in the S½NE¼ sec. 15 (1957). Floyd N. Champion, et al., 3316 E. Anaheim Street, Long Beach, owns five unpatented placer claims (Capitol Dome 1-5) covering about 75 acres in the NW¼SE¼ sec. 14, T. 4 S., R. 7 W., S.B.M. (1957).

History: This deposit was first worked about 1900 and was intermittently active on a small scale until 1937. It was further explored by several lessees during 1944-45 and apparently has since been idle.

Geology: The gypsum occurrence is similar to that of the Eagle Canyon deposit (described herein). Satin spar veinlets occur in metamorphosed Jurassic(?) Santiago Peak volcanic rocks along the Elsinore fault zone and in brown shales of the adjacent Silverado Formation. The main body of the deposit occurs along the west side of Main Street (Gypsum) Canyon and on the brush-covered ridge northwest toward Hagador Canyon. The gypsite-bearing zone is about 600 feet wide on the west margin of Main Street Canyon, but widens to nearly 1,500 feet on the ridge to the northwest. Tucker and Sampson (1945, p. 168) report that the exposed gypsite-bearing zone on the Morning Star claim was 700 feet in width. Several smaller exposures of gypsite lie on the east side of Main Street Canyon.

Development: Short adits, and shallow trenches, open cuts, and prospect pits.

Production: Undetermined intermittent production of gypsite for agricultural use by citrus growers in the vicinity of Corona ~~during a period~~ dating from before 1901 until 1935.

References: Aubury, 1906, p. 286; Merrill, 1917 [1919], p. 579; Tucker and Sampson, 1945, p. 168; Ver Planck, 1952, p. 57-58, 126, 136, 140; Gray, 1961, p. 85-86, 115.

C.H.G. 8/17/62.

658

Maria Mountains Deposits

Location: Secs. 1, 2, 3, 4 (proj.) T. 4 S., R. 20 E.; secs. 30, 31, 34, 35 (proj.) T. 3 S., R. 21 E.; and secs. 5, 6, and 7 (proj.), T. 4 S., R. 21 E., S.B.M., Midland and Big Maria Mountains quadrangles, 1952, 1951; on the west slope of the Big Maria Mountains and in the southeast one-third of the Little Maria Mountains near the town of Midland, 22 miles north-northwest of Blythe.

Ownership: United States Gypsum Company, 300 W. Adams St., Chicago 6, Ill.

History: When the Maria Mountains gypsum deposits were described by Merrill and Waring (1917, p. 577-579) they were claimed by a number of interests. Subsequent changes are here outlined.

U. S. Bureau of Land Management Mines records show that the United States Gypsum Company patented twenty-two 20-acre placer claims in the Little Maria Mountains and three 20-acre placer claims in the Big Maria Mountains in 1916. In the same year P.A. English, et. al. patented

five groups comprising forty, 20-acre claims, some in the Big Maria Mountains but principally in the Little Maria Mountains. About 1915, W. W. Orcutt, et. al., patented five placer claims in the northwest corner of the Little Maria Mountains gypsum bearing area comprising a total of 620 acres (Tucker and Sampson, 1929, p. 510; U. S. Bureau of ~~Mines~~ Land Management records).

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In 1920, the U. S. Gypsum Company was reported to have completed extensive exploratory work in the Little Maria Mountains area (Tucker, 1920, p. 327), and by 1929 a plant had been built and extensive development accomplished. In 1937 underground mining was started on property shown as the "Brown Mine" on the Midland quadrangle. This operation was discontinued in 1949 because of more economical open pits which had been started in 1946 in the area marked "Victor Mine" on the map (personal communication, E. E. Sturrock, U. S. Gypsum Mine Superintendent).

In 1929 Messrs. Garland, C. M. Langdon and Ray T. Savage, of Los Angeles, held an unspecified number of claims on the west slope of the Big Maria Mountains. A small crushing plant was employed on the Savage property (Tucker and Sampson, 1921, p. 513) and evidence was found that a small plant had once been used on the White Elephant claim, held in 1932 by Langdon, in sec. 35, T. 3, S., R. 21E., S.B.M.

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In the mid-30's, U. S. Gypsum, through the patent of 19 more claims in the Little Maria and 8 more claims in the Big Maria areas and other transactions, acquired the Garland, Garbutt and Orcutt, Langdon, and Savage deposits (U. S. Bureau of ~~Mines~~ Land Management records; Tucker and Sampson, 1945, p. 170).

In 1945 U. S. Gypsum Co. engaged Utah Construction Company to explore the Garbutt and Orcutt property and, in 1947, mining was begun. In 1948, Utah Construction Company acquired an interest in the property. It was closed in June, 1950 (Ver Planck, 1952, p. 13-14).

As reported by Ver Planck (1952, p. 104), "The United States Gypsum Company's plant at Midland, Riverside County, began producing uncalcined gypsum products in 1928 in a plant that has since been enlarged." In September, 1958 the facility was improved by the completion of a natural gas line, north from the Blythe area. This will facilitate the continued manufacture of calcined gypsum products which

has been roughly doubled since its inception August 15, 1928 (Tucker and Sampson, 1929, p. 515). The products are wallboard, plaster lath and interior plasters. In 1945 the wallboard plant was reported (Tucker and Sampson, 1945, p. 172) to have a capacity of 100,000 square feet of 3/8-inch wallboard and lath; at that time claimed to be the largest such plant in the United States. Products manufactured in lesser quantities were wall plaster, and finishing and casing plaster. Agricultural gypsum and cement retarder were to have been added to the plants list of products but these are not now (1960) being produced.

U.S. Gypsum's Midland Plant ceased operations in November, 1966 (Smith, 1969, p. 203). Most of the facility has since been removed.

Geology: In the Little Maria Mountains the area underlain by gypsiferous rocks is wedge-shaped, being about 2½ miles long, 2 3/4 miles wide at the east end and 1 mile wide at the west end. The rocks strike east and northeast and dip steeply north and northwest. The only published geologic map of the deposit covers ~~just~~ its western half (Ver Planck, 1952, pls. 2 and 3). Here, four, generally traceable gypsum zones as much as 150 feet thick containing beds of gypsum ranging from 0 to 10 feet in thickness, are included in altered limestone ~~formations~~ about 1,000-feet thick exposed roughly parallel to the north and south margins of the area. Between the two belts of limestone the central or axial part of the area consists of an indefinite thickness of gypsiferous greenschist.

A quartzite unit about 550 feet thick and a limestone unit 800 feet thick are exposed between the north margin of the gypsum-limestone formation and an upfaulted granitic body. The gypsum-bearing rocks lie on undifferentiated metamorphic and granitic rocks along the south margin of the deposit. The gypsum bodies commonly are mixed with the associated rock types in a manner described in detail by Ver Planck (1952, p. 17) who states that anhydrite was found in the Utah Construction Company Quarry, is common in the U. S. Gypsum Company quarries to the east, and is thought to be the immediate source of the gypsum.

The structure of the deposit has been suggested to be an anticline (Merrill and Waring, 1917, p. 578-579), an overturned anticline or possibly an unfolded, homoclinal sequence (Ver Planck, 1952, p. 18), or an overturned syncline (Shklanka, personal communication, 1958). The structural interpretation is important in regard to determining the best method to obtain reserves at depth. As with the Palen Mountains deposit (see herein), the disturbed condition of these rocks makes estimation of reserves uncertain.

The gypsum-bearing rocks exposed on the west flank of the Big Maria Mountains appear to be the same as those described above. They strike generally eastward and dip north in what appears to be a homoclinal structure, but Hamilton (1960, p. 277-278) has found this area to be complexly faulted.

Development: Prior to the mid-1930's the deposits in the Big Maria Mountains had been developed on a small scale and have since been held as reserves by U. S. Gypsum Company. The Savage deposit was explored by a 40-foot adit (Tucker and Sampson, 1929, p. 513) and the White Elephant claim by three short, chambered adits.

By 1945 development at the Brown mine in the Little Maria Mountains comprised an open pit 500 feet long, 50 feet wide and 50 feet deep from the bottom of which 2 tunnels about 200 feet long had been driven southwest. Nearby, to the southwest, two adits had been driven on gypsiferous units 20 to 60 feet in thickness. The lower adit was 1 mile long. Stopes were run to the surface at 25-foot centers, the distance to the surface being about 400 feet. The upper adit appears to have been less extensive and to have been driven in a parallel bed of gypsum overlying and a short distance to the north of the lower adit (Tucker and Sampson, 1945, p. 171).

The present quarry, at the site of the former Victor Mine, includes an area of about 1 square mile and comprises several ~~intercommunicating~~ pits as much as 100 feet deep on some faces. Gypsum ~~is~~ was drilled and blasted down from the quarry faces, loaded into trucks with power shovels and trucked to the nearby plant. Most of the impurities ~~are~~ were eliminated by selective procedures in the quarry.

The Utah Construction Company quarry is in sec. 11, T. 4 S., R. 20 E., S.B.M. Here three beds of gypsum as much as 60 feet in thickness striking N. 25° E. and dipping 60° NW. are exposed in benches on a low hill. The quarry is an irregular area about 700 feet long and 500 feet wide (Ver Planck, 1952, p. 18-20).

Production: U. S. Gypsum data not available; Utah Construction Company is credited with about 60,000 tons of agricultural gypsum (Ver Planck, 1952, p. 105).

References: Spurr, 1911, p. 787-790; Merrill and Waring, 1917, p. 577-579; Stone and others, 1920, p. 78-79; Tucker, 1920, p. 327; Tucker and Sampson, 1929, p. 510-515; 1945, p. 170-172, pl. 35; Ver Planck, 1950, p. 227; 1952, p. 13-20; 1957, p. 234; Hamilton, 1960, p. 277-278.

R.B.S.

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Morning Star Deposit

Location: NE 1/4 NE 1/4 sec. 1 (proj.), T. 2 S., R. 23 E., SW 1/4 SW 1/4 sec. 31, T. 1 S., R. 24 E., and NW 1/4 NW 1/4 sec. 6, T. 2 S., R. 24 E., S.B.M., Vidal quadrangle, 15', 1950; on the northwest side of a narrow, northeast-trending canyon in the Riverside Mountains. The name Morning Star is used for convenience because part of this deposit is overlapped by a lode claim of that name (see herein under gold).

Ownership: Undetermined.

Geology: A gypsum unit of undetermined purity is exposed through a horizontal distance of about 3,500 feet and appears to be as much as 100 feet thick. It strikes northeast and dips about 40° NW. The gypsum weathers to a porous, tan surface but fresh material is white and fine-grained. The rocks in the area are strongly sheared and locally contorted. This deposit is probably similar to others in the region in which gypsum is interbedded with gypsiferous schist and quartzite. The overlying and underlying rocks are impure limestone and dolomite of possible Paleozoic age, which form bold ridges and cliffs (fig. 34).

Development, Production, References: None

R.B.S. 4/20/61

Omei Claim

Location: S½ sec. 9, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, on the south side of Tin Mine Canyon.

Ownership: Mrs. B. I. Markwell, 1001 N. Lowell Street, Santa Ana (1957).

History: See White gypsum group.

Geology: See White gypsum group.

Development: See White gypsum group.

Production: See White gypsum group.

References: Gray, 1961, p. 116.

C.H.G. 3/3/61.

Palen Mountains Gypsum Deposit

Location: NE¼ T. 3 S., R. 18 E., S.B.M., Palen Mountains quadrangle, 15', 1952; in Palen Pass between the north end of the Palen Mountains and the southeast end of the Granite Mountains, about 25 miles northeast of Desert Center.

Ownership: Undetermined.

History: The gypsum deposits in the Palen Pass area were first described by Harder (1910, p. 407-416). In 1920, Joe Montgomery, and associates were planning to develop the property as the Standard Gypsum Company (Tucker, 1920, p. 326-327) but appear to have dropped the project. About 1930 extensive holdings are reported to have been patented by John Webb and George Pepperdine and additional development done in 1949 by Webb and Fleetwood Lawton (Ver Planck, 1952, p. 21). No record that patents were granted was found however, and subsequent litigation suggests that they were denied. The remoteness of the deposit and legal difficulties appear to have discouraged exploitation.

Photo 22

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Geology: The Palen Mountains Gypsum deposit includes several sequences of gypsiferous beds in a north-dipping, faulted homoclinal section of metamorphosed Precambrian igneous and Paleozoic (?) sedimentary rocks that are exposed in an area 3 miles long and 1 1/2 miles wide in Palen Pass. The gypsum occurs as irregular, massive beds of white, finely crystalline rock of reportedly good grade, ranging in thickness from 0 to 150 feet, interbedded with marble and quartzite or in thinly laminated, gypsiferous, epidote-rich schist. Anhydrite is not common, but its possible increase at depth has not been determined (Hoppin, 1954, p. 12-13). The gypsum beds pinch and swell, and contain fragments and small blocks of limestone. Thus, the estimation of gypsum reserves and the mining of a pure product would be complicated.

Development: The deposit has been explored by means of several shallow adits and pits, and extensive bulldozer cuts, but apparently there has been no systematic development.

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Production: Undetermined.

References: Harder, (E. C.), 1909, p. 407-416; Stone and others, 1920, p. 78; Tucker, 1920, p. 326-327; Tucker and Sampson, 1929, p. 510-514; 1945, p. 167, pl. 35; Miller, 1944, p. 28; Jenkins, (O. P.), and others, 1950, p. 227; Ver Planck, (W. E.), 1952, p. 21-24; 1957, p. 234; Hoppin, (R. A.), 1954, 25 pp.

R.B.S. 3/11/59.

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Riverside Mountains-Parkford Deposits

Location: Secs. 6 and 7, T. 2 S., R. 24 E., S.B.M., Parker quadrangle, 15', 1950 and Vidal quadrangle, 15', 1950; on the east slope of the Riverside Mountains, 6 miles south of Vidal.

Ownership: U. S. Government in part (Colorado River Indian Reservation), in part undetermined.

History: E. A. Parkford, Pacific Mutual Building, Los Angeles, and J. M. Wilson, Vidal, acquired an undetermined number of claims in sec. 7 prior to 1929 (Tucker and Sampson, 1929, p. 511). Subsequent reports mention or briefly describe these deposits, but give no ownership data. Apparently this material has not yet been mined.

Geology: The schistose, quartzitic, gypsiferous and carbonate rocks of Paleozoic (?) age underlying the east slope of the Riverside Mountains have been contorted, sheared and faulted, but the full extent to which these features have complicated the gypsum deposits has yet to be determined. The following data is from a report on the Parkford deposit (Tucker and Sampson, 1929, p.511) by Smith Emery and Company, Los Angeles.

Parkford

The deposit underlies a hill 250 feet high, 400 feet wide and 700 feet long and is exposed on three adjoining hogbacks through an additional distance of about 600 feet. Gypsum beds of high purity as much as 50 feet in thickness interbedded with limestone strike north and dip 30° to 60° west. The proportion of limestone increases in the south end of the outcrop (Tucker and Sampson, 1929, p. 511).

The Riverside Mountains deposit has been described (Ver Planck, 1952, p. 24) as comprising a 100-foot zone of coarsely crystalline white gypsum, interbedded with brown-weathering crystalline limestone and red quartzite, exposed through a distance of about half a mile. This deposit is in the west half of sec. 6.

Development: In 1929, the Parkford property had been developed by means of five adits ~~198, 40, 27, 26, and 20~~ 20 to 198 feet long, and open cuts but activity was confined to assessment work (Tucker and Sampson, 1929, p. 511). The Riverside Mountains deposit development consists of short adits and shallow pits (Ver Planck, 1952, p. 24).

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 511; 1945, p. 167, pl. 35; Ver Planck, 1950, p. 227; 1952, p. 24; 1957, p. 234.

R.B.S. (not visited)

Tecumseh Group

Location: SW¼ sec. 10, SE¼ sec. 9, NW¼ sec. 15, NE¼ sec. 16, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, between Tin Mine and Hagador Canyons.

Ownership: Orrin M. Pierce, 1607 N. Flower Street, Apt. G, Santa Ana (1957).

History: Parts of former White Gypsum and Hagador Canyon deposits (see herein) were relocated about 1954 as 5 claims (Tecumseh, Minot, Why Not, Alpha, Omega). Idle.

Geology: See White gypsum and Hagador Canyon deposits.

Development: See White gypsum and Hagador Canyon deposits.

Production: See White gypsum and Hagador Canyon deposits.

References: Gray, 1961, p. 116.

C.H.G. 3/3/61.

White Gypsum Group (Freeman-Nonhof, Big Chief, Ware)

Location: SE¼ sec. 9, SW¼ sec. 10, NE¼ sec. 16, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains 3½ miles southwest of Corona, on the south side of Tin Mine Canyon.

Ownership: P. E. Coleman, 301 Fruit Street, Santa Ana (1957).

History: Formerly a group of 8 unpatented claims (White Gypsum 1-8). The property was owned by G. R. Freeman and E. R. E. Nonof, Corona, in 1923 and a small production of gypsite was reported. About 1940 Howard S. Ware, Corona, acquired the property and it was leased in 1943 to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando, who made some exploratory bulldozer cuts. In 1947, bulk sampling was done on the White Gypsum group, then known as Ware gypsum. The property was later abandoned and partly relocated in 1954-56 as Big Chief, Omei, Tecumseh, and Elki (see herein).

Geology: Veinlets of satin spar and gypsite in hydrothermally altered volcanic rock (Santiago Peak Volcanics, largely hornblende andesite).

Development: Several small cuts, shallow pits, and short adits.

Production: Small production of gypsite reported in 1923. Most of the material was used locally as a soil conditioner, small amounts may have been shipped for agricultural use.

References: Ver Planck, 1952, p. 127, 142, 146; Gray, 1961, p. 116.

C.H.G. 3/3/61.

Iron

The large bodies of metamorphic rock exposed in the eastern half of Riverside County contain scattered masses of massive magnetite. The largest of these magnetite bodies is in the Eagle Mountains. Indeed, the Eagle Mountains deposit is the largest known deposit of iron ore in the west (see Eagle Mountain mine herein). In 1956, this ore body contained estimated reserves of 43,000,000 long tons (Gay, 1957, p. 247), a figure which must since have been revised upward on the basis of subsequent exploration.

In 1948, Kaiser Steel Corporation started utilizing ore from the Eagle Mountain mine as a source of blast furnace feed. By 1956 the mine had yielded 9,800,000 tons of blast furnace ore. Since 1956 mining and beneficiating efficiency and capacity have steadily increased at the mine in response to demands of the expanding and increasingly modern furnaces, mill, and fabricating plant at Fontana, and fabricating plants at Napa and Montebello. The productive capacity of the Kaiser Eagle Mountain mine will ~~find~~ has found further outlet in export shipping capacity ~~to be made available with~~ through the completion of a ~~new~~ bulk loading facility for ships at the Port of Long Beach (Davis and others, 1962, p. 3,4). This ~~new~~ facility ~~will have~~ has a capacity of 2,800 tons per hour.

The ore body at the Eagle Mountain mine was the only one being actively mined in Riverside County in 1962. Small deposits in the Palen and Maria mountains have been examined and one, the Iron King and Queen (see herein), has been extensively prospected, ~~and may soon be developed.~~

Black Giant Deposit

Location: Secs. 34 and 35 (proj.), T. 3 S., R. 13 E., S.B.M., Pinto Basin quadrangle, 15', 1963; Eagle Mountains, about 1 mile west of the Iron Chief mine, and 10 miles northeast of the East Pinto Basin-West Pinto Basin-Cottonwood Pass and Black Eagle mine roads intersection.

Ownership: Carl Saure and A. Vrbanac, 8312 California Avenue, Whittier, own 11 unpatented claims (March 1958).

History: Undetermined.

Geology: Thin, irregular and discontinuous pods and lenses of replacement magnetite occur in calcitic dolomite of Paleozoic (?) age.

Development: The property is developed only by shallow open cuts.

Production: Undetermined.

References: None.

J.R.E. 3/17/60

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Eagle Mountain Mine

Location: The main iron deposits are in secs. 36, 35, and 34, T. 3 S., R. 14 E., S.B.M. (proj.), Coxcomb Mountains quadrangle, 1943; Eagle Mountains, about 12 miles north-northwest of Desert Center on U.S. Highway 60-70. The steel plant is at Fontana, San Bernardino County, about 114 airline miles to the northwest.

Ownership: Kaiser Steel Corporation, P.O. Box 217, Fontana, San Bernardino County, owns at least 130 patented claims and about 40 unpatented claims (1960).

History: The following notes of historical interest concerning the Eagle Mountain iron district are taken from U.S. Bureau of Mines Information Circular 7735, 1956.

> "The importance of the Eagle Mountain district as a potential source of iron ore on the Pacific coast was recognized early in the century by E.H. Harriman of the Southern Pacific Railroad. Over 100 claims were acquired and patented in 1908; but until the late 1930's this area had no usable roads, water, or power. During this period far western iron-ore deposits held little commercial interest."

In 1909, E.C. Harder of the U.S. Geological Survey examined and prepared maps of the Eagle Mountain area. This study was the first detailed investigation of the iron ores of California.

Photo 23

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"The Riverside Iron and Steel Co. of Pasadena, California, was organized in 1940 and obtained control of the Southern Pacific Land Co. claims. The company intended to erect several electric furnaces on the property to make higher grade iron by the Knowles process, as developed by the Corby Iron & Steel Co. in England, using petroleum coke as a reducing agent. These plans had to be abandoned because of the war, and the only production during World War II was approximately 60,000 tons of crude iron ore for ship ballast and shipment to the cement industry.

"Under the Strategic Minerals Program, the Bureau of Mines, in conjunction with the Federal Geological Survey, started an exploration program September 8, 1941. This was completed May 16, 1942. Project work indicated the existence of a large tonnage of direct-shipping ore and a greater potential reserve of lower grade ore amenable to low-cost beneficiation.

"In 1946 Kaiser Steel Corp., which was operating 1 blast furnace and 7 open hearths using 50- to 55-percent iron ore from Cedar City, Utah, and high-sulfur ore from the Vulcan mine, California, acquired the property. During 1947-48, a railroad was built from the property to the Southern Pacific Railroad at Ferrum, California; a crushing plant and stockpiling and loading facilities were constructed. In the latter part of 1948 opencut mining was begun on the Bald Eagle deposit, and regular shipments of iron ore were made to the Fontana steel mills 164 miles away. In 1949 a second blast furnace of 1,200 tons daily capacity was added at Fontana, and a third blast furnace of 1,200 tons daily capacity was added in 1953."

During 1957 a fourth blast furnace was added as well as other facilities which increased the steel-producing capacity by 40 percent. Also during 1957 a new ore beneficiation plant was completed and placed on stream at the Eagle Mountain mine.

Geology: A metamorphic sedimentary rock sequence of Paleozoic or older age is intimately intruded by quartz monzonite. As a result of intrusion two calcitic dolomite units at different stratigraphic horizons are irregularly replaced by magnetite.

Following intrusion and accompanying mineralization, the metamorphic rocks were warped into a broad northwest-trending anticline. Folding was accompanied by much high angle faulting. (fig. 17). After deformation of the rock complex, granite bodies and dikes of syenite, diorite, and diabase were intruded. Several dikes cut the ore bodies as well as other units.

The metamorphic rocks consist of an undetermined thickness of vitreous quartzite at the base, overlain by 20-200 feet of rusty-colored schistose meta-arkose. Above the meta-arkose bed is 20-120 feet of white but tan weathering calcitic dolomite containing replacement bodies of magnetite (South-Bald Eagle or lower ore body), overlain by diopside rich quartzite ranging in thickness from 150-380 feet. Overlying the quartzite is another calcitic dolomite bed, ranging in thickness from 50-200 feet, also containing replacement bodies of magnetite (North or upper ore body). This unit is capped by a lime silicate rich quartzite, locally banded, and of undetermined thickness.

At present the principal ore bodies are the North and South deposits; the Bald Eagle deposit is nearly depleted of ore that can be mined by present open pit methods. The size and shape of the North and South ore bodies are given below.

Size and shape of the North Ore Body and South Ore Body

	North Ore Body, feet	South Ore Body, feet
Strike length	5,200	2,600
Length explored	1,400	2,200
Maximum width across outcrop	450	300
Maximum thickness normal to dip	325	80
Average thickness normal to dip	250	60
Average dip	45	30
Depth, Bureau of Mines exploration on dip	500	1,200
Probable depth on dip	850	1,800

Taken from U. S. Bureau of Mines Information Circular 7735, p. 7.

Subsequent geophysical and drilling programs have explored the extent of ore beneath the alluvium to the east of the present operation. It is common knowledge that additional reserves were found but no report on quantity or quality was obtained.

Commercial material is composed of black, granular magnetite; red, dense hematite; and minor amounts of pyrite. In the ore in the weathered zone which extends about 100 feet below the surface, hematite is in excess of magnetite by about 5:1, but at depth magnetite is predominant, although generally associated with pyrite (Trengove, 1956, p. 7). The highest grade ore is that material composed mostly of magnetite. The Lower grade ore contains greater amounts of hematite, and a mixed gangue material composed of pyrite, and/or the contact metamorphic minerals diopside, actinolite, tremolite, wollastonite, quartz, labradorite, and scaptolite. Serpentine, chlorite, and sepiolite occur as alteration prod-

ucts of the magnesium bearing contact metamorphic minerals, and are also gangue minerals. Locally, and especially near the surface, veinlets and coatings of gypsum fill crevasses and fissures. Gypsum and pyrite are particularly significant as they both contain sulfur which does not enhance the steel making process. Iron contained in material in the North-South pits ranges in grade from about 30 percent to 65 percent before beneficiation. Before shipping to the Fontana Steel plant ore is upgraded to at least 60 percent iron.

Development: Recent operations begun in 1952 are restricted to the North-South ore bodies and both are mined from 1 large pit (Sec. 27). Plans are such that when open pit mining methods are complete the pit will be 4,600 feet long, 2,000 feet wide at the widest point, and 660 feet from the highest elevation to the pit floor (Photo 23). It will have 22 benches, each 30 feet high, to provide for mining and stripping the two ore bodies (Trengove, 1956, p. 11).

Primary drilling is done with crawler mounted churn drills. Jackhammers and wagon drills are used only for roadwork and when new benches are begun (Trengove, 1956, p. 11). After blasting, broken ore is loaded by power shovels on trucks which transfer it to a jaw crusher set to 7½ inches. Crushed material is then moved by belt conveyor to the surge pile. Ore from the surge pile goes through a 3-inch and minus-1-inch crushing stage after which it is transferred to the beneficiation plant. This plant, (Photo 24) completed in 1957, utilizes magnetic and heavy media separation methods to upgrade the ore to at least 60% (shipping grade). From the plant ore is moved by belt conveyor to the stockpile from whence it goes to the loading tower in order to fill gondola cars for rail transport to Fontana. A detailed description of the mining

Pl. To 24

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techniques and milling operations is given by Trengove (1956).

Drilling (1960) revealed the presence of ore beneath the beneficiation plant, and it was planned to combine the Bald Eagle and North-South pit into one large East-West pit.

Development at the Eagle Mountain mine has continued. The following information was contained in a Kaiser Steel Corporation news release dated (for details see Drossel, 1967)
November 3, 1965.

"A major producing unit in Kaiser Steel's current $119 million expansion program went 'on stream' this month as marble-sized pellets of concentrated iron ore formed a new kind of stockpile at the Company's Eagle Mountain, California iron ore mine. Trial shipments have already begun.

The new facility is an iron ore pelletizing plant with an annual capacity of two million long tons of pellets. Operation of the plant, and expanded mining facilities to feed it has increased employment at the mine to more than 1,050.

The pellet plant produces almost perfectly round spheres of hardened ore of 65 percent iron content. Ore as it comes out of the ground at Eagle Mountain averages 40 to 45 percent iron. The concentrated pellets provide a highly efficient material for the production of iron or 'hot metal', the basic material from which steel is made".

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East Wide Canyon Iron-titanium deposit*

Location: NE¼ sec. 17, T. 2 S., R. 6 E., S.B.M., Thousand Palms quadrangle, 15' 1958, and Joshua Tree quadrangle, 1955; in Joshua Tree National Monument, 5 miles north of Fun Valley, on the southeast side of a steep hill on the east side of upper East Wide Canyon. Reached by about 5 miles of foot trail from the end of the road in East Wide Canyon.

Ownership: Southern Pacific Land Company, 65 Market Street, San Francisco 5.

History: The deposit has not been mined but was examined by Southern Pacific Company geologists in 1957 (Papke, K. G. and others, 1957). ~~The company study included geologic mapping and sampling.~~ Tests on separation of iron and titanium were made by the U. S. Bureau of Mines, Reno, Nevada.

*Adapted from an unpublished report by Keith G. Papke and others, courtesy of Southern Pacific Company.

Geology: The region is underlain by the Chuckwalla (Precambrian) complex of Miller (1944, p. 16-21). In sec. 17 and vicinity these rocks include medium- to coarse-grained, slightly foliated quartz monzonite and diorite gneiss. (Figure 46) In most exposures, foliation in the gneiss strikes northeast and dips northwest. Most of the granitic bodies appear to be crudely aligned with the northeast-trending gneissic foliation. Northwest-trending faults cut the area into blocks.

In the NE¼ sec. 17 iron-and titanium-rich gneiss occurs in several layers conformable with the gneiss and quartz monzonite. The iron-titanium layers strike northeast with an average dip of 45° NW. The exposed strike length of the mineralized gneiss is about 1,800 feet, with average total thickness of the two principal layers of iron-titanium about 55 feet. The southwest end of the mineralized zone apparently is terminated by a fault intruded by an acidic dike. On the northeast the mineralized zone appears to pinch out, but mica-rich gneiss with some iron-titanium lenses crops out farther northeast. ~~beyond the mapped area.~~

Figure 46

The principal minerals present are magnetite, ilmenite, and goethite. ~~Although most of the titanium is in the form of ilmenite some may occur as small grains of rutile.~~ Assays and magnetic-separation tests suggest the material may have the following approximate composition: magnetite 60 percent; ilmenite 20 percent; goethite, silicates, and other minerals 20 percent. Six samples taken across the southwest end of the main mass averaged 45.9 percent Fe, 19.5 percent TiO_2, 10.8 percent Si, trace P, and 0.07 percent S, (Papke, et. al. 1957).

Development: None, other than geologic mapping and sampling. Papke and others (1957, p. 4) estimate a total of about 1,500,000 long tons of material averaging more than 43 percent iron and 17 percent titanium oxide would be available per 100 feet of slope depth.

Production: None.

References: Miller, 1944, p. 16-21; Papke, 1957, 7 p.

C.H.G. 8/8/61.

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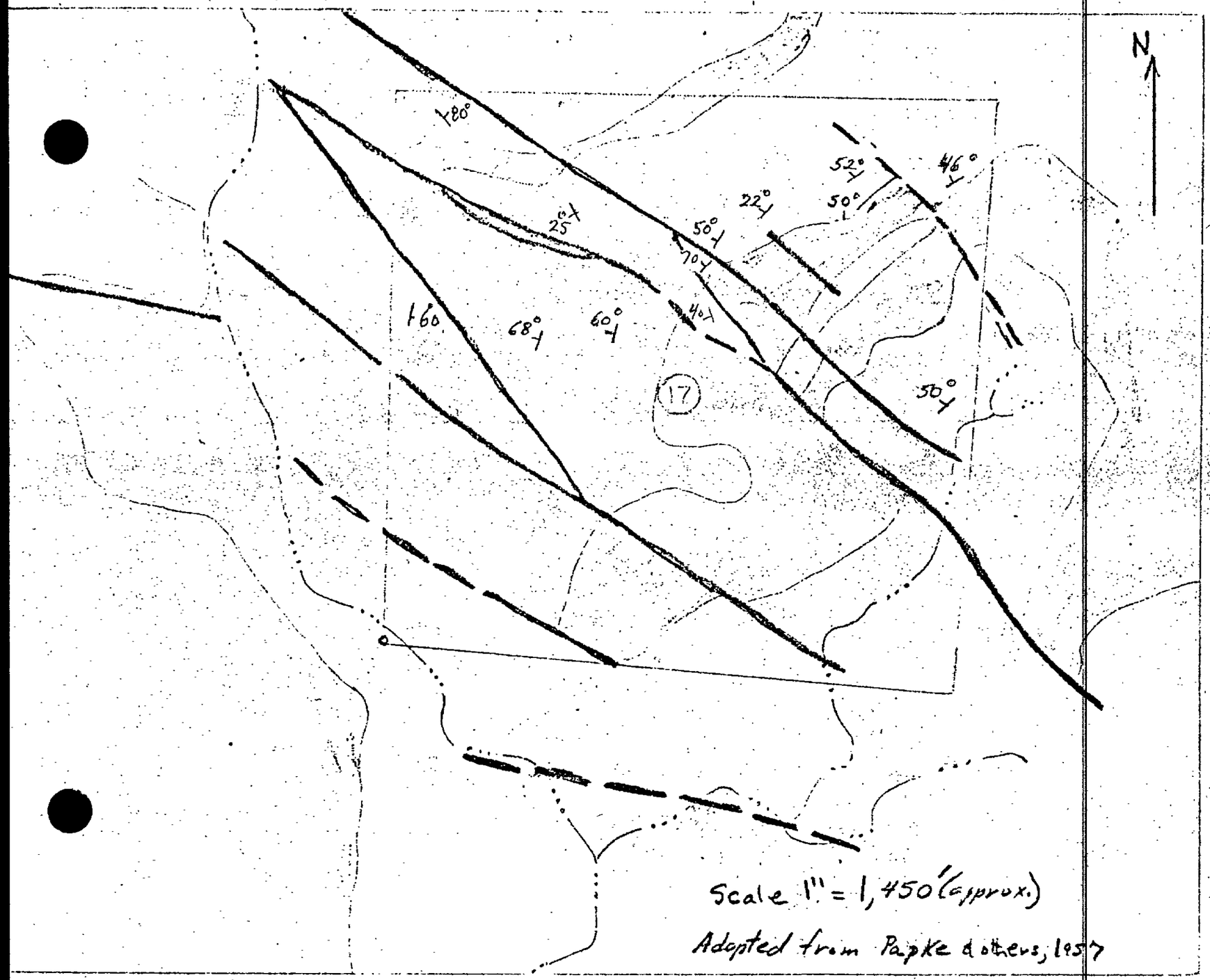
Iron - Titanium



Scale 1" = 1,450' (approx.)

Adapted from Papke & others, 1957

Geology of Section 17, T. 25, R. 6 E., S.B.M. & vicinity
East wide Canyon Iron-Titanium Deposit

EXPLANATION

Precambrian ?
Chuckwalla Complex

- Iron-Titanium mineralization
- Quartz Monzonite
- Diorite Gneiss

- Contact, with dip
- Fault
- Dip of foliation

Figure 46.

Iron Cap (Maria Mountains Iron Deposit) Claims

Location: NW¼ sec. 14, NE¼ sec. 15 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains, quadrangle, 1954; on a narrow ridge in the center of the Big Maria Mountains, 24 miles, by road and foot trail, north of Blythe.

Ownership: Not determined (1959).

History: Tucker and Sampson (1945, p. 146) briefly noted these claims as the "Maria Mountains Iron Deposit." J. O'Connell, Blythe, was the owner but no mention was made of development or activity.

Geology: Several elongate bodies of magnetite, containing some hematite, cap the crest of a narrow north-west-trending limestone ridge. The outcrop area of the magnetite body is about 1500 feet long and as much as 200 feet wide. The maximum thickness was not determined but it is probably less than 100 feet. The regional trend of the limestone and schist country rock is about N. 60° W. with dips of 20° to 30° southwest. Where the limestone contacts and intergrades with the iron ore it is sheared and contorted. The magnetite appears to have replaced the limestone. In some exposures near the margin of the ore body it is apparent that mineralization advanced more rapidly along some beds than others.

of Paleozoic(?) limestone and Precambrian schist

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Where the host rock is contorted, interposed ore is also contorted. Along the base of the ore bodies the host rock is strongly sheared and altered to epidote and tourmaline-actinolite schist. This shear zone contains sparse copper mineralization as fissure fillings and coatings of chrysocolla and malachite.

The volume of iron ore float in the alluvium and stream channels to the east and west of the deposit ~~probably~~ may exceed that of the ore remaining in place.

Development: Four shallow prospects and one 30-foot adit explore the shear zone underlying the magnetite ore bodies in an apparent quest for copper ore. No evidence was found indicating removal or exploration of the magnetite.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 146.

R.B.S. 1/13/59.

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Iron Cap and Iron King Claims

Location: SE¼ sec. 19 (proj.), T. 5 S., R. 18 E., S.B.M., Sidewinder Well quadrangle, 15' 1952; on the southwest flank of the Palen Mountains, 16 miles east-northeast of Desert Center.

Ownership: John J. O'Connell, 437 N. Oakhurst Drive, Beverly Hills.

History: When first reported (Tucker and Sampson, 1945, p. 146, pl. 35) this property was held by Jack O'Connell and C. J. Hill, Beverly Hills.

Geology: This deposit is exposed on the sides of a shallow ravine cut in the south flank of a ridge of altered metavolcanic and metasedimentary rocks of probable Mesozoic age. The head of the ravine lies athwart a vertical-to-steeply-north-dipping shear zone which strikes east-west and appears to be as much as 300 feet wide. Within the shear zone the country rock is altered to a mixture of quartz, epidote, and calcite, and in part replaced by irregular, lenticular masses of magnetite.

6

Individual bodies of magnetite as much as 15 feet ~~in~~ thick~~ness~~ and 50 feet in lateral extent are exposed but the bulk of the iron deposit appears to comprise swarms or zones of small bodies averaging perhaps 3 feet ~~in~~ thick~~ness~~ and 15 feet in exposed length. The magnetite is fractured and as the host rock has weathered the iron oxide bodies have crumbled to a litter of float. Thus the full extent or number of magnetite bodies is difficult to estimate. The ore bodies appear to be unevenly distributed across the full width of the shear zone and to have a lateral extent of about 400 feet. Surface indications of iron mineralization extend only 30 to 40 feet up the east slope of the ravine. The western limit of the deposit is concealed beneath a wash.

The chief impurities in the magnetite appear to be unreplaced bodies of altered country rock the most common constituent of which ~~(appears to be)~~ is epidote. One specimen of magnetite float contained perhaps as much as 20 percent by volume of slender, prismatic apatite crystals. The ubiquity of this undesirable impurity was not determined.

694

Several hundred feet south of the head of the ravine, the ridge along its west side is crossed by several crushed and sheared quartz veins. They strike approximately N. 10° E., dip steeply northwest, and range from 0 to about 1 foot in thickness. They contain chrysocolla and malachite as crusts and veinlets associated with scattered, small pockets of iron oxides. One vein has been prospected for gold.

Development: The magnetite deposit has been opened through an open trench about 15 feet long and 6 feet deep at the face, and several shallow prospect pits.

A single 15-foot vertical shaft has been sunk in one of the narrow quartz veins. ~~The collar is timbered and set with concrete.~~

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 146, pl. 35.

R.B.S. 3/16/62

Iron King and Iron Queen Claims

Location: S½SW¼SW¼ sec. 21 (proj.) and N½NW¼ sec. 28 (proj.), T. 5 S., R. 18 E., S.B.M., Sidewinder Well quadrangle, 15' 1952; on an isolated foothill at the south end of the Palen Mountains. These claims are at the end of an unimproved, sandy road which extends north 7½ miles from U.S. Highways 60 and 70 at a point 19½ miles east (by road) of Desert Center.

Ownership: S. E. Chiapella, 14208 Chandler Blvd., Van Nuys and John J. O'Connell, 437 No. Oakhurst Dr., Beverly Hills (1962).

History: This property has been extensively prospected but by 1962 has not yet (1962) been systematically mined.

Photo 25

696

Geology: The area of the Iron King and Iron Queen Claims is underlain by greenstone of probable Mesozoic age. The claims include a faulted and sheared zone as much as 100 feet wide which strikes about N. 75° W., dips 75° SW. The lateral extent of the ~~fault~~ zone was not determined. Lenses of massive magnetite lie in the fault where it is exposed on the east flank of a ridge zone. The largest magnetite body exposed is about 60 feet thick near the base of the ridge and narrows to a termination just below the ridge crest; a surface distance of about 300 feet. The main ore body appears to be flanked by at least two smaller lenses a few tens of feet in exposed length. One of the smaller bodies is a porous mass near the hanging wall just below the ridge crest, the other is an apatite rich lense near the footwall at about the same level. The ore bodies have gradational contacts with, and contain isolated ~~horses~~ masses of the ~~country rock~~ greenstone. They appear to be replacement deposits. In addition to contamination by included ~~country rock~~ greenstone the magnetite contains an undetermined but apparently high proportion of unevenly distributed apatite crystals.

No magnetite bodies were noted northwest of the ridge crest. Southeast of the ridge the main ore body is concealed by alluvium, but it appears to thicken both in that direction, and down the dip of the fault.

Development: This deposit has been exposed in an open cut at the base of the ridge and four evenly spaced bulldozer cuts on its east slope (Photo 25/).

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 146, pl. 35.

R.B.S. 11/28/62.

Lindy Loop #1 Deposit

Location: NE 1/4 sec. 36 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 15', 1951; Big Maria Mountains, about 12 miles north of Blythe.

Ownership: Alfred E. Lindburgh, P. O. Box 517, LaHabra, owns at least one unpatented claim (1958).

History: Undetermined.

Geology: A northwest-trending fault that dips 51° SW. separates coarse-grained limestone in the hanging wall from wollastonite-bearing carbonate rock in the footwall. Both of these rock units are members of Paleozoic (?) Maria Formation (Miller, 1944, p. 25-28). A gouge zone as much as 15 feet thick contains mineralized veins composed principally of spongy hematite, altering to limonite, with stringers of dirty-green epidote. Portions of the wall rock along the fault are stained blue by a secondary copper mineral, probably chrysocolla. The hematite veins are elongate, semi-tabular, and tend to pinch and swell. A kidney 2 feet in maximum width was observed. Locally the wollastonite-bearing rock has been replaced by magnetite. An irregular replacement body a few tens of feet wide occurs low on the west slope of the hill between a prospect pit and the dirt road leading from the workings.

699

Development: Several open cuts and prospects pits expose the veins along the fault zone.

Production: Undetermined.

References: Miller, 1944, p. 32.

J.R.E. 12/17/58

700

Sulphide Bismuth (Lang) Mine

Location: NE¼ sec. 11, T. 2 S., R. 7 E., S.B.M., Twentynine Palms quadrangle, 15' 1955; Joshua Tree National Monument, on the north slope of the Little San Bernardino Mountains on a ridge 2 3/4 miles west of Hidden Valley on the west side of Johnny Lang Canyon.

Ownership: William F. and Frances M. Keys, P.O. Box 114, Joshua Tree hold at least one claim (Sulphide bismuth iron).

History: This claim is reported to have been first located by Johnny Lang, about 1900, and was then known as the Lang Copper Mine. (Oral Communication W. F. Keys, 1960). Apparently the development work was done mostly by Mr. Lang in the early 1900's. In 1925, the claim was relocated by Mr. Keys.

Geology: The mine workings explore an iron-rich body in biotite-quartz gneiss. The iron-rich body strikes north to N. 20° W. and is vertical as indicated by well defined bands of red-brown iron gossan-like material and black magnetite-rich material. This body is 50 feet wide at the shaft and is at least 350 feet long. One sample which appeared typical of the magnetite-rich material was found to contain magnetite, laumontite, limonite, enstatite, and tremolite. The magnetite appeared

701

to be the most abundant constituent and the tremolite is altered from the enstatite. Bismuth and titanium were not detected.

Development: In a ravine at the north end and at the east side of the iron-rich body a 200-foot crosscut adit is driven along a shear zone in gneiss which strikes N. 40° to 60° E., and dips 50° W. to vertical. A second adit, 50 feet above, is driven 75 feet on a parallel shear. About 300 feet to the south, the south end of the iron-rich body is explored by means of a 100-foot vertical shaft, equipped with an old windlass and wood ladder.

Production: Undetermined. William F. Keys (oral communication, 1960) reports that the 20 tons of bismuth reportedly produced in 1904 from the Lost Horse Mine (see herein) actually was from the Sulphide bismuth mine.

References: None.

C.H.G. 1/28/60.

702

Unidentified Iron Prospect

Location: SW¼ sec. 1 (proj.), T. 2 S., R. 23 E., S.B.M., Vidal quadrangle, 1950; on the west flank of the Riverside Mountains about a quarter of a mile northeast of the Gold Rice Mine.

Ownership: Undetermined.

History: Undetermined.

Geology: This deposit lies in a narrow valley along a contact between limestone (Paleozoic (?)) on the southeast and schist (Precambrian) on the northwest. The general strike of the rocks is N. 60° E. and the dip about 25° NW. The sheared condition of the schist and the contorted structure of the limestone underlying it suggest that the limestone and schist are in fault contact and that the valley is cut along the trace of a fault of considerable displacement. This might be the same fault that controlled mineralization at the Morning Star mine in the floor of a neighboring valley about one mile to the northeast (see herein). Hematite and barite occur in veins as much as 4 feet wide irregularly exposed through a distance of about 100 feet along the base of a limestone ridge on the southeast side of the valley. The barite appears to comprise less than 50 percent of the vein material but, locally, is intimately mixed with the iron oxides. Part of the deposit is covered by alluvium.

Development: Several shallow open cuts.

Production: Undetermined.

References: None.

R.B.S. 4/21/61

Lead, Silver and Zinc

Lead, silver and zinc, are here grouped under one heading because their ore minerals commonly are found together and, in Riverside County, these metals generally have been marketed as byproducts. Lead and silver have been mined for their own value in only three or four mines and even in such deposits these metals generally are accompanied by some other more valuable metal such as copper or gold. Ore containing appreicable quantities of zinc has been encountered in only the Bald Eagle mine, although it has been reported from the Balck Eagle mine and perhaps one or two other localities, where it is of minor significance.

From 1891 to 1961, a total of 2,228,662 pounds of lead valued at ~~$341,975~~ $137,035 was reported from Riverside County. The total value is based on a price per pound which has fluctuated from a low of three cents in 1932 to a high of 18 cents in 1948. In 1961, the price ranged between 10 and 11 cents.

The principal ore of lead is galena, but many of the deeply weathered veins, exposed in the mines of Riverside County, contain appreciable proportions of secondary lead minerals of which cerussite is the most common. Wulfenite is farily abundant in many mines, especially those in the Chuckwalla Mountains, but generally as disseminated, small crystals. Pyromorphite is present in a prospect near the Red Cloud mine, but it might be more common as it is easily confused with copper carbonate.

Silver valued at ~~$127,248~~ 126,657 was reported from mines in Riverside County between 1891 and 1961. 19 1 Most of the silver came from gold mines where it was found mixed in the gold or disseminated in sulfides. The lead sulfide, galena, is a particularly common host to silver. The mineral argentite has been reported from the Homestake group (see under copper) and might be present in the Bald Eagle mine (personal communication, Danny G. Figureoa) but such ore minerals of silver appear to be uncommon in the metal-bearing veins of the county.

Except for 1,901 pounds of zinc reported in the 1951 yield of the Bald Eagle mine, zinc production in Riverside County has never been large enough to achieve the notice of market statisticians. The 1951 yield was from the mineral sphalerite.

Bald Eagle (Neal Group) Mine

Location: SE¼ sec. 27 and NE¼ sec. 34, T. 3 S., R. 21 E., S.B.M. (proj.), Midland quadrangle, 15' 1952; Mig Maria Mountains, about 3 miles northeast of Midland. figure 47

Ownership: Undetermined.

History: In 1929, the property consisted of 2 claims and was owned by Mr. Neal, Kingman, Arizona (Tucker and Sampson, 1945 p. 491). Lead-silver-copper mineralization, accompanying a felsite dike intrusion into limestone, was reported. Development consisted of a 60-foot shaft and 100 feet of tunnel work. No shipments of ore were made previous to 1929. The property was idle in 1929, and 1945 (Tucker and Sampson, 1945, p. 148), but was relocated in 1950 by Dan Figuerca, P.O. Box 453, Blythe. In 1950 and 1951 the mine was active and production was recorded.

Figure 47

Geology: The mine area is along the contact between an intrusive body of fine-grained Mesozoic granodiorite (?) and northeast-trending, tan-colored dolomitic limestone of Paleozoic(?) age (fig. 47). The dolomitic limestone is blocky and jointed, very coarse grained in large part, and dips gently northwestward. Most of the workings are in a pre-mineral fault zone which served as a channel-way for veins containing hematite, chalcopyrite, galena, sphalerite, epidote, chert, quartz and silver. Subsequent oxidation of vein material has resulted in the formation of azurite, limonite, plumbojarosite and jarosite. Seams of drusy, white gypsum occur locally, coating both vein material and country rock. Locally, veins of quartz and epidote, as much as 5 feet thick, intrude the dolomitic limestone. About half a mile north of the adits a well developed tactite zone occurs. Thin intercalated layers of brown garnet, white quartz, white and blue calcite, black tourmaline and green epidote are present in this zone. A mass of Precambrian augen gneiss rests upon the dolomitic limestone, and forms the backbone of the ridge above and northwest of the workings.

Photo 26

709

Development: Of a total of 9 adits, 5 have been driven northwest, 2 north, 1 northeast and 1 south. They are all in dolomitic limestone above the intrusive contact (~~fig. 1~~). About half a mile northeast and about 200 feet higher on the same slope are 3 shafts of varying depth but no more than 50 feet. They are inclined about 45° northwest and in a tactite zone (~~fig. 3~~). Workings, including adits, winzes, raises and stopes aggregate over 1300 feet and are accessible by jeep road, and foot travel on a good trail. ~~The dirt road~~ joins the Midland road about 2½ miles southeast of Midland (~~fig. 1~~). ~~Elevation of the workings is approximately 2000 feet.~~ The mine is idle.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owner.

Year	Crude ore (tons)	Recoverable Metals: Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1950	56	1	390	108	15,922	------
1951*	181	---	1186	---	52,415	1,901

* The 1951 yield comprised both mined ore and dump material. The mined ore was found near the surface in the form of a kidney of sulfides. The site of this operation is marked by an open gallery near the point where the road turns west at the head of the canyon (~~fig. 4~~ Photo, 26 1) (personal communication, Danny G. Figueroa).

References: Tucker & Sampson, 1945, p. 148; Tucker, 1929, p. 491.

J.R.E. 12/18/58.

710

Lead-silver-zinc

Figure 47.

T. 3 S.

SCALE

0 ½ 1

MILES

15°

21

1200

1600

1013

Big Horn

VABM 2870

2000

Gneissose granite

Lamprophyre dike zone

Quartz gabbro

Styx

BM. 1033

1467

Dolomitic limestone

Siliceous Dolomite quartzite

NEAL GROUP (or BALD EAGLE MINE)

with 2021

1128

Midland

4

3

5

Geology modified from an anonymous source

By James R. Evans, December 1958

T. 4 S. – R. 21 E.

47

Figure 4. Index and geologic map showing the location and areal distribution of the workings of the Bald Eagle (Neal Group) (topography from U.S.G.S. 15' Midland quadrangle, 1952).

Black Eagle Mine

Location: Sec. 30?, T. 3 S., R. 14 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinto Basin Eagle Tank quadrangle, 15', 1943; Eagle Mountains, about 12½ miles northeast of the East Pinto Basin-West Pinto Basin - Cottonwood Pass and Black Eagle mine roads intersection and adjacent to the Black Eagle mine road.

Ownership: Kaiser Steel Corporation, P.O. Box 217, Fontana, owns at least 3 patented claims; Mileta Nos. 1, 2, and 3 (March 1960).

History: The mine was originally located by Mr. E. Rust in 1898, and relocated by Edward Harmon in 1921 (Tucker, 1924, unpublished Field Report No. 84). In 1924, the property comprised 3 unpatented claims (Mileta Nos. 1, 2, and 3) and was still owned by Edward Harmon of San Bernardino, but under option to A. W. Scott and George Hayden of Los Angeles. Water was hauled 20 miles north from Cottonwood Springs in a 45 gallon tank. The mine was active and 6 men were employed (Tucker, 1924, p. 193). Tucker and Sampson (1929, pp. 474-475) report the mine was in operation from 1923 until the latter part of 1928.

By 1929, the mine was owned by the Black Eagle Mines Incorporated, L. M. Clancy, president, 505 Roosevelt Boulevard, Los Angeles, and was reported idle. The mine was apparently operated intermittently from about 1930 until the latter part of 1940. California Division of Mines records show a nearly continuous record of production from 1935 to 1940. In the early part of 1939, a 100-ton concentration and flotation plant was installed on the property. The plant was operated from July 1939 to January 1940, and treated ore at the rate of 75 tons per 24 hours. During this period the value of concentrates shipped was $53,706 (Tucker and Sampson, 1945, p. 147). Concentrates were shipped to Midvale, Utah, and 20 men were employed (Tucker and Sampson 1940, p. 47). All mine and mill equipment were removed from the property in December 1940. In 1945, the mine was owned by Imperial Metals Incorporated, S. B. Mosher, president, 811 W. 7th Street, Los Angeles (Tucker and Sampson, 1945, p. 146).

712

Geology: A fault zone separating diorite from quartzite contains a major N. 70° W.-trending and 85° N.-dipping quartz vein (Black Eagle Vein) filled with galena, malachite, azurite, cuprite, anglesite, cerrusite, lead vanadinite ~~vanadium~~, gold and silver. The vein ranges in thickness from 4 to 10 feet, has an average thickness of 6 feet, and a proven surface length of about 3000 feet. About 1400 feet west of the main shaft another vein (South Vein) striking N. 40° W. and dipping steeply northeast, intersects the Bald Eagle Vein at an oblique angle (see fig. 48). It is of minor importance and nearly all the work has been confined to the Bald Eagle Vein (Tucker and Sampson, 1945, p. 146).

figure 48

713

Development: A two-compartment shaft is sunk in the Black Eagle vein to a depth of 650 feet, with levels at 60, 100, 150, 200, 300, and 500 feet. On the 60-foot (adit level), a drift extends 600 feet west and 160 feet east from the shaft. On the 150-foot level, a drift runs 500 feet west and 180 feet east from the shaft. A drift 200 feet west and a drift 180 feet east are found on the 200-foot level. On the 300-foot level, a 485-foot drift extends west from whence a crosscut extends south 550 feet to the South vein. The vein has been drifted 170 feet from the crosscut. At present (1960), the mine is in large part caved, filled, and boarded over.

Production: The total production of the mine is estimated by Tucker and Sampson (1945, p. 147) to be valued at $200,000. They list the following data for concentrates and ore shipped from the property from 1935 to 1940.

Year	Copper		Lead		Silver
	Pounds	Value	Pounds	Value	Value
1935	2,073	$ 172	15,303	$ 616	$ 1,953
1936	6,355	525	53,983	2,483	4,269
1938	15,044	1,479	241,510	11,109	3,387
1939	68,683	7,143	634,071	29,801	11,604
1940	22,269	2,516	536,047	26,823	22,510

714

References: Tucker, 1924, unpublished Field Report No. 84; Tucker 1924, pp. 193-196; Tucker and Sampson, 1929, pp. 474-476; Tucker and Sampson, 1940, p. 47; Tucker and Sampson, 1945, pp. 146-147; Newman, 1924, unpublished report on the Black Eagle mine; 6 pp.

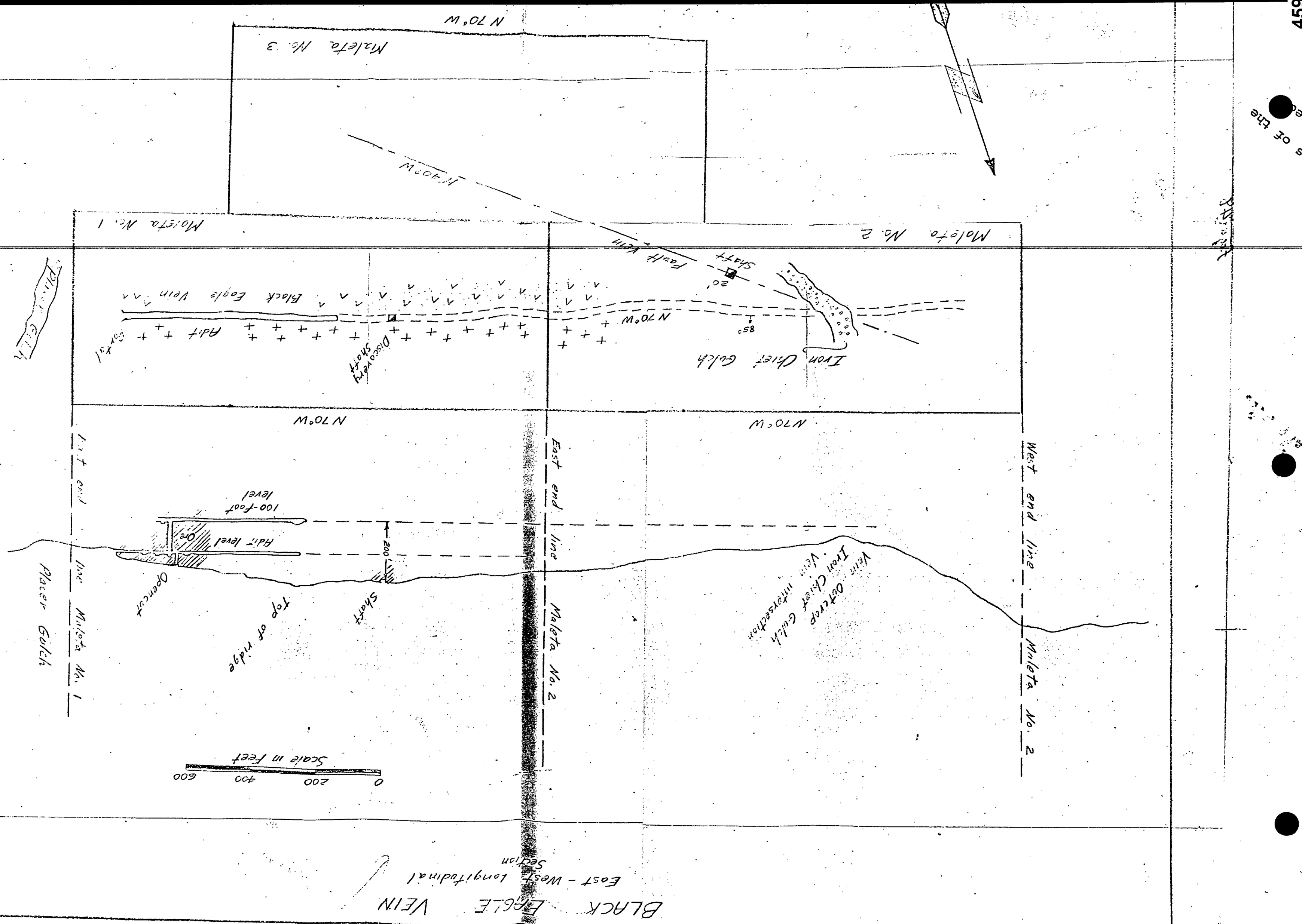
J.R.E. 3/17/60

Lead-silver-zinc

Figure 48. Plan map and longitudinal sections of the Black Eagle Vein in 1924 (adapted from an unpublished report by M. A. Newman.)

BLACK EAGLE VEIN

East - West longitudinal Section

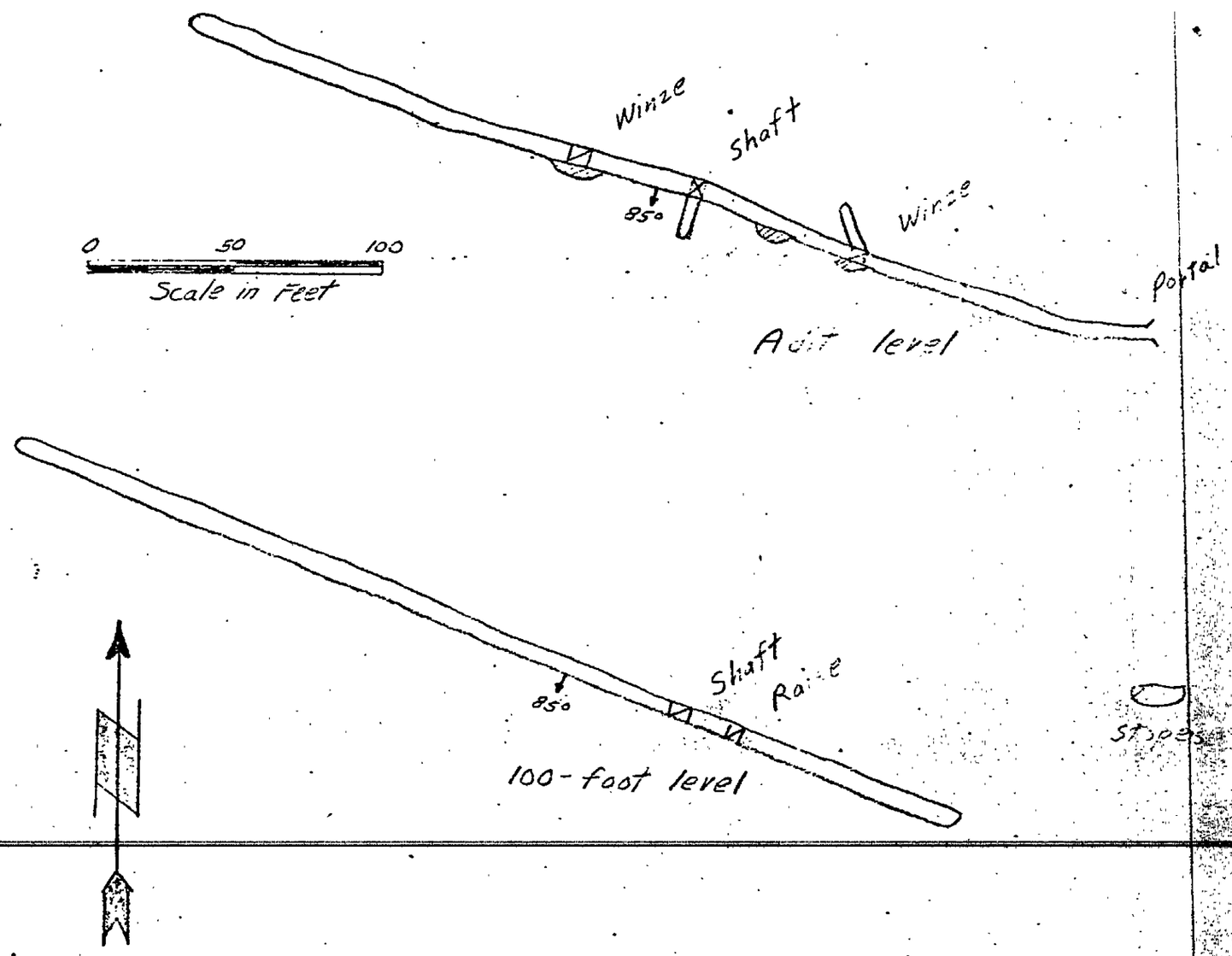


N 40° W

Maleta No. 3

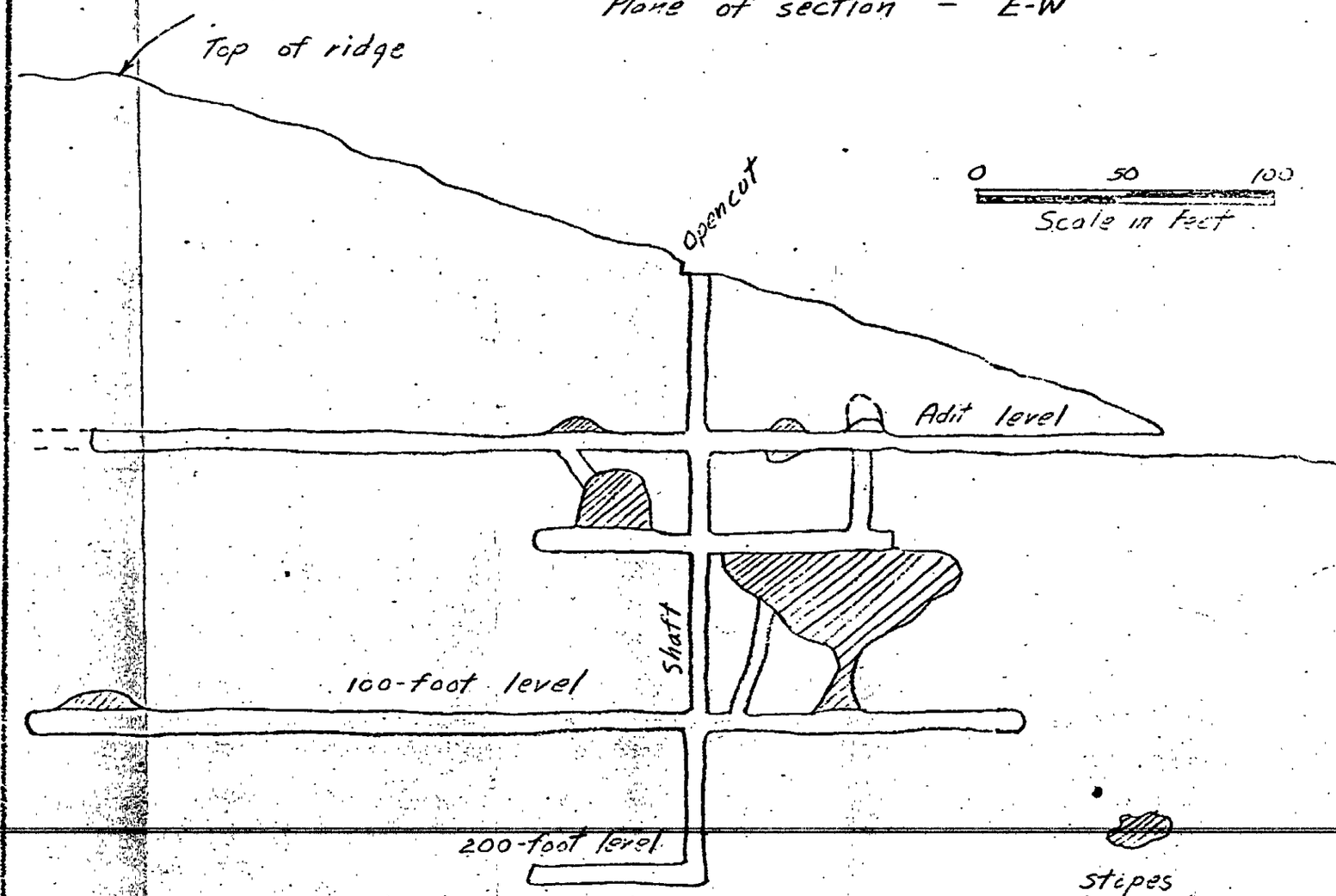
N 70° W

Plan Map Of the Black Eagle Vein



Longitudinal Section Of The Black Eagle Vein

Plane of section - E-W



Cap Hunter (Poor Boy) Mine

Location: Sec. 34 (proj.), T. 7 S., R. 16 E., S.B.M., Chuckwalla Mountains quadrangle, 15', 1963; on the south side of a west-trending valley near the south margin of the Chuckwalla Mountains. The mine is at the end of Dupont Road, which extends southwest from U.S. 60-70.

Ownership: Undetermined.

History: The Cap Hunter mine appears to be an old claim, but no records were found dated earlier than 1952. From 1952 to 1954, the mine was held by Roy M. Berg, Box 456, Desert Center. In 1957, it was held by Jack Stewart, William Sandoval and Bert L. George, who called it the Poor Boy mine.

Geology: The low ridges in the mine area are underlain by Pre-cambrian gneiss. A fault zone 1 to 2 feet wide is poorly exposed through a horizontal distance of about 400 feet. It strikes N. 75° W., and dips 45° SW. The fault contains a quartz vein, a foot or less in thickness, which carries iron oxides, galena, secondary copper minerals, and small proportions of cerussite. The vein quartz has been fractured, and the resulting spaces filled by the iron and copper minerals.

716

Development: The workings, now inaccessible, comprise 3 inclined shafts on the fault and an undetermined ~~amount~~ number of drifting $ and stoping cs. The southeast shaft is about 50 feet deep, ~~and collared by collapsing timber.~~ The middle shaft, about 125 feet to the northwest, is caved and flooded to within about 20 feet of the collar. The northwest shaft, about 280 feet farther to the northwest, is 25 feet deep and has no vein exposed in it.

Production: Compiled by the U. S. Bureau of Mines and published with permission of the owners.

Year	Crude ore (tons)	Recoverable Metals			
		Gold ~~(ounces)~~ oz.	Silver ~~(ounces)~~ oz.	Copper ~~(pounds)~~ lbs.	Lead ~~(pounds)~~ lbs.
1952	1		5		316
1953	3	1	25		1,098
1954	40	1	15	54	850

References: None.

R.B.S. 1/22/60.

717

Corona Lead-Zinc Mine

Location: .SE¼ sec. 14, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles south of Corona on a steep ridge along the west side of Manning Canyon, midway between Eagle and Main Street (Gypsum) Canyons.

Ownership: Robert a Mattey, Jr., 11359 Biona Drive, Los Angeles 66, formerly held five lode claims by location—Wild Oak Nos. 1-5.

History: Located by Joe Smith, Temecula, and Fred Spiess, Corona, probably in the early 1940's. In 1943-45, it was under lease and option to Victor Mishelle, Corona Lead-Zinc Company, Malibu Beach, but was idle in 1945 (Tucker and Sampson, 1945, p. 147). About 1948, the property was acquired by Mr. Mattey, who did some development work for several years. In 1953, the principal adit was locked, the open cuts slumped, and the entire area covered with dense brush. The property has remained idle.

718

Geology: According to Tucker and Sampson (1945, p. 147) the mine explores a vein that contains oxidized lead-zinc and occurs in marine metasedimentary rocks. The mineralized areas occur along fracture zones in a small pod of quartzite, gray hornfels, and metagraywacke of the (Triassic(?) Bedford Canyon Formation. The metamorphic rocks are engulfed in hornblende andesite of the (Jurassic(?) Santiago Peak Volcanics. Most of the lead-zinc is in a single discontinuous calcite-quartz vein exposed high on the steep west side of Manning Canyon. The vein material is mostly limonite-stained white to brown calcite with minor amounts of vein quartz ~~showing~~ marked with sparse black manganese dendrite. The vein fills a fracture zone which strikes northeast and dips 45° northwest. The vein ranges from 2 to 6 feet in width but the mineralized zone extends over as much as 15 feet and the metasedimentary country rock carries pyrite and pyrite altered to limonite. When visited in 1953 little vein material was encountered and no ore minerals were observed.

719

Development: Open cuts and adits. Tucker and Sampson (1945, p. 147) described the development thus: main workings were an open cut driven northeast for 360 feet and which explored the principal fracture zone high on the ridge west of Manning Canyon. Three hundred feet below the open cut and at the floor of Manning Canyon on its west side a crosscut adit, 92 feet long in 1945, was being driven N. 15° W. to intersect the vein exposed by the open cut above. This crosscut apparently did not cut the vein, although the rock in the face carried pyrite. Farther up Manning Canyon, about 300 feet west of the crosscut adit, there is a small open cut and two short adits are driven on a vein parallel to the principal mineralized zone exposed on the ridge above.

Production: A small mill was built in Manning Canyon in the early 1940's and although it is said to have been in operation about 1943 no record of production was found.

References: Tucker and Sampson, 1945, p. 147-148; Goodwin, 1957, p. 601-602; Gray, 1961, p. 61-62, 116.

C.H.G. 8/17/62.

720

Desert Center Mine

Location: SW¼ sec. 18, NW¼ sec. 19, T. 7 S., R. 17 E., (proj.) S.B.M., ~~U.S. Army Corps of Engineers~~, Chuckwalla Mountains quadrangle, 15', 1943; and Sidewinder Well quadrangle, 1952; on the east slope of the Chuckwalla Mountains about 2 miles south of Ship Creek. In March 63 of 1962, a crude road had been bulldozed northwestward to the property from the Aztec Mines area on Dupont Road (shown on the Sidewinder Well quadrangle).

Ownership: C. H. McDonell and Gilbert Martin, c/o Vaux, 817 Balboa Blvd., Balboa, or Box 523, Desert Center.

History: The Desert Center mine was first described in 1929 (Tucker and Sampson, p. 491), at which time the property was held by S. A. Ragsdale, Desert Center and only assessment work was being done. U. S. Bureau of Mines records show that, in 1940, this property was held by Desert Center Mining Company, Los Angeles. In 1945, the mine was idle (Tucker and Sampson, 1945, p. 148, pl. 35). The present owners have held claims in the area since the mid-1950's.

721

Geology: The mine area is underlain by gneissic granitic rock cut by northeast and northwest-trending faults which contain metaliferous vein deposits. The best-exposed deposit cuts across a saddle in a narrow ridge west of the wash parallel to which the road to the mine ascends. In the saddle, a fault zone 6 feet wide strikes N. 60° E. and dips 85° SE. Within the fault zone are a basic dike about 2 feet thick and pods and stringers of quartz as much as 10 inches thick. The quartz is fractured and contains local concentrations of iron oxides, cerussite, and partially altered galena. In addition to lead, this deposit is reported (U.S. Bureau of Mines records) to contain small proportions of gold and silver. The deposit is exposed through a horizontal distance of about 100 feet on the northeast slope of the saddle, some 50 feet on the southwest slope, and an additional 150 to 200 feet southwestward across an adjoining spur.

A second fault is poorly exposed along the crest of a low, narrow ridge at the end of the road, parallel to the east bank of the wash and about 1,000 feet northeast of the above deposit. This fault zone appears to be about 18 inches wide. It strikes N. 50° W. and is vertical. Although vein material is not common in the outcrop, the mine dump shows vein quartz fragments as much as 6 inches thick containing small masses (bunches) of galena, cerussite, iron oxides, and sparse crusts and void fillings (bunches) of secondary copper minerals. The lateral exposed extent of this fault may comprise the full length of the ridge, a distance of 1,000 or more feet, but it appears to be sparsely mineralized. At the southeast end of this ridge a 4-foot-wide fault zone strikes N. 85° E. and is vertical where exposed at the collar of a shaft. Here a 4-inch quartz vein contains small crystals of pyrite.

Development: The southwest saddle is explored by a 12-foot drift adit and six prospect pits on its northeast slope and a 25-foot shaft and several prospect pits on the southwest slope. The northeast ridge is explored by two shafts, both sealed against entry. One of these shafts appears to explore the junction of the N. 85° E. fault and the ridge fault. The other is about 400 feet to the northwest and appears to explore an ore shoot. The present owner is building a ~~cable conveyor system~~ aerial tram from the southwest-saddle development to a site near the end of the road at the toe of the northeast ridge.

Production: U. S. Bureau of Mines records show that in 1940, 4 tons of ore yielded 2 ounces of gold and 3 ounces of silver. Though not reported for that shipment, lead is the most abundant metal in this deposit.

References: Tucker and Sampson: 1929, p. 491; 1945, p. 148, pl. 35.

R.B.S. 3/15/62.

724

Groover (Carbonate Lead) Mine

Location: Sec. 4 (proj.), T. 2 S., R. 11 E., S.B.M., Valley Mountain quadrangle, 15', 1956; Pinto Mountains, 6 miles south-southwest of Old Dale (Figure 49).

Ownership: F. E. Groover, 12691 Trask Avenue, Garden Grove, owns 1 unpatented claim (1958).

History: Undetermined.

Geology: An intrusive mass of porphyritic quartz monzonite into white, tan weathering medium-grained dolomitic limestone, has produced a tactite zone as much as 7 feet thick. The intrusion has been along a fault. The tactite zone contains galena, azurite, malachite, and minor amounts of gold and silver. Several thin diorite dikes cut the quartz monzonite, and one near the portal of the main adit is about 7 feet thick and bounded by faults. The dolomitic limestone is a part of a sequence of northerly-dipping metasedimentary rocks of Paleozoic (?) age composed principally of varicolored quartzites. Normal faults, trending northwest and dipping southwest, cut both the quartz monzonite and the metasedimentary rocks.

Figure 49

725

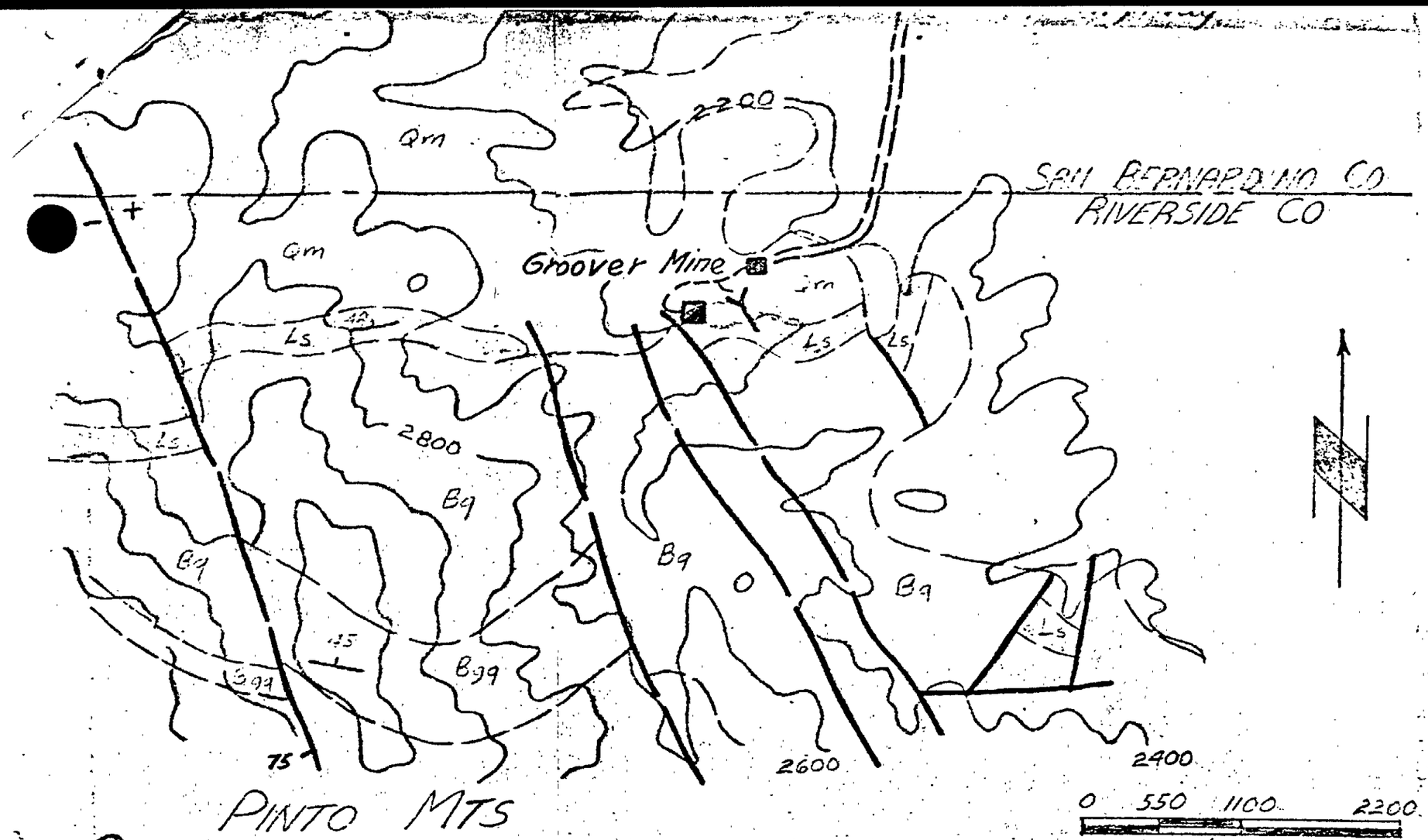
Development: A 2-compartment main shaft is sunk 150 feet north at 45° in a northeast-trending fault plane. The fault is exposed southwest and northeast a total of 215 feet from the shaft along the strike by surface trenching and open cuts. At the bottom of the shaft, a drift extends west about 30 feet. The main adit, 300 feet east of the main shaft, is driven south about 90 feet. At 50 feet a crosscut extends 95 feet southeast. At the end of the crosscut a raise connects to the ground surface 20 feet above. The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/29/60

726



A

Qal Alluvium

Qm Quartz monzonite

Bgg Blue-gray quartzite

Bq Buff quartzite

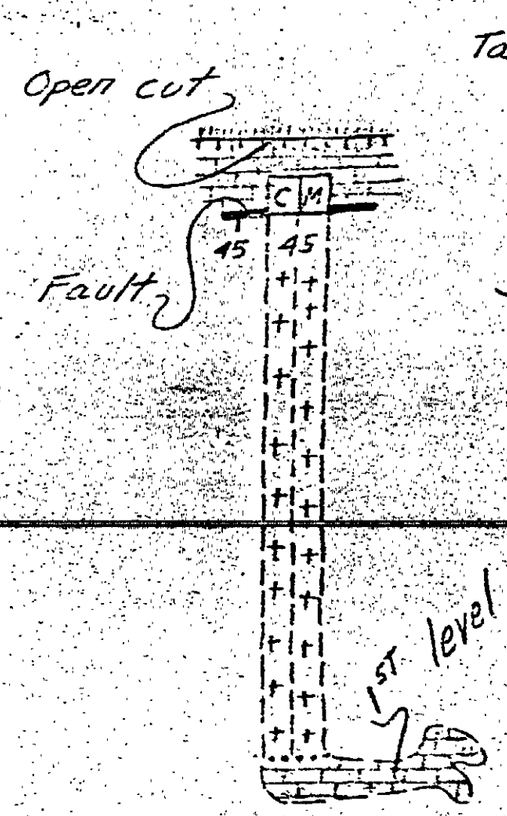
Ls Limestone

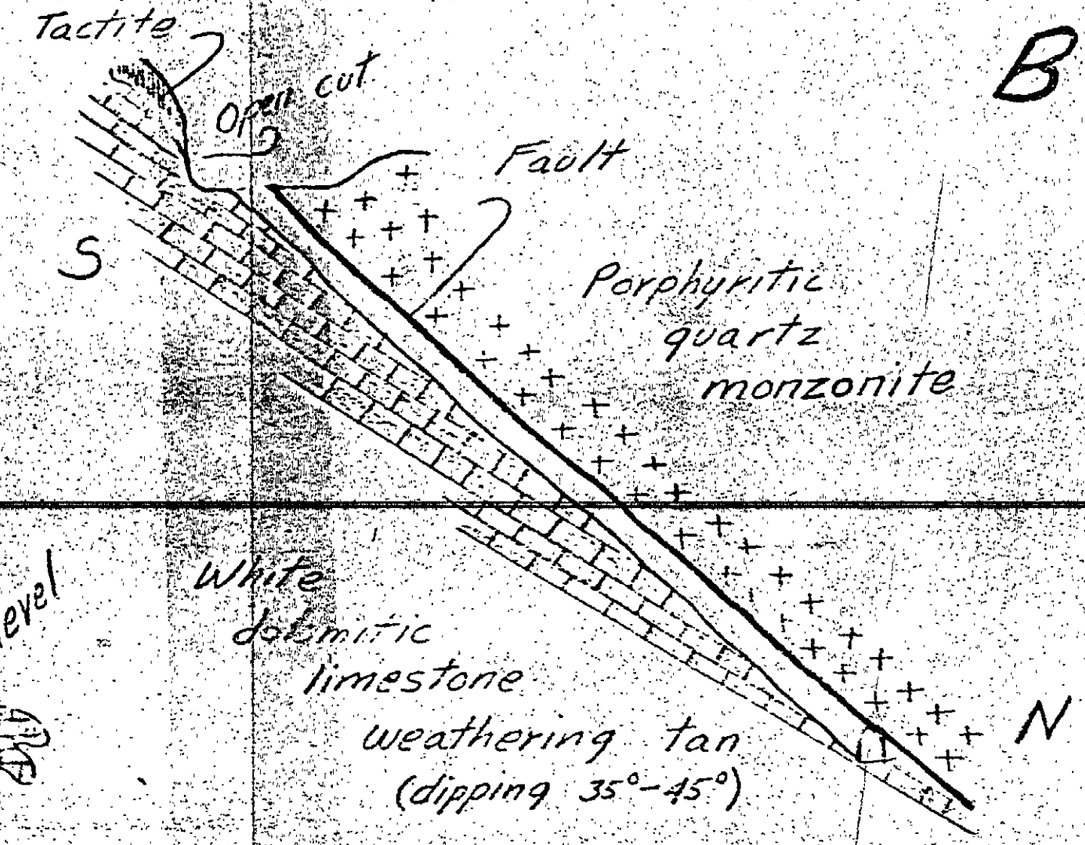
75 Fault approximately located

Contact approximately located

By James R. Evans
March 1960

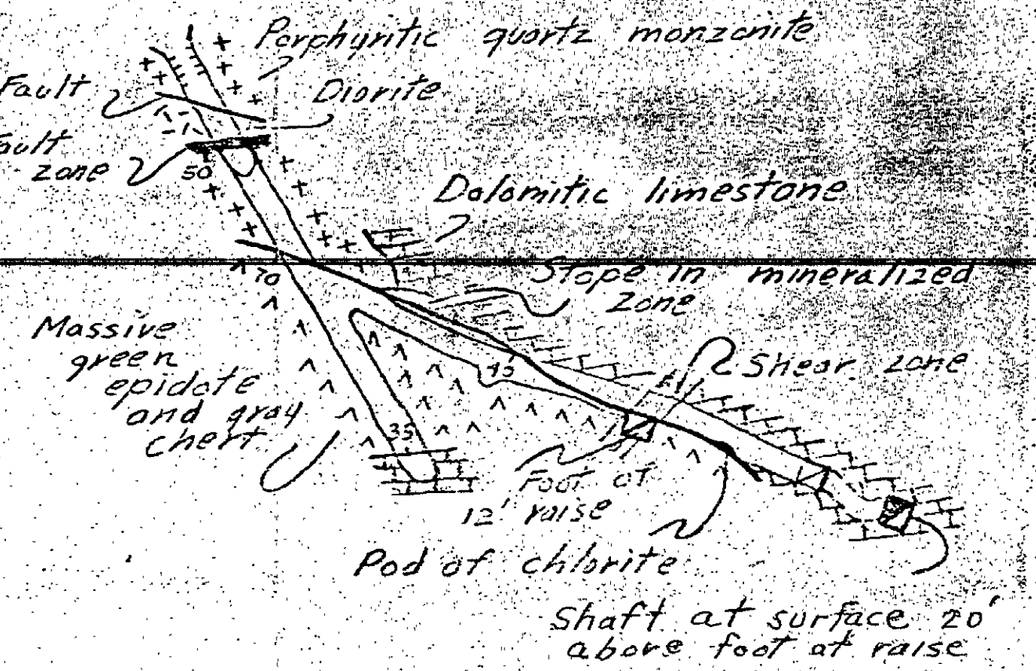
(Geology in part A modified from an anonymous source)





Main Shaft - Groover Mine

B



Main Adit - Groover Mine

0 20 40 80
Scale in Feet

Figure to be inserted

Figure 49. A. Geologic map of the Groover mine and adjacent area (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956). B. Geologic sketch maps of the main shaft and main adit of the Groover mine.

Jacklin Mine

Location: NE 1/4 NW 1/4 sec. 24, T. 1 S., R. 22 E., S.B.M., Vidal quadrangle, 15', 1950; on the northeast slope of the West Riverside Mountains, 7 1/4 miles southwest of Vidal.

Ownership: Undetermined.

History: Undetermined.

Geology: The country rock is slightly gneissic Mesozoic granodiorite. Irregular, tabular, and lenticular quartz bodies generally less than one foot in thickness and a few tens of feet in strike length, are exposed in the mine area. One such vein has been explored. It is vertical, strikes N. 55° E., is 4 to 6 inches wide in the mine workings, and is traceable for about 60 feet on the surface. The quartz contains small proportions of galena, chrysocolla, and iron oxides.

Development: A 75-foot drift has been driven southwest along the quartz vein described above.

Production: Undetermined.

References: None.

R.B.S. and C.H.G. 12/17/57

727

Part 3

Limestone, Dolomite, and Cement

Limestone production in Riverside County, a major mineral industry of the county, is estimated to be about one million tons each year. In 1963, most of this limestone was consumed in one portland cement plant, but limestone is also produced for roofing granules, white aggregate, asphalt tile filler, and other industrial purposes. Before the mid-1920's limestone was mined from deposits in the county for use in lime production, and at times limestone from the county has been utilized for poultry grit, beet-sugar manufacture, broken and crushed stone, building and ornamental stone, and flux in iron foundries. In addition to these deposits and the deposits being currently quarried, the county contains substantial, but largely undeveloped, reserves of carbonate rocks. Apparently some of these carbonate bodies are composed of industrial grade limestone, but in other bodies limestone and dolomite are too complexly intermixed to permit exploitation of either limestone or dolomite. Large masses of high-grade dolomite have not been reported.

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In 1963 some of the deposits suitable for industrial use still were too remote or inaccessible to be of immediate commercial interest but some probably will be placed in production within a few years. Because limestone and cement producers in Riverside County number fewer than three in each reportable category, production figures ~~(In 1931 were included with barite, gypsum, iron ore, peat, petroleum, and wollastonite, which had a combined value of $33,769,768.)~~ have been concealed under unapportioned since 1912.

Commercial limestone production in Riverside County probably began about 1890 with the inception of a small lime industry. By 1895 several small kilns were operating in the northwestern San Jacinto Mountains in the vicinity of Lamb Canyon. At Crestmore, in 1905, two kilns were operating and the lime, about 75,000 barrels of which had been produced at that quarry, was known as "Lily White" lime. Stone from the Crestmore deposits also had been utilized for sugar-beet refining as well as for building and ornamental stone. Nearby deposits in the Jurupa Mountains have also been utilized for cement manufacture at Crestmore, and in recent years have been a source of roofing granules and white aggregate.

The portland cement industry in Riverside County began in 1909 when the Riverside Cement Company completed a dry-process plant at Crestmore. In 1958 an extensive modernization and expansion program was started at Crestmore and was nearing completion by the end of 1963. In mid-1961 a new white cement plant, built adjaceht to the existing gray cement plant, went on stream. This plant is one of only 5 white cement plants in the United States and was the first new white cement plant built in this country in many years.

figure 50

730

For many years before 1942 the City of Riverside mined limestone from The New City quarry on Central Avenue for use in oil and macadam construction of city streets. Poultry grit was mined from a nearby deposit during 1933-1945. One deposit in the Jurupa Mountains west of Riverside was also mined for poultry grit in the late 1920's as were two deposits in Bautista Canyon southeast of Hemet. In the mid 1940's the Jurupa Mountain deposit was a source of foundry stone.

Since the 1950's limestone deposits near Nightingale at the north margin of the Santa Rosa Mountains have been under development as a source of roofing granules, ornamental stone, and other limestone products. Similar developments are under way in the Big Maria Mountains, a few miles northwest of Blythe at the east end of the county.

Limestone and dolomite bodies in Riverside County are parts of roof pendants of metamorphosed sedimentary rocks which have been intruded by granitic rocks. The metamorphic rock masses include quartzite, schist, hornfels, and contact-rocks, as well as the carbonate rocks, which are minor in most pendants. Few of the metamorphic bodies have been mapped in detail and little direct evidence of the age of the original strata has been found, but all apparently are pre-Cretaceous in age.

Most of the carbonate rock deposits in Riverside County occur in three areas, the northwestern tip, the west-central part, and the northeastern part of the county. In the northwestern tip of the county isolated roof pendants containing limestone-bearing metamorphic rocks of Mesozoic or Paleozoic age occur at Crestmore and in the Jurupa Mountains. To date these deposits provide the principal source of commercial limestone in the County. Several large undeveloped deposits exist in the northern and southern parts of the San Jacinto Mountains in the west-central part of the county. Among the more promising of these are the Guiberson and Sims deposits at the low north edge of the San Jacinto Mountains, and the Whitlock deposit high in the southern part of the mountains. These deposits apparently contain high-calcium, low-iron limestone, but also contain intermixed dolomite and dolomitic limestone. In the northern Santa Rosa Mountains limestone deposits near Nightingale have been mined intermittently on a small scale in recent years and significant reserves of high-quality limestone

apparently remain. These carbonate bodies, as well as numerous smaller bodies in the Santa Rosa and San Jacinto Mountains, are part of a thick and widely exposed sequence of pre-Cretaceous metamorphic rocks that is composed of mica schist and quartzite. Extensive deposits of limestone, dolomite, and dolomitic limestone occur in the Big and Little Maria Mountains in the northeastern part of Riverside County, about 15 miles northwest of Blythe. These deposits, of the Paleozoic(?) Maria Formation, are included in a thick sequence of quartzite, wollastonite-bearing rock, and schist. During the past several years efforts have been made to develop these deposits as a source of roofing granules and other limestone products. In the north-central part of the county carbonate rocks occur in the Eagle and Little San Bernardino Mountains, but large masses of pure limestone or dolomite are not presently known. These deposits, except for one or two small roofing granule operations during the 1950's, are undeveloped.

733

Best Ranch Deposit

This report is based largely on information contained in a recently-published description by Engel, Gay, and Rogers (1959, p. 97-99).

Location: Sec. 28, T. 5 S., R. 4 W., S.B.M., U.S. Army Corps of Engineers ~~Lake~~ Elsinore quadrangle, 1942; about 2½ miles northeast of Elsinore, and one mile southeast of Highway 74.

Ownership: John A. Snyder, Route 2, Box 220, Perris, holds (1959) patent to 160 acres including the old quarry site and kilns.

History: Two stone kilns, each about 25 feet tall, stand about 150 feet northwest of the deposit. Made of country rock, the kilns were built sometime prior to 1890, and reportedly produced a good quality of lime (Goodyear, 1890, p. 151). A plan to manufacture hydraulic cement was unsuccessful and the property has been idle since 1890.

734

Geology: A discontinucus line of elongate limestone bodies strikes N. 75° W. parallel to the bedding of surrounding slate. The deposit dips about 50° N.E. Though limestone is exposed through a strike distance of half a mile or more, only the largest body, measuring about 75 feet in maximum width and 100 yards or more in exposed length, was developed. The adjacent outcrop, about 200 yards to the northwest, is approximately 50 feet wide and at least 100 feet long. Outcrops are partially obscured by soil.

The limestone is massive, light- to dark-gray and characteristically mottled. It is pre-Cretaceous in age. An undetermined but apparently small proportion of dolomitic material is present locally. Silica is present in the form of cherty and jaspery streaks and small pods as much as several inches wide and several feet long. Silica increases in abundance towards the east end of the main outcrop. Abundant unoriented silky sheafs of tremolite blades occur in at least one zone that covers an area of about 75 square feet near the southern edge of the main outcrop. The limestone is silicified adjacent to a steeply dipping aplite dike which strikes N. 80° W. across the southern margin of the main body.

735

Development: A five-foot pit and a bench 20 feet long and as deep as 8 feet are cut in the west end of the main outcrop. A 60-foot crosscut adit driven S. 30° W. through the next outcrop to the northwest established a 50-foot width of limestone at a depth of 15 feet.

Production: Undetermined. The small size of the quarry and unworn condition of the kilns indicate that very few tons of lime were produced.

References: Goodyear, 1890, p.151; Engel and others, 1959, p. 97-99, pl. 2.

736

Big Maria Mountains Limestone Deposits

Location: Secs. 20, 21, 22, 27, 28, 34, 35 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mts. quadrangle, 1951; about 15 miles northwest of Blythe on the western slope of the central part of the Big Maria Mountains, about 5½ miles east of Inca.

Ownership: California Limestone Products, 139 South Beverly Drive, Beverly Hills holds claims totaling over 3,000 acres in the Big and Little Maria Mountains. In 1962 the General Minerals Corporation, 300 Sixteenth Street, Denver, Colorado (P.O. Box 13, Blythe) leased placer claims totaling 3,560 acres from California Limestone Products. In 1965 the property was reported purchased by Chas. Pfizer & Co., Inc., P.O. Drawer AD, Victorville, California 92392.

737

History: Development of these properties by California Limestone Products started in 1951, when the company was incorporated. They continued active development work throughout the 1950's and sought to develop markets for ornamental marble, terrazzo chips, roofing granules, and lime. Limestone products, however, apparently were never marketed by California Limestone Products who were chiefly engaged in mining manganese and in the development of wollastonite for use in the manufacture of rock wool. Since 1962 the General Minerals Corporation has been developing the limestone deposits for terrazzo chips, roofing granules, poultry grit, and other limestone products. In February 1963 they had a small grinding plant in operation at the former Woolstone Corporation plant in Blythe located near Midland Road and the Santa Fe Railroad (NE¼ sec. 6, T. 6 S., R. 23 E., S.B.M.).

Geology: Extensive deposits of limestone, dolomite, and dolomitic limestone occur in the Big Maria Mountains. These deposits are included in a thick sequence of quartzite, wollastonite-bearing rock, and schist of the Paleozoic (?) Maria Formation which has been much deformed. Carbonate rock bodies are as much as 3 miles long and one mile wide, and irregularly-shaped carbonate bodies are as much as 2 miles in diameter. Bodies which are chiefly limestone are as much as 1½ miles long and half a mile wide. Some crystalline limestone masses locally contain gypsum and there are large bodies of siliceous dolomite with quartzite. The principal limestone bodies observed, and which apparently lie within California Limestone Products properties, are mostly in sections 21, 27, 28, and 34, 35 (proj.), T. 4 S., R. 22 E., S.B.M. In sections 34 and 35 (proj.) white to buff, fine to medium crystalline limestone crops out in a northwest-trending and gently northeast-dipping layer more than 1½ miles long and ranging from 500 to 2,000 feet in width. About one mile to the northwest in sections 21, 27, and 28 (proj.) a sequence of metamorphic rocks strikes northwest and dips

about 50° northeast. Here the basal unit is a limestone layer about 100 feet thick and exposed along the strike for about 3,000 feet. This lower limestone is overlain by 500 feet of quartzite, schist, and wollastonite-bearing rock which is overlain by an upper limestone unit. This upper limestone layer ranges from 800 to 2,000 feet in width and has a strike length of about 8,000 feet. It is intruded by dark sills and faulted against schist. The lower carbonate unit (in secs. 27, 28; samples 1-4 below) is white to faintly salmon, massive, dense, fine to medium crystalline limestone and dolomite which weathers buff or light tan. The lower 150 feet (of an 800-foot wide exposure) of the upper carbonate unit (in sec. 21; samples 5-8 below) is off-white to white, massive, dense, fine to medium crystalline limestone, with some friable layers. Eight samples collected by the Division of Mines in March, 1956, and chemically analyzed by Abbot A. Hanks, Inc., San Francisco, were as follows:

740

Location	Sample no.	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	P_2O_5
Lower limestone unit, secs. 27, 28, T4S, R22E, SBM. Type grab spls. from 100-ft. section.	1	1.31%	0.11%	0.22%	54.41%	0.35%	0.01%
	2	0.42	0.15	0.17	30.05	21.67	0.02
	3	0.12	0.15	0.34	55.28	0.22	0.01
	4	0.33	0.18	0.40	54.92	0.29	Trace
Upper limestone unit, sec. 21, T4S, R22E, SBM. Type grab spls. from 150-ft. section	5	2.94	0.11	2.76	47.69	3.92	0.16
	6	1.81	0.11	1.61	52.53	0.96	0.11
	7	7.20	0.16	4.58	48.80	0.29	0.10
	8	2.87	0.11	3.18	48.20	3.34	0.12

Development: Open cuts and prospect pits.

Production: Undetermined. Probably a few thousand tons, or less.

References: none.

C.H.G. 8/20/63.

741

Blind Canyon Deposit

Location: SE¼SW¼ sec. 18, T. 2 S., R. 5 E., S.B.M., Palm Springs quadrangle, 15' 1957; south margin of the Little San Bernardino Mountains on the west side of Blind Canyon, 2 miles north of Desert Hot Springs.

Ownership: Metropolitan Water District of Southern California, 306 West Third St., Los Angeles.

History: During 1960 a small tonnage of limestone was quarried for roofing granules and/or ornamental stone and used in the Desert Hot Springs area. Idle 1961.

Geology: An irregular lens-shaped pendant of pre-Cretaceous impure limestone of the Chuckwalla complex strikes northwest along the ridge west of Blind Canyon. The limestone body has a maximum width of 500 feet and a length of 1,500 feet, but is interlayered with biotite schist and contains fingers of granitic rock. The limestone is fine to coarsely crystalline and is discolored along yellow-green serpentinized zones, but contains small patches of white material.

Development: Several faces in a small canyon have been blasted down, but there is no regular quarry.

Production: Undetermined, but apparently only a few tens of tons.

References: None.

C.H.G. 5/20/61.

742

Castro Quarry (Magstone Products)

Location: N½N½NW¼ sec. 1, T. 3 S., R. 5 W., S.B.M., Riverside East quadrangle, 7½', 1953; isolated, low hill, a quarter of a mile east of the intersection of Arlington Avenue and the Gage Canal, in the City of Riverside.

Ownership: Loren Creed, Riverside (1945). Undetermined (1963).

History: Apparently the Castro quarry is the site of the former Magstone Products operation described by Tucker and Sampson (1945, p. 173). From 1938 to 1945 Howard Small, Riverside, operating under the name Magstone Products, was a producer of limestone. The stone was hauled to a plant on North Main Street in Riverside where it was crushed and screened. The material was sold as poultry grit and as limestone flour for use in poultry feeds. In 1945 the plant had a capacity of 8 tons per day. Production has not been reported since 1945 and the quarry has apparently been idle since that date. Residential construction was underway adjacent to the quarry in 1963 and it appears unlikely that the quarry will be reopened.

Geology: The quarry area is underlain by poorly exposed pre-Cretaceous limestone, schist and skarn intruded by quartz diorite. Larsen (1951, plate 1) assigned the metamorphic rocks to the Paleozoic, and the intrusive rocks to the Cretaceous Bonsall Tonalite. The metamorphic sequence strikes about N. 35° E. and appears to dip about 50° SE. The limestone is medium to coarse crystalline, gray to white. The exposed mass of limestone and skarn is 400 feet long and 30 to 45 feet wide. The limestone is in two bodies, a north body about 350 feet long and 25 to 45 feet wide, and a small south body about 35 feet long and 10 feet wide. The two limestone bodies are separated by about 20 feet of skarn.

Development: Three side-hill cuts have been made in the limestone. The south mass and adjacent skarn contains one irregular quarry about 80 feet long more or less along the strike, and 5 to 20 feet wide. About 100 feet to the north an irregular quarry across the north mass is about 40 feet by 45 feet; 70 feet north of this quarry is a semicircular quarry about 40 feet long on the strike of the limestone and about 20 feet wide.

744

Production: Total undetermined, probably a few thousands of tons.

References: Tucker and Sampson, 1945, p. 173; Logan, 1947, p. 271; Larsen, 1951, plate 1.

C.H.G. 7/31/63.

Glen Avon (Mathews, Mira Loma) Limestone Deposit

Location: SW¼ sec. 2, T. 2 S., R. 6 W., S.B.M., San Bernardino quadrangle, 1954; southern slope of the western Jurupa Mountains, north of Glen Avon Heights at the north end of Fleming Street and about 7 miles northwest of Riverside.

Ownership: Mark Tungate, 275 Larchmont Blvd., Los Angeles (1942). Undetermined (1963).

History: Quarry opened about 1928 by W. B. Mathews, 1032 North Oakland Street, Pasadena. For several years limestone was shipped to Los Angeles where it was ground for poultry grit. After a long period of idleness the property was again active in 1942 and was then known as Mira Loma Dolomite. Miller Brothers Truck Company was the operator in 1942 and was shipping rock at $4.75 per ton to Bethlehem Steel Company and other iron foundries in Los Angeles. A crushing and screening plant was located just below the quarries. The property has been idle since before 1950.

746

Geology: Limestone occurs in two parallel lens-like bodies within a bedded sequence of siliceous metasedimentary rocks. This metamorphic sequence has been termed the Jurupa Series of questionable Paleozoic age, but some workers believe it may be Triassic (Mackevett, 1951, 14 p.). The limestone bodies dip steeply north and strike nearly due east. They have maximum exposed dimensions of about 1,000 feet long and 80 feet wide, and are separated by about 60 feet of schist. In places the limestone has been intruded by small fingers of granitic rock. The limestone is light gray to white, medium- to coarse-grained crystalline material, and is faintly banded.

747

Development: The upper limestone body has been mined at its east end by means of two open cuts parallel to the strike of the body. Each cut is about 150 feet long, 25-30 feet wide with 30-foot maximum depth. About 500 feet downslope to the southwest the lower limestone body has been explored by two small circular quarries, each about 20 feet in diameter and 20 feet deep.

Production: In mid 1929 shipments of 150 tons per month were made to Los Angeles and total shipments to that time were 500 tons. In September, 1942, shipments were 500 tons per month. Later shipments, if any, unknown. Total production probably no more than several thousands of tons.

References: Tucker and Sampson, 1929, p. 516; Tucker and Sampson, 1945, pl. 35, nos. 239, 240; Mackevett, 1951, 14 p., pl. 1.

C.H.G. 1/21/63.

748

Guiberson (Whitewater) Deposit

Location: SE¼ sec. 22, NW¼SW¼ sec. 23, T. 3 S., R. 3 E., S.B.M., Palm Springs quadrangle, 15' 1957; steep north margin of the San Jacinto Mountains, adjacent to San Gorgonio Wash three quarters of a mile south of Palm Springs Station, within the Palm Springs city boundary.

Ownership: S. A. Guiberson, 1000 Forrest Avenue, Dallas, Texas (1945). Undetermined (1963).

History: In 1894 (Crawford, p. 393) mentioned an undeveloped "white marble" at this location. By 1929 this property, which included 160 acres, had been explored by means of three adits driven south from San Gorgonio Wash and a number of open cuts. During the 1930's the Metropolitan Water District of Southern California examined the deposit (5 drill holes were put down) to determine its suitability for the manufacture of portland cement to be used in construction of the Colorado River Aqueduct. In 1955 the United States Cement Corporation examined the area in connection with their proposed cement plant near Cabazon. Opposition by residential property interests was the announced reason for abandoning the project. Apparently such continuing opposition precludes the exploitation of this deposit.

Geology: A sequence of pre-Cretaceous schists and carbonate rocks strikes about N. 50° W. and dips 65° NE. The limestone is white to gray and medium to coarsely crystalline. In places thin limestone beds 2-10 feet thick occur interbedded with mica schist, but much of the carbonate rock is massive and uncontaminated by other sediments. The limestone is, however, in some places contaminated by granitic dikes, dolomite, and schist. On the Guiberson property the area which is underlain mostly by carbonate rock is about 1,500 feet long and has a maximum width of 1,000 feet. This carbonate mass extends southeast into the Southern Pacific deposit (see herein) and the entire mass is about 4,000 feet long with a maximum width of 1,250 feet. According to Tucker and Sampson (1945, p. 172) five drill holes on the Guiberson property penetrated a maximum thickness of 110 feet of limestone, and that was not continuous. Reserves of carbonate rock are large but the quality of rock throughout the deposit is not known. Tucker and Sampson (1929, p. 516) listed one analysis as follows: SiO_2, 0.74%; Al_2O_3, 0.004%; Fe_2O_3, 0.009%; CaO, 53.29%; MgO, 2.39%.

750

Development: Three short adits and a number of open cuts.

Production: By 1947 no production of limestone had been reported from this deposit, and apparently there has since been none.

References: Crawford, 1894, p. 393; Tucker and Sampson, 1929, p. 515-516; Tucker and Sampson, 1932, p. 6, pl. 1; Tucker and Sampson, 1945, p. 172; Logan, 1947, p. 271).

C.H.G. 7/2/63.

Jensen Quarry

Location: SW¼ sec. 5, T. 2 S., R. 5 W., S.B.M., San Bernardino quadrangle, 15' 1954; southeastern part of the Jurupa Mountains, half a mile north of Sunnyslope and about 4 miles northwest of Riverside.

Ownership: Riverside Cement Company, Division of American Cement Corporation, Mill Office, P.O. Box 832, Riverside.

752

History: Jensen quarry was apparently opened during World War I by the Riverside Cement Company as a source of limestone for the company's cement plant at Crestmore, 2½ miles to the east. The quarry was shut down in 1927 and large-scale operations were not resumed until 1948 when Jensen quarry again became the major source of limestone for the Crestmore plant. In February 1954, the underground mine at Crestmore was shut down and Jensen quarry supplied all the limestone until March, 1955 when work started on a new underground mine at Crestmore. This mine went on full production in June, 1956 and limestone from the Jensen quarry has not since been utilized for portland cement manufacture. From 1953 to 1960, Sno-Top Rock Products Company produced limestone roofing granules and fines for asphalt tile filler and other industrial purposes from Jensen quarry at a small crushing and screening plant on the property. In November 1961, this operation was taken over by Snow Rock (see herein) who early in 1963 were producing white aggregate from the Jensen north quarry.

Geology: Limestone, associated with siliceous metamorphic rocks and intruded by Cretaceous Bonsall Tonalite, crops out in the quarry area over a crudely triangular-shaped area about 2,000 feet by 1,500 feet in plan. The limestone bodies strike northeast, dip 60°-80° S.E., and have apparent maximum thicknesses of at least 200 feet. The metamorphic complex has been termed the Jurupa Series of questionable Paleozoic age but some workers believe it may be Triassic in age. The limestone crops out boldly, is white, and is mostly medium- to coarse-grained calcite. Abundant graphite is disseminated in some of the limestone beds, and periclase, brucite, and hydromagnesite also occur. Rarer minerals such as spinel, pyrite, and diopside also occur and the mineral assemblage has been listed by Cooney (1956). Two undeveloped limestone bodies crop out in the SE¼ sec. 6 west and south of the Jensen quarry. The larger body is about 1,500 feet west of the quarry. It trends nearly north and is about 750 feet long and 350 feet wide. About 2,500 feet southwest of the quarry a somewhat hourglass-shaped body trends northeast and is about 1,000 feet long and ranges from less than 100 feet to more than 400 feet in width.

754

Development: The quarry includes three principal workings: the south quarry, the main quarry, and the north quarry. The south quarry is about 320 feet long in an easterly direction and 200 feet wide with maximum height of faces about 100 feet. The main quarry, in the central part of the limestone area and which furnished most of the limestone for cement manufacture since 1948, is nearly 450 feet long in a northwesterly direction and 200 feet wide. The north face is 230 feet high and the south face is about 100 feet high. The north quarry is irregular but has a total length of nearly 1,000 feet and has a steep southern face with maximum height of about 150 feet. This is the only quarry presently active (January, 1963) and is quarried by Snow Rock for white aggregate.

Production: Total production is undetermined, but apparently is several million tons. Early in 1963 production was about 100 tons per day.

References: Mackevett, 1951, 14 p.; Cooney, 1956.

C.H.G. 1/21/63.

Lamb Canyon (Snyder) Deposit

Location: NE¼SW¼, NW¼SE¼, sec. 32, T. 3 S., R. 1 W., S.B.M., Lakeview quadrangle, 7½', 1953; about 5 miles southwest of Beaumont in the northwestern San Jacinto Mountains on the east side of Lamb Canyon, near the crest of a prominent west-trending ridge.

Ownership: Undetermined.

History: The Lamb Canyon deposit probably was the source of limestone for Snyder's Kilns which in 1906 (Aubury, p.76) were reported to be 7 miles north of San Jacinto and operated by Ferdinand Snyder. The deposit was opened about 1896 and probably closed down shortly after 1906 and apparently has since remained idle. Two large steel-shell lime kilns are still standing on the south side of lower Lamb Canyon, about three quarters of a mile southwest of the quarries. The kilns were fired by wood, and the product was reported to be an excellent lime for sugar refineries.

Geology: Pre-Cretaceous limestone occurs in discontinuous lenses interbedded with mica schist and intruded by granitic rocks. This deposit, as well as a number of other limestone lenses, is part of a large mass of metamorphic rock that extends about 8 miles southeast from north of Lamb Canyon to Soboba Hot Springs. Several small layers of blue-gray to gray and white, fine to medium grained, crystalline limestone are exposed in two quarries and adjacent road cuts. The beds strike N. 55° W., and dip 55° NE. Although the rock appears to be high-calcium limestone all of the bodies observed are too small for economic operation. The sequence exposed in the road slot along the east side of the west or lower quarry from south to north is as follows: granite and schist; blue-gray limestone with minor schist and granite interleaves, 90 feet; gneissic granite, 30 feet; gray to white limestone, 30 feet (the layer that was mined); schist and granite containing about 6 thin limestone layers ranging from one foot to 4 feet in thickness, 200 feet. The limestone layers are exposed for a strike

length of about 250 feet in the quarry and road cut. About 500 feet to the northeast a second sequence of schist and limestone, parallel to the first sequence, is exposed in a shallow road cut. Here three beds of gray to white, fine to medium grained, crystalline limestone are exposed over a distance of about 150 feet. The limestone beds are 3 to 4 feet thick and are interleaved with schist and intruded by granite. The beds can be traced along their strike up the ridge to a second quarry (east or upper quarry) about 500 feet southwest of the road cut.

Development: The west quarry, adjacent to the road, is a side-hill cut about 50 feet long, 50 feet wide, with face 25 feet high. The east quarry, above the road, is a side-hill cut about 50 feet long and 15 feet deep.

Production: Undetermined, probably no more than a few thousands of tons.

References: Aubury, 1906, p. 76; Logan, 1947, p. 271.

C.H.G. 7/2/63.

Marl and Travertine Deposits North of Blythe

Marl and travertine have formed local caps, flanking sheets and buttressed benches (~~fig.~~ Photo 1 /) on spurs and foothills along the south and east flanks of the Big Maria Mountains, and the south, east, and north flanks of the Riverside Mountains; two arid ranges lying north of Blythe. These deposits are the remnants of a shore line of Pliocene(?) age, possibly that of a former, more northern lobe of the Gulf of California (Hamilton, 1960, p. 276-277). The marl appears once to have been beach or near shore sand composed almost entirely of marine shells, shell fragments, and the tests of microorganisms. The travertine was probably the result of the precipitation of calcium carbonate from saturated, saline water. Many of these deposits grade downward into subjacent alluvium and talus and at some localities the interface between cemented debris and underlying loose regolith has been the site of deposition of manganese oxides.

To the date of the field visit (~~1958~~) these unusual deposits of calcium carbonate have been exploited in only a small way as a source of dimension stone (~~fig.~~ Photo 2 /) and manganese ore. A local demand for agricultural marl is unlikely because of the natural alkalinity of soils in the Palo Verde Irrigation District.

References: Hamilton, 1960, p. 276-277; Thomas 1961, p. 69.

R.B.S. 4/10/58

T60

Moore Limestone Deposit (Bautista Canyon Deposits)

Location: NE¼NE¼ sec. 34, T. 5 S., R. 1 E., S.B.M., Hemet quadrangle, 1957; about 7½ miles southeast of Hemet on the west side of Bautista Creek, about 1,500 feet west and 300 feet above the Bautista Creek road.

Ownership: Undetermined.

History: Deposit was quarried on a small scale in the middle 1920's by J. S. Moore, Winchaster. Probably the rock was crushed and marketed as poultry grit. By 1929 the property was idle and apparently has since remained idle.

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Geology: Pre-Cretaceous limestone occurs in discontinuous lenses and bunches interbedded with mica and hornblende schist and intruded by granitic rocks. The metamorphic sequence strikes northwest (roughly parallel to the trend of Bautista Canyon) and dips 65°-75° NE. Two lenses of fetid, coarsely crystalline, white to light gray limestone with some associated tactite, hornblende schist, and hornfels crop out across a southwest-trending gulch. The lower lens is 20-30 feet thick and extends both north and south of the gulch. The upper lens is separated from the lower lens by 50-100 feet of schist and granitic rock. This upper lens is best exposed along a fire break at the ridge top where the lens may have a maximum thickness of 100-125 feet. It does not appear to have much strike length and seems to pinch out rapidly to the south. Ground water has discolored the limestone to red an unknown depth from the surface and the rock is extensively fractured. Some of the limestone is graphitic and some is sky-blue

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similar to Crestmore rock. Reserves cannot be estimated without further development work and intrusions of granite may be encountered. Two random type samples collected by the Division of Mines in 1953 and chemically analyzed by Abbot A. Hank, Inc., San Francisco showed the material to be dolomitic as follows:

Sample No.	Insoluble	Fe_2O_3 and Al_2O_3	CaO	MgO	P_2O_5
B.C.-N1	11.46%	0.60%	38.92%	8.65%	0.12%
B.C.-N2	0.86	0.38	50.00	4.89	0.17

Development: Side-hill cut 50 feet long with face 20 feet high. Rock was lowered from the quarry to truck at road level by means of a gravity incline tram car. Apparently this was a small scale hand-methods quarrying operation.

Production: Undetermined, probably no more than a few hundred tons.

References: Tucker and Sampson, 1929, p. 516; Tucker and Sampson, 1932, p. 7, pl. 1; Tucker and Sampson, 1945, p. 172; Logan, 1947, p. 272.

C.H.G. 7/2/63.

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New City Quarry

Location: S½ sec. 36, T. 2 S., R. 5 W., S.B.M., Riverside East quadrangle, 7½', 1953; northeast-trending, isolated hill on the north side of Central Avenue, three quarters of a mile east of Victoria Avenue in the City of Riverside.

Ownership: Undetermined (1963).

History: During the period from about 1930 to 1942 the City of Riverside quarried limestone for use in oil and macadam construction of city streets. Many of these streets are still in use in 1963, and apparently will continue to be serviceable for many years. The quarry was shut down because of World War II and apparently has not been reopened, but small amounts of remaining loose material may have been used intermittently. During the 1950's extensive residential construction began in the area and by 1963 the deposit was surrounded by homes and the floor of the old main quarry was occupied by a swim club. Future quarrying appears unlikely.

Geology: The quarry and adjacent hill are underlain by a sequence of pre-Cretaceous metamorphic rocks intruded by hornblende-biotite-quartz diorite. Larsen (1951, plate 1) mapped the metamorphic rocks as Paleozoic and assigned the intrusive rocks to the Cretaceous Bonsall Tonalite. The metamorphic sequence strikes about N. 40° E., dips 45° to 70° SE. and has a surface exposure of about 1,500 feet along the strike and a width of about 300 feet. The maximum true thickness of the metamorphic rocks is 200 feet at the south end of the deposit and thins to about 130 feet at the north end. The sequence exposed at the south end of the deposit, from west to east is: quartz diorite; limestone and predazzite, 40 feet; quartz diorite, 15 feet; pyroxene hornfels, 25 feet; quartz diorite, 10 feet, skarn, 5 feet; limestone and predazzite, 105 feet; quartz diorite. The limestone is medium to very coarse crystalline, white, gray, and light blue-gray. The maximum thickness of the west layer of limestone is about 40 feet and the east layer is about 120 feet in maximum thickness. At the north end of the deposit the west layer of limestone thins to less than 10 feet thick and the east layer thins to about 25 feet. Along the west edge of the east limestone layer is a thin garnet-pyroxene skarn zone, in most places about 2 feet thick. A number of minerals have been found in the quarry area and some have been reported by Murdoch and Webb (1955).

Development: Most of the quarrying was in the east limestone layer from one irregular side-hill quarry about 1,000 feet long opened on the south end of the deposit and extending along the strike of the limestone. This quarry was about 200 feet wide and had several irregular bench levels. At the north end of the deposit both the east and west limestone layers have been quarried from a side-hill cut about 200 feet long across the stike of the limestone layers and 150 feet wide. During the period of greatest activity in the middle 1930's crushing, sizing, and storage facilities were located at the quarry.

Production: Total undetermined, probably a few tens of thousands of tons each year during the 1930's. Apparently all of the limestone was used as broken and crushed stone in street construction.

References: Larsen, 1951, plate 1.

C.H.G. 7/30/63.

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Nightingale Limestone

Location: Secs. 6, 8, 9, 10, 11, 12, T. 7 S., R. 5 E., S.B.M., Idyllwild quadrangle, 15' 1959, and Palm Desert quadrangle, 1959; on the north and northeast flanks of the Santa Rosa Mountains astride State Highway 74 at Nightingale.

Ownership: Palm Canyon Rock Products, Inc., 865 North Palm Canyon Drive, Palm Springs, holds an undetermined number of claims (known as the Beckelman-Lucas limestone deposit) in section 6 at the head of Palm Canyon. Henry B. Tuttle and Associates, 218 S. Palm Canyon Drive, Palm Springs, hold claims in the N½ sec. 8, under the name White Ridge Dolomite Claims. Section 9 is owned in part by Palm Springs Alpine Estates. In section 11, at the head of Deep Canyon, 50 acres of rugged terrain are owned by the H. T. Lucas Mining Company, 1534 North Hobart Blvd., Los Angeles 27.

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History: Limestone in the Nightingale area has been known for many years (Merrill, 1917 [1919], p. 551, fig. 4). Parts of these deposits have been known as Pinyon Flat, Harris, and Big Hill Deposits (Tucker and Sampson, 1945, pl. 35, no. 233, no.236; Logan, 1947, p. 271-272). In 1946 Wright (pl. 1) mapped the limestone exposed in T. 7 S., R. 5 E. The Lucas Mining Company developed their property in Deep Canyon since World War II and it was probably most active during the 1950's. A crushing and grinding plant was built at the quarry site but was abandoned in 1957 in favor of their present plant near Thousand Palms. In 1958 this operation was leased by Imperial Limestone Products, Inc., who operated the property until 1960 when the operation was again assumed by the H. T. Lucas Mining Company. This property has apparently been intermittently active since 1960.

Roofing granules and decorative stone have been the chief products to date.

Geology: The Nightingale limestone deposit is part of a narrow belt of carbonate rock which is irregularly exposed for a distance of about 6 miles from the head of Palm Canyon southeastward across the head of Deep Canyon and thence into Horsethief Creek. The limestone is part of a metamorphic sequence composed mostly of schist and gneiss which continues southeastward across the divide between Toro Peak and Martinez Mountain, and down the southwest side of Black Rabbit and Martinez canyons and on into San Diego County. In the Nightingale area Wright (1946, p. 11) estimated the thickness of the limestone unit to be as great as 200 feet. In the east part of section 6 the maximum width of outcrop is about 1,300 feet. The strike of the metamorphic rocks ranges from north, in Palm Canyon, to easterly in the Nightingale area. Dips range from about 30° east to 40° north. This and other similar limestone units are part of an extensive irregular mass of metasedimentary rocks named the Palm Canyon Complex by Miller (1944). Miller considered these rocks to be Paleozoic in age and they are intruded by Mesozoic granitic rocks of the southern California Batholith. Locally, especially in the Martinez Canyon area, the limestone is altered to impure marble and tactite. In the Nightingale area the limestone is white, medium to coarse grained, and, though strongly sheared, large masses contain no visible impurities.

The following data, submitted by Mr. Harry Beckelman, Palm Canyon Rock Products, Inc., is an analysis of one sample by The Eisenhauer Laboratories, Los Angeles, February, 1959: $CaCO_3$, 99.94%; CaO, 55.57%; MgO, 0.21%; Mg, 0.10%; Fe_2O_3, 0.04%; Al_2O_3, 0.06%; SiO_2, 0.43%; acid insolubles, 0.43%; H_2O, 0.27%; loss on ignition, 43.78%; specific gravity, 2.7; hardness 3.2.

Development: To date (1936) [63] the principal site of mining has been a series of open cuts and benches, with faces as much as 75 feet high, extending through a horizontal distance of about half a mile in sections 11 and 12 on the Lucas property. In June, 1958, blasted rock was being handled with a front-loading dozer, a shaker screen, and belt loader, the raw product being trucked to the H. T. Lucas Co. roofing granule plant near Thousand Palms (Photo [41]).

Production: A large tonnage of material appears to have been removed from the Lucas property but no accurate total was obtained. Late in 1962 the Thousand Palms granule plant was using about 200 tons of white limestone a month; a demand which required only sporadic quarrying.

References: Merrill, 1917 [1919], p. 91; Miller, 1944, p. 21-25; Tucker and Sampson, 1945, pl. 35, no. 233, no. 236; Wright, 1946, p. 11, pl. 1; Logan 1947, p. 271-272, pl. 37, no. 12.

C.H.G. 8/20/63.

Nonhof Deposit

Location: Sec. 16(?) T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, about 3 miles southwest of Corona in the vicinity of Hagador Canyon. Location not verified.

Ownership: E. R. E. Nonhof, 1116 Ramona Avenue, Corona (1924). Undetermined (1961).

History: Mr. Nonhof located one claim in 1915 on which he reported a bold outcrop of "lime", 1,500 feet long, about 70 feet wide, and 50 feet thick; developed by a short adit. The writer was unable to locate such an outcrop in 1953. Ruins of a small lime kiln are said to have been found in upper Hagador Canyon in 1907, but were not identifiable in 1953.

Geology: Several small exposures of pyrite and limonite-bearing medium-grained crystalline limestone crop out, and limy metashales occur in the Triassic (?) Bedford Canyon Formation in the area. Perhaps these materials were the source of "limestone" for the small kiln.

Development: Several short adits, and a number of prospect pits have been opened in the area.

Production: Undetermined.

References: Gray, 1961, p. 116-117.

C.H.G. 3/3/61

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Riverside Cement Company, Division of American Cement Corporation (Crestmore) Deposit and Plant

Location: W½ sec. 2 (proj.), E½ sec. 3, T. 2 S., R. 5 W., S.B.M., San Bernardino quadrangle, 1954; about 3 miles northwest of Riverside at Crestmore Siding at the eastern margin of the Crestmore Hills.

Ownership: Riverside Cement Company, Division of American Cement Corporation, Mill office, P.O. Box 832, Riverside.

History: The Crestmore deposit has been mined for more than 60 years. Apparently the deposit was first developed in the late 1890's by the American Beet-Sugar Company and in the early 1900's was operated by the Sky Blue Marble and Onyx Company for building stone and lime (Aubury, 1906, p. 75). In October 1909 the Riverside Portland Cement Company completed a dry-process plant which has since been in continuous operation. The first quarry was opened on Chino Hill and quarrying operations later were extended to the north side of Sky Blue Hill, the northeastern of the twin hills, and the North Star, Lone Star, and Wet Weather quarries were successively opened. (Figure 52) Rip rap was taken from the Commercial quarry on the east side of Sky Blue Hill beginning about 1912, but later limestone from this quarry was used for the manufacture of cement. The Crestmore mine, in which a modi-

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fied block-caving system of mining eventually was employed, was opened in 1927 to extract the Chino limestone beneath the floor of the Chino quarry. The mine was worked through a 5-compartment vertical shaft 350 feet deep and is one of the few operations known to have used block-caving techniques in the mining of limestone. Block caving at Crestmore has been described in detail by Robotham, 1934; Bucky, 1945; Wightman, 1945; and Long and Obert, 1958. In 1941, surface quarries, including the Little Hill or Henshaw quarry in San Bernardino County 1½ miles northwest of the plant, were reactivated to supplement the underground production and in 1948 Jensen quarry (described herein), 2½ miles west of the plant, became the major source of limestone. In February 1954, the Crestmore mine was shut down and Jensen quarry supplied all the limestone until March 1955 when work started on a new underground mine at Crestmore to continue extraction of the Chino limestone. This mine, utilizing a room and pillar system, went on full production in June 1956 and has since supplied all limestone requirements.

The Crestmore plant had a rated annual capacity of 2,000,000 barrels in 1914 and by 1945 was well over 3,000,000 barrels from 13 kilns. Early in 1958, Riverside Cement Company merged with the Hercules Cement Corporation of Pennsylvania and the Peerless Cement Corporation of Michigan and became the Riverside Division of the American Cement Corporation. Plans were announced for extensive modernization and expansion at Crestmore and in 1958 a new administration and laboratory building was completed.

During 1960-61, new secondary crushing facilities, new packaging and storage facilities, and a new white cement plant were completed. The new white cement plant, built adjacent to the existing gray cement plant, was the first new white cement plant built in the United States in many years, and is one of the few in the world and the only United States plant to use the dry process. The white plant went on stream in mid-1961 with a capacity of about 250,000 barrels from one rotary kiln (9 by 253 feet).

Late in 1961, work began on an extensive modernization program for the gray plant including silos and a complete new raw end with blending piles. This construction was completed in 1962 and later phases of the modernization program, which will include first the replacement of the finish end and finally enlargement of raw materials handling capacity and installment of new rotary kilns, were under way.

Geology: At Crestmore, limestone and siliceous metasedimentary rocks occur as a large screen in Cretaceous quartz diorite (Bonsall Tonalite). The metamorphic rocks have been called the Jurupa Series (Daly, 1435, p. 639-642) and are regarded as probably of late Paleozoic or early Mesozoic age. The limestone deposit consists of two roughly lenticular, nearly parallel, bodies which ~~crop out~~ and are separated by about 500 feet of quartz diorite at the surface (Figure 50). The limestone bodies strike north and dip about 45° east. At depth and to the east the dips flatten to about 25-30°, the two bodies thicken, and they are separated by only 100 feet of quartz diorite. This quartz diorite layer is ~~a very~~ important feature as it permits the underground extraction of the lower limestone body without disruption of the upper body, which is overlain by water-saturated alluvium. In the outcrop

area the limestone bodies range in thickness from 200 to 300 feet, in ~~thickness~~ but to the east (down dip) the upper body (Sky Blue Quarry Limestone) is about 500 feet thick and the lower body (Chino Quarry Limestone, also called the Stanley Bed) is nearly 400 feet thick. The bodies extend about 2,500 feet along strike and are cut off at each end by quartz diorite. The limestone in both bodies is white, fine-to coarse-grained crystalline rock and contains varying amounts of brucite; the lower body contains extremely white rock and mill feed averages about 95 percent $CaCO_3$. In addition to being an important source of limestone, Crestmore is a world-famous mineral locality with nearly 150 recognized species. The minerals and geology at Crestmore have been described by many workers including Eakle, 1917; Woodford, 1943; Burnham, 1959; and Murdoch, 1961.

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Development: Since June 1956, all mining has been done by means of an open-stope, room-and-pillar mine. Completed unsupported rooms are about 60 feet wide and 70 feet high and 200 feet or more long, extending horizontally across the width of the deposit. The rooms are mined in two steps with an initial 30-foot cut and then a 40-foot slice is taken from the floor. Drilling is by an Ingersoll-Rand jumbo mounting four 505 wet drifters and by Gardner-Denver Air Trac drills. A Pitman Giraffe, mounted on a diesel truck, is used for loading holes and scaling in the rooms. Roof bolts are used where necessary. After blasting, loading in the rooms is done with Marion 93-M electric shovels equipped with short boom and sticks and a three-yard bucket. Kenworth 802-E electric trucks transport a 30-ton load from the face to the surface up a spiral adit and ramp with 10 percent grade. In 1963, the average length of truck haul is 1½ miles and mining is on the 220-foot level, 680 feet below the surface, (ground elevation at collar of old shaft is 900 feet above sea level).

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The electric trucks dump directly into the 60 by 84-inch primary jaw crusher. Secondary reduction to minus 3/8-inch mill feed is done in a Bulldog center-feed impact mill. These facilities supply both the white and gray plants. Secondary crushing output for gray plant feed is conveyed to a ground storage area where raw materials are automatically stored, blended, and reclaimed. This operation, installed in 1962, utilizes wing-type traveling tripper stackers, continuous samplers, and bucket-equipped digging wheels for reclaiming. From the storage area blended material goes by belt conveyor to the mill-feed bins in the raw grinding department. These operations are handled from a newly installed remote control room. Blended material is fed to 13 rotary kilns (8 feet 10 inches by 125 feet). This dry-process plant has a capacity of about 3,250,000 barrels.

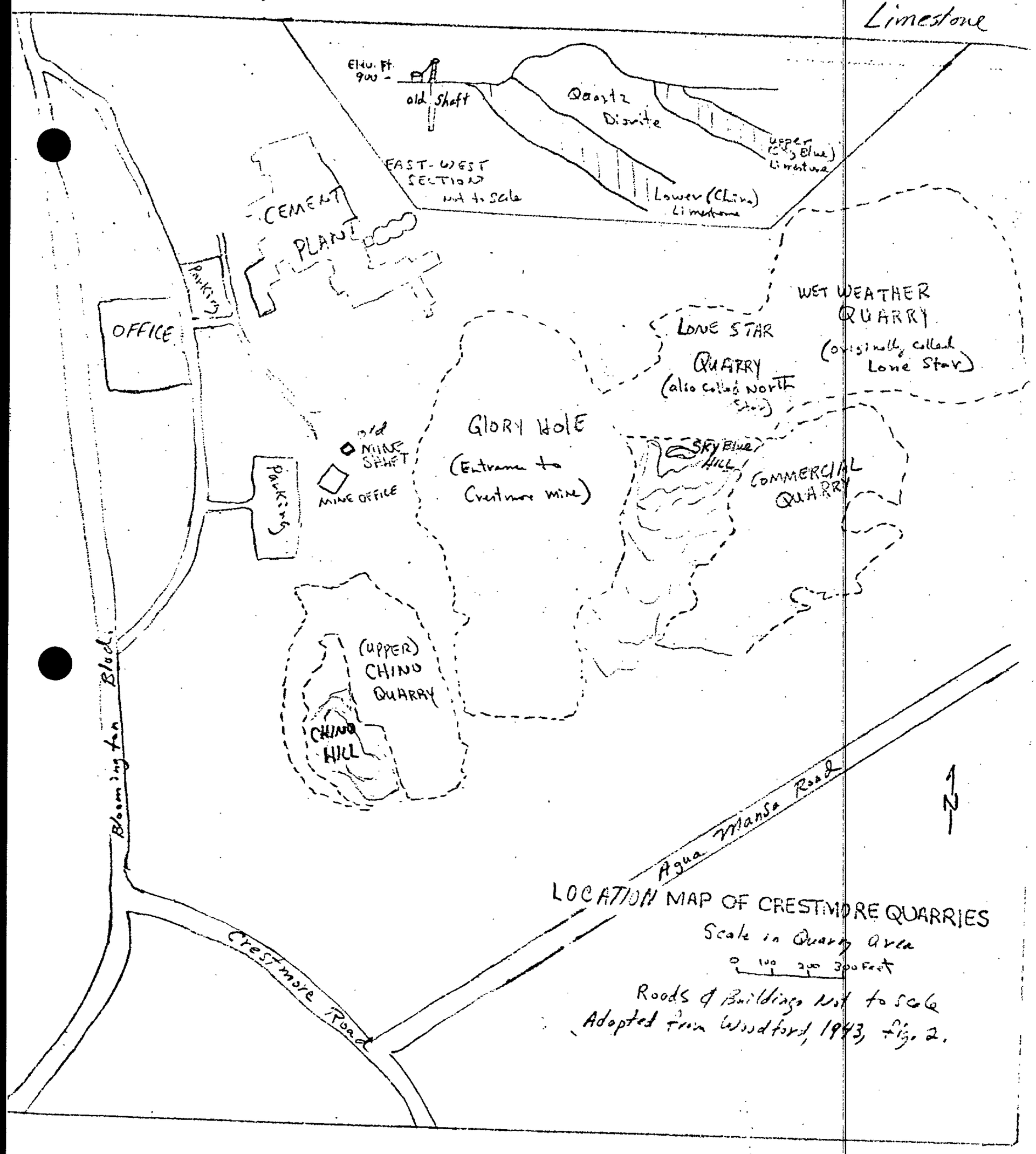
In addition to limestone, raw materials used include: alluvium, from shallow pits just east of the plant; gypsum; iron ore; quartzite; and red clay from a company mine in Temescal Canyon (Corona clay pit, described herein). Special materials used in the white plant include selectively mined white limestone; white silica sand from a company pit in the Corona sand district (Smith silica pit, described herein) and a low iron clay.

The Crestmore plant manufactures portland cement Types I and II, block cement, plastic cement, gun plastic cement, and white cement. These products are marketed in bulk and in bags under the brand names "Riverside" and "Riverside White".

Production: From 1930 to 1954, 7,882,000 tons of limestone and granitic materials were extracted from the Crestmore mine by block-caving methods. Since 1956, production has been about 80,000 tons of limestone per month. Total production not determined.

References: Aubury, 1906, p. 75-76; Merrill, 1917 [1919], p. 555-559; Eakle, 1917, p. 327-360; Tucker, 1921, p. 324-325; Tucker and Sampson, 1929, p. 517-519; Daly, 1931; ~~Daly, 1935, p. 638-659;~~ Robotham, 1934, 20 p.; Daly, 1935, p. 638-659; Woodford and others, 1941, p. 351-381; Woodford, 1943, p. 333-365; Bucky, 1945, p. 114-124; Tucker and Sampson, 1945, p. 173-174; Wightman, 1945, p. 215-224; Logan, 1947, p. 272-273; Burnham, 1954, p. 54-57; Burnham, 1954, p. 61-70; Persons, 1955, p. 76-78; Wightman, 1956, p. 33-36, p. 78; Wightman and others, 1957, p. 450-454; Long and Obert, 1958, 21 p.; Burnham, 1959, p. 879-919; Murdoch, 1961, p. 245-257; Utley, 1961, p. 127-130; Bowen and Gray, 1962 p. 7,10,11.

C.H.G. 2/21/63.



LOCATION MAP OF CRESTMORE QUARRIES

Scale in Quarry Area

0 100 200 300 Feet

Roads & Buildings not to scale

Adopted from Woodford, 1943, Fig. 2.

Figure 50

San Jacinto Rock Products Company's Limestone Deposit (Bautista Canyon Deposits)

Location: SW¼SE¼ sec. 35, T. 5 S., R. 1 E., S.B.M., Hemet quadrangle, 1957; about 8 miles southeast of Hemet on the west side of Bautista Creek on a steep hillslope, 150 - 200 feet above the creek level.

Ownership: San Jacinto Rock Products Company, G. W. Green, president, San Jacinto held one 20-acre claim in 1945. Undetermined (1963).

History: Quarry opened in 1926 as a source of poultry grit and was intermittently active as late as 1929. By 1932 the property was idle and apparently has since remained idle.

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Geology: Pre-Cretaceous limestone occurs in discontinuous lenses and bunches interbedded with mica and hornblende schist and intruded by granitic rocks, apparently part of the same sequence as exposed at the Moore deposit, one mile to the northwest. The limestone strikes northwest and appears to dip about 45° SW. where exposed in two cuts, but the extent of the beds cannot be determined because of soil and talus cover. The upper cut is near a hornfels and granite contact, the upper limit of the limestone. Exposed in the cuts is massive, very coarsely crystalline limestone, some of which is graphitic. Ground water has discolored the limestone to red for an unknown depth from the surface and the rock is extensively fractured. The limestone appears to be of good quality but reserves cannot be estimated from present exposures and intrusions of granite may be expected. Three random type samples collected by the Division of Mines in 1953 and chemically analyzed by Abbot A. Hanks, Inc., San Francisco, were as follows:

Sample no.	Insoluble	Fe_2O_3 and Al_2O_3	CaO	MgO	P_2O_5
B.C.-S1	1.56%	0.26%	53.17%	1.30%	0.01%
B.C.-S2	0.92	0.26	54.24	0.94	0.01
B.C.-S3	0.86	0.22	54.85	0.46	0.01

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Development: Two side-hill cuts. Lower cut is about 150 feet above creek level and is 100 feet long, 15-20 feet wide, with face 30 feet high. The second cut is about 80 feet above and is about 50 feet long, 10 feet high, and 15 feet wide. Blasted rock was allowed to roll downhill to the road where it was loaded onto a truck and hauled to San Jacinto for grinding in the company's plant.

Production: 500 tons by 1929, apparently little, if any, later production.

References: Tucker and Sampson, 1929, p. 519-520; Tucker and Sampson, 1932, p. 8, pl. 1; Tucker and Sampson, 1945, p. 172; Logan, 1947, p. 273.

C.H.G.7/2/63.

M82

Sims Limestone Deposit

Location: W½NW¼ sec. 7, T. 4 S., R. 1 E., S.B.M., and E½NE¼ sec. 12, T. 4 S., R. 1 W., S.B.M., San Jacinto quadrangle, 7½', 1953; Northern San Jacinto Mountains about 7 miles southeast of Beaumont, 1 mile south of the end of Highland Springs Avenue in the foothills above the south end of San Jacinto Nuevo y Potrero.

Ownership: Harold V. Sims, P.O. Box 16, San Jacinto holds an undetermined acreage of unpatented mining claims (1958).

History: Property located by Mr. Sims many years ago. Considerable exploration work has been done, but the property has not been put into production. In the early 1950's Kaiser Steel Corporation made an extensive examination of the property and field examinations have been made by at least one cement company. Access to the property is difficult because of the pattern of adjacent private land ownerships and the deposit was idle in July, 1963.

Geology: Pre-Cretaceous limestone and schist interfingered by granite occurs in two irregularly shaped bodies. The metamorphic sequence strikes northeast and dips steeply northwest. The larger metamorphic rock mass is about 1,500 feet long and 1,250 feet wide; the smaller mass, 500 feet to the west across a deep canyon, is about 750 feet long and 500 feet wide. Both of these bodies are largely limestone and dolomite, but also contain interfingered schist and granite. The limestone is gray to white, fine to very coarse crystalline, and contains some thin, irregular, seams of gray dolomite, as well as several large, spotty and irregular pods of dolomite. In places the limestone is banded and in other places contains a few small graphite crystals and graphitic steaks. Three main bodies of high calcium, coarse, white crystalline limestone are exposed. Perhaps each of these high grade bodies contains as much as 200,000 tons of readily available limestone. The deposit also contains several small masses of reddish-pink, medium grained dolomite which might find favor as a decorative or building stone.

In March, 1957, the Division of Mines collected seven samples from the east body and these samples were chemically analyzed by Abbot A. Hanks, Inc., San Francisco, as follows:

Sample No., location, and description	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	P_2O_5
SM-1. N. end of the S. ridge where best ls. is exposed; glassy, blue-grayish -white, coarsely xline ls.; very uniform, av. grain size about 0.6 cm.	0.67%	0.03%	0.17%	55.18%	0.28%	0.01%
SM-2. N. end same ridge as spl. 1. Mass of medium to fine-grained, blue-gray, uniform rock about 20 ft. long and 2 ft. thick.	4.28	0.19	1.09	52.20	0.47	0.01
SM-3. Near N. end of S. ridge; thin, irregular dol. seams cutting coarser-grained ls.; light blue-gray, fine xline rock with coarse calcite bands.	0.58	0.27	0.18	36.73	15.91	0.01
SM-4. Near S. end of best ls. mass; coarse -grained (1 cm.) glassy white ls., with sparse segregations of fine graphite.	0.24	0.06	0.07	55.53	0.22	0.02
SM-5. W. side of S. ridge in fire break; reddish-pink, medium grained dol. in a single mass about 4 ft. wide.	0.60	0.36	0.15	34.47	17.76	.14
SM-6. "Gully" section along trail, type rock; coarsely xline, glassy white rock with black graphite xls. and a few graphitic streaks.	0.16	0.03	0.05	55.72	0.13	0.01
SM-7. North sub lens, on trail near N. end of deposit; coarsely xline bluish-gray and glassy white variegated ls. containing some small graphite xls.	0.24	0.05	0.06	55.14	0.54	0.01

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Development: The limestone bodies have been explored by trails, and extensive bulldozer cuts and jeep roads, and perhaps by drilling.

Production: None.

References: Fraser, 1931, map facing p. 540.

C.H.G. 7/2/53.

Snow Rock

Location: SW¼ sec. 5, T. 2 S., R. 5 W., S.B.M., San Bernardino quadrangle, 1954; southeastern part of the Jurupa Mountains, half a mile north of Sunnyslope and about 4 miles northwest of Riverside. Plant is at the northwest end of 27th Street.

Ownership: American Cement Corporation, Riverside Division, P.O. Box 832, Riverside. Leased to and operated by Snow Rock Division (7000 27th Street, Riverside) Sun Valley Mills, Room 702, Glendale Federal Building, Glendale 3.

History: In 1953, the Sno-Top Rock Products Company began operating a limestone-crushing plant at Jensen quarry (described herein). White limestone and marble that contained excessive magnesia were trucked about half a mile to the plant from the quarry, then active as a source of limestone for cement manufacture. At the plant the material was crushed, screened, and bagged, mainly for white roofing granules. Fines were used for asphalt tile filler and other industrial purposes. Sno-Top discontinued operations in 1960 and in November, 1961, the plant was taken over and put into operation by Snow Rock who, in 1963, continue to make crushed limestone products.

Geology: Pre Cretaceous medium- to coarse-grained crystalline, light gray to white limestone (see Jensen quarry herein).

Development: Snow Rock utilizes part of the Jensen north quarry area. In January, 1963 quarrying is from a segment of the north Jensen quarry about 200 feet long with face about 75 feet high. After blasting rock is loaded by a 1½-yard dipper shovel on Euclid 15-ton end-dump trucks for transport to the plant. Some secondary breaking is done at the quarry utilizing jack-hammer drilling. At the plant, trucks discharge to a Traylor 28-inch by 36-inch primary jaw crusher which feeds a surge bin. From the bin rock goes to a 10-inch by 20-inch secondary jaw crusher and then to an Over-strom vibrating screen. Oversize goes to a hammermill and then to 16-by-16 rolls. Final crushing in two small hammer mills to make the fine size reduces the material to minus 12 mesh. Finished material goes by elevator for storage in two silos. Most of the material is marketed in bulk, but some is bagged. Two sizes are produced, minus 12 mesh to minus 16 mesh; and minus 3/8-inch to plus 1/8-inch. The product is marked as white aggregate, mostly in the Los Angeles area under the trade name "Snow Rock". It is used chiefly to manufacture white concrete blocks and for white gunite sand.

Prcduction: Plant capacity is 100 tons per day maximum, and about 60 tons if making fines only.

References: Gay, 1957, p. 574.

C.H.G. 1/23/63.

named
Un(known) Prospect

Location: NW¼SW¼ sec. 32, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern slope of the Santa Ana Mountains, 7 3/4 miles southeast of Corona, just east of Bedford Motorway.

Ownership: Undetermined.

History: Undetermined.

Geology: Discontinuous lens, 20 to 30 feet wide, and about 1,000 feet long, of dark gray fine-grained limestone. Weathers light gray. Apparently in part brecciated. Strikes N. 65° E., dips 75° NW. Occurs within graywacke and slate of the Triassic(?) Bedford Canyon Formation. Reserves are apparently small. Analysis by Abbot A. Hanks, Inc., June 1956 of one random type sample collected by the writer was as follows:

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	P_2O_5
9.18%	0.80%	9.18%	43.74%	0.83%	0.03%

Development: Undeveloped prospect.

Production: None.

References: Gray, 1961, p. 117.

C.H.G.

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Whitestone Deposit

Location: SE¼ sec. 8, S½ sec. 9, E½ sec. 17, T. 2 S., R. 5 E., S.B.M., Joshua Tree quadrangle, 15' 1955, and Thousand Palms quadrangle, 1958; south flank of Little San Bernardino Mountains along east Blind Canyon 3 miles northeast of Desert Hot Springs.

Ownership: Secs. 9 and 17, Southern Pacific Land Co., 65 Market Street, San Francisco 5, leased to Edwin T. Murphy and Harry Feldman (1959); claims in sec. 8, Edwin T. Murphy and Harry Feldman (1959).

History: Claims were located and some development done in 1959.

Geology: Several small pendants of crystalline limestone or dolomite occur in foliated biotite diorite gneiss and biotite schist (Chuckwalla complex). One carbonate body in the E½ sec. 17 is about 100 feet long, 8 feet thick, and concordant with the gneiss. This limestone is coarsely crystalline and white, but with tiny pink brucite crystals and patches of yellow serpentine (Proctor, 1958, p. 38). In the S½ sec. 9, a lens of limestone about 150 feet in diameter crops out.

Development: Undetermined.

Production: Undetermined.

References: Proctor, 1958, p. 38.

C.H.G. 5/20/61.

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Whitlock Limestone Deposit

Location: NE¼ and E½SE¼ sec. 28, and secs. 27, 34, T. 6 S., R. 4 E., S.B.M., Idyllwild quadrangle, 15' 1959; San Jacinto Mountains about 3 miles east of Kenworthy Station, at the head of Bull Canyon.

Ownership: Robert M. Harris, 2380 Monterey Road, San Marino owns 11 claims totaling about 1,200 acres. (1963).

History: These claims were located as association placers about 1929 by Alan M. Whitlock and associates. To date limestone has not been mined from this property but the limestone has been extensively sampled and explored by means of roads and open cuts. About 1953 the area was examined by the National Cement Company which planned to erect a cement plant at Hemet. Part of this plan included transporting limestone slurry by a pipe line from the quarry site to plant site over a distance of 29 miles with a drop in elevation of 3,900 feet. This proposal was abandoned for the announced reason that a zoning permit could not be obtained because of local opposition to the proposed plant site. Since 1953 the property has been examined by several limestone consuming industries but the distance from markets has delayed the commercial development of the Whitlock limestone. The claims are active and assessment work has been done each year.

Geology: The limestone deposits lie high on steep ridges several miles east of Garner Valley and are surrounded by granite. These carbonate rock bodies are part of a very large belt of pre-Cretaceous metamorphic rocks which trends northwest from just north of upper Palm Canyon near State Highway 74 to about one mile southeast of Tahquitz Valley. This mass of metamorphic rocks is mostly mica schist, but also contains hornblende schist, quartzite, and limestone and is about 15 miles long and ranges from about one to four miles in width. The metamorphic rocks are intruded by granite and several large irregular bodies of granite, as much as two miles long, occur in the central part of the metamorphic belt. The Whitlock limestone deposit lies along the western margin of the metamorphic belt near its southern end. Here the limestone-bearing sequence is several miles long

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and two or three thousand feet thick. The limestone ranges from coarsely crystalline bluish-gray rock to finer grained banded rock. It is friable at the surface and deeply jointed both northeast and at right angles to this trend. The apparent bedding is parallel to the main north to northwest-trending joint system. The limestone layers are somewhat interbedded with mica schist and some scarn rock and pegmatite dikes occur locally with quartz-rich pegmatites and scarn plentiful in small bodies near the granite contact. Granite intrusions, however, have not penetrated the limestone to any great extent. The largest continuous limestone bodies appear to be about 1,000 feet long and from 300 to 900 feet wide. In 1953 the Division of Mines collected one random type sample which was chemically analyzed by Abbot A. Hanks, Inc., San Francisco, as follows: Insoluble, 1.14% Al_2O_3 and Fe_2O_3, 0.56%; CaO, 54.37%; MgO, 0.56%; P_2O_5, 0.05%.

From information furnished by Mr. Robert M. Harris (written communication, 1962) the average of 13 samples, each from a different part of the property, composed of 3 grab samples and 10 chip samples across limestone beds ranging from 30 feet to 350 feet in width was as follows: SiO_2, 1.56%; Al_2O_3 and Fe_2O_3, 0.92%; CaO, 52.8%; MgO, 1.21%; loss, 42.81%; and from 2 samples S, 0.0075%. These same samples showed the following ranges: CaO, 50.51-54.80%; MgO, 0.48-3.82%; SiO_2, 0.30-3.15%; Al_2O_3 and Fe_2O_3, 0.18-2.45%. Reserves of high-quality limestone apparently are very large. One private report estimated at least 900,000,000 tons in sight (personal communication, R. M. Harris, 1956).

Development: The deposit has been extensively sampled and a number of prospect pits, cuts, roads, and trails have been made in the course of development.

Production: By July, 1963, apparently none.

References: Fraser, 1931, map facing p. 540.

C.H.G. 7/2/63.

Magnesite

Hemet Magnesite Mine

Location: NW¼ sec. 31, T. 5 S., R. 1 W., S.B.M., Winchester quadrangle, 7.5', 1953; 3½ miles east and half a mile south of Winchester.

Ownership: The mine is patented, and in 1958, was owned by Mr. Roy Boswell of Los Angeles. Mr. Fletcher Nichols of Hemet held an adjoining claim on the same deposit (Schwarcz, 1958).

History: This magnesite deposit appears originally to have been discovered and explored in the search for gold (Hess, 1908, p. 38).

Between 1908 and about 1912 the deposit was worked for magnesite by the California Magnesite Co. for use as cement (Gale, 1914, p. 516). By 1917 this venture had failed and the mine was idle (Merrill and Waring, 1917, p. 119). In 1925 it was reported (Bradley, p. 61-65) that the mine had changed hands a number of times, that development and production had continued, and that the deposit was last mined in 1919 by the Welman-Lewis Co. of Los Angeles for Innes-Speiden & Co., Inc. of New York, lessees. By 1929 the machinery had been removed (Tucker and Sampson, 1929, p. 521). The mine has remained idle.

Geology: The Hemet Magnesite mine is on the crest of a northwest-trending ridge underlain (formed) by the northeast flank of a northwest-plunging, overturned, isoclinal fold, ~~(fig.)~~. The rocks in the mine area consist of schist, gneiss, quartzite, and intensely altered limestone which have been intruded by amphibolite, peridotite, and pegmatite. The mine explored a magnesite-filled stockwork in a body of altered peridotite exposed on the ridge crest. The ore body is exposed through a horizontal distance of about 700 feet and has an average width of about 150 feet. Its depth has not been determined. The stockwork fillings of magnesite form intersecting veins ranging from a fraction of an inch to about 4 inches in thickness. Gale states (1914, p. 519) that recoverable magnesite comprises about 10 percent of the mined rock and gives the following analysis of the magnesite:

SiO_2	6.17%
$Al_2O_3 + Fe_2O_3$	0.80
CaO	trace
MgO	43.80
CO_2	45.02
undet.	4.14

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Schwarcz (1958) states that the vein material consists of an intergrowth of fine-grained magnesite and opaline silica. The peridotite matrix was studied in thin section by Schwarcz who gives the following composition:

Magnesite	15%
Olivine	1%
Enstatite	3%
Talc	20%
Irresolvable Matrix (magnesite, limonite, opal serpentine(?))	60%
Serpentine	tr.

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Development: At present (1962) the underground workings of the mine are inaccessible. In 1925, Bradley (p. 62-64) gave the following description:

> "Mining is done by open cut and glory hole. A tunnel has been driven N.60°E. in the main quarry floor to cut the deposit thrcugh drifts along the orebody running N.40°W. The south drift connects by a chute with the glory hole 50 ft. below the top, and a raise in the north drift has been put up to tap the glory hole. The latter gives backs of 75 ft. Drifting will be continued southeast to determine the length of the orebody. It was the intention of the operators to glory-hole the entire top of the hill."
>
> "Surface equipment includes mechanical conveyors, screens, washers, a 6' x 60' rotary kiln, grinders and packing house."

A subsequent report (Tucker and Sampson, 1929, p. 521) states simply that:

> "A cross cut at a lower elevation is connected with the glory hole by a series of raises."

Production: Undetermined but probably small. In 1925, the kiln capacity was reported to have been 30 tons of calcined magnesite per 24 hour day (Bradley, 1925, p. 65).

References: Hess, 1908, p. 38-39; Gale, 1914, p. 616-619; Merrill and Waring, 1917, p. 539; Tucker, 1921, p. 327-328; Bradley, 1925, p. 61-65; Tucker and Sampson, 1929, p. 521; 1945, p. 175, pl. 35; Schwarcz, 1958, unpublished.

R.B.S.

Manganese

Manganese ore in grades ranging from 20% to 45% Mn has been produced in Riverside County in quantities exceeding 25,000 tons valued at more than $1,500,000. Production has been sporadic, having been restricted largely to periods of the two world wars or, made under the aegis of federal stockpiling programs (1953-1959). In Riverside County, the most productive manganese mining areas have been the north end of the McCoy Mountains and the southeastern end of the Little Maria Mountains. These two mountainous desert areas are in the ~~central~~ eastern part of the county about 20 miles northwest of Blythe.

In these areas manganese oxides, of probable hypogene origin, form fissure and void fillings in fault-zone breccias. The country rock has been replaced to a limited extent. Replacement appears to be the greatest where the rock is carbonate. The ore is largely the hard, psilomelane type and the bulk of the mine-run material, which ranges from 10 percent to 35 percent Mn, has required beneficiation.

Mining on a small scale has been both by open pit and underground. Milling facilities have operated at Inca siding and Ripley. By 1961, the Ripley plant had been dismantled, but the Inca facilities were still available. The fines from the Inca plant were further treated at a small Humphreys Spiral plant at Tasco siding (Photos 30 and 31) just north of Blythe. Much of the ore milled at Ripley came from the Mule Mountains area in Imperial County.

With the closing of the government carlot program, August 5, 1959, manganese mining in Riverside County ceased abruptly.

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Arlington-Black Jack Mine

Location: Secs. 18 and 19, T. 4 S., R. 20 E., S.B.M., Midland quadrangle, 15' 1952; at the north end of the McCoy Mountains, 30 miles by road northwest of Blythe.

Ownership: Georges F. Kremm, 161 E. Ontario, Chicago, Illinois (1959).

History: The earliest report on manganese from this area refers to a mine called the Black Bird from which ore was shipped during the spring of 1916 (Merrill and Waring, 1917, p. 545). By 1918 the names Black Jack mine or Schellenger claims were being used for claims which probably were situated just west and northwest of the property described herein but which are on the same vein system (Bradley, and others, 1918, p. 54-56). The name Arlington appears to have been applied to one or more claims which may represent a southeastward expansion of activities on the old Black Jack claims.

Photo 28

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E. E. Schellenger, Blythe, leased claims to Robert A. Kinzie and associates in 1915. In 1917 and 1918, the property was leased by Charles F. Bradford and associates, Blythe (Tucker and Sampson, 1929, p. 492). A note on a dispute over Bradford's purchase of the property and a description of the mine was made by Trask (1950, p. 177-178). The Arlington-Black Jack mine was active during World War II, at which time it was owned by Fred W. and Walter Kroger, Pomona, and Lewis I. Berck and others, Monrovia, who had leased it to Arlington Manganese Company (Tucker and Sampson, 1945, p. 149).

In 1956, the Aspen Mining Company mined ore which was concentrated in mills at Inca Siding and Tasco Siding north of Blythe. The concentrate was sold to General Services Administration under the carlot program (Davis, 1957, p. 331, fig. 17). From 1957 to late in 1958, under the same program, this mine was operated by California Limestone Products, Blythe. The property was then leased to Mines Contracting Company until the close of the carlot program, August 5, 1959.

Photo 29

Geology: The rock in the mine area is massive, sheared and jointed, granite porphyry of Paleozoic (?) age. Numerous, north-northwest to north-northeast-trending, steeply-dipping faults cross the area. The faults are part of a system exposed in an area of about two square miles at the extreme north end of the McCoy Mountains. The fault zones are occupied by brecciated country rock in irregular, tabular masses as much as 20 feet wide. The fissures and cavities of the breccia have been filled almost completely by oxides of manganese, principally psilomelane. The ore minerals appear to have replaced the host rock to a small extent. Traces of iron oxides are present. Mine-run ore ranges from 28 to 35 percent Mn. Higher grade ore has brought some shipments to averages above 40 percent.

Development: Two adits bear south-southeast on a fault which strikes N. 25° W., and dips 55° SW. The lower adit is near the base of the slope. The upper adit is about 125 feet higher on the fault zone. Its portal is in the face of a cut 100 feet long, 15 to 20 feet wide, and about 50 feet high.

Photo 30

803

A D.M.E.A. loan was obtained by California Limestone Products for a 900 foot crosscut and 500 feet of drifting to explore parallel fault zones to the west of the old workings. When visited (Nov. 20, 1958) the crosscut, which was started at a point about 300 feet in from the portal of the upper adit, had been driven about 800 feet west and roughly 500 feet of drifting completed on 4 faults crossed by the new exploration (fig. 51). The new ore bodies are proving to be narrower than those in the old workings, few exceeding 5 feet in width. Though occasional streaks of high grade are found, most of the ore is a mixture of breccia and manganous oxides. When visited (Nov. 20, 1958) work was in progress extending a drift north from the new crosscut at a point about 300 feet west of the old adit. At that time the drift was about 40 feet long. Some ore has been taken from the drifts and short raises which have explored ore shoots. Except for a few stulls, no timber is used in the new workings. In the old workings, - especially at the base of the stopes, considerable timber and sheathing was used and is still largely intact owing, in part, to the dryness of the mine.

Figure 51

In addition to the underground exploration a considerable amount of ore ~~is~~ was being removed in 1958 from several open cuts 300 to 500 feet west of the upper adit. Activity is centered on a cut in which ore as much as 3 feet wide is exposed for about 300 feet along the strike. This fault strikes N. 15° - 30° E. and the dip ranges from 75° SE. to vertical. Two other ore-bearing faults parallel it to the northwest. One of these crosses a shallow ravine about 200 feet northwest of the above described cut. At this point a pit about 50 feet long and 18 feet deep explores a 3-foot vein. According to one of the miners, a high grade body up to 3 feet wide was removed from this site. The second vein, about 200 feet up the slope to the west, is exposed for 400 to 500 feet, is up to 4 feet wide, but is as yet unexplored.

Production: Accurate figures are wanting on the yield of specific properties in the district. Leases have changed hands frequently. Local milling facilities at Inca Siding have received ore from other near-by mines, and, though most of the ore is milled, a considerable tonnage has been hand cobbed and sorted and high grade shipments made directly to the purchasers. The following data are for the Arlington-Black Jack and near by claims ~~(fig.)~~

Photo 31

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Year	Ore (tons)	Reported average Percent Mn
1915	1,500	40+
1917-1918	3,000	45
1942-1945	8,500	20-42
1953-1955	-	-
1956-1958	*	28-35

*In November, 1958, 60 tons a day being sent to mill at Inca Siding. Duration of production undetermined. Idle, 1960.

References: Merrill and Waring, 1917, p. 545; Bradley and others, 1918, p. 54-56; Jones, 1920, p. 196-197, pl.9; Tucker and Sampson, 1929, p. 492; 1945, p. 149; Hewett, et al., 1936, p. 85, map sheet 2; Jenkins, et al. 1943, p. 82-83, 154; Trask, 1950, p. 177-178; Davis, 1957, p. 331, fig. 17.

R.B.S. 11/20/58.

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MANGANESE
FIG. 5

ARLINGTON BLACK JACK MINE

(manganese)

Sec. 19 (projected), T.4S, R.19E., SBM., Riverside Co.

Sketch of Main Workings as of January 15, 1959
(plan view)

Scale
0 100 200 300
1 inch equals 100 feet

Symbols — open — filled

† vertical dip	C ore chute	//// Stope	Fault zone
55 dip and strike	⊠ foot of raise		
	⊡ head of winze		

N

Adits 125 Feet (±) apart in plane of fault

Stope

Stope

60

60

Arlington No. 3 (Black Metal) Claim

Location: N½ sec. 19 (proj.), T. 4 S., R. 20 E., S.B.M., Midland quadrangle, 15' 1952; near the north end of the McCoy Mountains.

Ownership: Georges F. Kremm, 161 E. Ontario, Chicago, Illinois. Under lease to Dan Figueroa, P.O. Box 453, Blythe (1959).

Geology: Mineralized breccia as much as 3 feet wide lies along a vertical fault zone in Paleozoic(?) granite porphyry, striking N. 30° E., which is poorly exposed for about 50 feet low on the west side of a shallow canyon. The principal ore mineral is psilomelane, which forms banded fissure fillings in the fault breccia. Pyrolusite is present and what might be manganite forms layers of columnar crystals in the psilomelane. Thin encrustations of calcite are common.

Development: A vertical shaft was sunk 150 feet on the fault. At the bottom of the shaft a 220-foot drift bears northeast and a 150-foot drift southwest. A ventilation shaft connects the south drift with the surface. When visited (January 1959) stoping was in progress along the drifts. Stopes had reached the surface about twenty feet on either side of the shaft collar but the relationship of these stopes to those along the drifts was not determined.

Production: When visited in 1959 the mine was yielding about 1 carload of concentrates (federal carlot program specifications) per month. The mine was idled by the termination of the carlot program (August, 1959).

References: None.

R.B.S. 1/16/59

803

Beal-McClellan (Black Eagle and Newport, Brum and Newport) Property

This report is based largely on information contained in a recently published description by Engel, Gay and Rogers (1959, p. 75-76).

Location: Sec. 23, T. 5 S., R. 4 W., S.B.M., U. S. Army Corps of Engineers, Lake Elsinore quadrangle, 15', 1942; on the ridge line of the west side of Railroad Canyon.

Ownership: G. S. Beal and R. W. McClellan, Elsinore, and G. R. Smith, La Habra, hold a patent (1950) on what was formerly railroad land.

History: As early as 1900, development was reported in the area of this deposit (Aubury, 1906, p. 336), but not until the second world war was ore removed on a commercial basis.

Past reports describe under "Elsinore deposits" two showings of manganese in secs. 23 and 24, T. 5 S., R. 4 W., S.B.M., a "West group" in section 23 on the west side of Railroad Canyon, and an "East group" in section 24 on the east side of the canyon.

A comparison of these reports with field observations made in 1955 confirms the speculation by Trask (1950, p. 181) that these descriptions were based on observations at the Beal-McClellan deposit. All workings reported in section 23 (e. g. Aubury, 1906, p. 336; Bradley, 1918, p. 58; Merrill, 1919, p. 546; Tucker, 1929, p. 493; Jenkins, 1943, p. 83; Trask, 1950, p. 182-183; and Tucker, 1945, p. 150) apparently apply to the Beal-McClellan deposit.

The East group of Elsinore claims (Merrill, 1919, p. 546) was reported to be half a mile north of the West group and to extend as far as 1½ miles east of the railroad in the bottom of Railroad Canyon (Bradley, 1918, p. 58). Merrill (1919, p. 546) indicates that this group includes three parallel veins that crop out discontinuously for a strike distance of several hundred feet, the central vein being poorly exposed but possibly 16 to 20 feet wide. A later report (Bradley, 1918, p. 58), quoted with slight modification by Trask (1950, p. 182-183), apparently applies this description of the central vein of the East group to a vein on the West group, actually the Beal-McClellan property (Engel, 1959, p. 76-77).

Geology: The deposit parallels the bedding planes of slate that here strikes N. 60° to 65° W. and dips 50° NE. The manganese-bearing zone is 3 to 4 feet wide as exposed in mine workings, and can be traced discontinuously for more than 250 yards down a steep draw eastward. The manganese impregnates a siliceous layer, apparently a somewhat recrystallized, banded chert (Trask, 1950, p. 180-182).

Just east of the ridge line, manganese minerals occupy nearly the whole width of the chert zone as exposed in mine openings. To the east and west manganese content in the zone decreases and is seen as parallel dark bands in the chert and siliceous slates. Similar dark banding occurs in the slates just northwest of the ridge line exposures.

The ore consists of black manganese oxides, both hard and soft, apparently formed by partial to complete oxidation of rhodonite. Prismatic rhodonite crystals as long as 0.2 of an inch have been reported (Trask, 1950, p. 181). Dark-brown, massive, opaline

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material, sparingly present, has been tentatively identified as neotocite or bementite (Trask, 1950, p. 181). An analysis of a sample from the property showed 34.42 percent manganese, 9.52 percent silica, and 0.14 percent phosphorus (Bradley, 1918, p. 57). A dump sample contained 30.87 percent manganese (Trask, 1950, p. 182). The most completely oxidized, hence most valuable ore appears to be within 20 feet of the ground surface and to grade downward into unreplaced rhodonite and chert.

812

Development: Mining has been confined to the richest part of the exposed portion of the zone which is in the 75-foot segment just east of the ridge line. About 50 feet below the ridge line an irregular drift adit extends about 80 feet into the hillside. The first 40 feet of the adit has been extended upward into an irregular open stope about 25 feet high and 3 or 4 feet wide.

The 10-foot crosscuts into the hanging wall, at about 40 and 60 feet from the portal of the adit, penetrate barren slate. About 150 feet below and east of the main workings, black and white banded siliceous rock, apparently the strike extension of the chert band, has been prospected in a small cut, but no ore has been removed. About 450 feet farther east along the strike similar material ~~carries~~ contains a 2-foot width of black manganese-bearing rock where exposed in an inclined open-cut about 30 feet long, 10 to 15 feet wide, and as much as 5 feet deep.

813

Production: Trask (1950, p. 181) states that a production of 50 tons is listed from the claim; the 1941 production was said to be 30 tons. In 1945, the property was idle, but it was reported that several cars of ore previously shipped to Kaiser Steel Company at Fontana contained 30 to 35 percent manganese (Tucker, 1945, p. 150). No subsequent work has been done to alter the estimate that no more than 100 tons of additional oxide ore could be expected from the developed ore bed (Trask, 1950, p. 182).

References: Aubury, 1906, p. 336; Bradley, 1918, p. 58; Merrill, 1919, p. 546; Jenkins, 1943, p. 83; Tucker, 1945, p. 150; Trask, 1950, p. 181; Engel and others, 1959, p. 75-77.

R.B.S., from Engel and others.

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Big Bullett Manganese Claims

Location: NW¼ sec. 31, T. 6 S., R. 11 E., S.B.M., Mortmar quadrangle, 7.5', 1958; at the western edge of the Orocopia Mountains, 2 miles southeast of Shavers Well.

Ownership: Leland Noblitt, Brawley.

History: One, of a reported 20 claims, was being worked in 1945 (Tucker and Sampson, 1945, p. 149-150), but any previous or subsequent history was not found.

Geology: This deposit is exposed on the west slope of a ridge formed in strongly foliated schistose rocks striking N. 30° - 40° W. and dipping 20° - 35° NE. Manganese oxides occur in lenticular masses, as much as 3 feet thick in an irregular zone of contorted and silicified schist, ranging from 4 to 7 feet in thickness, which parallels the foliation of the country rock. The manganiferous zone is exposed for about 500 feet up the slope and across the crest of the ridge. It appears to be thinning to the southeast. To the northwest the deposit is covered by alluvium.

The manganese minerals apparently were deposited as compact masses of radiating crystals in vugs and fissures in the contorted zone. Much of the crystalline material has altered to porous, amorphous clots and layers of pyrolusite, a light and friable ore.

Development: The deposit has been explored by an open cut 20 feet long and 8 feet deep and sever .l shallow prospects.

Because of intermixed quartz , this manganese-bearing material would have to be concentrated by some means in order to be of commercial grade. In most present mills it probably would yield an excessive proportion of fines because of its light, friable texture.

Production: In 1945 about 10 tons of manganese oxides had been mined. This material was reported to contain 30 percent manganese (Tucker and Sampson, 1945, p. 149-150). Idle, (1960).

References: Tucker and Sampson, 1945, p. 149-150, pl. 35.

R.B.S. 2/10/60

816

Black Ace (Doran) Mine

Location: .SE¼ sec. 23 (proj.), T. 3 S., R. 18 E., S.B.M., Palen Mountains quadrangle, 15' 1952; 30 miles, by road, northeast of Desert Center at the north end of the Palen Mountains.

Ownership: L. W. Coffin, and others, 1280 Dwight Way, San Bernardino.

History: This property was formerly known as the Doran Manganese claims. W. C. Doran, the original owner, located the property in 1915 (Bradley, 1918, p. 57-58). No record was found of how long Doran held the property or the extent of development, however, by 1929 he was referred to as the former owner (Tucker and Sampson, 1929, p. 493). A description of the claims ~~is included in California Division of Mines Bulletin 152~~ was made by (Trask, 1950, p. 182) which is a modification of the earlier description by Bradley (1918, p. 57-58). During 1953 this deposit was worked under lease by Ike Kusisto.

Geology: The country rock in the mine area appears to be a sequence of layered volcanic rocks; probably the McCoy Mountains formation ~~(Miller, 1944, p. 32)~~. Where observed, in and about the mine, these rocks are hydrothermally altered.

A shear zone as much as 50 feet in width strikes N. 20° E. across a northwest-trending ridge and dips about 65° SE. It is exposed in a ravine in the northeast side of the ridge and several hundred feet down the southwest slope. A mixture of manganese oxides, chiefly of the psilomelane type with lesser proportions of manganite and pyrolusite, occurs as fissure and breccia fillings in the shear zone. Such manganese oxide bodies are irregular, tabular masses ranging from a fraction of an inch to 20 feet in width. Intermixed country rock is the chief impurity. Thin incrustations of calcite are common.

Development: The shear zone has been entered on 2 levels; both in the ravine in the northeast slope of the ridge. The lower level is an adit driven south-~~east~~ west 150 feet on an ore body as much as 6 feet wide. A raise, fitted with a loading chute, was driven to the surface from a point about 115 feet from the portal. A 12-foot crosscut turns 65° to the right at a point 85 feet from the portal. It turns left into a 30-foot drift roughly parallel to the main adit but no ore is exposed. The upper workings are about 100 feet farther up the ravine. They consist of 2 short drift adits, one on the footwall and one along the hanging wall of

the shear zone and parallel with an open cut. The open cut is about 75 feet long and 20 feet high from which an adit extends another 50 feet southwest. An orebody 20 feet wide is exposed in the face of the cut and in the adit. The adit along the hanging wall side of the shear zone extends about 20 feet southwest. A 2-foot-wide vein has been stoped to a height of about 25 feet along most of its length. The footwall adit runs southwest about 40 feet along a narrow shear. At its end a narrow, 50-foot raise follows an ore body about 13 inches wide.

The portals of all the adits except that in the open cut are timbered but otherwise little timber was used.

The ore from the upper workings was dumped into the ravine and channeled into the raise coming up from the loading chute in the lower adit. From the portal of the lower adit ore was lowered down some 400 feet of inclined railway to a loading bunker in the canyon below.

819

Production: The only report of yield is a small tonnage of ore, containing 31 percent manganese, in 1953 (Ike Kusisto, personal communication). When visited (February, 1959) the mine was idle, however, the property appeared to have been only recently idled. Judging from the extent of the workings a considerable total tonnage must have been shipped; probably during the recent government stockpiling programs.

References: Bradley, 1918, p. 57-58; Tucker and Sampson, 1929, p. 493; Miller, 1944, p. 32; Trask, 1950, p. 176-185.

R.B.S. 2/5/59

820

Black Rock Claim

Location: W½ sec. 22, T. 3 S., R. 23 E., S.B.M., Big Maria Mountains quadrangle (15, 1951); on the south slope of Quien Sabe Point, 25 miles north of Blythe.

Ownership: Harley K. West, 2362, 246th St., Lomita, California and Ruth Richardson, Box 185, Othello, Washington (1958).

History: A recent claim (1953).

Geology: The Black Rock claim is underlain by Precambrian mica schist cut by granite pegmatite dikes and at least one shear zone. The sheared and mineralized rocks are exposed for about 50 feet across the crest of a ridge east of the camp site. They occur at the junction of the shear zone and a pegmatite dike. Oxides of manganese and iron are associated with barite and quartz in fissure fillings in a zone as much as 3 feet wide including both schist and pegmatite.

Development: Little more than discovery and assessment work, in the form of shallow pits and trenches, had been done at the time of the writer's visit (December 1958).

Production: None.

References: None.

R.B.S. 12/17/58.

821

Black Strike (Grosse Claims) Claim

Location: N½ sec. 19, (proj.), T 4 S., R. 20 E., S.B.M., Midland quadrangle, 15' 1952; at the north end of the McCoy Mountains.

Ownership: Georges F. Kremm, 161 E. Ontario, Chicago, Illinois. Leased to Dan Figueroa, P.O. Box 453, Blythe (January 1959). claim

History: The Black Strike appears to coincide with part of a former group of claims known as the Grosse Manganese claims (Bradley, and others, 1918, p. 58; Tucker and Sampson, 1929, p. 493) from which ore was being shipped during the 1920's.

Geology: Two converging faults, one striking N. 20° W. and dipping 70° SW. and the other striking N. 10° E. and dipping 75° NW., are exposed on the north side of a shallow canyon. Both faults include irregular bodies of brecciated and mineralized granite porphyry country rock as much as 6 feet wide. Manganese ore minerals, chiefly psilomelane but with minor amounts of pyrolusite and manganite, were deposited in the fractures and openings of the fault breccia. Though not well exposed on the surface, this deposit ~~could probably be traced northward to the Black Jack and proven to be part of the same deposit.~~ may be a Southward extension of the Black Jack vein.

822

Development: Two adits, one driven 200 feet N. 20° W. on one fault and the other, 75 to 100 feet up the slope to the northwest, driven 80 to 100 feet N. 10° E. of the other fault, were under development in January, 1959. Along both adits the more favorable concentrations of ore are being stoped, and have been stoped to the surface at several points.

The older workings explored outcrops in the canyon bottom immediately to the south. Seasonal flooding is filling the old shafts and stopes with debris and would hinder their reopening.

Production: At least 2 carloads of manganese ore shipped from the old workings during the year 1918 (Bradley and others, 1918, p. 58). The current yield is 1 carload per month (lessee, personal communication, January 1959).

References: Bradley and others, 1918, p. 58; Tucker and Sampson, 1929, p. 493.

R.B.S. 1/16/59.

George (Red Rock) Claims

Location: E½ sec. 32 (proj.) and W½ sec. 33, (proj.), T. 4 S., R. 20 E., S.B.M., Midland quadrangle, 1952; on the east slope of the McCoy Mountains, half a mile northeast of the St. John Mine, about 9 miles by road west of Inca Siding.

Ownership: James F. and Bertha C. George, 3165 S. Spring St., Blythe, hold 8 claims - Bertha 1-5 and G & G 1-3 (1958).

History: In 1918, this property was described under the name Red Rock mine (Trask and others, 1950, p. 179-180). It was owned at that time by E. E. Schellenger of Blythe and operated under lease by Dee Clark of Blythe.

824

Geology: The mine area is underlain by sheared, granite porphyry, cut by at least 6 closely-spaced, north- to north-northwest-trending, vertical- to steeply northeast-dipping faults. The faults are poorly exposed through horizontal distances of 50 to 200 feet across a low, narrow, east-trending spur. They comprise zones ranging in width from 1 to 4 feet filled with brecciated country rock, manganese oxides, barite, and calcite. The manganiferous fissure and void fillings range from 0 to 1 foot in width. The manganese oxides, barite, and calcite commonly occur as discreet, alternating layers, about one inch in thickness, suggestive of sequential deposition. Recurrent movement on the faults has brecciated the manganiferous material along narrow, irregular zones within the larger fault zones and the resulting mixture of rock and mineral matter is cemented by calcite.

Careful mining and sorting would yield small quantities of high-grade ore but ~~the bulk~~ most of the material would demand beneficiation. Concentration by gravity methods might prove difficult because of the ~~abundance~~ presence of barite in the deposit. ~~The specific gravity of barite ranges from 4.3 to 4.6; that of psilomelane, the type of ore here involved, is 3.3 to 4.7.~~

825

Development: Five fault zones have been exposed in 2 discontinuous trenches as much as 12 feet deep and 150 feet long and 3 open cuts as much as 20 feet deep at the face. The open cuts are in the south flank of the spur and the trenches extend northward across its crest. The 2 trenches and 3 open cuts are evenly spaced through a horizontal distance of about 300 feet.

Production: By October, 1918 one rail car of ore had been shipped (Trask and others, 1950, p. 180). No other record was found.

References: Trask [redacted], 1950, p. 179-180.

R.B.S. 1/14/59.

826

Langdon Mine

Location: NW¼ sec. 17, T. 4 S., R. 21 E., S.B.M., Midland quadrangle, 15' 1952; about 3½ miles by road northwest of Inca siding.

Ownership: California Limestone Products, Blythe, (January, 1959).

History: In 1918, the Langdon mine was owned by H. N. Mabery, Los Angeles, and Chas. E. Brown, Mecca, who were shipping 4 tons of manganese ore daily. (Bradley, and others, 1918, p. 59). During World War I, 1,500 tons of ore were shipped from the Langdon and claims nearby but from the end of the war until as late as 1943 the property remained idle (Trask, and others, 1943, p. 83, 156). During 1944 this mine was under lease to J. Figueroa, who made several small shipments of ore to Metal Reserve Company's stockpile at Parker, Arizona. The ore was reported to contain 35 to 40 percent manganese and 8 percent silica. In 1945, the claims were again idle (Tucker and Sampson, 1945, p. 150). From 1951 to 1958 the present owner worked the Langdon mine. When visited in January of 1959 the mine was under lease to Virgel Denning who was shipping ore to the federal government through the "carlot" program (terminated August 5, 1959).

827

Geology: A fault zone trends about N. 30° W. along the eastern base of a group of low hills. The zone includes a large volume of brecciated, gray- to pink Paleozoic (?) limestone which contains oxides of manganese as fissure and cavity fillings. The ore is chiefly of the hard, psilomelane type. The fault zone appears to dip northeast and is as much as 100 feet wide.

Most of the ore bodies occur as veins one inch or less wide. Some larger ore bodies have been encountered, but larger masses tend to be full of voids surrounded by coalescing, botryoidal surfaces. Thin crusts of calcite are common.

Development: Prior to 1951, this deposit was developed by means of adits, drifts and shallow shafts in an effort to discover local concentrations of ore. Mining under the current ownership has been largely by open pit, the object being to remove large quantities of milling-grade ore. In the process, the former workings are being destroyed. When visited (January, 1959), the mineralized zone had been exposed for about 1,000 feet by a series of joined pits as much as 100 feet wide and a maximum of 60 feet deep. Ore is trucked to a mill at Inca Siding.

828

Production: About four carloads of concentrates (40.00+ percent Mn.; 15 percent max. -20 mesh) per month were being shipped when the property was visited in 1959.

References: Bradley, Walter W., and others, 1918, p. 59; Tucker, 1921, p. 328-329; Trask, and others, 1943, p. 82-83, 154; Tucker and Sampson, 1945, p. 150.

R.B.S. 1/13/59.

829

(Paddy Faulkner Claim)

Lucky Boy Mine

Location: NW¼, sec. 24 (proj.), T. 3 S., R. 20 E., S.B.M., Midland quadrangle, 15' 1952; 3½ miles northwest of Midland, at the south end of a low, elongate ridge.

Ownership: Undetermined.

History: This claim is reported to have been located in 1942 by Herman Kiel under the name Paddy Faulkner Claim (Wilson, 1943, p. 185). Details of its subsequent history were not found but it is apparent that a few tons of ore have been removed from the property.

Geology: The mine area is underlain by schist which strikes N. 60° - 80° E., dips 55° - 65° NW., and includes two thin limestone units about 100 feet apart. A vertical fault strikes N. 30° W. across the claim. (Figure 52) There is a right-lateral separation of about 18 feet where this fault cuts the limestone units. The limestone is strongly sheared and further deformed by drag near the fault. Mineralizing solutions appear to have followed the fault, and to have selectively replaced the sheared limestone by oxides of manganese. Manganese mineralization is confined to the fault zone and the truncated limestone units on its southwest side. The ore is a porous mixture of psilomelane, pyrolusite, sericite, and calcite. The ore-bearing limestone units are 10 and 15 feet wide and crop out for about 100 feet down the slope between the trace of the fault and the alluvium to the southwest. Thin stringers of ore are irregularly exposed on weathered limestone surfaces.

530 figure 52

Production: Undetermined.

Development: A 50-foot shaft inclined 50° NW. was sunk on an ore shoot as much as 10 feet wide at the junction of one of the limestone units and the fault. When visited (Feb. 1959) a head frame was intact at the collar. The down-slope limestone outcrops were explored by shallow prospect pits and one shallow trench was dug in the fault zone about midway between the limestone units. All of these prospects expose some manganese (Mn) oxides but no presently mineable ore bodies.

References: Wilson, 1943, p. 185.

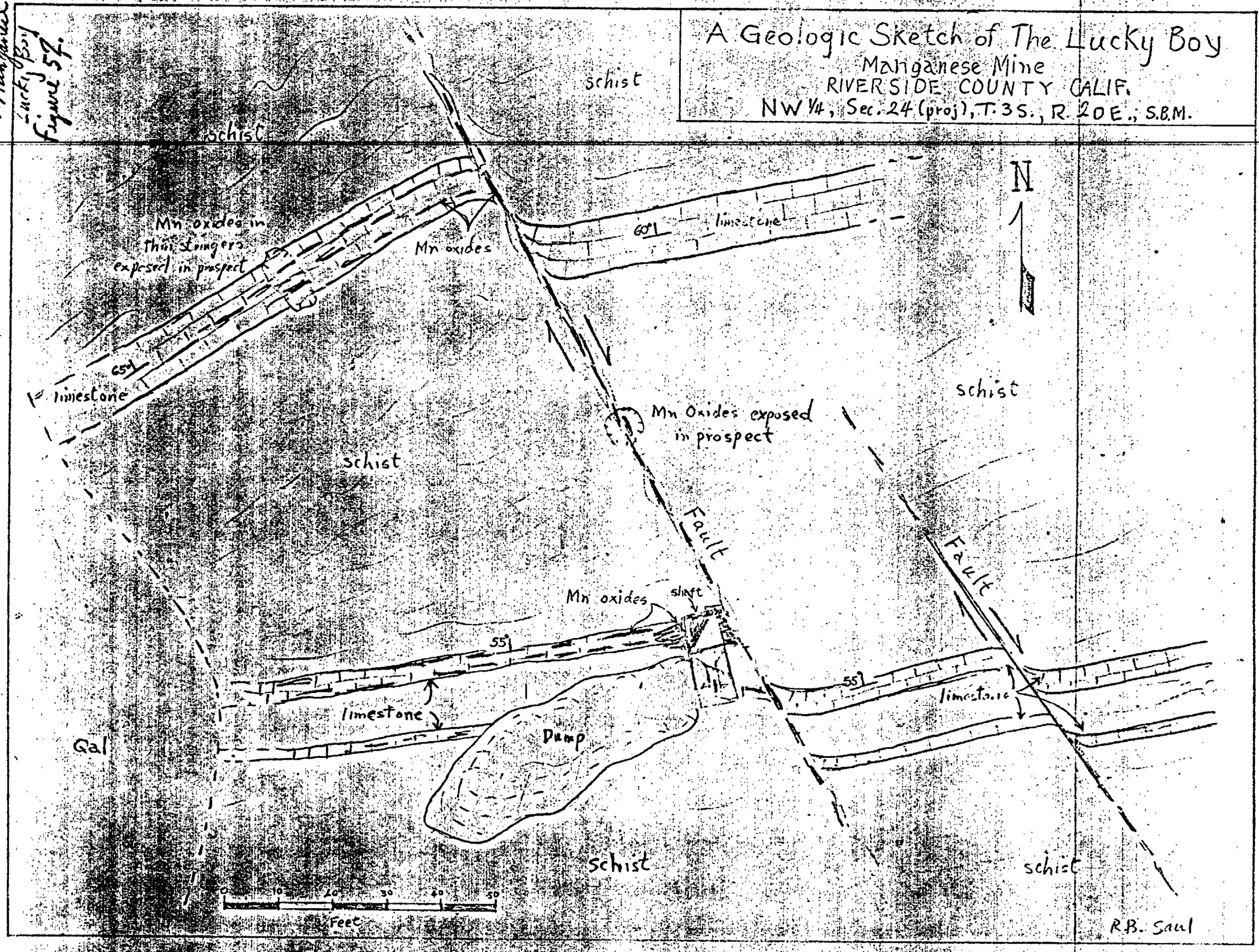
R.B.S. 2/3/59

831

Manganese
Lucky Boy
Figure 52.

A Geologic Sketch of The Lucky Boy Manganese Mine

RIVERSIDE COUNTY CALIF.
NW¼, Sec. 24 (proj), T. 3S., R. 2OE., S.B.M.



(Social Manganese mine)

Manganese Canyon Group

Location: SW¼ sec. 13, and NE¼ sec. 24, T. 4 S., R. 19 E., S.B.M., Midland quadrangle, 1952; at the north end of the McCoy Mountains.

Ownership: Dan Figueroa and Sons, P.O. Box 453, Blythe.

History: Hudson (1950, p. 180) gave a brief description of what appears to have been early (1918) development on one of the original claims (Social Manganese mine) of this group. The present owner was active on this property in 1958.

Geology: Fault planes occupied by masses of mineralized breccia as much as 15 feet wide cut sheared and jointed granite porphyry. The breccia zones are exposed on the sides of a steep canyon and on the ridges in the rugged area immediately west of the Black Jack claims (see herein) and are a part of the same mineralized fault system. The faults form a large-scale boxwork of northeast and northwest-trending breaks which are vertical or dip steeply northwest or southwest.

Photo 32

832

The ore is of the psilomelane type with some pyrolusite and interlayered crystalline oxides which may be manganite. The oxides comprise fissure and void fillings, ranging from thin coatings to irregular masses as much as a foot thick and several tens of feet in lateral extent in the fault breccia. The explored fault zones are in a group exposed on a ridge in the angle formed where the canyon turns south. Here, four fault zones are exposed about 200 feet above the canyon floor. The widest of these is as much as 15 feet wide. It strikes obliquely down the ridge N. 15° W., and dips 70° SW. and is joined, near the crest of the ridge and on the north slope, by the other 3 narrower faults which strike N. 25° E., N. 40° E. and N. 25° E. The lowest of these 3 faults dips 55° NW.; the other 2 are vertical.

Development: The widest fault is explored by an open-cut, as much as 40 feet deep, on the north slope near the crest of the ridge. The other 3 faults are opened on the crest of the ridge and about 50 feet across the west slope by shallow open-cuts. Half way down the north slope the westernmost of the narrower faults is followed south about 140 feet by an adit in which the ore is as much as 5 feet wide. A 190-foot adit was driven S. 75° E. into the west slope about 100 feet below the ridge-crest workings in an apparent attempt to crosscut the mineralized faults. The adit reached a 12-foot-wide ore body. About 15 feet from the portal a raise was driven to the surface. An ore chute was installed and ore from the ridge above allowed to gravitate down the slope into the open raise. In addition, the workings on the ridge were served by an aerial tramway down the north slope.

The ridge, which forms the north and west sides of the canyon, has been extensively prospected and trenched by former operators and one cut, on the north side of the canyon, appears to have been mined by the current owner. It is about 50 feet long, and 15 feet deep on an ore body as much as 6 feet wide in a fault striking N. 20° W., and dipping 70° SW.

Production: According to the owner, in 1958, 4 carloads of ore were shipped from this mine on the government carlot program; the ore was milled at Inca Siding. No earlier figures were given.

References: Trask Hudson, ~~F. S.~~, 1950, p. 180.

R.B.S. 1/15/59

835

Yellow Stone (Giant Chief) Claim

Location: NW¼ sec. 24 (proj.), T. 3 S., R. 20 E., S.B.M., Midland quadrangle, 15' 1952; on a low outcrop of limestone and schist about 2,000 feet southeast of the Lucky Boy mine and about 3½ miles northwest of Midland.

Ownership: Ellen Wendling, Box 344, Blythe, California (January 1959).

History: The Yellow Stone claim is a relocation of the former disputed Giant Chief claim described by Wilson in 1943 (Trask, 1950, p. 183).

Geology: A complex of limestone and schist units appear to be faulted along the southwest side of a low, limestone knoll which rises a few feet above the gravel-covered surface of a pediment. The planar structure of the rocks strikes N. 80° E., and dips 40° NW. The limestone unit exposed on the knoll contains numerous thin veins of manganese oxides. The principal ore mass thus far visible in the workings appears to consist of a tabular body of psilomelane-type oxides as much as a foot wide which lies in a shear zone parallel to the schistosity and roughly coincident with a limestone unit, just north of the limestone knoll.

No fault is exposed in the workings but, as suggested, one might lie just southwest of the knoll. If such a fault is a controlling factor, as is true at the nearby Lucky Boy mine, more extensive ore bodies may yet be found along it.

Development: A single open pit about 15 feet deep was dug on the mineralized shear zone north of the limestone knoll. The ore is exposed in its west wall.

Production: Undetermined.

References: Wilson, 1943, see Trask, 1950, p. 183.

R.B.S. 2/3/59.

Mica

Ida V. Mine

Location: Near the center of sec. 10, T. 7 S., R. 2 E., S.B.M., Hemet quadrangle, 15', 1957; low on the east slope of Coahuila Mountain.

Ownership: Undetermined (1958).

History: The original date of location was not determined, but the Ida V. claim was relocated in 1954 by Charles I. Rossman and others. The mine probably was operated late in 1954 and during 1955.

Geology: A muscovite-rich dike is exposed on the Ida V. property. It strikes N. 40° W. and dips 25° NE., is 10 to 15 feet wide and is poorly exposed for about 500 feet up a brush-covered ridge. The dike consists of quartz, feldspar, muscovite and biotite mica, black tourmaline, and garnet. The dike shows no consistent zoning, but local concentrations of mica, garnet, and black tourmaline, are present. The relative proportions of the constituents were not determined because of limited exposure of the pegmatite body and the poor condition of the mine. Books of brittle, herring-boned muscovite, 4 inches across the cleaved face and 6 inches thick, are exposed near the portal of the adit.

Development: A single drift adit about 40 feet long was driven in the process of removing a concentration of muscovite mica crystals. When visited (June, 1958) the adit was partially caved and the road, leading to the property from Pomroy's ranch, was in bad repair.

Production: According to T. C. Pomroy, a local resident, the mica was mined out ~~(ran out)~~ after a small tonnage had been shipped (presumably during the 1954-1955 period), to a Los Angeles paint manufacturer to be ground and used in their products ~~(T. C. Pomroy, personal communication)~~.

References: None.

R.B.S. 6/27/58.

Johnson Deposit

Location: SW¼ sec. 9, T. 3 S., R. 6 E., S.B.M., Thousand Palms quadrangle, 15' 1958; south margin of the Little San Bernardino Mountains about 8 miles southeast of Desert Hot Springs, in the first canyon east of East Wide Canyon.

Ownership: Southern Pacific Land Company, 65 Market Street, San Francisco 5.

History: The deposit was worked briefly in 1940 by a Mr. Johnson. A few tons of biotite and vermiculite were mined, crushed at the site, and hauled to San Bernardino where the material was expanded in a rotary kiln. About 1958, the property was leased by Christopher Mines, Inc., who prospected the property for vermiculite and uranium. At that time the deposit was examined by the California Zonolite Company, but was not put into operation because of estimated small reserves of high-grade vermiculite.

840

Geology: A mass of hornblende-pyroxene-biotite schist occurs in foliated quartz biotite gneiss and biotite schist (Chuckwalla Complex). The hornblende-biotite schist mass crops out along both sides of the canyon and is about 900 feet in diameter with most of the body lying on the east side of the canyon. Locally the body is altered to hydrobiotite and vermiculite (Proctor, 1958, p. 45). According to Proctor (1958, p. 46) there is an estimated 50,000 tons of altered rock.

Development: Several steep faces along the canyon have been blasted down, but no regular quarry has been opened.

Production: Probably about 100 tons to perhaps a few hundred tons in 1940.

References: Proctor, 1958, p. 45-46.

C.H.G. 5/20/61

841

Pine Knot (Lucky Day, Lucky Lay) deposit

Location: SE 1/4 NW 1/4 sec. 6, T. 2 S., R. 7 E., S.B.M., Joshua Tree quadrangle, 15', 1955; Joshua Tree National Monument, 7 1/2 miles south of Joshua Tree on the east side of Lower Covington Flat at its south end, about 200 feet above the valley.

Ownership: A. M. and M. C. Roberts, E. L. and Lois Boren (1942). Undetermined (1960).

History: The Pine Knot claim was located at some unknown date prior to the establishment of Joshua Tree National Monument in 1936. No recent work was observed in January 1960.

Geology: Medium- to coarse-grained, banded, quartz monzonite gneiss contains pods of impure biotite. The biotite occurs as black to grayish green, small thin plates. The mica pods range in thickness from 2 inches to 3 feet, and are as much as 6 feet long where exposed in pits. Some of the pods strike N. 65° W. and dip 45° NE.; others strike N. 70° E. and dip 40° NW.

Development: Mica pods have been explored by one pit about 10 feet in diameter and 6 feet deep, and by 4 small cuts; each about 6 feet deep.

Production: Undetermined.

References: None.

C.H.G. 1/27/60

842

Mineral Point

Lord Deposit

Location: Undetermined, probably was in the area of NW¼ sec. 14, NE¼ sec. 15, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, between Main Street and Hagador Canyons.

Ownership: Undetermined. May be part of several claims held by Josephine Middleworth, 847 West 9th Street, Corona, or on patented ranch land owned by W. H. Redding, 1008 South Pacific Avenue, San Pedro (1957). See Middlesworth Clay deposit herein.

History: Aubury (1906, p. 339) reported a bed of fine-grained, light-colored, yellow ochre 8 feet wide in a deposit of fire clay. In 1905, George W. Lord, Corona, was the operator. Apparently long idle.

Geology: Paleocene Silverado Formation clays crop out in this area.

Development: Numerous prospect pits and open-cuts and several caved adits.

Production: Undetermined.

References: Aubury, 1906, p. 339; Merrill, 1917 [1919] p. 579; Symons 1930, p. 156; Gray, 1961, p. 117.

C.H.G. 3/6/61.

National Paint and Color Company Deposit

Location: Undetermined, probably was in the NW¼ sec. 14, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, northwest side of Main Street Canyon.

Ownership: Undetermined.

History: According to Aubury (1906, p. 339). the National Paint and Color Company produced about 20 colors of natural pigments (ochre, red oxide, vermillion red, grays, etc.) in Corona in 1905. Long idle.

Geology: The National Paint and Color Company is reported (Aubury, 1906, p. 339) to have held extensive clay deposits near Corona; one tract of 20 acres contained a 5-foot bed of ochre stated to be of a very choice quality. This bed of ochre was not observed in 1957, but clays of the ~~Paleocene~~ Silverado Formation crop out in the area.

Development: Undetermined.

Production: Undetermined.

References: Aubury, 1906, p. 339; Symons, 1930, p. 156; Gray 1961, p. 117.

C.H.G. 3/6/61.

Paint Mine

Location: Undetermined, probably was in the area of the NW¼ sec. 14, NE¼ sec. 15, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern flank of the Santa Ana Mountains, 3½ miles southwest of Corona, between Main Street and Hagador Canyons.

Ownership: Undertermined.

History: This property was developed by G. W. Lord, Corona, before 1905 and in 1905 was owned by the Corona Pressed Brick and Terra Cotta Company. The deposit was reported to be about 500 yards northwest of the Lord deposit, described herein. Long idle.

Geology: Paleocene Silverado Formation clays crop out in this area.

Development: Undetermined.

Production: Undetermined.

References: Aubury, 1906, p. 339; Symons, 1930, p. 156; Gray, 1961, p. 117.

C.H.G. 3/6/61.

Molybdenum

4 L's (Dorothy Ann) Prospect

Location: The extreme southwest corner of sec. 34, T. 4 S., R. 2 E., S.B.M., Lake Fulmor quadrangle, 7.5', 1956; near the intersection of San Jacinto Ridge Truck Trail and Stone Creek, about 8 miles, by road, northwest of Idyllwild.

Ownership: C. H. Brooks (1958).

History: Bob Appleton of Pine Cove is reported to have stated that this property was worked for molybdenum, probably during the first World War (personal communication, Norman Sanders, 1961).

Geology: The mine area is underlain by granitic rock, probably Mesozoic in age, that forms much of the San Jacinto Mountains. A thin quartz vein was noted by Mr. Sanders in the upper workings. The presence of molybdenum-bearing minerals was not proven.

Development: The only development observed in July, 1958 was a 40-foot adit driven N. 75°W. in sheared and apparently barren granitic rock. Norman Sanders reports that there is, in addition, a 60-foot adit driven N. 50° W. from which extend two, 60-foot drifts bearing N. 16° E. and a 20-foot raise to the surface. These are a short distance up the slope from the truck trail and the 40-foot adit and are obscured by brush.

Production: The small extent of the workings and the observed and reported narrowness of the veins, suggest the yield of this mine, if any, was probably small.

References: None.

R.B.S. 7/22/58.

Peat

Burro Flats Deposit

Location: SE¼ sec. 14, T. 2 S., R. 1 E., S.B.M., Cabazon quadrangle, 7½', 1956; south edge of Burro Flats, at the head of Potrero Creek, about 4 miles north-northeast of Banning.

Ownership: U. S. Government; leased to the Morongo Corporation with the permission of the Morongo Indian Tribe.

History: Development was started by the present lessee in the fall of 1956.

Geology: Ground water, dammed in a sagpond on a fault of the San Andreas fault system has resulted in the development of a peat bog. The peat is composed mainly of the compacted and partly decomposed remains of reeds, rushes, and sedges (grasses). The deposit underlies an irregular area of about 21 acres and ranges from 0-16 feet in thickness. It is wedge shaped in profile being thickest along the south margin adjacent to the fault. The peat thins to the north where it becomes interbedded with clay, silt, and gravel.

848

Development: The bog has been partly drained to facilitate mining. The exposed surface of the peat is loosened with a harrow and allowed to dry, in place, to about 25 percent water by weight. The peat is loaded into trucks with a power shovel, ground in a plant adjacent to the bog, and trucked to a bagging plant near Banning.

Production: Since 1956 production has been irregular. Current output is somewhat seasonal because the principal market is ~~1~~ 10 golf clubs who use the peat as a conditioning material in seeding and maintaining greens and fairways. The present (November, 1960) yield is about 1,000 yards per month.

Grinding is done according to specifications of the users. ~~(A broader market is anticipated by the operators in sale of this product to home gardners.)~~

References: Saul, 1960, p. 8-9.

R.B.S.

849

Perlite

Great Western Exploration Company Perlite ~~Prospect~~ (Deposit)

Location: Secs. 26 and 27, T. 8 S., R. 18 E. (proj.), S.B.M., Chuckwalla Spring Quadrangle, 15', 1953, on the south slope of the Little Chuckwalla Mountains about 10 miles westerly from Wiley's Well.

Ownership: Eight claims owned by Great Western Exploration Co. Inc., Room 908, 408 S. Spring Street, Los Angeles.

History: The perlite deposits on these claims are said to have been discovered in 1947-48, by George B. Gibford and associates, but were never worked until 1961 when a small plant was erected to obtain perlite for testing purposes. The property was idle in November 1961.

Photo 33

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Geology: The perlite occurs in lens-like bodies associated with flows of rhyolite and discontinuous layers of pumiceous tuff breccia. These flows of rhyolite and perlite rest unconformably upon andesite and are overlain unconformably by flows of basalt. In the vicinity of the perlite claims, the sequence of volcanic rocks dips in a southeasterly direction and has a strike that ranges from northeasterly to almost north. There are three main bodies of perlite in the mapped area (fig. 53). The largest body is approximately 4,000 ft. in length and ranges in thickness from 50 to 130 ft. The perlite in this body is pumiceous, light gray in color, and expands satisfactorlily. The screening plant is located near the southern end of the medium-sized body of perlite which measures about 1,200 ft. in length, and ranges in thickness from a few feet to 80 feet. The perlite in this lens is the dense, medium gray onion skin variety and it too expands satisfactorily. Near the southern end of the mapped area is the third body of perlite which measures at least 1,000 ft. in length and is probably no more than a few tens of feet in thickness. This perlite too is pumiceous and is similar in all respects to the perlite in the large body. It occurs between two flows of perlitic rhyolite, but probably does not constitute a large source of perlite since one would need to mine the perlite by

figure 53

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underground methods after stripping the surface. Several small faults in the area dislocate the perlite bodies, however, none of the faults is of sufficient magnitude to materially effect the mining of the perlite.

Comments: Considerable testing has been done on the various grades of perlite (pumiceous perlite and dense onion skin perlite) and all tests indicate that the perlite will expand satisfactorily and may be used as aggregate for acoustical insulating plasters or in the manufacture of wall board.

Development: Development consists principally of shallow trenching in several areas where perlite crops out, and the removal of debris from other areas where the perlite was not exposed.

The deposit contains substantial reserves.

C.W.C. 3/1/62

Photo-34

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GEOLOGIC MAP

of part of

The GREAT WESTERN COMPANY PERLITE PROPERTY

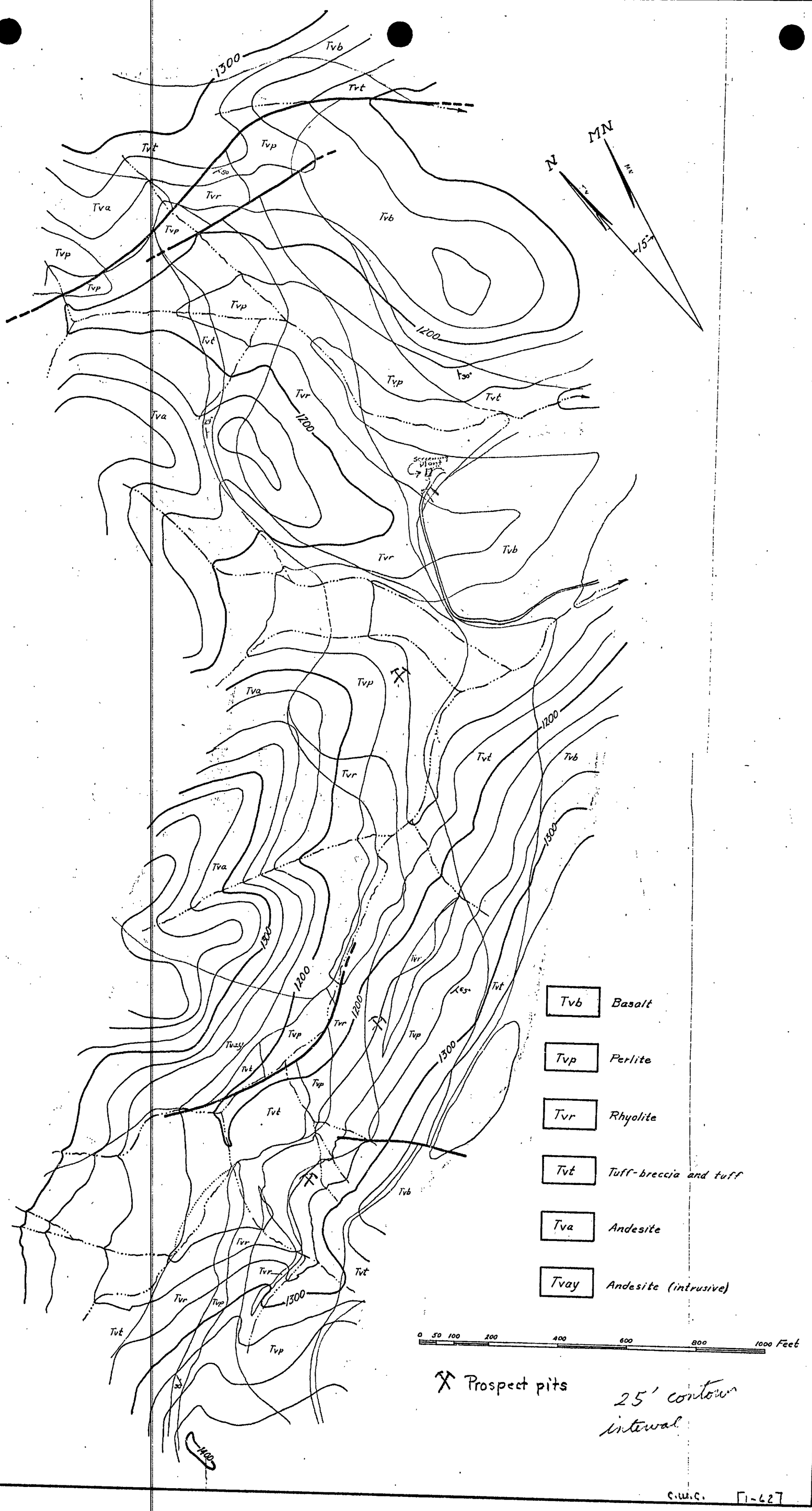
Little Chuckwalla Mountains, Riverside County

California

Sections 26 and 27, T. 8 S., R 18 E (projected)

Geology and Topography by

Charles W. Chesterman, 1949


1300
Tvb
Tvt
Tvp
Tvr
Tva
1200
Screening Plant
MN
N
15°
Tvay
Tvb Basalt
Tvp Perlite
Tvr Rhyolite
Tvt Tuff-breccia and tuff
Tva Andesite
Tvay Andesite (intrusive)
0 50 100 200 400 600 800 1000 Feet
Prospect pits
25' contour interval
C.W.C. [1-62]

Petroleum

Exploration for oil has been carried on in Riverside County for more than 50 years. Prior to 1966 the area of chief interest, and the only one in which any success had been achieved was in the southeastern Puente Hills in the vicinity of Prado Dam (Plate 2/). Here, sedimentary rocks of Miocene and Pliocene age are folded and faulted along the trace of the Chino fault. Oil and gas accumulated in structural traps comprise the Mahala oil field (Michelin, 1958). The southeastern end of this field (about sixteen percent of the mapped area of the field) extends into Riverside County from adjacent San Bernardino County (Gaede, 1969, pl. 1).

In the Mahala oil field the oil has accumulated in a faulted anticline. It is produced from three sand zones: the Abacherli, which is 50 feet in average thickness and reached at average depth of 2,500 feet; the Lower Michelin, which is 200 feet in average thickness and reached at average depth of 1,500 feet; and the Upper Michelin, which is 250 feet in average thickness and is reached at an average depth of 1,250 feet. All three sands are in the Puente Formation (Upper Michelin). The Abacherli sand yields 24-gravity oil. Both Michelin sands yields oil of 27 gravity. Only a small proportion of the oil produced

from the Mahala field has come from the few wells drilled within Riverside County. Exploration and extension of the producing area of the field has been northwestward, in San Bernardino County. The first well, Mahala Oil Company well No. 1 was completed in 1921. The early history of drilling in this field is detailed in an account by Gaede and Dosch (1955). By the end of 1957 there were 13 completed well in a proven area of 100 acres (Durham and Yerkes, 1964). In 1970 Mahala oil field comprised 29 operating wells in 230 proven acres. Only one of the 29 wells was in the Prado Dam, (Riverside County) area (California Division of Oil and Gas, 1970).

The Prado-Corona oil field was discovered in 1966 (Gaede, 1969) just east of the Mahala oil field and adjacent to the northwest boundaries of the City of Corona, in Riverside County. This is the first field of importance lying entirely within Riverside County. In 1969 it consisted of two oval shaped areas, each less than a mile long, that were about one mile apart on a northwest-trending line across the Santa Ana River (Gaede, 1969, pl. 1). The northwest part of the field is designated the Sardco area, the southeast part is designated the Goedhart area.

The structure of the Sardco area is a faulted anticline. Northwest-trending normal faults formed blocks in which petroleum accumulated. The northwest and southeast productive limits had not yet been determined in 1969 (Gaede). By 1972 the Sardco area comprised eight wells in 125 proven acres (Russel Farrell, personal communication).

The structure of the Goedhart area is similar to the Sardco area and is part of the same structural trend. By 1972 the Goedhart area comprised 6 wells in 122 proven acres (Charles Howell, personal communication).

In the Prado-Corona field, drilling has penetrated strata ranging in age from Upper Eocene through Holocene in the Sardco area, and from Upper Cretaceous through Holocene in the Goedhart area. The deepest well in the Sardco area reaches a total depth of 3,214 feet and in the Goedhart area, 3,984 feet. There are two producing zones in the field, the Upper and Lower Hunter in the Soquel member of the Puente Formation. The units yielding the gas and oil comprise sandstone and conglomerate averaging 150 feet in thickness in the Sardco area. These rocks have an average porosity of 36 percent and an average permeability of 174 millidarcys with a range from 31 to 435 millidarcys. In the Sardco area, wells have initial daily yields from the

combined Upper and Lower Hunter zones of between 13 and 168 barrels of 15 to 18.5-degree gravity oil and 0 to 25 Mcf. of gas. In the Goedhart area, wells completed in the Lower Hunter oil zone have initial yields of 12 to 45 barrels of 15-degree gravity oil (Gaede, 1969).

Dry gas is found in the Goedhart area in the Upper Hunter zone. Wells have restricted initial daily yields ranging between 1,100 and 2,200 Mcf. of gas, with average tubing and casing pressures of 800 and 850 psi, respectively. The gas consists of 98 percent methane by volume and contains 0.066 gallons of liquid per Mcf.; Btu rating is 1,018 per cubic foot (Gaede, 1969).

By 1970, accumulated production in the Prado-Corona oil field totaled 174,130 bbl. of oil and 3,064 Mcf. of gas. Preliminary figures for 1971 are: 70,408 bbl. of oil, 10,099 bbl. of water, 1,200 Mcf. of wet gas, and 382,449 Mcf. of dry gas (California Division of Oil and Gas).

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Table 4/ Exploratory Wells Drilled Outside of Oil and Gas Fields in Search of Oil or Stratigraphic Information in Riverside County.*
Those lying in the Prado Dam-Corona area are plotted on Plate 2/.

* Data from California Division of Oil and Gas annual summaries of operations

T.	R.	Sec.	Owner and Well Name	Date Started	Date Aban-doned	Total Depth	Remarks (geology at bottom unless otherwise indicated)
2S	7W	35	Tannehill, L.B; No. 1	2-20	1925	580	Elevation 605'
2S	6W	15	Kosanke, J.F.; No. 1	3-36	1937	896	Showof oil and gas reported.
2S	5W	31	Arl Oil Co.; No. 1	9-22	pre-1925	1125?	
2S	3W	14	Cheney Oil Lease Syn.; No. 1	3-23	1926	1950	
2S	2W	16	Midway Oil Syn. (Beaumont Midway Oil Co.); No. 1	3-22	1926(?)	5358	
2S	2W	35	Alberta Oil Co.; No. 1		1933	3180	
2S	2W	35	Smith, S.V.; Haskell 1	12-52	1933	1332	Quaternary
2S	1W	12	Riverside County Oil Co.; No. 1	11-20	pre-1925	2235	
2S	3E	25	Painted Hills Oil Assn.; No. 1	5-20	1925	1400	
2S	4E	11	Amundson, Floyd; No. 1	6-26	1926	212	
2S	4E	14	Century Oil Assn.; No. 1	4-21	pre-1925	500	
2S	4E	30	Painted Hills Oil Assn., No. 2	11-21	pre-1925	400	
2S	4E	33	Wallenberg; Daisy 1	1918			
2S	6W	19	Prosper, D. Smith: "Smith & Scott" #2	10-24-57	11-1-57	651	Dry hole, bottomed in granite: base of fresh water sands 90'; elevation at collar 680'.
2S	6W	20	Prosper D. Smith: "Smith & Scott" #1	5-12-57	11-1-57	411	Dry hole, bottomed in granite; base of fresh water sands 80'; elevation at collar 690'.
2S	6W	30	Southern California Petroleum Corp. "Taber Estate" Core Hole 1	12-11-44	12-30-44	210	Dry hole, bottomed in granite; sand and gravel to granite contact at 192'.
3S	7W	2	Corona Oil Co.; No. 1	11-20	1921	400	

3S	7W	7	Julian S. Gould "T.B.G."	6-62		1965	1880	Miocene; elevation 520
3S	7W	8	Cherrydale Oil Co.; Cherrydale 1			1952	2478	Miocene
3S	7W	9	Airways Petroleum Corp.; Santa Anaheim 1	9-49	Susp.	1950	2830	
3S	7W	26	Neuvo Oil Co.; No. 1					
3S	7W	33	Ciroco Oil Co.; Ciroco-Wright 1	11-51		1952	1520	1954 deepened to 4027 Frank Pettyridge
3S	6W	25	Easton-Monell; No. 1			1933	3090	
3S	5W	6	Arl Oil Co.; No. 1	11-21	pre-	1925		Granite
3S	4W	12	Mathews, Roland & Dalziel; No. 1	10-22		1927	2610	Granite ?
3S	2W	15	Moreno Oil Co.; No. 1	10-20		1925	1700	
3S	2W	26	Nuevo Oil Co.; No. 1	12-20		1928	2225	
3S	1W	1	Beck, Frank; No. 1	1-31			450	Converted to water well.
3S	1W	12	Beaumont Expl. Co.; John Drew 1	6-53		1953	2215	Pliocene
3S	1W	15	Rippeto, L.W. (Beaumont Crude Oil Co.): No. 1	3-21	pre-	1925	1925	
3S	2E	5	Clark, L.R.; No. 5			1928	1960	
3S	3E	1	C & K Oil Co. "Moore"	11-55		1961	868	Alluvium
3S	3E	2	Parsons Petroleum Co.	12-62		1963	460	Alluvium 0-270; Basement (decomposed granite) 270
3S	3E	9	Cabaxon Oil Co. (Cabazon Central Oil Co.); No. 1	8-22	pre-	1925	600	
3S	4E	4 or 5	Western Dev. Corp. (Banning Oil Co.); No. 1	4-21		1930	975	
3S	7W	3	Clifford A. Robinett "Pinkerton" #1	8-31-54		9-8-54	1068	Dry hole, bottomed in shale.
3S	7W	14	John L. Smith "Sullivan" #1	12-9-57		12-12-57	352	Dry hole, bottomed in granite. Elevation 600' above sea level
3S	7W	15	J.B. Nelson "Lillibridge" #1	11-17-56		2-3-57	1360	Dry hole, bottomed in Middle Puente; cemented to 750' and converted to water well 6/56; elect. log- 500'-1346'; elevation 525' above sea level.
3S	7W	15	Joseph A. Traver, Opr. "Traver-Government" 2	6-67			1340	Puente (upper Miocene)

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3S	7W	16	Santa Fe Drilling Co. "Sardco"	10-63	1963	2672	Upper Mohnian (Div. C 1, 230; basement 2500
3S	7W	22	J.B. Nelson "Lillibridge" Government #1	9-3-58	9-17-58	1711	Bottomed in Lower Mohnian; dry hole; elect. log. 285'-1200'; elevation 535 above sea level
3S	7W	22	J.B. Nelson "U.S." #1	1-30-58	5-6-58	1829	Dry hole, bottomed in volcanic rocks of possible Miocene age; elect. log 155'-1825' elevation 450' above sea level.
3S	7W	29	U-Tex Oil Company "Prado Dam" #1	1-23-57	2-10-57	2438	Dry hole, bottomed in gray, hard ss-- no oil showings-- no water; elevation 625'
3S	7W	7	Julian S. Gould, "T.B.G." #1	6-14-62	10-10-62	1880	Dry hole; bottomed in shale Upper "Michelin" zone; a few traces of oil and gas; elevation 520'.
3S	7W	7	Julian S. Gould "T.P. Gov." #1	11-1-59	Idle	1388	Light showings of oil at several depths; operations suspended; elevation 619'.
3S	7W	8	Cherrydale Oil Co. "Cherrydale"	6-51	1962	2497	Soquel, Div. D. (Upper Miocene)
3S	7W	18	C.D. Howe "Cree" #1	11-14-57	12-3-57	3075	Dry hole; top of Mohnian at 2505; elevation 600'.
3S	7W	18	C.D. Howe "Prado Oil Co." #7	8-1-58	8-7-58	2900	Dry hole, showed traces of oil; top Upper Mohnian Div. C, 2360; top "Michelin" zone, 2620; elevation 509'.
3S	7W	18	C.D. Howe "Wilcox" #1	5-18-57	6-29-57	4490	Small yield of oil and gas, no production; bottomed in Upper Miocene; Mohnian 2705-3595; Delmontian 1980-2700; elevation 790'.
3S	7W	18	Shaffer Rentals, Inc. "Hudson" #2	3-29-60	4-9-60 Idle	3909	Appears to have pumped oil; bottomed in ss. and sh. elevation 920'.

3S	7W	18	Atlantic Oil Co. "Atlantic Aros" #1	4-14-57	5-9-57 Idle	3853	A small producer, appears to have bottomed in or just below oil sand; elevation 850'.
3S	7W	18	Prado Basin Oil Co. "Gov. T N.P.-C" #1	10-4-59	10-25-39	4609	Dry hole; bottomed in Lower Mohnian; top of Michelin 3225, top of Yorba sh. 3650, top of Yorba sd. 4460; elevation 768'.
3S	7W	17	Alpoil Company "Gov. TMp-C" #1	11-2-60	11-13-60	3569	A small yield; appears to have bottomed in sediments; top of Delmontian 1560? 1680? top of Upper Mohnian 2280 Div. C, top of Yorba sh. 2660 Div. D, top of Yorba sd. 3345 Div. D, elevati 475'.
3S	7W	17	Alpoil Company "Gov. T.M.P.-D" #1	7-16-60	7-29-60	3626	Dry hole; bottomed in Puente fm.; top of Delmontian 1630, top of Upper Mohnian 2260 Div. C, top of Yorba Shale 2690 Div. D, top of Yorba sd. 3500 Div. D.; elevation 477'.
3S	7W	20	Macrate Oil Co. G-G1	2-16-57	3-29-57	3613	Small yield; bottomed in ss. probably Miocene; elevation 487'.
3S	7W	20	A.L. Hunter, Operator "Sardco" #1	11-19-60	11-29-60	3747	Small yield; bottomed in Miocene sediments; Yorba shale (in Div. D 2710, Mohnian Div. D? 3747; elevation 475'.
3S	7W	20	A.L. Hunter, Operator "Sardco" #2	3-13-61	6-28-61	3337	Small yield, no commercial production; bottomed in siltstone top of Yorba sh. 2655; elevation 482'.
3S	7W	19	Cree Oil Company "Prado-Government" #1	10-11-56	11-10-57	2600	In sediments at 1963', dry hole, elevation 493'.
3S	7W	22	E.J. Fife and R.E. Fife, Sr. "Gov't"	4-65	1965	190	Alluvium (Recent); elevation 530'

3S	7W	22	Joseph A. Tarver "Tarver-Government"	12-64	1965	1177	Miocene; elevation 539'.
3S	7W	23	Roy E. Fife, Jr.	11-62	1965	1569	Miocene; elevation 546'.
3S	7W	28	C.D. Draucker "Shaw"	10-68	1968	2800	Upper Hunter 2624; Sespe 2680-28 (Oligocene)
3S	7W	29	Al Godfrey Drilling Co. "Botiller" 1	7-15-54	10-31-54	4726	Bottom not reported--probably in seds; dry hole; elevation 575'.
3S	7W	29	Isaac M. Stewart 1 "Stewart"	3-3-56	3-26-36	1890	Dry hole; bottomed in bouldery sand, elevation 575'.
3S	7W	34	Edgington Oil Refineries, Inc. "Pipkin" #1	6-8-61	7-8-61	4371	Dry hole; base of Puente Div. E? 2820; elevation 920'; in seds at 4367'.
3S	7W	28	Edgington Oil Refineries Inc. "Thomas" #1	4-14-61	5-5-61	4575	Dry hole; base of Repetto; 1550? top of Puente (same); Middle Eocene Santiago Fm. 3200?; Upper Cretaceous 4510? elevation 667'.
3S	7W	30	Pacific Drilling Co. "Savi"	11-68	1968	4380	Div. E. (Upper Miocene) elevatio 467'.
3S	7W	30	Pacific Drilling Co. "Trudell"	1-67	1968	3992	Repetto 0-1040; Delmontian 1040; Div. c 1400; Div. D 1880-3992 (Upper Miocene)
3S	7W	30	Pacific Drilling Co. "Savi" 1	11-68	1969	4331	Div. D (Yorba) 250-680; Div. D (Soquel) 680-2395; Div. D (Yorba) 2395-3300; Div. E (LaVida) 3300-4331; Miocene; elevation 466'.
3S	7W	30	Pacific Drilling Co. "Savi" 2	4-69	1969	805	Recent-Pleistocene)-120; Div. D (Yorba) 120-620; Div. D (Soquel) 620-805; Upper Miocene; elevation 488'.

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3S	7W	33	Pethybridge and Erlich "Wright" #1	11-12-51	11-30-51	1505	Gas showings; no production; bottomed in black shale; elevation 826.5'.
3S	7W	33	A.L. Hunter "V.O.W.M." #1	11-15-61	11-29-61	4157	No production; Silverado fm. 50-1040; Cretaceous (Ladd Fm.), 1040-2540; Chino fault, 2540-2600; Mohnian D, 2600-26400; Olig-M. Eocene (Sespe-Santiago) 2640-3935; Paleocene (Silverado) 3935-4157; elevation 780'.
3S	3E	1	C & K Oil Co.; Moore No. 1	1957	—	—	
3S	5E	35	The Texas Co.; "Edom" Shore 1	1954	—	7468	
4S	6W	17	Reed, Kenneth E.; Kincheloe 1	1-50	3-50	609	Elevation 950'.
4S	6W	21	Hammerling, Max N.; M.N.H. 1	11-51	3-52	797	Non-commercial gas and oil shows; top granite 763; converted water well.
4S	6W	28	Elkhorn Petroleum Co.; "Heinlein" #1	4-49	5-49	950	
4S	6W	28	Frontier Petroleum Co.; "Barger" #1	1-49	2-50	1060	Elevation 998'.
4S	6W	28	Johnson, C.H. (Fife Bros.; Orangethorpe Oil Co.); "Heinlein" #1 (Orangethorpe 1)	1-49	1951	678	
4S	6W	28	Palm, Peter; No. 1	6-50	6-50	825	Bottomed in ss and sh; elevation 1005'.
4S	6W	28	Trabuca Oil Co.; No. 1	5-25	1931	4500	
4S	6W	28	Trabuca Oil Co.; No. 1-A		1931	4490	
4S	6W	28	McFadden, M.A. "Uncle Bill"	1-63	1963	781	Sespe (Oligocene)
4S	6W	28	Red Star Oil Co. "Red Star-Earl"	12-62	1963	2910	Vaqueros 240; Sespe 840; Santiago 1500; basement (volcanic-Paleocene) 2250-2910

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4S	6W	29	V.O.D. Oil Co. Inc.; "Berghofer" 1	11-50	1953	1823	
4S	6W	34	Mankin, John & Johnson (Frontier Petroleum Co.); Case 1	2-50	2-50	845	Elevation 1164'.
4S	2W	2	Neuvo Oil Co.; No. 1		1926	2225	
4S	1W	21	Grayco Oil; San Jacinto 1	Susp.	1951	210	
4S	1E	30	Wonder Oil Co.; Stroh 1	10-42	1942	2800	
4S	6W	17	A.W. Duncan	—	—	—	Wildcat; elevation about 1000'.
4S	6W	28	McFadden "Uncle Bill:			800	Elevation 800'.
4S	6W	28	Red Star Oil Co. "Red Star-Earl" #1	12-30-62	3-26-63	2910	Elevation 1080'; never produced
4S	6W	28	Notterman, Nick L. "Notterman" 1	5-56	7-56	851	Elevation 1150'; gr. Sandy sh.
5S	6W	3	Kronisch, E.; Christopher 1		1925	1190	
5S	6W	3	Kronisch, Eugen; "Christopher	10-51	1963	1090	Quaternary
5S	6W	12	Berghofer, Victor; "Berghofer" 1	2-50	1950	1062	
5S	5W	26	St. Pierre, Andrew, J.; "St. Pierre" 1	9-51	1952	936	Showings reported at 400'.
5S	5W	36	Great Coastal Oil Corp.; No. 1	9-34	1937	2991	Basement
5S	2W	16	Dorn, Ella Chisholm; No. 1	3-50	1950	216	
5S	1W	10	Hemet Petroleum Corp.; No. 1	5-27	1931	3625	
5S	1E	23	Pioneer Oil Syn.; No. 1	8-21	1923	460	
5S	7E	11	C.H.S. Co., Ltd.; "Bobbie" 1	12-50	1951	1901	Fine-grained gray sand.
6S	4W	18	Arnold, Anne; Conklin-Walker 1	5-52	1952	2306	Eocene?
7S	3W	14	Murrietta Valley Oil Co.; No. 1	6-23	1925-26	1120	Jurassic
7S	3W	23	Albert Petroleum Corp. (Fidelity Realty Corp.); Watt 2	7-29	1939	2786	Jurassic
7S	3W	23	Fidelity Realty Corp., Ltd. (Hall, Holtz & Hennessy); Watt 1	6-28	1929	956	
7S	3E	21	Bent, Crawford H.; Bent 1	8-51	1951	383	Granite
7S	10E	25	Spindle Top Oil Assn., No. 1	2-23	1937	3800	Pliocene?
8S	1W	13	Palomar Petroleum Co. "Tyrrell" 1	11-46	1948	2594	

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ELEMENTS

RARE-EARTH (~~MINERALIZATION~~)

The emphasis given to prospecting for radioactive minerals by the ground and airborne reconnaissance work of the U. S. Geological Survey in conjunction with the U. S. Atomic Energy Commission in the Live Oak Tank - White Tank areas in Riverside County during 1949 and 1952 (Noxham, 1952) soon led to serious local prospecting and the discovery of radioactive material in the Music Valley area. This area, in north central Riverside County, contains the principal occurrences of rare-earth elements found to date in the County. At first these deposits were thought to contain uranium, but by 1959 no more than traces of uranium had been found, whereas xenotime, the thorium-bearing phosphate of yttrium, was determined to be the main radioactive mineral and to represent the only material of possible commercial interest. All of the deposits in the Music Valley area are similar in nature and occur in the Pinto Gneiss of Precambrian (?) age.

In a general way, the rare-earth mineral deposits in the southern Music Valley area occur in a northwest-trending belt about three miles wide and six miles long (~~Figures 1 and 2~~). Shallow and relatively barren prospect pits dot the mountains on both sides of the valley.

Xenotime is almost entirely confined to the Pinto Gneiss, in which it is irregularly distributed and only locally concentrated in sufficient quantity to give an abnormal radioactive anomaly, and to be of possible commercial interest. It nearly always occurs in biotite-rich lenses, pods, and folia in the gneiss.

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Mineral concentrations appear to have formed early, either before or during metamorphism of the gneiss. If the gneiss is a metasedimentary rock, the rare-earth minerals could well have been detrital grains in the original sediment, perhaps concentrated locally along bedding planes. These planes might represent zones of relative weakness in which growth of xenotime could readily be accomplished during metamorphism. The majority of evidence and the best evidence point to a detrital origin for the rare-earth minerals modified later by metamorphism.

The future commercial development of these deposits depends mostly on the development of new uses for yttrium and its compounds. Current research by the U. S. Bureau of Mines should lead to new applications of yttrium and reduced costs of separating the metal from its sub-group associates, thus creating a new demand for the metal.

There are no quoted prices for xenotime concentrates and any sales of concentrates will have to be made by contract with potential purchasers. Dow Chemical Company and Lindsay Division of American Potash and Chemical Corporation are the major purchasers in the United States.

With additional exploration work in order to gain a better idea of reserves, and the consolidation of all the properties to be operated through one concern with one mill, the now marginal mineral material could be of economic interest when a market develops.

The grade of the deposits and the extent of mineralization has not been fully determined.

Ajax Prospect

Location: E 1/2 sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), Valley Mountain quadrangle, 15', 1956; Pinto Mountains, Gold Park, 9.2 miles S. 32° E. of Four Corners, Twentynint Palms.

Ownership: Milton E., and Earl C. Tubbs, 8315 East Fifth Street, Downey, own 2 unpatented claims (March 1959).

History: Probably located during the period of uranium prospecting during the middle 1950's.

Geology: The (Precambrian) Pinto Gneiss is locally intruded by porphyritic hornblende diorite. Several minor faults cut the strongly foliated gneiss. No mineralization was observed here and no radioactive anomaly was detected.

Development: Four shallow prospect pits are dug in the Pinto Gneiss. The upper two are in a northeast-trending and minor fault zone. The claims were not being worked in March 1959.

Production: None.

References: ~~None.~~ Evans, 1964, p. 12

J.R.E. 3/19/59

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Baby Blue (Dixie Girl) Prospect

Location: N-½ sec. 9, T. 2 S., R. 10 E., S.B.B. & M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Music Valley, 10.7 miles S. 39° E. of Four Corners, Twentynine Palms, ~~(see pl. 1)~~.

Ownership: James E., Charles R., and Harold R. Stewart have filed one unpatented claim (March 1959).

~~History: See Rare-Earth commodity section.~~ None

Geology: Pinto Gneiss, composed of 30-50 percent biotite with abundant quartz and oligoclase, and minor amounts of microcline and orthoclase, is well exposed in a shallow vertical cut. Folia of biotite, a fraction of an inch to 2 inches thick, trend northwest and dip south from 25° - 50°. The folia are closely interspaced with quartzo-feldspathic zones, and locally are interrupted by coarse-grained augens of oligoclase. Meager amounts of xenotime occur in the biotite folia and are readily visible only ~~in thin section~~ under high magnifications. Radioactive anomalies are very mild and the maximum reading recorded was 0.06 milliroentgens per hour above background.

Development: A 6-foot to 9-foot vertical cut 12 feet long and an 8-foot deep pit several tens of yards to the west comprise the workings. The prospect was not being worked in March 1959.

Production: None.

References: ~~None.~~ Evans, 1964, p. 10

J.R.E. 3/17/59.

865

Desert View Claim

Location: Secs. 31 and 32, T. 5 S., R. 10 E., S.B.M., Cottonwood Spring quadrangle, 15 min, 1958; Little San Bernardino Mountains, about 16 miles east of Indio and 1¼ mile northwest of Cactus City.

Ownership: Willis Murphy, Rt. 3, Box 1076, Yucaipa, owns 1 unpatented lode claim (January 1960).

History: In 1952, the claim was owned by Willis Murphy and E. H. Kreuger of Yucaipa Valley (Walker, Lovering and Stephens, 1956, p. 26).

Geology: Pinto gneiss is cut by several muscovite-garnet pegmatite dikes. One dike trends north, dips west and is as much as 2 feet thick. It has been intermittently exposed about 50 feet along the strike. Radioactive rare-earth bearing minerals (probably monazite and/or xenotime) are apparently sparsely and locally distributed in the gneiss. The dikes were not detectably radioactive.

An assay of two selected specimens collected in pits adjacent to the discovery monument show an equivalent uranium content of 0.13 and 0.15 percent, and a uranium content of 0.01 and 0.005 percent, respectively (Walker, Lovering, and Stephens, 1956, p. 26).

866

Development: Several shallow pits and bulldozer scrapes plus a 35-foot trench are cut in the Pinto gneiss; generally along dike-gneiss contacts.

Production: None.

References: Walker, Lovering, and Stephens, 1956, p. 26.

J.R.E. 1/28/60.

867

Live Oak Tank Area

Location: Secs. 17 and 16, T. 2 S., R. 9 E., S.B.M. (proj.), Lost Horse Mountain quadrangle, 1953; Joshua Tree National Monument, about 9½ miles south of Twenty-nine Palms, and 1 mile northeast of Jumbo Rocks Campground.

Ownership: Undetermined.

History: The Live Oak Tank area was examined by D. G. Wyant of the U. S. Geological Survey on December 13, 1948 as part of a study of radioactive deposits in California.

Geology: Monazite-bearing black sand of Recent age occurs in discontinuous patches on the surface of a dry wash. The sand patches range in length from a few inches to several feet, and are from 1 mm. to half an inch thick. Most of the sand was derived from White Tank ~~quartz~~ monzonite, and probably was deposited on the surface of the dry wash in the closing stages of the last flash flood. Samples of White Tank ~~quartz~~ monzonite and Pinto gneiss were analyzed for equivalent uranium, and uranium content (Table 1/). Most of the anomalous radioactivity in this area was attributed to thorium in monazite and xenotime, and to a lesser extent to radioactive titanite, zircon, and biotite (Walker, Lovering, and Stephens 1956, p. 25).

Development: None. Good gravel and dirt roads provide ready access to the area.

Production: None.

References: Walker, Lovering, and Stephens, 1956, p. 25).

J.R.E. 1/25/60

869

Sample number	Analyses			Description
	Field	Laboratory		
	* (MR/hr)	eU (percent)	U (percent)	
DW-79:				
246	0.04	0.008	0.003	3' chip, hornblende-biotite inclusion (Pinto gneiss) in White Tanks monzonite
247	.05	.005	.001	Placer, Recent gravel, incl. black sand; average material
248	.03	.002	.000	10' chip, schist inclusion (Pinto gneiss) in White Tanks monzonite
249	.02	.004	.000	Grab, chips of White Tanks monzonite from area 50' square
250	.05	.011	.001	Placer, black sand skimmed from surface dry wash
251	.02	.004	.003	Grab, chips of White Tanks monzonite from area 50' square
DW-80:				
252	.60 app.	.035	.005	Grab, biotite-feldspar porphyritic sill or dike in Pinto gneiss

* Average reading at the outcrop. Background included. Average background was 0.025 MR/hr.

Table 5 → Table 1. Sampling data, Live Oak Tank area, Riverside County, California (after Walker, Lovering, and Stephens, 1956, p. 25).

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Peerless Nuclear Minerals Deposits

Location: Secs. 5, and 8, and 16 (?), T. 25, R. 10 E., S.B.M., (proj.) Valley Mountain quadrangle, 1956; Pinto Mountains, about 10 miles east-southeast of Four Corners, Twentynine Palms (see pl. 1).

Ownership: Carlos J. Bassler, Jr., and Francis E. Bassler, 2112 Cedar Street, Alhambra own 17 unpatented lode claims (March 1959); E. O. Dunkin, et al., P. O. Box 482, Twentynine Palms own 7 unpatented lode claims (March 1959); all claims as of November 15, 1957 are leased to Peerless Nuclear Minerals, Inc., P. O. Box 243, Rialto, John E. Lund, president, Homer Van Dyke, secretary. Claims leased by Peerless Nuclear Minerals, Inc., include the Hansen Number 2, and Uranus numbers 2, 4, and 6. Several claims between the Uranus Group and the Hansen Group, known as the Thunderbird Group, are also leased by the company.

~~History: See Rare Earth commodity section.~~

~~Geology of the deposits~~

Hansen Number 2 Deposit: A small pit is dug in weathered, and sheared Pinto gneiss cut by a narrow andesitic-basalt dike. Medium-to coarse-grained augens of oligoclase interrupt the thin biotite folia which contain small amounts of microscopic xenotime crystals. Foliation trends north and northwest, and dips from 35° east to 60° northeast. Radioactivity is mild to medium in intensity and the maximum anomaly of 0.45 milliroentgens per hour was recorded in a shear zone at the northeast end of the pit.

Uranus Number 2 Deposit: Highly sheared Pinto gneiss is exposed by a bulldozer cut, and two shallow open cuts. Biotite folia in the gneiss are as much as 2 inches thick, but average only about 1/4 inch. Rock is weathered to a depth of 1 to 2 feet. Radioactivity ~~is mild~~ except in one small area where an anomaly of 0.38 milliroentgens per hour was recorded. Thin sections of gneiss here showed minor amounts of very fine-grained xenotime in biotite rich areas.

Uranus Number 4 Deposit: Several areas of anomalous radioactivity have been explored at the Uranus Number 4 deposit. An anomaly of 1.3 milliroentgens per hour was reported here by Walker, Lovering, and Stephens in 1956 (p. 26). Probably this reading was recorded at Pit 2 where the bulk of roughly 500 tons of Pinto gneiss has been removed and stockpiled at the Silver Bell processing plant 2½ miles north of Twentynine Palms on Utah Trail. The radioactivity of the stockpile ranges from 0.08 milliroentgens per hour to 0.24 milliroentgens per hour, averaging 0.11 milliroentgens per hour. Radioactive anomalies of mild to medium intensity are found near Pits 2, and 4. There are two areas that have relatively high readings; one is just south of Pit 4 (0.22 milliroentgens per hour), and the other near the face of Pit 2 (0.15 milliroentgens per hour). Radioactivity was more intense here before the removal of rock to the stockpile. A pronounced radioactive belt about 300 feet long and close to 60 feet wide extends from the area adjacent to Pits 3, and 6 through Pit 4 and open cut 5, to open cut 1. The central part of this belt has an anomaly of 0.12 milliroentgens per hour.

Figure 54

872

Gneiss in the vicinity of Pits 2 and 4 is chlorite-rich, well fractured and cut by a prominent north-trending and steeply west-dipping shear zone. A crumbly and highly-weathered andesitic-basalt dike is contained in this sheared zone. Broken and finely-sheared hornblende diorite is intruded into the gneiss and is exposed in the northeast part of Pit 2. A reddish-brown soil, one to three feet thick, caps the gneiss at the top of the ridge near Pits 3 and 6. The soil zone is well exposed near the top of Pit 3.

In addition to biotite folia, xenotime-bearing biotite-rich pods nearly one and one-half feet thick, and three to five feet long are interspaced with quartz-sodic oligoclase zones. The pods are exposed in the face of Pit 2 where the radioactivity is most intense.

Uranus Number 6 Deposit: Only one small area was found to be radioactive at this deposit. A moderately intense anomaly of 0.40 milliroentgens per hour was recorded at the top of the extreme south end of the elongate 11-foot deep cut. The anomaly was recorded in weathered Pinto gneiss which is in fault contact with hornblende diorite. A thin section study showed that irregular grains of altered xenotime are responsible for almost all the radioactivity. The alteration product is an orange to brown substance probably hydrous iron oxides. A few minute grains of allanite (?) were also observed.

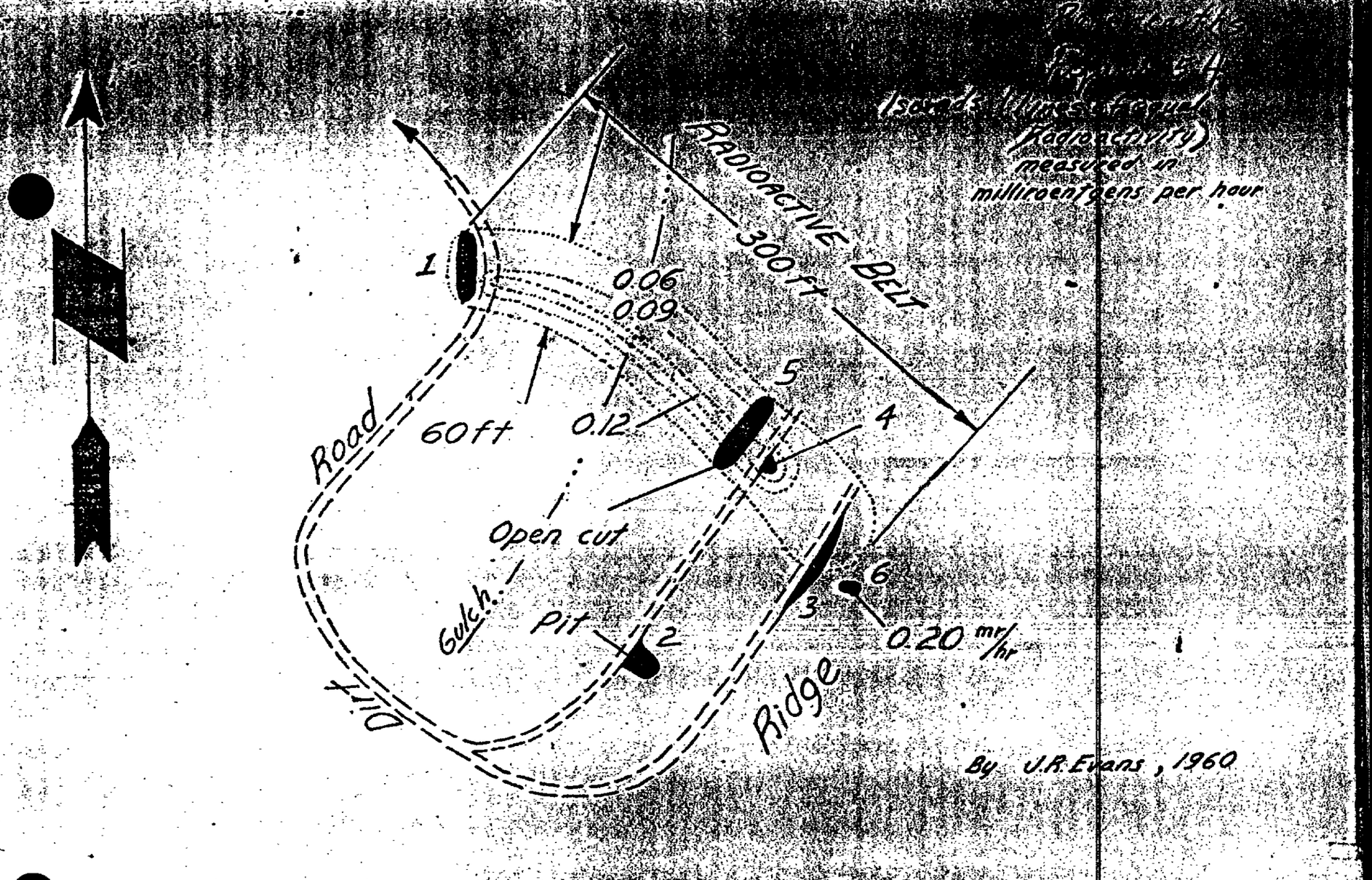
Foliation in the gneiss trends nearly west and dips southerly from 45° to 80°. In general the folia range from one-eighth of an inch to one-quarter of an inch in thickness. At the face of the cut, however, there are biotite rich pods as much as one and one-half foot thick.

A punky west-trending andesitic basalt dike, and an aplite dike both put the gneiss near the front of the cut. Bedrock in this area is capped by 6 inches to 1-foot of red-brown soil, and is much weathered two to three feet lower.

Production: None.

References: Walker, Lovering, and Stephens 1956, pp. 25-26.; EVANS, 1964, p. 10.

J.R.E. March 1959.



URANUS NUMBER 4 DEPOSIT

Figure 54. Sketch of the workings at the Uranus Number 4 deposit showing the trend and extent of the radioactive belt.

Peerless Nuclear Minerals Deposits

U-Thor Deposit

Location: Sec. 21, T. 2 S., R. 10 E., S.B.M., (proj.), Pinkham Well quadrangle, 15' 1943; Pinto Mountains, 12.7 miles, S.34° E. of Four Corners, Twentynine Palms.

Ownership: Three lode claims, and a mill are owned by the Desert Dominion Mining and Milling Co., Inc., Wayne E. Chambers, president, 9262 Live Oak Avenue, Fontana.

History: None.

Geology: The deposit is on top of a northwest-trending hill that rises abruptly about 500 feet above the sandy flat floor of Music Valley to a maximum elevation of 3,214 feet.

Much of the hilltop is underlain by highly radioactive Pinto gneiss. An anomaly of 1.7 milliroentgens per hour was recorded in a pit near the central part of the area mapped. An anomaly of 0.8 milliroentgens per hour was recorded in a less-pronounced center of radioactivity 90 feet southeast of the pit adjacent to a shallow cliff. An elongate radioactive zone about 270 feet by 135 feet surrounds the pit area, and roughly defines the surface shape and areal extent of mineralized gneiss.

Gneiss in the pit area is extremely biotite-rich and contains abundant small orange grains of xenotime. Xenotime composes nearly 35 percent of some selected hand specimens. Minor quantities of monazite and allanite (?) are also present.

Hornblende diorite intrudes the gneiss, and is poorly exposed as two tabular bands nearly isolating a small central body of gneiss from two

Figure 55

875

larger outlying bodies. Diorite is also exposed in the bottom of the pit. Foliation in the gneiss trends generally southwest and dips from 25° to 38° south. It is fairly constant in both direction and magnitude in each body of gneiss. The diorite-gneiss contact is graditional over two to four feet. In the contact zone the diorite contains as much as 15 percent biotite. Narrow aplite dikes, and small irregular bodies of quartz cut both the hornblende diorite and the gneiss. A small lenticular dike of andesitic-basalt cuts the diorite near its contact with the gneiss in the southeast part of the area mapped.

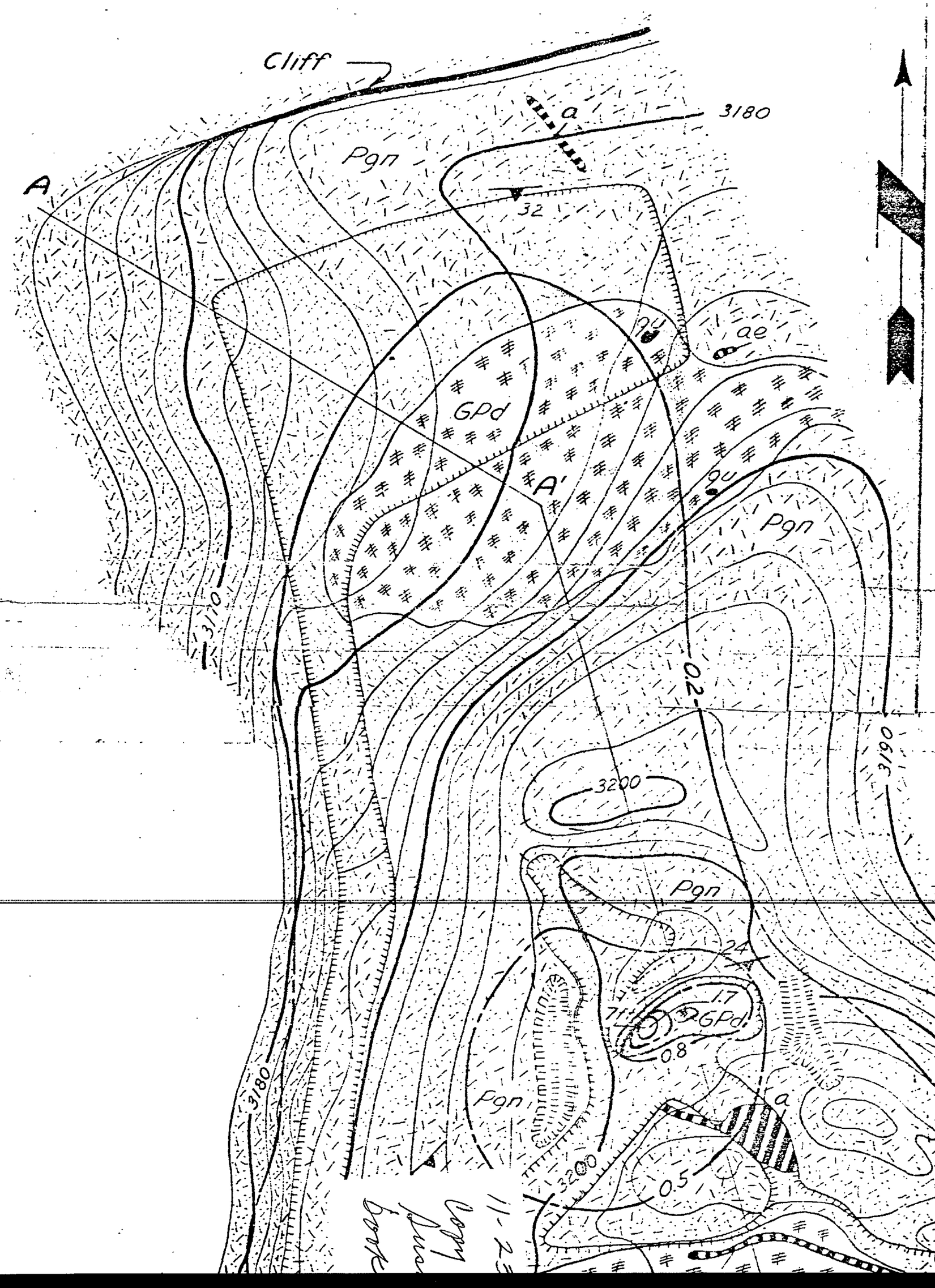
Development: Work consists of several shallow prospect pits and open cuts. The largest pit, in the center of the area mapped, is 37 feet long in an east-west direction, 7 to 15 feet wide and 1 to 7 feet deep. ~~Nearly 3 miles of often steep but good dirt road lead to the area from the sandy Music Valley road.~~ About 50 tons of mineralized gneiss have been removed from the pit, transported to the mill and stockpiled. The mill is 3½ miles southeast of Twentynine Palms on Base Line Road, ~~near a sand and gravel plant~~.

Production: None.

References: ~~None.~~ EVANS, 1964, p. 15

J.R.E. March 1959.

876



EXPLANATION

qu

Milky quartz

ae a

Aplite dikes
ae; epidote-rich aplite dikes

a-b

Andesitic-basalt dike

GPd

Gold Park Gabbro-Diorite; massive, and mesocratic hornblende diorite

Pgn

Pinto Gneiss; foliated quartz-biotite-plagioclase gneiss

Rock contact, dashed where approximate

35

Strike and dip of foliation

Shallow open cut

7ft

Pit, showing depth

Dump

1.7

Isorads; interval is 0.3 millircentgens per hour; number indicates higest radioactivity in mr/hr

11-23
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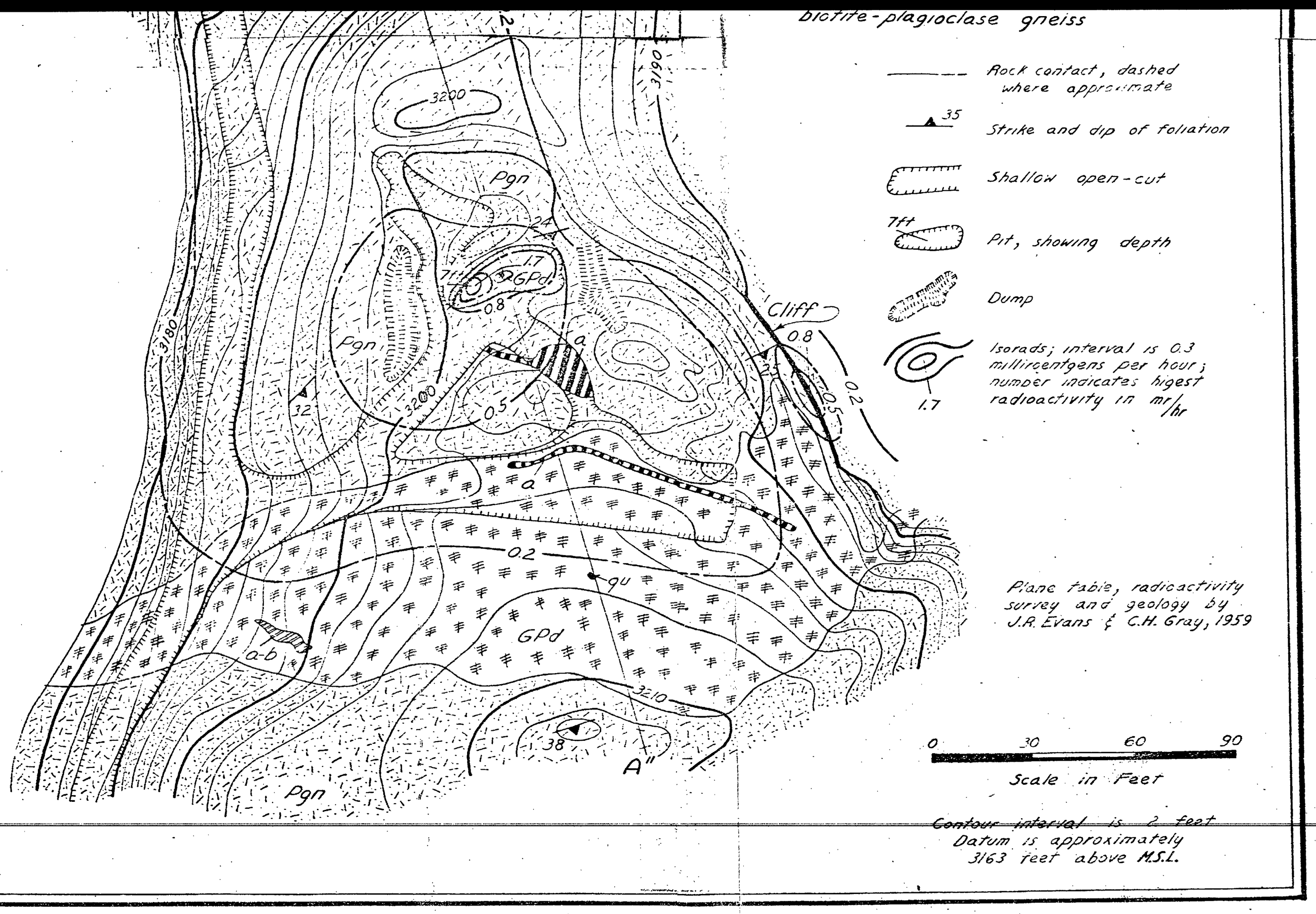

Figure 55. Geologic and isorad map of the U-Thor deposit.

Rare-Earths

Rock Products
Broken & Crushed stone
Figure 56 Roofing Granules

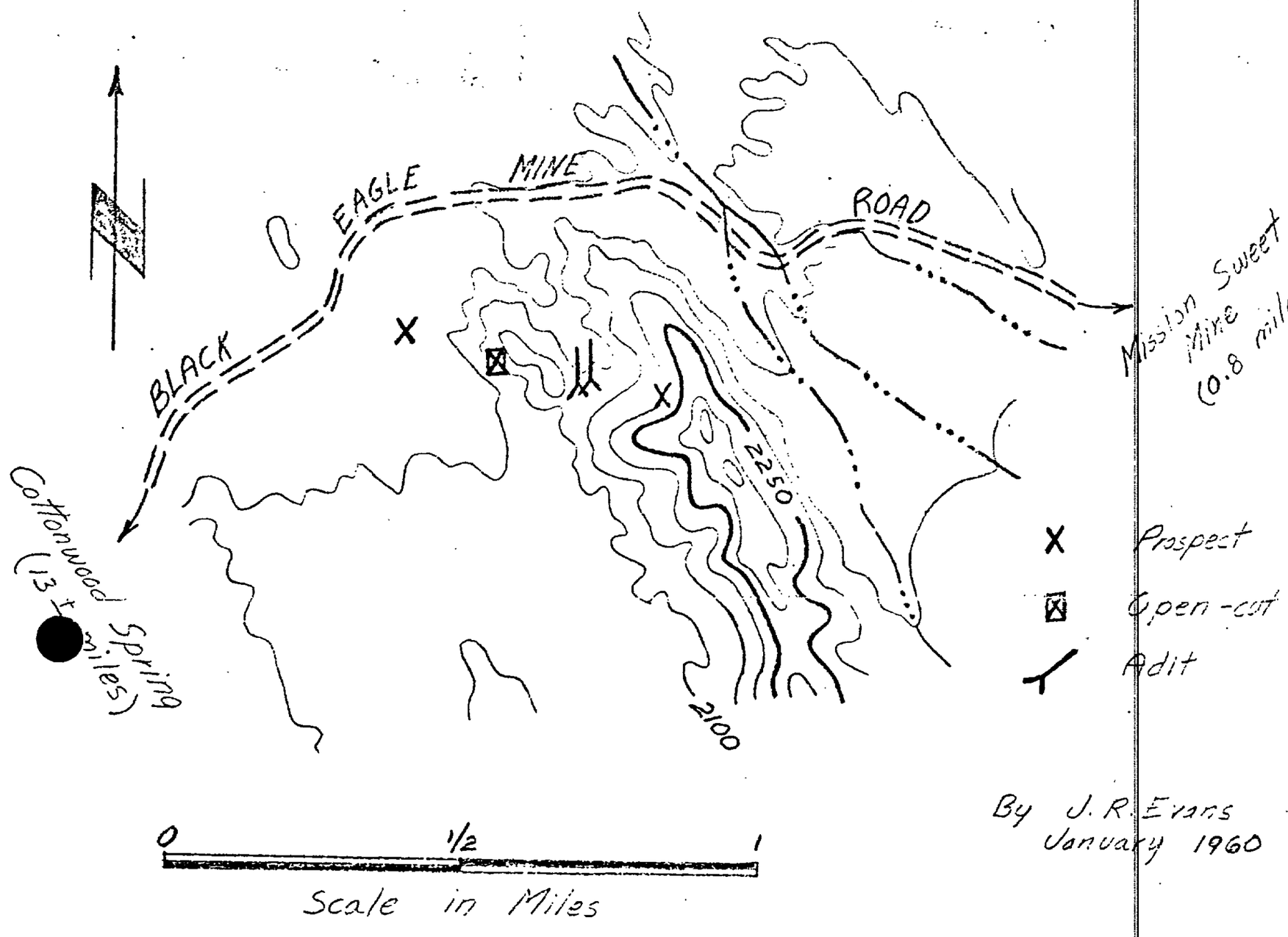

Figure 51. Sketch map showing the location of the Storm Sulfide (Green Giant - Long Green) deposit (topography from U.S.A.C.E. 15' Eagle Tank quadrangle, 1943).

Broken and Crushed Stone.

Blarney Stone (Harlow, Corona) Quarry

Location: SW¼ sec. 15 (proj.), T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 6 miles southeast of Corona along the east side of Temescal Wash, half a mile south of Cajalco Road.

Ownership: ~~Miss~~ Miss Lela May Harlow, Cajalco Road, Corona. Leased by Stringfellow Quarry Company, P.O. Box 6, Riverside, and operated under the name Corona Quarries, Inc.

History: Area was first quarried about 1935 to 1939 by Pantages Construction who quarried rock for the A.T. & S.F. R.R. Co., probably for track ballast. Quarry was idle until 1953 when the Stringfellow Company together with the Livingston Rock and Gravel Company, Inc. reopened the quarry and began large scale operations. The quarry has since been intermittently active and has supplied broken or crushed stone to a number of projects including: Long Beach drainage canal, 1955; San Gabriel Canyon, 1957; Santa Ana River levee in Orange County, 1958; Long Beach area flood control channels, 1958-62. In January 1963 the quarry was being maintained on a stand-by basis.

894

Geology: Three rock types have been quarried from three adjacent bodies, each about a quarter of a mile by half a mile in plan. These Cretaceous rock bodies crop out along the railroad cut on the east side of Temescal Wash and from north to south are: dark gray, fine grained, San Marcos Gabbro; buff to gray, fine grained granophyre; and light gray to tan quartz monzonite. In addition, some masses of Bedford Canyon Formation (Triassic?) hornfels probably are included in these intrusive bodies. Although several distinct rock types are included in the quarry the rock might be described in more general terms as a closely to moderately jointed medium gray dense rock with a few phenocrysts and rust stained fractures. Tests on 3 samples from the Blarney Stone quarry made about 1939 by the District Laboratory, Corps of Engineers, U. S. Army, showed the following:

Specific Gravity	Absorption	L. A. Rattler, % loss at 500 Revs. average	minimum	maximum
2.71	0.3	13.4	15.8	11.0

Because of the joint pattern large size rock is not purposely produced as it would result in excessive waste and the quarry is used mostly as a source of rip rap but also yields some derrick stone. Any large boulders that do occur are stockpiled for special jobs.

Development: An irregular area nearly 2,000 feet long has been quarried, mostly on one level, along the railroad. The principal quarry area is about 1,000 feet long and 300 feet wide with sloping face 300 feet high. Some mining is done directly by 3-yard dipper shovels but in other places the rock is harder and requires drilling and blasting. Standard quarry equipment is employed such as Caterpillar tractors with front end loaders (rock baskets) and bulldozers, drop ball cranes, dipper shovels, jackhammers, and air Tracdrils. Facilities for making small sized material include grizzly, bin, jaw crusher, and vibrating screens. Processed material goes by belt conveyor to storage bins or stockpiles. About 50 percent of the rock mined is waste. A small proportion of this fine size material is sold for road base and other uses, but much of it must be stockpiled.

896

Production: In recent years when in full operation quarrying has been at the rate of 6,000 tons per day. In 1958 about 250,000 tons of small rock were furnished to the Orange County Santa Ana River Levee and since 1958 about 500,000 tons of rock have been furnished to Long Beach Area flood control channels. Total production is not known, but is believed to be more than one million tons.

References: none.

C.H.G. 5/21/63.

Christopher Mines, Inc. Claims

Location: SW¼ sec. 36, T. 2 S., R. 3 E., S.B.M., Whitewater quadrangle, 7½', 1955; reported by (Proctor, unpublished thesis, 1958) to be between the Super creek Mine and Painted Hills Quarry (see herein).

History: Undetermined.

Geology: Same as Painted Hills Quarry (see herein).

Development: Undetermined.

Production: Undetermined.

References: Proctor, unpublished thesis, 1958, R.B.S.

898

Haven Granite Company

Location: SW¼ sec. 9 (proj.), T. 2 S., R. 5 W., S.B.M., San Bernardino quadrangle, 1954; at Ormand Siding on the west side of the southern Crestmore Hills at the north end of Pacific Avenue, about 3½ miles northwest of Riverside.

Ownership: Haven Granite Company, 890 South Arroyo Parkway, Pasadena 2. Plant address Route 5, Box 319-A, Riverside.

History: In 1952, the Haven Granite Company built a small plant at the Ormand quarry (described herein) to process loose rock on the quarry floor for poultry grit. This plant has since been in continucus operation and the company is the largest producer of poultry grit in California.

Geology: The mineral material utilized is Cretaceous granodiorite (Woodson Mountain Grancdiorite?), see Ormand quarry for description.

899

Development: A large tonnage of loose granodiorite remains on the floor of Ormand quarry from former large scale operations. Much of the material is of suitable size for the plant but some large boulders are split by blasting; drilling is by jackhammer. Loose rock is loaded by 3/4 yard Northwest 25 power shovel on to small end dump truck which hauls the material to the plant, about half a mile south of the quarry. Here the truck discharges over a grizzly feeder to a 20- by 30-inch primary jaw crusher which yields a 4-inch maximum product. Material then goes to a 4- by 6-inch secondary jaw crusher the product of which is elevated to shaker screens. Over-size goes through a scalper trommel screen and the plus 3/4-inch material is sent to a gyratory crusher and the minus 3/4-inch material goes to a roll crusher. The plant employs an extensive dust control system. Finished product, all of which is marketed for poultry grit, ranges from 3/16-inch to ¼-inch in size. Most of the grit is packaged in 100 pound paper bags, but some bulk material is sold. Material from this plant is marketed under the trade name "Haven Granite Grit" in six standard sizes throughout the western states, including Hawaii.

Production: Total undetermined, plant capacity is 60 tons per day.

References: Gay, 1957, p. 578-579.

C.H.G. 1/23/63.

900

Jameson Quarry

Location: SW¼ sec. 29, T. 3 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about one mile west of Home Gardens in low hills on the north side of old State Highway 18.

Ownership: Mrs. Mary C. Jameson, 316 East Olive Street, Corona, owns about 55 acres of patented ranch land (1957).

History: Small quarry opened at some unknown time before 1924. During 1939-40 it was operated extensively by J. B. Stringfellow, Riverside, and furnished rubble, riprap, derrick stone, and toe rock used to face Prado Dam and its abutments. The property then remained idle until about 1950 when Mr. Stringfellow quarried a small tonnage of rubble stone. Since 1950 the quarry has been inactive, except for the occasional gathering of small amounts of remaining loose material to be used locally as ornamental stone.

Geology: Pink, fine-grained, granular micropegmatite granite crops out over an area about 2 miles long and ranges from a quarter of a mile to three-quarters of a mile in width. The rock occurs as reddish-brown, sheet-like masses and is well jointed so as to break into crude rectangular blocks. Apparently there are substantial reserves of material suitable for small or medium-sized rubble stone.

901

Development: Rock was quarried on one level from a north-south bench about 200 feet long with the face 10 to 50 feet high. Potential backs are about 80 feet.

Production: Large, but undetermined tonnage.

References: Gray, 1961, p. 87-88, 117.

C.H.G. 8/17/62.

90z

Ormand Quarry

Location: NW¼ sec. 9 (proj.), T. 2 S., R. 5 W., S.B.M., San Bernardino quadrangle, 1954; at Ormand Siding on the west side of the southern Crestmore Hills, at the north end of Pacific Avenue, about 3½ miles northwest of Riverside.

Ownership: Guy F. Atkinson Company, Santa Fe Avenue and 223rd Street, Long Beach, owns about 640 acres, most of which is in section 9.

History: The Ormand quarry was opened by the Hauser Construction Company in August 1925 to supply stone for the Long Beach Harbor breakwater. At that time the operation was locally called the Kumpe-Hauser quarry. By mid-1929, the Long Beach breakwater project had been completed and the quarry was furnishing rock for Rainbow pier at Long Beach. From late 1929 until 1944, the quarry was ~~only~~ intermittently active on a relatively small scale, but did supply rock for some Metropolitan Water District aqueduct dams and other similar structures. Apparently at least during part of this period it was known as the Rohl-Connolly quarry. About 1944, the quarry was acquired by the Guy F. Atkinson Company and during 1944-45 was operated on a large scale by Atkinson to supply rock for the Seal Beach breakwater. Since 1945, the quarry has been maintained on a stand-by basis and has furnished small tonnages of rock intermittently for several projects. Since 1952, the Haven Granite Company (described herein) has utilized rock blasted down during former large scale operations as a source of poultry grit.

Geology: Quarry opened in a large mass of Cretaceous granodiorite (Woodson Mountain Granodiorite?) which crops out over much of the north half of section 9. The granodiorite forms bouldery hills that rise abruptly to heights of 800 feet above the alluviated valley. The granodiorite ranges from fine to coarse-grained, is light gray to gray, contains only a small proportion of ferromagnesian minerals, and in a few places contains dark inclusions. The entire quarry appears to be in granodiorite except for an area of schist and gneiss about 400 feet wide at the south end of the north-trending face. The granodiorite is dense, but is jointed and breaks into large blocks. Tests on 8 samples from the Ormand quarry made about 1939 by the District Laboratory, Corps of Engineers, U.S. Army, showed the following:

Specific gravity	Absorption	L. A. Rattler % loss at 500 Revs.		
		Average	Maximum	Minimum
2.78	------	38.4	41.9	34.7

905

Development: Main quarry, on one level, trends north. It is 2,200 feet long and the face has a maximum height of 290 feet. At the south end of the face is an unquarried area about 400 feet wide of schist and gneiss. Trending southeast from the unquarried area is a second face about 400 feet long and 200 feet high. All heavy duty quarrying equipment has been removed from the property. Quarrying methods used during the former large scale operations are described by Tucker and Sampson (1929, p. 509; 1945 p. 166).

Production: 1925-29 (2 million tons of riprap for Long Beach breakwater); 1944-45 (700,000 tons for Seal Beach breakwater); undetermined smaller amounts at various times. Since 1952, a few hundred tons per month of remaining loose rock has been crushed for poultry grit by the Haven Granite Company (See herein). Total production is probably well over 3 million tons.

References: Tucker and Sampson, 1929, p. 509; The Explosives Engineer, Oct. 1929; Tucker and Sampson, 1945, p. 166; Gay, 1957, p. 586.

C.H.G. 1/23/63

Painted Hill (Whitewater Sericite Schist) Quarry

Location: E½ sec. 35, W½ sec. 36, T. 2 S., R. 3 E., S.B.M., Whitewater quadrangle, 7½', 1955; on Painted Hill near the east bank of Whitewater River, 2 miles north of Whitewater.

Ownership: Kenneth J. Mackenzie, P.O. Box 133, Whitewater, holds 5 unpatented claims.

History: The Painted Hills Quarry was first reported as a source of sericite schist (Tucker and Sampson, 1945, p. 182, pl. 35), but the extent of actual quarrying prior to 1954, when the present owner acquired the property, was not determined. Since 1954 the property has been worked intermittently.

Geology: The Painted Hill area is underlain by a strongly foliated Precambrian igneous-metamorphic complex (Allen, 1957, pls. 1, 4). The strike of the foliation ranges from west to N. 30° W. and the dip from vertical to 40° N.E. The quarried product is a sericite-rich, iron-stained, flaggy- to massive, gneissic, granitic rock. It has been marketed locally and in Los Angeles as a decorative landscaping and building material and some has been ground for roofing granules. Soft, relatively pure sericite schist is present in the quarry as lenticular bodies ranging from 0 to as much as 20 feet in thickness.

907

Development: The quarry is opened in a natural ampitheater about one-half mile in diameter, the south and southeast sides of which have been worked to a moderate extent by three open cuts 50 to 100 feet in width and depth.

Production: The owner stated that 600 to 700 tons of rock had been marketed in the period July 1954 through October 1960.

References: Tucker and Sampson, 1945, p. 182, pl. 35; Allen, 1957, pls. 1, 4.

R.B.S. 10/20/60.

908

Palo Verde Dam Quarries

Location: NE¼ sec. 14, T. 5 S., R. 23 E., SW¼ sec. 18 and NW¼ sec. 19, T. 5 S., R. 24 E., S.B.M., Blythe N.E. quadrangle, 1951; about 13½ miles by road (U.S. 95), north of Blythe.

Ownership: Public domain (1958).

History: Riprap and fill material were first taken from these sites in 1945 when the U. S. Government built a temporary rock weir to restore the surface level of the Colorado River for the Palo Verde Irrigation District. The level of the river had dropped as a result of desilting in the lakes behind Boulder, Parker and Headgate Rock dams. During the years 1954 to 1958 material was quarried for the construction of the more permanent Palo Verde Dam (Palo Verde Irrigation District reports, 1954 and 1957).

909

Geology: Two quarries yielded materials for the diversion dam. One is just west of the damsite in sections 18 and 19. This quarry is in alluvium and adjacent to exposures of gneissic granite. Both the alluvium, which consists of gravel, sand, clay, and caliche, and the gneissic bedrock, were quarried. The heavier riprap was quarried from the walls of a narrow canyon in section 14, about 1½ miles northwest of the dam. The material is dense, finely crystalline, dolomitic limestone. It is wall bedded; individual beds range from one inch to ten feet in thickness. In the quarry the strike is northeast and the dip about 30° to the southeast. The thickness and extent of the formation was not determined.

Development: The quarry near the damsite consists of a shallow pit 150 feet to 200 feet in diameter and several cuts along a shallow arroyo. The riprap quarry in section 14 has two faces; one on either side of the canyon. The southwest face is about 400 feet long and 50 feet high. The other face, opposite it, is about 200 feet long and 50 feet high.

Production: The total yardage of material used in the dam projects was not determined.

References: Palo Verde Irrigation District annual reports for 1954 and 1957.

R.B.S. 11/19/58.

911

Sidebotham (Phillips) Quarry

Location: W½NW¼; NW¼SW¼ sec. 5, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 2 miles southeast of Corona, south of Temescal Wash and east of Compton Siding.

Ownership: Temescal Clay, Inc. c/o F. A. Stearns, El Cerrito, Corona, owns about 100 acres of patented land in section 5 (1963).

History: Two quarries opened in the middle 1930's to furnish rubble, riprap, and track ballast for the A.T. & S.F.R.R. Co., who reported production during 1935-39. The south quarry has since been inactive, but the north quarry was reopened and operated by Silberberger Constructors, Inc., Quest Haven Road, San Marcos, during the latter part of 1962. Early in 1963 it too was inactive. In July 1963, Silberberger Constructors again reactivated the north quarry to supply 50,000 tons of riprap material to the Orange County coastal area.

Geology: Rock exposed in the quarry area is an equigranular to somewhat porphyritic, medium-grained granodiorite. The rock is dark gray to blue-gray on weathered surfaces and dark greenish-gray on fresh surfaces and is hard, irregularly jointed, and breaks into large, blocky, generally unweathered masses. The north quarry has about one foot of red soil overburden and 3 to 5 feet of weathered grandodiorite below the soil. The face shows a few thin seams of altered clay-like material. Tests on two samples from the Sidebotham quarry made about 1939 by the District Laboratory, Corps of Engineers, U. S. Army, showed the following:

		L. A. Rattler, % loss at 500 rpm		
Specific gravity	Absorption	Average	Maximum	Minimum
2.70	0.2	12.2	13.2	11.1

913

Development: Rock has been removed from two quarries in gentle, low hills. The south quarry (NW¼SW¼ sec. 5) is roughly circular in plan and about 250 feet in diameter. It was worked from a single level with the face 10 to 40 feet high, but has potential backs of about 80 feet. The second quarry is about half a mile to the north (NW¼NW¼ sec. 5) and is opened on one level about 500 feet long in a southeast-northwest direction with the bench about 150 feet wide. The face is from 25 to 75 feet high with potential backs of about 120 feet.

Production: Large, but undetermined total tonnage. In 1962 the north quarry furnished about 30,000 tons of riprap material for the San Pedro Cabrillo area.

References: Gray, 1961, p. 88-99, 117.

C.H.G. 8/20/62.

9/4

Temescal Canyon (Hawley, Pacific Rock and Gravel Co.)

Rock Quarry

Location: SW¼ sec. 33, T. 3 S., R. 6 W.; NW¼ sec. 4, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; one mile south of Home Gardens along the east side of Temescal Wash near its northwest end.

Ownership: James Spires, Anaheim owns the north quarry and Pacific Rock and Gravel Company, 400 East Arrow Highway, Arcadia owns the south quarry and adjoining property totaling 670 acres (July, 1963).

History: The Temescal Canyon Rock quarry was first opened in May 1957 by the Temescal Rock Products Company, Corona to supply stone for a levee being constructed along the Santa Ana River west of Riverside. By September 1957 Matich Brothers and Sundt Company Contractors, Colton was the operator. The quarried product included facing stone, toe stone, and derrick stone in several sizes ranging from 1 pound to 4,500 pounds. The levee project was completed in 1958 and the quarry was inactive until 1960 when Hawley Rock, Inc., 5277 North Vincent Avenue, Azusa reopened the quarry under the name Hawley Rock Quarry, Inc. to supply rock for flood control channels. The quarry has been intermittently active on a stand-by basis since 1961. In July 1963, the south quarry was acquired by Pacific Rock and Gravel.

915

Geology: Most of the rock in the quarry area is an equigranular to somewhat porphyritic granodiorite, a medium-grained, dark-colored intrusive rock of Jurassic or Cretaceous age. The granodiorite is dark gray to blue-gray on weathered surfaces and gray to dark greenish-gray on fresh fractures and forms subrounded hills. In the north quarry only granodiorite is exposed, but in the south quarry is exposed a small mass, about 300 feet long and 25 to 50 feet wide, of dark blue-black quartz latite porphyry. The porphyry is surrounded by the granodiorite. Large reserves are available, as the granodiorite crops out in a belt more than one mile long and about 1,000 feet in average width. In 1957 the U.S. Army Engineer Division Laboratory, Corps of Engineers, Sausalito, tested samples of the granodiorite and obtained the following data:

Weight lbs./cu.ft.	Apparent Specific gravity	Specific gravity Saturated, surface dry	Absorption	L.A.Rattler, % loss at 1000 rpm	
				Grade E	Grade F
169.7	2.721	2.712	0.19	19.2	19.7

916

Development: Two quarries about 1,250 feet apart on the east side of Temescal Wash. Here the rising topography provided a natural slope for the initial quarry face which was steepened by blasting to form a face about 60 feet high. Potential maximum backs are about 250 feet above the floor of Temescal Wash. In 1963 the north quarry was about 325 feet long and 200 feet wide with face 40 feet high; the south quarry was somewhat semicircular in plan and was about 150 feet long, 250 feet wide, and with face about 150 feet high.

Production: About 250,000 tons during 1957-58, and about 150,000 tons during 1960-61. Apparently since 1961 only small intermittent production.

References: Gray, 1961, p. 89-91, 117.

C.H.G. 7/20/63.

917

Stringfellow (Bly Brothers and McGilliard, Shannahan) Quarry

Location: NW¼ and SE¼ sec. 1, T. 2 S., R. 6 W., S.B.M., San Bernardino quadrangle, 1954; about 6 miles northwest of Riverside in the central part of the Jurupa Mountains, north of Glen Avon Heights at the north end of Pyrite Street.

Ownership: Stringfellow Quarry Company, P.O. Box 6, Riverside.

History: These quarries were first operated about 1900 by the West Riverside Granite Company. By 1905, Bly Brothers were working two quarries which furnished a large quantity of granite used for building purposes. The rock was shipped to Los Angeles for cutting and finishing at the firm's stoneyard. Annual production of 120 carloads of dimension stone and 1,200 carloads of riprap ~~is~~ was reported for 1914, at which time the operation was known as Bly Brothers and McGilliard Stone Company. In 1928, about 150 tons of rock was shipped each month to Los Angeles where the rock was ground for use as roofing material and chicken grit. Since the 1920's, the principal product has been harbor riprap for breakwaters and seawalls (Long Beach breakwater 1925-29; Seal Beach 1944-49; Redondo Beach 1953-56; 1956-63 various harbor and flood control projects). During the 1940's, the property operated under the name Shannahan Quarries. The quarries were acquired by the Stringfellow Quarry Company about 1951 and have since been active each year.

Geology: The quarries are in a roughly rectangular shaped mass of Cretaceous Woodson Mountain Granodiorite about 2,000 feet by 1,000 feet in plan. Two sets of joints, one set trending east and about 8 to 10 feet apart, and the other set trending north assist quarrying operations. Overburden is generally not present, but weathered debris averaging 1 foot in thickness overlies the granodiorite in places.

Tests on 8 samples from the Shannahan quarry made about 1939 by the District Laboratory, Corps of Engineers, U.S. Army, showed the following:

Specific gravity	Absorption	L.A. Rattler, % loss at 500 revs.		
		Average	Maximum	Minimum
2.68	0.4	38.6	43.8	32.2

919

Development: Two quarries and a few small prospect cuts. The smaller quarry, in the NW¼ sec. 1 and known as the old quarry, is circular in plan and about 300 feet in diameter with maximum face height of 150 feet. It has been inactive since before 1930. About 800 feet to the southeast and in the SE¼ sec. 1 is the new quarry. By 1929, it had been developed on one level 150 feet long with face height of 80 feet; in 1950, the bench was 700 feet long and 75 feet high; and by 1963, the quarry was L-shaped with a total length of 1,500 feet and maximum face height of 200 feet. Primary blasting is infrequent and is usually by the coyote hole method, secondary shooting is by jack hammer drilling. Loading at the quarry is by 3/4 yard to 3 yard power shovels or crane and rock hook, depending on rock size. To make small sizes material is trucked to an adjacent plant which utilizes a feeder grizzly, jaw crusher, and standard Hewitt Robins screens to size the rock. Products include riprap, derrick stone, and building stone. Most of the material used for flood control riprap is 4 inches or larger, with a range of 1-inch to 15-inches. Material as large as 3 to 4 tons is also quarried.

Production: By 1929 the property was reported to have yielded about 600,000 tons of stone and since 1951 the Stringfellow Quarry Company has produced about 750,000 tons. In recent years production has averaged 50,000 to 75,000 tons per year, and some years more than 200,000 tons are shipped. Total production is unknown but certainly is well over one million tons.

References: Aubury, 1906, p. 42-44; Merrill, 1917 [1919], p. 585; Tucker and Sampson, 1929, p. 508; Tucker and Sampson, 1945, p. 166; Mackevett, 1951, p. 13, pl. 1; Gay, 1957, p. 573, 586.

C.H.G. 1/21/63.

921

Super Creek Mine

Location: SW¼ sec. 36, T. 2 S., R. 3 E., S.B.M., Whitewater quadrangle, 7½', 1955; on the southeast flank of Painted Hill. The property is reached by means of an unimproved dirt road extending northeastward 2 to 3 miles from Whitewater.

Ownership: In 1958, three claims were held by a man named Grossman (Proctor, 1967, p. 39) ~~unpublished thesis~~.

History: Undetermined.

Geology: Same as Painted Hills Quarry (see herein).

Development: Assessment work in the form of roads and open cuts (1959).

Production: Undetermined.

References: Proctor, 1965, p. 39 ~~unpublished thesis~~, ~~1958~~, R.B.S. 12/59.

922

identified
Unknown Pit

Location: SW¼NE¼ sec. 4, T. 5 S., R. 6 W., S.B.M., Corona South quadrangle 7½', 1954; northeastern flank of the Santa Ana Mountains, about 8 miles southeast of Corona, on a ridge midway between Bixby and Anderson Canyons.

Ownership: Alfred H. and Sue M. Beazley, 601 Fern Drive, Fullerton, own patented ranch land in this area (1957).

History: Pit opened during 1956. Idle 1957.

Geology: Brownish-gray, soft, much weathered biotite quartz diorite (phase of the San Marcos Gabbro). Largely altered to clay minerals, breaks into very fine-grained material.

Development: Shallow bulldozer cut.

Production: Small amount scraped from ridge in 1956, probably used locally by ranchers to surface unpaved roads.

References: Gray, 1961, p. 118.

C.H.G, 3/6/61.

923

identified

Unknown Pit

Location: NE¼NW¼ sec. 9, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954: northwest of El Cerrito Village and about 3½ miles southeast of Corona.

Ownership: Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul, Minnesota (P.O. Box 276, Corona) (1957).

History: Undetermined. Idle 1957.

Geology: Light brownish-gray, soft, weathered quartz monzonite (Home Gardens Quartz Monzonite Porphyry) with minor hard, light gray blocks.

Development: Two small, nearly connected quarries totaling about 100 feet in length with face from 10 to 25 feet high. Mined by power shovel without blasting.

Production: Small intermittent production, probably used locally to surface unpaved roads.

References: Gray, 1961, p. 118.

C.H.G. 3/6/61.

924

Decomposed Granite

Decomposed, crystalline, igneous rock commonly called decomposed granite or D.G. is widely available in western Riverside County in areas underlain by the rocks of the Southern California Batholith. Such material is favored for road base work because it compacts well, yet remains permeable; characteristics not generally found in sand or soil.

Contractors seeking sources of D.G. must generally contact local land owners and it is usually agreed that pit sites will be left in a graded and orderly condition.

During 1961, the following firms were reported producers of decomposed granite in Riverside County:

Name	Address
Corona Dee Gee Co.	Corona
Gilbert A. Morris Excavating Co.	P.O. Box 194, Idyllwild
Riley Materials Co.	6740 Pedley Rd., Arlington

Photo 39

925

Dimension Stone

Blue-Gray Granite Quarry

Location: NE¼NE¼ sec. 14, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; about 1½ miles southwest of Val Verde in low, rounded hills half a mile southwest of the intersection of Cajalco Road and Seaton Avenue.

Ownership: N. B. Walters, 28 Chapel Street, Alhambra (1945). Undetermined (1963).

History: In 1929 the quarry was under lease to E. Johnson and one man was employed in the production of monumental stone. By 1945 the quarry was idle and remained idle in 1963. Periods of activity since 1945, if any, are not known, but the size of the quarry suggests that it may have been a source of broken or crushed stone, rather than monumental stone, at some period. ~~At various times~~ this quarry has been known by different names including Johnson, Perris, Riverside Quarry, and Riverside Granite Company.

926

Geology: Rock exposed in the quarry faces is light gray, medium-to coarse-grained quartz diorite with abundant ferromagnesian minerals (Cretaceous Bonsall Tonalite). In places the rock contains abundant, irregular gneissic inclusions, mostly cobble sized or smaller. The surface is weathered irregularly to depths of 5 to 10 feet, and in places irregular weathered zones extend to the bottom of the exposed quarry faces. According to Tucker and Sampson (1929, p. 508) the material being quarried was a fine-grained granite having a very uniform mineral pattern which made it an ideal monumental stone. In 1963 only limited areas of such rock were observed in the quarry faces. Tests on four samples from this quarry made about 1939 by the District Laboratory, Corps of Engineers, U.S. Army, showed the following:

		L. A. Rattler, % loss at 500 Revs.		
Specific Gravity	—	Average	maximum	minimum
2.69		65.7	100.0	48.7

927

Development: Oval shaped side-hill quarry about 130 feet by 150 feet with maximum face of 40 feet opens from end of a railroad spur. The quarry connects to a slot along the spur about 250 feet long, 80 feet wide and 20 feet deep. This slot may have also been quarried. Equipment in use when the quarry was active in 1929 included an air compressor, jackhammers, and a stiff-legged derrick. Apparently monumental stone was selectively quarried, judging from the large amount of large boulders in the waste pile at the north end of the railroad slot. These boulders might be a source of rubble or riprap for small local construction projects. It appears unlikely, however, that this quarry will be a favorable future source of monumental stone because of the problems presented by irregular weather/zones, deep overburden, and irregular distribution of inclusions.

Production: Total undetermined; 250 cubic feet per month in 1929.

References: Tucker and Sampson, 1929, p. 508; Tucker and Sampson, 1945, p. 166.

C.H.G. 7/1/63.

928

Riverside County
Real Products
Mineralogical Study

Delano Black Granite

Location: W½W½SE¼, W½ and NE¼ Gov't. Lot 7, SW¼ Lot 2, SE¼ Lot 3, E½ Lot 6, Lots 9 and 12 sec. 32, W½ NW¼ sec. 33, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle 7½', 1953; bouldery terrain of the Gavilan Hills about 5 miles west of Perris in western Riverside County, along both sides of Santa Rosa Road at the old Virginia (Virginia-Shay, Missing Link) mine (fig. 42), adjacent to the Royal Black granite quarry (see herein).

Ownership: Bert Gilmer and associates, 4325 East San Miguel, Phoenix 18, Arizona hold a 160-acre association placer claim (Delano mining claim, W½W½SE¼, W½ and NE¼ Gov't. Lot 7, SW¼ Lot 2, SE¼ Lot 3, E½ Lot 6, Lots 9 and 12 sec. 32, excluding patented areas) and own 80 acres of fee land (W½ NW¼ sec. 33).

History: This area was extensively prospected for gold before 1900 with some activity through the 1940's. A number of old shafts, adits, and pits in section 32 reflect this early search for metals. Monument stone was quarried briefly about 1930 from several small workings north of Santa Rosa Road in the NW¼ section 33. Apparently this was the first stone operation in this area and was followed in 1936 by the opening of the adjacent Royal Black granite quarry. After an idleness of nearly 35 years the property again became active in June 1964 when the Delano mining claim was located. By October 1964 stone had not been shipped but location work had been done and development work was in progress.

930

Geology: This property is underlain by part of the same body of distinctive reddish-brown or bronze-weathering basic igneous rock as described under Royal Black granite quarry (which see herein).

Two samples were collected by geologists of the California Division of Mines and Geology in October 1964, from a shallow face opened at the NW Corner of SW¼ NW¼ SE¼ sec. 32, on the south side of a prominent drainage. Preliminary microscopic examination of these samples showed the following:

Sample G-1: Biotite quartz norite.

Hypautomorphic-granular, medium to coarse grained.

Melanocratic appearing.

Labradorite	70%	(Mineral percentages approximate)
Hypersthene	12%	
Biotite	8%	
Quartz	6%	
Augite	4%	

Minor hornblende, apatite, K-spar, zircon and ores.

931

Sample G-2: Pyroxene-biotite-hornblende quartz diorite. Hypautomorphic-granular, medium to coarse grained. Melanocratic, but in hand specimen lighter in color than G-1.

Andesine	53%	(Mineral percentages approximate)
Hornblende	15%	
Biotite	15%	
Augite	12%	
Quartz	4%	
Hypersthene	1%	

Minor K-spar(?), apatite, zircon, and ores, and white mica, secondary after plagioclase.

Development: Several small faces have been opened and roads built or repaired throughout the property. Sampling and testing are reported to have been done. In the NW¼ section 33, about 300 feet north of Santa Rosa Road on the south slope of a low knoll is an open-cut bench about 50 feet wide with face 12 feet high. This cut apparently was made when the property was first quarried about 1930.

Production: A few tons of monument stone in the 1930's. By December 1, 1964 the present operators had not yet placed the property in production.

References: Dudley, 1935, p. 501, 506, map facing p. 506; Larsen, 1948, p. 46, 47.

D.M.M. & C.H.G. 12/1/64.

933

Dendrite Deposit

Location: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), Pinto Basin quadrangle, 15'; 1963; Pinto Mountains, nearly 600 feet northwest of the Duplex mine and about 6 miles southeast of New Dale (site).

Ownership: Walt Rose and Charley Wade, General Delivery, Twenty-nine Palms, own at least one unpatented claim.

History: The deposit was discovered in the late 1950's by the present owners. Stone is quarried only intermittently as no permanent market has been established.

Geology: Massive, Mesozoic quartz monzonite is cut by a N. 80° W.-trending, steeply southwest-dipping, very fine-grained dike. The dike is 10 feet in average width, pale green, and discolored by black dendrites of manganese oxide. As the dendrites are fernlike in appearance, the name "Fern Rock" has been applied to quarried stone. The dike extends for at least several tens of yards west and east from the quarry pits, but is only locally stained with manganese dendrites, and probably does not contain commercial material alongs its entire length. The rock is well cleaved near the surface and appears fairly easy to quarry to a depth of 15 feet.

934

Development: A small tonnage of stone has been removed from shallow open cuts and trenches which have exposed the dike about 30 feet along the strike.

Production: None, as of March 1970.

References: None.

J.R.E. 3/10/60

935

Royal Black Granite Quarry

Location: E½SE¼, E½W½SE¼, SE¼ Gov't. Lot 7 sec. 32, NW¼SW¼, W½NE¼SW¼ sec. 33, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle 7½', 1953; bouldery terrain of the Gavilan Hills about 5 miles west of Perris in western Riverside County, quarry is a quarter of a mile south of Santa Rosa Road and the old Virginia (Virginia-Shay, Missing Link) mine. (fig. 42)

Ownership: Royal Black Granite Quarry, P.O. Box 487, Escondido (Robert N. Johnson and others, P.O. Box 123, Perris) holds a 160 acre association placer claim (Royal Black mining claim, E½SE¼, E½W½SE¼, SE¼ Gov't. lot 7 sec. 32, excluding patented areas) and owns 60 acres of fee land (NW¼SW¼, W½NE¼SW¼ sec. 33).

936

History: This area was extensively prospected for gold before 1900 with some activity through the 1940's. A number of old shafts, adits, and pits in section 32 testify to this early search for metals. Apparently this property was first quarried for dimension stone in 1936 when Emil John opened the Royal Black granite quarry at the site of the present quarry and also at the hillcrest a quarter of a mile to the southwest, where most of the quarrying was done. This quarry was active until 1948 as a source of dimension stone and a few larger blocks. According to the owner polished black facing stone on the Los Angeles Times building was supplied from this quarry, as was facing stone for buildings as far distant as Canada and Oregon.

After an idleness of about 25 years the Royal Black mining claim was located in August 1963, a large Guy derrick was installed and quarrying began. The quarry was largely inactive during most of 1964, but some development work was done on other parts of the property.

937

Geology: The quarry area is underlain by a distinctive reddish-brown or bronze-weathering basic igneous rock. On fresh surfaces the rock is black and commercially is termed "black granite", although microscopic examination indicates it ranges from gabbro-norite to quartz diorite in composition. This rock mass is an unusual part of the southern California batholith for several reasons. First, physically, it is an extremely constant, even grained, massive rock and at every place observed is inclusion free. Secondly it occurs as exceptionally large unfractured blocks. Blocks at least 20 to 30 feet square are seen in the quarry face; the blocks being separated by seams and cracks. In addition the composition of the rock is uncommon for rocks of the Southern California batholith. As is usual in black granite the rock does not display well defined rift, grain or hardway splitting directions, such as are commonly seen in regular granite bodies.

938

Dudley (1935, p. 501, map facing p. 506) named this rock the Virginia Quartz-Hypersthene Norite because of its occurrence near the old Virginia mine and its composition. He reported that microscopic examination showed the rock to contain 51% plagioclase (labradorite), 6% orthoclase, 14% quartz, 12% hypersthene, 8% biotite, and 6% augite and hornblende with the accessory minerals zircon, apatite, rutile, and magnetite. Dudley's map shows this rock body to extend west from the Virginia mine for a distance of about 3 miles and to range from about 3/4 mile to ½ mile in width. The area is included in the large region later studied by Larsen (1948), but because of the scale of the map Larsen (1948, pl. 1) included the Virginia Norite with his San Marcos Gabbro. Larsen (1948, p. 46-47) did recognize and describe an east-west body of quartz norite located about 6 miles west of Perris, apparently the same rock body earlier described and mapped by Dudley (1935).

Photo 40

939

A brief geologic examination of the area made by geologists of the California Division of Mines and Geology in August and October 1964, suggests that rocks of the same type and apparent quality as the dark colored rock being quarried may exist throughout most of an area about one mile long and perhaps three quarters of a mile wide. Within this area there are also zones of pale whitish gray to gray rock which may be in bodies large enough for quarrying. Preliminary microscopic examination of two samples of the dark rock, one (M-1) from the active quarry (Fig. 42) and one from a prospect at the guy station east of the quarry (59-2), showed the following:

Sample M-1: Quartz diorite.

Hypautomorphic-granular, medium to coarse grained.

Melanocratic appearing.

Andesine	56%	(mineral percentages approximate)
Biotite	16%	
Augite	14%	
Quartz	13%	
Hypersthene	1%	

Minor K-spar, hornblende, apatite, zircon and ores.

940

Sample 59-2: Quartz diorite.

Hypautomorphic-granular, medium to coarse grained.

Melanocratic appearing.

Andesine	60%	(mineral percentages approximate)
Quartz	15%	
Pyroxene	12.5%	
(Clinopyroxene, orthopyroxene)		
Biotite	12.5%	

Minor K-spar, hornblende, apatite, zircon, ores

Tests made on samples from the Royal Black granite quarry were as follows:*

Compressive strength: method of test ASTM C170-50

Sample number	Compressive strength
1	32,600 psi
2	29,500 psi
3	35,100 psi
Average	32,400 psi

Absorption test: method of test ASTM C97-47

Sample number	Absorption
1	0.03%
2	0.03%
3	0.03%
Average	0.03%

*Testing by Twin City Testing and Engineering Laboratory, Inc., 2440 Franklin Ave., St. Paul 14, Minn. dated Oct. 10, 1963 - test data courtesy of Royal Black Granite Quarry, P.O. Box 487, Escondido, California.

941

Development: Principal quarry is a single north-south bench level about 300 feet long, 100 feet wide, with face 50 to 75 feet high. In addition several faces have been newly opened or reopened near the crest of the hill above the quarry, but have not been quarried during the present operation.

In the quarry large blocks are loosened and trimmed by careful blasting. Loosened blocks are then moved from the face by means of a Guy derrick with 115-foot high mast and 100-foot boom, loaded on trucks, and transported to rail cars at Perris. Blocks shipped are in the range of 8 to 30 tons and have dimensions in the range of about 5'x5'x15' to 5'x8'x12'.

The blocks are shipped for finishing to the Delano Granite Works, Inc., quarries and manufacturers of structural and monumental granites, Delano, Minnesota. Here the blocks are trimmed and cut to desired sizes for building facing stone and monument stone. After polishing the finished stone is trucked to the job site. In 1963 this stone was used in Ogden, Utah and late in 1964 was scheduled for a new Federal building in New York City, a job that will require shipment of about 3,000 tons of stone.

Production: About 1,000 tons to Nov. 1, 1964. The rock is sold for $5.50 per cubic foot on rail cars at Perris.

References: Dudley, 1935, p. 501, 506, map facing p. 506; Larsen, 1948, p. 46, 47.

Morton
D.M.~~H~~. & C.H.G. 12/1/64.
^

943

Rock Products

Sand and Gravel

Since 1949, the annual value of sand and gravel produced in Riverside County has been measurable in terms of millions of dollars (table 1/). Prior to 1955 most of the reported production came from pits quarries within the county. However, the sand and gravel industry has become increasingly flexible and mobile and the compilation of statistics for any given area can be misleading. Since 1955, much of the aggregate used in the more urban areas of the west end of the county has been transported as "ready-mix" or bulk raw material from plants and pits quarries in adjacent San Bernardino County.

Because Riverside County is undergoing rapid economic growth and a population increase which, between 1950 and 1960, exceeded that of any one of 15 states in the nation (Jamison, 1960, p. 3), increasing numbers of producers of building materials are establishing plants within the county. Riverside is the chief center of urban growth in the county. Future suburban development in the Perris-Hemet-San Jacinto area is probable and the increasing popularity of the Coachella Valley resort areas should stimulate a growing demand for building materials.

Photo 35

877

Construction of concrete bridges, abutments, and highways and the mixing and application of black top entail the transport of a variety of materials from relatively fixed sources. County, state and federal authorities involved in road-building activity maintain some local sources of materials but frequently place contracts with private companies. Much road base material, fill, and riprap are obtained from sites convenient to construction locations, usually as a one time operation.

When the state supplies plans and specifications for highway work to interests bidding for contracts, it will (upon request and for a small fee) supply test data on materials available or involved in the work areas. Data for Riverside County are at the State Division of Highways, District 8, Materials Department, ~~247 3rd Street~~, San Bernardino.

Most sand and gravel concerns have one, or possibly several, permanent ~~quarries~~ pits. Many have, in addition, portable equipment to handle on-site jobs such as highway work or to obtain a particular grade of material from a source richer in that grade than their permanent pit.

Pits 36

878

The sand and gravel deposits of Riverside County consist of stream channel gravel, terrace deposits, and alluvial fan deposits. Rarely, if ever, will a single site yield a balanced supply of all grades of sand and gravel. It is common practice to employ crushing equipment but in sandy deposits, such as those found in the Riverside, Hemet, and Indio areas, supplementary supplies of rock must sometimes be sought. For general soundness of material and abundance of supply the alluvial fans and stream channel deposits along the north side of San Gorgonio Pass have proven to be one of the best sources of gravel in the western half of Riverside County.

In the sparsely populated eastern half of Riverside County the principal markets for aggregate are the agricultural communities along the Colorado River; Blythe, Ripley, and Palo Verde.

Photo 37

879

Abundant sand and gravel is present in stream channel and alluvial fan deposits along the margins of the mountainous areas of the eastern half of the county. In much of the desert area, however, alluvial material which underlies and adjoins the present water courses appears to have remained unworked by water since early Quaternary time (pl. [illegible]) and perhaps longer. In such material, a desert soil profile has become established, a result of which is the formation of a dense layer of caliche or hard pan (fig. [illegible]). Indeed, in some areas there appears to be a succession of such layers (see herein under Chuckwalla Spring placers in gold section). Thus, what once was loose gravel is now, in part cemented. A different problem exists in the area underlain by the Palo Verde Mesa, overlooking the flood plain of the Colorado River. Here, the Colorado River appears to have reworked the valley fill during Quarternary time. Although the material contains less caliche, there is a high proportion of fine silt and sand. Reworked fragments of clay-rich sediment are common in this deposit. Local firms have found that these clay fragments hang up in washers, or, if allowed to remain in the aggregate cause "pop-outs" in concrete. (See tabulated list for a description of deposits.)

Pl. 38

880

Specialty Sand

Corona Silica Sand Deposit (Owens-Illinois Glass Co., Corona Sand Plant No. 96; P. J. Weisel Industrial Sand Co.)

Location: NE¼ sec. 21; SE¼ sec. 16, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; 6 road miles southeast of Corona athwart State Highway 71 on west side of Temescal Wash.

Ownership: Louis A. Weisel, et al., La Habra, own about 550 acres of patented land in secs. 15, 16, 21 and 22, T. 4 S., R. 6 W., S.B.M. The Owens-Illinois Glass Company, 330 Sansome Street, San Francisco (P.O. Box 298, Corona) holds under lease about 140 acres in secs. 16 and 21 (1957).

History: The Corona silica sand deposit is the oldest continuously operated source of silica sand in southern California and continues to be the principal source. The deposit was opened and developed in the early 1920's by the P. J. Weisel Industrial Sand Company who operated the plant until 1945 when it and the deposit were taken over by the Owens-Illinois Glass Company. A new and much larger plant was erected in 1947 near the site of the old plant which was dismantled. The new plant began production in 1948 and has since been in continuous operation.

881

Geology: Sand is obtained from a quartz-rich facies in the lower part of the Paleocene Silverado Formation and is apparently nonmarine. The deposit consists of gently dipping, thinly bedded and locally cross-bedded white sandstone. Where exposed in the active pit west of the highway and in the old quarry face east of the highway, the usable sandstone is about 120 feet thick. In the mine area the Silverado Formation is exposed over an irregularly shaped rectangular area about 2,000 feet wide and 3,000 feet long. The sandstone is covered by overburden ranging from several feet of older alluvium in low-lying areas, to 20 feet or more of Quaternary terrace gravels, which cap the deposit unconformably on several low hilltops. The sandstone is coarse-grained to pebbly and is weakly cemented by clay and contains lenses of gray or grayish-green silt and sandy clay. The sand size particles are almost wholly angular to subangular quartz grains, and the pebbles, which are rounded, are of quartz and feldspar. Abundant pearly gray to black flakes of mica commonly give the sand a distinctive schistose appearance. About 30 to 40 percent of the deposit is clay, silt, and fine sand (-200 mesh); 60 to 70 percent is sand and small pebble sized (+200 mesh to ¼-inch); and generally less than 10 percent is large pebbles (+¼-inch to ¼-inch).

882

Development: Inactive quarry east of the highway is 600 feet long and 600 feet wide with face about 120 feet high. The active open pit is west of the highway. In 1956 this pit was crudely triangular in plan, and had dimensions of about 800 feet by 450 feet by 700 feet and a maximum depth of about 120 feet. Since 1956 overburden has been stripped from a large area about 1,250 feet by 800 feet in plan adjoining the north edge of the pit and present mining is in this north extension of the pit. Both the mining operation and the processing plant have been described by Gray (1961, p. 97-101). The function of the plant is to remove clay and iron-bearing constituents from the sand and to produce high grade silica sand suitable for use in the manufacture of glass. Two grades of sand are produced: "flint" sand (Fe_2O_3 content 0.03% to 0.035%) which is used to make colorless glass, and "amber" sand (Fe_2O_3 content 0.04% to 0.10%) which is used in the manufacture of amber- and green-colored glass containers. Waste pond material contains a large proportion of clay. After settling this material is sold to a number of companies for use as a constituent in the manufacture of common clay products.

883

Production: Initial capacity of the plant in 1943 was 90 tons per hour of crude sand with output of about 30 tons of finished flint sand and 15 tons of amber sand per hour. In recent years production has been at the rate of about 20,000 tons per month. The product is shipped to the Los Angeles area.

References: Tucker and Sampson, 1929, p. 504; Tucker and Sampson, 1945, p. 163-164; Gray, 1961, p. 97-101, 119.

C.H.G. 6/20/63.

884

Coronita Ranch Sand Deposit

Location: SW¼ sec. 16, E½SE¼ sec. 17, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; 6½ road miles southeast of Corona along the east margin of lower Bedford Wash a quarter of a mile west of State Highway 71.

Ownership: Coronita Ranch, Joel D. Middleton, 9531 Heather Road, Beverly Hills, and Donald C. McMillan, 8704 Colima Road, Whittier, own 240 acres of patented ranch land.

History: This property was first explored for glass sand in April 1957, when 10 drill holes were put down in the SW¼ sec. 16 along the southeast margin of and east of Bedford Wash. The work was under the direction of Mr. Meredith C. Brown. Early in 1958 the property was taken under option by the Del Monte Properties Company, Pacific Grove, who did additional drilling and sampling in this area and also on other parts of the Coronita Ranch in secs. 17, 18, 19, and 20, T. 4 S., R. 6 W., S.B.M. Although beneficiation tests and analyses of samples indicate that the sand is probably of glass grade (Brown, 1957) the deposit has not been mined.

Geology: The Coronita Ranch sand deposit adjoins the west edge of the Corona silica sand deposit (described elsewhere in this report) and apparently is the northwest extension of the same sequence of Silverado Formation sandstones and clayey sandstones which have been mined for many years. On the Coronita Ranch property the Silverado sandstone crops cut in one small exposure on the east bluff of Bedford Wash. Here it strikes N. 45° W. and dips 8° to 10° SW. The remainder of the property is covered mostly by older alluvium, but one small hill is capped by terrace deposits. Low hills, which rise along the south margin of the property east of Bedford Wash, are underlain by the Sespe and Vaqueros formations. Five drill holes, ranging from 26 to 90 feet in depth, encountered overburden only; five other drill holes encountered medium- to coarse-grained Silverado sandstone, siltstone, and sandy clay with abundant greenish-gray mica. These holes all bottomed in this formation at 90 feet, with overburden ranging from 2 to 24 feet.

Development: Drilling and sampling only.

Production: None.

References: Brown, 1957, 8 p.; Gray, 1961, p. 101-103, 119.

C.H.G. 8/22/62.

886

Jackson and Havens Deposit

Location: Undetermined, probably in the SW¼ sec. 11(?) T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern margin of the Santa Ana Mountains, 3 miles southwest of Corona, midway between Main Street and Hagador Canyons.

Ownership: George W. Lord, Corona (1924); undetermined (1961).

History: Reported under development in 1924 by Jackson and Havens, Riverside; this deposit, discovered in 1917, was worked intermittently prior to 1924, but apparently not since. During 1922, sand was shipped to the Union Tool Company, Los Angeles. By 1956, all equipment had been removed.

Geology: A bed of white "molding" sand about 30 feet thick composed of coarse, white sub-angular arkose (~~Paleocene~~ Silverado Formation?) overlain by about 2 feet of gravel and soil overburden (Quaternary terrace deposit?) was reported under development by Jackson and Havens in 1924.

Development: The deposit was worked by open cuts, the material being loaded into small mine cars and transported to loading bins.

Production: Undetermined but apparently small.

References: Gray, 1961, p. 120.

C.H.G. 3/7/61.

887

Nonhof Deposit

Location: NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7½', 1954; northeastern margin of the Santa Ana Mountains, 3 miles southwest of Corona, west side of lower Hagador Canyon.

Ownership: Arthur Weirick, Chase & Skyline Drive, Corona (1956).

History: This deposit, discovered in 1900, is reported to have been productive before 1907 (personal communication, Mrs. Irene J. Ware, Corona) and may be one of the glass sand deposits noted by Aubury (1906, p. 375) as under development by the Corona Pressed Brick Company about 1905. In 1956, the workings were not identifiable and may have been destroyed by work at the adjacent McKnight clay mine. Long idle.

Geology: In 1924, Mr. Nonhof reported a bedded deposit of sand, 50 feet thick, in unconsolidated sands, gravels, and clays (~~of Paleocene~~ Silverado Formation). Sand deposit covered about 2 acres with a 5-foot thick overburden of gravel and soil (Quaternary terrace deposit).

Development: Consisted of open cuts and one 50-foot adit in 1924.

Production: Undetermined, but probably small.

References: Aubury, 1906, p. 375; Gray, 1961, p. 120.

C.H.G.

888

Smith Silica Pit (Jones, Hoag Ranch, Sand Deposit)

Location: SW¼ sec. 17, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles southeast of Corona, between Bedford and Joseph Canyons.

Ownership: Riverside Cement Company Division of the American Cement Corporation, P.O. Box 832, Riverside, owns 80 acres of patented ranch land.

History: The Jones deposit, on the old Hoag Ranch, was owned in 1925 by A. E. Jones of Corona who did some open cut development work and erected a wooden loading bin. Apparently there was little or no production of glass sand from this property, but small amounts of sand may have been produced and used as foundry sand in the 1920's. In 1958 the property was acquired by the Riverside Cement Company who did extensive drilling and sampling. Early in 1961 the property was put into production as a source of white silica sand for use in the manufacture of white portland cement at the company's new white plant at Crestmore.

889

Geology: The deposit is composed of generally massive, poorly consolidated, white sandstone which is locally conglomeratic. It is probably of Pliocene age. Indistinct bedding appears to strike northwestward and dip about 20° southeast. The sandstone consists mostly of quartz and feldspar. In places the unconsolidated sand contains very little mica and has no visible impurities, elsewhere it contains much mica, occasional sandy clay layers, clay shale clasts, and cobbles of granitic, volcanic, and metasedimentary rock. The mixed sandstone and conglomeratic sandstone is exposed over an area about 1,000 feet square. An overburden, 5 to 10 feet thick, of older alluvium covers the central and southern part. Tucker and Sampson (1929, p. 505) state that the raw material was reported to contain 97.45 percent silica and was upgraded to 97.54 percent silica after washing and screening and that the iron content ranged from 0.09 percent to 0.11 percent.

Development: The property has undergone extensive drilling and sampling. Mining is from a side hill open cut about 300 feet long and 200 feet wide with face 10 feet high. Mining is done by tournapull equipment and bulldozer, which in a period of several days mines about one year's supply of sand. The sand is hauled by truck-trailer equipment to Crestmore.

890

Production: Since mid 1961, about 10,000 to 15,000 tons each year.

References: Tucker and Sampson, 1929, p. 505; Sampson and Tucker, 1931, p. 443; Tucker and Sampson, 1945, p. 163; Gray, 1961, p. 103, 119.

C.H.G. 6/20/63.

891

Temescal Canyon Silica Sand Deposit

Location: NE¼ sec. 29, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; 5 miles southeast of Corona, southeast of Bedford Motorway, and north of McBribe Canyon.

Ownership: Arthur E. Garratt, 3340 Eastern Avenue, Los Angeles 32, owns sec. 29, formerly railroad land (1957).

History: Area prospected for glass sand years ago (probably in the 1920's) by means of several shallow pits from which a small production may have been obtained. Early in 1956 the Ottawa Silica Company, Ottawa, Illinois, took the property under option and explored in this area and also in the W½ sec. 28. The property was not put into production.

Geology: Coarse, weakly indurated, white arkose of probable upper Eocene to lower Miocene age (undifferentiated Vaqueros and Sespe formations) crops out over much of the N½NE¼ sec. 29, but the flat topped ridges in this area are capped by Quaternary terrace gravels. South of these exposures is a fault sliver of Paleocene Silverado Formation, composed of sandstone, clayey sandstone, and clay, which crops out along the northeast side of the Elsinore fault and extends from McBribe Canyon northwest along the margin of the Santa Ana Mountains. The fault sliver is about 600 feet wide and 2,000 feet long.

592

Development: Eight 18-inch diameter drill holes were put down in the NE¼ sec. 29 in 1956 and the remainder of the area was explored by numerous bulldozer cuts and trenches.

Production: Undetermined, probably none.

References: Sampson and Tucker, 1931, p. 444; Gray, 1961, p. 103, 119.

C.H.G. 8/24/62.

Broken and Crushed Stone
Roofing Granules

Storm Sulfide (Green Giant-Long Green) Deposit

Location: Sec. 4, T. 4 S., R. 13 E., S.B.M. (proj.)., Pinto Basin quadrangle, 15', 1963; Eagle Mountains, about 13 miles northeast of Cottonwood Spring and 7.5 miles northeast of the East Pinto Basin Road-West Pinto Basin Road-Black Eagle mine road intersection (figure 56).

Ownership: Barry Storm, P. O. Box 74, Inyokern, owns two unpatented lode claims (February 1960).

History: In August 1957, the property was owned by Henry B. Tuttle, 218 South Palm Canyon Drive, Palm Springs. At this time, Mr. Tuttle owned 4 unpatented lode claims: Green Giant nos. 1 and 2, and Long Green nos. 1 and 2. The Green Giant no. 2 (open-cut site, fig. 56) was leased to the Lucas Mining and Milling Co., Thousand Palms (Harry T. Lucas, President). Green rock was mined and sold at $20 per ton for roofing granules (oral communication, 8/1/57, Henry B. Tuttle).

Geology: Irregular green bodies of mixed idocrase, garnet and epidote occur in a contact zone, as much as 20 feet thick, between light colored quartz monzonite, cut locally by narrow, dense black dikes, and bluish-gray calcitic dolomite weathering light tan.

Figure 56

Plate 41

944

Development: Workings consist of bulldozer scrapes, prospect pits, an open-cut, and two adjacent adits [illegible]. The open-cut, from which rock for roofing granules was extracted, is 60 feet long, 40 feet wide, and 20 feet deep. The westernmost adit is about 75 feet long. It is driven north and is overhand stoped 15 feet to the surface 25 feet from the portal. Several tens of feet east is another adit driven north 15 feet. The property was idle when visited but may be worked intermittently.

Production: Undetermined.

Reverences: None.

J.R.E. 1/27/60.

945

Temescal Rock Quarry

Location: S½ sec. 4, T. 4 S., R. 6 W., S.B.M., Corona South quadrangle, 7½', 1954; about 4 miles southeast of Corona, on the east side of Temescal Canyon.

Ownership: Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul, Minnesota (P.O. Box 815, Corona 1) owns patented land in secs. 4, 5 and 9, T. 4 S., R. 6 W., S.B.M. totaling about 1,000 acres (1957).

History: Quarry was opened about 1888 to furnish rock for macadamizing streets in Los Angeles and nearby towns. By 1914 the quarry was owned and operated by the Temescal Rock Company whose plant had a capacity of 1,500 to 2,000 tons of crushed rock products per day. About 1920 the quarry was purchased by the Blue Diamond Materials Company who used the rock for building aggregate and road metal until 1927 when the plant was destroyed by fire. The property remained idle until 1947 when it was reopened by the present owner to produce roofing granules and has been in continuous operation since.

946

Geology: The quarry is in Temescal Wash Quartz Latite Porphyry, a fine-grained, dark-colored, intrusive rock of probable Jurassic age. The quartz latite is blue-gray on weathered surfaces and blue-black to gray on fresh fractures. The rock consists of abundant white feldspar and quartz phenocrysts in a gray microcrystalline groundmass. It has good breakage qualities and is very hard.

947

Development: The quarry face is steep and nearly 400 feet high on one bench level. Mining continues to widen the bench, which is about 1,000 feet long, on that face. In 1956 the length of the quarry, on the same bench, was extended about 900 feet to the south. The original north part of the quarry, however, continued to be the chief source of rock. Quarried rock is moved by belt conveyor to a processing plant in the canyon below the quarry. The function of the plant (described by Gray, 1961, p. 93-95) is twofold; first the material is crushed and screened into sizes suitable for various types of roofing granules and second, artificial colors are applied and bonded to the granules. Granules are produced in a variety of sizes and a wide range of colors. The major output is fine-grained material in the range 10 to 35 mesh used for processed roofing; additional but smaller amounts of coarse granules are produced for built-up roofing. During the 1950's these coarse granules were colored and bagged at a small plant on East Third Street, Corona, north of the city park, but about 1960 this plant was dismantled and the operation moved to a portion of the main plant in Temescal Canyon.

In addition to roofing granules this operation yields at least three by-products. Since 1956 reject material (-28 mesh) from the crushing operations has been used by several plants in sewer pipe manufacture. In 1963 Fontana Paving, Inc. erected an asphalt plant in Temescal Wash about one mile northwest of Temescal Rock Quarry from which quarry waste is used to make asphalt paving. The asphalt plant also utilizes decomposed Cajalco Quartz Monzonite and sandy alluvium from the east side of Temescal Wash adjacent to the plant. Also in 1963 Pomona Ready Mix Concrete erected a batch plant just west of the asphalt plant. Crushed rock for concrete gravel is supplied from the Temescal Rock Quarry and sand is mined from Temescal Wash adjacent to the plant.

Production: Initial capacity of the Temescal Canyon plant was about 100,000 tons of granules each year. This has been substantially increased and by 1963 was over 200,000 tons.

References: Goodyear, 1888, p. 506; Merrill, 1917 [1919], p. 586-587; Tucker, 1921, p. 331-332; Tucker, 1924, p. 45; Allen, 1923, p. 887-890; Bradley, 1923, p. 95; Tucker and Sampson, 1929, p. 508, 524; Tucker and Sampson, 1945, p. 166-167; Ingram, 1949, p. 457; Utley, 1949, 5 p.; Megaphone, 1951, p. 6-7; Jahns, 1954, p. 21; Gray, 1961, p. 93-95.

C.H.G. 6/20/63.

949

Salt

The first attempt to collect and market salt in the area now included in the county was that of the New Liverpool Salt Company. In 1884, this company began work harvesting a natural layer of salt, ranging in thickness from 10 to 20 inches, which had formed on the then dry surface of the Salton Sea. The plant was located at Salton, a station on the Southern Pacific Railroad near the northeast margin of the playa surface. The following quote from Bailey (1902, p. 124) outlines the method and working conditions of the enterprise.

"The sight at the salt works is an interesting one, for thousands of tons [of salt] are piled up like huge snow drifts, and a large force of men is busy preparing and packing, ready for market, salt of all grades and kinds. The workmen are Indians.... belonging to the Coahuilla tribe, and are large, well-developed men, who are not affected by the dazzling sunlight, and who are able to work ten hours a day with the thermometer registering 150° in the sun. The Indians operate cable plows, that cut salt furrows 8 feet wide and 6 inches deep, each plow harvesting over 700 tons of pure salt per day. A portable railroad conveys the salt to the works."

950

This operation continued until the flood of 1905-1907 left the plant under 60 feet of water (Brown, 1923, p. 11-12, pl. 4; Ver Planck, 1957, p. 115).

A later attempt to win salt from this basin was made in 1927 by Seth Hartley who experimented with solar evaporation near Caleb at the north end of the sea. A crop of 1,500 tons was harvested in 1929 (Tucker and Sampson, 1929, p. 526) but no further activity was reported (Ver Planck, 1957, p. 115).

The two other desert basins in Riverside County, Palen Dry Lake and Ford Dry Lake northeast and east of Desert Center, do not appear to contain extensive deposits of evaporites although some well water in that area is strongly charged with dissolved mineral matter.

Salt is no longer produced in Riverside County.

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Table 6. SOIL SURVEYS

Soil is as much a part of the earth as the rocks from which it is derived and it is our most important basic natural resource. (Accordingly it is appropriate to include the following source data in this report.)

Soil and Land Classification Surveys in Riverside County

Adapted from a state-wide compilation by Walter W. Weir, Department of Soils, University of California, Berkeley

Name of Survey	Date	Made by	Area Surveyed	Type of Survey	Scale of Maps
Soil Survey San Bernardino Valley	1904	1	portions of area around Riverside and Perris Valley	soil, semi-detail	1" = 1 mi.
Soil Survey Riverside Area	1915	1,2	western part of county	soil, detail	1" = 1 mi.
Reconnaissance Soil Survey Central Southern Area	1917	1,2	county west of desert	soil, recon	1" = 2 mi.
Soil Survey Indio Area	1903	1	lower portion Coachella Valley	soil, semi-detail	1" = 1 mi.
Soil Survey Coachella Valley	1923	1,2	344 sq. mi. S. portion of valley	soil, detail	1" = 1 mi.
Soil Survey Palo Verde Area	1922	1,2	423 sq. mi. Palo Verde Valley	soil, detail	1" = 1 mi.
Soils of Palo Verde Mesa	1946	2	40 sq. mi. Palo Verde Mesa	soil, detail	1" = 1/2 mi.
Soils of Portion of Palo Verde Valley (Between Levee and River)	1947	2	about 60 sq. mi. along river	soil, detail	1" = 1 mi.

Name of Survey	Date	Made by	Area Surveyed	Type of Survey	Scale of Maps
Reconnaissance Soil Survey of San Diego Region	1915	1,2	strip 6 mi. wide along SW edge of county	soil recon	1" = 2 mi.
Mira Loma SCD	1914	3	6,500 Ac NW corner of county	SCS, detail	1" = 1320'
Elsinore-Murrieta-Anza SCD	1953 (IP)	3	92,634 Ac Sw portion Co.	SCS, detail	1" = 660'
Riverside-Corona SCD	1953 (IP)	3	2,540 Ac W. end of county	SCS, detail	1" = 660'
San Gorgonio SCD	1953	3	106,662 Ac N. central portion of county	SCS, detail	1" = 660'
San Jacinto Basin SCD	1953 (IP)	3	96,133 Ac W. central portion of county	SCS, detail	1" = 660'
Yucaipa Valley SCD	1952	3	south of Yucaipa	SCS, detail	1" = 660'
West End SCD	1953 (IP)	3	west of Riverside	SCS, detail	1" = 660'
Southwest Riverside County Reconnaissance	1945	3	288,000 Ac	SCS recon	1" = 660'
Santa Margarita Investigations Land Classification	1953	4	portion of Santa Margarita Ranch	LC recon	1/250,000
Chuckawalla Valley	1939	5	120,000 Ac	LC, semi-detail	---
Coachella Valley	1942-43	5	142,000 Ac	LC, detail	1" = 1 mi.
Soil-Geologic Survey	1943	6	areas in NF only	soil and geology recon	1/2" = 1 mi.

1 USDA U.S. Department of Agriculture, Soil Survey Division
2 UC University of California, Department of Soils
3 SCS U.S. Department of Agriculture, Soil Conservation Service
4 DWR Division of Water Resources, Department of Public Works
5 USBR U.S. Bureau of Reclamation
6 CFRES California Forest and Range Experiment Station, Forestry Bldg., University of California, Berke
--- Information not currently (1954) available

Reference copies of local soil surveys are on file in the office of the University of California Farm Advisor and (your local) Public Library.

Some of the published soil surveys are still available. Inquiries may be mailed to:

Agricultural Publications
207 University Hall
University of California
Berkeley 4, California

Explain your need. A limited number of surveys are available and not all requests can be granted.

Talc

Palen Mountains Talc Deposit

Location: Sec. 18 (proj.), T. 5 S., R. 18 E., S.B.M., Sidewinder Well quadrangle, 15' 1952; 15 miles northeast of Desert Center at the southwest edge of the Palen Mountains.

Ownership: Not determined (1959).

History: In 1945, this property was held by E. T. Herman, El Segundo, and Leslie C. Mott, Los Angeles (Tucker and Sampson, 1945, p. 182). It was idle then and when visited in March, 1959.

Geology: The area of the deposit is underlain by metasedimentary rocks of the McCoy Mountains formation. (Miller, 1944, p. 32). A shear zone as wide as 60 feet strikes N. 70° W. across the north slope of a steep ridge and dips 70° SW. It is traceable for approximately three-quarters of a mile between its faulted southeast end and the alluvium to the northwest. The shear zone comprises irregular masses of talcose schist and friable, white talc. The following analysis, submitted by the owners (1945), appeared in a previous report (Tucker and Sampson, 1945, p. 182).

Photo 42

955

	Percent
Silica (SiO_2)	60.70
Iron and aluminum oxides (Fe_2O_3 and Al_2O_3)	1.95
Calcium oxide (CaO)	trace
Magnesium oxide (MgO)	30.88
Water (H_2O)	4.50

Development: The principal development is at the east end of the outcrop. It consists of shallow open cuts and a 30-foot crosscut driven from the footwall through solid talc. About 10 feet from the face of the crosscut there is a 10-foot winze.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 182, pl. 35.

R.B.S. 3/12/59.

956

Tunnel Claim

Location: NE¼ sec. 23, T. 7 S., R. 11 E., S.B.M., Orocopia Canyon quadrangle, 7.5', 1958; reached by an unimproved road which extends northward from a Coachella Canal siphon marked as the site of BM 67 on the topographic map.

Ownership: Undetermined.

History: Undetermined.

Geology: A shear zone, about 40 feet wide containing talcose, chlorite-actinolite schist crops out through a strike distance of about 500 feet on a steep slope cut in flaggy, quartz-biotite gneiss. The zone strikes N. 60° W., and dips 30° SW.

Development: The deposit is opened by several open-cuts; one in the canyon wall, the others higher on the slope to the northwest. ~~The adit, shown on the topographic map, either never existed or is now covered.~~

Production: Undetermined.

References: None.

R.B.S. 2/26/60.

957

Tin

The first, ~~and still the most important,~~ ~~recorded~~ discovery of tin in California was in the Temescal district, Riverside County, prior to the Civil War, probably in 1853 (Hanks, 1884, p. 120-122). Presumably the initial discovery was at Cajalco Hill (site of the Temescal or Cajalco mine). Exploration stopped with the outbreak of the Civil War, but was resumed in 1868, and in 1869 a 15.34 ton shipment of ore was made to San Francisco (Page and Thayer, 1945, p. 1). Subsequently ore was mined during 1891 and 1892 and later in 1928-29. During the early 1940's the U. S. Geological Survey examined the area and an open-file report was prepared (Page and Thayer, 1945, 24 p., 13 figs.), but the mines have remained idle. The total production of tin from Riverside County is estimated at about 130 long tons, all of which apparently came from the Temescal (Cajalco) mine.

The Temescal (Cajalco) mine and several neighboring properties which together comprise the Temescal tin district are confined to an area of approximately 15 square miles about 5 miles southeast of Corona and 11 miles southwest of Riverside. Here a mass of quartz monzonite contains a group of tourmaline-quartz veins in ~~only~~ a few of which recoverable amounts of cassiterite have been found. Probably several hundred veins have been seriously explored in the Temescal district and numerous smaller stringers and tourmalinized zones also exist. The veins are commonly zoned or banded, but most of the veins that are a foot or less in width consist entirely of mottled tourmaline rock or silicified rock. In the wider parts of the veins, where mineralization was more intense, their centers are occupied by a layer of fine-grained tourmaline a few inches wide. The veins apparently replaced the quartz monzonite along fissures soon after it solidified. Assays indicate that almost all of the veins contain 0.03 to 0.1 percent tin, but samples assaying more than 0.1 percent have been collected in very few places. Cassiterite occurs as disseminations and as bunches and stringers in the tourmaline-quartz rocks (Page and Thayer, 1945, 24 p., 13 figs.).

In addition to the Temescal district traces of tin in Riverside County are reported in the Elsinore district, about 15 miles to the southeast. The area at the Chief of the Hills group (see herein) was prospected in the late 1920's but no tin was produced. In the mid-1930's prospectors sought tin in the hills a few miles east of Elsinore but little or none was found (Engel et al., 1959, p. 77).

960

American Flag and Monarch Mines*

Location: Reported to be "2 miles east of Elsinore", not identified in 1955. Reported to comprise 12 claims in 3 groups.

Ownership: Undetermined.

History: Area prospected for tin in the mid-1930's.

Geology: Triassic(?) slates and quartzites (Bedford Canyon Formation) and granitic rocks (Bonsall tonalite?) and basic dikes. No veins; "dikes" are mainly colored streaks in granitic rocks.

Development: Explored by at least 20 open cuts, pits, and shallow shafts. Six samples taken from places designated by former owners as carrying 22 to 80 lbs. tin per ton were found to contain less than 0.4 lb. tin per ton; less than 0.2 lb. nickel and 0.4 lb. cobalt.

Production: Apparently none.

References: Bedford and Johnson, 1946, p. 10; Engel et. al., 1959, p. 77, 126.

C.H.G. 8/7/62

* Adapted from Engel et al., 1959, p. 77, 126.

961

Black Rock (North Black Rocks) Deposit

Location: Secs. 18, 19, T. 4 S., R. 5 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; 7½ miles southeast of Corona and half a mile south of Lake Mathews on both sides of Cajalco Road.

Ownership: In 1945, holdings comprised 400 acres owned by W. B. Moore, Moore Bros., 711 Baker Building, Walla Walla, Washington. Present (1962) extent of holdings and ownership not determined, but at least part of the area is owned by the Metropolitan Water District of Southern California, 306 West Third Street, Los Angeles, California.

History: The Black Rocks Tin Syndicate sampled about 40 veins in the NW¼ sec. 18 in 1927-29 by means of one inclined shaft and prospect pits on the veins (Page and Thayer, 1945, p. 23). The property has been idle since the 1930's.

Geology: Tourmaline-quartz veins and pipes in quartz monzonite. Tucker and Sampson (1945, p. 151) reported twelve tourmaline veins striking northeast, dipping 60° SE., and ranging in width from 4 to 30 feet. According to Page and Thayer (1945, p. 24) about 310 samples were taken by the Black Rocks Tin Syndicate and only occasional assays showed more than 0.08 percent of tin, and the highest was 0.18 percent.

962

Development: One inclined shaft sunk to a depth of 125 feet (Tucker and Sampson, 1945, p. 151) and a few prospect pits.

Production: Undetermined, but apparently none.

References: Tucker and Sampson, 1929, p. 495-96; Sampson, 1935, p. 516; Tucker and Sampson, 1945, p. 151; Page and Thayer, 1945, 24 p., figs. 4, 6; Bedford and Johnson, 1946, p. 10; Gray, 1957, p. 643.

C.H.G. 8/10/62.

963

Chief of the Hills Group*

Location: NE¼ sec. 4, NW¼ sec. 3, T. 6 S., R. 4 W., S.B.M., Elsinore quadrangle 7½', 1953; east side of high point on ridge one mile west of Railroad Canyon Dam, about 2 airline miles east of Elsinore.

Ownership: J. M. Mack, C. L. Berry, and Mary Briner, Elsinore (1926); public domain (1945); undetermined (1962).

History: Area prospected in the late 1920's and 5 claims were located in December 1926. By 1929, the property was idle and there is no report of renewed activity.

Geology: Country rock is Triassic(?) slate, quartzite, and metaconglomerate (Bedford Canyon Formation); beds strike N.5° to 20°W., dip 80°E. Comb quartz veins 2 to 3 inches wide on edge of metaconglomerate body; much discoloration by iron, manganese(?) oxides. Tin reported to occur as reddish brown crystals lining cavities in minutely crystalline tourmaline associated with 5 fine-grained granitic dikes (Tucker and Sampson, 1929, p. 496); tin minerals not found in 1954. Reported assays of 0.30 to 2.21 percent tin (Tucker and Sampson, 1929, p. 496), and 7 percent tin (Segerstrom, 1941, p. 551).

*Adapted from Engel et al.; 1959, p. 77, 126.

964

Development: Prospected by shallow trenches and 100-foot vertical shaft with crosscuts driven 20 feet east and 10 feet west at bottom. West crosscut reported driven in material that assayed 0.31 to 1.22 percent tin (Tucker and Sampson, 1929, p. 496). Shaft open but inaccessible in 1954, inhabited by owls.

Production: No ~~production~~ mg.

References: Tucker and Sampson, 1929, p. 496; Sampson, 1935, p. 516; Segerstrom, 1941, p. 551; Tucker and Sampson, 1945, p. 152, pl. 35; Larsen, 1948, p. 133; Larsen, 1951, p. 49; Engel et al., 1959, p. 77, 126.

C.H.G. 8/7/62.

Holmes Ranch Deposit

Location: NW¼ sec. 12, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 6 miles southeast of Corona and 1½ miles southeast of Cajalco Hill, along Cajalco Canyon west, and adjacent to, Cajalco Dam and Spillway.

Ownership: In 1945, Tucker and Sampson (p. 152) reported the ranch consisted of 560 acres owned by Lawrence Holmes, Arlington, California. Ownership and extent of holdings were not determined in 1962.

History: Probably first prospected during the late 1800's, when the nearby Cajalco Mine was active. By 1929 (Tucker and Sampson, p. 496), the property was under option to Southern California Tin Corporation, but other than sampling no development work had been done on the vein. The area was included in studies made by the U.S. Geological Survey in the 1940's (Page and Thayer, 1945) ~~24 p. 13 figs.~~ but has remained idle.

Geology: A group of tourmaline veins in quartz monzonite occur in the SW¼ sec. 1 and the NW¼ sec. 12. The veins trend about N. 20°E. and most dip 50° to 80° NW., but a few dip 60° to 65° SE. Fifteen samples contained only traces of cassiterite (Page and Thayer, 1945, p. 23). Tucker and Sampson (1945, p. 152) reported the vein outcrop to be from 6 to 15 feet in width.

Development: Two shafts of undetermined extent are on either side of Cajalco Canyon, but apparently not on tourmaline veins. These two shafts are said to have been sunk during construction work at Cajalco Dam during the 1930's. The veins have been explored by means of several trenches and pits.

Production: Undetermined, apparently none.

References: Tucker and Sampson, 1929, p. 496; Sampson, 1935, p. 516; Tucker and Sampson, 1945, p. 152; Page and Thayer, 1945, 24 p. 13 figs.; Bedford and Johnson, 1946, p. 9.

C.H.G. 8/10/62

967

Moore Deposit

Location: Secs. 13, 14, 23, 24, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 7 miles southeast of Corona and 2 miles southeast of Cajalco Hill.

Ownership: 600-acre ranch held by Robert L. Moore estate, Riverside, California in 1945. Present (1962) owner and extent of holdings not determined.

History: Said to have been discovered in 1891 and some development work done during 1927-29. Idle since the early 1930's.

Geology: Series of parallel quartz-tourmaline veins in Mesozoic quartz monzonite. The veins strike northeast, are reported to contain copper oxides, and chalcopyrite is disseminated in the wall rock (Tucker and Sampson, 1945, p. 152).

Development: Several shallow shafts 20 to 40 feet deep on different veins.

Production: Undetermined, apparently none.

References: Tucker and Sampson, 1929, p. 496; Sampson, 1935, p. 516-517; Tucker and Sampson, 1945, p. 152; Bedford and Johnson, 1946, p. 10.

C.H.G. 8/10/62.

968

Prospect* (Name undetermined)

Location: SW¼ sec. 4, T. 6 S., R. 4 W., S.B.M., Elsinore quadrangle 7½', 1953; southern base of low hills about one mile east of Elsinore, about ¼ of a mile west of city dump.

Ownership: Undetermined.

History: Area prospected for tin in the mid-1930's; idle many years.

Geology: Deeply weathered diorite and gabbro (San Marcos gabbro) cut by sheared aplitic dike 5 feet wide, traceable more than 100 yards trending N. 65° E.

Development: Tin minerals reported sought in several shallow pits along the southeast edge of the dike, and a 30-foot shaft, caved at the bottom and inaccessible at the westernmost exposure of the dike.

Production: Little or no production.

References: Larsen, 1948, p. 133; Larsen, 1951, p. 49; Engel et al., 1959, p. 77, 127.

C.H.G. 8/7/62.

*Adapted from Engel et al., 1959, p. 77, 127.

969

Prospect* (Name undetermined)

Location: S½ sec. 22, N½ sec. 27, T. 5 S., R. 4 W., S.B.M., Elsinore quadrangle, 7½', 1953; about 3/4 of a mile southeast of Highway 74, about 3½ airline miles northeast of Elsinore.

Ownership: Undetermined.

History: Area prospected for tin in the mid-1930's; idle many years.

Geology: Pegmatite dike trends northeasterly through quartz diorite (Bonsall tonalite) near contact with Triassic(?) slates (Bedford Canyon Formation). Traces of topaz and tourmaline were exposed in a shallow cut, but tin-bearing minerals were not observed in 1954.

Development: Shallow open cut.

Production: No production.

References: Larsen, 1948, p. 133; Larsen, 1951, p. 49; Engel et al., 1959, p. 77, 127.

C.H.G. 8/7/62

* Adapted from Engel et al., 1959, p. 77, 127.

970

South Black Rock Deposit

Location: NW¼ sec. 19, T. 4 S., R. 5 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; about 7 miles southeast of Corona and 1½ miles south of Lake Mathews.

Ownership: 80-acre tract owned by Hewitt S. West in 1945. Ownership and extent of holdings not determined (1962).

History: By 1929, the property had been explored by means of several shallow shafts and was under option to the American Tin Corporation but was idle (Tucker and Sampson, 1929, p. 497). The area was examined during the 1940's by the U.S. Geological Survey (Page and Thayer, 1945) and has since remained idle.

Geology: Tourmaline-quartz veins in quartz monzonite. According to Page and Thayer (1945, p. 24) the veins strike N. 30°-60° E. and, for the most part, dip 65°-80° SE. In places they are as much as 30 feet wide and are continuously exposed for as much as 800 feet. More than 150 assays of samples taken by the Black Rocks Tin Syndicate (about 1927-29) indicate that the average grade of these veins is probably between 0.03 and 0.05 percent of tin. The upper 30 feet of shaft No. 2 averages about 0.10 percent of tin over an average width of 56 inches.

Development: Two shallow inclined shafts sunk on the veins, and several shallow pits and trenches.

Production: Undetermined, apparently none.

References: Tucker and Sampson, 1929, p. 497; Sampson, 1935, p. 517; Tucker and Sampson, 1945, p. 152; Page and Thayer, 1945, 24 p. 13 figs.; Bedford and Johnson, 1946, p. 10; Gray, 1957, p. 643.

C.H.G. 8/10/62.

Temescal (Cajalco) Mine

Location: Secs. 2, 3, 10, 11, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, 7½', 1953; 5 miles southeast of Corona and 1¼ miles west of Lake Mathews. The principal workings (Williams or No. 1 shaft and Robinson shaft) are in the SW¼ sec. 2, just northeast of Cajalco Hill.

Ownership: In 1945, the holdings comprised 870 acres owned by Tinco Corporation, Richmond, Virginia. Amertin Incorprated, 1 North 6th Street, Richmond 19, Virginia was the owner of record in 1957. In the early 1960's, the mine area and a large tract of adjacent land were acquired by the Lake Mathews Farming Company, Route 2, Box 98, Corona, California.

History: Tin was discovered in the Temescal district prior to the Civil War, probably in 1853. A vertical shaft had been sunk 95 feet when the outbreak of the Civil War stopped the work. Exploration was resumed in 1868, and in 1869 a 15.34 ton shipment of ore to San Francisco was said to have yielded 6,895 pounds of tin (Page and Thayer, 1945, p. 1). However, the first production of record was in 1891. Ore was mined during 1891 and 1892 and later in 1928-29. In 1942, a modern 100-ton mill was erected and 1,400 tons of surface vein material was put through with a recovery of less than a pound of tin oxide per ton (Tucker and Sampson, 1945, p. 154). During the period 1940-45 the U. S. Geological Survey mapped and sampled the area in considerable detail; the Cajalco mine was partly unwatered and the upper part of the old stope was examined. This investigation resulted in an open file report (Page and Thayer, 1945). Since 1945, the owners have attempted to reactivate the mine, but the property has remained idle. By 1963, a considerable acreage of citrus orchards had been planted in the area immediately north and west of the mine.

Geology: Tin, in the mineral cassiterite, is associated with veins and pipe-like masses of tourmaline-quartz rock in coarse-grained quartz monzonite (mapped as a phase of the Woodson Mountain granodiorite by Larsen, 1948, p. 132-133, plate 1). According to Page and Thayer (1945, p. 7,8) the average width of the veins, including spotted tourmaline rock and silicified rock, probably is 1 to 2 feet, although some of the veins are 6 feet wide, and in places a few are 15 to 20 feet wide. Most of the veins are less than 1,000 feet long and are discontinuous, although one vein system is about 4,800 feet long. The downward extent of the veins is not known but the Cajalco vein was followed to a depth of 690 feet and was not bottomed. Most of the veins, including the Cajalco vein, are in coarse-grained quartz monzonite, strike from about N. 20° E. to N. 50° E., and dip from 50° to 85° NW.

975

The Cajalco vein is exposed on the surface discontinuously over a length of 550 feet and has been explored continuously over a length of 1,000 feet. It strikes about N. 55° E. and dips ~~from~~ 55° to 80° NW. On the surface the vein is as much as 5 feet thick and, as exposed in the mine workings, ranges from 1 inch to 5 feet 10 inches. Maps of the mine indicate that two ore shoots were developed. One was about 70 feet and the other 160 feet in strike length, and the ~~larger~~ longer one had a dip length of about 240 feet. The Cajalco vein averages about 0.15 percent of tin. The cassiterite occurs as disseminations and as bunches and stringers in the tourmaline-quartz rocks. The ore that was milled is reported to have averaged in the range of 2 to 5 percent SnO_2 (Page and Thayer$, 1945, 24 pp., 13 figs.).

976

Development: The principal workings at the Temescal mine explored the Cajalco or No. 1 vein and consist of an adit, a vertical shaft (the Robinson) now caved, an inclined shaft (the Williams or No. 1) that extends to a vertical depth of 540 feet, a raise to the surface from stope No. 1, and more than 5,800 feet of drifts and crosscuts on seven levels (Page and Thayer, 1945, p. 15). Other veins in the area have been explored by numerous shafts and adits with drifts and crosscuts. Considerable stripping and trenching also have been done on the veins. Most of the underground workings, including the stopes by means of which the two ore shoots were mined, are now inaccessible.

Production: The entire production apparently came from two connected cassiterite-bearing ore shoots in the Cajalco vein. According to Segerstrom (1941, p. 543) about 113 long tons of tin ~~were~~ was produced from the district. Page and Thayer (1945, p. 2) arrive at a figure of about 130.5 long tons, using data from Rolker (1895, p. 537) and Segerstrom (1941, p. 543).

977

References: Hanks, 1884, p. 120-122; Goodyear, 1888, p. 506; Crossman, 1890; Benedict, 1890, p. 450-453; Fairbanks, 1893, p. 111-113; Rolker, 1895, p. 537; Fairbanks, 1897, p. 39-42; Merrill, 1917 [1919], p. 547-550; Tucker, 1924, p. 46; West, 1928, p. 131-132; Tucker and Sampson, 1929, p. 497-499; Sampson, 1935, p. 517-518; Segerstrom, 1941, p. 533-34, 543, 550-551; Tucker and Sampson, 1945, p. 153-154; Page and Thayer, 1945, 24 p. 13 figs.; Bedford and Johnson, 1946, 14 p.; Larsen, 1948, p. 132-133, pl. 1; Larsen, 1951, p. 48, 49, pl. 1; Pampeyan, 1952; Gray, 1957, p. 641-644.

C.H.G. 8/9/62.

978

Tungsten

Riverside County tungsten production started in 1942 and ended in 1956, with some of the included years showing no recorded yield. ~~As shown on plate 27~~ accurate figures from which to derive year-by-year totals were not found, ~~however~~, at best tungsten has been a minor commodity in the county.

The largest single source of tungsten has been the Pawnee mine (see herein) in the Beauty Peak area, the holdings of which lie largely in San Diego County. The other properties appear to have yielded only small quantities of concentrates.

Scheelite ($CaWO_4$) has been found in gold districts in association with quartz veins and igneous dikes. Traces of scheelite have been found in contact zones in the igneous-metamorphic complex of the Big Maria Mountains at the eastern end of the county, but the most promising prospects have been in tactite bodies in the metamorphosed rocks of the San Jacinto and Santa Rosa mountains and the Beauty Peak area.

There are no known high-grade tungsten deposits in Riverside County and activity in tungsten mining has been largely dependent upon the government stockpiling programs authorized between 1946 and 1959. Stockpile purchase of tungsten concentrate was authorized under the Strategic and Critical Materials Stock Piling Act (Public Law 520, approved July 23, 1946) and the Defense Production Act of 1950 (Public Law 774 , approved September 8, 1950). Purchase of concentrates from domestic producers was terminated in December 1956, and the last contract for the acquisition of foreign concentrate was fulfilled in 1959.

980

Aztec (Chuckwalla Tungsten Mine) Claim

Location: Sec. 22 (proj.), T. 6 S., R. 15 E., S.B.M., ~~U. S. Army~~ Corps of Engineers, Chuckwalla Mountains quadrangle, 15', 1945; 5¼ miles south of Desert Center and 2 miles west of Aztec Well.

Ownership: Last reported (1958) owner was Bonnie L. Bowers, et al., 302 San Antonio Avenue, San Diego 6.

History: Tucker and Sampson, (1945, p. 154, pl. 35) described a property under the name Chuckwalla Tungsten Mine, which resembles the Aztec claim but the location given is about five miles to the east near Corn Spring. The Aztec claim once was called the Chuckwalla Tungsten Mine but this may simply be a duplication of names.

According to papers found on the property, in 1949 and 1950 the Aztec claim was held by Oscar F. Neuerberg, 8094 El Capitan, La Mesa, but the earliest date of the present owners claim was not determined.

981

Geology: The Aztec Claim is on a quartz vein ranging from 0 to 4 feet in thickness which strikes N. 40° - 70° W. across a low granite ridge through a distance of about 200 feet. The vein dips 35° to 40° SW. Scheelite is present as scattered crystals and as thin, lenticular bodies as much as 1½ inches wide. It is characterized by a straw-yellow to honey-brown color. In addition, the vein carries scattered, small bunches of pyrite, chalcopyrite and galena. Most of the pyrite has altered to iron oxides and secondary copper minerals.

Development: A crosscut adit has been driven into the west slope of the ridge (fig.). The vein was reached about 10 feet from the portal and a drift was run 40 feet southeast. Two short raises extend 10 and 15 feet to the surface from the drift. An open-cut has been dug on the east slope of the ridge with the apparent purpose of starting a drift adit to join the working in the west slope. Some trenching has been done on the outcrop.

Production: Undetermined. Idle, 1960.

References: Tucker and Sampson, 1945, p. 154, pl. 35.

R.B.S. 2/24/60.

982

Crescent Deposit

Location: SE 1/4 sec.28, T. 4 S., R. 23 E., S.B.M. (proj.), Big Maria Mountains SE. quadrangle, 7 1/2', 1955; Big Maria Mountains, about 18 miles north of Blythe.

Ownership: Undetermined.

History: Clyde H. Reynolds located the Crescent claim in May 1954.

Geology: Much of the work is in a tactite zone, as much as 10 feet thick, between intrusive (Mesozoic?), leucogranite and tan-colored wollastonite-bearing, Paleozoic (?), carbonate rock. The wollastonite-bearing rock trends northwest, dips 41° SW, and locally is coated with black desert varnish. The tactite is composed largely of garnet, green diopside and chlorite, and minor amounts of green prismatic epidote and clear to cloudy scheelite, all in a matrix of brown medium-grained limestone.

983

Development: Several pits and trenches, the largest about 15 feet in length, have been dug south into the tactite zone. In the adjacent gulch, numerous small pits, open cuts, and trails have been gouged out. All work here is in wollastonite-bearing rock, and no mineralization was observed. A good dirt road leads from the property, passing by several Giant Indian Intaglios, to a junction with U. S. Highway 95 about 17 miles north of Blythe. Elevation of the prospect is about 800 feet. It is idle.

Production: Undetermined.

References: Miller, 1944, p. 32.

J.R.E. 12/19/58.

5

984

Garnet Queen Mine

Location: NE¼SE¼ sec. 20, T. 7 S., R. 5 E., S.B.M., Toro Peak quadrangle, 15' 1941; on the east slope of Santa Rosa Mountain at an elevation of 6,000 feet.

Ownership: Santa Rosa Tungsten Corporation holds the mineral rights to this property (1958).

History: The Garnet Queen mine This property was first worked in 1896, in search of gold. Subsequent activity has been devoted to the exploration of a scheelite-bearing deposit. In 1941, a small concentration plant was installed by Elliot and associates, Glendale, California (Tucker and Sampson, 1941, p. 582) but no record of activity in subsequent years was found.

Geology: The Garnet Queen Mine explores one of a number of scattered, scheelite-bearing tactite bodies in a belt of pre-Cretaceous schists which strikes east to southeast across the granitic terrain of Santa Rosa Mountain (Wright, 1946, pl. 1). When visited in 1958, the ore body was not exposed. Tucker and Sampson (1941, p. 582) state that the width of the tactite ranges from 2 to 6 feet and its attitude is N. 8° E., 70° S. It is composed of quartz, garnet, epidote, diopside and 0.7 percent WO_3, contained in sparsely distributed scheelite.

Development: The workings consist of an open trench about 100 feet long and a 30-foot vertical shaft. The vertical shaft was sunk in 1896. It is reported to have followed gold-bearing quartz stringers (Tucker and Sampson, 1941, p. 582). ~~Idle.~~

Production: The plant built in 1941, had a capacity of 10 tons per day. The concentrate was reported to have contained 60 percent WO_3 (Tucker and Sampson, 1941, p. 582) but the amount shipped was not determined.

References: Tucker and Sampson, 1941, p. 582; 1945, p. 154; Wright, 1946, pl. 1).

R.B.S. 6/26/58.

986

Lucky Strike Mine

Location: NE¼ SW¼ sec. 33, T. 8 S., R. 3 E., S.B.M., Warner Springs quadrangle, 15' 1939; about one mile north of Chihuahua Creek and just east of the road connecting Duranso and Chihuahua valleys.

Ownership: Undetermined (1958).

History: Undetermined.

Geology: The Lucky Strike mine is in an area of pre-Cretaceous gneissic metamorphic rocks cut by thin pegmatite dikes. A tactite zone is exposed in an area about 200 feet square on a low ridge, on the north side of a canyon. The tactite consists of garnet, quartz, epidote, calcite and presumably, some scheelite, though none was found in samples taken.

Development: The tactite body was explored by an adit of undetermined but probably short length, driven eastward into the side of the ridge. The portal is badly caved. In addition, several shallow pits and trenches indent the crest and sides of the ridge.

Production: Undetermined. Idle.

References: None.

R.B.S. 7/21/58.

987

Pawnee (Carr, Oak Grove) Mine

The following information is taken in part from a report by F. H. Weber, Jr., done in the course of his work in San Diego County.

Location: NE¼ sec. 6, T. 9 S., R. 3 E., (San Diego County), and sec. 31, T. 8 S., R 3 E., (Riverside County), S.B.M., Warner Springs quadrangle, 1939; about 6 miles northeast of Oak Grove, along the boundary between San Diego and Riverside Counties.

Ownership: Verdi Development Company, 2623 Hyperion Ave., Los Angeles 23, holds 5 unpatented claims (1957).

History: The tungsten-bearing deposits on the lower southeast slopes of Beauty Mountain were first prospected in 1917 by Bert Simmons and John Wentworth of Aguanga who located 18 claims in the area, and perhaps produced a small quantity of tungsten-bearing concentrates. The deposits were then idle until the Pawnee deposit was developed and worked on a small scale in the late 1930's by Frank Carr of Aguanga. In the 1940's, it was worked by E. L. and William Carr. The Pawnee Mine Incorporated, of Beverly Hills acquired the Pawnee property in 1951 and sold it to the Verdi Development Company in late 1955 or early 1956. It has been idle since 1956.

Geology: The tungsten-bearing deposits in the Beauty Mountain area consist of bodies of tactite enclosed concordantly in metamorphic rocks composed chiefly of schist and gneiss. Small irregular intrusive bodies of granitic rocks cut the metamorphic rocks. Of chief interest on the Pawnee property are two bodies of tactite about 1500 feet apart, on a narrow north-trending interfluve that abutts Chihuahua Creek on the south. The more productive of the two lies in San Diego County, about 400 feet north of Chihuahua Creek and 150 feet north of the mill. (see figure 11) This body strikes N. 20°-25° E. and dips about 85° southeast. It ranges in length from 55 to 70 feet, and in width averages about 8 feet. The body has been worked vertically to a depth of about 140 feet. It is composed of a medium- to coarse-grained aggregate of quartz, brown garnet, epidote, calcite, diopside (?), and scheelite. The ore probably averaged about one percent tungsten trioxide.

The second body of tactite lies about 1,500 feet to the north of the more productive body, on the west side of the ridge, and in Riverside County. It has yielded only a small amount of tungsten ore. The body strikes north-northwestward and dips steeply southeast. Its dimensions were estimated by L. C. Penhoel (unpublished consulting report, 1953) as follows: length, 75 feet or more; width, 45 to 55 feet. It probably averages about ½ percent tungsten trioxide.

Development: The more productive body is developed by a 180-foot shaft from which drifts trend north-northeastward and south-southwestward on the 90- and 140-foot levels, respectively. The two drifts range in length from 70 to 90 feet and lead to stopes. From a point 50 feet south of, and 35 feet lower than the collar of the shaft, a drift adit trends N. 10° E. From this drift, the orebody was stoped to the surface, to leave a trench-like glory hole which ranges in depth from 10 to 40 feet, and in width from 10 to 15 feet.

Production: Total production from the deposits in the area is probably slightly more than 3,000 units of tungsten trioxide (WO_3).

Ore was milled on the property. The mill was still mainly intact in 1958, and contained a jaw-crusher, rolls, ball mill, and 2 concentrating tables. It had a capacity of about 1 to 2 tons per hour.

990

References: Hess and Larsen, 1921, p. 260-261; Tucker, 1925, p. 353; Tucker and Sampson, 1940, p. 48; 1941 p. 583-584; 1945, p. 156; Partridge, 1941, p. 318; Jenkins, 1942, p. 344, 353; Kerr, 1946, p. 161; Eng. and Min. Jour., Mar. 1956, p. 132.

F.H.W. 6/58.

Tubbs Claims

Location: Sec. 5 (prol.), T. 7 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers, Chuckwalla Mountains quadrangle, 15', 1945; on the southwest side of a northwest-trending canyon 9 miles by dirt road southeast from U. S. Highways 60 and 70, and 8 miles south-southwest of Desert Center. These claims are just southwest of the Red Cloud Group (fig. 39).

Ownership: Elmer E. Tubbs, 516 Eye Street, Bakersfield, holds five unpatented claims.

History: This ground once was worked for gold in the late 1800's and may be the site of the long abandoned Keystone, Blackbird, and Monarch Mines (Orcutt, 1890, p. 901), and of the Liberty group (Tucker and Sampson, 1929, p. 453).

Geology: This deposit lies in the plane of a fault which strikes N. 10° W. and has a vertical- to steeply-northeasterly dip. The fault zone is as much as 20 feet wide and well exposed for several thousand feet. The deposit comprises a quartz vein containing pyrite and secondary oxides of iron, a basic dike, and a silicified zone ranging from 7 to 10 feet wide. The tungsten-bearing quartz appears to have filled and altered fractured portions of the basic dike. The resulting silicified material contains minor proportions of iron oxides, lavender fluorite, and scheelite. According to the owner, a significant proportion of the tungsten-bearing quartz contains about 1 percent scheelite.

992

Development: Although no systematic mining has been done for scheelite the deposit has been well prospected by means of a 50-foot shaft, a 50-foot adit, two 30-foot adits, and numerous open cuts and trenches some of which probably represent the search for gold by previous owners.

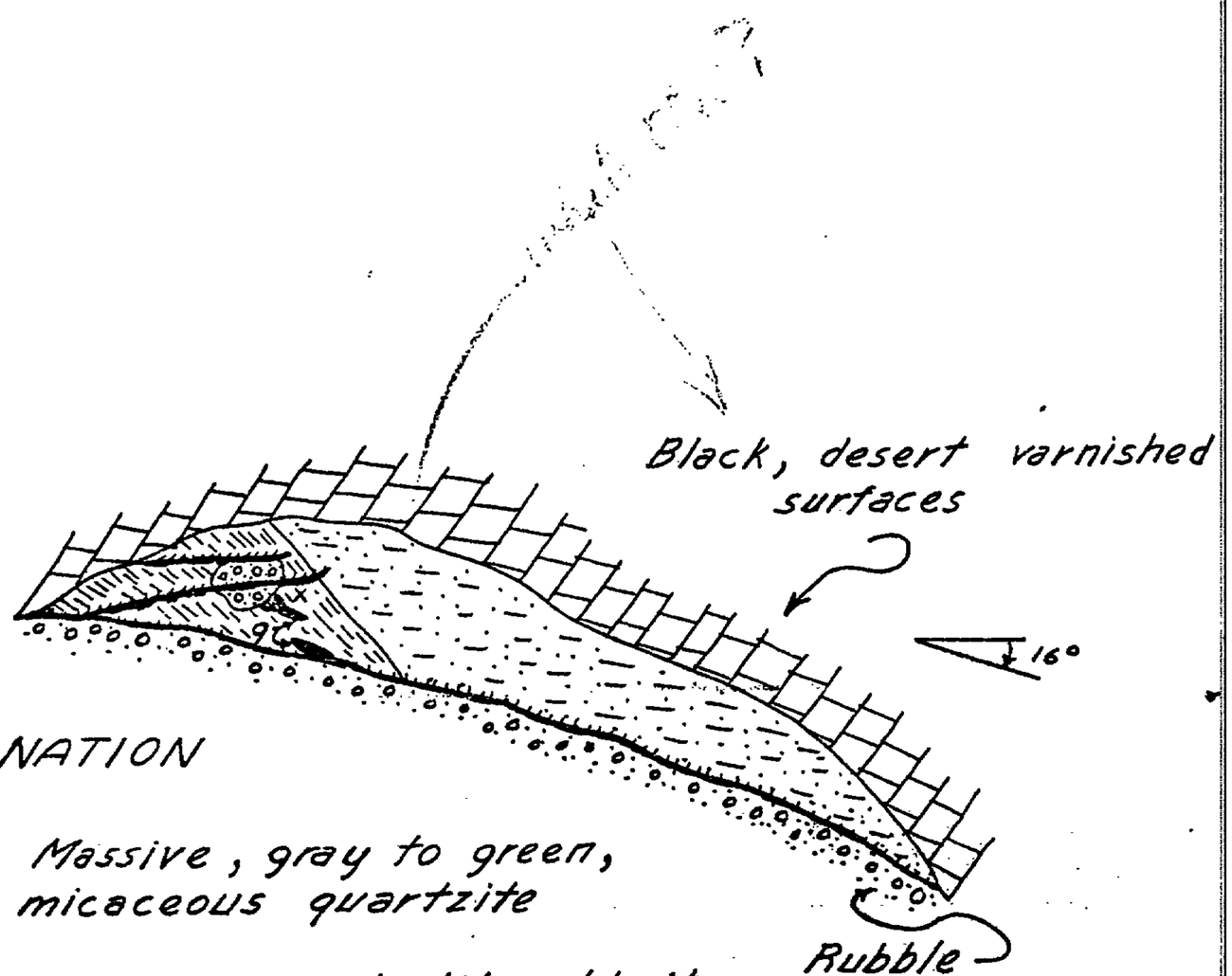
Production: Undetermined. ~~Idle.~~

References: ~~None.~~ Oneal, 1890, p. 901; Tucker and Sampson, 1929, p. 483.
R.B.S. 1/21/60.

57

Figure 2. Looking southeast into the face of an open cut above adit 1 and below and to the right of a larger open cut (figs. 1 and 3).

Figure 54.



EXPLANATION

- Massive, gray to green, micaceous quartzite
- Platy, green, biotite, chlorite schist
- Veins of milky quartz
- Floor of open cut
- x Sample locality (uranophane-bearing rock)

Scale

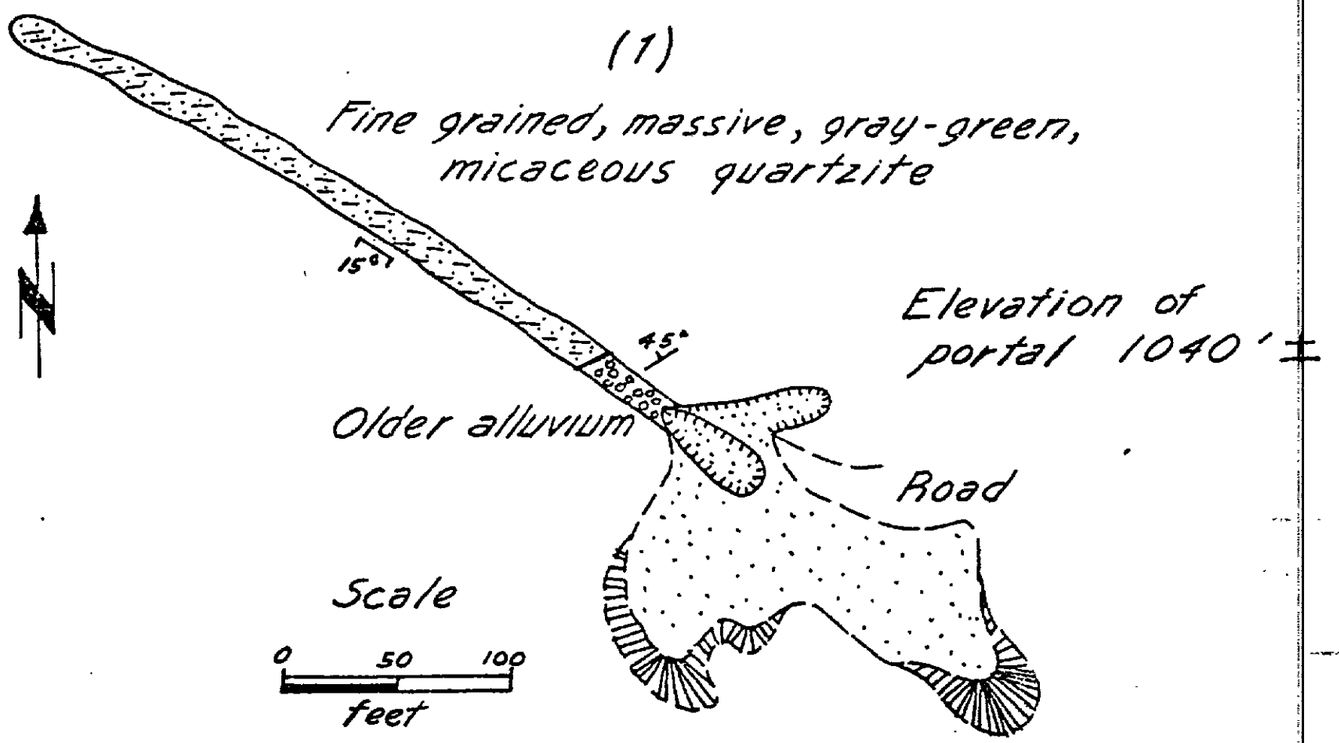
0 12.5 25

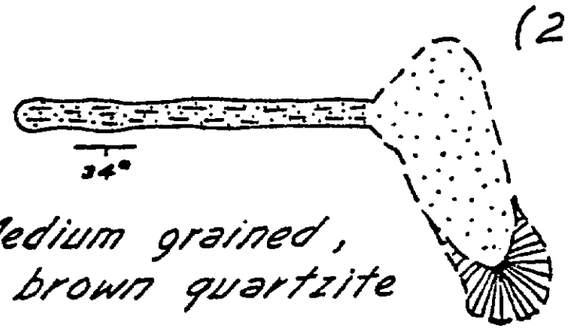
feet

By James R. Evans
November 1958

Uranium

figure 57.





Narrow gauge rails extend from the working face to the crest of each tailings pile

Elevation of portal 960'±

By James R. Evans
November 1958

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Figure (1) Sketch map of adits in the northwest (1) and northeast (2) part of section 23, Caproni-Woock uranium groups.

Production: N. A. Caproni reports that between early 1956 and mid-1958, 44 tons of ore, containing between 0.27 and 0.67 percent U_3O_8 was shipped to the A.E.C., in Denver, Colorado.

References: Miller, 1944, p. 32.

J.R.E. 11/18/58.

997

Geology: Exploratory work is in fractured and jointed, west-trending metamorphic rocks which form the southern part of the McCoy Mountains. The metamorphic rocks, referred to by Miller (1944, p. 32) as the McCoy formation, are composed largely of gray to greenish-brown metaconglomerate, quartzite, schist and slate with some gray to white quartzite. They have been warped into a broad arch that plunges east. A thin veneer of black desert varnish coats the metaconglomerate and quartzite surfaces. Veins of milky quartz, ranging in thickness from 0 to 15 feet, crop out locally. Thin patches of drusy uranophane and autunite occur as coatings on some of the rock exposed by surface excavations, and at the face of a 238-foot adit.

Development: Numerous open cuts and shallow prospect pits dot the south slope of McCoy Peak. An adit 238 feet long and 2 large open cuts are in the northwest part of section 23, midway up the south slope of a west-trending ridge (figs. 2, 3, and 4). Another adit, 155 feet long, is in the northeast part of section 23 on the east slope of a south-trending ridge, about half a mile east of the previously mentioned adit (fig. 1). The areas of exploration are accessible by fair and good dirt roads which join U. S. Highways 70 and 66 about 16 miles west of Blythe. The claims were not being worked in November 1958.

Ironwood #1 Prospect

Location: NW 1/4 sec. 20, T. 3 S., R. 23 E., S.B.M. (proj.), Big Maria Mountains NE. quadrangle, 7 1/2', 1954; Big Maria Mountains, about 20 miles north of Blythe and 3 miles west of Quien Sabe Point.

Ownership: Undetermined.

History: Guy Waite and Cyrus H. Ferguson, Box 29, Parker Star Route, Blythe, located the Ironwood #1 claim in March 1956.

Geology: The prospect is in fine to medium-grained, Precambrian hornblende granite. Thin pegmatite dikes occur locally and may contain radioactive minerals. No mineralization was observed and no radioactive anomaly was recorded.

Development: A 9-foot burrow has been dug into the east side of a stream bank at about a 1,000 foot elevation.

Production: Undetermined.

References: None

J.R.E. 12/16/58

998

Northeast No. 1 Claim

Location: E½ W½ sec. 19, T. 6 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 15' 1952; about 2 miles north of U. S. 60-70 and 12 miles west of Blythe on the south margin of the McCoy Mountains.

Ownership: Joseph and Charles Safranek, 4219 Lennox Blvd., Lennox.

History: Undetermined.

Geology: This property lies along the east face of a narrow, north-northwest-trending ridge of sheared, metasedimentary rocks. A secondary, yellow radioactive mineral resembling carnotite is unevenly distributed along shear zones in which it has impregnated porous material and formed thin crusts and fissure fillings. The deposit is exposed in an area several hundred feet long and about 100 feet wide. Its full extent and average grade was not determined when visited in October of 1960.

Development: The radioactive area has been opened by several bulldozer cuts but no systematic exploration appears to have been done.

Production: Undetermined.

References: Butler, Finch, and Twenhofel, 1962.

R.B.S. 10/17/60

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Uranium

The uranium boom of the late 1940's and early 1950's encouraged many people to stake claims in Riverside County but none of these holdings had yielded saleable ore in profitable quantites (through 1962).

Secondary uranium minerals are present as thin fissure fillings and crusts in fractured metamorphic rocks in scattered localities and several gold mines and prospects have been found to contain mildly radioactive, unidentified material (see also tabulated list under Radioactive Deposits).

Caproni-Woock Groups

Location: SE¼ sec. 13, SW¼ sec. 14, (proj.), and N½ sec. 23, N½ sec. 24, T. 6 S., R. 20 E., S.B.M., McCoy Spring quadrangle, 15' 1952; McCoy Mountains, about 17 miles west of Blythe on the south slope of McCoy Peak.

Ownership: N. A. Caproni, 510 N. 4th St., Blythe, owns the Real McCoy group of 29 unpatented claims, the Melody group of 15 unpatented claims, and the Kings Ransom group of 7 unpatented claims. N. A. Caproni and W. R. Woock, 339 E. Lockport St., Lodi, own the Royal Flush group of 155 unpatented claims (N. A. Caproni, oral communication, November 1958).

History: Undetermined.

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Ram Deposit

Location: SE 1/4 sec. 4, T. 2 S., R. 11 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, 7.2 miles S. 16° W. of Old Dale (junction of the Twentynine Palms Highway and the Gold Crown Road).

Ownership: R. H. Morath, E. Adamson, and B. Raush, 11060 Brink, Norwalk, own at least 13 unpatented claims (October 1959).

History: Undetermined.

Geology: The Ram deposit is in an area underlain by blue-gray and buff quartzite and coarse-grained tan to white limestone beds of Paleozoic (?) age (fig. 58). Lenses of uraninite (UO_2) no more than 1 inch thick are almost entirely altered to the secondary uranium minerals carnotite-$K_2 (UO_2) (VO_4)_2 \cdot nH_2O$, uranophane - $Ca (UO_2)_2 (SiO_3)_2 (OH)_2 \cdot 5H_2O$, and cuprosklowskite - $Cu(UO_2)_2 (SiO_3)_2 \cdot 6H_2O$. The lenses occur in some of the numerous fractures, joint planes, and minor faults in blue-gray quartzite. Locally surfaces of the quartzite are coated with yellow and yellow-green secondary uranium minerals.

Figure 59

1000

Development: Three prospect pits, a 15-foot rectangular open cut, and a 30-foot adit are cut in the west slope of a north-trending ridge (fig. 58/). Several other prospect pits are across the canyon to the west, and also adjacent to the road leading north toward the Groover mine.

Production: Undetermined.

References: None.

J.R.E. 10/12/59.

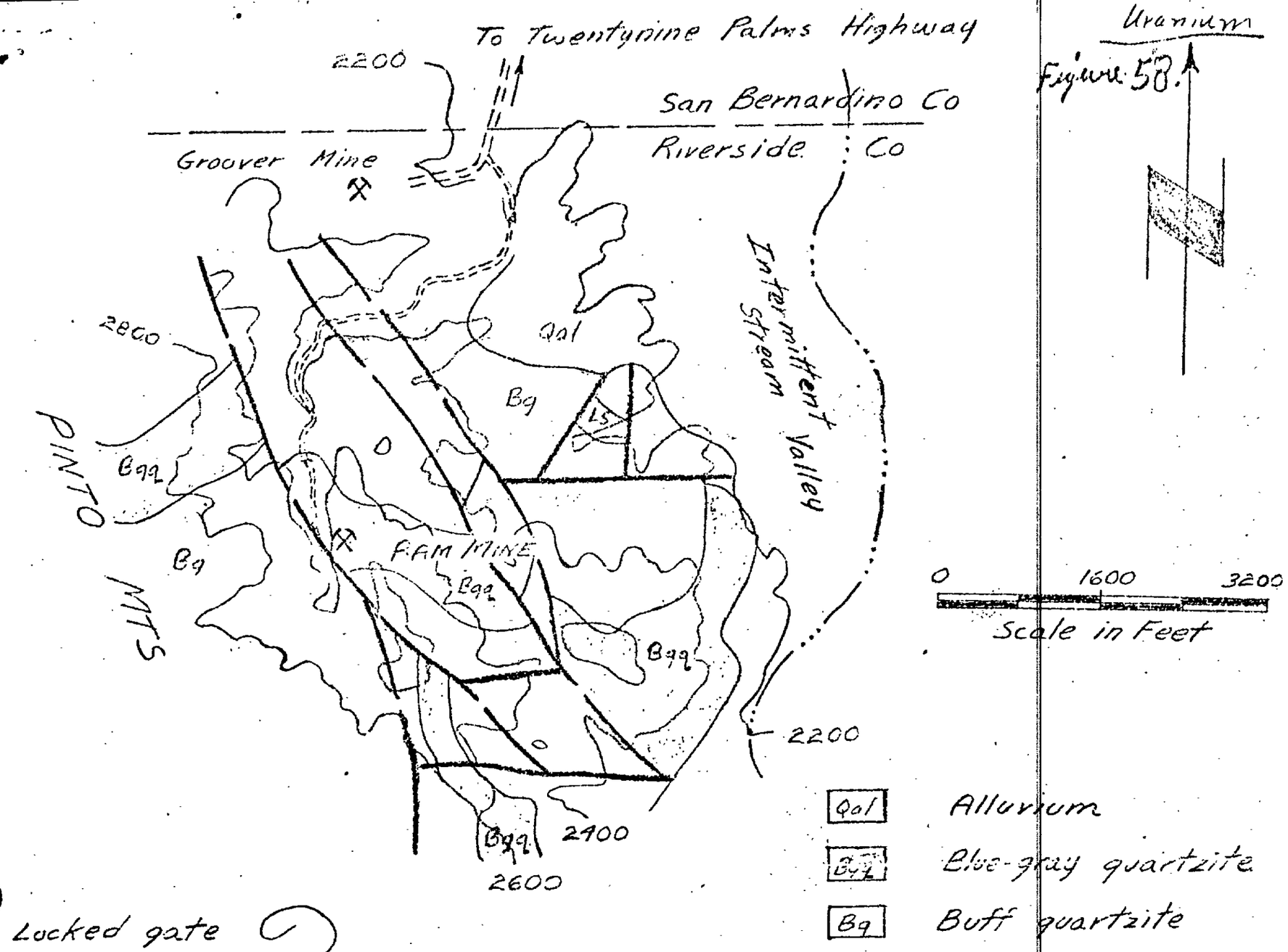
1001

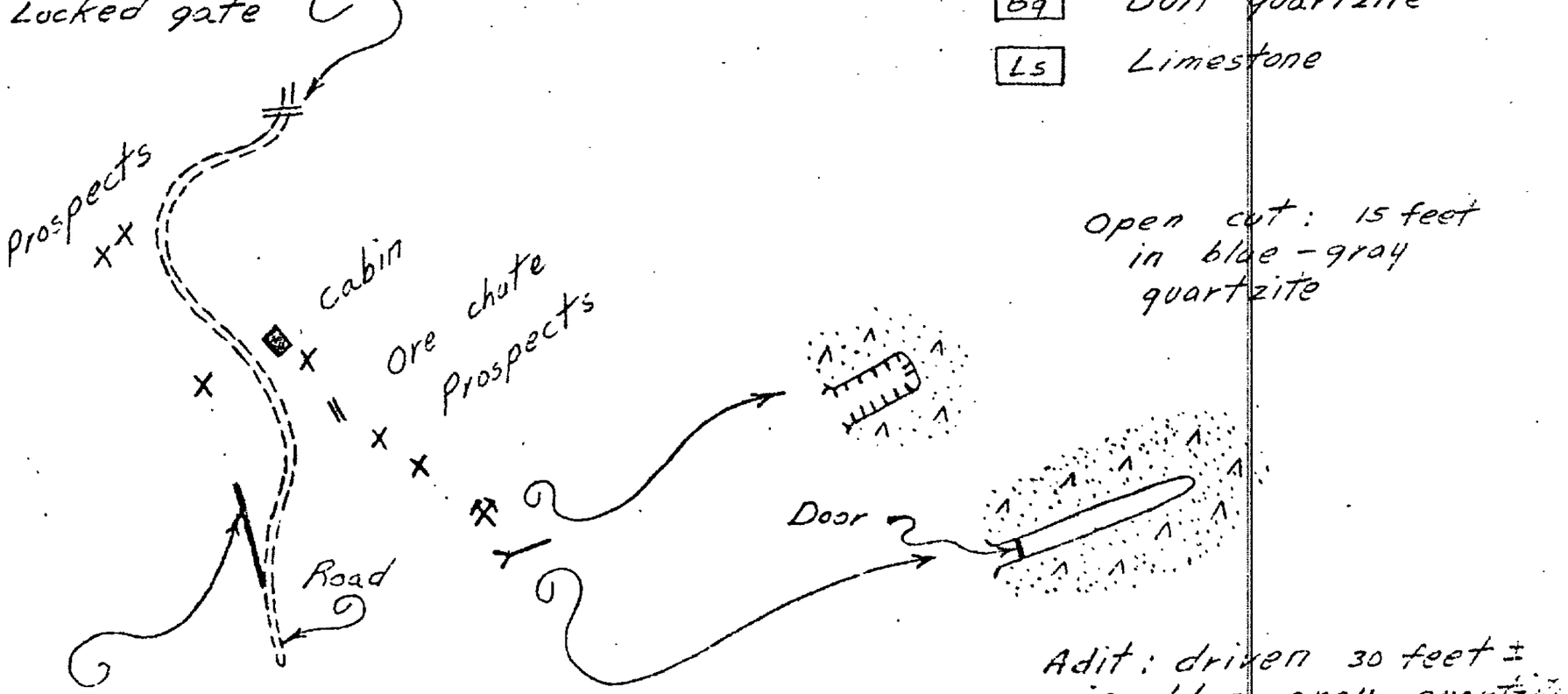
Figure 58 (1) Geologic sketch maps (A and B), showing the location, geology (A), and principal workings (B) of the Ram deposit (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Uranium

Figure 58.

A





B

By James R. Evans
October 1959

(Geology modified from an anonymous source)

Water Resources

Riverside County water resources have been studied in a series of separate investigations each of which has been confined to a specific basin or desert region. Much of the material in this section is based upon reports (listed in the bibliography) by the following authors:

Walter C. Mendenhall, 1909, Coachella Valley)

Gerald A. Waring, 1919, (San Jacinto and Temecula basins)

McHis, Hollin F., 1934, (Riverside, Arlington and Temescal basins)

Wayne MacHostie, 1955, (Elsinore Basin)

David B. Willets and others, 1954, (Colorado River Basin)

Robert M. Dean, 1955, (San Jacinto and Elsinore Basins)

L. R. Illingworth, 1955 (Santa Margarita River Investigation)

Wayne MacHostie and A. J. Doleini, 1959 (Santa Ana River investigation)

Fred Kunkel, 1963, (Pinto Basin)

Surface water

Figure 59

(~~The accompanying map~~) shows the principal watersheds, basins, water bodies and aqueducts in Riverside County.

Figure 59

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The principal sources of surface water in the western half of the county are the San Bernardino and San Jacinto mountain ranges, and Agua Tibia and Palomar mountains. Except for the San Jacinto Mountains, these catchment areas lie outside the county boundaries. The sparse ~~(surface flow)~~ runoff in the desert east of the Coachella Valley ~~(in the day)~~ enters washes in which water flows only during storms or unusually wet seasons. The Colorado River adjoins the eastern edge of the County.

The Santa Ana River gains a fairly sustained flow of good water from the San Bernardino Mountains, although the surface flow is only intermittent. The high quality of this water is attributed to storage of rain and melted snow in granitic and metamorphic rocks from which a minimum of dissolved matter is derived. Downstream tributaries drain areas underlain in part by sedimentary rocks containing more readily soluble minerals and connate brines.

The Whitewater River extends from headwaters on the southeast slope of the San Bernardino Mountains to the Salton Sea. It flows through its entire length only under flood conditions. In its headwater region the Whitewater River has a sustained flow of good water but this seldom extends beyond the canyon mouth at Whitewater, at or near which point it percolates into the alluvium and into the groundwater basin of Coachella Valley. In its lower reaches the channel of the Whitewater River has been deepened to

afford drainage for irrigated lands. Here water entering the Salton Sea contains nearly 5,000 parts per million total dissolved solids.

The San Jacinto River flows from headwaters on the southwest slope of the San Jacinto Mountains to a terminus in the Elsinore Basin. ~~Storage and diversion have dried most of the stream bed during much of the year.~~ Little surface flow reaches the Elsinore Basin except in times of flood because of Railroad Canyon Dam. The San Jacinto River is one of the important sources of groundwater recharge in the San Jacinto and Perris valleys. Water discharged from the Railroad Canyon Reservoir recharges the groundwater supply in the Sedco area southeast of Elsinore.

The upper 5 miles of the Santa Margarita River and most of its headwater tributaries lie within Riverside County. This river flows southwest from Temecula to the Pacific Ocean. The headwater area includes the watershed of Murrieta Creek and most of the watershed of Temecula Creek. Murrieta Creek drains the Elsinore ~~Trough~~ basin as far northwest as Wildomar and is joined by smaller creeks which drain areas as far northeast as Domenigoni, Diamond, and Weber valleys. Temecula Creek and its tributaries drain the north slopes of Agua Tibia and Palomar mountains and Oakgrove Valley to the southeast in adjoining parts of San Diego County; areas as far east as Coahuila and Burnt Valleys and northeast as far as Reed Valley below the southwest slopes of Red and Little Coahuila mountains.

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Most of the stream beds in the Santa Margarita River watershed are dry during much of the year. Surface water quality varies both areally and with rate of flow but in general it is suitable for irrigation and domestic use.

Ground water

Ground water is that water in the zone of saturation lying below the water table. The quality, quantity, and distribution of ground water is governed by geologic and climatic history and the modifications of human use and development.

Riverside County comprises a part of the earth's crust which is cut by at least two major fault systems and many local fault and fracture systems. Groundwater storage tends to be compartmented in discreet basins, especially in the fault-bounded valleys of the eastern desert area. Annual recharge from rainfall is small and in most basins water encountered in wells represents accumulated storage. Water quality generally is better in basins from which there is a regular subsurface discharge. In the western half of the county water commonly is sought in buried stream courses. One such source is a north-trending, bedrock canyon underlying the alluvium in the Arlington and Riverside areas. Another canyon, cut in bed rock, appears to control subsurface drainage in the Moreno, Perris, San Jacinto and Nuniee valleys. Some wells in the Nuniee Valley have yielded over 1,000 gallons per minute when pumped, but

some trouble has been encountered with water mineralized by buried organic materials. In parts of the above named valleys both pumping and recharge are hindered by the low permeability of the sediments. As the basins filled the gradients of the influent streams decreased and the basin fill was capped mainly by fine deeply weathered material. Rain water commonly ponds and evaporates without penetrating the valley floor. Some permeable beds comprise narrow, irregular channel filling which wells encounter only by luck. Some wells must penetrate numerous permeable sand layers to support pumping. As a general rule sediments become more coarse and permeable with depth but in many wells near basins margins bed rock is reached before adequate yield is assured.

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The area surrounding Corona is called the Temescal Basin. This basin occupies the Elsinore Fault Zone from Elsinore northwest to the Santa Ana River. It is drained through Temescal Wash. Groundwater in Temescal Basin is derived mainly through percolation from Temescal Wash and numerous small water courses draining the northeast slope of the Santa Ana Mountains. Some additional water is gained from irrigation return and possibly from underflow from Arlington basin, to the northeast, through Arlington Gap. On rare occasions Temescal Wash receives overflow from Lake Elsinore, the last outflow having occurred in 1917. As a result the water of Lake Elsinore usually contains substantial concentrations of salt.

Because of poorer lower tributary water and effluent seepage from ground water or sewage, the quality of water in subsurface flow tends to be markedly poorer in the Santa Ana River during the summer months, especially below Prado Dam at the western tip of the county.

1007

The northwest end of the Coachella Valley is the only desert area which receives runoff from timbered highlands in or adjacent to the county. In the Whitewater area the well depths are about 500 feet. At Palm Springs wells range from 100 to 200 feet in depth. Southeast of Indio ground water is encountered within 50 feet of the surface. Early wells in the Coachella area yielded surface artesian flow from ground water confined beneath impermeable surface material. Artesian effects still exist in wells of that area but do not reach the surface. Ground water quality shows an irregular, progressive decrease from Whitewater to the Salton Sea. One change is a decrease in calcium ions and an increase in sodium ions. The total amounts of dissolved mineral matter are small, however, and in the irrigated areas of the southeast end of the Coachella Valley many farmers use well water to supplement imported Colorado River water and a few prefer its exclusive use. Natural mixing of imported water with ground water is inhibited by fine-grained sediments which underlie most of the irrigated areas.

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In the desert area lying between Indio and Blythe the principal proven groundwater storage areas are Pinto Basin and the basin underlying Chuckwalla Valley.

In Pinto Basin, ground water is deeper than 95 feet below the surface. In 1953, Kunkel estimated the storage capacity of the upper 100 feet of saturated alluvium in the central part of the basin to be about 250,000 acre-feet. The water in Pinto Basin is the sodium sulfate type containing less than 1,000 ppm (parts per million) dissolved solids. It would be considered of good general quality save for a fluoride content from 2.0 ppm to as high as 2.7 ppm. The U.S. Public Health Service (1946) set a mandatory upper limit of 1.5 ppm of fluoride for drinking and culinary water supplied by interstate carriers and others subject to federal quarantine regulations. Sodium ion concentrations in water from several wells in the basin are between 200 and 300 ppm which is high enough to make the water of doubtful quality for irrigation.

The water in Pinto Basin is the result of long accumulation. Subsurface flow is eastward toward a narrow channel between the east end of the Eagle Mountains and the Corcomb Mountains. Here, groundwater is reported to discharge across a subsurface barrier into the lower, adjacent basin underlying the Chuckwalla Valley.

Until recent years, wells in the Chuckwalla Valley have yielded water of poor quality. Total dissolved solids are reported to range from 420 ppm to as high as 4,372 ppm with fluoride concentrations that range from 1.7 ppm to 35.0 ppm. This water is from wells ranging in depth from 15 feet to 400 feet. Depth to water is reported to range from 11 feet to 70 feet. In the early 1960's several wells were drilled to depths ranging from 700 feet to 900 feet. Water of improved quality is reported from these deep wells but no chemical data were obtained. No data on reserves or groundwater movement were obtained for the Chuckwalla Valley. Palen and Ford dry lakes are base levels for surface drainage.. Judging from surface drainage the Wiley Well area, east of the Little Chuckwalla Mountains, appears to be the most likely site for subsurface discharge from the Chuckwalla Valley if such drainage exists.

Groundwater recharge in the Palo Verde Valley is by percolation from the Colorado River and sporadic discharge from desert washes, primarily McCoy Wash. The City of Blythe draws water from wells for domestic use. The well water has a higher total-dissolved-solids analysis than the river water. Like the river water, available analyses show no fluoride.

Early efforts to develop water supplies in Riverside county consisted mainly in the use of natural springs, streams, and sinking shallow wells. In the desert, miners usually had to transport water. Six wells were dug in Pinto Basin during the various periods of mining activity. By the later 1950's two of these had been destroyed and two had fallen into disuse. In the early 30's the Metropolitan Water District dug Pinto Well at the outlet of Pinto Basin. Kaiser Steel Corporation has used Pinto well since 1949, and in 1957 completed a nearby well. The water from these wells is used at the Eagle Mountain mine and beneficiation plant. By 1959 Kaiser's annual consumption from the wells was 1,700 acre feet. From 1953 through February 1956 the water level in Pinto Well had lowered about 2.5 feet. From February 1955 through October 1960 water levels in both wells was down 14 feet. The old well and new well are 402 feet and 675 feet in depth respectively; in 1960 water levels were 102.62 feet and 114.22 feet below the surface.

Conservation and supplement

Using local sources of water as a basis of judgement, much of Riverside County is water deficient. The Palo Verde Valley, Pinto Basin (and possibly the Chuckwalla Valley), the southeast half of the Coachella Valley (southeast of Indio) and the watershed of the Santa Margarita River are areas in which natural reserves meet or exceed the demands of development.

Various systems of water conservation, flood control and importation are in use to supply the demands of the populous western half of the county. The south fork of the San Jacinto Rivers was dammed in 1895 by the Lake Hemet Water Company. The reservoir (Lake Hemet) has a capacity of 14,000 acre-feet. In 1923 the Temescal Water Company dammed the main channel of the San Jacinto River to form Railroad Canyon Reservoir with a capacity of 12,000 acre-feet. The Gage Canal Company constructed the 1,000 acre-foot Mockingbird Canyon Reservoir in 1914. In 1949 the Vail Company completed Vail Dam and reservoir on Temecula Creek the maximum reservoir capacity of which is about 49,500 acre-feet.

The U. S. Army Corps of Engineers has engaged in flood-control work; Prado Dam is the most extensive of their projects in Riverside Co. This earth-fill dam blocks the head of Santa Ana Canyon at the east end of Chino Hills. It is 2,280 feet long and 106 feet high. The project was started in 1938 and completed in 1941. Flood waters are controlled by other smaller structures such as the Bautista Creek Debris Basin near Hemet, completed in 1961.

In some areas in and adjacent to Riverside County special spreading and percolation basins are used to facilitate recharge of groundwater basins with water which might otherwise be lost to the sea.

1012

To supplement the general deficient [1] supply water supplies of the coastal basins of southern California two Colorado River aqueduct systems have been constructed and in 1963, county officials hope that an additional supply will be available some time in the 1970's from the distribution system of the ~~(Feather River Project)~~ California Aqueduct [1].

The Colorado River Aqueduct was started in December, 1932 and completed in June, 1941. From the intake at Parker Reservoir to the terminal storage and water conservation basin of Lake Mathews in western Riverside County, the aqueduct comprises 92 miles of tunnels 13 feet in diameter, 63 miles of concrete-lined canal, 55 miles of concrete lined conduits, 29 miles of inverted siphons totaling 144 in number, and 321 miles of power lines from Hoover Dam to power 5 pumping plants of 9 pumps each. The Colorado River Aqueduct serves portions of six counties including Riverside County. In Riverside County the area served is included in two water districts known as the Western Municipal Water District and the Eastern Municipal Water District. The Western Municipal Water District comprises Riverside, Elsinore, Corona, and some unincorporated areas. The Eastern Municipal Water District includes Hemet, Perris, San Jacinto and surrounding unincorporated areas.

Irrigation water is imported to the Coachella Valley through the Coachella Canal. This canal was built during the late 30's and early 40's. It draws water from the All American Canal which heads at Imperial Dam at the southeastern edge of Imperial County. The Coachella Canal extends from the southeast corner of Imperial Valley northwest along the northeast side of the Imperial and Coachella valleys to the northwest edge of Indio. From Indio the canal water is delivered as far southwest as the Oasis area through the Oasis Lateral.

The Palo Verde Valley is served by the Palo Verde Irrigation District. This district's water is drawn from the Colorado River at Palo Verde Dam about 10 miles north of Blythe. The Palo Verde Irrigation District has established water rights dating back to 1877. Between 1908 and 1955 the District irrigated all cultivated land within 90% of its gross valley area by gravity from the river. Following the construction, in 1942, of Headgate Rock Dam, below Parker Dam, the desilted water of the Colorado River began to degrade the river bed. The water level dropped and the District had to install pumps. The U.S. Government constructed a temporary rock weir in 1945 to maintain the water level at the canal intake. By 1958 a permanent dam (Palo Verde Dam) was built about 1,000 feet downstream from the loose rock weir. A stable head is now maintained for the district's irrigation system.

R.B.S.

1014

Wollastonite

Deposits of wollastonite of varying purity are exposed in extensive areas in the Big Maria, ~~and~~ Little Maria (~~Mountains~~) and the Riceo mountains, 16 to 20 miles northwest of Blythe (fig.). Wollastonite of high purity forms pods which range from a few inches to as much as 1,800 feet in maximum length. The most extensive wollastonite body appears to form the core of a shallow anticline plunging west-northwest on the west side of the Big Maria Mountains (Troxel, 1957, p. 693, 694). The mineralization is probably a result of dynamo-thermal metamorphism.

Most of the area underlain by wollastonite-bearing rocks is covered by placer claims of U. S. Gypsum Co., Midland, and California Limestone Products, Blythe. The latter firm has tentatively explored a deposit in the Little Maria Mountains with plans for its ultimate use as a raw material at their rockwool plant of Woolstone Inc., north of Blythe. The deposits in the Little Maria Mountains were acquired in 1965 by Chas. Pfizer & Co., Inc who continued exploration work.

7015

The principal use, to date (1961), of wollastonite from the Maria Mountains is for decorative rock. Because float fragments of the material weather with a directional grain, in shades of gray and brown, the material has been marketed under the trade name of "Driftwood Stone". Jontz Stone Co., 185648 E. Highway 60-70, Blythe and Lawrence Johnson, Mineral Exploit Co., P.O. Box 821, Blythe, were marketing this rock in 1961.

The float fragments of weathered wollastonite are gathered from hillsides and alluvial surfaces, trucked to Blythe and sold to dealers.

Although production figures were not obtained the popularity of the rock suggests that a large tonnage has been marketed, mostly in the Los Angeles area and possibly east to the Phoenix area.

Limited amounts of wollastonite have been used as a ceramic raw material in California but industry demands have thus far been met by wollastonite from a deposit in New York State (Troxel, 1957, p. 697). Consistency of grade and milling characteristics have yet to be established for the Riverside County material described above.

Photo 43

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Tabulated List of Mines and Mineral Deposits

Riverside County, California*

Asbestos

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Dunn Asbestos deposit	Secs. 32 and 35, T6S, R5E, SBM, 4 mi. northwest of Nightingale Camp.	Elmer E. Dunn, Pinyon Flat (1945)	Amphibole asbestos in belt of serpentinized rocks. Asbestos in narrow fractures and shears.	Worked through open cuts (Tucker 1945, p. 158, pl. 35).

*This tabulation contains data primarily on deposits not described in the text. Alternate or discarded names of described deposits are in this list. It is not a complete index of deposits. The symbol (t) means, see text for description.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Perris Asbestos deposit	Sec. 2, T5S, R4W, SBM, 2 mi. southwest of Perris.	I. O. Walser, Los Angeles (1945).	Amphibole asbestos in veins 6 in. to 2 ft. wide in sheared granitic rock.	100 tons reported shipped to Soto Battery Box Manufacturing Co. in 1930. Worked through open cuts. Reported worked out in 1945 (Tucker 1945, p. 159, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Serpentine Hill claims	Sec. 35, T6S, R5E, SBM, just east of Pinyon Flat.	Undetermined (1961)		(Tucker 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
5	Atlas Pit	S½S½NE¼SW¼ sec. 26, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash, at the western margin of the Gavilan Hills ½ mile north of Arcilla Siding.	International Pipe and Ceramics Corporation, 2901 Los Feliz Blvd, Los Angeles 39	Much of the property is underlain by Triassic(?) Bedford Canyon Formation, but across the northern part is a band of residual claystone derived by weathering of Bedford Canyon Formation. In 1963 clays exposed in the pit included gray plastic, brown plastic, red mottled, and "bone" clays. Clay beds strike nearly east-west and dip 15° to 30° northerly.	15 acres. Apparently mined by the Atlas Fire Brick Company in the 1920's for use at their Los Angeles Plant. Later acquired by Gladding, McBean and Co. Inactive for many years since the 1920's but reactivated in 1960 and mined as part of the adjoining Corona Clay Pit of Riverside Cement Co. In 1963 the Atlas pit was about 150 feet long on several irregular bench levels with maximum face about 50 feet high. Part of the red mottled clay and all of the gray plastic clay goes to the Corona plant of International Pipe and Ceramics Corp. The remainder of the red mottled clay goes to the Crestmore plant of Riverside Cement Co., and the "bone" clay goes to their Oro Grande plant. After stripping mining is by Caterpillar D-8 equipped with ripper and bulldozer. Front end Caterpillar loader loads clay directly into truck and trailer units for transport to the plants. (Dietrich, 1928, plate 10 facing p. 162).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
7	Brown (J. W. Wilson)	N½ sec. 23 and 24, T1S, R23E, SBM, 3 miles south-southwest of Vidal along the Riverside-San Bernardino County line.	This is near or part of claim held by Mr. Brown, Vidal	The area is a badlands cut in late Tertiary and/or Quaternary strata deposited in a lake, estuary or bay. At least one bed contains pelycepod remains of undetermined systematic and ecologic affinities. Shark teeth have been reported from this locality. Impure, ~~bentonitic~~ clay forms a unit as much as 20 feet thick.	The principal exposures lie in San Bernardino County where clay beds have been mined on a small scale. The material is ground at a small plant at Vidal and sold for use in well drilling. Samples from this deposit were once tested and found unsuitable for ceramic use. (Dietrich, 1928, p. 181-182, 340; Tucker, 1929, p. 502).
	Brown Star claims				See Middleworth dep (t)
	Castillo deposit				See Castillo, under clay (t)
	Corona clay deposit				See Belford Canyon clay dep (t)
	Corona shale mine				See Clay Ranch clay dep and Waterflow shale dep (t)
	Dutch placer				See Kramer clay dep (t)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
16	Elsinore Joint Property	W½NE¼, SE¼NE¼ sec. 26, T5S, R5W, SBM. Low hills 2 miles southeast of Alberhill.	Pacific Clay Products, 1255 West Fourth Street, Los Angeles owns a half interest with International Pipe and Ceramics Corp., 2901 Los Feliz Blvd. Los Angeles 39.	Northern part of property covered by Quaternary terrace deposits. Southern part underlain by Paleocene Silverado Formation (upper part) green clay shale and micaceous arkose; beds strike northwest, dip 15°S.; southeastern part underlain by Silverado Formation (lower part) white, and red, white and buff mottled claystone, beds strike northwest, dip 6°S.	120 acres held in alternate 10 acre blocks by the two owners. Only the Hoist pit area (see herein in text), idle since 1912, has been mined. Both owners have done drilling and made bulldozer cuts on their respective parcels of land in recent years. In June 1963 the International Pipe and Ceramics Corp. drilled several tests holes in their area just south of the old Hoist pit. One drill hole was as follows: Buff sandy overburden, 25 feet; red clay, 45 feet; buff and gray clay, 20 feet. Holes were drilled to 90 feet and the two observed were still in clay at 90 feet. (Dietrich, 1928, p. 181, plate 10 facing p. 162).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
17	El Sobrante	NE¼ sec. 26, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash, at the western margin of the Gavilan Hills, ½ mile north of Arcilla Siding.	Pacific Clay Products, 1255 West Fourth St, Los Angeles	Central part of property underlain by Triassic(?) Bedford Canyon Formation slate, argillite, and quartzite which strikes northwest and dips about 40° northeast. Along the east side of the property the Bedford Canyon Formation is overlain by nearly flatlying green clay shale and micaceous arkose of the upper part of the Paleocene Silverado Formation. Along the west margin of the Bedford Canyon Formation is a narrow band of residual claystone derived by weathering of the Bedford Canyon Formation. This band of claystone trends northeast and ranges in width from a featheredge to about 200 feet. The west portion of the property is underlain by nearly flat lying green clay shale and micaceous arkose of the upper part of the Silverado Formation, which overlies the band of residual claystone.	Property consists of 160 acres. Held by Pacific Clay Products since before 1928. So far as known no development work has been done. (Dietrich, 1928, plate 10 facing p. 162, p. 181; Rogers, 1959, pl. 5).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Evans Shafts	NE¼ sec. 31, T5S, R4W, SBM, east side of State Highway 74, half a mile northeast of North Elsinore.	Undetermined	Surface covered by Quaternary alluvium. Clay not exposed.	Stauffer (1945, map Station 4) listed the area as ...."Evans shafts and incline to the fire clay." In 1963 only a small caved working was found in this location, but a shallow depression suggests the presence of caved underground workings. (Stauffer, 1946, map Sta. 4).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
22	Findley Prospect Findley clay deposit	SE¼NW¼ sec. 2, T5S, R6W, SBM. 9 miles southeast of Corona in low hills in Temescal Valley, 1 mile south of Arcilla Siding.	Undetermined	Area covered by Quaternary terrace deposits. Underlain by Triassic(?) Bedford Canyon Formation with upper surface weathered to form residual claystone. Thin (10 to 15 feet) discontinuous exposures of Paleocene Silverado Formation green clay shale and micaceous arkose. Small exposure of pink mottled clay.	Small prospect pit, date unknown. See Tyler Canyon clay deposit.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Freeman	Undetermined; probably various deposits between Main Street and Hagador Canyons about 3½ miles southwest of Corona	Undetermined	Clay-bearing Paleocene Silverado Formation sandstone and siltstone crop out in this area.	(Gray, 1961, p. 77-78, 111).

Clay

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
25	Harlow Pit	SW¼NW¼ sec. 15 (proj.), T4S, R6W, SBM. 5 miles southeast of Corona at the south side of lower Cajalco Canyon east of Temescal Wash.	Miss Lela May Harlow, Cajalco Road, Corona	Thin band of Paleocene Silverado Formation siltstone and clay shale strikes northwest and dips 45° NE. Silverado Formation crops out at base of a low hill and overlies residual claystone formed by weathering of Triassic(?) Bedford Canyon Formation. Hill is capped by Quaternary terrace deposits.	Pit opened by Liston Brick Company about 1954 as a source of material for their nearby brick plant. Both the Silverado Formation and residual claystone have been mined on a small scale up to the present (1963) as needed. Pit is a sloping side-hill cut about 150 feet long and 100 feet wide. Sequence exposed in main working in June 1963 was buff mottled claystone with red and gray pods, about 20 feet thick; overlain by red, sandy, clay soil about 5 feet thick.

Hoag Ranch clay pit

See Jones clay pit (7)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Hoff Ganister Fire Brick Company	Undetermined			By 1928 some prospecting had been done by core-drilling and test-pitting. In 1929 property was reported to be 100 acres in sec. 22, T.5 S., R. 5 W., S.B.M. Apparently this property is now part of the holdings of International Pipe and Ceramics Corporation (Sloan pit area), or possibly is within the Alberhill Mines of Pacific Clay Products. (Dietrich, 1928, p. 174; Tucker and Sampson, 1929, p. 500; Sampson, 1935, p. 519).
	Hoffman deposit Leo Lorenzo				See Jones clay deposit (t) See Kraenen clay deposit (t)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lord Deposit	Undetermined; may be same as Middlesworth clay or part of Corona placer described herein	Undetermined	Undetermined	George W. Lord, Corona reported light gray, fine-grained fire clay under development in 1905. (Aubury, 1906, p. 233; Gray, 1961, p. 71, 72, 78, 112).
	McVicar pit				See Susie plain (T)
	Morton deposit				See Elsinore Clay Co. (T)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
39	Murphy Pit	N½NW¼ sec. 35, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash, at the western margin of the Gavilan Hills, ¼ mile west of Arcilla Siding.	Pacific Clay Products, 1255 West Fourth St., Los Angeles	Residual mottled claystone derived by weathering of Triassic(?) Bedford Canyon Formation and Jurassic (?) quartz latite porphyry occur in the western part of the property. Claystone is overlain by terrace deposits. Eastern part of property is underlain by Bedford Canyon Formation and quartz latite porphyry. According to Tucker and Sampson (1945, p. 162) red and yellowish-brown clay about 30 feet thick was overlain by 20 feet of overburden. In 1963 only residual pink mottled clay was observed with a terrace deposit overburden of at least 10 feet.	50 acre tract. Pacific Clay Manufacturing Co. owned and operated a large pit here in 1904 and the pit was still active in 1920, operated by the Pacific Sewer Pipe Co. By 1945 the Murphy pit was a side hill cut with a face 200 feet long and 50 feet high, operated by Pacific Clay Products. By 1963 an area about 1,250 feet long and 500 feet wide contained several irregular pits, the largest about 500 feet long, 200 feet wide, and 50 feet deep. Property has been idle since 1959. (Aubury, 1906, p. 223-224; Merrill, 1917 [1919]; p. 569; Boalich and others, 1920, p. 89-90; Tucker and Sampson, 1945, p. 161-162; Stauffer, 1946, map Sta. 26).

Clay

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
45	Park	E½NW¼ sec. 26, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash at the western margin of the Gavilan Hills, ½ mile north of Arcilla Siding.	Liston Brick Co. Lionel P. Liston, P.O. Box 7, Corona	Northeastern part of the property is underlain by Triassic(?) Bedford Canyon Formation and Jurassic(?) quartz latite porphyry. Nearly flat lying green clay shale and micaceous arkose of the upper part of the Paleocene Silverado Formation crop out in the eastern and central part of the property. These sediments overlie residual claystone derived by weathering of Bedford Canyon Formation metamorphic rocks. The claystone crops out in the southwestern part of the property and ranges in width from 500 feet to 750 feet.	The Blue Face, Cross Cut, Grand View, and Oak Tree placer mining claims totaling 85.04 acres were patented to Thomas E. Parks and others in 1914. Acquired by Liston Brick Co. about 1950. Apparently the property has not been mined; but has been explored in recent years by drilling. (Aubury, 1906, p. 224; Dietrich, 1928, plate 10 facing p. 162, p. 180; Rogers, 1959, pl. 5).

Red Bull

See Middleworth dq. #1 (L)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
49	Quintet	W½NW¼ sec. 26, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash, at the western margin of the Gavilan Hills, ½ mile north of Arcilla Siding.	Pacific Clay Products, 1255 West Fourth St., Los Angeles	Much of the property is underlain by Jurassic(?) quartz latite porphyry, but the central and southeastern portions are underlain at different points by residual clay derived from weathering of quartz latite porphyry and Bedford Canyon Formation metamorphic rocks. Exposures of the clays range in width from 75 feet to 500 feet. The residual clays are overlain by nearly flat lying green clay shale and micaceous arkose of the upper part of the Paleocene Silverado Formation.	Quintet placer mining claim of 88.79 acres was patented to Pacific Clay Products in 1926. The property has not been mined but has been extensively explored in recent years by means of drilling. (Dietrich, 1928, plate 10 facing p. 162, p. 180; Rogers, 1959, plate 5).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
52	Silt deposit (name undetermined) Sky Ranch clay mine; west pit	E½ sec. 5, T5S, R3W, SBM. 1½ miles southeast of Perris along the San Jacinto River.	Undetermined	Quaternary river silt and silty clay.	Colton Cement Plant is reported to have used clay at some period, before 1906 from the area of the San Jacinto River where traversed by the Santa Fe Railroad (Aubury, 1906, p. 224). No trace of former workings was found in 1963. See Wardlow shale mine

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
53	South Pit	SE¼SW¼ sec. 35, T4S, R6W, SBM. 8½ miles southeast of Corona in low hills in Temescal Valley, southwest side of Temescal Wash, 3/4 mile south of Arcilla Siding.	Pacific Clay Products 1255 West Fourth St, Los Angeles	Area covered by Quaternary terrace deposits. Underlain by Triassic(?) Bedford Canyon Formation with upper surface weathered to form residual claystone. Thin (10 to 15 feet) discontinuous exposures of Paleocene Silverado Formation green clay shale and micaceous arkose. In 1942 the pit exposed a high alumina clay horizon about 4 feet thick. The sequence exposed in the main part of the pit in 1963 was as follows: Bouldery, sandy overburden, 10-15 feet; red and gray mottled clay, 5 feet; white clayey sand, 2 feet; gray-white plastic clay, 1½ feet; red and gray mottled clay, 1½ feet; "bone" clay, 10 feet. The beds strike about N. 70° W., dip 10° SW., but in places appear to be nearly flat-lying. Overburden ranges from 10 to 30 feet.	28 acre tract. Pit probably opened after 1926. By 1942 it was being mined by Pacific Clay Products who have continued to mine intermittently until the present (1963). In 1945 the pit was a side-hill cut 250 feet long and 30 feet high; overburden was 10-15 feet, white siliceous fire clay 12-18 feet, red clay 15 feet. By 1963 the active pit was about 300 feet long, 200 feet wide, and 30 feet deep. Clay is mined by contract about once a year, stockpiled, and hauled to the Los Nietos plant as needed. Total production is unknown, but in recent years has been a few thousand tons each year. Clay reserves in the immediate pit area appear to be small. (Tucker and Sampson, 1945, p. 162; Stauffer, 1946, Map Sta. 24).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
58	Temescal Lease	NW¼SW¼ sec. 35, T4S, R6W, SBM. 8½ miles southeast of Corona in low hills in Temescal Valley, southwest side of Temescal Wash, ½ mile southwest of Arcilla Siding.	Pacific Clay Products, 1255 West Fourth St., Los Angeles	Area covered by Quaternary terrace deposits. Underlain by Triassic(?) Bedford Canyon Formation with upper surface weathered to form residual claystone. Thin (10 to 15 feet) discontinuous exposures of Paleocene Silverado Formation green clay shale and micaceous arkose.	Prospected but Triangular shaped 20 acre tract. Not developed for clay, in use as a stockpile area in 1963.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
59	Temescal Water Co.	NE¼SW¼, NW¼SE¼ sec. 35, T4S, R6W, SBM. 8½ miles southeast of Corona in low hills in Temescal Valley, southwest side of Temescal Wash, ½ mile south of Arcilla Siding.	Temescal Water Co., 707 Main Street, Corona. Leased in part to Atlas Sewer Pipe Co., 10009 South Painter St., Whittier and in part to Mission Clay Products Co., 16961 East Santiago Blvd., Olive.	Area covered by Quaternary terrace deposits. Underlain by Triassic(?) Bedford Canyon Formation with upper surface weathered to form residual claystone. Thin (10 to 15 feet) discontinuous exposures of Paleocene Silverado Formation green clay shale and micaceous arkose. The pit active in 1942 exposed pink mottled clay and a high alumina clay horizon about 4 feet thick with overburden 10 to 30 feet. The 1963 pit sequence was: sandy conglomerate overburden, 10 feet; dark red clay, 15 feet; gray plastic clay, 3 feet; buff and red mottled clay, 3 feet. Beds strike about N. 55° W., dip 10° SW., but in places appear to be nearly flat-lying.	Pit in NE¼SW¼ sec. 35 opened in 1926 by open cut 25 feet wide and 40 feet long. In 1942 the pit was operated by Emsco Clay Co. and was about 300 feet long, 250 feet wide and 50 feet deep. This pit was inactive in January 1963, and apparently had been idle for some time. The active pit in 1963 is at the west side of Temescal Wash in the NW¼SE¼ sec. 35. It is a somewhat L-shaped side-hill cut about 300 feet long, 150 feet wide, and 30 feet deep. Mining for both lease holders is done by the Corona Clay Company utilizing bulldozers, rippers, power shovels, and front-end loaders. The several types of clay are stockpiled separately and transported as needed to the Atlas Sewer Pipe Company plant in Whittier and Mission Clay Products Company plant in Olive. The Corona Clay Company has mined this area for a number of years, probably since the late 1940's. Production of a few thousand tons each year, total undetermined. (Dietrich, 1928, p. 181, 329; Stauffer, 1946 Map Sta. 25).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
60	Terra Cotta Eighty	W½SW¼ sec. 26, T5S, R5W, SBM. Low hills 2 miles southeast of Alberhill.	Pacific Clay Products, 1255 West Fourth Street, Los Angeles	Most of the area is covered by Quaternary terrace deposits. Triassic(?) Bedford Canyon Formation crops out along the western margin of the property and green clay shale and micaceous arkose of the Paleocene Silverado Formation (upper part) crop out along the northern and eastern margins.	80 acres held by present owner since before 1926. May be site of the Dolbeer and Hoff Coal prospect, active in the 1880's (see in text under Coal). Area apparently has not been mined for clay. Drilling in the north part of property by Pacific Clay Products in the early 1960's is said to have penetrated commercial clays at depth. (Dietrich, 1928, p. 181, plate 10 facing p. 162).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
61	Terra Cotta Plant Site	NE¼SW¼ sec. 26, T5S, R5W, SBM. Low hills 2 miles southeast of Alberhill.	Pacific Clay Products, 1255 West Fourth Street, Los Angeles	East half of property covered by Quaternary alluvium; Paleocene Silverado Formation (upper part) green clay shale and micaceous arkose crops out in west half. Property drilled in the early 1960's by Pacific Clay Products who reported clay encountered at minable depths.	40 acres held by present owner since about 1912. In 1905 the California Fire-Proof Construction Company was operating a plant at this site for the manufacture of sewer pipe, earthenware, and hollow bricks. Earlier the plant was owned by the Dolbeer Estate. By 1912 the plant was controlled by the Pacific Sewer Pipe Company, and is said to have been destroyed by fire that year. In 1905 the source of clay was the Alberhill pits, but earlier clay had been mined from 2 pits on the hillside at the factory. May be site of the Dolbeer and Hoff Coal prospect (see in text under Coal). By 1920 the plant had been dismantled. (Aubury, 1906, p. 222; Merrill, 1917 [1919], p. 570; Boalich and others, 1920, p. 90; Dietrich, 1928, p. 181, plate 10 facing p. 162).

Tilleton Refract Co.

Pacific Clay Products plant (T.)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
64	Tropico (Temescal) Tract	S½SW¼ and W½SE¼ sec. 26, T4S, R6W, SBM. 8½ miles southeast of Corona on the northeast side of Temescal Wash, at the western margin of the Gavilan Hills, ¼ mile north of Arcilla Siding.	International Pipe and Ceramics Corporation, 2901 Los Feliz Blvd, Los Angeles 39	Eastern part of the property is underlain by Triassic(?) Bedford Canyon Formation and Jurassic(?) quartz latite porphyry. The western part is underlain by residual clay derived by weathering of quartz latite porphyry and Bedford Canyon Formation. According to Dietrich (1928, p. 173) red, pink-mottled and blue plastic clays have been mined from this tract.	Property consists of 172.65 acres. Acquired by Gladding McBean and Co. in the mid 1920's from Tropico Potteries. By 1925 the principal pit was 800 feet long, 500 feet wide and had a maximum face height of 150 feet. There were also some underground workings of unknown extent. The pit was idle in 1925 and has been idle much of the time since. The property was last active in 1949 when some mining was done in open pits. By 1963 work on adjacent properties had obscured or destroyed much of the former Tropico Tract workings. (Dietrich, 1928, plate 10 facing p. 162; p. 173-174).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
65	Twin Springs (Temescal Sixty) prospect	NW¼NW¼ and N½NE¼ NW¼ sec. 12, T5S, R6W, SBM. In Temescal Valley 4 miles northwest of Alberhill, on the west side of Highway 71.	Temescal Water Co., 707 Main Street, Corona	Gypsiferous clay shale and sandstone (Paleocene Silverado Formation) crops out over an oval shaped area 200 feet wide and 500 feet long just west of the railroad cut. Shale strikes northeast, dips 40° NW. Clay was not exposed in January 1963, but the property is said to contain a bed of steeply dipping "bone" clay.	Pacific Clay Products held 60 acres under lease for many years. Prospect was explored many years ago, probably before 1928, by means of an adit, which was not located in 1963. Apparently the adit had disappeared before 1946. (Dietrich, 1928, p. 181, pl. 10 facing p. 162; Sutherland, 1935, p. 71; Stauffer, 1946, map station 23).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Hancock's Brick Yard	SE¼ sec. 6, T2S, R4W, SBM. 3½ miles northeast of Riverside.	Hancock Brick Co. 21516 Main Street Highgrove.	Red clay soil was mined for many years from pit 10 to 20 feet deep.	Plant for the manufacture of common red brick; located in San Bernardino County. Incorrectly listed as a Riverside County location in previous reports. Probably so located because prior to about 1915 the plant and shallow pits were located in the SE¼ sec. 14, T. 2 S., R. 5 W., S.B.M., on the bluff just southeast of Fairmont Park in Riverside, in the area later occupied by the Southern Sierras Power Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
31	Los Angeles Brick and Clay Products Company				See under clay section in text.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mission Clay Products				See: Mount Clay Products.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
38	Mount (Mission) Clay Products	SE¼ sec. 34, T4S, R6W, SBM. 9 miles southeast of Corona in low hills in Temescal Valley, ¼ mile west of State Highway 71.	Mission Clay Products Company 16961 East Santiago Blvd. Olive	Area covered by Quaternary terrace deposits.	Late in 1958 a small plant utilizing a beehive kiln was erected by William J. Mount for the manufacture of vitrified sewer tile and drain pipe and common red brick. Raw materials used included soil from the plant area and clay purchased from the Corona Clay Co. Plant was idle in January, 1963 and by June 1963 had been acquired by Mission Clay Products.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Prado Tile Company	Vicinity of Prado Dam Spillway, 4 miles west of Corona.			For many years at a plant at the settlement of Prado, West of Corona, hand-made roofing tile and Mexican pottery were manufactured from clays supplied from the Corona area. The plant (or plants?) which was operated at different times by the Prado Tile Co., La Olla Tile Co., and the Casa Blanco Tile Co., was closed about 1940 when the Prado flood control project acquired the former site of Prado. (Dietrich, 1928, p. 180; Gray, 1961, p. 63).
	Williams coal mine				Coal
	Hoy Ranch clay pit				Sec. Alberhill Coal & Clay Co. (†)
	Hoffman's prospect				Sec. Jones clay deposit (†)
	Jones deposit				Sec. Jones clay deposit (†)
	Kraus group				Sec. Jones clay deposit (†)
					Sec. Kraus clay deposit (†)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
75	Aztec Badger State	Reported to be in Sec. 30 (proj.), T. 4 S, R. 20 E., SBM, high on the west slope of the McCoy Mountains. Accessible only by trail.	Undetermined	Probably similar to the Eagle Nest (herein)	(James F. George, 316 S. Spring, Blythe, personal communication). → Eagle Nest mine (L)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
74	Big Basin (Hines) Copper Prospect	NW¼NE¼ sec. 3, T4S, R6W, SBM. In a highland valley one mile northwest of Cajalco Hill and the Cajalco tin mine.	Lake Mathews Farming Co. Route 2, Box 98 Corona	Jurassic, Temescal Wash Quartz Latite Porphyry cut by shear zone which strikes N.45°E., dips 45°NW. Several small black tourmaline dikes which strike nearly north also crop out in the area. Across about 80 feet of highly altered rock in the shear zone are 4 parallel "veins" or mineralized shears ranging from a few inches to 6 feet in width. Mineralization consists of reddish-brown to black iron oxide, malachite and chrysocolla coatings and a few spots of azurite.	Area was prospected for copper carbonate before 1915. In 1946 the area was prospected by bulldozer trenching over an area some 500 feet by 50 feet, with a few isolated trenches about 1,000 feet southwest of the main trenches. Soil overburden ranged from 2 to 6 feet and trenches penetrated as much as 10 feet of copper-bearing quartz latite. A vertical shaft had been sunk to a depth of 20 feet in 1946, and an old 35 foot shaft had been filled by the trenching. About a carload of "shipping ore" was stockpiled on the property in Oct. 1946 from which a random type sample was selected. This sample was assayed by Abbot A. Hanks Inc., San Francisco and showed 0.025 oz. gold and 16.57 oz. silver per ton and 2.69% copper. In January 1963 no evidence of former prospecting was found, the shaft was in use as a waste water sump and the area had been planted to avocado and citrus trees. (Div. Mines Field Report No. 131.; Waring, 1919, p. 15).

Copper

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
79	Collins Prospect	NE¼ sec. 4 (proj.), T4S, R6W, SBM. Half a mile east of Temescal Canyon, about 500 feet above the canyon floor.	Wesley R. Collins 19951 Gavilan Road Riverside	Jurassic(?) Temescal Wash Quartz Latite Porphyry. Steeply-dipping shear zone trends northwest, exposed in open cut 200 feet northwest of shaft. Sample from small stockpile near the shaft was much altered; mineralization consisted of black tourmaline, reddish-brown to black iron oxide and sparse thin coatings of malachite and chrysocolla.	Area prospected in 1956 and 2 carloads of copper ore shipped to A.S. & R. at Midvale, Utah. Smelter assay is said to have shown 0.8% Cu. In 1962 a vertical 2-compartment shaft was sunk. In January 1963 it was filled with water to within 25 feet of the surface. Size of dump suggests shaft may be about 100 feet deep. Several bulldozer cuts have been made along the shear zone both east and west of the shaft. Inactive in January, 1963, but head frame and hoist house remained on the property. Intermittent prospecting apparently is being done.

Crescent

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Electric Copper and Gold/~~mine~~ Hope Lion's Den claims	Sec. 25, T6S, R4W, SBM, 5 mi. southeast of Elsinore. Not verified (1961)	Undetermined	A mineralized zone as much as 20 feet wide in schist near a contact with granitic rock. Reported to carry copper, silver, and gold in cuprite, chrysocolla, chalcopyrite, and pyrite.	Developed through a 60-ft. inclined shaft, a 20-ft. crosscut and 20 ft. of drifting. (Tucker 1929, p. 470; 1945, p. 125, pl. 35). See Anderson mine (1) See Little Mountain claims (1)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mountain King (claim)	Sec. 23, T4S, R20E, SBM.	Undetermined		(Tucker 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palen Copper mines	Sec. 22, T5S, R18E, SBM, on west side of Palen Mts.	Undetermined	Reported as a vein 50 ft. wide in quartzite and porphyry and a ledge in sandstone, quartzite and granulite.	Explored through shallow shafts, cuts and prospects. Reported to have ore containing as much as 30 percent copper. (Aubury 1908, p. 341; Tucker 1945, pl. 35; Eric 1945, p. 294).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Silver Joe	Sec. 18 or 19, T4S, R19E, SBM, on the east slope of the Palen Mts. about 1 mile southwest of the Homestake (see herein under copper)	Floyd Vernoy and B. H. Craig, 938 Maple, Beaumont (1962)	A northwest-trending shear zone contains sporadic quartz lenses ranging from 0 to 6 inches wide. Vein material comprises fractured, euhedral quartz crystals, as large as one-half inch in diameter and 2 inches long, cemented with chalcocite and secondary carbonates. Shear zone traceable about 300 feet (Personal communication, Tomo Ito, 1963).	Developed through an 8-foot shaft and shallow prospects.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	American Enam. Tiling Co. Brown deposit Bloom mine	Reported to be in SE¼ sec. 28, T4S, R2W, SBM, about 3¼ mi. east of Nuevo.	Undetermined	Diorite cut by dike comprising massive quartz and segregations of feldspar, about 100 ft. wide and exposed for 1,500 ft.	Explored by open cuts of undetermined extent. Mined on a small scale in 1920's (Sampson 1931, p. 421-422; 1935, p. 521; Tucker 1945, pl. 35). St. Perris Mining Co.

Feldspar-silica

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Dunn (claim)	Sec. 2, T7S, R5E, SBM.	Undetermined		(Tucker 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ensley-Spaulding (deposit)	T6S, R2W(?), SBM, 7 mi. southwest of Hemet.	Undetermined	Reported to be several small lenses (probably pegmatite) in granite. Feldspar one ft. thick pinching out at shallow depth.	Four cars (presumably feldspar) shipped by 1929 (Tucker 1929, p. 504).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	La Borde (deposit)	Reported to be in sec. 28, T4S, R2W, SBM, about 3 mi. east of Nuevo.	Undetermined	Feldspar occurs as irregular lenses and masses in pegmatite dike of unreported extent in diorite.	About 2,000 tons of feldspar reported shipped by 1931 (Tucker 1929, p. 505; Sampson 1931, p. 422; 1935, p. 521; Tucker 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Machado (deposit	SE¼ sec. 9, T5S, R2W, SBM, about one mile west of Homeland on the south margin of the Lakeview Mts.	Undetermined	Feldspar-quartz pegmatite dikes as much as 30 ft. wide strike N.40°E., dip at low angles northwest, country rock diorite.	Explored by open cuts and trenches of undetermined extent. Reported to have yielded 60 cars feldspar prior to 1931. (Tucker 1929, p. 505-506; Sampson 1931, p. 423-424; 1935, p. 521; Tucker 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Morgan Ranch (~~deposit~~) Nuevo	Reported to be in sec. 28, T4S, R2W, SBM, about 3 mi. east of Nuevo.	Undetermined	Feldspar and quartz in parallel, northwest-trending dikes of unspecified dimensions.	(Sampson 1931, p. 424; 1935, p. 521; Tucker 1945, pl. 35). see Southern Pacific deposit

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Patterson (deposit)	Reported to be in sec. 29, T4S, R2W, SBM, about 2 mi. east of Nuevo.	Undetermined	Parallel, feldspar-quartz-rich pegmatite dikes strike N.40°W., dip 60° NW.; are 20 to 30 ft. wide and exposed for 200 ft.	Reported developed through 50-ft. adit to bottom of glory hole. (Sampson 1931, p. 424; 1935, p. 521; Tucker 1945, pl.35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Riverside Cement	E½ sec. 29, T4S, R2W, SBM, probably on west slope of ridge in NE¼ of section.	Undetermined	Feldspar-rich pegmatite dikes of unreported thickness and extent.	This deposit was worked by Riverside Portland Cement Co., prior to 1929, for feldspar to be used in their plant near Riverside. (Tucker, 1929, p. 506; 1945, pl. 35; Sampson 1931, p. 425).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	San Jacinto Rock Products Co.	Sec.?, T5S, R1W, SBM, on southwest slope of Polly Butte, 3 miles south of Hemet.	Undetermined	Undetermined	Probably Hemet Silica deposit (see herein).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
98	Spicer Silica	SE¼SW¼ sec. 29(?), T2S, R4W, SBM. Low hill just west of U.S. Highway 60 and 395. May be in SW¼ sec. 21 low on west margin of Box Springs Mtns., ¼± mi. east of Santa Fe RR.	Undetermined	According to Tucker and Sampson (1929, p. 506-507), two small lenses of quartz occur in granite and strike N. 65° W., dip 55° SW. The quartz lenses were reported to have a maximum thickness of 3 ft., were about 10 ft. apart, and had been exposed for about 12 feet along the dip. In sec. 21 narrow beryl and columbite bearing pegmatite dikes occur in quartz diorite.	In sec. 29 is a side-hill semicircular cut about 150 ft. long, 75 feet wide and 15 feet deep. This cut may be the Spicer silica described by Tucker and Sampson (1929, p. 506-507), but in 1963 the faces were slumped and the quartz lenses were not observed. Several thin pegmatite dikes, as much as 8 inches thick, occur in blue-gray quartz diorite (Cretaceous Bonsall Tonalite). In sec. 21 several workings, the largest of which is a trench 40 ft. long, expose pegmatite dikes. This location more closely matches the early descriptions of Tucker and Sampson. No production, idle in 1929 and apparently has since remained idle. (Tucker and Sampson, 1929, p. 506-507; Sampson and Tucker, 1931, p. 444; Tucker and Sampson, 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
99	Stone and Alexander Quarry	NE¼ sec. 19, T2S, R5W, SBM. About 4 miles west of Riverside on the southeast slope of the Pedley Hills, a quarter of a mile northwest of Limonite Ave.	C. P. Stone, 845 So. Hill St., Los Angeles (1929). Undetermined (1963)	Pegmatite dikes in Cretaceous Bonsall Tonalite. Five dikes about 40 feet apart strike N. 45° W., are vertical to steeply northeast dipping, and are about 1,500 feet long. Dikes range in width from 6 feet or less to 25 feet and are composed of quartz and orthoclase feldspar with very little biotite.	Open cuts and trenches. In 1929 an open cut at the foot of the hill was 15 feet deep and 30 feet long with an adit driven 25 feet into the hill. This open cut explored a northwest-trending vertical pegmatite dike 25 feet wide. In 1963 these workings were mostly filled, but a face about 10 feet high and 25 feet long cut in a quartz-orthoclase feldspar dike remained. About 1,000 feet northwest of this cut and on top of the hill is a trench some 80 feet long with an average depth of 10 feet. This trench explores a quartz-orthoclase feldspar dike six feet wide. The quarry was idle in 1929 and apparently has since remained idle. In 1963 residential development surrounded the lower filled workings and residences covered the hills below the upper trench. (Tucker and Sampson, 1929, p. 507; Sampson and Tucker, 1931, p. 425).

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Feldspar-silica

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Warren ~~deposit~~	Reported to be in E½ sec. 21, T4S, R2W, SBM, about 4½ mi. east of Nuevo.	Undetermined	Parallel quartz-feldspar-rich dikes of unreported extent.	Developed through open cut 70 ft. deep by 25 ft. wide and 50 ft. long and an underlying adit which connects with the open cut by two 25-ft. raises. Also other short adits and shallow cuts. (Tucker 1929, p. 507; 1945, pl.35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Weir Feldspar (deposit) Williamson mi Yellow Queen	Reported to be in NE¼ sec. 29, T4S, R2W, SBM, about 2½ mi. east of Nuevo.	Reported to be patented; held in 1931 by A. C. Weir, Los Angeles	Narrow pegmatite dikes in granitic rock.	Prospected by series of open cuts. (Sampson 1931, p. 426; Tucker 1945, pl. 35). See Coachella Brine (t) See White Prince dep. (t)

Garnet

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Sunny Day (mine)	Near Indio	John I. Fassett, 271 W. 4th Street, San Pedro (1937)		(Eardley-Wilmot, 1937, p. 23; Troxel, 1957, p. 24).
	April Fool California Gem Columbia Gem				Gems See Belo Horizonte claim (t)
	Beryl Crystal Magee				See Schindler claims (t) See Anita mine (t)
	Silica Beryl				See Schindler claims (t)
	Simmons -				See Fallo mine (t)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Alice (mine)	T6 and 7S, R14 and 15E (?), SBM.		Abundance of chrysocolla noted by Orcutt.	No other record or field evidence of a mine of this name in the Chuckwalla Mtns. Ore type suggests mislocation from Riverside Mtns. (See Alice herein). (Orcut, 1890, p. 901; Merrill, 1919, p. 539).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Allen Placers American Flag	Sec. 12, T4S, R20E, SBM, in the Little Maria Mts.	U.S. Gypsum Co.	An area, partially covered by gravel, underlain by complexly folded and faulted gypsum, limestone, lime-silicate rocks and schist (see discussion under Marie Mountains deposits in gypsum section).	Patented in 1934, the Allen, Riverside and Victor were called the Allen Group Placers. See Hidden Treasure claims (2)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Annie Laurie	Sec.?, T5S, R11E; Secs. 3,4, T4S, R13E, SBM.	Undetermined	Undetermined	A patented claim and millsite surveyed for Iron Chief Mining Co. in 1910 and tied to U.S. Mineral Monument no. 139 (Saul, 1962, p. 7).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Annie Rooney ~~mine~~	T2S, R12E, SBM.	Undetermined (1961		(Merrill, 1919, p. 538).

S4

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ardanelle (claim)	T6S, R16E, SBM, 3 miles SE. Corn Springs.	Undetermined	Vein on felsite-porphyry contact.	Open cut and drift (Tucker, 1929, p. 472).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Argonaut ~~(group)~~ Arica	NE¼ sec. 9, T6S, R4W, SBM, about 1½ miles east of Elsinore; ¼ mile south of Palisades prospect.	J. H. Wrench, Elsinore (1937)	Country rock diorite and gabbro, generallly fractured and deeply weathered. Gold was sought in or adjacent to aplitic and basic dikes of various attitudes.	A 14-ft. pit, 2 adits 12 and 75 ft. long, and shallow pits and trenches explore scattered dikes (Engel, 1959, p. 113). See Lum Gray mine (E)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Arroyo del Toro (~~prospects~~)	Secs. 6, 7 (?), T5S, R4W, SBM.	Undetermined (1959)	Granodiorite, slate and quartz latite porphyry.	Prospects. (Larsen, 1948, p. 130; 1951, p. 47; Engel, 1959, p. 113).

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bankers ~~(group)~~	Sec. 27, T6S, R15E, SBM, 4 miles west of Corn Springs	Undetermined (1961)		(Merrill, 1919, p. 540; Tucker, 1929, p. 473; 1945, p. 128, pl. 35).
	Baumonk				Crescent (L)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Binkley's diggings	Sec. 2, T6S, R4W, SBM, near the junction of Cottonwood Canyon and San Jacinto River about 3 miles east of Elsinore.	Undetermined		Active in 1876, extent or success undetermined (Merrill, 1919, p. 527; Engel, 1959, p. 113).

Gold

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Pt. Canyon Gr.				[illegible] (3)
	Black Diamond	Sec.? T5S, R12E	Undetermined	Undetermined	Tied to U.S. Mineral Monument No. 140. (Saul 1962, p. 7).
	Black Jack claims				Fr. De Palma (2)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Black Eagle placer	Sec. 24, T8S, R5E, on or near Buck Ridge.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Black Warrior	Sec. 5, T5S, R23E, SBM.	Undetermined		Could be an older name for the Lindy Loop #1 deposit (see herein under iron) (Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Black Warrior (See Blue Bell in this list)				
	Blackbird				See Tubbs claim (t), under tungsten - p11
					63

Gold

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Blue Bell	Sec. 6, T2S, R24E	Undetermined	This property is in an area underlain by complexly folded and sheared carbonate and schistose rocks.	Two claims, the Black Warrior and Blue Bell, were patented by Vidal Mining Co. in 1922. At that time these claims were called the Blue Bell group. (Tucker 1945, pl. 35).

Blue Bell

See Golden Bell (?)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Blue Goose	Sec. 23, T7S, R6W, SBM (proj.), near north rim of Verdugo Canyon, ½ mile south of Wheeler Ranch.	George W. Williams, Box 462, San Juan Capistrano, and Charles Christopherson, Box 205, San Juan Capistrano (1954)	Brecciated zone near contact of andesite and dacite porphyry replaced and filled by quartz, sericite, and limonite derived from oxidation of pyrite.	Undeveloped (1959) (Engel, 1959, p. 114).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bob Cat No. 1				See Purple Hope.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bonanza	NW¼(?) sec. 29, T2S, R3E, SBM, in Cottonwood Canyon about 1 mile southeast of Cox Ranch and 5 miles northwest of Whitewater.	James Varia, 39067 Orchard St. Rt. 1, Cherry Valley; Chas. Armijo, 5313 Ave. L-10 Quartz Hill; James Kaiser, 1648 N. Florida Banning; Joseph Desmarias, 4315 Mountain Ave., San Bernardino.	A vein of unreported width and extent in a faulted and sheared complex of igneous and metamorphic rocks within the San Andreas fault zone.	Appears to be a relocation of an old, undescribed property. Developed through a 119-foot adit. No road to property (1963).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bonanza Crater (group)	Sec. 1, T4S, R10E, SBM (proj.).	Undetermined		(Tucker, 1945, pl. 35).

6B

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bonanza Lode	NE¼ sec. 26(?), T3S, R8E, SBM, 1 mile southwest of Pinyon Well, north slope of Little San Bernardino Mtns.	Undetermined (1960)	Quartz veins cutting coarse-grained quartz monzonite.	Location is from patent plats and Tucker and Sampson (1945, pl. 35, no. 24), but no mine was found here. May be an erroneous location; property could be in NW¼ sec. 26. In NW¼ sec. 26 quartz monzonite cut by quartz veins striking northwest and dipping steeply southwest. Here, veins explored by pits and shafts (See Hansen mine herein).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Boulder claim	T6S, R15E, SBM, one mile west of Granite mine.	Undetermined	Vein reported to strike north and dip nearly vertically.	By 1917 mine comprised three shafts 30, 50, and 100 feet deep, a 200-foot adit and open cuts. (Crawford, 1896, p. 310; Merrill, 1919, p. 540).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Brady prospect	NE¼ sec. 4, T6S, R4W, SBM, southwest slope of hills about 1½ miles east of Elsinore.	E. H. Brady, Elsinore (1937)	Contact of diorite and gabbro with schist where vein quartz accompanies a 4 to 6 foot wide aplitic dike, now much fractured and decomposed, that strikes N. 50° W. and is vertical.	Dike zone explored by 35-foot vertical shaft with lateral workings of undetermined extent, and two other shafts, one 15 feet deep with a 25-foot connecting adit and one 35 feet deep. (Engel, 1959, p. 114).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	~~mine~~				See Plate (4)
	C & C Consolidated ~~(mine)~~	4 miles west of Perris	Undetermined	Narrow vein in granitic rock.	Developed through a 150-foot adit and a shaft. (Crawford, 1896, p. 310; Merrill, 1919, p. 532).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Champion (mine)	T6 or 7S (?), R14 or 15E (?).	Undetermined		Argentiferous lead ore, wulfenite noted by Orcutt. (Orcutt, 1890, p. 901).
	Chuckwalla				5... Bryan (2)
	Chuckwalla Mt Red'l G.				3... Bryan (2)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Coffee (mine)	T6S, R15E, SBM, 4 miles west of Corn Springs.	Undetermined	Northwest trending vein as much as 18 inches wide.	Shaft 56 feet deep reported in 1917. (Crawford, 1896, p. 310; Merrill, 1919, p. 540; Tucker, 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Colorado (mine)				See Justice.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Colorado ~~claim~~	Sec. 36, T1S, R23E, SBM.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Columbus (mine)	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Corn Springs Placer (claim) Desert Gold Group	Sec. 28 (proj.), T6S, R16E, SBM, at Corn Springs 7½ miles southeast of Desert Center.	Undetermined	Alluvial deposit at east (drainage outlet) end of a narrow valley.	One patented claim. No record of production; probably small. (Saul, 1962, p. 4,7). See Neck mine and Thelma Group. (1)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Double Eagle (mine)	T8S, R20E, (?), SBM, probably on east slope of Mule Mountains.	Undetermined		(Merrill, 1919, p. 541).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Echo Valley	Secs. 1,2, T7S, R14E, SBM, on the southwest margin of the Chuckwalla Mts., about 1 mile southeast of the Model mine.	J. H. Barry, 8242 Garibaldi Ave., San Gabriel; Myron Smith, Box 8, Box Canyon Rd., Canoga Park		Once part of Chuckawalla and Model Group (see herein under Model). Purchased by these owners in 1941 (personal communication, J. H. Barry, 3/22/63).
	Edith				See Mammoth (?)
	El Dorado				See Now El Dorado (?)
	Enseparation				See Hidden (?)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ethel (mine)	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Fish (mine)	T7S, R12E (?), SBM, 6 miles northeast Dos Palmas and 12 miles northeast of Salton.	Undetermined	Reported to be a quartz vein.	Adit on vein. May be an old name for Dos Palmas (see herein). (Crawford, 1894, p. 221; 1896, p. 311; Merrill, 1919, p. 541; Tucker 1929, p. 477; 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Free Coinage and Charity ~~(mine)~~	T6 S, R13E, SBM.	Undetermined.	Quartz vein with some argentiferous galens and lead carbonate.	This might have been a different name for the Sterling mine (see herein). (Crawford, 1894, p. 221; 1896, p. 311; Merrill 1919, p. 541; Tucker, 1945, pl.35)
	Goat, Goat Basin	}			Free Bronze mine (?)
	Gold Coin				See Gold Galena (?)
	Gold Crown #1				See Rich Gold (?).
	Gold Flake				See Nonpareil Mine (?)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Gold Hill ~~mine~~	Sec. 3, T4S, R10E, SBM (proj.).	Undetermined		(Tucker, 1929, p. 479; 1945, pl. 35).
	Gold Master				See Black Warrior (?)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Gold Prince				North extension of Good Hope, which see. (Merrill, 1919, p. 532).
	Gold Rose				See Brooklyn (1)
	Gold Tiger				See Black Bear (1)
	Golden Chariot				See Golden Chariot (1)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Golden Crown	Sec. 29? T6S, R4E, SBM, about 2 miles east of Kenworthy Guard Station	Dexter C. Mayne, 25889 Columbia St., Hemet	Narrow veins reported to be of good grade; presumably in a fault or shear zone in diorite. ~~as are most of the mines in the area.~~	One inaccessable, 100-foot shaft. Prospecting and trenching during 1962-63 have exposed (vein system through about 500 feet claim purchased by this owner early in 1962. (Written communication, Dexter C. Mayne, May, 1963.)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Golden Key	Sec. ?, T6S, R16E.	Undetermined	Undetermined	Developed by 55-foot shaft, 20-foot tunnel, 45 feet of drifts, and a 5-foot by 20-foot open cut. Gold-silver ore produced 1934 to 1937, also contained 1.77% lead and recoverable copper. (Eric, 1948, p. 292; Goodwin, 1957, p. 602).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Golden Rule (group)	Reported to be in sec. 30, T2S, R10E, SBM, south of Twentynine Palms in the Pinto Mountains.	Undetermined	Vein striking N.30°W. and dipping 80°W. occurs in gneissoid granite. Range s in width from 1 to 2 feet. Diorite dike on footwall.	75-foot shaft on vein with drift 35 feet south at 50-foot level. Mine active in 1929 (Tucker and Sampson, 1929, p. 480).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Golton (group) (Mineral Chief)	NW¼ sec. 20, T5S, R4W, SBM, about 2½ miles north-northeast of North Elsinore.	D. V. French and J. S. Hopper (1946)	Two vuggy quartz veins 1½ and 3 feet wide about 250 yards apart in northerly trending, steeply dipping zones, 3 to 5 feet wide, of shattered porous, iron and manganese-stained siliceous rocks in quartz latite porphyry.	West vein explored by 10-foot open cut and 15-foot inclined shaft; east vein by 65-foot adit. (Tucker, 1929, p. 480; 1945, pl. 35; Engel, 1959, p. 115).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Good Hope (group)	Sec. 25, T2S, R3E, SBM, about 1 mile east of Whitewater Wash.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Gray	Sec. 24, T4S, R18E (proj.), SBM, in the central Palen Mts. about 2 miles southwest of the Homestake (herein under copper).	Undetermined	Undetermined	Patent was applied for on a single claim but no record was found that it was granted (U.S.B.L.M. records, 1932).

Gray

See Lom Gray (1)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Gray Eagle (see Waterloo in this list)				

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Great Eastern	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Hager-Kale (mine)	Reported to be in sec. 2, T3S, R5E, SBM.	Undetermined	Vein quartz (probably in gneiss of the Chuckwalla Complex).	(Proctor, 1958, p. 142).
	Hensen) Hansen well				Sec. 2 T3S R5E (?)
	Hexie				Sec. 2 T3S R5E (?)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Hidden Canyon claim	Sec. 23, T6S, R9E, SBM.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Hillerman (claim)	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).
	Hillside Group				See Brown mine (?).
	Tulip Queen				See Tulip X. Group

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ingersoll (Ramona) mine	Reported to be 50 miles northeast of Walters Station probably T2S, R12E, SBM.	Undetermined	A nearly vertical vein strikes north and ranges in thickness from 1 to 3 feet.	Two shafts, 40 and 80 feet deep (Crawford 1896, p. 311; Merrill, 1919, p. 538; Tucker, 1929, p. 482; 1945, pl. 35).
	J. J. Knife				D. Morning Star (?)
	Juanita #5				San Nicholas Queen (?)

Gold

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Jumping Jack	Sec. 32(?), T6S, R16E, SBM, about 1½ miles southwest of Corn Spring	Undetermined	Undetermined	Surveyed for patent in 1913; survey no. 5066, tied to U.S. Mineral Monument no. 146. Survey plats marked "rejected". Property developed through a 190-foot drift adit driven S.22°W., three inclined shafts of moderate depth, one short winze, and a vertical shaft of unmarked depth (data from plat map).

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Justice (Colorado) ~~mine~~	Sec. 32, T4S, R4W, SBM.	Undetermined; a patented claim and millsite. Roger Clapp % L... Dutt... 5122 N. June Hollywood; a patented claim and millsite	A narrow quartz vein of reportedly high grade in diorite.	The old workings are caved and appear long neglected. (Merrill, 1919, p. 531; Tucker, 1929, p. 483; 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Katherin No. 2 placer (claim)	Sec. 1 (proj.), T2S, R12E, SBM, about ½ mile south of Gold Rose mine.	Ben Stauffer, P.O. Box 202, Johannesburg (1960)	Alluvium; probably fanglomerate.	Numerous shallow cuts, 25-foot adit and partly caved 40-foot adit to base of shallow shaft. (Oral communication, Michael R. Perkins).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lake View ~~prospect~~	NW¼ sec. 4, T6S, R4W, SBM, about 1½ miles northeast of Elsinore.	Mack and Thurman (1937)	Deeply weathered and chloritized diorite includes shear zones containing alaskitic, aplitic, and pegmatitic dikes. Gold sought in shear zones which strike N. to NE., dip 35° to 60° SE.	Workings include pits 15 and 25 ft. deep about 75 ft. apart in a SW.-NE. line, with a 12-ft. adit driven northward between them, exploring different shear zones. (Engel, 1959, p. 116).
	La Flama				See Fig. of the Workings
	La Rica				See Stone House mine (4)
	Laceter				See Lost Angel mine (5)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lee (prospect)	SE¼ sec. 14, T6S, R5W, SBM, east base of Elsinore Mountains about 2 miles southeast of Willard.	Undetermined	Fault contact between slate and quartzite and diorite and gabbro.	Explored by 25-ft. crosscut adit filled with sand to within 2 ft. of back. Neither ore mineralization nor definite vein visible. (Engel, 1959, p. 116).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Liberty (group)	T7S, R15E, SBM, "in Red Cloud Canyon".	Undetermined	Quartz veins along a dike cutting gneiss. Average value reported to be about $6 per ton.	Development consists of open cuts and one adit. Reported as part of "old Red Cloud Group". This could be the same property as the Tubbs claims (see herein). (Tucker, 1929, p. 483).
	Liberty Grp				See Tubbs claims (?) and Tungsten
	Little Maggie				See Maggie mine (?)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Little Pete (claim) Long Shot #1	Sec. 31(?), T4S, R4W, SBM, 4 miles west of Perris.	Undetermined	Narrow, west trending vein containing arsenical pyrite.	(Crawford, 1896, p. 312; Merrill, 1919, p. 531; Tucker, 1929, p. 483; 1945, pl. 35). St. Louis Group (?)

Gold

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lone Star	Sec.?, T2S, R12E, SBM.	Undetermined	Undetermined	Patent survey no. 6330, tied to U.S. Mineral Monument no. 202; surveyed in 1945 (Saul 1962, p. 7).
	Los Angeles				See Brooklyn mine (4)
	Last Parallel				See Hidden mine (1)
	Lucky Boy				See Elton mine (4)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lucky Lady group	Sec. 17, T3S, R11E, SBM (proj.).	Undetermined	Undetermined	(Tucker and Sampson, 1945, pl. 35) not confirmed.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lucky Lady claim	SE¼ sec. 19 (proj.), T7S, R17E, SBM.	Undetermined	Property not visited; probably resembles nearby Aztec and Rainbow claims which are northwest-trending gold-bearing quartz veins in gneissic country rock.	Developed during 1930's and worked for an unreported but probably short period. Explored by single shaft 75 feet deep from which an unspecified amount of ore of good grade was taken (J. Dupont, personal communication, April, 1959).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lucky Strike	Sec.?, T6S, R15E, SBM, in the Chuckwalla Mts.	Undetermined	Undetermined	Claim and mill site; patent survey no. 6400, tied to U.S. Location Monument no. 205; surveyed in 1947 (Saul 1962, p. 7).
	N. Haney				See Desert Queen (6)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	McKinley Bill claim	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Meek (group)	Sec. 15, T2S, R11E, SBM (proj.).	Undetermined	Undetermined	(Tucker and Sampson, 1945, pl. 35). Not confirmed.

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mineral Chief ~~Claim~~				See Golton group.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Minnie Ha-Ha claim)	NE¼NW¼ sec. 32, T6S, R4E, SBM, about 2 miles east-southeast of Kenworthy.	E. M. and Hazel A. Olsen, 14548 Dalman, Whittier (1958)		County and Forest Service records.
	Mining Link				See Virginia mine
	Monarch				See Tubbs Link (1) under target gall
	Morgan claim				See Morning Star (1)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mountain King	N½ sec. 29(?), T4S, R20E, SBM.	Undetermined	A vein reported to be as much as 30 feet wide strikes northwest. County rock is granite porphyry.	Developed through a 40-ft. shaft and 4 open cuts (Aubury, 1908, p. 342; Tucker, 1929, p. 471).

Gold
Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Musick (~~claim~~)	NE¼ sec. 23, T5S, R4W, SBM, west side of Railroad Canyon, about 4½ miles~~x~~ northeast of Elsinore.	Undetermined	Quartz veins 1-2 in. wide strike N. 5°-20°W. dip about 70°NE. parallel to parting planes of slate.	Workings, now caved, comprise a shaft 40 ft. deep and shallow pits and trenches. (Engel, 1959, p. 117).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Nicolite (claim)	Sec. 32, T1S, R24E, SBM.	Undetermined		(Tucker, 1945, pl. 35).
	Northern Be				See Santa Ysabel Mine (?)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	North Star (claim)	Sec. 33, T4S, R4W, SBM.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	O'Brien (mine)	Sec. 16(?), T4S, R4W, SBM, about 4½ miles northeast of Elsinore and 1 mile west of Good Hope mine.	Undetermined		(Crawford, 1894, p. 224; Engel, 1959, p. 118).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ohio (claims)	NE¼ sec. 1, T2S, R22E, SBM, at the southeast margin of the West Riverside Mtns.	R. F. Boyd and A. Geiger, Vidal (1958)	Gneiss cut by thin pegmatite dikes and quartz veins. Explored dike attitude approximately N.45°E., 70°SE.: composed of quartz, microcline, chlorite, calcite, and hematite.	A single, shallow, inclined shaft explores a poorly exposed pegmatite dike.

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	O K ~~Claim~~				See McKinley Bill.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Onward ~~mine~~	T2S, R19 or 20 E(?) SBM, probably in the Arica Mtns.	Undetermined		(Crawford, 1894, p. 224).
	ophir				See Lucky Strike (4)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Opulent (mine)	T6S, R14E(?), SBM.	Undetermined	Wulfenite noted here by Orcutt in 1888.	(Orcutt, 1890, p. 901).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Oro Copio mine	Reported to be in sec. 6, T2S, R10E, and sec. 12, T2S, R9E, SBM (proj.), about 9½ miles southeast of Twentynine Palms in the Pinto Mtns. Gold Park area.	Undetermined	Narrow quartz veins striking N.10° E. in a shear zone in granite gneiss.	Three shafts, 50, 75, and 100 feet deep respectively, sunk on veins. Apparently active in 1921 when owned by Gold Park Consolidated Mines Co. and 1921-29. Last reported owned by Ellsworth Nickols, Santa Ana. (Tucker, 1921, p. 348; Tucker and Sampson, 1929, p. 486).

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Oro Plomo (group	Sec. 19, T4S, R22E, (proj.) SBM, on the west side of the Big Maria Mountains.	Undetermined	Quartz vein in gneiss and schist.	Eight shallow shafts and several cuts. (Unpublished report).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Oro Vista (mine)	Sec. 28, T7S, R5E, SBM, 6 mi. southwest of Nightingale.	Undetermined	Quartz vein on granite-schist contact.	(Tucker 1945, p. 141, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Owens (claim)	NE¼ sec. 5, T5S, R4W, SBM, 3/5 mile due east of Good Hope mine.	William A. Owens, Route 2, Box 228E, Perris	Diorite aplite dike 3-5 ft. wide trends N. 10° E., discontinuously exposed for 100 yards or more through deeply weathered quartz diorite.	Gold sought in 4 shallow pits and shafts now largely caved in line trending for 75 yards N.25°E. across aplite dike. Deepest shaft is 30 ft. (Engel, 1959, p. 118).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Oxbow (Group)	Sec. 36, T1S, R23E, SBM, in the Riverside Mountains.	John H. Ware, 408 N. 9th St., Santa Paula (?)		This group appears to have been adjacent to or near the Gold Dollar (see herein). A claim named "Oxbow" is held (1958), in addition to the Gold Dollar, by J. H. Ware (Merrill, 1919, p. 544; Tucker, 1929, p. 486; 1945, pl. 35; county records).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palo Verde (group	T8S, R21E(?), SBM, probably on the east slope of the Mule Mountains.			(Merrill, 1919, p. 541).

Pitch

Sec N

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Paymaster (mine) Paymaster Peggy	Sec. 15, T3S, R10E, SBM.	P.O. Murphy and E. Leith, Twentynine Palms (1945)	Vein in schist, strikes northwest, dip 40°SW, width 2 ft.	Inclined shaft sunk on the vein to a depth of 140 ft.; drifts on 50 and 100 ft. levels. Probably same as Black Warrior (see herein). (Tucker, 1945, p. 141). See Black Warrior (1) See Group (1)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Perris ~~claim~~ Pilot	Sec. 31, T4S, R4W, SBM.	Undetermined		(Crawford, 1896, p. 313; Merrill, 1919, p. 531; Tucker, 1929, p. 486; 1945, pl. 35). See Trimmel (6)

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Pinto Lode (claim	Sec. 24, T6S, R4E, SBM, in Palm Canyon	Undetermined		(Tucker, 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Pinto placers	Sec. 21, T2S, R12E, SBM.	Undetermined		(Tucker, 1945, pl. 35).
	Pinyon Well				See New Eldorado mill (4)
	Pinto Well				See Cap Hunter (4)

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Porcupine (~~claim~~)	T2S, R12E(?), SBM.			(Merrill, 1919, p. 537).
	Postmaster-				See Jim (t).
	Priest				See Pr... (t)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Punch ~~claim~~	T8S, R21E(?), SBM, probably on the east slope of the Mule Mountains.	Undetermined		(Merrill, 1919, p. 541).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Purple Hope (Bob Cat No. 1)	SE¼ sec. 24, T5S, R5W, SBM, on the north side of a prominent hill, about 2 3/4 miles east of Alberhill.	H. L. Long, W. E. Giles, M. Isaac, G. J. Isaac, 8232 South Nutwood Street, Anaheim (1954).	Metamorphosed tuff and related volcanic sediments; strike N.35°W., dip 60° SW.; form prominent outcrop in a shattered zone which is bleached and stained with iron and manganese oxides and includes abundant clayey gouge.	Explored by inclined shaft driven northwest; caved at 6-ft. depth; 15-ft. trench with 8-ft. face; several shallow pits. (Engel, 1959, p. 118-119).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ragged Top ~~group~~	NW¼ sec. 18, T6S, R3W, SBM, in Cottonwood Canyon, 3 miles east of Elsinore.	Undetermined	Quartz veins in granitic rock.	Two adits 500 ft. apart driven 50 and 60 ft. SE. (Tucker, 1929, p. 486).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ramona mine				See Ingersoll mine.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Red Bird No. 1 Red Head	SE¼ sec. 24, T5S, R5W, SBM, on the northeast side of prominent hill about 2 3/4 miles east of Alberhill.	A. W. Meier and J. Taylor, address not determined (1947)	Metamorphosed tuff and related volcanic sediments about 100 yards east of contact with quartz latite porphyry. Dike-like outcrops trend N. 30° W., dip 60° W.	Explored and mined in open pit 20 ft. deep, 25 ft. wide, 35 ft. long and smaller pits. (Engel, 1959, p. 119). See Red Cloud group (?) 137

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Reliance	Sec. 25, T1S, R23E, SBM, on the north-west slope of the Riverside Mts.	Undetermined	Undetermined, probably schistose rocks cut by faults mineralized with primary and secondary copper minerals, gold and iron oxides.	Four claims; Fraction #2, Independence, Klondyke, and Reliance were patented in 1922, by W. F. Holt, as the Reliance group.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Republican claim	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Revenue ~~claim~~	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Richey (mine)				See Coffee (mine)
	Ronnie B				See Atlanta (±)
	Rosario				See Santa Rosa (±)
	S. J. Dmjo				See Gold Crown (±)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	San Jacinto (claim)	SE¼ sec. 10, T5S, R4W, SBM, northwest side of Highway 84 about ½ mile northeast of Good Hope mine.	Mrs. Velma L. Teater, 500 South Commonwealth, Los Angeles (1955)	Northeast extension of Good Hope vein.	Claim of Good Hope group. (Tucker, 1945, plate 35; Engel, 1959, p. 119).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	San Mateo Canyon prospects)	T8S, R5 and 6W, SBM, lower San Mateo Canyon for about a mile north of its junction with Nickel (Quail) Canyon, and several miles south of that point.	Undetermined	Granodiorite and andesite porphyry contain unproved showings of gold, silver copper and iron.	Prospected intermittently since about 1900. Accessible by jeep since late 1940's. Most of this property appears to lie south of the Riverside-San Diego County boundary (Larsen, 1948, p. 132; 1951, p. 48; Engel, 1959, p. 119).
	Santa Fe				See Roosevelt and Rail.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Schiller ~~(claim)~~	T2S, R12E, SBM.	Undetermined		(Merrill, 1919, p. 538).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Senate ~~mine~~	T8S, R21E(?), SBM, probably on the east slope of the Mule Mountains.	Undetermined		(Merrill, 1919, p. 541).
	Sippi				See Loct Illus 1 (L)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	S. S. Mine	T2S, R12E, SBM, "4 miles south of Virginia Dale".	Undetermined		Reported as a long abandoned mine which once produced some good ore. (Crawford, 1894, p. 224; 1896, p. 314; Merrill, 1919, p. 538; Tucker, 1929, p. 487).
	Star				See Frank Hall (5)
	Staple				See Top of the World (1)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Storm King #5 claim)	Sec. 2, T2S, R12E, SBM.	Seeley W. Mudd and Philip Wiseman (1938)	Free gold in steeply dipping quartz vein striking N. 20° E. along andesite porphyry-quartz monzonite contact.	This is part of holdings which lie in both Riverside and San Bernardino Counties (see O.K. Mine: Wright, 1953, p. 50). Vein explored to depth of 800 ft. by inclined shaft and extensive level workings. (Cloudman, 1919, p. 802; Eric, 1948, p. 313; Tucker, 1930, p. 246; 1931, p. 306; Wright, 1953, p. 50).
	Sonnit				Sec F by Grid ( )

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Sunny Boy (claim)	Sec. 6, T2S, R9E, SBM.	Undetermined		Was not identified in the field but may now be part of the Desert Queen mine (see herein). (Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Sunnyside ~~mine~~ Sunrise Sunset Sunset Thelma	T6 or 7S, R14 or 15E, SBM.	Undetermined	Quartz vein carrying argentiferous lead ores with gold.	Shaft. (Orcutt, 1910, p. 901; Merrill, 1919, p. 539; Tucker, 1929, p. 488).

Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Thurman (claims)	Secs. 19 and 26, T6S, R3W, SBM.	J. G. Thurman, Elsinore (1929)	A porphyritic dike 4 ft. wide in schist strikes N. 20° W., and dips 70° E. Reported to run $4 per ton in gold.	One small open cut. Mr. Thurman had other claims which see herein under Lake View prospect. (Tucker, 1929, p. 488; 1945, pl. 35).
	Tingman-Hall				

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Tyler's diggings	Sec. 10, T6S, R4W, SBM, about 2½ miles east of Elsinore.	Undetermined		Reported active in 1876. (Merrill, 1919, p. 527; Engel, 1959, p. 120).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
28	~~Prospect (Name~~ undetermined~~)~~	SW¼SE¼ sec. 4, T5S, R5W, SBM. In the Gavilan Hills, 1 mile southeast of Estelle Mtn.	Undetermined	Irregular shaped body of Jurrasic quartz latite porphyry about 1,500 feet long, 500 feet wide and surrounded by Cretaceous granodiorite. At granodiorite contact the east margin of the quartz latite porphyry contains iron oxides and thin quartz stringers which strike N.60°W., dip 45°SW.	Quartz stringers explored by means of a side hill cut 15 feet deep and 20 feet wide and several other shallow cuts. Apparently long idle.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
28	~~Prospect (Name~~ undetermined	NW¼NE¼ sec. 4, T5S, R5W, SBM. In the Gavilan Hills north of Estelle Mtn. Road, 1 mile east of Estelle Mtn.	Undetermined	Shear zone in altered volcanic rock is 1-1½ feet wide, strikes N.60°W., dips 83°SW. at surface, vertical at depth. In porphyritic andesite tuff or breccia (Jurassic Santiago Peak Volcanics). Volcanics are stained red-brown or purple-gray and contain thin, black, manganese seams.	Shear zone explored by means of a vertical shaft, estimated to be about 100 feet deep. A small open cut 10 feet deep and 15 feet long is just west of the shaft. In January 1963 no equipment remained on the property which apparently has been long idle.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified prospects~~	W½ sec. 23, T5S, R4W , SBM, about 4½ miles northeast of Elsinore.	Undetermined	Schist and slate cut by northeast-trending faults and northwest-trending aplitic and alaskitic bodies. Quartz in shear zone.	Trenches in a linear series nearly ¼ mile long. (Engel, 1959, p. 120-121).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified prospect~~	N½ sec. 14, T5S, R4W, SBM, about 7 miles northeast of Elsinore.	Undetermined	Glassy quartz vein 3 ft. wide strikes north, dips 70°-80° W. in bedding plane of slate. Septum of decomposed granitic rock divides vein.	Gold sought in vertical shaft on vein 50 ft. or more deep. (Engel, 1959, p. 121).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified prospect~~	SE¼ sec. 15, T5S, R5W, SBM, about 1/3 mile northeast of Alberhill.	Undetermined	West-trending fault zone in metavolcanic rocks.	Prospected by a 10-ft. adit. (Engel, 1959, p. 121).

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified prospect~~	NE¼ sec. 22, T5S, R5W, SBM, about 3/4 of a mile east of Alberhill.	Undetermined.	Sheared, weathered shale and slate strike N. 30° W., dip 60° NE.	Prospected by 185-ft. crosscut adit. (Engel, 1959, p. 121).
	Victor-				See Top of the World (6)
	Virginia Shay				See Virginia (4)
	Walker-				See Lucky Boy (5)

Gold

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Waterloo	Sec. 25, T3S, R14E, SBM, on the east slope of the Eagle Mts.	Sold to the State of California in 1918	Undetermined	Patent survey no. 4872 listed as Gray Eagle, tied to U.S. Mineral Monument no. 141 (Saul 1962, p. 7).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Waters Placer White Owl	17 miles northeast of Sidewinder Well, probably on the west slope of the Palen Mountains near Palen Pass.	Undetermined		Reported to have yielded "some" gold. (Tucker, 1929, p. 489). See Map Sheet No. 1

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	White Star (~~claim~~	Sec. 12, T2S, R10E, (proj.), SBM.	Undetermined		(Tucker, 1945, pl. 35).

White (Old)

S - Red Cloud (?).

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Gold

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Willow (mine)	T6S, R15E, SBM, 5 miles northwest of Corn Springs.	Undetermined	Quartz and calcite vein from 6 inches to 4 feet wide strikes west and dips 30° south.	Developed through 30-ft. inclined shaft and open cuts along outcrop through a distance of 750 ft. (Tucker, 1929, p. 489).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Winchester Placer	SW¼SE¼ sec. 29, T6S, R4E, SBM., about 2 miles east-southeast of Kenworthy Guard Station.	Raymond E. and Ceba E. Noble, 209 Taylor Ave., Montebello (1958)		(Forest Service records; county records).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Wrench (prospect)	S½ sec. 34, T5S, R4W, SBM, about 2½ miles northwest of Elsinore.	J. H. Wrench, Elsinore (1937)	Quartz stringers strike N. 70° W., and dip 45° NE. roughly parallel with the fracture of quartzite and slate in a zone 3-4 ft. wide.	Worked through open cut 10 ft. wide, 20 ft. long, now caved to average depth of about 5 ft. Dump suggests concealed underground workings. (Engel, 1959, p. 120).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Yucca Buttes	Sec. 10, T5S, R11E (proj.), SBM.	Undetermined		(Tucker, 1945, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Barth (Prizer)	Undetermined: Reported (Ver Planck, 1952, p. 124) location in sec. 2, T4S, R7W, SBM, doubtful	Undetermined	Area covered by alluvium.	Location may have been for a grinding or storage area; gypsum probably obtained from Eagle Canyon-Tin Mine Canyon gypsite belt in nearby Santa Ana Mountains. Operation by H. A. Prizer in 1909 and W. C. Barth in 1914. Reported small production of agricultural gypsite in 1909, 1914, and 1917. (Merrill, 1917, p. 597; Ver Planck, 1952, p. 124-125; Gray, 1961, p. 115).
	Capitol Dome				For Main Street Canyon (L)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	El Cerrito Ranch	Undetermined	Undetermined		A small tonnage of gypsite reported produced in period 1915-1917 for private agricultural use. Probably mined from Eagle Canyon-Tin Mine Canyon gypsite belt about 3 miles south and southwest of Corona in Santa Ana Mountains. (Merrill, 1917, p. 579; Ver Planck, 1952, p. 135; Gray, 1961, p. 115).
	Frazer				See Eagle Canyon (t)
	Freeman-Nonhof				See White Gypsum and Big Chief (t)
	Garbutt and Orcutt				See Maria Mountains
	Garland				See Maria Mountains
	Gypsum Canyon				See Main Street Canyon
	Langdon				See Maria Mountains

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Omei ~~(claim)~~	S½ sec. 9, T4S, R7W, SBM, northeastern flank of Santa Ana Mountains 3½ miles southwest of Corona	Mrs. B. I. Markwell, 1001 N. Lowell St. Santa Ana (1957)	See White gypsum group	(Gray, 1961, p. 116).
	Parkford				See Riverside Mountains deposit (t)
	Prizer				See Barth (t)
	Red Bull				See Hagador Canyon (t)
	Savage				See Mana Mountains (t)
	Ware				See White Gypsum and Prizer (t)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Iron	Secs.? T3S, R14E, SBM, in the Eagle Mts.	Kaiser Steel Corporation	Undetermined	Claims named Iron Nos. 1,2,3,5,7,8,10,13, 14,16,17,18,20,22,23,25,26,27, and 33; Rodger Nos. 1,2,4,5,8, and 9 lodes; patent survey no. 3902, completed in 1901, tied to U.S. Mineral Monuments 85 and 86 (Saul 1962, p. 7).

Laing

Sulphide P... (t)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Little Maria (Randolph & Hamilton?)	W½ sec. 29 (proj.), T3S, R20E, SBM, in Little Maria Mountains about 5 miles north of the Arlington Black Jack manganese mine.	Undetermined	A body of magnetite of undetermined but probably relatively small dimensions, is exposed in an area largely underlain by carbonate-rich rocks of the Maria Formation.	This deposit has probably been known for many years, but the only report which might be supposed to allude to it is about a copper claim, the Randolph and Hamilton. (Merrill, 1917, p. 525).
	Maria Mountain Iron deposit				See Iron Cap claims (L)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Lead King	Sec.?, T6S, R16E, SBM in Chuckwalla Mtns.	P. E. Gates, Los Angeles (1949)	Undetermined	Small shipment to Wickenberg in 1949; smelter recovery 24.8% lead and 7 ounces of silver per ton (Goodwin, 1967, p. 603).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	MacLeish	Sec.?, T5S, R20E, SBM., appears to be in central McCoy Mtns. area.	Undetermined	Undetermined	Ore shipped in 1918 showed a smelter recovery of 54.6% lead, 85 ounces of silver per ton, 0.111 ounces of gold, and recoverable copper. (Eric, 1948, p. 293; Goodwin, 1957, p. 604).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	McConkey	Sec.?, T2S, R12E, SBM.	Undetermined	Undetermined	Ore shipped from Dale district in 1941 contained 6.25% lead, 1.15% copper; 2.25 ounces of silver, and 0.25 ounce of gold per ton. (Eric, 1948, p. 293; Goodwin 1957, p. 604).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mecca	Sec.?, T4S, R11E, SBM.	Undetermined	Undetermined	Pinion district, 47 miles from Mecca. Inclined shaft 250 feet deep; about 1000 feet of drifts. Between 1923 and 1928, about 1050 tons of complex sulfide ore was mined and shipped. Smelters recovery averaged 25% lead, 2.86% copper; 14.76 ounces of silver, and 0.452 ounce of gold per ton. (Eric, 1948, p. 293; Goodwin 1957 p. 604-605).
	Neal				See Bald Eagle (?)

Lead - Silver - Zinc

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Oro Mega	Sec.?, T3S, R12E, SBM, 20 miles south-east of Twentynine Palms at the base of the east slope of Pinto Mts., at edge of Joshua Tree National Monument.	F. E. Grover, 1223 West Bay Ave., Newport Beach (1950)	Undetermined	Development consists of 2 open cuts 60 feet by 600 feet by 3 feet, and 2 adits. Concentrates representing about 7% of the bulk ore were shipped to Selby in 1949-1950. Recoverable metal in the bulk ore has averaged about 2.88% lead; 0.92 ounce of silver, 0.08 ounce of gold per ton, and recoverable copper. Ore was milled at the Ivanhoe mill. (Goodwin, 1957, p. 606).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palisade	Sec.?, T5S, R20E, SBM.	Undetermined	Undetermined	Shipped ore in 1919; smelter recovery was 13.48% lead, 6.10% copper; 6.73 ounces of silver and some gold. (Eric 1948, p. 294; Goodwin 1957, p. 606).

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Lead-Silver - Zinc

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palisades group	SE¼ sec. 4, T6S, R4W, SBM, about 2 miles east of Elsinore.	George Peterson Elsinore (1929)	Sheeted, fractured zone, 2-3 ft. wide, strikes N.60°E., dips 50°SE° in deeply weathered diorite and gabbro. Associated with iron-stained dioritic dike and dark green diabasic and lamprophyric dikes. Limonite and secondary calcite occur in fractures. Ore minerals not visible, although unspecifice quantities of silver, lead, copper, and gold reported in 1929.	Workings disposed for several hundred yards in a northeasterly direction, include inaccessible 30-ft. inclined shaft on sheeted zone and several shallow pits. Nearly ¼ mile northeast are several caved pits 4-7 ft. deep, and one 35-ft. adit in similar rocks. Production, if any, undetermined but small. (Eric 1948, p. 294, map; Tucker, 1929, p. 491; 1945, p. 148, pl. 35; Engel, 1959, p. 123).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Scott Lode No. 1	Sec.?, T5S, R20E, SBM, 14 miles south of Rice. Seems to be an uncertain location. Distance from rice suggests that it is same as Bald Eagle (see herein).	Undetermined	Undetermined	Developed by a 350-foot inclined shaft, 300-foot tunnel, and 120 feet of drifts. Shipped complex ore in 1924; smelter recovery was 24,82% lead, 5.72% copper; 16 ounces of silver, and 0.52 ounce of gold per ton. In 1934 2,100 tons of gold ore yielded 128.08 ounces of gold, 50 ounces of silver, 239 pounds of copper, and 1,108 pounds of lead. (Eric 1948, p. 295; Goodwin 1957, p. 607; U.S. Bureau of Mines records).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Winfield No. 2	Sec.?, T4S, R10E, SBM, Eagle Mt. district, 55 miles northeast of Indio.	W. E. Covey, S.B. Mosher, Box 1135, Indio (1952) Operators: Scott & Lindsay, Box 154, Indio (1952)	Undetermined	Small shipment of complex ore sent to Selby in 1952; smelter recovery approximately 2.62% lead, 5.20% copper; 6.50 ounces of silver, 0.05 ounces of gold per ton, and some zinc. (Goodwin 1957, p. 608).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Big Hill	Sec. 6, T7S, R5E, SBM. Not confirmed (1963)			See Nightingale limestone in text. (Tucker and Sampson, 1945, pl. 35, no. 233; Logan, 1947, p. 272, pl. 37, no. 12).
	Bautista Canyon Deposits				

Limestone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
320	Blue Diamond and Eagle	NW¼ sec. 17, NE¼ sec. 18, T4S, R1E SBM. San Jacinto Mountains about 2 miles northeast of Sobaba Hot Springs.	Harold V. Sims, P.O. Box 16, San Jacinto (1958)	Lenses of pre-Cretaceous gray to white crystalline limestone. Beds strike north to northwest.	In 1958 Mr. Sims held two unpatented claims in the NW¼ sec. 17, Blue Diamond No. 1 and Eagle No. 1. By 1958 these deposits were undeveloped and were accessible by foot only.

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Limestone
Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Blythe Cement nos. 1 to 5	Published location (Logan, 1947, p. 270) appears to be in error; probably located in sec. 25, T3S, R19E, and sec. 30, T3S, R20E (proj.), SBM, on the south slope of the Little Maria Mts. about 4 miles north of the Arlington Black Jack mine.	Undetermined. (1963) Last reported owners W. V. and G. M. Neuman, B. F. and J. E. Rockhold, Martha B. and E. E. Schellenger, Mrs. Lulla Stearns and D. R. Hall, Blythe (1947)	Deposit in an area underlain by intensely folded and sheared carbon-ate rich rocks of the Paleozoic(?) Maria Formation. The central part of sec. 25 is underlain by a mass about ½ mile wide of crystalline limestone with zones of siliceous dolomite and quartzite. This mass extends north into sec. 24 which is almost wholly underlain by these strata.	Five 160-acre association placer claims were located in 1928-29. Apparently these deposits are undeveloped. (Logan, 1947, p. 270).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Cameron Marble Co.	E½ sec. 14, T5S, R5E, SBM., 1 mile west of Rancho Mirage; and W½ sec. 30, T5S, R6E, SBM., 1 mile southwest of Palm Desert. Not confirmed, 1963.	Undetermined	Pre-Cretaceous crystalline limestone with biotite schist and gneiss. Dibblee (1945, plate 2) mapped a large body of undifferentiated Triassic and/or Paleozoic metasedimentary rocks (including limestone) in this area. In sec. 14 a bed of "marble" was reported to strike east, dip 25° S., to be 30 ft. thick, and to crop out for 2,500 ft. In sec. 30 a bed of "marble" 30 ft. wide was reported to strike N. 65° E., dip 23° S., and to crop out for 850 ft. This "marble" was reported to be creamy white with black and gray mottling, (Div. Mines Field Rept. 72, Riverside Co.).	In 1914 the Cameron Marble Co., 1022 California Bldg., Los Angeles, was reported to hold "marble" deposits at these locations. By 1914 only assessment work had been done and apparently the deposits have not been mined. (Dibblee, 1954, pl. 2; Div. Mines Field Rept. 72, Riverside Co.).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Carbonate Blanket (4 placer claims)	Probably on N. slope of Little Maria Mts. about one to 1½ miles NW. of Midland.	Undetermined (1963). Might be held, all or in part, by U.S. Gypsum Co. Last reported owners W. V. and G. M. Neuman, B. F. and J. E. Rockhold, Martha B. and E.E. Schellinger, Mrs. Lulla Stearns and D. R. Hall. Blythe, (1947)	Deposit on or near the north margin of a structurally-complex exposure of mixed carbonate, gypsiferous, calcsilicate, and schistose rocks of the Paleozoic(?) Maria Formation. About 1½ miles northwest of Midland is a metamorphic rock mass as much as 3/4 mile wide and several miles long composed mostly of siliceous dolomite with quartzite, but also with zones of crystalline limestone.	Four association placer claims were located in 1928-29. Apparently the carbonate rocks are undeveloped. (Logan, 1947, p. 270).

Limest.
Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
322	Chino Canyon Deposits	E½ sec. 6, W½ sec. 5, T3S, R4E, SBM. Along the north side of Chino Canyon near the west boundary of the City of Palm Springs.	Sec. 6 is within the Agua Caliente Indian Reservation; sec. 5 is owned by the Southern Pacific Co., 65 Market St., San Francisco 5.	Interbedded pre-Cretaceous schist and carbonate rocks intruded by granitic rocks. Numerous beds of crystalline limestone strike north to northwest and dip about 50° east. Major carbonate-bearing zones range from 500 to 1,500 ft. in length and are as much as 100 ft. wide.	Deposits have not been developed. The small size of individual limestone bodies and the nearness of Palm Springs probably precludes commercial development.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
323	Eden Hot Springs Limestone Deposit	NW¼NW¼ sec. 25, T3S, R2W, SBM. About 9 miles northwest of San Jacinto, 3/4 mile southeast of Eden Hot Springs at the base of the steep west face of Mt. Eden.	Thos. D. McTavish, Route 1, Box 82, Camarillo (1945). Undetermined (1963)	Pre-Cretaceous limestone, the northwestern extension of a sequence of metamorphic rocks mapped by Fraser (1931, plate facing p. 540) as Paleozoic or older. White to gray, medium to coarsely crystalline limestone mass strikes northwest, dips about 40° NE. Limestone mass is probably more than 1,000 ft. long and 200 to 300 ft. wide.	In 1929 the deposit, which is on private land, was owned by Eden Hot Springs, Inc. The deposit appears to be high-grade white limestone. Previous reports state that the $CaCO_3$ was reported to be 98%. Apparently this deposit has not been mined as no evidence of development work was observed in July, 1963. (Tucker and Sampson, 1929, p. 515; Tucker and Sampson, 1932, p. 6, pl. 1; Tucker and Sampson, 1945, p. 172; Logan, 1947, p. 271).

Friant Hill Quarry

2nd Old City Quarry (?)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
32	Fingal Deposit	Sec. 17, T3S, R3E, SBM. North-trending spur at the north margin of the San Jacinto Mtns., one mile southeast of Fingal.	Undetermined	Pre-Cretaceous limestone interbedded with mica schist and granitic gneiss. Band composed mostly of limestone, about 2,500 ft. long and 100 ft. wide, strikes northwest, dips 65° NE.	Narrow band of limestone cuts across a spur just south of the center sec. 17, mostly in the NE¼SW¼ sec. 17. Apparently undeveloped.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Harris	Sec. 9, T7S, R5E, SBM. Not confirmed (1963)			See Nightingale limestone in text. (Tucker and Sampson, 1945, pl. 35, no. 236; Logan, 1947, p. 271).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
327	Hubbard Limestone Deposit	S½ sec. 24, T4S, R1W, SBM. About 3/4 mile northwest of Soboba Hot Springs, on the steep west face of the San Jacinto Mountains, northeast side of State Highway 79.	W. F. Rohland and Mary Heinsen, Gilman Hot Springs, (1945) Undetermined (1963)	Pre-Cretaceous, medium to coarse crystalline white limestone lens in a large mass of Pre-Cretaceous metamorphic rocks, which are mostly schist and quartzite. Limestone strikes N. 40° W., dips 18° NE. One of a number of limestone lenses in the large metamorphic rock mass that extends about 8 miles northwest from Soboba Hot Springs to just beyond Lamb Canyon.	Limestone was mined from an open cut 75 ft. long with face 20 ft. high, located at the head of a steep, narrow ravine about 1,000 ft. above Highway 79. Property was owned and operated by the Snowflake Lime Company, probably about 1900, and supplied limestone to a steel-shell limekiln which still stands near Highway 79. Tucker and Sampson (1945, p. 173) report that the limestone was blasted and allowed to roll down the canyon to the kiln. Early day residents, however, state that the limestone was lowered to the kiln by means of a cableway tram, but no trace of such an installation remained in 1963. The lime is said to have been used extensively for building mortar throughout southern California. By 1929 the quarry was owned by Omar H. Hubbard, Long Beach, but had been idle for some years and has not since been operated. (Tucker and Sampson, 1929, p. 516; Tucker and Sampson, 1932, p. 7; pl.1 Tucker and Sampson, 1945, p. 271; Logan, 1947, p. 172-173)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Mammoth 7 Limestone Claim	Undetermined	Louis Steck, 443 North 7th Street, Colton (1947), Undetermined (1963)		According to Logan (1947, p. 272) Louis Steck held 80 acres within one mile of the Palm Springs Station. Apparently this location was in the vicinity of the Novelle, Guiberson, and Southern Pacific limestone deposits (see herein). Mr. Steck is reported to have shipped a few carloads of limestone to Los Angeles in the early 1940's, and to have made several exploratory cuts. (Logan, 1947, p. 272).
	Mira Loma				

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
332	Mt. Edna Deposit North Hill Quarry	SW¼ sec. 28, T3S, R1E, SBM. 4 miles south of Banning, on the southwest face of Mt. Edna at the Colorado River Aqueduct, north side of the old Banning-Idyllwild Road.	Undetermined	Limestone body occurs with pre-Cretaceous mica schist, a pendant in bouldery granite. Gray to white, medium to coarse crystalline limestone strikes northwest, appears to dip northeast. Limestone mass is about 2,500 ft. long, 250 to 500 ft. wide.	West edge of deposit has been explored by a road-like dozer cut about 500 ft. long. Apparently no production and no recent activity. See Old City Quarry under Rock Product (Building crushed stone) t 190

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
336	Novelle Limestone Deposit	NW¼NW¼ sec. 26; NE¼, NE¼ sec. 27, T3S, R3E, SBM. Steep northern margin of San Jacinto Mtns., about one mile south of Palms Springs Station, in the City of Palm Springs.	George A. Novelle, Monrovia (1932) Undetermined (1963)	Series of interbedded pre-Cretaceous schist and carbonate rocks intruded by granitic rock strikes N. 50° W., dips 55° NE. In the northwest corner of sec. 26 and the northeast corner of sec. 27 is a mass of blue to gray coarse crystalline limestone about 1,500 ft. long and 900 ft. wide, but also contains some dolomite and interbedded schist. In addition thin limestone beds in mica schist crop out at several places in the northern half of sec. 26.	In the late 1920's George Novelle held all of sec. 26. By 1945 the property was reported to have reverted to the public domain. Apparently this deposit has not been mined; the nearness of Palm Springs probably precludes its exploitation. (Tucker and Sampson, 1929, p. 516-517; Tucker and Sampson, 1932, p. 8, pl. 1; Tucker and Sampson, 1945, p. 173; Logan, 1947, p. 272).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Old City Quarry (Fairmount Hill Quarry, North Hill Quarry)				See under Rock Products, Broken and Crushed Stone.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palm Springs Canyon	Secs. 25, 36, T5S, R4E, SBM. In Palm Springs Canyon, about 9 miles south of Palm Springs. Not confirmed (1963).	Undetermined	A large mass of pre-Cretaceous metamorphic rock crops out along the east side of Palm Springs Canyon. The sequence strikes north and dips 35° E. The metamorphic series is mostly mica schist, but contains minor amounts of limestone and quartzite (Fraser, 1931, plate facing p. 540).	In 1945 Tucker and Sampson (no. 243, plate 35) listed a limestone deposit at this location. Apparently it is undeveloped. (Fraser, 1931, plate facing p. 540; Tucker and Sampson, 1945, plate 35).

Limestone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palo Verde Dam Quarries				See in text under Rock Products, Broken and Crushed Stone.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Pinyon Flat	Secs. 5, 6, T7S, R5E, SBM. Not confirmed (1963)			See Nightingale limestone in text. (Merrill, 1917, [1919], p. 551, fig. 4; Logan 1947, p.272, pl. 37, no. 12).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
337	Potrero Creek Deposit	W½ sec. 34, T3S, R1W, SBM. 4½ miles due south of Beaumont and 1 mile west of San Jacinto Nuevo y Potrero	Riverside Cement Company, Division of American Cement Corporation, mill office, P.O. Box 832, Riverside (1962)	At least 5 limestone bodies occur in a mass of pre-Cretaceous metamorphic rock (mostly schist and quartzite) which crops out as an irregularly shaped mass in the central part of sec. 34. This metamorphic rock mass is about 1 mile long and ranges from ¼ to 3/4 mile in width. Gray to white, medium to coarse crystalline limestone bodies strike northwest and dip 50°-60° NE. The two largest limestone bodies, about ½ mile apart, appear to be from 1,000 to 1,500 ft. long and 250 to 500 ft. wide.	Local residents report that limestone was transported from this deposit about 1900-1915 by pack mules and presumably was burned locally for building lime. The principal limestone bodies have been explored or mined from a number of small cuts. About 1960 the Riverside Cement Company explored the property and did some drilling, but in 1963 the deposit remained idle.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Schellinger (Schellenger) [illegible]	Sec. 22, T3S (proj.) R21E, SBM, on the north slope of the Big Maria Mts., about 2½ miles NE. of Styx	Undetermined (1963). Reported probably to have reverted to public domain (1945).	Deposit part of an east-west trending belt about 1 mile long and ½ mile wide of mixed carbonate-rich rocks. White to gray, coarsely crystalline limestone of the Paleozoic(?) Maria Formation. Reported (Tucker and Sampson, 1945, p. 174) to be 200 feet thick and to have shown, by analyses, to be 98.45 percent calcium carbonate and 0.25 percent "magnesia".	Apparently undeveloped. (Tucker and Sampson, 1929, p. 520-521; Tucker and Sampson, 1945, p. 174, pl. 35). [illegible] 197

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
343	Southern Pacific Deposits	S½SW¼ sec. 23, T3S, R3E, SBM. North margin of the San Jacinto Mtns., 3/4 mile south of Palm Springs Station; and SE¼NW¼, SE¼SE¼, sec. 25, T3S, R3E, SBM. on each side of the mouth of Blaisdell Canyon, about 1 mile south of Windy Point.	Southern Pacific Company, 65 Market Street, San Francisco 5, owns all of sec. 25 and all of sec. 23 except the NW¼SW¼.	Series of pre-Cretaceous mica schist, granitic gneiss, and limestone. The limestone is white to gray and medium to coarsely crystalline. Part of the limestone is massive and uncontaminated with other sediments, but in places it is contaminated by granitic dikes, dolomite, and schist. A metamorphic mass in sec. 23 consisting mostly of limestone strikes about N. 50° W., dips 65° NE., and has maximum dimensions of 2,750 ft. by 1,250 ft. This mass is the southeast extension of the Guiberson deposit (see herein). The principal limestone-bearing sequence in sec. 25 lies in the SE¼NW¼ and has maximum dimensions of 1,500 ft. by 900 ft. The beds strike N. 10-15° W., dip 65° NE. Three limestone beds in the SE¼SE¼ sec. 25 range from 1,250 ft. to 1,750 ft. in length and are 200-250 ft. wide, separated by 250 to 400 ft. of schist.	Apparently no production from these deposits. The nearness of Palm Springs probably precludes their commercial exploitation. (Tucker and Sampson, 1929, p. 521; Tucker and Sampson, 1932, p. 8, pl. 1; Tucker and Sampson, 1945, p. 174; Logan, 1947, p. 273-274).

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Limestone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Whitecap Limestone No. 1 and No. 2	SW¼ sec. 29, W½ sec. 31, sec. 32 (proj.) T3S, R21E, SBM, one to two miles NE. of Midland in the Big Maria Mts.	Undetermined (1963). Probably held at least in part by U.S. Gypsum. Last reported owners W. V. and G. M. Neuman, B. F. and J. E. Rockhold, Martha B. and E. E. Schellenger, Mrs. Lulla Stearns, and D. R. Hall, Blythe (1947).	Deposit part of an east-west trending belt of mixed, carbonate-rich rocks of the Paleozoic(?) Maria Formation. 160-acre placer locations reported (Logan, 1947, p. 274) to be on high calcium limestone. The SW¼ of sec. 31 (proj.) is underlain by crystalline limestone.	Two 160-acre placer locations made in 1928. Apparently the limestone deposits are undeveloped. (Logan, 1947, p. 274).

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Limestone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Whitewater Deposit				See Guiberson deposit.
	Nichols				Magnesite See Hemit Magnesite

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Black Bird Black Eagle & Newport Black Horse group)	Sec. 24(?), T4S, R19E, SBM. Four claims just west of Black Jack mine.	Undetermined	Mn oxides in narrow veins in rhyolite (granite porphyry).	~~See Calington - Blackjack (t)~~ See Bead - McClellan (t) Probably in part the same as the Manganese Canyon group (see herein). (Bradley, 1918, p. 56; Tucker, 1929, p. 492).
	Black Jack				See Adington - Black Jack (t)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Box Canyon Manganese deposit	Sec. 24, T6S, R10E, SBM. 1/8 mile west of Shavers Well.	Leland Noblitt, Brawley (1945)	Manganese oxides and quartz in irregular bodies in schist.	This deposit probably similar to the Big Bullett claims (see herein). Developed by shallow, open cut. (Tucker 1945, p. 150, pl. 35; Trask, 1950, p. 182).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bray ~~mine~~	Sec. 19 (proj.), T4S, R20E, SBM, about 1000 ft. south of Black Jack group.	Undetermined	Probably similar to Black Strike (see herein).	Reportedly yielded 44 percent Mn ore in 1918. May be same or near Black Strike (see herein). (Bradley, 1918, p. 56; Tucker 1929, p. 493; Trask 1950, p. 178).
	Brennan prospect				Big Bear (-Mc Call...) (?)

~~Gold~~ Manganese

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Clark and Losekamp prospect	SW part of T5S, R1W, SBM, 4 miles southeast Winchester.	Undetermined	Manganese oxides in bedded rocks.	(Trask, 1950, p. 182).
	[illegible]				See [illegible]
	Elsinore				See [illegible]
	Giant Chief				See [illegible]

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Groce (mine)	Sec. 19 (proj.), T4S, R20E, SBM.	Undetermined	4-8 inches of high-grade Mn oxides in faulted granite porphyry.	Probably the same property as Black Strike (see herein). Ore reported shipped from this property in 1918. (Tucker, 1929, p. 493; Trask, 1950, p. 174-179).
	Groce				P. Pat. Black Strike (?)
	Mabey & Brown				(See Livingstone ?)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Noblett Manganese (claim)	Sec. 23, T6S, R10E, SBM.	Probably Leland Noblett, Brawley (1945)	Probably similar to Big Bullett claims (see herein).	(Tucker 1945, pl. 35).
	Paddy Fault (NW)				See Kunkel Property

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palen Mountains deposit	T4S, R18E(?) SBM.	Undetermined		(Bradley, 1918, p. 59; Trask, 1950, p. 185).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Palo Verde Region	8 mi. NW.(?) of Palo Verde.	Undetermined		Claims reported in 1918 as belonging to Lugo and Justice Smith of Palo Verde appear to be mislocated and probably lie in Imperial Co. southwest rather than northwest of Palo Verde. May be the Lugo (Lost Donkey, Palo Verde) claims. (Bradley, 1918, p. 59; Tucker 1929, p. 494; Trask, 1950, p. 76-77).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Parsons (mine)	Sec. 19 (proj.), T4S, R20E, SBM, probably just south of the Black Strike (see herein).	Undetermined	Manganese oxide vein as wide as 2.5 feet in fault-breccia zone in granite porphyry.	Developed through 100-foot shaft with drifts on three levels. By 1918 property had yielded 500 tons of ore. (Trask, 1950, p. 179).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Pinkham (prospect)	T6S, R9E, SBM, 10 miles east of Mecca.	Undetermined		Apparently little more than a prospect, reported in 1916 as "indications of ore are said to be blocks of float of manganese oxide". (Trask, 1950, p. 185).

Manganese

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Robinhood No. 4	NE¼ sec. 33, T5S, R4W, SBM, about 1½ miles southeast of highway 74 and about 2 miles northeast of Elsinore.	Giles D. and Eunice M. Robbins, 2754½ Nebraska Avenue, South Gate (1942)	Triassic ~~Santa Ana~~ (Bedford Canyon) chloritic shaly slate contains 3-ft. wide manganiferous siliceous layer along bedding. Manganese oxide replacement of rhodonite and black stained quartz. Manganiferous layer massive except 6 in. of parallel banding on each border suggests layering, possibly of chert beds.	Exposures limited to 10-ft. trench with 7-ft. face; 3-ft. pit 50 ft. southeast on same lense, and 10-ft. long outcrop of similar material 30 ft. to southwest and 100 ft. south of trench. No production. (Engel, 1959, p. 124-125).

Manganese

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unnamed prospect~~	NW¼ sec. 34, T5S, R4W, SBM, 2 miles southeast of Highway 74 and 2 1/8 miles northeast of Elsinore.	Undetermined	Manganese oxides in siliceous bed 4½ ft. thick with quartz and a little rhodonite.	Manganese-bearing bed exposed along 20-ft. trench with 5-ft. race; offset segment of similar zone exposed in shallow pit just southeast. (Engel, 1959, p. 125).
	Lucky Day Lucky Lay				Mica per Pete Kreat dig[illegible]

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Agua Caliente Spring				See Palm Springs.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bundy Hot Springs (Bundy's Elsinore Hot Springs)				See Lake Elsinore Hotel

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
365	City of Elsinore Wells	SE¼ sec. 6, T6S, R4W, SBM.	City of Elsinore, (C. O. Soots, Supt. of Public Works, City Hall, Elsinore) (1955)		Two wells in Elsinore: No. 1 in City Maintenance yard, west of north end of Langstaff Street; No. 2 well 500 ft. southwest of No. 1, between Langstaff and Riley Streets, north of Flint Street. (Engel, 1959, p. 104-105, 139).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
366	Creswell Baths	Cor. secs. 5,6,7,8, T6S, R4W, SBM.	Noritatsu and Mitsuyo Nakai, Spring and Franklin Streets, Elsinore (1955)		(Engel, 1959, p. 105, 139).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
367	Desert Hot Springs	E½ sec. 30, T2S, R5E, SBM.	L. W. Coffee, 257 S. Spring St., Los Angeles (1945)	Hot-water wells in the San Andreas fault zone.	Well, sunk in 1940, in the San Andreas fault encountered hot water at a depth of 300 ft. As of 1945 eight wells were developed with a combined capacity of 1500 gals. per minute in temperatures ranging from 112° to 116°. Water used in bath house and swimming pool. (Tucker 1945, p. 175-176).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
368	Eden Hot Springs	E½ sec. 23, T3S, R2W, SBM.	M. Greenberg (1945)	Eight small springs in the San Jacinto Fault zone.	Maximum temperature of water about 110°F. Bathhouse and swimming pool. (Waring, 1915, p.37; Tucker 1929, p. 523; 1945, p. 176).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Elsinore Springs				See Lake Elsinore Hotel and Lakeview Inn hot springs.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Elsinore Hot Springs				See Lakeview Inn hot springs.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
369	Gilman Hot Springs (Relief Hot Springs, San Jacinto Hot Springs).	SE¼ sec. 9, T4S, R1W, SBM, 3 miles north of San Jacinto on State Highway 79.	Gilman Hot Springs, Mrs. Joe Gilman, proprietor and Wm. Gilman, mgr. (1945)	About 6 springs in the San Jacinto fault zone near the base of the San Jacinto Mtns.	Hot spring, motor hotel and golf resort. Reported in 1945, as equipped with hotel, cottages and cabins, a large garage. Roman tub baths, mud baths and swimming pool. (Waring, 1915, p. 38; Tucker, 1929, p. 521-523; Sampson, 1931, p. 8, pl. 1; Tucker, 1945, p. 176-177).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
370	Glen Ivy Hot Springs	Sec. 10, T5S, R6W, SBM, at base of Santa Ana Mtns. in Temescal Canyon, 10 miles south of Corona.	Axel Springborg and wife (1945)	Small springs having a reported temperature as high as 110°F. issue from the Elsinore fault zone through fractured granitic and porphyritic rocks.	Reported in 1945 to be equipped with a bathhouse, swimming pool and accommodations for guests. (Waring, 1915, p. 42; Tucker, 1929, p. 521; 1945, p. 178).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
371	Highland Springs	W½ sec. 25, T2S, R1W, SBM, about 3 miles northeast of Beaumont.	F. S. and W. W. Hirsh, 646 E. 8th Street, Los Angeles (1945)	Springs issuing from the San Andreas fault zone at the base of the south slope of the San Bernardino Mtns. Water temperature 112°F.	Described in 1945 as comprising a bathhouse and large swimming pool. (Tucker, 1945, p. 178-179).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
372	Lake Elsinore Hotel (Bundy's Elsinore Hot Springs, Bundy Hot Springs, Elsinore Springs Elsinore Hot Springs, Wreden, (Wrenden))	Cor. secs. 5,6,7,8, T6S, R4W, SBM (proj.), Main at Franklin Streets, Elsinore.	Dr. Wm. E. Schwartz, 605 North Sierra Drive, Beverly Hills. Leased to George Lewis, Murray Finberg and M. L. Herbener, Box 236, Elsinore (1955).	In 1915, Waring reported: "Many small hot springs formerly issued along the northeast side of Elsinore Lake. In the early nineties, however, a canal was cut and the water of the lake was conducted northward for irrigation, and since that time most of the springs have ceased to flow. Hot sulphurated water is still obtained, however, from shallow wells." (Waring, 1915, p. 42).	A resort comprising a hotel and bathhouse (1945). (Waring, 1915, p. 43, 387; Merrill, 1919, p. 58, 581; Tucker, 1929, p. 523; 1945, p. 181, pl. 35; Larsen 1948, p. 128; 1951, p. 45; Engel, 1959, p. 105, 139).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
373	Lakeview Inn Hot Springs (Elsinore Springs, Elsinore Hot Spring)	NE¼ sec. 7, T6S, R4W, SBM (proj.), Graham at Riley Streets, Elsinore.			(Waring, 1915, p. 42-43, 387; Merrill, 1919, p. 580; Tucker, 1929, p. 521-523; 1945, p. 179, pl. 35; Engel, 1959, p. 106, 140).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
374	Murrieta Hot Springs	SW¼ sec. 13, SE¼ sec. 14 (proj.), T7S, R3W, SBM, on Webster Avenue about 4 miles east of Murrieta.	Guenther's Murrieta Hot Springs, Murrieta Hot Springs Road	Hot springs issuing from the Elsinore fault zone at base of a gravel bluff. Three springs with a maximum temperature of about 136°.	Hotel, bath-house, cottages and bungalows, and landing field for aircraft. (Waring, 1915, p. 44; Tucker, 1929, p. 523; 1945, p. 179-180, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
375	Nichols Warm Springs	SE¼, sec. 36, T6S, R21E, SBM, 7½ miles west of Blythe on U.S. 60-70.	Nicholls Warm Springs, A. E. Nicholls, President.	Undisturbed alluvial deposits underlying the Palo Verde Mesa.	A cased, 14-inch well, 638 feet deep drilled in May, 1946. Well does not reach bed rock. Static water level was 138 feet. Temperature of water coming out of well 92°. Average analysis ppm Total solids ----------1811.6 Total Chloride (NaCl) ------ 852.2 Total Sulphate (Na_2SO_4) ---- 810.5 Total Alkalinity ($CaCO_3$) --- 111.0

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
376	Palm Springs	SW Cor. sec. 14, T4S, R4E, SBM, at the corner of Indian Avenue and Taquitz Drive in the city of Palm Springs.	Undetermined	Probably issues from a fault along the base of the mountains.	(Waring, 1915, p. 338; Merrill, 1919, p. 581; Tucker, 1929, p. 523; Sampson, 1931, p. 9, pl. 1; Tucker, 1945, p. 180, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Relief Hot Springs				See Gilman Hot Springs.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	San Jacinto Hot Springs				See Gilman Hot Springs.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
377	Soboba Hot Springs	NW¼ sec. 30, T4S, R1E, SBM, near Highway 79 about 1 mile northeast of San Jacinto	John G. Althouse, San Jacinto	Six springs issue from the San Jacinto fault. Water temperature ranged from 70° to 118° F. in 1945 (Tucker, p. 180).	Equipped with bath house, separate dwellings, and a swimming pool (1945). (Waring, 1915, p. 39; Tucker, 1929, p. 23; Sampson, 1931, p. 10, pl. 1; Tucker, 1945, p. 180-181).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Wreden (Wrenden)				See Lake Elsinore Hotel.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Aurora No. 1 mine	Sec. 26, T6S, R14E, (proj.), SBM.	Tyler Bennett and A. H. Hummel, N. Hollywood (1956)	Unidentified radioactive mineral in copper-stained quartz vein in granite.	May be an old gold prospect. (Walker, 1956, p. 12, 26).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Big Cat	SW¼SW¼ sec. 17, T7S, R4E, SBM. 4¼ miles east of Anza.	J. W. and R. F. Barnes 230 E. Bennett St., Compton (1962)	Sheared and faulted granitic rock in the San Jacinto Fault ~~trace~~ Zone.	Property located by this owner May 6, 1957. Developed by single, 20-foot shaft. Anomalous radioactivity, ~~possibly due to radon gas,~~ reported by owner, ~~to be confined to shaft.~~ No uranium mineral yet identified (1962).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Northeast No. 1 claim	E½W¼ sec. 19, T6S, R21E, SBM, about 2 miles north of U.S. 66-70 and 12 miles west of Blythe on the south slope of the McCoy Mtns.	Joseph and Charles Safrnek, 4219 Lennox Blvd., Lennox	Property lies on east slope of narrow, north-northwest-trending ridge of sheared, metasedimentary rocks. Secondary, yellow, radioactive mineral resembling carnotite unevenly distributed along shear zones in which it has impregnated porous material and formed thin crusts and fissure fillings. Deposit exposed in area several hundred feet long and about 100 feet wide. Full extent not determined.	Radioactive area opened by several bulldozer cuts (Butler, 1962).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Ironwood No. 1 Prospect	NW¼ sec. 20, T3S, R23E, (proj.), SBM, about 20 miles north of Blythe and 3 miles west of Quien Sabe Point.	Undetermined	Fine to-medium-grained hornblend granite cut by thin pegmatite dikes. No unusual mineralization or radioactivity found.	Located in 1956 by Guy Waite and Cyrus H. Ferguson, Box 29, Parker Star Rt., Blythe. Development comprises a 9-foot burrow in east bank of wash, and road work.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
452	Berdoo Adit Aggregate	SW¼ sec. 10, T4S, R8E, SBM, in Berdoo Canyon 3½ miles northeast of the intersection of Berdoo Canyon and Dillon Road.	Metropolitan Water District of Southern California, 306 West Third St., Los Angeles	Terrace deposits and/or older alluvium along north side of Berdoo Canyon. Material semi-consolidated, massive, poorly sorted sand, gravel, and boulder conglomerate. Deposits about 3 miles long and average of a quarter of a mile in width. Thickness undetermined.	Sand and gravel used in concrete aggregate taken from deposit during construction of Colorado River Aqueduct, 1932-41. Since inactive. Open pits and cuts.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
453	Corona Rock Company	W½ sec. 32, T3S, R6W, SBM, northwest end of Temescal Wash, 2 miles southeast of Corona, along the east side of the city dump.	Riverside County Flood Control District (1957).	Quaternary alluvium in Temescal Wash; dirty, silty sand with sparse gravel.	About 1937, a small sand and gravel plant known as the Corona Rock Company was erected and operated by Bill Flynn. Dismantled after several years operation. Several small, shallow pits 10-15 feet deep.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
454	Desert Hot Springs Ready Mix, Inc. (deposit)	SE¼ sec. 13, T2S, R4E, SBM, about 1½ miles NW. of Desert Hot Springs	Desert Hot Springs Ready Mix, Inc. Box 286, Desert Hot Springs	Dry wash extends south for about ½ mile from head of canyon. Width ranges from 100-300; up to 50 deep on bed rock. About 70 percent gravel, interstratified layers of sand and gravel up to 1' thick. No overburden or replenishment. Few percent plus 4" gravel. Occasional 2' boulders.	Excavated with dragline scraper and bulldozer to depths of about 50'. Feed empties over primary jaw which crushes plus 4" gravel. From jaw, feed conveyed to trommel screen from which plus 1½" goes to secondary jaw crusher. Wash over standard vibrating screens, twin sand drag. Capacity 60 tons/hr. concrete sand and gravel.

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Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
455	Fan Hill Canyon deposit	SW¼SE¼ sec. 20, T3S, R7E, SBM, south edge of Little San Bernardino Mts., 9 miles northeast of Thousand Palms, at west margin of Fan Hill Canyon.	Undetermined	Quaternary alluvium, mostly a sandy, pebble and cobble conglomerate with few boulders. Clasts of metamorphic and granitic rock found in Little San Bernardino Mts.	Probably used in construction of Colorado River aqueduct, 1932-41. Roughly circular pit 400 feet in diameter and 10 to 25 feet deep.

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Sand and gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
456	Fargo Canyon Talus ~~deposit~~	Sec. 10, T5S, R8E, SBM, north side of Fargo Canyon Road, 4½ miles northeast of Indio.	Undetermined.	Quaternary alluvial fan. Sandy conglomerate with cobbles and boulders of granitic and metamorphic rocks.	Material tested for all American Canal in 1949 by U.S.Bureau of Reclamation (Report No. C-440). The sample submitted contained a 1½ inch maximum size aggregate and is suitable for use as concrete aggregate, provided the sand is washed to remove silt and an air-entraining agent used in the concrete. No report of use in Government construction. Small pit 150 feet long, 50 feet wide and 20 feet deep. (Dickey and Porter, 1952, p. 9).

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Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
457	Flat Top Mountain deposit	SW¼ sec. 33, T3S, R5E, SBM, southeast end of Indio Hills 5 miles northwest of Thousand Palms on the south side of Flat Top Mountain.	Undetermined	Dune sand.	Shallow pit on hillslope, about 500 feet wide and 750 feet long. Probably used in local highway construction.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
458	Hicks-Allred Indio Hills (deposit)	SW¼ sec. 5, T4S, R6E, SBM. Approx. 2½ miles north of Thousand Palms.	Hicks-Allred, 36711 Cathedral Canyon Drive, Cathedral City	(See Yaeger)	Excavate with tractor bull-dozer that pushes material to plant. Crush over-size in two jaw crushers. Wash over standard vibratory screens, sand rake. Capacity 130 tons/hr. Products - concrete sand and gravel.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
459	Industrial Asphalt (Kuster and Waterbury, Transit Mixed Concrete Co.) Corona plant	SE¼ sec. 30, west margin SW¼ sec. 29, (proj.), T3S, R6W, SBM. At Porphyry station, 1 mile east of Corona in lower Temescal Wash.	Industrial Asphalt of California, Inc., 1027 Quarry, Corona (main office, Santa Fe Springs). (1963)	Quaternary stream deposit of silty sand and gravel.	Medium sized plant for concrete sand and gravel operated for many years by Kuster and Waterbury before 1942; from 1942 to the late 1950's by Transit Mixed Concrete Co., who built a new small plant. The most recent operator was Industrial Asphalt. Plant closed down in 1961, apparently because economic depth limit of deposit was reached. Most of the mining was from 2 adjacent pits east of the plant; one pit is about 1,000 ft. by 750ft. and 40 ft. deep; the other pit is about 750 ft. by 500 ft. and 30 ft. deep. Total production undetermined, probably a few hundreds of thousand of tons of washed sand and gravel. (Gray, 1957, p. 96, 119).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Kuster and Waterbury				See: Industrial Asphalt, Corona plant.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
460	Massey Indian Ave. deposit	W½SW¼ sec. 23, T3S, R4E, SBM on Indian Ave. 3 miles south of Garnet	Massey Sand and Rock Co., 43-850 Monroe St., Indio	Whitewater wash. Interbedded gravelly layers up to 1', and sand layers from 1-3' thick. Deposit at least 50' deep, extends north for several miles from intersection with U.S. 60 and to the east of its confluence with San Gorgonio River, for about 5 miles. Width of deposit ranges from 0.25 mile at head to about 1.0 mile south of Garnet. No overburden. Slight replenishment. Abundant cobbles and boulders up to 3'; 18" max. size gravel near Whitewater dimishes to 4" max. near Garnet where few percent plus 4" gravel and occasional 3' boulders present. Gravel content 65 percent near Whitewater dimishes to 25 percent near Garnet.	Excavate from pit approx. 1000' in diameter to depths of 50' with bulldozer (which pushes material to a conveyor). Convey about 300' to plant. Scalp oversize off top deck double vibrating screen. Sand goes to Wemco sandscrew. Crush oversize in two jaw crushers. Wash over standard vibrating screens, sand drag. Capacity of 2200 tons/day. Material used for concrete and bituminous sand and gravel, plaster sand.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
461	Massey Indio Hills deposit	NE¼ sec. 3, T5S, R7E, SBM, about 3 miles north of Indio	Massey Sand and Rock Co., P.O. Box 487, Indio	Alluvial fan deposit on southwest flanks of Indio Hills. Developed area covers about ½ sq. mile. Deposit contains about 35 percent gravel. At least 60' deep. Interbedded sand and conglomerate layers range from 1 to 3' in thickness. No overburden or replenishment. Abundant plus 3" gravel, av. max. size 18"; some 2' boulders. Max. size dimishes to west and north.	Excavate with shovel from pit with working face about 30' high. Haul about 2000' in end dump trucks to plant. Discharge over grizzly into primary jaw crusher. Crush plus 3" in secondary cone. Wash over standard vibrating screens; sand wheel. Bucket elevator and conveyors load bunkers. Capacity 2500 tons/9 hrs. Products - concrete and bituminous sand and gravel, road base, plaster sand. Have hot mix on premises. Truck to ready mix plant in Indio.

Sand and gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
462	Massey Whitewater (deposit)	NE¼ sec. 11, T3S, R3E, SBM, ¼ mile north of Whitewater	Massey Sand and Rock Co., 43-850 Monroe St., Indio	See Massey Indian Ave. deposit	Excavate with shovel from pit in dry wash. Haul by truck to nearby plant. Depth of deposit 50'. Abundant boulders. Pit run dumped over grizzly into reciprocating feeder. Crush in primary and secondary jaw, tertiary cone and roll crushers. Dry screen over standard vibrating screens. Capacity of 450 tons/hr. Concrete and bituminous sand and gravel, road base.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
463	Mission Creek (deposit)	S½ sec. 16, T2S, R4E, SBM, 4 miles northwest of Desert Hot Springs in Mission Creek just east of Twentynine Palms highway.	Undetermined	Alluvium of unknown depth covers large area. Apparently material in Mission Creek-Dry Morongo Wash area has more favorable sand-gravel-reject fines ratio than does the material adjacent to the wash.	The deposit was opened in 1957 and operated from June 1957, to February 1958 by the Gunther-Shirley-Lane Co. Aggregate for concrete was supplied to the nearby semi-portable plant of the American Pipe Construction Co. where precast pipe was made for use in the Colorado River Aqueduct expansion in the area. Inactive since 1958. Large open-pit quarries. Semiportable plant produced washed sand and gravel. International TD24 Tractor dozer fed hopper directly from pits. (Proctor, 1958, p. 143).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
464	Murrieta Borrow Pit	SW corner of Webster and Jefferson Aves. in the Murrieta portion of the Temecula Rancho, one mile southeast of Murrieta	Riverside County	Coarse fanglomerate with interbedded sand and silt (Quaternary Pauba Formation of Mann, 1955, plate 1).	Used as a source of road metal by Riverside County since 1950. Mine intermittently from an open pit.

Corona Quad Geol Map no. 56

Rock Products

Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
465	Pomona Ready Mix Concrete	NE¼NE¼ sec. 5, T4S, R6W, SBM. East side of Temescal Wash, 3 miles southeast of Corona.	Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn. owns a large tract of land. Pomona Ready Mix Concrete, Upland, owns and operates the plant.	Recent stream-deposited sand in Temescal Wash.	Ready Mix concrete batch plant erected early in 1963. Plant utilizes quarry waste from Temescal Rock Quarry for concrete gravel and sand from Temescal Wash adjacent to the plant. Sand is mined by front end tractor loader from small pit about 50 feet by 100 feet and 10 feet deep.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
466	Riverside County Gravel Pit	E½NW¼, W½NE¼ sec. 29, T6S, R7E, SBM.	Riverside County	Quaternary alluvial fan deposit of sand and gravel.	Owned by Riverside County since 1947. Development undetermined.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
467	Riverside County Gravel Pit	SE¼NE¼NE¼ sec. 20, T7S, R3E, SBM. west side of Bahrman Rd., ¼ mile south of Coahuila Rd.	Riverside County	Quaternary stream deposit.	Owned by Riverside County since 1946. Development undetermined, probably a local source of fill and road metal.

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Rock Products

Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
468	Riverside Sand Company	NE¼SW¼ sec. 25, T2S, R6W, SBM. North bank of Santa Ana River ¼ mile east of Van Buren Blvd. (Pedley Road).	Riverside Sand Company 7626 Arlington Ave. Riverside	Quaternary sand deposit along margin of Santa Ana River channel. Deposit contains minor proportion of gravel with a few cobbles.	Circular pit about 200 feet in diameter filled to surface with water. Pit 35 feet deep. Plant erected in 1960 and placed in operation September 1962. Mine with 2 cu. yd. slack line drag which feeds a bin. Raw material goes by belt conveyor to shaker screens, washing; rock is scalped off and sent to one pile, coarse sand to another pile, finer sand to a third pile. Silt and mud fines are rejected by a twin sand drag and returned to river bank area. Plant capacity is 65 tons per hour; 100 tons per hour with a larger drag. Products include: Plaster sand, concrete sand, 3/4-inch rock, and pea gravel.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
469	San Gorgonio Rock Products ~~deposit~~	NW¼ sec. 3, T3S, R1E, SBM, about ¼ mile N. of Banning.	San Gorgonio Rock Products, P.O. Box 1414, Banning	Dry wash deposit extends from north of Banning to confluence with White-water River, a distance of about 15 miles. Width of deposit ranges from 250' at head to 1000' farther east; at least 60' deep. Slight overburden. No replenishment. Average maximum gravel 6", with boulders up to 2' present. About 65 percent gravel content. Abun-dant plus 1½" gravel.	Excavate from pit 1000' long x 300' wide x 60' deep, with shovel. Haul in end dump truck several hundred feet to plant. Work in 25' benches. Crush oversize in primary jaw and secondary cone crushers. Wash over standard vibrating screens; sand screw and sand drag. Capacity 250 tons/hr. Concrete and bituminous sand and gravel, road base, plaster sand.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
470	Service Rock (The Service Gravel) Company	SE¼ sec. 3, E½ sec. 10 (proj.) T2S, R5W, SBM. West side of Santa Ana River, 2½ miles northwest of Riverside.	Undetermined	River terrace deposit along west side of Santa Ana River. Overburden in the area mined averaged about 5 feet of silt and soil; sand and gravel layer was 15-20 feet thick and bottomed in a silt layer which is underlain by coarse, buff, sand with no gravel. Deposit averaged about 60 percent sand and 10 percent silt waste. Most of the gravel was less than 2-inch with a few cobbles. This material was tested by the U.S. Bureau of Reclamation in 1945 (Report No. C-275) and found to be suitable for concrete aggregate.	Area totaling about a quarter section was mined from some 8 pits in secs. 3 and 10 from 1920 to 1955. Early operations started before 1920 in the SE¼ sec. 10 where The Service Gravel Co. erected its first plant. During the late 1920's and early 1930's the plant and several pits were in the SE¼ sec. 3. A third and final plant was completed in 1936 at C Street and Crestmore Road and was active until 1955 when the available gravel deposits were worked out. In 1941 the operation became the Service Rock Co. From 1936 to 1955 mining was from several pits in the E½ sec. 10. The plant produced 85 tons per hour of washed sand and gravel products including plaster, concrete, and engine sand; and gravel up to 1½ inch. Total production from the area is unknown, but probably was about 2,000,000 tons. (Dickey and Porter, 1952, p. 3). 256

Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
471	Shepwells Big Maria deposit	Pit: SE¼ sec. 27, T5S, R23E, SBM, about 6 miles north of Blythe. Road base from County pit SE¼ sec. 25, T5S, R22E, SBM. Plant on Riverside Ave. in Blythe.	Shepwells Inc., P.O. Box 87, Blythe	Dry wash deposit extends for about 1 mile north of intersection with Highway 95. About 500' wide and at least 50' deep. No overburden or replenishment. Max. size gravel 8", some 12' boulders. About 60 percent gravel content.	Excavate from pit approx. 300' wide x 250' long x 50' deep. Haul about 6 miles to plant. Crush in primary jaw and secondary cone crusher; wash over vibrating screens. Capacity 300 yds/day. Products - concrete and bituminous sand and gravel.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
472	Thermal Canyon Wash deposit	SE¼ sec. 18, T6S, R9E, SBM, west edge of Mecca Hills at the end of Ave. 56, 3½ miles east of Thermal.	Undetermined. Co-Val Concrete Pipe Co., Coachella operator (?) (1959)	Alluvium, mostly sandy, pebble and cobble conglomerate with few boulders. Clasts of metamorphic and granitic rocks.	Sample of sand and gravel from sec. 18, 2½ miles east of Thermal tested for All American Canal in 1949 (Report No. C-440) contained 1½-inch maximum size aggregate; is of inferior quality but suitable for use in mild climate if sand washed free of silt and air entraining agent used in mix. Pit 300 feet long, 50 to 150 feet wide and 25 feet deep. Largely dismantled plant (crusher, screens, loading bin) apparently produced unwashed aggregate. No report of use in government construction. (Dickey and Porter, 1952, p. 9).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Transit Mixed Concrete Company Corona plant				See: Industrial Asphalt, Corona plant.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
473	Triangle Rock Products, Inc. Mira Loma Plant	NE¼ sec. 6, T2S, R6W, SBM, in lower Day Creek at Mira Loma. 10 miles west of Riverside at Wineville Road and U.S. Highway 60.	Triangle Rock Products, Inc. 2400 West Highland P.O. Box 2083 San Bernardino	Dry wash and/or old alluvial fan from south flank of San Gabriel Mountains. Deposit opened over an area about 2,000 feet long and 1,000 feet wide. Mined to depths of 40-50 feet where deposit bottoms in silt. Ten to 20 feet reddish-brown dirty silt overburden. No replenishment. Maximum size of gravel 6" to 8" with very few up to 1 foot, mostly 3" to 4". About 50 percent gravel. Pit shows mostly well mixed sand and gravel; in places layers of sand 1 to 1½ feet thick and gravel 2 to 4 feet thick. Layers horizontal, material soft, nonindurated. Gravel mostly mica schist and granitic debris.	Excavate with Link Belt 1-yd. dipper shovel from pit with working face about 40' high. Haul about 2,000' to plant in KW 17-ton end dump trucks. Discharge over grizzly into primary jaw crusher. Crush oversize in secondary Symons Cone and Traylor 3-foot cone. Discharge to 5' x 10' inclined shaker screen. Wash over standard vibrating screens. Conveyors load bunkers. Pit area covers about 60 acres. Products include concrete and plaster sand, unwashed sand, and concrete gravel up to 2½ inches. Capacity 300 tons per hour.

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Rock Products

Sand and Gravel
Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
474	~~Pit (name~~ undetermined	NW¼SE¼ sec. 8, T3S, R2W, SBM. Dry wash north side of State Highway 79, about 13 miles northwest of San Jacinto.	Undetermined	Quaternary stream and/or alluvial fan with some gravel. Most clasts are cobbles or smaller of granitic rock, some metamorphic and volcanic clasts.	Utilized during World War II as a source of sub-base and/or aggregate for construction at March Air Force Base. Large open pit, not well defined but about 1,000 ft. long, 500 ft. wide, and 50 ft. deep. Apparently long idle.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
475	~~Pit (name~~ undetermined~~)~~	SW¼SE¼ sec. 8, T3S, R2W, SBM. Edge of dry wash, south side of State Highwas 79, about 13 miles northwest of San Jacinto.	Undetermined	Quaternary stream and/or alluvial fan deposit of sand with some gravel. Most clasts are cobbles or smaller of granitic rock, some metamorphic and volcanic clasts.	Pit about 300 ft. long, 150 ft. wide, 25 ft. deep. Material used as a source of sub-base and/or aggregate for construction at March Air Force Base about 1953; apparently since idle.

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Rock Products

Sand and Gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
476	~~Pit (name~~ undetermined~~)~~	SW¼SW¼ sec. 14, T4S, R1W, SBM. 2¼ miles due north of San Jacinto, on the northeast side of State Highway 79.	Undetermined	Quaternary alluvial fan deposit. Dirty gravel, mixed with considerable decomposed granitic material.	Circular pit 150 ft. diameter, 40 ft. maximum depth. Apparently a local source of sand and gravel for fill or highway construction. Pit opened before 1953, idle in 1963.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
477	Undetermined (Unidentified) (~~gravel pit~~)	SW¼ sec. 32, T4S, R8E, SBM, in the valley between the Indio Hills and Little San Bernardino Mts., east of Dillon Road 1 3/4 miles south of the Berdoo Canyon road intersection.	Undetermined	Alluvial fan material. A "dirty" unsorted, cobble, sand, and boulder fanglomerate with little gravel.	Open-pit about 350 feet x 100 feet x 25 feet deep.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
478	Undetermined ~~Unidentified~~ (~~gravel pit~~)	SW¼SW¼ sec. 6, T4S, R6E, SBM, south margin of the Indio Hills, 2 miles north of Thousand Palms	Undetermined	Sandy conglomerate	Pit about 200 feet x 100 feet x 25 feet deep.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
479	Undetermined ~~Unidentified deposit~~	SE¼ sec. 28, T4S, R6W, SBM, Temescal Valley, 7 miles southeast of Corona, in lower Brown Canyon.	Mrs. R. Boyd & W. Heinlein, 3265 Floresto Ave., Los Angeles own patented ranch land (1957); 50 acres leased to Temescal Rock Products Company, P.O. Box 364, Corona, (1957)	Stream gravels said to be 80 percent rock with average thickness of 40 feet.	Undeveloped (Gray, 1961, p. 119).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
480	Valley Rock and Sand Corp.	Plant and deposit: E½SE¼ sec. 22, T3S, R2W, SBM. At Jackrabbit trail and State Highway 79, about 10 miles northwest of San Jacinto.	Valley Rock and Sand Corp., 24161 State St. (P.O. Box 926) San Jacinto	Quaternary stream deposit. Narrow dry wash, maximum width 750 ft., extends for several miles along the west side of Jackrabbit Trail. Deposit opened over an area about 1,000 ft. long and 400 ft. wide. Mined to depths of 10 to 40 ft. where deposit bottoms in silt or in places schist. No replenishment. Sandy silt overburden 3-4 ft. Horizontal layers of non indurated rather well mixed sand and gravel. Very few clasts more than 1-ft. diameter, most are cobbles or smaller. About 75% sand, 5% rock, 20% silt. Most clasts are hard granitic rock, some metamorphic and volcanic clasts.	Plant in operation since 1944. Excavate with northwest 3/4-yd. dipper shovel from pit with working face about 40 ft. high. Haul about 1,500 ft. to plant in 10-yd. Reo end-dump trucks. Discharge over grizzly into hopper which feeds a 3-deck vibrating screen. Oversize (+3/4-in.) goes to jaw crusher. Crusher product returns to the 3-deck screen. Material is washed on 2 bottom decks by water spray bars. Sand size from bottom screen goes through a drag washer, then a wheel washer, and to stockpile. Rock from upper screens goes to loading bins for storage. Products include concrete and plaster sand, concrete gravel and pea rock (3/8-in. to 3/4-in.), and road gravel (1/8-in. to 3/8-in.). Capacity is 150 tons per hour, operate at about 80 tons per hour.

Sand and gravel

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
481	Valley Transit Cement Co. (deposit)	W NE¼ sec. 32, T8S, R9E, SBM, about 2 miles south of Oasis	Valley Transit Cement Co., Inc., P.O. Box 1489, El Centro	Broad alluvial plain on flanks of Santa Rosa Mts. encompasses several square miles. Developed area covers several acres. Sparse sand interbeds. About 65 percent gravel. Material coarser at depth. Gravel reported present to depths of about 75'. Water table at 70'. No overburden. No replenishment. Dry, abundant plus 3" gravel, 10", some 2' boulders present.	Excavate and feed plant with bulldozer tractor, work to about 10' depth. Pit run goes to primary jaw crusher, wash over standard vibrating screens. Plus 3" crushed in secondary cone. Wash sand in screw type classifier. Capacity 140 tons/hr. Concrete sand and gravel. Have batch plant and own ready mix trucks.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
482	Yeager Indio Hills ~~Deposit~~	SW¼ sec. 5, T4S, R6E, SBM, approx. 2½ miles north of Thousand Palms.	E. L. Yeager Co., P.O. Box 87, Riverside.	Deposit at head of alluvial fan in dry wash. Approx. 300' wide x 1000' long x at least 35' deep. Abundant sand -- approx. 35-50 percent of deposit. No overburden or replenishment. Average max. size gravel 9", abundant plus 3", occasional 3' boulders present.	Excavate with tractor that pushes material to plant. Crush in primary jaw and secondary cone crushers; standard vibrating screens. Capacity 200 tons/hr. Bituminous sand and gravel produced.

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Rock Products

Specialty (~~Foundry~~) Sand

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
486	Jurupa (Riverside) Molding Sand Deposit	SW¼ sec. 29, T2S, R5W, SBM. Along the south bank of Santa Ana River at the north end of Fremont St., 3½ miles southwest of Riverside.	Undetermined	Sand occurs as a reddish layer on the surface of a Quaternary terrace. According to Wright (1948, p. 57) at the Jurupa deposit this layer is 6 to 8 feet thick and is underlain in part by light-gray silty sediments. Granitic rock (Bonsall Tonalite?) is reported to occur beneath part of the excavation. Overburden consists of clay-poor sand that averages 1 foot in thickness. The molding-sand layer is unstratified, poorly consolidated, and contains many minute sponge-like pores. Small igneous pebbles are sparsely scattered throughout the layer. Within the limits of the excavation, the sand is both vertically and laterally uniform. Similar material occurs as a thin, residual mantle on nearby granitic hills.	Riverside molding sand, also known as "V3" or "Pedley sand" was mined intermittently west of Riverside in the vicinity of the Santa Ana River channel from the 1920's until the 1950's. The Jurupa deposit, on the south bank of the river, was opened in 1923 by Harry E. Blood who shipped 6-8 cars per month. During the 1940's this deposit was operated by Miller Brothers, Huntington Park. An excavation on the north bank was operated by Westlake and Sons, Los Angeles, at some period prior to 1947. Riverside sand was found most suitable for light gray iron, brass, and bronze castings. A smooth finish was produced. When the area was visited in January 1963, the sites of former excavations could not be definitely determined. Apparently molding sand has not been mined in this area for many years. (Wright, 1948, p. 57-58).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
394	Bernasconi Quarry	SW¼NE¼ sec. 11, T4S, R3W, SBM. In the Bernasconi Hills at the west side of Bernasconi Pass, south side of Martin Street.	James Minor, San Jacinto (1961)	Light to very dark gray, coarse-grained granodiorite (mapped as Granodiorite west of Lakeview by Larsen, 1951, plate 1). Contains abundant dark, flat, elongated, oriented inclusions concentrated in parallel streaks. Rock in quarry face is well fractured. Overburden ranges from 0 to 5 feet of decomposed granodiorite.	Quarry opened in July, 1961, to furnish rubble and riprap for the San Jacinto River levee project. Operated by Hugh Seeger, Whittier. Quarry is sidehill cut on one main bench level about 300 feet long, 175 feet wide with face 40 feet high. Rock was crushed and sized at the quarry for the levee project which was completed late in 1961. Quarry apparently has since been idle. A considerable tonnage of large boulders remain below the quarry bench, where they were apparently pushed aside as waste.
	Blue Diamond Materials Co.				(c Transcontinental Rock Corp. under Roofing Granules)

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
396	Box Springs Quarry	SW¼NE¼ sec. 33, T2S, R4W, SBM. Along the east side of the railroad, in Box Springs Canyon ½ mile northwest of Box Springs.	Santa Fe Railway System, 121 East Sixth St., Los Angeles 14.	Light to dark gray, medium grained, quartz diorite (Cretaceous Bonsall Tonalite). Bouldery surface, no overburden. Rock is somewhat fractured.	Santa Fe Railway has intermittently quarried rock for use as rubble and track ballast since at least 1940. Quarry is side-hill cut on one level along the track, about 1,250 ft. long and 50 to 100 ft. wide. Face is 30 to 60 ft. high. Idle in July 1963.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
397	Casa Blanca Quarries	S½ sec. 10, T3S, R5W, SBM. 1 mile southeast of Casa Blanca. Two quarries, the larger on the south edge of Quarry Hill on the northwest corner of Madison St. and Lenox Ave.; the other quarry is about 1/3 mile to the south, northeast of the intersection of Dufferin Ave. and Grace St.	Undetermined	Dark gray, medium grained granitic rock (Cretaceous Bonsall Tonalite). Contains dark inclusions ranging from a fraction of an inch to several inches in diameter. Rock is jointed and breaks to regular even surfaces along lines of fracture.	In 1905 the quarries were owned by the Southern Pacific Railroad Co., and operated by the California Construction Co. who were shipping stone for use as rubble in construction of the San Pedro breakwater. In 1905 the north quarry had an opening about 100 feet square with a face of from 50 to 60 feet; the south quarry was 100 feet long, 30 feet wide, with a face of from 30 to 40 feet. By 1914 these quarries were reported as long idle. In January 1963, both quarries were being utilized as dump sites; their dimensions appeared to have been only slightly enlarged from those of 1905. (Aubury, 1906, p. 44-46; Merrill, 1917 [1919] p. 584).

Broken and crushed stone

Riverside

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Christopher Mines, Inc. claim	SW¼ sec. 36, T2S, R3E, SBM, between Super Creek mine and Painted Hill Quarry (see herein).	Last reported: Christopher Mines, Inc. c/o E. O. McFall, Box 341, Glendale	Like Painted Hill Quarry (see herein).	(Proctor, 1962, p. 23, unpublished thesis).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Desert Sunset	NW¼ NE¼, Sec. 21, T3S, R21E, SBM, on a small foothill at the northwest end of the Big Maria Mountains.	U. S. Minerals Development Corp.	Quartzite in a formation of undescribed extent, probably the Paleozoic (?) Maria formation widely exposed in the area. Quarried rock cleaves into tabular fragments colored by iron and manganese oxides, stains, and coatings.	Quartzite sold under the name of "rosado stone" for decorative stone work (published decision; U.S. Department of the Interior, Bureau of Land Management, July 22, 1963).

Glen Gant

Stone Supply (C)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
400	Hole Ranch Quarry	NW¼NW¼ sec. 22 (proj.) T3S, R6W, SBM. Low isolated hill just north of the west end of Buchanan St., 1½ miles southwest of La Sierra.	Undetermined	Light gray, medium grained granodiorite (Cretaceous Mt. Hole Granodiorite). Surface deeply weathered with large hard boulders remaining.	Two small sidehill quarries. The larger quarry, on the east side of the hill, is about 50 feet by 25 feet and 25 feet deep; the other quarry, on the west side of the hill, is about 40 feet in diameter and 15 feet deep. Tests on two samples from the Hole Ranch quarry made about 1939 by the District Laboratory, Corps of Engineers, U.S. Army, showed the following: L.A. Rattler, % loss at 500 revs. Specific Gravity Average maximum minimum 2.71 35.5 38.0 33.0

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
402	Juaro Canyon Quarry Long Distance Matich Brothers and Spindt Company	SW¼SW¼ sec. 20, T4S, R1E, SBM. West side of upper Juaro Canyon, 1 mile east of Soboba Hot Springs.	Hawley Rock Inc. 5277 North Vincent Ave., Azusa, (P.O. Box 7, Irwindale)	Coarse grained, light colored granite. Rock exposed in quarry face is well fractured and apparently has good breakage qualities. No overburden. Mapped by Fraser (1931, plate facing p. 540) as Jurassic(?) granite.	Side-hill quarry on one level about 200 ft. long, 100 ft. wide, face 40 ft. high. Quarry was opened and operated by Hawley Rock Inc. in 1961 to furnish rock for the San Jacinto River levee project. Total production undetermined, probably a few tens of thousands of tons. Idle since late 1961. see Storm Drainage (5) 2c Tomahawk Canyon rockquarry (2)

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	New City Quarry				See under limestone in text.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
403	Old City Quarry (Fairmount Hill Quarry, North Hill Quarry).	SW¼ sec. 14 (proj.) T2S, R5W, SBM. South of and above Fairmont Park in a hill area bounded by Locust St. on the east, Redwood Dr. on the west, Houghton Ave. on the south, and Banks St. on the north.	City of Riverside	Dark gray weathered quartz diorite (Cretaceous Bonsall Tonalite?) has intruded a sequence of marble and schist over an area about 1,000 feet long and 300 feet wide. The metamorphic rocks strike nearly east-west and are steeply dipping. The marble beds range from less than 2 feet to about 12 feet in width and the longest exposed strike length of marble is about 220 feet. A number of minerals have been reported from this quarry area (see Murdoch and Webb, 1956).	In 1914 the City of Riverside was operating a crusher on the site to provide crushed stone for macadam and concrete. Apparently both the diorite and metamorphic rocks were utilized. At least 5 separate quarries are identifiable in the area with the largest about 100 feet wide, 150 feet long, and face 50 feet high. Most of the rock mined apparently was quartz diorite but the metamorphic sequence is also present in the quarries. Apparently the limestone was never utilized other than for aggregate. These quarries have been idle for about 50 years, except for furnishing occasional small amounts of decomposed material for local use. (Aubury, 1906, p. 320).

ROCK PRODUCT
Broken and Crushed rock

RIVERSIDE COUNTY

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Super Creek	SW¼ sec. 36, T 2 S, R 3 E, SBM, on the southeast flank of Painted Hill	Reported to be held by a man named Grossman (1958)	Same as Painted Hill Quarry (herein).	Activity confined to assessment work in the form of roads and open cuts (1959). (Proctor, 1968, p. 39 ~~unpublished thesis.~~)

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Riverside Well Board
No. 13

Rock Products

Broken and Crushed Stone

Granite
Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	~~Quarry (Name~~ undetermined~~)~~	SE¼SE¼ sec. 2, T3S, R6W, SBM. Low hill east of Tyler St., and between Gramercy Pl. and Hedrick Ave.	Undetermined	Blocky, hard, blue gray granitic rock (Cretaceous San Marcos Gabbro?).	Small shallow quarry with a few quarried blocks scattered about the area. Apparently was once a minor source of building stone, but long inactive. In January 1963, the area was almost completely residential.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	~~Quarry (name undetermined)~~	NW¼ sec. 3, T2S, R6W, SBM. North edge of the Jurupa Mountains.	Riverside County	Cretaceous Woodson Mountain Granodiorite. Light gray, hard, fine-grained, inclusion-free granodiorite.	Apparently quarried on a small scale at some unknown time for building purposes. In 1950 the quarry was about 50 feet long, 20 feet wide, and 15 feet high. Idle in 1950. By 1963 the quarry was nearly filled with debris and was being utilized as a Riverside County disposal area. (Mackevett, 1951, p. 13).

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Stone, Metasandstone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	undetermined ~~Unidentified quarry~~	E½ sec. 14, T5S, R4W, SBM. Low hills about ¼ of a mile northeast of San Jacinto River; about 6 miles northeast of Elsinore.	Undetermined		(Engel, 1959, p. 101).

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Stone, Metasandstone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified road material pit~~	SE¼ sec. 19, T5S, R4W, SBM, at southern tip of hills 3 miles due north of Elsinore.	Undetermined		Road material pit. (Engel, 1959, p. 102).

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Stone, Metasandstone)

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified road material pit~~	NE¼ sec. 24, T5S, R5W, SBM, southeastern end of hills about 4 miles northwest of Elsinore.	Undetermined		Road material pit. (Engel, 1959, p. 102).
	Whitewater Granite Select pit				P.e Pauba Hills granite (?)

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Rock Products

Stone — Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
4/2	Arnold Heights Pit	W½ sec. 27, T3S, R4W, SBM. Low hills about 1 mile west of Alessandro, south of Van Buren Blvd.	U.S. Air Force	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Several pits in this area have been mined by the U.S. Air Force since the 1940's as a source of road metal for March Air Force Base and adjacent installations. Mining has been from an irregular area about 1,000 ft. by 500 ft. with pits from 10 to 20 ft. deep. In 1963 two pits were active. Equipment includes bulldozers, rippers, scrapers, front-end loaders.

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Rock Products

Decomposed Granite

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
413	Brokar Pit	SW¼SW¼ sec. 20, T2S, R5W, SBM. Along the east side of a small wash on the east side of 54th Street; south-eastern Pedley Hills south of Limonite Ave.	Cleo E. Brokar 6401 54th Street Riverside	Weathered Cretaceous granitic rock (Bonsall Tonalite).	Irregular pit area about 300 feet long, 100 feet wide, with maximum depth of 40 feet, has been mined from about 6 small pockets at different levels. Soil is loosened and piled by small dozer and ripper equipped Cletrac. Material is loaded by Ford Ferguson front end loader on small dump tracks directly at the face for transport to market. A small, local source of "decomposed granite".

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
414	Coplin Pit	SE¼NW¼ sec. 29 (proj.), T3S, R6W, SBM. North-trending low hill north side of Sampson St. and the Santa Fe R.R., 1 3/4 miles east of Corona.	Corona Dee Gee Company, 609 Corona, Corona	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Decomposed granite has been quarried from this area for many years for local use as road metal. In 1963 the Corona Dee Gee Co. was operating a rather large somewhat U-shaped sidehill cut about 1,500 ft. long, 500 ft. wide, with maximum depth of about 50 ft. Mining is done by a Caterpillar D-8 with bulldozer and ripper. Loosened material is pushed into a hopper from which trucks are belt-loaded. Front-end loader is also used. Present mining started in the late 1950's, apparently reactivating an old pit. About 1,000 ft. to the southwest, just north of the railroad, is a small pit, apparently long idle.

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Corona Soil Geol. rept. no. 55

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
415	Fontana Paving, Inc.	NE¼NE¼ sec. 5, T4S, 46W, SBM. East side Temescal Wash, 3 miles southeast of Corona.	Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn. owns a large tract of land. Fontana Paving, Inc., 8747 Lime St., Fontana owns and operates the plant.	Weathered Cajalco Quartz Monzonite and older alluvium.	Modern plant to make asphalt paving was erected early in 1963 by Fontana Paving. This plant utilizes weathered quartz monzonite and alluvium mined from shallow pits east of the plant, and quarry waste from the Temescal Rock Quarry. The Corona Clay Co. also intermittently mines "decomposed granite" from the same pit area used by Fontana Paving. This material is sold locally for road surfacing.

289

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
4/6	Nason Street Pit	S½NW¼ sec. 3, T3S, R3W, SBM. 3 miles east of Sunnymead at the northeast corner of the intersection of U.S. Highway 60 and Nason Street.	Undetermined	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Irregular area about 1,000 ft. by 500 ft. was mined to depths of 10-15 ft. Irregular hard zones were left as "islands". Pit was operated in 1942 by the Service Rock Company, Riverside. Material was used as sub-base in runway construction and as road metal at March Air Force Base. Production of several tens of thousands of tons. Apparently idle since 1942, and in 1963 construction of the Nason Street Overcrossing on the freeway obliterated most of the pit area.

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
4/7	Nuevo Road Decomposed Granite quarry	SE¼SE¼ sec. 24, T4S, R4W, SBM, near the west end of Nuevo Road	Land owner undetermined. Site leased by E. L. Yager Co. (1959)	Deeply weathered Perris Quartz-Diorite (Dudley, 1935, p. 501)	When visited quarry was a bull-dozed area about 500 ft. long and 200 ft. wide. The weathered diorite (DG) was being mixed, at the quarry, as follows: 67 percent DG 33 percent 1½"-3/8" crushed rock and an additional 2½ percent cement 8½ percent water This mixture was trucked to the nearby construction site of U.S. Highway 395 to be used as "cement treated sub base". The DG was run through 1½ screen without crushing. As much as 2,000 tons per day of mixed road base taken from site (see Plate C (figure ___)).

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
418	Riley Materials Company	NE¼SW¼ sec. 25, T2S, R6W, SBM. North bank of Santa Ana River, east side of Van Buren Blvd. (Pedley Road).	Riley Materials Co. 6740 Doolittle St. Riverside	Light gray, weathered, granitic rock with hard, dark black, inclusions (Cretaceous Bonsall Tonalite).	Mine with small bulldozer from pit 150 feet long, 75-100 feet wide, and face 20 feet high. In addition to decomposed granite this company markets fill sand and silt obtained from the adjacent dry margin of the Santa Ana River.

292

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
4/9	Riverside County Gravel Pit	SE¼NW¼SW¼ sec. 2, T4S, R4W, SBM. Low hills ¼ mile south of Markham Street and 1¾ miles west of Highway 395.	Riverside County owns 10 acres	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Development not determined.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
420	Riverside County Gravel Pit	NW¼SW¼ sec. 4, T3S, R6W, SBM. Southeast of intersection of Arlington Ave. and 6th Street, 2 miles east of Norco.	Riverside County	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Owned by Riverside County since 1949. Development undetermined.

294

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
421	Riverside County Gravel Pit	W½SE¼SE¼ sec. 19, T6S, R2W, SBM. ¼ mile west of the intersection of Leon Road and Keller Road.	Riverside County	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Owned by Riverside County since 1941. Development undetermined.

295

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
422	Riverside County Gravel Pit	N½SE¼NE¼ sec. 26, T5S, R3W, SBM. 3 miles southeast of Romoland, northwest of the intersection of Menifee Road and Simpson Road.	Riverside County	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Owned by Riverside County since 1948. Development undetermined.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
423	Riverside County Gravel Pit	S½NE¼NW¼ and N½SE¼NW¼ sec. 29, T5S, R3W, SBM. 3½ miles southwest of Romoland, ½ mile west of Murrieta Road.	Riverside County	Weathered metamorphic rock (mapped as Triassic Bedford Canyon Formation by Larsen, 1951, plate 1).	Owned by Riverside County since 1950. Development undetermined.

297

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
124	Riverside County Gravel Pit	SW¼SW¼SW¼ sec. 18, T5S, R3E, SBM.	Riverside County owns about 6 acres	Weathered granitic rock, mapped as Jurassic(?) granite (Fraser, 1931, plate facing p. 540).	Owned by Riverside County since 1948. Development undetermined.

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
425	Riverside County Gravel Pit	E½SE¼SE¼ sec. 19, T5S, R1E, SBM. Southwest intersection of Pleasant and Harrison Aves.	Riverside County	Weathered granitic rock, mapped as Jurassic(?) granite (Fraser, 1931, plate facing p. 540).	Owned by Riverside County since 1946. Development undetermined, apparently used locally for road metal.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
426	Riverside County Gravel Pit	E½NW¼, W½NE¼ sec. 9, T4S, R3W, SBM. Isolated small hill south of Martin Street at south end of Evans Road.	Riverside County	Weathered granitic rock (mapped as "Granodiorite West of Lakeview" by Larsen, 1951, plate 1).	Owned by Riverside County since 1945. Development undetermined.

300

Riverside West Quad

Rock Products
Decomposed Granite
Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
427	Riverside County Pit ~~(name undetermined)~~	NW¼SW¼ sec. 25, T2S, R6W, SBM. Along the north bluff of Santa Ana River west of Van Buren Blvd. (Pedley Rd.), 3/4 mile SE. of Pedley.	Riverside County	Weathered Cretaceous granitic rock (Bonsall Tonalite).	Pit about 1,000 feet long, 500 feet wide, maximum depth of 25 feet. Mined as a source of road metal by Riverside County since before 1930. Active.

301

Rock Products

Decomposed Granite

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
428	Riverside County Pit ~~(Name undetermined)~~	NE¼ sec. 12, T3S, R6W, SBM. ¼ mile southwest of the intersection of Van Buren Blvd. and Challen Ave. at the northeast edge of low hills 3/4 mile northwest of Arlington.	Riverside County	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Pit about 200 feet long, 50 feet wide with maximum height of face 40 feet. Apparently used as a source of road metal by Riverside County Road Dept. from 1916 until recent years. In January 1963 the area was being utilized as a dump site.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
429	Riverside County Gravel Pit	N½NE¼SW¼ sec. 11, T6S, R4W, SBM. 3 miles east of Elsinore, south side of Railroad Canyon Road.	Riverside County	Weathered granodiorite (Cretaceous Woodson Mountain Granodiorite of Larsen, 1951, plate 1).	Owned by Riverside County since 1949. Development undetermined.

303

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
430	Riverside County Gravel Pit	SE¼SE¼ sec. 23, T6S, R4W, SBM. West end of Bundy Canyon, north side of Bundy Canyon Road.	Riverside County owns 85.78 acres.	Weathered granitic rock (mapped as Cretaceous San Marcos Gabbro by Larsen, 1951, plate 1).	Owned by Riverside County since 1938. Development undetermined.

304

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
431	Riverside County Gravel Pit	N½NW¼SW¼ sec. 8, T6S, R4W, SBM. Northeast trending ridge along the south side of Moroni Ave., ¼ mile east of Elsinore City Hall.	Riverside County	Weathered granitic and metamorphic rock (mapped as Cretaceous San Marcos Gabbro and Triassic Bedford Canyon Formation by Larsen, 1951, plate 1).	Owned by Riverside County since 1944. Development undetermined.

305

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
432	Sugar Loaf Pit	NE¼SE¼SE¼ sec. 17, T2S, R4W, SBM. In the Box Springs Mtns. east of Sugarloaf Mtn. at the north end of Mt. Vernon Ave.	Joe Brennan and Sons, 1869 Service Court, Riverside.	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Mined by present operator since the late 1950's as a source of road metal and fill material. Pit is a somewhat semi-circular side-hill cut with radius about 400 ft. and maximum height of developed face about 40 ft. Standard excavating equipment is used. Small intermittent production each year, total undetermined. Active 1963.

306

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
433	Undetermined ~~Pit (name undetermined)~~	SE¼SW¼, sec. 30, T4S, R4W, SBM. Just south of Santa Rosa Road.	Undetermined	Weathered blue-gray granitic rock (Cretaceous Bonsall Tonalite).	Pit 50 feet by 100 feet and 20 feet deep. Idle, but apparently active in recent years.

307

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
434	Undetermined ~~Pit (name undetermined)~~	SW¼ sec. 2, T2S, R6W, SBM, South edge of the Jurupa Mountains, at the north end of Fleming Street	Undetermined	Decomposed Triassic(?) granitic gneiss.	Small pit 50 by 150 feet and 25 feet maximum depth. No equipment. Idle.

308

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
435	~~Pit (name undetermined)~~ Undetermined	E½SW¼ sec. 17, T3S, R4W, SBM. Low hills east side of Elsinore Road, 3/4 mile south of Alessandro Blvd.	Undetermined	Weathered granitic rock (Cretaceous Bonsall Tonalite). Gray decomposed "granite", about one-foot of red soil overburden.	Irregular, shallow side-hill cut, about 350 ft. by 200 ft., and 10 to 15 ft. deep. For many years a source of decomposed "granite" used locally for road metal. Mined intermittently, inactive June 1963.

309

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
436	~~Pit (name~~ undetermined~~)~~	SE¼NE¼NE¼ sec. 32, T2S, R4W, SBM. Isolated hill, south side of lower Box Springs Canyon.	Undetermined	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Side-hill cut about 150 ft. long, 10-15 ft. deep. Apparently a local source of road metal. Apparently long idle.

310

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
137	~~Pit (name~~ undetermined~~)~~.	NW¼NW¼ sec. 15, T3S, R4W, SBM. South side Alessandro Blvd., ½ mile west of U.S. Highway 395.	U.S. Air Force	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Irregular shallow pit 10 to 15 ft. deep covers an area about 500 ft. by 350 ft. Has been mined as a source of road metal and sub base fill for March Air Force Base projects. In the early 1950's the Service Rock Co., Riverside, mined a considerable quantity of this material for housing projects at the air base. Idle in 1963.

311

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
138	Pit (~~name~~ undetermined)	SW¼SW¼ sec. 10, T3S, R4W, SBM. North side of Alessandro Blvd., ½ mile west of U.S. Highway 395.	Undetermined	Weathered granitic rock (Cretaceous Bonsall Tonalite).	Side-hill cut about 300 ft. long, 150 ft. wide, and 15 feet deep. In 1942 the Service Rock Co., Riverside, mined a large tonnage of this material for use as sub base in runway construction and for road metal at March Air Force Base. Inactive in 1963, and apparently long idle.

312

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
437	~~Pit (Name undetermined)~~	NE¼SE¼ sec. 36 (proj.), T3S, R6W, SBM. West side of Taylor Street, 3/4 mile north of Cajalco Dike.	Undetermined	Weathered quartz monzonite (Cretaceous Woodson Mountain Granodiorite).	Side hill circular cut, 75 feet in diameter, 25 feet deep. Apparently a local source of road metal, long idle.

3/3

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
440	~~Pit (Name~~ undetermined)	NW¼NW¼ sec. 32, T2S, R5W, SBM. Southeast Corner of Mountain View and Fremont Streets, Riverside.	Undetermined. Reported to be operated by E. L. Yeager Construction Co., Riverside, and the City of Riverside.	Light gray, weathered, granitic rock (Cretaceous Bonsall Tonalite).	Area has been a local source of decomposed granite for many years. Shallow pit covers an area about 1,500 feet by 500 feet. Mining has been on several irregular levels, maximum depth about 40 feet. Mining is done by bulldozer, ripper, and skip loaders. Active January, 1963.

314

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
141	~~Pit (name~~ undetermined~~)~~	NW¼NE¼ sec. 14, T5S, R2W, SBM. Small isolated hill, ¼ mile west of California Ave., south of Highway 74.	Undetermined	Weathered granitic rock (Cretaceous San Marcos Gabbro).	Side hill cut on west side of hill, apparently active in 1963.

315

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
42	~~Pit (name~~ undetermined~~)~~	NE¼SW¼ sec. 36, T4S, R4W, SBM. 1½ miles southwest of Perris, ¼ mile north of Ellis Ave.	Undetermined	Reddish-brown weathered granitic rock (Cretaceous Bonsall Tonalite).	Decomposed "granite" has been quarried from an irregular pit area about 500 feet by 300 feet and 10 feet deep. Hard, unweathered zones are left as "islands". Mining is done with a Ferguson rubber-tired tractor equipped with front-end loader and fresno. Pit apparently active, but not in operation at time of visit 7/2/63.

316

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
443	~~RIE (Name~~ undetermined~~)~~	SW¼ sec. 14, T2S, R6W, SBM. on the west side of Felspar St., ¼ mile south of Jurupa Road.	Undetermined (1963)	Weathered mica schist (Triassic? Bedford Canyon Formation) and granitic material.	Semicircular pit, 75 feet wide, 75 feet long, maximum face height 20 feet. Apparently a former source of "decomposed granite", long idle.

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Rock Products

Decomposed Granite

Riverside Co.

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
444	~~Pit (Name~~ undetermined~~)~~	NE¼NE¼ sec. 22, T2S, R6W, SBM. Low hill on the east side of Cedar Street, between 53rd and 56th Streets.	Undetermined	Weathered mine schist (Triassic? Bedford Canyon Formation) and granitic material (Cretaceous San Marcos Gabbro).	Shallow working on northwest flank of hill over an area about 150 by 200 feet and 5 feet deep. The south flank of the hill has also been mined over an area about 200 by 80 feet and 15 feet deep. Apparently a source of "decomposed granite". Idle.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
445	~~Pit (Name~~ undetermined~~)~~	NW¼SW¼ sec. 29, T3S, R5W, SBM. East side of McAllister St.	Undetermined	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Circular quarry, 100 feet in diameter, maximum height of face 15 feet. One foot of soil overburden. Intermittently active as a local source of decomposed granite. Idle in January 1963.

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Rock Product

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
446	~~Pit (Name~~ undetermined~~)~~	SW¼NW¼ sec. 29, T3S, R5W, SBM. Along the west side of McAllister St.	Undetermined	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite?)	Narrow pit along road cut, 150 feet long, face 15 feet high. Apparently once used as a local source of road metal. Long idle.

320

Riverside 15' Quad.
No. 11

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
447	~~Pit (Name~~ undetermined~~)~~	SE¼ sec. 25 (proj.) T3S, R6W, SBM. East side of Taylor Ave., 2¼ miles southeast of Magnolia Ave.	Undetermined	Weathered granitic rock (Cretaceous) Woodson Mountain Granodiorite).	Shallow circular pit 100 feet in diameter, 15 feet deep. Long idle. In use as a dump in January 1963.

321

Riverside Co. No. 12

Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
448	~~Pit (Name~~ undetermined~~)~~	NE¼ sec. 25 (proj.) T3S, R6W, SBM. West side of Taylor St., 2 miles southeast of Magnolia Ave.	Undetermined	Weathered granitic rock (Cretaceous Woodson Mountain Granodiorite).	Shallow borrow pit mined by small skip loader, for use in surfacing local roads. Intermittently active.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
449	~~Pit (name~~ undetermined~~)~~	SE¼NW¼ sec. 11, T4S, R4W, SBM. Low hills north side of Cajalco Road, 1½ miles west of Highway 395.	Undetermined	Weathered granitic rock (Cretaceous Bonsall Tonalite) with irregular, hard unweathered areas.	Decomposed "granite" has been removed inbetween the hard areas over an irregular area about 50 feet by 100 feet with a maximum depth of 10 feet. Inactive.

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Rock Products

Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
450	~~Pit (Name~~ undetermined~~)~~	NW¼NW¼ sec. 5, T3S, R5W, SBM. Southwest corner of Arlington and Colorado Aves., Riverside.	Undetermined	Weathered (Cretaceous) Bonsall Tonalite.	Shallow pit, maximum depth 10 feet. Mined many years ago as a local source of decomposed granite. Long inactive.

324

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
451	~~Quarry (name undetermined)~~	NW¼NE¼ sec. 32, T4S, R4W, SBM. South side of Santa Rosa Road, 4½ miles west of Perris.	Undetermined	Weathered blue-gray granitic rock (Cretaceous Bonsall Tonalite?).	Side-hill quarry about 300 feet long, 100 feet wide, 40-foot face. Idle, but apparently has been active in recent years.

Decr., of Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified~~	NE¼NW¼ sec. 9, T4S, R6W, SBM, northwest of El Cerrito Village and about 3½ miles southeast of Corona.	Minnesota Mining and Manufacturing Company, 900 Bush Ave., St. Paul, Minnesota (P.O. Box 276, Corona)	Light brownish-gray, soft, weathered quartz monzonite with minor hard, light gray blocks.	Two small, nearly connected quarries totaling about 100 feet in length with face from 10 to 25 feet high. Mined by power shovel without blasting. Small intermittent production, probably used locally to surface roads. (Gray, 1961, p. 118).

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Decomposed Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified~~	SW¼NE¼ sec. 4, T5S, R6W, SBM, about 8 miles southeast of Corona on a ridge between Bixby and Anderson Canyons.	Alfred H. and Sue M. Beazley, 601 Fern Drive, Fullerton, own patented ranch land in area.	Brownish-gray, soft, weathered biotite quartz diorite. Largely altered to clay, breaks into fine-grained material.	Shallow bulldozer cut opened in 1956 in which year a small volume of material removed for local use, probably on roads. (Gray, 1961, p. 118).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Corona Rock Company				See Mt. Hole Quarries and Sierra Grande Quarries. Rounded Wollastonite (L)

328

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
389	Mt. Hole Quarries	Secs. 8,16,17, T3S., R6W, SBM. In the La Sierra Hills 2 to 3 miles north and northeast of Porphyry Station	Wyle Labs Norco Facility, 1841 Hillside, Norco owns the area in sec. 17 in which the best-developed quarries lie.	Light gray, medium grained, porphyritic granodiorite which weathers into huge light-colored boulders of disintegration (mapped as Mt. Hole Granodiorite by Larsen, 1951, plate 1).	In the early 1900's a number of operators including the Corona Rock Co., Lane Bros., and the Sierra Grande Quarries quarried dimension stone from large boulders of granodiorite in secs. 8,16, and 17. Products included Belgian paving blocks, monumental stone, and rock for concrete, macadam and railway ballast. Numerous split boulders attest to the widespread activity, but in only a few places were regular quarries opened. Three small side hill quarries are located in the N½ of sec. 17. The largest quarry is in the NE. corner of sec. 17 and is about 100 ft. long, 50 ft. wide, with face 40 ft. high. This is the most recently active quarry and was operated by Livingston Rock and Gravel Co., Inc. about 1956-57 as a source of rubble stone. Apparently the other quarries have been idle since about 1925. (Aubury, 1906, p. 46-47; Merrill, 1917 [1919], p. 584-585; Tucker and Sampson, 1929, p. 508; Tucker and Sampson, 1945, p. 166).

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Granite

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Quarry (name undetermined)	NW¼ sec. 3, T2S, R6W, SBM. North edge of the Jurupa Mountains.	Riverside County	Cretaceous Woodson Mountain Granodiorite. Light gray, hard, fine-grained, inclusion-free granodiorite.	Apparently quarried on a small scale at some unknown time for building purposes. In 1950 the quarry was about 50 feet long, 20 feet wide, and 15 feet high. Idle in 1950. By 1963 the quarry was nearly filled with debris and was being utilized as a Riverside County disposal area. (Mackevett, 1951, p. 13).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
391	Rubidoux Hill Quarry	NE¼ sec. 22 (proj.), T2S, R5W, SBM. North end of Mount Rubidoux, south side of 8th St. Not verified, 1963.	Undetermined	Pale gray Cretaceous granite. Weathered to a depth of several feet. Medium grained. ~~Fine or coarse gr?~~	Small quarry active prior to 1905, apparently used for building stone, probably local use for foundations. Owned by Riverside Water Company in 1905. Apparently inactive since before 1905. (Aubury, 1906, p. 47).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
392	Sierra Grande Quarries	N½SW¼ sec. 29 (proj.), T3S, R6W, North end of SBM. /north-trending hill, just south of Santa Fe RR., ¼ mile east of Porphyry Station.	Undetermined	Pink, indistinctly granular, micropegmatite granite. Rock occurs as reddish-brown, sheet-like masses and is well jointed.	Irregular side-hill quarry about 750 feet long, face about 40 feet high. Apparently this is one of a number of quarries operated in the vicinity of Porphyry Station in the early 1900's. All quarries were idle before 1929 and except for the Jameson and Mt. Hole quarries (see herein) have apparently remained idle. Belgian paving blocks, monumental stone, and rock for concrete, macadam, and railway ballast were the chief products. In many places boulders were quarried and no particular quarry site was opened. (Aubury, 1906, p. 46-47; Merrill, 1917, /1919/, p. 584-585; Tucker and Sampson, 1929, p. 508; Tucker and Sampson, 1945, p. 166).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1 393	Temecula Quarries	E½SE¼ sec. 24, T8S, R3W, SBM. 2 miles south of Temecula along the west side of Highway U.S. 395; NE¼SW¼ sec. 30, T8S, R2W, SBM. South side of Wolf Valley, east of Hwy. 395.	Undetermined	Unweathered large residual boulders of Cretaceous Woodson Mountain Granodiorite. Rock had a very even fracture which resulted in large, regular, smooth surfaces after being split. Fresh rock had a light gray color with a faint rose tint.	A quarry in Sec. 24 was active in 1889 and by 1905 two quarries were active. One operated by Patrick Quinn was in sec. 24, and the other, operated by F. L. Fernald is reported by local residents to have been in Wolf Valley (sec. 30?). The quarries were worked by hand and most of the stone was quarried from boulders. Products included Belgian paving blocks, curbing, flagging, and fence posts. Some of these stone blocks are still in use (in 1963) at Temecula. The quarries were still active in 1915 and were operated by M. Machado and Joseph Winkles. By 1929 the quarries were idle and have since remained idle. (Goodyear, 1890, p. 149; Aubury, 1906, p. 42-43, 47; Merrill, 1917 [1919], p. 586; Tucker and Sampson, 1929, p. 509; Tucker and Sampson, 1945, p. 166; Mann, 1955, p. 19, plate 1).

333

~~Granite~~ Dimension Stone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified quarry~~	SW¼NW¼ sec. 32, T4S, R4W, SBM, on the west side of a low knoll (see figure 47).	Undetermined	Gray, moderately coarse grained "Perris Quartz Diorite" (Dudley, 1935, p. 501)	Developed through an open cut. Stone appears to have been cut here but tonnage yielded not determined.

334

~~Granite~~ Dimension Stone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	~~Unidentified~~ ~~quarry~~	NW¼ sec. 17, T5S, R4W, SBM, Arroyo del Toro area about 4 miles north of Elsinore.	Undetermined		Quarry, (Dudley, 1935, p. 506; Engel, 1959, p. 100, 136).

335

~~Granite~~ Dimension Stone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified quarry~~	SE¼ sec. 18, T5S, R4W, SBM, Arroyo del Toro area, about 3 - 3/4 miles north of Elsinore.	Undetermined.		Quarry, (Dudley, 1935, p. 506; Engel, 1959, p. 100, 136).

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~~Granite~~ Dimension Stone

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified quarry~~	SW¼ sec. 18, T5S, R4W, SBM, Arroyo del Toro area, about 3½ miles north of Elsinore	Undetermined		Quarry. (Dudley, 1935, p. 506; Engel, 1959, p. 100, 136).

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Stone - Slate

Riverside County

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Rainbow Slate group	T5S, R4W, SBM.	Rainbow Mining and Mineral Products Co.		"Three miles north of Elsinore". Probably in area of slate outcrops in Railroad Canyon. Dark, red, yellow, and brown slates in beds 6 to 8 ft. thick quarried prior to 1929 and ground in a 20-ton capacity plant for roofing purposes. Production undetermined. (Tucker 1929, p. 524; Engel, 1959, p. 138).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Riverside Quarries Company deposit	Sec. 24(?), T5S, R4W, SBM, about 4 miles south of Perris.			Reported explored through open cut 200 ft. long 15 ft. wide and 12 ft. deep. (Tucker, 1929, p. 524; Engel, 1959, p. 103).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Wrench Slate prospect	S½ sec. 34, T5S, R4W, SBM.	J. H. Wrench, Elsinore (1937)	Fissile slate strikes N. 60°W. and dips 65° NE.	See Wrench prospect under gold. About 200 ft. east of the gold prospect, an open pit with face 20 ft. long and 5 ft. high. Curvature of slaty cleavage planes, abundant cross fractures, and tendency of slate to fray on weathered edges limit commercial possibilities. (Engel, 1959, p. 138).

340

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	~~Unidentified~~ ~~slate quarry~~	S½ sec. 23, T5S, R4W, SBM, west side of Railroad Canyon, about ¼ mi. from stream, about 4 mi. NE. Elsinore.	Undetermined		Quarry. (Dudley, 1935, p. 494; Larsen, 1948, p. 129; 1951, p. 45; Engel, 1959, p. 138).

341

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Undetermined ~~Unidentified~~ ~~slate quarry~~	N½ sec. 26, T5S, R4W, SBM, west side of Railroad Canyon, about ¼ mi. from stream, about 4 mi. NE. Elsinore.	Undetermined		Quarry. (Dudley, 1935, p. 494; Larsen, 1948, p. 129; 1951, p. 45; Engel, 1959, p. 138).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Bloom ~~claim~~	Secs. 15, 21, T7S, R13E, SBM.	Undetermined	This material is probably of an age and origin similar to that mined at the Bertram deposit a few miles to the southwest near the Salton Sea in Imperial County. See the following references (Tucker, 1924, p. 87-91; 1926, p. 281-283; Sampson, 1942, p. 140-143).	(Tucker, 1945, pl. 35).
	... Black Tin				Tin See ... Black Rock (1) 343

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1	Beauty Mountain claim	Sec. 36, T8S, R2E, SBM.	Undetermined		(Tucker, 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Blue Bird and Eagle claims	Sec. 29, T3S, R1E, SBM.	Undetermined		(Tucker, 1945, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1	Blue Boy and Black Mt. group	Sec. 3, T4S, R1E, SBM, 8 miles south of Banning, 1 mile west of Twin Pines Ranch.	J. O. Mayall, Santa Ana (1945)	Garnet-epidote tactite and schist with scheelite, reported to carry 1 to 6 percent, WO_3 in zone 2-4 feet wide.	Developed through 10-ft. shaft and open cuts. Twelve tons high-grade ore reported removed (1945). (Tucker, 1941, p. 582; 1945, p. 154, pl. 35).

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Dumbbell #1 and #2; G. S. #3, #4, #5 (claims)	Sec. 18, T7S, R5E, SBM, on north slope of Santa Rosa Mtns.	Gerhardt A. Steffen, 3603 Helms Ave., Culver City (1958)	Probably tactite in igneous-metamorphic rocks.	(Personal communication, A. S. Gerhardt, July 31, 1958).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Magnesium Canyon Tungsten (mine) (Cottonwood #1 - #3)	Sec. 22, T5S, R5E, SBM, 15 miles west of Indio.	Mr. and Mrs. Milton L. Knapp, P.O. Box 365, Arlington (1958) Under lease and option to T. J. Young, Los Angeles 1941-1943	A zone of scheelite-bearing quartz, epidote, garnet tactite bodies in igneous-metamorphic rocks. Tactite bodies 3 to 60 ft. in thickness and 100 to 300 ft. in exposed lateral extent. Assays report 0.8 to 1.5 percent WO_3.	Developed by 7 trenches and a 25-ft. shaft (Tucker, 1941, p. 582-583; 1945, p. 155, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Matilda group	Sec. 28(?), T7S, R15E (proj.) SBM, on southwest slope of Chuckwalla Mts.	E. G. Sweeney, 355 Norton St., Long Beach (1945)	Scheelite in quartz-epidote-garnet zones at and near contact of diorite dikes and schist.	Extent of development not determined; shipments, reported made to Metal Reserve Company's stockpile at Parker, Ariz. said to average 2 percent + WO_3. (Tucker, 1945, p. 155-156, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Miller Ranch	Sec. 2, T8S, R6E, SBM, 24 mi. southwest of Indio.	George A. Glover, Box 1187, Palm Springs (1955).	Tactite-bearing carbonate in igneous-metamorphic rocks. Reported to assay 1 percent WO_3 in ore body 2 to 7 feet wide.	Developed through 56-ft. adit and 20-ft. shaft. (Tucker, 1941, p. 583; 1945, p. 156, pl. 35).
	[illegible]				(See [illegible] mine (?))
					352

MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Phoenix Tungsten (Maynard) prospects	Sec. 9, T5S, R4E., SBM, approx. 7 miles southeast Palm Springs.	Andreas Canyon Club Inc., Palm Springs, 640 acres pat'd. land (1945)	Scheelite-bearing tactite in metamorphosed carbonate rocks in ridge between Andreas and Murray Canyons. Zones as much as 18 feet wide form about eight bodies exposed through horizontal distance of about 900 feet.	Developed through open cut. (Tucker, 1945, p. 156-157, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1	Pigeon Creek Tungsten mine	Sec. 11, T7S, R5E, SBM, ½ mile south of Pinion Flat.	Jack Harris and Associates, Los Angeles (1945)	Scheelite in tactite at granite-limestone contact in zone 10 to 20 ft. wide.	Developed through open cut. (Tucker, 1945, p. 157, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1	Ribbonwood Tungsten, Inc. claims\	Sec. 26, T7S, R5E, SBM, northeast slope Santa Rosa Mts.	Ray Galenor and George Stallman, Walter P. Story Bldg., Los Angeles (1945)	Scheelite in garnet-epidote-quartz tactite along granite-schist contacts. Some ore reported 2 percent + WO_3.	Developed through 40-ft. adit. Few tons of ore shipped to Parker stockpile. (Tucker, 1945, p. 157-,58, pl. 35).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
	Asbestos King (claim)	About 15 miles southeast of Indio.	Undetermined		(Wright, 1950, p. 184; 1957, p. 359; Murdoch, 1959, p. 29).

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
503	Good Fairy	SW¼ sec. 10 (proj.), NW¼ sec. 15 (proj.), T8S, R17E, SBM, on the north slope of Chuckwalla Mtns. about 1 mile north-northeast of Chuckwalla Spring.	Undetermined	A shear zone as much as 12 feet wide in gneissic diorite strikes N. to N.15°E., dips 65°E.; is exposed through about 500 feet. A quartz vein 3 to 8 feet thick lies along footwall. Vein fractured and stained by secondary iron minerals, resembles gold ore of nearby mines. Local claim holder (Ben I. Brewer) identified this as a tungsten prospect. Presence of tungsten minerals not verified.	Shear zone explored through 4 shallow prospect pits.

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MAP NO.	NAME OF CLAIM, MINE, OR GROUP	LOCATION	OWNER (NAME, ADDRESS)	GEOLOGY	REMARKS AND REFERENCES
1	Indian Tungsten mine	Sec. 28, T7S, R5E, SBM, 6 miles south of Pinon Flat.	Elmer E. Dunn, Pinyon Flat (1945)	Scheelite in garnet-epidote tactite body 60 feet wide and 600 feet in length.	Developed by 150-foot crosscut adit. (Tucker 1945, p. 155, pl. 35).

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Field Trip No. 4

GEOLOGY OF THE NORTHERN PENINSULAR RANGES, SOUTHERN CALIFORNIA: GEOLOGIC GUIDE AND ROAD LOG

by

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California Division of Mines and Geology
Los Angeles, California

March 1971

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Figure 2. Generalized geologic map of part of the Northern Peninsular Ranges.
Figure 3. Geology of part of the Elsinore Fault Zone.

INTRODUCTION AND ACKNOWLEDGMENTS

This guide covers the north-central part of the Peninsular Ranges, principally in western Riverside County, southern California. Commencing and terminating at the University of California, Riverside campus, the route of travel is a loop of 124 miles, with one short side trip (Fig. 1). The route affords ready access to a variety of geologic features: prebatholithic rocks, rocks of the southern California batholith, Upper Cretaceous to Pleistocene sedimentary rocks, Holocene alluvial deposits, recent fault features, and various geomorphic features. A considerably longer guide, overlapping part of this guide, has been prepared by Jahns (1954a).

The entire Peninsular Range province has been best described in some detail by Jahns (1954b, pp. 29-52) who included a map, and all but the Los Angeles basin part, more briefly by Gray *et al.*, (1971). In 1948 Larsen described the southern California batholith and included a map at a scale of 1:125,000. A number of workers have mapped and described parts of the northern Peninsular Ranges. Published regional reports include the Perris block (Dudley, 1935, 1936), Corona-Elsinore-Murrieta area along the Elsinore fault (Gray, 1954), the Temecula region of the Elsinore fault zone (Mann, 1955) and the Los Angeles basin (Yerkes *et al.*, 1965). For a synthesis of general distribution of major rock units and faults, the reader is referred to Dibblee (1968).

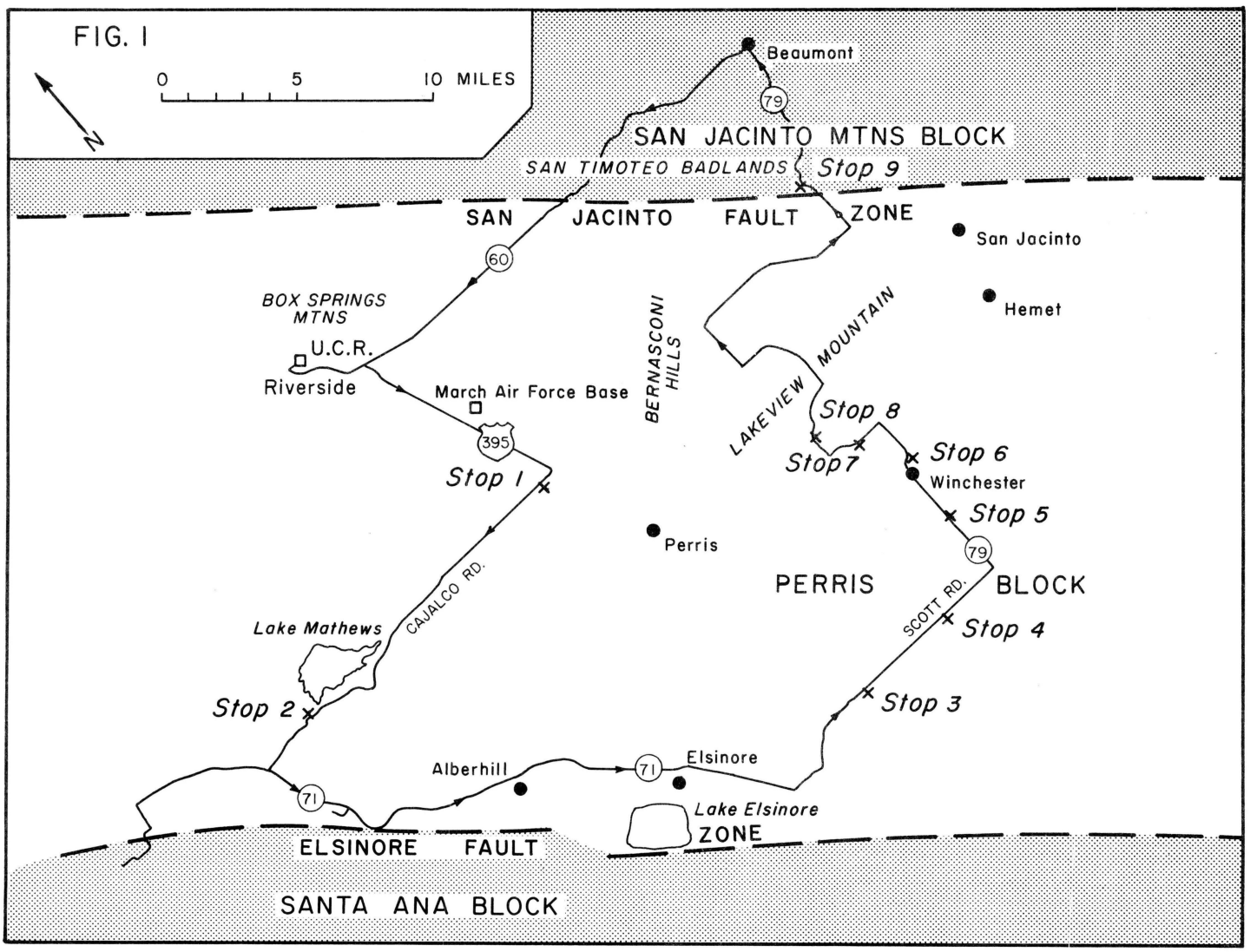
The accompanying generalized geologic map, Figure 2, is after Rogers (1966); modified by the authors. Additional data, mainly structural, were obtained from Engel (1959), English (1953), Gray (1961 and unpublished mapping), Jahns (1954b), Jenney (1968), Larsen, Norman (1962), Menzie (1962), Morton (1969, 1971, and unpublished mapping), and Schwarcz (1969).

A.O. Woodford, Pomona College, kindly made available an unpublished manuscript. Professor Woodford and R.F. Yerkes, U.S. Geological Survey, critically read the geologic synopsis of this guide.

GEOLOGIC SYNOPSIS OF THE NORTHERN PENINSULAR RANGES

An elongate, physiographic domain, the Peninsular Range province extends south-southeast from the latitude of Los Angeles-San Bernardino to the southern tip of Baja California. The western part of the province is submerged, and is part of the area termed the continental borderland (Shepard and Emery, 1941). High prominences of the Peninsular Ranges contintental borderland form the islands of Santa Catalina, Santa Barbara, San Nicolas, and San Clemente off the southern California coast.

Within the province is a general coincidence of both structural and physiographic features—all having a northwest trend (Jahns, 1954b; Larsen, 1948, pp. 119-127). This trend predates the emplacement of the southern California batholith ($\cong$110 m.y.) and has been repeatedly reinforced. Topographically, the province tilts gently westward to depths of about 5,000 feet below sea level over the United States part of the continental borderland. The San Jacinto Mountains along the eastern margin reach elevations in excess of 10,000 feet and drop precipitously to the Salton trough on the east.



INDEX MAP SHOWING MAJOR GEOMORPHIC FEATURES AND ROUTE OF TRAVEL.

GENERALIZED GEOLOGIC MAP OF PART OF THE NORTHERN PENINSULAR RANGES, SOUTHERN CALIFORNIA.

FIG. 2

AFTER ROGERS 1965, MODIFIED BY D.M. MORTON AND C.H. GRAY 1971.

EXPLANATION

TERTIARY AND PLEISTOCENE — HOLOCENE
- Qal — Quaternary Alluvium
- Older Alluvium
- Pliocene-Pleistocene Nonmarine Deposits

TERTIARY AND UPPER CRETACEOUS
- Middle Miocene through Pliocene Sedimentary Rocks of the Los Angeles Basin
- Upper Cretaceous and Paleocene through Lower Miocene Sedimentary Rocks

CRETACEOUS
- Granitic Rocks of the Southern California Batholith
- Gabbro of the Southern California Batholith

JURASSIC
- Metamorphic Rocks of Jurassic Age and Probable Jurassic Age
- Jurassic Volcanic and Related Rocks

?
- Metamorphic Rocks of Unknown Age

- Foliation in Batholithic Rocks

BEAUMONT
Stop 10
Stop 9
SAN JACINTO FAULT
SAN JACINTO FAULT ZONE
CASA LOMA FAULT
San Jacinto Valley
SAN JACINTO
HEMET
Moreno Valley
U.C.R.
RIVERSIDE
LAKEVIEW
MARCH AIR FORCE BASE
Perris Valley
Stop 1
Stop 8
Stop 7
Stop 6
WINCHESTER
Stop 5
PERRIS
Stop 4
Stop 3
Stop 2
Lake Mathews
CORONA
CHINO FAULT
ELSINORE FAULT
ELSINORE
ELSINORE FAULT ZONE
Lake Elsinore
SANTA ANA MTNS.
Qal

0 1 2 3 4 5
MILES

N

The landward northern Peninsular Ranges are 60 to 80 miles in width, and divided into three elongate structural blocks separated by major northwest-striking fault zones. From west to east: the Newport-Inglewood zone forms the boundary between the largely submerged continental borderland block to the west and the Santa Ana block to the east; the Elsinore zone and associated Elsinore-Temecula graben separate the Santa Ana block from the Perris block. Eastward, the San Jacinto zone separates the Perris block and San Jacinto Mountains block.

Basement Rocks

The northern Peninsular Ranges consist of pre-Turonian basement rocks separated by a profound unconformity from a superjacent sedimentary sequence of Turonian and younger age. The basement rocks can be divided into two distinctly different complexes: a western complex west of the Newport-Inglewood zone and an eastern complex east of this zone (Woodford, 1960; Yerkes *et al., 1965).*

Western Basement Complex: The western basement complex belongs to the blueschist metamorphic facies characterized by lawsonite and glaucophane. The dominant rock is the Catalina Schist (Catalina metamorphic facies of Woodford, 1924), made up of metamorphosed clastic and volcanic rocks, and serpentinite, which is, in part, intruded by Miocene dacite porphyry and quartz diorite (Forman, 1970; Schoellhamer and Woodford, 1951; Woodford, 1960). Conspicuous by their absence are the granitic rocks that are elsewhere widespread in the Peninsular and Transverse Ranges.

Although the Catalina Schist is of low metamorphic grade, no fossils have been reported. Woodford (1924), on the basis of lithology, correlated this schist with the Franciscan Formation to the north, which is Late Jurassic to early Late Cretaceous in age (Bailey *et al.,* 1964; Irwin, 1967). Forman (1970) reports a K-Ar age of about 100 m.y. for the Catalina Schist.

Eastern Basement Complex: East of the Newport-Inglewood zone the basement consists of granitic rocks, incipiently metamorphosed clastic and volcanic rocks, and locally, marble. Metamorphic grade of the clastic rocks increases progressively eastward, noticeably in the Perris block. Granitic rocks of the southern California batholith have invaded all of these rocks. The eastward increase in regional metamorphic grade is independent of the distribution of individual plutons of the batholith. Local contact metamorphism, however, accompanied the emplacement of the batholith and gave rise to several well-known complex mineral assemblages (e.g., Crestmore—see Burnham, 1959; Murdoch, 1961). Foliation in the metamorphic rocks, which generally strikes northwest, predates emplacement of the batholith (Schwarcz, 1969). Local deviation in the foliation has been produced by the emplacement of some plutons (e.g., Morton, 1969).

In the Santa Ana block the oldest dated rock is a sequence of incipiently metamorphosed, thin-bedded argillite, graywacke, and quartzite, with local pods of marble, termed the Bedford Canyon Formation (Gray, 1961; Larsen, 1948). The

TABLE 1

GENERALIZED GEOLOGIC COLUMN NORTHERN PENINSULAR RANGES (EXCLUDING THE LOS ANGELES BASIN)

Age	*Formation*	*Description*	*Distribution*	*Max. Estimated Thickness in Feet*
Quaternary	Holocene alluvium; Pleistocene nonmarine; Bautista Beds and Temecula Arkose; Pleistocene marine deposits.	Continental sands, gravels, lake beds. Marine fossiliferous terrace deposits.	Marine terrace deposits along coast. Alluvial fan deposits, lake beds, and valley fill in interior areas.	8,000 (?) in San Jacinto Valley.
Continental Pliocene	San Timoteo and Mt. Eden.	Continental sandstones, silt stones and conglomerate; redbeds. Upper part of San Timoteo is Pleistocene.	West of San Jacinto Mts. along San Jacinto fault.	7,000
Marine Pliocene	Repetto (?)	Thick-bedded white sandstone, conglomerate, silt, and shale. Marine.	Northwest end of Elsinore Trough at Corona on margin of Los Angeles Basin.	2,000 near Corona
Pliocene	Santa Rosa Basalt	Basalt, andesite, and pyroclastics.	Mesa-capping basalt near Murrieta.	Several hundred
Upper Miocene	Puente	Sandy siltstone and shale; minor sandstone, conglomerate and diatomite. Marine.	Northwest end of Elsinore Trough at Corona on margin of Los Angeles Basin.	1,000 (?)
Middle Miocene	San Onofre Breccia	Blocks of glaucophane and similar schists.	Oceanside north on coastal margin of region.	2,500
	Topanga	Buff sandstone, conglomerate, and sandy siltstone. Marine.	Northwest end of Elsinore Trough near Corona.	800
Lower Miocene to Upper Eocene	Vaqueros (Lower Miocene) and Sespe (Upper Eocene-Lower Miocene).	White, buff, red and green sandstone, conglomerate, sandy clay, and siltstone. Interfingering marine and nonmarine.	Northwest end of Elsinore Trough near Corona. West flank of Santa Ana Mts. at Trabuco Canyon.	3,000 combined
Eocene	Santiago	Buff sandstone, siltstone, and conglomerate. Marine.	North and northeastern margins of Santa Ana Mts. near Corona.	600 near Corona
Paleocene	Silverado	Upper part marine sandstone, conglomerate, siltstone, and shale; lower part nonmarine or brackish water sandstone, conglomerate, clay, lignite.	Elsinore Trough from Elsinore to Santa Ana River at northwest tip of Santa Ana Mts.	2,000 (?) at Corona
Upper Cretaceous	Williams and Ladd	Sandy shale or siltstone, arkosic sandstone, boulder conglomerate. Well stratified, fossiliferous. Marine.	Along northern part of coastal strip and around northwest tip of Santa Ana Mts. Underlies younger formations.	5,500
Cretaceous	Trabuco	Red and gray-green boulder conglomerate and sandstone. Nonmarine (?).	In Santa Ana Mts. northerly from Plano Trabuco to Black Star Canyon; southwest of Corona.	1,000; 600 near Corona
	Unconformity			
Cretaceous	Plutonic intrusive rocks of southern California batholith.	Granite, adamellite, granodiorite, quartz diorite, tonalite, diorite, and gabbro.	Basement rocks throughout the region.	
Jurassic	Santiago Peak	Volcanics, metavolcanics and hypabyssal intrusive rocks.	Part of basement rocks along western margin of plutonic basement rocks.	Several thousand
	Bedford Canyon	Argillite, slate, schist, quartzite, and minor marbles.	Roof pendants widely distributed in western part of batholith.	Several thousand
Jurassic (?)	French Valley [may overlie Bedford Canyon Fm.].	Quartzite, schist, and amphibolite.	Central part of Perris block.	13,000
Paleozoic (?)	Unnamed	Schist, gneiss, phyllite, quartzite, and marble.	Roof pendants widely distributed in eastern part of batholith; chiefly in San Jacinto and Santa Rosa Mts.	Several thousand

orientation of sedimentary structures indicates that the Bedford Canyon is highly deformed. Owing to the structural complexity and monotonous nature of this sequence, the overall structure and original thickness are unknown (Gray, 1961). Larsen (1948, p. 22) considered the unit to have a stratigraphic thickness of 20,000 feet; Gray (1961, p. 12) believes this thickness to be excessive.

Prior to 1960 the Bedford Canyon Formation was generally considered to be Triassic (Gray, 1961, pp. 12-13), but Fairbanks (1893, p. 116) originally regarded these rocks as Carboniferous. The Triassic age was based upon a sparse collection of the pelecypod *Daonella sanctaeanae* Smith, the Upper Triassic ammonite genera *Discotropites* and *Juvavites,* and rhynchonellid brachiopods of the Triassic genus *Halorella* (Engel, 1959, p. 20, 23, and 24). Subsequent collections, however, indicate an early Late Jurassic (Callovian) (Imlay, 1963; Silberling *et al.,* 1961) and lower Middle Jurassic (Bajocian) (Imlay, 1964) age for the Bedford Canyon. Brachiopods formerly considered to be *Halorella* are now thought to be a new genus, perhaps transitional between *Halorella* of the Upper Triassic and *Peregrinella* of the Lower Cretaceous (Silberling *et al.,* 1961).

Unconformably overlying the Bedford Canyon Formation is the Santiago Peak Volcanics (Larsen, 1948). Most of the rock is of dacitic to andesitic composition. In the northern Santa Ana Mountains this unit has an apparent maximum thickness of 2,300 feet (Gray, 1961, p. 15). The age of the Santiago Peak Volcanics is considered to be Jurassic (Fife *et al.,* 1967). Shallow, intrusive rocks related to the Santiago Peak Volcanics occur in the Bedford Canyon Formation.

Metamorphic rocks in the western and central parts of the Perris block have been correlated, on the basis of lithology, with the Bedford Canyon Formation and Santiago Peak Volcanics (Gray, 1961; Larsen, 1948; Schwarcz, 1969). They are, however, in general more intensely metamorphosed than the Bedford Canyon in the Santa Ana Mountains. Also widespread in the northwestern part of the block is the Temescal Wash Quartz Latite Porphyry (Dudley, 1935, p. 497). Supposedly of Jurassic age, this porphyry may be related to the Santiago Peak Volcanics.

In the Winchester area (north-central part of the Perris block) rocks correlated with the Bedford Canyon Formation are considered by Schwarcz (1969) to be conformably overlain by a 13,000 foot thick sequence of quartzite, schist, and amphibolite. Schwarcz (1969, p. 19) considered the original sediment of this sequence, which he named the French Valley Formation, "to have been deposited in a marginal basin (Krumbein and Sloss, 1963, p. 418), flanking a cratonic highland and possibly transitional on the west into a eugeosyncline." These rocks earlier were considered to be of Paleozoic age (Larsen, 1948; Webb, 1939), as based on a fossil later believed to have been imported (letter to A.O. Woodford from R.W. Webb, November 20, 1959; ref. in Woodford, 1960). Schwarcz's work clearly shows the incompatibility of the fossil with the rocks in the area of its reported occurrence. Just west of the Winchester area, in rocks apparently equivalent to the French Valley Formation, M.A. Murphy (pers. comm., 1968) collected pelecypods of uncertain age. These pelecypods have been considered to be either Late Triassic or Jurassic in age (Schwarcz, 1969).

The metamorphic grade of French Valley Formation rocks increases abruptly eastward in the Winchester area, passing in map distance of less than two miles from a muscovite zone, through andalusite, sillimanite, and garnet isograds. Based on mineral assemblages (Morton, 1969; Schwarcz, 1969) metamorphism was of the Abukuma (andalusite-sillimanite) type (Winkler, 1965).

At the northern end of the Perris block (e.g., Crestmore, Jurupa Hills, Slover Hill) and southeast of Hemet (Bautista Canyon), the metamorphic rocks commonly contain marble, on the basis of which they may be possibly Paleozoic in age (see Woodford, 1960).

The western San Jacinto Mountains block includes banded gneiss, marble, amphibolite schist, quartzite, and metaconglomerate of the almandine amphibolite facies (Sharp, 1967, p. 717). On the east side of the San Jacinto Mountains and passing southward through the Santa Rosa Mountains is a thick zone of cataclastic rocks as well as abundant marble and dolomite (Sharp, 1967, 1968; Theodore, 1966, 1970). These rocks are of unknown age.

Southern California Batholith

Larsen (1941) gave the name Southern California batholith to a sequence of plutonic rocks that makes up much of the eastern basement complex. Rocks of this composite batholith range in composition from olivine gabbro to granite and form myriad bodies of differing shapes and sizes. The general sequence of emplacement has been basic to silicic (gabbro to granite). Although Dudley (1935) first mapped the northern Perris block, the batholith is best known through the works of Larsen, especially his 1948 Memoir.

In the Santa Ana Mountains batholithic rocks intrude the Jurassic Bedford Canyon Formation and are overlain by the Upper Cretaceous Trabuco Formation, a nonmarine conglomerate that contains clasts of granitic rocks resembling those of the batholith. In northern Baja California, early Upper Cretaceous rocks (upper Cenomanian and Turonian) are intruded by rocks of the batholith and are in turn overlain by late Upper Cretaceous (Senonian) sedimentary rocks (see Woodford and Harris, 1938) which there indicates that the batholith is of middle Late Cretaceous age. Geochronological data from U-Pb isotopes in zircon have yielded dates in the interval 100 to 120 m.y. (e.g., Banks and Silver, 1961). K-Ar dates for batholith rocks give consistently younger ages, clustering in the low 90 m.y. range (Evernden and Kistler, 1970; Morton, 1969).

Lithologically, the batholith is composed of essentially three rock types: gabbro, quartz diorite (tonalite), and granodiorite. In its northwestern part, Larsen (1948, 1951, 1954) found the batholith to consist of 7% gabbro, 63% quartz diorite, and 28% granodiorite, with granite constituting only 2%. Gabbro, generally called San Marcos Gabbro (Larsen, 1948; Miller, 1937, 1938), is typically a hornblende or hornblende-bearing gabbro, but is extremely variable in mineralogy. Rocks called San Marcos Gabbro include allivalite, troctolite, norite, quartz norite, and anorthosite. Quartz diorite (tonalite) is the most abundant rock type and Bonsall Tonalite (Hurlbut, 1935) the most common unit. Typically the quartz diorites are medium- to coarse-grained biotite-hornblende quartz diorites. Most

are foliated and commonly contain flattened, discoidal, dark inclusions; some exposures exhibit abundant schlieren. Granodiorite, most of which is termed the Woodson Mountain Granodiorite, is generally a relatively uniform, medium-grained rock, either massive or foliated (Larsen, 1948). Some exposures are essentially inclusion free; others are choked with inclusions. Locally a porphyritic or sub-porphyritic texture is prominent.

A number of discrete plutonic bodies or complexes have been studied in detail. These studies indicate the batholith was emplaced by a variety of processes including magmatic, both forceful (Menzie, 1962; Morton, 1969) and passive (Jenney, 1968; Morton and Baird, 1971), and by replacement (Jahns, 1948). Complex internal structures have been demonstrated for some granitic rocks (Morton, 1969; Osborn, 1939).

An exhaustive chemical investigation of the batholithic rocks has been conducted in the northern Peninsular Ranges. Preliminary results of this study show a marked systematic chemical variation parallel to the structural grain (Baird *et al.*, 1965, 1966, 1970). Two individual plutons have been studied chemically. Both bodies show a chemical variation essentially parallel to their structural configuration. In the Box Springs Mountains complex, Joshi (1969) found the core to be more silicic than the margin and considered the variation to be a function of elevation differences. The Lakeview Mountains pluton has a more basic core than margin, reflecting original magma differences (Baird *et al.*, 1967; Morton *et al.*, 1969).

Superjacent Series Sedimentary rocks and unconsolidated sediments range in age from Upper Cretaceous to Holocene and recent. The northern Santa Ana Mountains and adjacent Elsinore fault zone contain the greatest variety of these units. On the Perris and San Jacinto Mountains blocks the superjacent series is essentially limited to late Tertiary and Quaternary nonmarine deposits.

Santa Ana Block and Elsinore Fault Zone

The northern Santa Ana Mountains and the adjacent Elsinore fault zone are part of the Los Angeles basin, which developed during Miocene time. Thus, the later history of this part of the Peninsular Ranges differs considerably from that to the east. Prior to the inception of the Los Angeles basin, this part of the Peninsular Ranges was the site of discontinuous deposition beginning in Late Cretaceous time. For a summary of the history of the Los Angeles basin, the reader is referred to Yerkes *et al.* (1965).

Upper Cretaceous rocks in the northern Santa Ana Mountains attain a thickness of 5,500 feet (Woodford *et al.*, 1954). Resting unconformably upon basement is the Trabuco Formation (Packard, 1916), a 400- to 700-foot sequence of unfossiliferous conglomerate (Gray, 1961, p. 18-19). Clasts in the conglomerate are primarily Santiago Peak Volcanics and related rocks, with minor, but strikingly ubiquitous, clasts of biotite granodiorite.

Above the Trabuco Formation is an Upper Cretaceous marine sequence of conglomerate, sandstone, siltstone, and shale. Termed the Ladd Formation, it has a stratigraphic thickness of 1,700 feet. In places this formation has been divided into two members: the Baker Canyon Conglomerate Member (with fauna of Turonian age) and overlying Holz Shale Member (Turonian to Campanian) (Gray, 1961; Woodring and Popenoe, 1942). Unconform-

ably overlying the Ladd Formation is the Williams Formation. The lower part (Schulz Ranch Sandstone Member) is an unfossiliferous arkosic sandstone and the upper part (Pleasants Sandstone Member) is a fossiliferous (Campanian), shaly sandstone with intercalated lenses of sandstone (Popenoe, 1937; p. 380).

Paleocene rocks, about 1,400 feet thick in the Santa Ana Mountains (Woodford *et al.*, 1954, p. 69), are called the Silverado Formation (Woodring and Popenoe, 1945). They rest unconformably upon Upper Cretaceous and basement rocks in the Santa Ana Mountains and in the Elsinore fault zone (Gray, 1961). Basal Silverado consists of nonmarine conglomerate and feldspathic sandstone. Locally, the sandstone is extremely rich in biotite and resembles biotite schist (Woodford *et al.*, 1954, p. 69). The upper part of the Silverado is a fossiliferous marine sandstone and siltstone.

The basal part of the formation contains large amounts of high-alumina clay. This clay includes both residual and sedimentary clay, some of which is bauxitic (Gray, 1961, p. 25). The residual clay was derived from *in situ* weathering of a variety of basement rocks (Gray, 1961, p. 63). The clay and local silica sand deposits of the Silverado support a number of mining operations which date back over 80 years, among which are the most productive clay operations in southern California.

The Eocene Santiago Formation apparently conformably overlies the Silverado Formation (Woodring and Popenoe, 1945). Predominantly sandstone, the lower part of the Santiago contains a middle Eocene molluscan fauna; the Santiago has a maximum thickness of approximately 2,700 feet. The upper part of the Santiago at least locally contains nonmarine conglomerate and sandstone and is gradational with the Sespe Formation. Late Eocene to earliest Miocene nonmarine Sespe Formation and the early Miocene marine Vaqueros Formation have been mapped as an undifferentiated unit as much as 3,000 feet thick. They consist of vari-colored (maroon, gray, red, and greenish) sandstone and conglomerate (Gray, 1961). These rocks apparently rest conformably upon the Santiago Formation in the Santa Ana Mountains (Woodford *et al.*, 1954, p. 69) and unconformably upon the Santiago west of Corona (Gray, 1961, p. 30).

Following the deposition of lower Miocene sediments was a period of general emergence and erosion which produced a widespread unconformity throughout much of the Los Angeles basin. During middle Miocene time, a northwest-trending embayment covered the site of the basin, with highlands rising both to the northeast and southwest (Yerkes *et al.*, 1965). During part of this time, the western basement (Catalina Schist) emerged and rapidly shed debris which entered the southwest side of the marine embayment to form the San Onofre Breccia (Woodford, 1925).

Marine middle Miocene rocks crop out in the northwestern Santa Ana Mountains and in limited exposures in the Corona area where they have been assigned to the Topanga Formation. In the Corona area these rocks consist of sandstone and conglomerate which have yielded middle Miocene megafossils and microfossils (Gray, 1961, p. 31).

During upper Miocene to lower Pliocene time, with the main phase of basin development there was essentially continuous subsidence and deposition in the Los Angeles basin (Yerkes *et al.*, 1965, p. 17).

Upper Miocene marine sedimentary rocks, the Puente Formation as much as 13,400 feet thick in the Los Angeles basin, occur in the northernmost Santa Ana Mountains and underlie the Puente-Chino Hills to the north. In the Corona area a few patches of siltstone, sandstone, and conglomerate contain upper Miocene foraminifera and are assigned to the Puente Formation (Gray, 1961, p. 31-35). Immediately east of Corona the apparent eastward limit of deposition of this unit is marked by a cliff-like, buttressed unconformity between granitic rock and fossiliferous sandstone and conglomerate tentatively correlated with the Puente Formation (Gray, unpublished map, 1969).

Lower Pliocene sandstone and siltstone with interbedded conglomerate conformably overlie the upper Miocene rocks in the northeasternmost Santa Ana Mountains and along the margins of the Puente Hills. East of there, these strata have not been named. At the end of the Pliocene, the Puente-Chino Hills and Santa Ana Mountains emerged, which have subsequently not been submerged. During late Pleistocene through Holocene, the Los Angeles basin gradually ceased to be a site of major deposition with a continual westward withdrawal of the sea (Yerkes *et al.*, 1965, p. 19-20).

Alluvial deposits of Pleistocene to Recent age are similar over most of the northern Peninsular Ranges. Stream terrace deposits are widespread along major drainages; most consist of unconsolidated gravels in a poorly sorted, sandy matrix, reddish-brown to tan or buff in color. Clasts are of differing composition, depending upon source area. Older terrace deposits are commonly dissected and have nearly flat upper surfaces. They range in thickness from less than one foot to over 100 feet.

Older alluvium is widespread and occurs generally as dissected alluvial fan deposits. Characteristically, the older alluvium is red-brown and well-indurated. It contains considerable clay, with subangular to rounded small clasts.

Tertiary and Quaternary deposits on the Perris and San Jacinto Mountains Blocks

Nonmarine Pliocene to Pleistocene deposits, other than "older alluvium," are very restricted in the northern Perris block. Two east-trending, largely obscured stream channels cross the northwestern part of the block. During recent construction, a Pliocene mammalian fauna was discovered near Lake Mathews (Proctor and Downs, 1963) in poorly sorted, arkosic sandstone that fills a channel cut in basement rock on the Perris surface, an erosion surface at the 1,700 foot elevation.

A much smaller, somewhat sinuous stream channel occurs on the Lakeview-Gavilan surface, a 2,100-foot erosion surface south of Lake Mathews. Mantled by cobbles, it stands in base relief above a largely bedrock surface (Dudley, 1953). Small patches of gray, poorly bedded sediment of unknown age occur on the Lakeview-Gavilan surface in the Lakeview Mountains (Morton, 1971).

Unconsolidated, buff colored, decomposed arkosic sediment underlies older alluvium in the Canyon Lake area (formerly Railroad Canyon) east of Elsinore. This sediment apparently fills an east-trending depression in the basement.

Nonmarine Pliocene and Pleistocene deposits are widespread in the northern San Jacinto Mountains block; the northern 25 miles of the block is underlain by sedimentary deposits

comprising the "San Timoteo Badlands." Sediments overlying basement are generally coarse, arkosic sandstone and conglomerate red beds. Overlying the red beds are buff- to gray- and greenish-gray sandstone, conglomerate beds and lenses, and siltstone. Some conglomerate lenses are monolithologic, composed of quartz diorite clasts as much as 20 feet in diameter (Morton, 1971). The lower part of the sequence is generally termed the Mt. Eden Formation, or Beds, and the higher part, the San Timoteo Formation. The Mt. Eden Formation is probably mainly middle Pliocene in age and the San Timoteo is upper Pliocene in age.

These and similar sediments, east and southeast of Hemet have yielded a mid-Pliocene (Hemphillian), early Pleistocene (Blancan) and later Pleistocene (Irvingtonian) fauna (Frick, 1921; Savage *et al.,* 1954). They have also yielded a mid-Pliocene to early Pleistocene flora (Axelrod, 1937, 1945, 1966).

Faults

The Peninsular Ranges abruptly terminate to the north against the east-trending Transverse Ranges. The Malibu Coast-Santa Monica-Raymond Hill-Sierra Madre-Cucamonga fault complex marks their northern terminus, extending from the Pacific Ocean to the Devore area near Cajon Pass. East of Devore this boundary is apparently offset on the San Jacinto fault approximately 15 miles right laterally to the Redlands area. From this point the boundary is termed the Banning fault, which continues eastward into the San Gorgonio Pass area.

The several blocks of the Peninsular Ranges are separated by northwest-striking faults belonging to the San Andreas fault system (Crowell, 1962). The major fault zones are, from west to east: the Newport-Inglewood, the Elsinore-Whittier, and San Jacinto. The Newport-Inglewood zone is poorly exposed; the other zones consist of a complex of subparallel, en échelon, or anastomosing faults. Individual faults within each zone show evidence of recent displacement as indicated by ephemeral features such as closed depressions and scarps.

The presence of unlike metamorphic rocks on opposite sides of the Newport-Inglewood fault zone suggests considerable displacement and recently it has been considered the "proto-San Andreas" fault in southern California (Suppe, 1970). Pre-late middle Miocene displacement of undetermined amount and sense juxtaposed the Eastern and Western basement complexes and exposed Western basement to erosion. Lower Pliocene strata are separated as much as 5,000 feet in a right lateral sense along faults of the zone. Vertical separation at the basement surface locally attains 4,000 feet across the zone, but that of Pliocene strata commonly does not exceed 1,000 feet and that at the base of the Pleistocene 200 feet. Late movement on the fault has resulted in arching of young sediments to form low hills along the zone (Yerkes *et al.,* 1965, p. 48) and seismic activity (i.e., Long Beach earthquake of 1933) indicates continued movement (Barrows, in press, 1971).

The Elsinore-Whittier fault zone, with a known length of about 135 miles, extends from the Whittier Narrows area, east of Los Angeles, southeast to at least within a few miles of the International Border. Bifurcating at the north end of the Santa Ana Mountains, its west

branch is termed the Whittier fault. The east branch, the Chino fault, passes along the east side of the Chino (Puente) Hills northwest of Corona. From the Corona area southward the zone is designated Elsinore.

Along the Whittier fault, local structural data indicate an oblique net slip (right-lateral reverse) of about 15,000 feet since Miocene time; this part of the fault zone may have been active since middle Miocene time (Yerkes *et al.*, 1965, p. 50).

Displacement on the Elsinore fault zone has been considered essentially normal, reverse, as well as lateral by various workers (Gray, 1961, p. 46). Distribution of basement rocks across the faults suggests possible lateral displacement on the order of a few miles. Sag ponds and scarps along faults of this zone indicate recent movement (e.g., Glen Ivy, Willard, and Wildomar).

The San Jacinto is the only fault of the San Andreas system, including the San Andreas, to cross the southern Transverse Ranges without deviating from its general strike or being terminated. On the contrary, the San Jacinto fault appears to offset the southern, east-striking faults of the Transverse Ranges (Allen, 1957, p. 339; Sharp, 1967, p. 726). Based on its straightness, continuity, and seismic history, it appears to be the most active fault of the San Andreas system in southern California (Sharp, 1967). Based on a number of offset basement contacts southeast of Hemet, Sharp (1967) determined a 15-mile right-lateral displacement across the San Jacinto. He also found Pleistocene deposits offset right laterally at least 3.2 miles and stream courses offset half a mile.

In the San Jacinto Valley, a remarkably deep, narrow graben has developed between the San Jacinto and adjacent Casa Loma faults. North of San Jacinto the depth to basement in this alluvial-filled graben is some 8,000 feet beneath the present valley floor (Fett, 1968). It is thought this graben developed and filled since the early Pleistocene. Currently, parts of the graben are undergoing rapid subsidence. Surface expression of this subsidence is widespread (Fett *et al.*, 1966) and includes major surface fissures (Morton, 1971). This active subsidence, which in part may be of tectonic origin, appears to be mainly the result of ground-water withdrawal. A large number of recent surface expressions of faulting occur on the San Jacinto fault (Sharp, 1970).

Seismically, the San Jacinto fault zone has been the most active member of the San Andreas system; many destructive earthquakes having occurred along the zone since the turn of the century (e.g., 1899, 1918, 1923, 1937, and 1954) (Allen *et al.*, 1967).

Geomorphology

A number of low-relief, erosional surfaces occur throughout much of the northern Penisnular Ranges at different elevations. They are best developed, and exposed, on the Perris block. Erosional surfaces are present there at elevations of 1,700; 2,100; and 2,500 feet (Dudley, 1936; Larsen, 1948). There is also a largely buried canyon system. Dudley (1936, pp. 358-387) believed that the Perris block, which is bounded on the southwest by the Temecula-Elsinore trough, had a geomorphic history briefly summarized as follows:

1. A mature surface was developed in the area of the Perris block. Drainage was at that time toward the east.

2. This old topography was partly buried by sediments, and the Perris surface was developed. This surface, cut on crystalline rocks and interrupted here and there by monadnocks, lies at an altitude of about 1,700 feet.
3. Sediments accumulated over a large area, and the Lakeview-Gavilan surface at an altitude of about 2,100 feet was formed.
4. Erosion exhumed the Perris surface, and the San Jacinto River then flowed across this surface and through the Santa Ana Mountains to the sea. The river thus is superimposed where it crosses monadnocks on the Perris surface.
5. The San Jacinto River was captured by Temescal Creek, a tributary of the Santa Ana River. Elsinore Lake is a temporary feature, incidental to recent faulting.

A revised interpretation of the development of these features, and their relations to contemporary tectonism has been proposed by Woodford *et al.* (in press, 1971).

Of particular interest is the San Jacinto River course, which may once have flowed across the present area of the Santa Ana Mountains. Apparently movement of the Elsinore fault zone uplifted the Santa Ana Mountains across its path, disrupting the earlier westward course of the drainage and causing the present northward drainage along the Elsinore fault zone toward present-day Santa Ana Canyon. The canyon itself is probably antecedent, as uplift of the Santa Ana Mountains continued after the initial disruption of the San Jacinto River course. Currently except for periods of extraordinary runoff, such as during 1916-1917, the San Jacinto River runoff terminates at Lake Elsinore, a closed depression marking the northern end of the Temecula-Elsinore graben.

FIELD TRIP ROAD LOG

The starting point of the trip is located on the west flank of a funnel-shaped granitic complex (see Fig. 2). This complex, part of the southern California batholith, and termed the Box Springs body (Menzie, 1962), is elliptical in plan (5 x 8 miles) with its long dimension oriented N.40°W. It consists principally of two parts: an outer zone composed of foliated quartz diorite (tonalite) and granodiorite, with minor quartz monzonite and granite; and an interior or center (2 x 3 miles), of massive quartz diorite. Quartz diorite (Bonsall Tonalite), the most abundant rock in the outer zone, is strongly foliated with common to abundant inclusions most of which are disc-like in shape. The long dimensions of the inclusions, as well as the long dimensions of tabular and platy minerals, define the foliation. Quartz diorite comprising the center contains sparse unoriented inclusions. Menzie considers the complex resulted from mobilization of largely crystallized quartz diorite (which forms the outer zone) and was later intruded by magma which formed the central part of the complex. Movements in the largely crystallized quartz diorite resulted in formation of the foliation and "flattening" of the inclusions (after Menzie, 1962).

0.0 Start trip. Parking Lot, Ramada Inn, Riverside. Proceed east from parking lot to University Avenue and hence onto southbound US 395. Highway proceeds up Box Springs grade passing through exposures of typical Bonsall Tonalite. Note the foliated nature of the rock and the common pancake shaped dark inclusions.

3.6 Highway grade decreases on entering the 1,700+ foot Perris erosional surface.

4.1 Overpass across Santa Fe tracks. Here a thin veneer of gray Pleistocene (?) sediments covers the Bonsall Tonalite.

4.3 Highway branches. Bear to the right on US 395.

4.6 To left (northeast) is the east-striking, north-dipping southern part of the Box Springs complex.

5.5 The valley floor, termed the Paloma surface (Woodford *et al.*, 1971), subtly reaches elevation 100-200 feet below the Perris surface.

6.5 Highway crosses Allesandro Road (traffic light).

7.6 March Air Force Base Depot. Strategic Air Command (SAC) headquarters to left.

8.6 Highway crosses Van Buren Boulevard (traffic light).

8.8 Ahead to the right the low relief hills silhouette the Perris surface rising above the alluviated valley.

11.0 Four miles east are the Bernasconi Hills. These hills are upper parts of a buried stream system which drained towards the highway, where at this point the valley fill is over 800 feet deep (Bean, 1955). The former drainage direction abruptly reversed at the west edge of the Bernasconi Hills and flowed eastward towards the San Jacinto Mountains and emptied into a graben along the San Jacinto fault zone (Woodford *et al.*, 1971).

12.5 Right turn off US 395 onto Cajalco Road.

12.6 Low dump 200 yards south of Cajalco Road is spoilage from the Metropolitan Water District's (MWD) Val Verde Tunnel. This tunnel is part of the elaborate aqueduct that brings water from the Colorado River to the metropolitan areas of southern California. Our route follows the aqueduct for the next ten miles to Lake Mathews, an MWD reservoir.

12.9 Near horizontal skyline to south is the Perris surface developed on Bonsall Tonalite.

13.5 Contact between alluvium and Bonsall Tonalite.

13.8 **Stop 1**: Turn left (south) onto dirt road. Proceed for 0.2 mile to dump from MWD tunnel to view abundant fresh boulders of quartz diorite. This quartz diorite is from the Riverside-Perris pluton (Jenney, 1968), a large elongated (4.9 x 13 miles) body of Bonsall Tonalite of predominantly a biotite-hornblende quartz diorite. To the northeast it merges with the Box Springs Mountain body. Like the outer quartz diorite in the Box Springs Mountains, this rock is strongly foliated with abundant inclusions oriented north-northwest and dipping moderately to the northeast. In general the dip flattens from west to east across the pluton. Jenney (1968) considers the quartz diorite to have been intruded into a tensional environment which allowed permissive entry of the quartz diorite magma (after Jenney, 1968). Return to Cajalco Road.

14.1 Cajalco Road reaches top of the Perris surface.

14.8 Intersection of Cajalco Road and Clark Street. A few hundred feet to the left is a buried Pliocene-Pleistocene stream channel marked by the low rounded hills. Note the lack of rounded boulders which would indicate the presence of granitic rocks.

15.4 Cajalco Road crosses north-trending arm of the channel.

16.3 Exposure of Bonsall Tonalite.

16.5 To the left is dump from MWD Val Verde tunnel. To right is an exposure of hybrid rocks. Folded inclusion-like layers in migmatite are oriented with fold axes striking northwest and plunging to southeast. (Note: As of 12/30/70 road was in process of being straightened. In the future the road will pass through the migmatitic rocks.)

17.5 Intersection with Wood Road. To the north is brown-weathered quartz diorite within typical gray-weathered Bonsall Tonalite.

17.6 Road cut in red older alluvium covering buried Pliocene channel. The buried channel is essentially parallel to, and to the left of, the road.

18.1 Smooth hills to the north and south of road are underlain predominantly by pre-batholithic schist.

18.5 Lazy MC Ranch. To the southwest the upper surface of the flat topped hills is the Lakeview-Gavilan surface (2,100 feet of elevation).

18.7 Riverside County fire station.

19.5 On left are dissected Pleistocene fan deposits of red-brown alluvium overlying the buried channel.

20.9 For next several miles the road continues through dissected Pleistocene alluvium. View to the northeast of the Perris surface.

22.2 Water to north and northwest is MWD reservoir Lake Mathews (Cajalco Reservoir). San Gabriel Mountains on skyline to north.

23.2 Straight ahead on skyline is Santiago Peak, the highest point in the Santa Ana Mountains (5,687 feet) on the west side of the Elsinore fault zone.

23.8 Road veers to northwest leaving the Pliocene channel.

24.5 Altered quartz monzonite. This is the start of an extensive area of rock which has been silicified and tourmalinized.

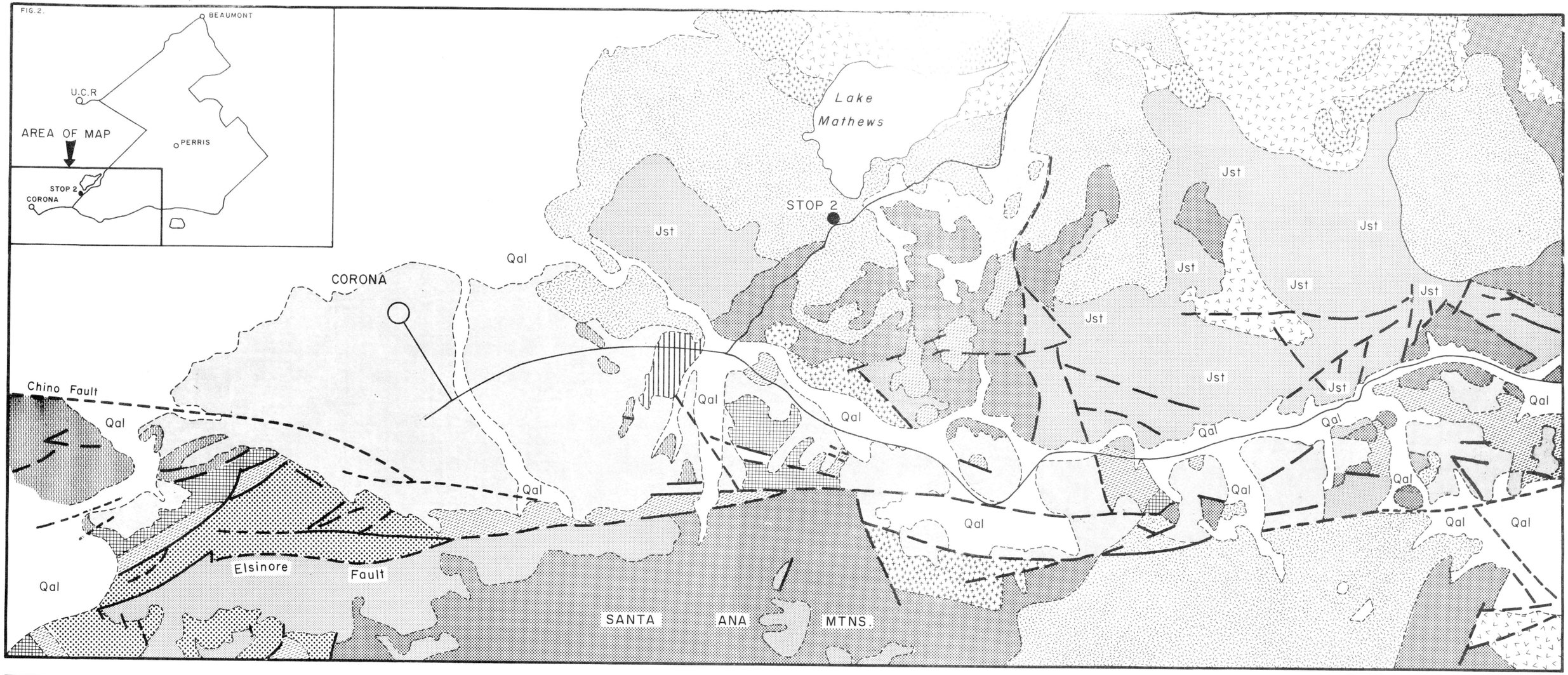
24.8 Small dark outcrops half a mile to the south (left) consist of quartz monzonite completely altered to silica-tourmaline rock termed tourmaline "blowouts." This tourmaline-silica rock is locally tin-bearing.

25.2 To right behind fence is prosptec for tin.

25.4 Dirt road to left leads to site of excavation just south of Cajalco Road that yielded Pliocene mammalian fauna (Proctor and Downs, 1963). At this point the channel turns to the north and extends to the reservoir.

26.0 Intersection of La Sierra Avenue and Cajalco Road; take left branch (Cajalco Road).

26.7 **Stop 2:** Park on shoulder and walk or take dirt road to right to low ridge just north of Cajalco Road (see Fig. 3). Rock is subporphyritic quartz monzonite which contains local "veins" of tourmalinized rock. Lake Mathews dam is to northeast at head of Cajalco Canyon. Numerous prospects to north and northeast explore tourmalinized rock for tin. Low, dark hill to north is Cajalco Hill, site of Cajalco (Temescal) tin mine. Tin was discovered in the area around 1853. The main mining activity was between 1869 and 1892, 1928-29, and 1942. The Cajalco mine, the only producer, had a total production of about 130 long tons of tin (Gray, 1957).



Qal Alluvium

Older Alluvium (includes terrace deposits)

Undifferentiated marine Pliocene and Puente Formation

Topanga Formation

Undifferentiated Vaqueros, Sespe and Santiago Formations

Silverado Formation

Ladd and Trabuco Formation

Undifferentiated granitic rocks

Quartz diorite (primarily Bonsall tonalite, quartz diorite of the Lakeview Mtns. pluton

Gabbro and diorite

Santiago Peak volcanics

Jst Temescal Wash quartz latite porphyry

Bedford Canyon Formation

N

0 1 2 3 4 5

MILES

Fig. 3. GEOLOGY OF PART OF THE ELSINORE FAULT ZONE.

by

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1971

27.5 Dark colored tourmalinized rock on left in the road cut is in mixed granitic rock and Bedford Canyon Formation (?).

27.8 Road cut on left is in Bedford Canyon (?) rock. Here it is predominantly siliceous with some phyllite.

28.2 Elsinore trough (fault zone) straight ahead. From here to the trough the predominant rock type is Bedford Canyon Formation (?).

28.6 Quarry in red rock to left is mostly weathered Bedford Canyon Formation (?) with some sediments of the Silverado Formation.

29.0 Road cut in Pleistocene (?) older alluvium.

29.3 Road crosses Santa Fe tracks. Railroad cut to right is in Bedford Canyon Formation (?) overlain by terrace deposit.

29.6 Intersection Cajalco Road and Temescal Canyon Road. Turn right onto Temescal Canyon Road for Corona Skyline Drive side trip. Turn left on Temescal Canyon Road for continuation of trip.

CORONA SKYLINE DRIVE SIDE TRIP

(0.5) International Pipe & Ceramics Corporation, Corona Plant (Interpace) (formerly Gladding, McBean & Company). Produces red-burning heavy clay products (e.g. sewer pipe, drain tile, and conduit). Plant uses local clays and filler clays, mostly from Paleocene Silverado Formation.

(0.6) Brown- to dark-gray, sandy, older alluvium containing angular cobble clasts.

(0.8) El Cerrito Hills. Exposed on both sides of highway is white to buff and brown sandstone of the middle Miocene Topanga Formation. Some of the Topanga is buff and brown siltstone and shale; in places Topanga strata are diatomaceous.

(1.3) Temescal Canyon Road changes to Ontario Avenue. Ahead to right is operation of Minnesota Mining & Manufacturing Company. Large quarry is developed in Temescal Wash Quartz Latite Porphyry of probable Jurassic age. Rock is crushed, screened, and colored with a sub-vitreous, bonded, ceramic-type glaze and used as granules for roofing materials. This operation produces most of the granules used for processed roofing materials on the west coast; shipments are made as far north as Vancouver, British Columbia. This operation has been active since 1948, although the quarry, Temescal Rock Quarry, was opened and produced rock for macadamizing streets in Los Angeles and area in 1888. Quarry operation in the early 1920s was by tunnel or coyote system which brought down 600,000 to 1,500,000 tons of rock in each blast which used 45 to 125 tons of powder (Gray, 1961). Some of these large blasts in more recent years have been used by seismologists for refining seismic travel times (Richter, 1958).

(1.6) On north side of road are outcrops of granitic rocks (quartz monzonite and hornblende granodiorite porphyry).

(2.0) Is small road cut and along north side of highway is undifferentiated Puente Formation of upper Miocene age. In this area the Puente is mostly white to greenish-gray, thin-bedded, diatomaceous siltstone; some buff to gray siltstone and

shale, and brown to buff sandstone, with local conglomerate lenses.

(2.2) Road crosses north end of short stretch of the Corona Freeway (State Highway 71) and joins Highway 71 (Ontario Avenue).

(4.4) Intersection with Main Street. Proceed ahead on Ontario Avenue. The nearby citrus acreage and the town of Corona are developed on a surface of Quaternary older alluvium, the Corona compound alluvial fan.

(5.4) Intersection of Ontario Avenue and Lincoln Avenue; turn left onto Lincoln Avenue.

(6.4) Turn right onto Chase Drive. To the west and south the break in slope in Quaternary older alluvium may be the surface expression of the Chino fault. Further southeast anomalous scarplets and benches in the older alluvium, as well as a definite scarp at the contact between Quaternary terrace deposits and older alluvium, apparently mark the trace of the Chino fault.

(6.8) Oak Avenue. Road cut at left in Quaternary older alluvium.

(7.0) Intersection Chase Drive and Skyline Drive; turn left (south) onto Skyline Drive.

(7.2) Cleveland National Forest Boundary sign and end of pavement. To left (east) is Paleocene Silverado Formation capped by flat-topped Quaternary terrace deposits. Terrace deposits here are at two different elevations that are attributed to erosion, rather than faulting.

(7.4) To left (east) Silverado sandstone and conglomerate capped by brown Quaternary terrace deposits along lower Hagador Canyon.

(7.6) Junction of Hagador and Tin Mine Canyons; keep right along Tin Mine Canyon.

(7.8) To right (north) is white to buff sandstone and conglomerate of the Silverado Formation.

(8.0) Northwest-striking fault along bare cliff faces juxtaposes upper Cretaceous Ladd Formation (Baker Canyon Conglomerate Member) and Paleocene Silverado Formation. Just to west is reef-type deposit in the Baker Canyon containing abundant oyster debris. Channel to left (Tin Mine Canyon bottom) contains boulders derived from the Ladd Formation (Baker Canyon Conglomerate Member) a short distance to the northwest on the brush-covered slope. These boulders contain numerous *Actaeonella oviformis* Gabb and are from a highly fossiliferous, generally hard, sandstone layer that crops out discontinuously over about one and a half miles from Tin Mine Canyon northwest to Mabey Canyon. In places this sandstone contains abundant *Trigonarca californica* Packard and other material that indicates a *Glycymeris pacificus* fauna.

(8.1) Draw on skyline to northwest (right) is contact between the Cretaceous Trabuco Formation (red, buff, and grayish-green massive conglomerate, minor sandstone, probably nonmarine) and Ladd Formation (Baker Canyon Conglomerate member).

(8.3) Road leaves canyon bottom and starts upgrade. Cars can be left here and the remaining trip (0.8 mile) made on foot, or there is a more narrow parking area 0.7 mile further on. Rock exposed in road cut is Jurassic Santiago Peak Volcanics—just west of the Elsinore fault.

(8.4) Road crosses the northwest-striking and steeply south-dipping Elsinore fault and passes back from Santiago Peak Volcanics into Trabuco Formation.

(9.1) Switchback. Turn around here (if driving). The switchback is essentially on the Elsinore fault which again separates Santiago Peak Volcanics on the west from Trabuco conglomerate (note clasts of weathered biotite granodiorite). The switchback is in Santiago Peak Volcanics and immediately below and above the switchback, the contact between the Santiago Peak Volcanics and Trabuco conglomerate can be seen. Up the road 0.1 mile, the fault zone is well exposed in the road cut. The switchback turn out provides a vantage point for a sweeping view of the general area to the south and east.

South across Tin Mine Canyon the bare scar high on the brush-covered slope is an old gypsum working (active in the 1920s) in altered Santiago Peak Volcanics. To the southeast (south side of Tin Mine Canyon) the Elsinore fault crosses the low, rounded, brush-covered landslide debris. Here the fault is at the break in slope between nearby flat-topped areas, which developed through landsliding, and Santiago Peak volcanics. The scars along this trace also are old gypsum prospects. Fault crosses the far ridge, with the line of eucalyptus trees, at the break in slope between this flat-topped ridge (Silverado Formation capped by Quaternary terrace deposit) and the abruptly rising, steep, brush-covered hills to the south (Santiago Peak Volcanics and Bedford Canyon Formation). Continuing to the southeast the Elsinore fault is essentially at the break in slope and separates the Silverado Formation from Santiago Peak Volcanics and Bedford Canyon Formation.

Below, in lower Tin Mine Canyon, the bare hill at left is sandstone of the Baker Canyon Conglomerate Member in fault contact with Silverado sandstone and siltstone. Brushy hills north of Skyline Drive and toward the observer are Cretaceous sandstone and conglomerate (Trabuco Formation and Baker Canyon Conglomerate Member).

Retrace route to intersection Cajalco Road and Temescal Road.

29.6 Proceed southeastward on Temescal Canyon Road.

30.0 Butterfield Stage Station Historical marker. Ahead is spoil bank from Owens-Illinois glass sand operation.

30.3 At left, under the two tanks, terrace deposits overlie Silverado Formation. To right is the glass sand pit of Owens-Illinois in essentially flat-lying Silverado. Farther to the right the freeway traffic is essentially along the contact between the Silverado and the overlying undifferentiated Sespe and Vaqueros Formations (upper Eocene to lower Miocene) which is also essentially flat lying. The Elsinore fault is located along the base of the high hills (Santa Ana Mountains) which are underlain predominantly by Jurassic Bedford Canyon Formation.

30.5 Owens-Illinois glass sand plant. This is the oldest continuously operating and principal source of silica sand in southern California. The sand is obtained from a quartz-rich facies of the Silverado. In the quarry some 120 feet of usable sandstone

is exposed; well data, however, indicates locally the sandstone is nearly 300 feet thick. Yearly production exceeds 100,000 tons of finished sand, of both flint and amber, with some monthly production more than 20,000 tons. To left are silt-clay waste ponds from Owens-Illinois operations. This material has been used by several companies in the manufacture of clay products.

32.0 At left San Marcos Gabbro and Bedford Canyon Formation form the low part of the hills. Overlying the basement rocks are both residual clay deposits and Silverado Formation.

33.1 Temescal (Harrington and Atlas) clay pits are to the left (east). Both residual and sedimentary clays of the Silverado Formation are mined.

33.5 Stop Sign. Proceed southeastward on Highway 71.

33.7 To right is Mission Clay Products which produces sewer pipe. Hills to left are Quaternary terrace deposits capping clay deposits of residual clay derived from the Bedford Canyon and Silverado Formations.

33.9 Turn right onto Lawson-Hunt Road.

34.1 Terrace deposits on right. Sag pond to left developed on north branch of Glen Ivy fault, part of the Elsinore fault zone. The road follows along the trace of this fault with a southwest facing scarp.

34.6 Light colored sediments in road cut are probably part of the Silverado Formation brought up along the Glen Ivy fault.

34.7 Lawson Road-Hunt Road intersection. To the northwest the trace of the fault is marked by saddles and aligned gullies in several ridges. Retrace route along trace of Glen Ivy fault to Highway 71.

35.5 Rejoin Highway 71 and turn right.

35.7 Dense vegetation at right marks the position of the Glen Ivy fault.

36.0 Entrance to Glen Ivy Resort. The south branch of the Glen Ivy fault goes through the resort but its trace is masked by recent alluvial deposits.

36.5 To the left are Holocene terrace deposits.

37.0 Santa Fe Railroad underpass. Hill straight ahead (Estelle Mountain) underlain by intermediate composition batholith rock and Temescal Wash Quartz Latite Porphyry.

37.3 Steep walled gorge ahead is superposed meander of Temescal Wash. The stream is believed to have cut a cover of sedimentary rocks which formerly filled the valley (Dudley, 1936).

38.0 Highway 71 ascends terrace deposits which cover fossiliferous Silverado Formation. The obvious break in slope paralleling and just to the left of the road is a modified fault scarp. Rock on the east side of fault is the Temescal Wash Quartz Latite Porphyry.

38.6 Highway 71 crosses fault separating Silverado Formation from Temescal Wash Quartz Latite Porphyry.

38.9 Upper end of the superposed drainage.

39.0 South end of Lee Lake, a reservoir for Temescal Water Company. This is a good

vantage point from which to view the steep walled gorge. To the southwest terrace deposits cap Silverado Formation beyond the railroad tracks.

39.4 Dissected alluvial fan deposits capping Silverado Formation.

41.0 Alberhill turnoff.

41.7 Santiago Peak volcanics (Jurassic age) are exposed in road cut on left. To the right is the operation of Pacific Clay Products and the community of Alberhill which developed around the clay mining industry. The clay deposits in the Alberhill area are of both residual and sedimentary origin and are restricted to a zone within (or just below) the Paleocene Silverado Formation. Residual clay deposits, which attain a thickness of 130 feet, have been developed from the Bedford Canyon Formation, Santiago Peak Volcanics, Temescal Wash Quartz Latite Porphyry and dioritic-gabbroic rocks. The sedimentary clay is the product of local erosion of the clay which developed on the weathered basement. Sedimentary clay averages 80 feet in thickness with a maximum of about 150 feet. Two main types of clay products are produced: red burning clay is used to make heavy clay products (e.g., brick, sewer pipe and tile); white burning clay is used to produce refractory clay products (e.g., firebrick and flue lining material). In the early 1880s both coal and clay were mined at Alberhill. Mining at the time was by underground methods. The coal, lignite, was of low grade and soon constituted only a nuisance to clay mining. Between 1895 and 1955 almost six million tons of clay had been mined in the Alberhill area. By 1955 as much as 800 tons of clay was being mined each day (Engel *et al.*, 1959, pp. 77-97).

42.7 Hill to right is Bedford Canyon Formation overlain by Silverado Formation which is in turn covered by Quaternary terrace deposits and dumps from the clay mining. The road follows Walker Canyon which is apparently a superposed drainage.

45.2 Elsinore City limits.

45.3 Exposures of Bedford Canyon Formation.

45.8 Closed depression to right of highway. At this site earlier (1926) was a fissure at least an eighth of a mile in length which later formed a trench in places more than ten feet deep and averaging two or three feet in width. According to local residents this feature developed at the time of the 1918 San Jacinto earthquake (Engel, 1959, p. 52).

46.1 State Park turnoff. The broad valley to the right is underlain by Silverado Formation.

46.9 Junction with Highway 74. Low hills ahead and to left are underlain mostly by rocks presumed to be equivalent to Bedford Canyon Formation. To the right on the west side of the low hills is trace of the Glen Ivy fault.

48.1 Turnoff to downtown Elsinore and San Juan Capistrano.

48.4 Boulders of dioritic rock to left.

48.8 Hills straight ahead on skyline are at the northern end of the Paloma Valley ring-complex.

50.0 Railroad Canyon Road. At this point the San Jacinto River enters the Elsinore

Valley (trough) from the Perris block. The Elsinore trough here constitutes a closed depression and is filled by ephemeral Lake Elsinore. In historic times only during a few prolonged periods of wet years, the last being 1916-17, has the lake overflowed entering Temescal Wash which drains northward to Santa Ana Canyon and ultimately the Pacific Ocean. A recent gravity investigation indicates the valley to be underlain by four to 8,000 feet of sediments (Ghaeni, 1967).

51.0 Road cuts in old dissected alluvial fan.

51.8 To the right in the Elsinore trough is a low hill, Rome Hill, which is bounded on both sides by faults of the Elsinore fault zone. The fault on the north is generally termed the Wildomar fault, the fault to the west, the Willard fault, the frontal fault of the Santa Ana Range in this area.

53.1 Turn left onto Bundy Canyon Road. On the skyline to the northeast is a contact between San Marcos Gabbro to the right, which constitutes the interior rock of the Paloma Valley ring-complex, and granodiorite to the left, which is the outer part of the Paloma Valley ring-complex. Immediate hills on both sides of the road are granodiorite of the Paloma Valley ring-complex which contain blocks of gabbro. This composite ring-complex consists of an older, singular ring-dike, with two subsidiary shorter-arc inner dikes; and a younger set of thin, shorter-arced dikes, largely inside the older ring-dike. The older ring-dike is granodiorite (Woodson Mountain Granodiorite of Larsen, 1948), has nearly vertical walls, and is elliptical in plan with its long axis (nine miles) oriented west-northwest. This dike was emplaced in, and contains numerous inclusions of, gabbro. Largely within the older ring-dike are more than 200 younger, shorter-arced dikes, half a foot to three feet thick. These dikes, of granitic composition, define a ring-structure which cuts older-dike rock as well as gabbro. The structure is of a classical form with moderately- to steeply-dipping margins and a horizontal center. Spatially associated with the younger dikes are a number of bodies of fine-grained granophyre. The older ring-dike appears to have resulted from vertical ring-fracturing and emplacement by magmatic stopping. Granitic magma was emplaced along a younger set of domal ring-fractures. Granophyre resulted from "pressure quenching" of part of the magma which formed the younger ring-dike (after Morton and Baird, 1971).

53.7 Decomposed granite quarry with gabbro blocks within granodiorite.

54.0 Contact of the inner side of the ring-dike (granodiorite to gabbro).

54.5 Hills ahead and to right are underlain by gabbro which is intruded by granitic dikes which form an annular pattern.

55.0 Bundy Canyon Road reaches the Perris surface. The red-brown soil is characteristic of decomposed gabbro.

55.5 Granitic dikes of the ring-dike in gabbro.

55.8 To the north is the contact between gabbro and older ring-dike rock.

56.0 To the north (left) is an exposure of a finger of metamorphic rock which interrupts the otherwise continuous outer ring-dike. Note that the metamorphic rock weathers similarly to the gabbro giving rise to smooth slopes devoid of prominent

outcrops.

56.6 Road cut in San Marcos Gabbro.

57.3 At this point contact between gabbro and outer ring-dike rock is just north of the road.

57.5 Intersection with Murietta Road. Exposed in road cut to left is migmatitic rock consisting of gabbro partly digested by ring-dike rock. This is essentially at the contact of the gabbro and ring-dike.

57.8 Bundy Canyon Road crosses back into the ring-dike (granodiorite) which here strikes northwest. Hill on skyline to the south (right) is at the structural center of the ring-dike complex. Top of hill is a body of granophyre.

58.1 **Stop 3:** Road cut in weathered San Marcos Gabbro with kernels of fresh rock.

59.8 Intersection with US 395. Continue straight across and continue east on Scott Road.

59.9 Boulders of ring-dike rock protrude above valley floor (Paloma surface of Woodford *et al.*, 1971).

60.6 Northeast end of Paloma ring-dike complex.

61.8 **Stop 4:** Intersection of Scott Road and Briggs Road. The road cut is in phyllitic quartz-rich metamorphic rock correlated with Bedford Canyon Formation. Hills to the left, underlain by phyllite and slate, contain a few gold-bearing quartz veins. Small building at the base of the hill is the Leon gold mine.

62.3 Hills to right are underlain by San Marcos Gabbro.

63.0 Road crosses contact between San Marcos Gabbro and granodiorite of the Domenigoni Valley pluton. The discontinuously exposed Domenigoni Valley pluton is elliptical in plan (4 x 8 miles) and oriented slightly west of north; similar rock occurs west of the pluton. The pluton invades country rock of the Bedford Canyon and French Valley Formations. The pluton, partly discordant and partly concordant, is composed of homogeneous appearing granodiorite-quartz diorite. In all but its southernmost part the plutonic rock is massive,and contains abundant unoriented inclusions. In its southernmost part the pluton is faintly foliated and contains inclusions parallel to the margin of the pluton. Two relatively consistent, steeply-dipping joint sets are present; one strikes northeast, the other northwest. A dike swarm, principally of quartz latite composition, occurs in the northwest-striking joint set. Most of the dike rock is porphyritic with a foliated structure and with a lineation produced by micaceous streaks and oriented hornblende and plagioclase crystals, on S-surfaces of the foliated rock. This lineation is strikingly consistent in orientation; it trends southeast and plunges at moderate angles to the southeast. Field evidence suggests most of the pluton was passively emplaced. Movement within quartz latite dikes after they were largely crystallized produced cataclastic texture (after Morton, unpublished mapping, 1970).

64.4 To the left is outcrop of resistant foliated quartz latite dike rock in granodiorite.

64.8 Hills on skyline to east are underlain by metasedimentary rocks of the French Valley Formation (Schwarcz, 1969).

65.0 Intersection with Winchester Road. Turn left.

65.8 Skyline to west and north is underlain by Domenigoni Valley pluton rock cut by abundant foliated quartz latite dikes.

67.0 Ahead and to left are wall-like masses of resistant quartz latite.

67.6 **Stop 5**: Road cut affords excellent exposure of granodiorite cut by foliated quartz latite dikes.

67.8 To right at base of low hills is seen the contact between the pluton and the French Valley Formation.

68.4 Road cut shows typical rock of the pluton with abundant unoriented equidimensional dark inclusions.

68.6 To the east on the far hillside is the open pit working of the old Winchester magnesite mine developed in a metaserpentine body.

68.8 Hills on skyline ahead are underlain by French Valley Formation and cut by granitic dikes. To the northwest is the contact between the Domenigoni pluton to the west, and French Valley Formation rocks to the east.

69.6 Downtown Winchester.

70.3 **Stop 6**: Cordierite-bearing biotite schist of the French Valley Formation.

71.1 Hills to right are underlain by San Marcos Gabbro which is here primarily olivine gabbro. Bouldery hills straight ahead are part of the Lakeview Mountains pluton.

71.8 Low hills to right are quartz diorite and migmatitic quartz dioritic rock that surround the Lakeview Mountains pluton.

72.2 Intersection with Highway 74. Turn left.

72.6 Workings on hill to right are feldspar-quartz prospects in pegmatite dikes in the Lakeview Mountains pluton.

73.0 Road cuts in foliated quartz dioritic rock.

73.5 **Stop 7**: Exposures of foliated quartz dioritic and migmatitic rock.

74.5 Turn right onto Juniper Flats Road.

75.1 Cross contact between foliated quartz dioritic rock and Lakeview Mountains pluton.

75.6 **Stop 8**: Outcrops to left contain abundant schlieren which are characteristic of rock of the Lakeview Mountains pluton. This pluton is a steep-walled body tear-shaped in ground plan, exposed discontinuously over an area of 60-80 square miles. Located at an abrupt local deflection of the northwest-striking regional grain, it is concordant with the enclosing rocks, which consist of varied granitic and mixed granitic-metamorphic rocks. The pluton is almost entirely coarse-grained hornblende-biotite-quartz diorite that lacks potassium feldspar. Schlieren are ubiquitous, as are lenticular inclusions, which parallel the schlieren. Schlieren, which impart to the rock an extreme small-scale mineralogic heterogeneity, geometrically fall into three orientation groups with the most pronounced concordant to the outline of the body. The other two groups, which are discordant, strike northwest and northeast. Granitic pegmatite dikes, hypersthene gabbro masses, and both mafic and leucocratic quartz diorite are concentrated in the geometrically and structurally deduced center of the pluton. It is believed the pluton was emplaced forcefully

producing the deflection in the regional grain. The pegmatite dikes represent the fugitive constituents of the pluton-forming magma and their concentation in the center of the pluton marks the last part of the pluton to crystallize. An extensive chemical study shows the pluton is highly homogeneous on a large scale and extremely heterogeneous on a small scale. However, a weak, but consistent, zonational chemical pattern parallels the walls of the pluton. This zonation shows the pluton has a relatively basic and dense core and implies the last rock to crystallize was more basic than rock formed earlier (after Morton, 1969; Morton *et al.*, 1969).

75.9 Quarry in partly decomposed quartz diorite. Note the numerous schlieren.

76.5 Road reaches the 2,100 ft. Lakeview-Gavilan surface.

76.9 Thin veneer of gray bedded sediments on Lakeview-Gavilan surface.

77.8 Turn left.

78.0 Flat skyline to west and east are remnants of a 2,500 foot surface (Magee surface of Woodford *et al.*, 1971). To the north is seen a continuation of the Lakeview-Gavilan surface.

78.2 Road cut in typical rock of the pluton with abundant schlieren. Northward towards the center of the pluton granitic pegmatite dikes become common to abundant.

79.3 To the northeast is a good view of the Lakeview-Gavilan surface.

80.1 Road cut in old red alluvium.

81.4 Low hills on skyline straight ahead are the northwest part of the Lakeview Mountains pluton. Higher hills, Bernasconi Hills, are underlain by a variety of granitic rock and schist.

81.9 Turn right onto Hansen Avenue.

84.0 Community of Lakeview. Turn right onto Ramona Expressway.

84.2 Hill to the left is schist of unknown age intruded by quartz diorite. Straight ahead the higher hills are mostly metamorphic rock and the lower hills, the San Timoteo Badlands, Pliocene-Pleistocene sediments. The San Jacinto fault bounds these hills on the southwest.

86.7 In the small canyon to the south is located the contact between the Lakeview Mountains pluton to the west and foliated granitic rocks to the east.

88.0 Line of cottonwood trees to the left marks the Casa Loma fault. An 8,000-foot deep sediment-filled graben is located between the Casa Loma fault and the San Jacinto fault (Fett, 1968).

89.0 Low hill to the left, Casa Loma Hill, is a tectonically produced feature along the Casa Loma fault (Proctor, 1962).

89.5 Road crosses Casa Loma fault scarp.

89.8 West side of the high hills ahead is the modified fault scarp of the San Jacinto fault. These hills are covered by extensive landslide deposits.

91.2 Turn left onto Sanderson Avenue.

92.1 San Jacinto River.

92.9 Road crosses San Jacinto fault. Note fault scarp which produced southwest-facing break-in-slope in alluvium to northwest.

93.1 The road crosses the Gilman Springs Road. Continue straight ahead on Highway 79 (Lamb Canyon Road) entering the Badlands.

93.2 Road cut in coarse clastic red beds of Pliocene age.

93.9 **Stop 9:** Road cut affords excellent view of a minor reverse fault. Here schist of unknown age has been thrust over Pliocene red beds.

94.0 Depositional contact of red beds over gneiss. The road for a short distance to the north skirts this depositional contact.

94.3 Road cut in schist.

94.7 **Stop 10:** To the right is schist and marble of unknown age. Just north of the road is a depositional contact between these rocks and Pliocene sediments. The Pliocene sediments contain lenticular beds of monolithologic conglomerate with clasts of quartz diorite as much as 20 feet in diameter.

95.1 To left are beds of boulder conglomerate.

95.4 Prominent red bed to the left is the approximate top of the red beds in this sequence. Above this marker unit gray to tan, finer grained clastic rocks predominate.

97.0 Bouldery hill to the north is quartz diorite. Lithologically it is the same as the clasts in the conglomerate to the south and may have been the source for the clasts.

97.7 Contact between sediments and quartz diorite.

97.9 Contact between quartz diorite and sediments.

98.4 Contact between Pliocene-Pleistocene sediments and Pleistocene red alluvium.

98.8 Road cut in red alluvium. Straight ahead on the skyline is San Gorgonio Peak—high point of the San Bernardino Mountains, 11,502 feet.

99.7 Southern Pacific Railroad and the town of Beaumont.

99.9 Left turn onto Interstate Highway 10 towards Los Angeles. Enter left lanes to take Highway 60 to Riverside.

100.7 Take Highway 60 west towards Riverside.

102.3 Road cuts in red alluvium.

103.1 Road crosses contact back into Pleistocene sediments.

103.4 Jack Rabbit Trail turnoff.

103.8 Terrace deposits to the right are of old red alluvium.

104.5 Recent terraces to the right have been cut by San Timoteo stream.

105.2 Re-enter San Timoteo Badlands. Highway is essentially normal to the length of the Badlands and predominant structure which, in a gross form, is a northwest-trending anticline.

106.2 Eastward-dipping coarse clastic Pliocene-Pleistocene sediments.

107.7 Westward-dipping Pliocene-Pleistocene sediments on the south flank of the anticline.

109.4 Hemet—San Jacinto turnoff.

110.1 Highway crosses San Jacinto fault.

110.4 Smooth-topped hills to the northwest are underlain by quartz diorite and separated from the Badlands to the east by the San Jacinto fault.

115.0 To the northeast is Pigeon Pass Valley. Exposed on both sides are rocks of the Box Springs complex. Note the eastward dip of the rocks on the west side of the valley and the westward dip of the rocks on the east side.

119.2 San Diego turnoff onto US 395.

119.5 Junction with US 395.

122.6 University Avenue turnoff. Bear to the right to return to Ramada Inn.

123.8 Parking Lot, Ramada Inn, Riverside. End of trip.

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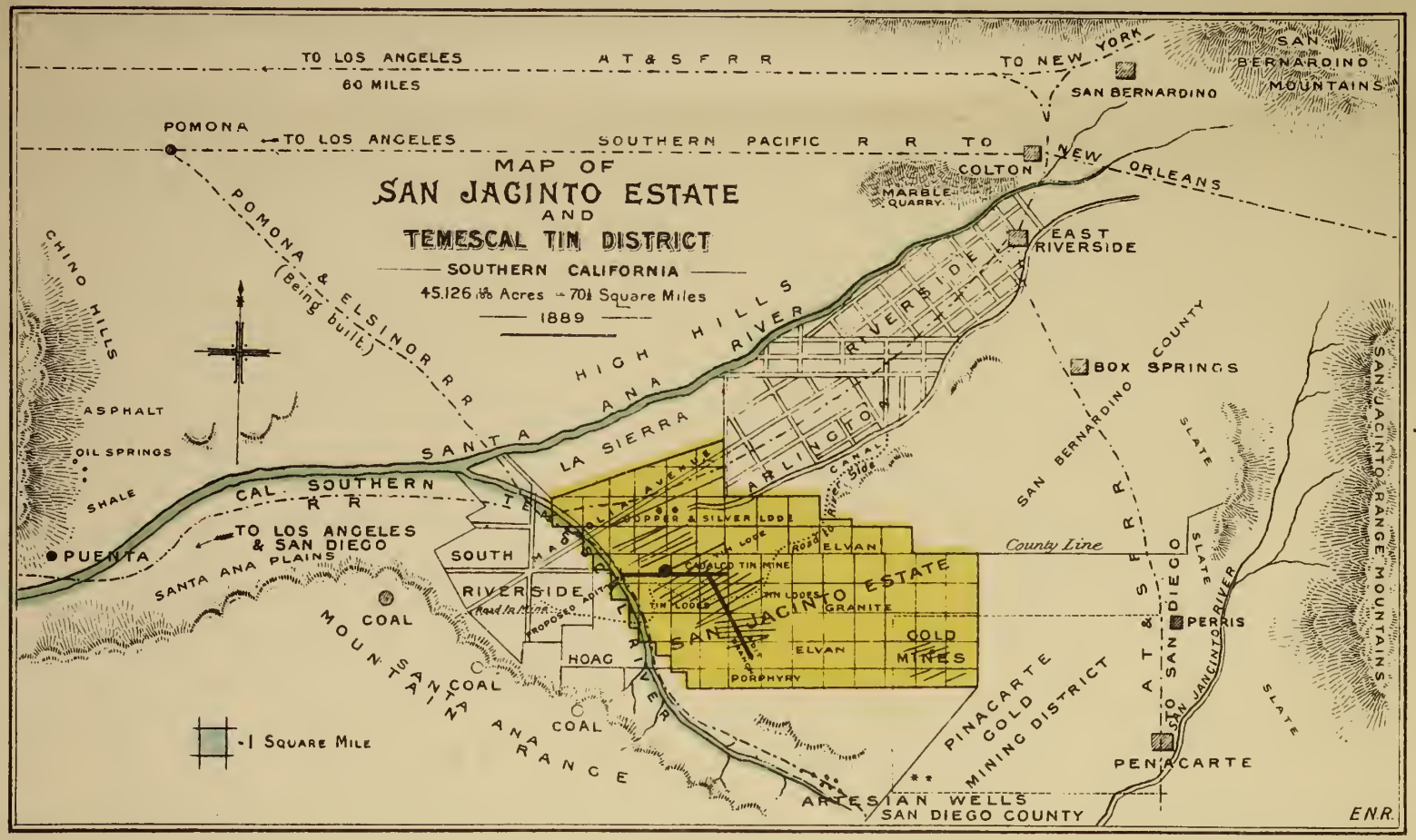
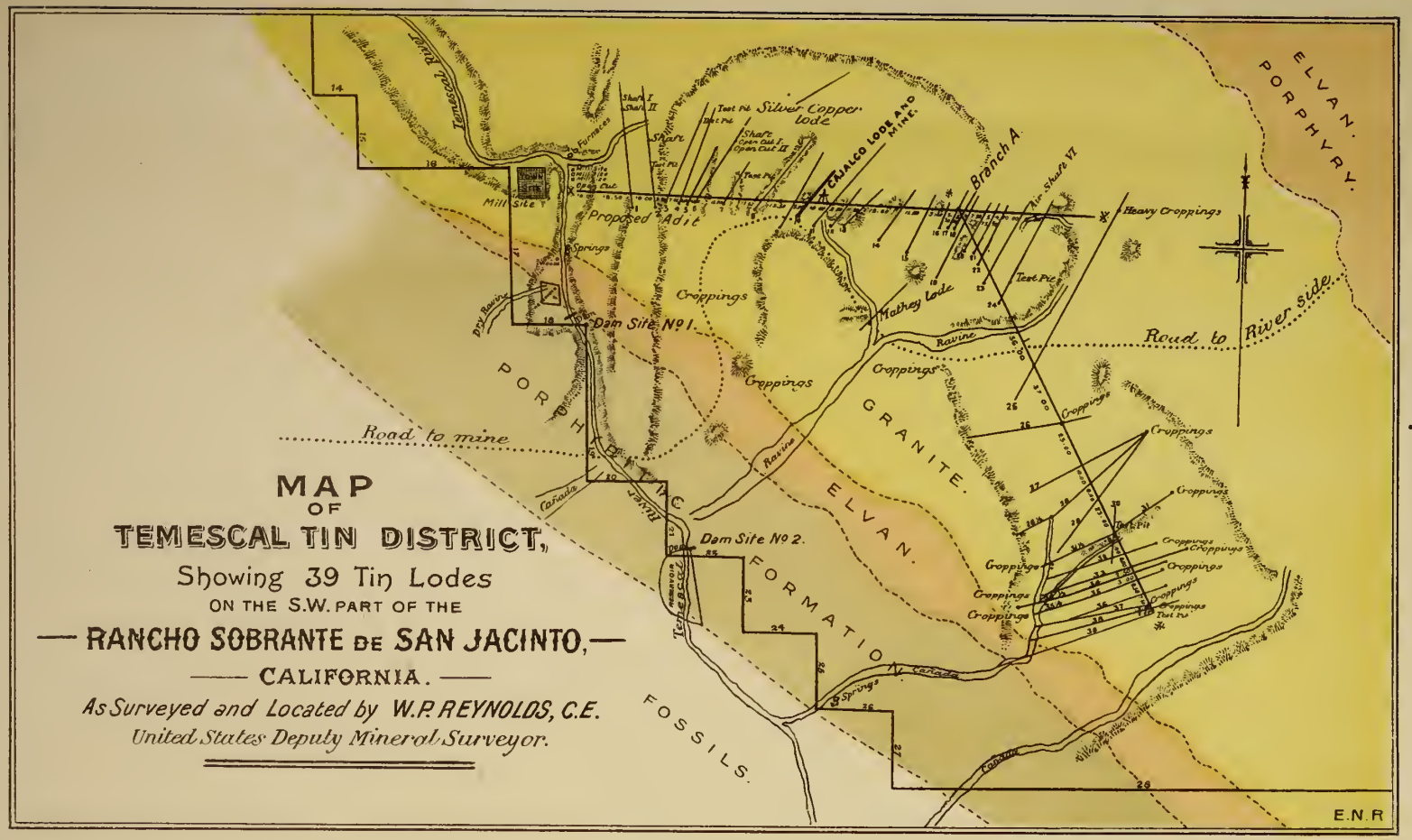

TO LOS ANGELES
60 MILES
A T & S F R R
TO NEW YORK
SAN BERNARDINO
SAN BERNARDINO MOUNTAINS
POMONA
TO LOS ANGELES
SOUTHERN PACIFIC R R TO NEW ORLEANS
COLTON
MARBLE QUARRY
MAP OF
SAN JACINTO ESTATE
AND
TEMESCAL TIN DISTRICT
SOUTHERN CALIFORNIA
45,126 16/100 Acres = 70½ Square Miles
1889
POMONA & ELSINOR R R
(Being built)
CHINO HILLS
HIGH HILLS
SANTA ANA RIVER
RIVERSIDE
EAST RIVERSIDE
ASPHALT
OIL SPRINGS
SHALE
LA SIERRA
ARLINGTON
CANAL
Side
BOX SPRINGS
SAN BERNARDINO COUNTY
SLATE
SAN JACINTO RANGE MOUNTAINS
CAL SOUTHERN R R
TEMESCAL AVENUE
UPPER & SILVER LODE
ELVAN
TO LOS ANGELES & SAN DIEGO
PUENTA
SANTA ANA PLAINS
SOUTH RIVERSIDE
Road to Mine
PROPOSED R R
TIN LODES
GRANITE
SAN JACINTO ESTATE
COLD MINES
ELVAN
PORPHYRY
HOAG
COAL
MOUNTAIN COAL
COAL
SANTA ANA RANGE
1 Square Mile
County Line
A T & S F R R
TO SAN DIEGO
PERRIS
SAN JACINTO RIVER
PINACARTE GOLD MINING DISTRICT
PINACARTE
ARTESIAN WELLS
SAN DIEGO COUNTY
ENR.

Map B


MAP
OF
TEMESCAL TIN DISTRICT,
Showing 39 Tin Lodes
ON THE S.W. PART OF THE
— RANCHO SOBRANTE DE SAN JACINTO, —
— CALIFORNIA. —
As Surveyed and Located by W.P. REYNOLDS, C.E.
United States Deputy Mineral Surveyor.
Temescal River
Silver Copper lode
CAJALCO LODE AND MINE
Branch A
Air Shaft VI
Heavy Croppings
Proposed Adit
Mill Site
Springs
Croppings
Dam Site No 1.
Mathey lode
Road to River side.
Road to mine
PORPHYRY
GRANITE.
ELVAN.
Dam Site No 2.
FORMATION
FOSSILS.
ELVAN. PORPHYRY.
E.N.R

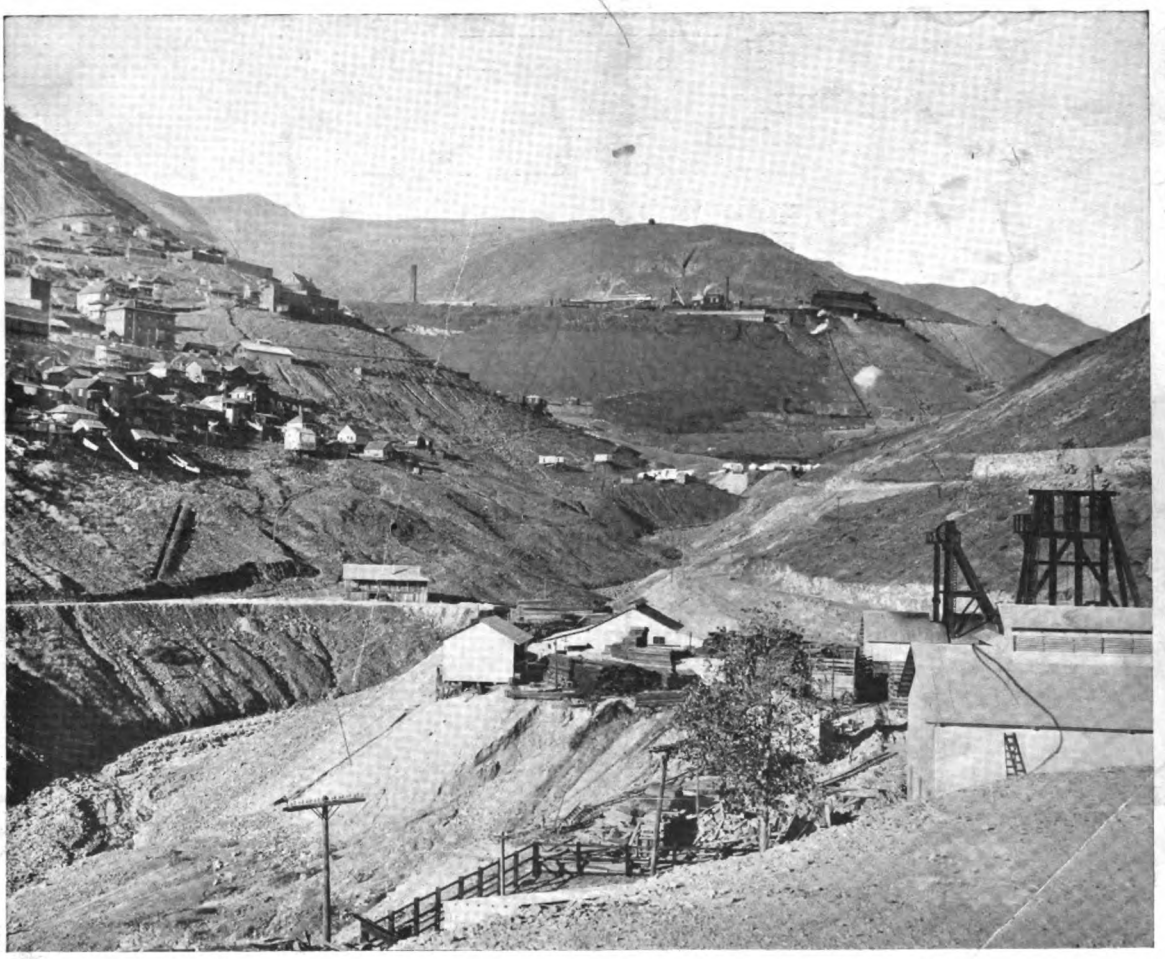
Map D

May, 1922

PACIFIC MINING NEWS

Supplement to

ENGINEERING & MINING JOURNAL-PRESS



UNITED VERDE, ARIZONA — MINE IN FOREGROUND, SLAG DUMP IN BACKGROUND

A NOTED mine in one of the great copper districts of a state pre-eminent as a copper producer — The ores in the mine are of sufficient grade to be smelted directly in blast furnaces and reverberatories — The copper matte is converted and the blister copper shipped to refineries — Both the mining and smelting plants are modern and efficient — A model town for employes is maintained at Clarkdale

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Letters to the Editor

Californian Clays Require Special Treatment to Meet Metallurgical Demands

For 16 months I have been conducting a survey of the state of California, having for its object the location, inspection and classification of clay deposits, with especial reference to clays having technical and superior metallurgical value. At the conclusion of this survey it was considered that refractory clays of Carboniferous age are poorly represented, and that the majority of deposits in the state belong to the Eocene Tertiary, with a marked development of clay beds of technical value in the Ione formation. Plastic clays of the ball-clay type are scarce, and the same may be said of flint clays.

The best metallurgical clay in the state was discovered in Amador county and near Carbondale; it is the nearest approach to the German Klingenburg pot clay that has been uncovered in the United States. Some of these clays vitrify below Cone 3, and have an initial deformation point in excess of Cone 33. In the same vicinity are deposits of clay of the Gross-Almerode type, also of high fusion point and great strength, both in the raw and in the burned state. They are for the most part white, but occasionally are found of a chocolate-brown color, of extreme plasticity and suitable for pencil clays.

In the northern part of the state and along the Sacramento Valley, typical Tertiary clays are exposed that are suitable for the general run of semi-dense burning ware. As a general rule, strictly Tertiary clays are found to be of less value for refractory ware than either the Cretaceous clays or Pennsylvanian clays. This holds true for the Californian clays as well as for the clays that are found in the East and in the South.

No exceptionally refractory clays are mined in the southern part of the state, although considerable quantities of "moderate-virtue" clays are mined in the Temescal Valley near Los Angeles and used locally. These have been developed along a major fault line; they lie in a depressional area. Owing to much major, minor and cross faulting of the region the continuity and uniformity of any particular clay bed or stratum is much disturbed and is a hindrance to the mining of clay of uniform chemical composition. Although clay from this valley will continue to be in demand owing to the nearness to Los Angeles and for lack of superior materials close by, I fail to find in the region clays possessing extraordinary metallurgical value.

In Section 26, Township 4 South, Range 6 West of Riverside county I discovered the only known deposit of bauxite in the state. This is of the oolitic and lateritic variety and similar to the bauxite ores of Dutch and British Guiana. The deposit is undeveloped. The quantity is limited to perhaps a few thousand tons principally of bauxitic material. The clay has a superior fusion point and the deposit is six miles from the nearest railroad spur.

After having studied the principal geological formations of the state wherein clay may be developed and after having examined many desert types of kaolin I conclude that future requirements of industry will necessitate the beneficiation of clays now used in the raw state before they can meet the increasingly strict technical requirements of metallurgical practice.

L. M. RICHARD.

Venice, Cal., Mar. 16, 1922.

Defining "Engineering" Without Inviting Comment on Altruistic Motives

Much discussion has centered recently in the technical press anent the proper definitions of "engineer" and "engineering." This indicates that various suggestions made from time to time have failed to meet general approval. The most dogmatic of these originated from the Institute of Civil Engineers, which defines the engineer as one whose characteristic was, "Directing the great sources of nature for the use and convenience of man." The idea of altruism is expanded in the definition adopted by the United Engineering Societies and found in the library at New York, which states that engineering is "the art of organizing and directing man, and controlling the forces of nature for the benefit of the human race." Wide publicity was given in 1918 to yet another version of the same idea, by which it was maintained that "an engineer is one who scientifically directs man-power, and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind."

The drawback to such high-flown interpretations is that they are each the work of one mind, or, at most, of a few minds. In spite of this they are usually hewn in stone, cast in bronze, or recorded in some other imperishable manner. The original definition of the civil engineers having met with the silence that is too often taken as indicative of approval, and the main idea of altruism and nobility of aim having been elaborated by others, it is not unreasonable that a civil engineer should be among the first to discountenance further discussion. It is strange, however, that his contention should have received so much support from academic quarters.

The age of oligarchic domination by means of individual ideas is past; the opinions of all are welcome and needed. In Berkeley we are forever reminded that the purpose of a school of agriculture is "To rescue for human society the native values of rural life." Every morning I expect to read in the local paper the inquiry of some perplexed visitor who has attempted to analyze the inscription that faces the city; he will probably sign himself "G. Helpus," or words to that effect.

The majority of suggestions are one-man ideas. They become valuable when discussed and, possibly, amended by others. The story of Fido may be recalled: He was a pampered pet with an abnormal appetite. One morning he saw what he thought was his usual dish of white breakfast food and cream; and, without further thought, gulped it down in a few mouthfuls. Alas! it was liquid plaster of paris. Whereupon Fido "passed out," creeping away to die under the shade of some bushes. Several months later, when all that was mortal of him had disappeared, his mistress found the plaster cast of his internal anatomy. This was cherished as the sole link with the past; it was placed in a glass case with this inscription thereon: "Fido—An Inside View; Taken by Himself."

Few of us there are who are not guilty of "inside views." Some years ago I had the temerity to propose that an engineer is, essentially, "a technician who applies creative effort to the solution of a problem or to the operation of an enterprise." I also stated that "much engineering effort is beneficial to mankind, but it would be invidious to emphasize this fact in the formulation of the definition of an engineer." These ideas are so opposed to all definitions that have received wide prominence and publicity that I await a repetition of the phenomenon that recently disturbed the town of Chico. In any case, I am unwilling to agree that engineers should admit the impossibility of defining their own calling.

A. W. ALLEN.

San Francisco, March 31, 1922.

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