THE CLAY RESOURCES AND THE CERAMIC INDUSTRY OF CALIFORNIA

BY
WALDEMAR FENN DIETRICH

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1928

PHOTO No 1. Russ Building, San Francisco, faced with architectural terra cotta manufactured at the Lincoln plant of Gladding, McBean & Co. (Photo supplied through the courtesy of the company.)

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
FRED G. STEVENOT, Director

DIVISION OF MINES AND MINING
FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT State Mineralogist

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LETTER OF TRANSMITTAL.

To His Excellency, Hon. C. C. Young,
Governor of the State of California.

Sir: I have the honor to herewith transmit Bulletin No. 99 of the State Division of Mines and Mining on the Clay Resources of California.

This work deals in detail with one of California's nonmetallic mineral industries which is annually growing in importance and value. Ceramic plants are being established in increasing numbers, existing plants are being enlarged, and a wide variety of products is being put on the market. Our natural deposits of clays in this state form the basis upon which these industries are founded.

This bulletin is the result of over two years' field and laboratory investigations conducted by Mr. W. F. Dietrich, associate professor of mining engineering at Stanford University; the work being handled on a cooperative basis between the University and this Division. Acknowledgement is here made of the courtesy and cooperation of Mr. Theodore J. Hoover, Dean of the School of Engineering of Stanford University.

Respectfully submitted.

Lloyd L. Root,
State Mineralogist.

Chapter I.

INTRODUCTION.

The scope of this report is confined to a study of the raw materials and manufacturing practice of that part of the ceramic industry of California which involves the manufacture of products which "are molded in the aqueous plastic condition and which derive their strength from the partial fusion (vitrification) of silicates at high temperatures."[1] This restriction excludes glass, enameled metals, cements, limes, plasters, and most abrasives, which in modern parlance are broadly considered to belong to the field of ceramics.

The report includes a brief technical description of most of the clay-working plants and known clay deposits in California, together with the results of laboratory tests of the important clays of the state.. The principal emphasis is upon the economic and technologic phases of the clay-working industry of California, rather than upon its geologic aspects.

The field work was done in the summers of 1925 and 1926, and the total time in the field was five months. In a state having 155,652 square miles of land area, it was obviously impossible in the period of the field examination to make detailed investigations of all known clay deposits, or to search for new deposits not already known to the ceramic industry, the Mining Bureau, or to local inhabitants in the possible clay areas. Hence the principal value of this report lies in the fact that it is a record of progress of the clay industry and presents for the first time standard test data on the known clays as a basis of comparison for new clays that may be discovered in the future. The uses of many of the clays that were tested are very well known from plant experience, so that it should not be difficult for the intelligent plant operator to correlate the test data with the results of commercial practice, not only for the clays now in use in his plant, but for other clays that have been tested.

The search for high-grade clays on the Pacific coast has received new impetus in recent years on account of the phenomenal increase in population in the region and the consequent increased demand for structural and decorative clay products. There seems little doubt that this is but the beginning of one of the greatest periods of expansion that the world has ever seen. If this view of the future is correct, California is destined to become one of the great ceramic centers of the United States. That new clay deposits will be discovered is almost a foregone conclusion. Thus far, only the obvious deposits have been found, and only those that can be cheaply mined, and that can be used without beneficiation, have been exploited. The geologic column of California is practically complete, and there remain many thousands of square miles of land that have never been thoroughly prospected for clays. Prospectors and local residents away from existing clay producing regions are on the whole unfamiliar with the nature of clays, but it is certain that their knowledge will improve by contact with trained men who are on the lookout for new discoveries. It is true that the abundance of cheaply recoverable terra cotta and fire clays has

[1] Wilson, Hewitt, Ceramics, p. 2, McGraw-Hill Book Co., 1927.

heretofore hindered the development of new resources, but with the rapid acquisition of the best of these deposits by single manufacturing interests, and with the increasing demand for new types of clays, either to displace those varieties now being imported from outside of the state, or to make improved products, the incentive to clay prospecting will be entirely adequate.

METHODS OF INVESTIGATION.

The field work on the clay deposits consisted of a visit to each property to obtain clay samples and to prepare a description of the development and mining operations, the thickness of the clay and overburden and other features of possible interest. Most of the samples were taken from exposed surfaces, and due precautions were taken to secure samples that were representative of the workable beds of clay. In a few places, samples were taken from bins or storage piles, if these seemed more suitable for securing representative samples than the clay banks. In some instances, samples were submitted by the clay producers themselves as being representative of their deposits. A number of core drill samples were obtained from the Ione district, through the courtesy of S. E. Kieffer.

The plant descriptions were nearly all prepared by the author after an inspection of the plant. Many of these descriptions were submitted to the plant executive for approval before publication. A few descriptions were prepared by members of the organization concerned.

Descriptions of a number of plants that were started subsequent to the field investigation or that were overlooked by the author, were prepared by Messrs. Laizure, Logan, or Tucker, district engineers, Division of Mines and Mining.

The test work was done in the ceramic laboratory of the Department of Mining and Metallurgy at Stanford University by methods described in Chapter IV.

PREVIOUS WORK.

The clays and clay industries of California were described in two earlier reports[1] of this Bureau. These reports include descriptions of known deposits and of the operating plants, but contain very few data on the ceramic properties of the clays.

Most of the county reports of the Bureau contain descriptions of clay deposits and clay-working plants that were prepared by members of the State Mineralogist's staff. In a number of cases these descriptions are sufficiently up to date to permit their use in the present report, and are reprinted here for the sake of completeness and continuity, as the county reports are scattered through a number of volumes of the State Mineralogist's reports.

An important article[2] on the Alberhill clays by the late J. H. Hill, then president of the Alberhill Coal and Clay Company, was published by the Bureau in 1923.

[1] Structural and Industrial Materials of California: Cal. State Min. Bur., Bulletin 38, part III, pp. 190–259, 1906.
The Clay Industry in California: Cal. State Min. Bur., Prel. Report No. 7, 102 pages, 1920.

[2] Hill, J. H., Clay deposits of the Alberhill Coal and Clay Company: State Mineralogist's Report XIX, pp. 185–210, 1923.

The ceramic properties and chemical analyses of certain clays from the Alberhill district have been given by Burchfiel.[1]

The clay mining and preparation plant of the Clay Corporation of California, at Lincoln, has been described by C. N. Schuette.[2]

All of the foregoing references were freely used in the preparation of this bulletin, even at the cost of repetition, as it was desired to bring together in one volume all of the available information on the clay resources of the state.

ACKNOWLEDGMENTS.

In a work of this nature it is impossible to give individual acknowledgment to all those who contributed to it. The writer wishes to express his appreciation of the courtesies that were extended to him by many persons connected with the ceramic industry of California. Their cooperation in making this bulletin possible is especially noteworthy in view of the fact that, on the whole, the ceramic industry today remains as one of the few mineral industries that extensively uses secret processes and secret formulae.

Prof. Hewitt Wilson of the University of Washington rendered invaluable assistance in outlining the methods of clay testing and in making many valuable suggestions and criticisms.

Mr. John T. Roberts, president of the Stockton Fire Brick Company, generously contributed equipment and refractories to the ceramic laboratory in which the test work was done, and was ever ready to give valuable advice and information during the progress of the work.

Mr. L. M. Richard, consulting economic geologist for Gladding, McBean and Company, was especially helpful in the field in the Alberhill-Corona district, and contributed many ideas concerning the organization of the report.

Several graduate students in metallurgy or ceramics at Stanford University contributed to various phases of the investigation, especially in the laboratory. Among these should be mentioned V. J. Minner, C. W. Briggs, H. J. O'Carroll, D. R. Irving and R. E. Paine.

Acknowledgment is also due to Messrs. Walter W. Bradley, W. Burling Tucker and C. A. Logan of the Division of Mines and Mining for assistance in compiling data, and for many helpful suggestions regarding the conduct of the work. In addition, Messrs. Tucker, Logan, and C. McK. Laizure supplied a number of descriptions of deposits or plants not visited by the author, acknowledgments of which are made in the text.

GENERAL REFERENCES.

Little space has been devoted in this report to the origin of clay, its chemical and physical properties, or to clay-working processes in general. Such information has usually been included in clay reports from other states, but there seems little justification for its inclusion here, in view of the fact that there are now a number of excellent texts for those who desire such information. A few of the more important works are listed below:

[1] Burchfiel, B. M., Refractory clays of the Alberhill, California, deposits: Jour. Amer. Cer. Soc., Vol. 6, pp. 1167–1175, 1923.

[2] Schuette, C. N., Engineering principles applied to the exploitation of a clay deposit: Eng. & Min. Jour.-Press, Vol. 121, p. 964, June 12, 1926.

Wilson, Hewitt, "Ceramics." McGraw-Hill Book Co., New York, 1927. An excellent text on clay technology, covering the chemical and physical properties of clays. Not suitable for readers who have no knowledge of chemistry or physics.

Andrews, A. I., "Ceramic Tests and Calculations." John Wiley and Sons, 1928. An elementary text on the methods of clay testing, and on the calculations relative to glazes, bodies, enamels and glasses.

Searle, A. B., "The Chemistry and Physics of Clays and Other Ceramic Materials." Ernest Benn, Ltd., London, 1924. A valuable reference work of scientific conceptions and data on clays. Particularly useful to research workers.

Ries, Heinrich, "Clays, Their Occurrence, Properties and Uses," 3d Edition. John Wiley and Sons, 1927. The standard work on the geology and origin of clays, with sufficient information on properties and uses to serve as an elementary text. Perhaps the best general work for the layman.

"Clay Products Cyclopedia and Equipment Catalog." Issued annually by Industrial Publications, Inc., Chicago, Illinois. A useful reference, of particular value as a dictionary of ceramic nomenclature and for the descriptions and illustrations of ceramic equipment.

Chapter II.

SUMMARY OF THE CERAMIC INDUSTRY OF CALIFORNIA.

INTRODUCTION.

For the benefit of those who may be unfamiliar with clay-working processes, a brief summary of clay technology is given.

Definition of clay: "Clays are the weathered products of the silicate rocks, containing sufficient hydrous silicate of alumina in the softened condition to produce a plastic or semiplastic mass when tempered with water."[1] Clays may be classified into many types. In this report a classification is used that is based upon physical properties and uses. The details of this classification are given in Chapter IV.

Definitions of a few of the more general terms used in clay momenclature are given below:[2]

Kaolin is amorphous hydrated aluminum silicate, corresponding to the formula of $Al_2O_3.2SiO_2.2H_2O$ and is the most important constituent of china clay. The term is widely used in commercial practice to include china clay and rock high in china clay.

China clay is the commercial variety of kaolin. It may occur naturally in deposits of sufficient purity, but is more often prepared by the purification of natural deposits. It burns white, and has high refractoriness, but the plasticity is generally poor.

Ball clays are white or light-cream-burning clays of high plasticity and bonding power that vitrify to dense impervious bodies at comparatively low temperatures.

Fireclays are those clays that withstand high temperatures, particularly those that do not fuse at temperatures below 1605° C. (2921° F., cone 27). They are used in the manufacture of fire brick or other refractories and are often used for architectural terra cotta, wall tile, etc.

Face brick clays may be divided into one of three groups. (1) Red-burning clay; (2) white-burning clay; (3) buff-burning clay. The color, plasticity, shrinkage, and vitrification must fall within certain general limits, dependent upon the type of brick to be manufactured.

Common brick clays vary widely in their composition and properties. They are usually high in fluxes and in most cases are red-burning. They should mold easily and develop hardness and strength at as low a firing temperature as possible without seriously warping or cracking.

Slip clays are fine grained, and contain a high proportion of fluxes. They should melt at a low temperature (preferably below 1200° C., cone 5) to a greenish or brown glass to form a natural glaze.

Clay preparation: With the exception of some of the heavy structural products, it is seldom possible to find a single raw material that

[1] Wilson, Hewitt, Ceramics, p. 7.
[2] See Wilson, *op. cit.*, pp. 28–39, and Clay Products Cyclopedia, 1926, pp. 94–96, for further details.

possesses the desired plastic, drying and firing characteristics for making a given ceramic product. It is usually necessary, therefore, to blend several clays and nonplastics in order to control the properties of the finished product. For example, clays having different percentages of iron may be blended to secure the desired color; highly plastic clays may be blended with those having poor plasticity in order to control shrinkage and porosity; feldspar may be added as a flux to lower the temperature of vitrification; crushed quartz or crushed calcined clay may be used as a "grog" to produce a skeleton structure that is bonded by the clay, giving greater strength and less tendency to warp than if clay alone were used.

After deciding upon the proportions of the various raw materials, some of them are ground separately and others are ground after mixing, either by dry or wet methods. Ball mills and grinding pans are the principal types of machinery used for fine grinding. At some point in the process, all the materials are mixed together, the proper amount of water is added, and the mass is subjected to a thorough mixing, with or without additional grinding. For the manufacture of many types of ware, the plastic mass is allowed to age in humidified rooms or under wet sacking for a period of 24 hours to one month, in order to secure uniform distribution of the water and to develop maximum plasticity.

Manufacturing processes: After the clay is properly prepared, the three essential steps in the manufacture of a ceramic product of the type under consideration are shaping, drying and firing. A fourth process that is applied to certain types of ware is glazing.

Shaping: The shaping of clay wares may be done while the clay is in one of the four different degrees of plasticity: (1) Dry pressing of pulverized mixtures to which has been added just enough water to bind the mass together when subjected to pressure in hydraulic, cam, or screw presses. This process is principally used for shaping floor and wall tile, especially the hard vitrified tile used in bath-room floors, and to some extent it is used in common brick and face brick manufacture. (2) Stiff-mud shaping, in which sufficient water is added to the clay to permit the mass to flow through a die without rupture. A column of clay is pushed through a hollow die by a plunger or screw or the clay may be pressed into a steel mold by a plunger. This is the usual process for making common brick, face brick, fire brick, and roofing tile, and is the only method in use for shaping hollow tile, sewer pipe, drain tile, and electrical conduit. (3) Soft-mud shaping, in which almost enough water is added to cause stickiness. This consistency is used for the hand pressing of terra cotta and tile in plaster molds, for the shaping of pottery and stoneware on pottery wheels or in molds, for the hand molding of roofing tile over paper covered wooden molds, or for the hand or mechanical pressing of common brick or face brick. (4) Casting, in which the finely-ground mixture is suspended in water so that the resultant "slip" may be poured into plaster molds. The plaster absorbs water from the slip, gradually precipitating the solids against the inner walls of the mold. When the walls are thick enough, the surplus slip is poured from the mold, the object is left in the mold until stiff enough to stand its own weight, then the mold is stripped off and the shape allowed to dry. Casting is the cheapest method of producing pottery on a large scale, and is the principal method in use for shaping sanitary porcelain.

Drying: The drying of clay wares may be done under sheds in the open, in specially heated rooms, or in specially designed humidity dryers in which the three factors of time, temperature and humidity are under close control. The type of drying will depend upon the characteristics of the clay used and upon the shape and size of the ware to be dried. As clay shrinks during drying, it is important that the drying be controlled in such a way as to avoid undue strains which might cause cracks in the dried ware, or lines of weakness which would result in cracks during the subsequent firing operation.

Firing: The proper firing of ceramic ware is perhaps the most important part of the process, and many types of kilns are available for the purpose. The essential conditions to be met by a ceramic kiln are control of the time-temperature cycle and uniformity of heat distribution. In some cases, kiln gases can not be allowed to come in contact with the ware, so that muffle kilns are necessary, or else the ware is enclosed in fireclay receptacles known as "saggers." Most kilns now in use are of the periodic type, but there is a growing tendency to use continuous kilns in which the ware is set on trucks which move through a tunnel that is fired near its mid-point. Firing temperatures range from 895° C. (1643° F.) for soft-burned common brick to 1350° C. (2462° F.) for hard porcelain and fire brick. A few special products are fired as high as 1640° C. (2984° F.).[1]

Glazing: Glazing may be done by dipping, spraying, or painting a water suspension of the glaze ingredients on the ware either before firing, or after a preliminary (biscuit) firing. In some cases where complicated polychrome decorations are used, several firings are necessary before the piece is finished. Salt glazing is another method, wherein common salt is vaporized in the kiln during firing, the sodium of the salt reacting with the clay body to form a fusible compound.

CLAY DEPOSITS OF CALIFORNIA.

In practically all of the low altitude areas of California there is an abundance of common clay and shale suitable for the manufacture of common brick and hollow building tile. By reason of the low unit value of these products, the raw material must be cheaply mined, and will not stand transportation charges from points very distant from the brick yards, which are situated near the centers of consumption. In the San Joaquin and Sacramento valleys, it has been difficult to find good bodies of clay with sufficient plasticity for the manufacture of the best quality of building brick, and some of the plants in this area have been forced to ship plastic clay from different points to mix with the local materials. In the San Francisco Bay district and in Los Angeles County, the two important centers of consumption, there are ample common clay resources. The same is true of the smaller valleys in the Coast Range and in the foothills of the Sierra Nevada.

In the mountainous portions of the state, in the desert regions, and in the volcanic area of the northeastern counties, it is difficult to find

[1] Pyrometric cones are extensively used in the ceramic industry as temperature indicators. See table No. 9 in Chapter IV.

suitable common brick clays, but as these areas will probably never be thickly populated, such brick as are needed can be shipped in from more distant points.

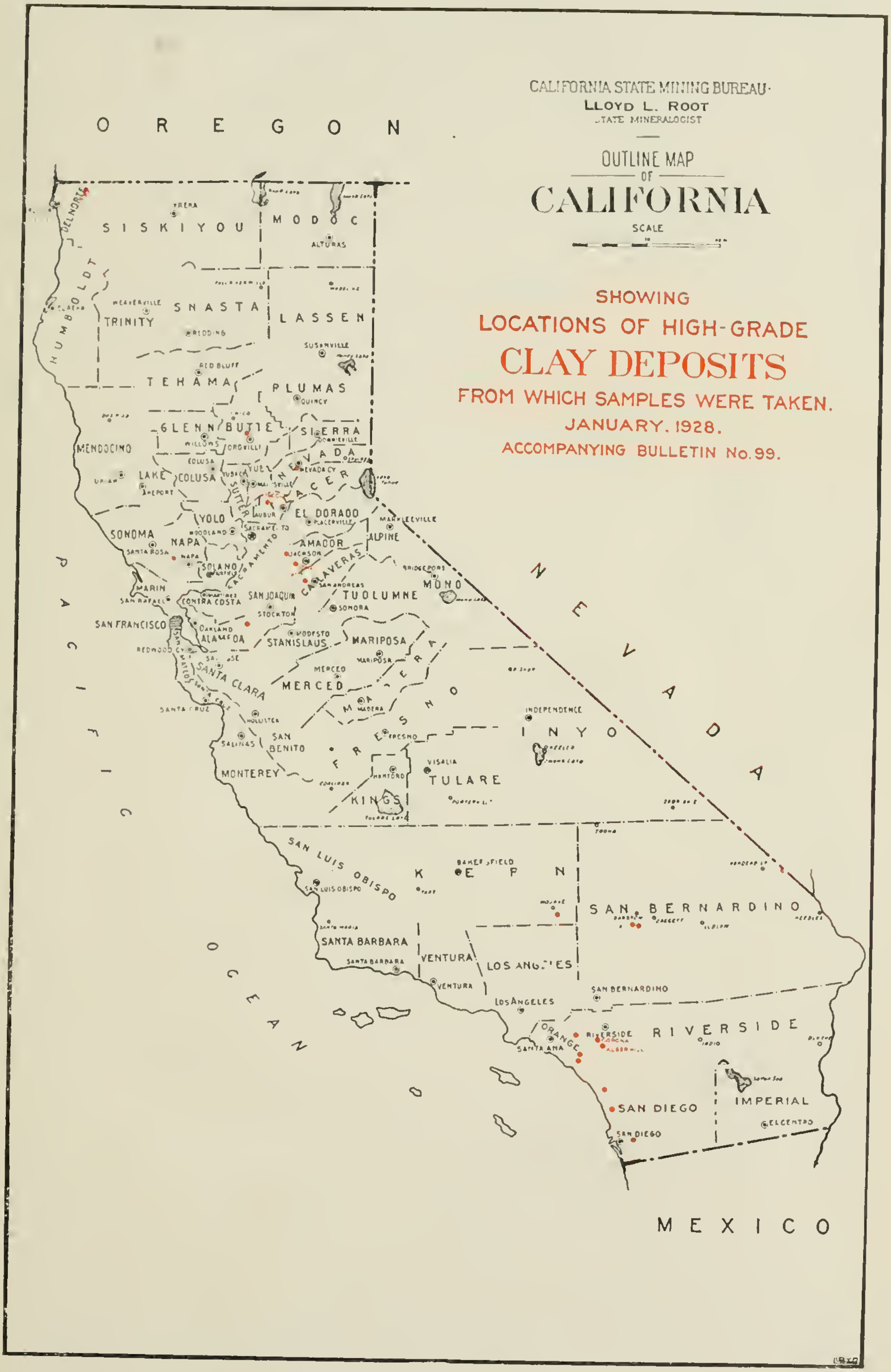
The demand for paving brick has never been great enough to lead to an intensive search for red-burning shales of the type used elsewhere in the United States for paving brick manufacture. A few such shales are known, and one or two deposits are being worked, but, for the most part, the demand for paving brick, sewer pipe, conduit pipe, and other red-burned vitrified products has been met by a blending of various clays, with or without grog. Three deposits are of special interest in this connection: the Natoma clay (see samples No. 210 and 212), which consists of fine gold-dredge tailings deposited in settling basins; the Goat Ranch shale (see sample No. 282), an Upper Cretaceous shale in Santa Ana Canyon; and the Santa Margarita shale (see samples No. 216 and 217), from an undeveloped deposit along the Southern Pacific Railroad near Santa Margarita.

The general distribution of the high-grade clays of California is shown on Plate I.

The high-grade clays of the state are found mainly in deposits of Eocene age, although there is one important area of Pleistocene clay, and the importance of certain beds in the Upper Chico (Cretaceous) is just receiving recognition. Approximately 90 per cent of the high-grade clays of the state are now being mined from one of three areas: the Alberhill-Corona district in Riverside County; the Ione district in Amador County; and the Lincoln district in Placer County. The age of the clays in all three districts is Eocene, and the deposits were formed by sedimentation in inland seas, with or without subsequent alteration.

The Alberhill-Corona clays occur in an area in the Temescal Valley some twelve miles long and two miles wide. In many places the clay beds are three to four hundred feet thick. The clays were laid down in Eocene time in an arm of the sea. The region is characterized by a discontinuity of structure that arose from folding, faulting, and erosion subsequent to clay deposition, and by extreme local variations in the individual clay beds caused by variations in the conditions of sedimentation. A wide variety of red, pink, and buff-burning plastic clays and a good range of plastic and semi-plastic fireclays are produced in the district. The colored clays are used for face brick, roofing tile and red earthenware, and as an ingredient of sewer pipe, electrical conduit and other mixes. The buff-burning clays, generally refractory, are used for architectural terra cotta, stoneware, decorative tile, pottery, etc. The refractory clays are used for fire brick and other refractory shapes. A few selected varieties are sufficiently free from coloring compounds to permit their restricted use in white-burned products. The typical clays are characterized by excellent plasticity, low or medium dry strength, low or medium drying and firing shrinkage, and open fired texture. A few varieties are found that possess high dry strength and high shrinkage, and that vitrify completely within commercial firing ranges, but these are the exception rather than the rule. The proportion of sand in the clays varies widely from almost pure sand to pure clay, resulting in a wide range of commercial varieties.

The Ione clays and sands occur in a belt about twelve miles long and one-half to one mile wide. The total thickness of clay is not known,


CALIFORNIA STATE MINING BUREAU
LLOYD L. ROOT
STATE MINERALOGIST
OUTLINE MAP
OF
CALIFORNIA
SCALE
SHOWING
LOCATIONS OF HIGH-GRADE
CLAY DEPOSITS
FROM WHICH SAMPLES WERE TAKEN.
JANUARY, 1928.
ACCOMPANYING BULLETIN No. 99.
OREGON
NEVADA
MEXICO
PACIFIC OCEAN
SISKIYOU
MODOC
ALTURAS
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
LAKE
COLUSA
YOLO
EL DORADO
ALPINE
SONOMA
NAPA
AMADOR
SOLANO
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SANTA CLARA
MERCED
INDEPENDENCE
INYO
SAN BENITO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL

but in a number of places a thickness of over 100 feet has been demonstrated. The beds are more continuous, and have less local variations in the character of the material, than is the case at Alberhill. The area is important for its high-grade fireclay and fire-sand. Some plastic pink- and buff-burning clays are also produced for use in terra cotta, stoneware and pottery manufacture. The fireclays are the most refractory that have thus far been found in the state, but are characterized by low dry strength and high firing shrinkage, with a strong tendency to crack when fired. The fire-sands are composed of quartz-mica sand with from 10 to 25 per cent of clay, and are important as a nonplastic ingredient of fire brick mixtures, to diminish the shrinkage and the tendency to crack. Future developments in this area are expected to greatly extend the known dimensions of the clay beds, and to disclose other varieties of clay not now accessible.

The Lincoln clays lie in an isolated remnant of the Ione formation (Eocene), protected by a lava capping. The beds underlie a low hill adjoining the town of Lincoln. The clay is continuous over an area of about four square miles, to a depth of approximately 100 feet below the lava capping. The Lincoln clay is an excellent buff-burning plastic fireclay that is especially valuable in the manufacture of architectural terra cotta, faience tile, fire brick, and other products. There are also beds of pink-burning clays that are used in sewer pipe, roofing tile and face brick mixtures. The Lincoln clays have excellent plasticity, medium dry and fired strength, a long vitrification range, and, although the shrinkage is high, the clay can stand rapid firing without cracking.

Some other clay producing areas of lesser importance are: (1) The Cardiff-Carlsbad area in San Diego County, containing excellent fireclays, some of which are closely similar to the famous Gros-Almerode fireclays of Germany; (2) The Santa Margarita Rancho deposit, near San Juan Capistrano, San Diego County, containing important deposits of highly aluminous fireclay; (3) The Hunter Ranch deposit, near El Toro, Orange County, where there is an excellent fireclay, associated with a bed of kaolin and sand from which a high-grade kaolin can be recovered; (4) The Goat Ranch deposit, in Santa Ana Canyon, Orange County, an Upper Chico (Cretaceous) deposit of flint fireclay.

California is especially favored with resources of nonplastic ceramic materials. At Campo, San Diego County, is a large deposit of excellent feldspar, and many other feldspar deposits are known in southern California. Silica is available in many forms in California and near the border in Nevada. A large deposit of quartzite has been found in the desert south of Barstow, from which silica brick is being made. Talc, used in some floor-tile bodies, is available from a number of sources. The most extensive deposits of andalusite and cyanite in the United States occur in California. These minerals are of increasing importance in the manufacture of high-grade refractories.

The most important ceramic materials that are thus far lacking in California are ball and china clays equal in purity and uniformity to those from the deposits of England or from the eastern United States. A clay possessing the properties of a mixture of the two varieties has been found in San Bernardino County, and a good china clay has been found in Nevada, but thus far production has been small, and most of the ball and china clay requirements of the California industry are met by importation from the eastern states or from England. One of the factors that has hindered the establishment of a local clay washing industry to produce china clay is the low price of Belgian glass sand at Pacific coast ports, making it unprofitable to market the quartz sand which would be a by-product of kaolin washing. Since the yield of kaolin would be but 20 to 30 per cent from the known deposits in California, the importance of a satisfactory market for the sand is apparent.

While a few small deposits of bone clay have been found in southern California, highly aluminous clay is relatively scarce, and no commercial deposits of diaspore, bauxite or gibbsite[1] have been discovered in California.

MINING METHODS.

Most of the clay deposits of California are mined by open pit methods, and with the exception of most of the common clay deposits, hand methods predominate. Where a production of the order of one car (50 tons) per day or more is needed mechanical methods are in general use, if topographic features are favorable, and if no hand sorting of the clay is necessary.

Drilling and blasting are necessary at many of the deposits. The holes are usually drilled with hand augers, and blasted with light charges of low-power explosives. As a rule, a nearly vertical bank is carried, and the height of the bank corresponds to the thickness of the bed being mined. Stripping of overburden, if any, is carried out in advance of mining, on a separate bench.

The hand methods in use involve pick and shovel loading into auto trucks, wagons, mine cars, wheelbarrows, or loading chutes, depending on local conditions.

The mechanical methods include horse-drawn scrapers, power-driven drag scrapers, and power shovels of various types actuated by gasoline or electricity. The scrapers usually load directly into hoppers, from which the clay is drawn off into auto trucks, industrial railway cars, or onto belt or bucket conveyors. The shovels load into auto trucks, or into industrial or standard railway cars.

Most of the underground mining is done by the room and pillar method, from a tunnel entry, with only such auxiliary timber support as is necessary to support localized blocks of loose ground. While pillars are robbed as much as is practicable, from 20 to 35 per cent of the clay must be left in the pillars to support the workings.

Transportation from the pit to the plant or railroad siding is done at many properties in the original vehicle in which the clay is loaded. At other properties a loading platform or chute is placed as near the pit as possible, and the clay is transferred to cars on an industrial railroad or into auto trucks.

Most of the clay mining in the state is done on contract, especially at smaller properties. To one familiar with metal mining, the methods in use at many of the properties seem needlessly crude and wasteful of human energy, but the short working season, seldom longer than from

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[1] These three minerals are types of aluminum hydroxide. Diaspore contains 12–14 per cent of water and has a formula approximating to $Al_2O_3.H_2O$. Bauxite contains 20–24 per cent of water and corresponds to $Al_2O_3.2H_2O$. Gibbsite contains 27–35 per cent of water and corresponds to $Al_2O_3.3H_2O$. See Searle "The Chemistry and Physics of Clays," p. 339. The bauxites are used in the manufacture of metallic aluminum, and are valuable for the manufacture of a superior type of fire brick (diaspore brick) that is more refractory than ordinary fireclay brick. These brick are used, among other purposes, for lining the clinkering zone of cement kilns.

May to October, the comparatively small scale of operation, the fluctuation of demand, the irregularity and small size of some of the deposits, the necessity of hand sorting in a number of cases, and the fact that many of the deposits are mined under a royalty lease, all must be given due consideration before any valid criticisms can be made.

Clay mining costs for open pit work range from 10¢ to 25¢ per ton for scraper or shovel loading, to 20¢ to 50¢ per ton for hand loading. Hand sorting may double the cost of hand loading. Transportation to the pit mouth, or to a bin within a few hundred yards of the pit, may add from 5¢ to 25¢ per ton. Incidentals may total from 5¢ to 25¢, making the total direct cost vary between the approximate limits of 20¢ and $1.50 per ton. In addition, many of the properties are several miles from a railroad or plant and must stand a transportation cost that may be in excess of $1 per ton. The longest auto truck haul noted was 15 miles, and there are a number of deposits where the haul is from three to eight miles from the pit to a railroad or plant. Where a royalty is paid, the charge is usually from 10¢ to 25¢ per ton.

Underground mining costs are naturally higher than open pit costs, but the direct cost of mining and loading, including hand sorting, is seldom in excess of $1 per ton. Haulage and transportation costs must be added.

As an indirect indication of costs, the selling prices of a number of clays may be cited: The price of Alberhill clay f.o.b. gondola cars at Alberhill ranges from $1 per ton for the cheaper grades that occur in large deposits and that are cheaply mined by mechanical methods, to $5.50 per ton for the rarer varieties that are hand sorted and may be mined by underground methods. The price of Lincoln clay, mined by a power shovel from a large pit, is nominally $1.75 per ton, f.o.b. Lincoln.

CERAMIC PLANTS.

A check list of the clay-working plants of California, with the products made in each, is given in Table 1. It will be noted that the majority of the plants in the state are in or near the two major centers of population and industry, the Los Angeles area, and the San Francisco Bay district. However, common brick and hollow-tile plants are well distributed among the lesser centers of population, and there are a number of important manufacturers of high-grade ceramic products whose plants are at some distance from the larger centers. Some of the plants in the latter group have been built adjacent to clay pits in order to secure close coordination between the clay quarrying and the manufacturing plant. Since freight rates on finished products are higher than on raw materials, it is advantageous to locate the plant near the geographical center of consumption of finished ware.

The check list also reveals the wide diversity of the California industry and shows that nearly all of the ceramic products now in use are manufactured in one or more California plants. The important exceptions are magnesia brick, chrome brick and chemical porcelain and stoneware. Magnesia brick were made for a short time during the World War, when foreign supplies were unavailable, and earlier attempts were made by various companies, but the business is uneconomic under normal conditions.

TABLE No. 1. CHECK LIST OF CERAMIC PLANTS IN CALIFORNIA, AND PRODUCTS MANUFACTURED.

			Products Manufactured																							
			Structural Ceramics												Refractories			Pottery and Miscellany								
County	Name of Plant	Described on page	Common brick	Paving brick	Face brick	Sewer pipe	Drain tile	Hollow block	Terra cotta	Conduits	Roofing tile	Flue lining and chimney pipe	Floor and terrace tile	Wall and fire place tile	Fire clay brick	Silica brick	Special refractories	Tableware	Kitchenware	Art or garden pottery	Sanitary ware	Stoneware	Flower pots, ollas, etc.	Electrical insulators	Porcel in specialties	Cast iron enameling
Alameda	California Bisque Doll Co.	38																		x						
	California Faience Co.	39																		x						
	California Pottery Co.	39				x					x	x	x	x						x		x				
	N. Clark & Sons	40				x			x			x			x											
	W. S. Dickey Plant No. 18 (Livermore)	40			x							x			x											
	W. S. Dickey Plant (Niles)	40		x				x																		
	Electrical Porcelain Works	40																						x		
	Hidecker Tile Co.	41									x															
	Kraft Tile Co.	41												x												
	Miller's Oakland Art Pottery	41				x	x					x														
	M. & S. Tile Co.	41									x															
	Muresque Tiles, Inc.	42												x												
	Remillard Brick Co.	42	x																							
	Tech. Porcelain & China Ware Co.	42																						x		
	Walrich Pottery	45												x						x						
	Westinghouse High Voltage Insulator Co.	45																						x		
	Woolenius Tiles	49												x												
Amador	Ione Fire Brick Co.	60													x											
Butte	Lund Clay Plant	65	x																							
	Table Mt. Clay Products Co.	65			x																					
Contra Costa	California Art Tile Co.	72												x												
	Mastercraft Tile & Roofing Co.	73																								
	Port Costa Brick Works	73	x					x																		
	Richmond Pressed Brick Co.	74	x	x	x								x		x											
	Standard Sanitary Manufacturing Co.	75																			x					x
Fresno	Craycroft Brick Co.	78	x		x			x																		
	Pioneer Brick & Tile Co.	78	x																							

Humboldt	J. D. Thompson Brick Co.	81	x				x	x																		
Imperial	Simons Brick Co.	86	x																							
Kern	Bakersfield Sandstone Brick Co.	89	x																							
	Kern County Brick Co.	89	x																							
Los Angeles	Acme Brick Co.	94	x																							
	Alhambra Kilns, Inc.	94									x		x													
	American China Co.	94												x												
	American Encaustic Tiling Co.	95											x	x												
	American Refractories Co.	96													x		x									
	Angulo Tile Plant	97									x															
	Atlas Fire Brick Co.	97													x											
	Batchelder-Wilson Tile Co.	97							x				x	x												
	J. A. Bauer Pottery Co.	98																	x			x	x			
	California Brick & Tile Co.	98	x																							
	California Clay Products Co.	99											x	x												
	City Brick Co.	100	x																							
	Claycraft Potteries, Inc.	100												x												
	H. F. Coors Co., Inc.	100																							x	
	Davidson Brick Co.	100	x																							
	Empire China Co.	101																x								
	Emsco Refractories Co.	101													x	x										
	Gladding, McBean & Co. (3 plants)	101	x		x	x		x	x		x	x	x	x												
	Globe Tile & Porcelain Works	103											x													
	H. & H. Tile Co.	103											x													
	Italian Terra Cotta Co.	103																		x						
	K. & M. Pottery	104																				x	x			
	K. & K Brick Co.	104	x																							
	[1]La Cal Tile Co.	104																								
	Linderman and Decker Co.	104									x															
	Long Beach Brick Co.	105	x																							
	Los Angeles Brick Co. (3 plants)	105	x					x																		
	Malibu Potteries	107												x												
	Mission Brick Co.	107	x																							
	Mission China Co.	109																x								
	Pacific Clay Products Co. (3 plants)	109			x	x	x			x		x			x							x	x			
	Pomona Brick Co.	116	x																							
	Pomona Tile Manufacturing Co.	117											x	x												
	Poxon Pottery	117																x								
	St. Louis Fire Brick & Clay Co.	118													x											
	Santa Monica Brick Co.	118	x		x						x		x													
	Simons Brick Co. (3 plants)	119	x								x															
	[2]Standard Brick Co. (2 plants)	120	x																							
	Torrance Brick Co. (2 plants)	120	x		x			x																		
	Tudor Art Tile Co.	121												x												
	Vitrefrax Co.	121															x									
	Washington Iron Works	122																								x
	Western Brick Co.	122	x																							
	Whiting-Mead Co.	123																		x	x					x

TABLE No. 1. CHECK LIST OF CERAMIC PLANTS IN CALIFORNIA, AND PRODUCTS MANUFACTURED—Continued.

County	Name of Plant	Described on page	Products Manufactured																							
			Structural Ceramics												Refractories			Pottery and Miscellany								
			Common brick	Paving brick	Face brick	Sewer pipe	Drain tile	Hollow block	Terra cotta	Conduits	Roofing tile	Flue lining and chimney pipe	Floor and terrace tile	Wall and fire place tile	Fire clay brick	Silica brick	Special refractories	Tableware	Kitchenware	Art or garden pottery	Sanitary ware	Stoneware	Flower pots, ollas, etc.	Electrical insulators	Porcelain specialties	Cast iron enameling
Marin	McNear Brick Co.	124	x																							
Merced	California Pottery Co.	128					x	x			x															
Monterey	Arca Roofing Tile Plant	130									x															
	Monterey Mission Tile Co.	131									x		x													
Orange [3]	Brea Clay Products Co.	140	x																							
	Garber Brick & Tile Co.	141	x								x		x													
	La Bolsa Tile Co.	142	x		x		x	x																		
	Olive Roofing Tile Co.	144									x															
Placer	Gladding, McBean & Co.	151			x	x			x		x	x			x					x						
Riverside	Gladding, McBean & Co.	171			x			x			x				x											
	Los Angeles Brick Co.	174			x										x											
	Hancock's Brick Yard	181	x																							
	Prado Tile Co.	181									x									x						
Sacramento	Cannon and Company	183			x			x							x											
	Muddox Pottery	186				x						x														
	Panama Pottery	187																		x		x	x			
	Sacramento Brick Co.	188	x																							
	Valley Brick Co.	189	x																							
San Diego	National Brick Co.	203	x																							
	Old Mission Tile Co.	203									x															
	San Diego Brick & Tile Co.	203	x					x																		
	Union Brick Co.	204	x																							
	Vitrified Products Co.	205			x			x			x		x													
San Francisco	Jalanivich and Olsen	207																		x						
	Tara's Porcelain Laboratory	207																							x	

San Joaquin	San Joaquin Brick Co.	208	x																						
	Stockton Brick & Tile Co.	208	x					x																	
	[1]Stockton Fire Brick Co.	209													x										
San Luis Obispo	San Luis Brick Works	213	x					x			x														
San Mateo	West Coast Porcelain Manufacturers	215																		x	x				
Santa Barbara	Angulo Tile Co. (2 plants)	218									x		x												
	Maengenberg & Whitiker	218	x				x	x																	
Santa Clara	Garden City Pottery Co.	219																				x	x		
	Kartschoke Clay Products Co.	221				x					(x)	x													
	Platts Premier Porcelain, Inc.	221																			x				
	Remillard Brick Co.	221	x																						
	San Jose Brick & Tile Co.	221	x																						
	San Jose Tile Co.	221											x	x											
	S. & S. Tile Co.	231											x	x											
Tehama	O'Connor Bros. Brickyard	231	x																						
Tulare	S. P. Brick & Tile Co.	232	x					x																	
Ventura	Anderson and Hardison	234	x																						
	Peoples Lumber Company	234	x		x		x	x			x														
Yuba	Marysville Brick Co.	236	x																						

[1] Detailed information lacking as to products made.
[2] Also make sewer brick.
[3] The Orange County Brick and Tile Company, manufacturers of sand-lime brick is described on page 141
[4] Also manufactures diatomaceous insulating brick and shapes.

MANUFACTURING METHODS IN CALIFORNIA PLANTS.

Common brick: In California, one common brick plant uses the dry-press process, and the other plants are nearly equally divided between the soft-mud and the stiff-mud process. Nearly all of the plants use drying sheds in the open, but some use drying racks in an enclosed and heated building, and a few use waste-heat or separately-fired tunnel driers. Field kilns are preferred in southern California, where there is little rainfall throughout the year, and continuous kilns of the Hoffman type are preferred in northern California. Oil is the usual fuel for the field kilns, although natural gas is used at some plants which are located near the oil fields. At some plants, gas is used during the water-smoking period and oil for the balance of the firing cycle. The continuous kilns are fired with coal. Firing temperatures range from cone 08 to cone 1 (950° to 1160° C.).

No mechanical hacking, setting or loading machines are in use in California. So far as could be ascertained, none of these devices have been given a trial in the state. It would seem that even though such machines in their present form may not be entirely satisfactory, the hope of saving from 25 to 40 man-shifts per 100,000 brick would be a sufficient inducement to encourage the development of automatic brick-handling machines, especially in the larger plants.

Hollow block: All hollow block are shaped in auger machines. Some of the plants making hollow block are also making common brick and both products are subjected to the same drying and firing treatment. Waste-heat or separately-fired tunnel driers are in use at a number of plants. Field kilns are widely used, but several plants use Hoffman kilns, one uses a Haigh kiln, and a few use use round down-draft kilns. Firing temperatures are usually between cone 04 and cone 3 (1060° to 1170° C.).

Face brick: Most of the face brick of California is shaped by the stiff-mud process. Much of it is repressed. The dry-press method is used at a few important plants. Drying is usually done in waste-heat tunnel driers, and round down-draft kilns are used at all plants for firing.[1] The firing temperatures usually approximate cone 02 to cone 5 (1125° to 1205° C.).

Sewer pipe: All sewer pipe is made in presses which are usually operated by electric power. Drying is done on drier floors which are usually heated by steam or waste heat from the kilns. Round down-draft kilns are used for firing and the firing temperatures range from cone 02 to cone 5 (1125° to 1205° C.). The dry strength of some of the sewer pipe mixes in use in California is too low to permit setting to the full height of the kilns, so that the capacity per kiln is not so great as at most of the eastern plants where stronger clays are available.

Drain tile: There is little demand for drain tile in California and it is only made in a few plants, where it is shaped by auger machines, dried on heated drying floors and fired in round down-draft kilns.

Terra cotta: Architectural terra cotta is an important product in California. A particularly fine example of its use is shown on the

[1] The wide range of colors demanded by modern architectural design is secured by varying the body mixture and by the normal differences of temperature at different parts of the kilns.

frontispiece, Photo No. 1, which is a view of the Russ Building, in San Francisco. The typical body in use in California consists of a siliceous plastic fireclay mixed with an equal weight of nonplastics, such as quartz sand and grog made by regrinding rejected terra cotta from the plant. This produces a body having an absorption of about 15 per cent, when fired to cone 4 to 6 (1190° to 1230° C.). The mixing, pugging and aging of the body mix is highly important, and due precautions are taken at all plants to ensure uniformity of the plastic mix that is sent to the pressers. All shapes are made by hand pressing in plaster molds. After drying to leather hardness, the molds are stripped and the pieces are finished by hand, after which they are dried and sprayed with glaze. A few Carrier humidity driers are used in California in place of the usual method of drying on heated floors. In California, the ware is fired to cones 4 to 6 (1190° to 1230° C.) in round down-draft kilns.

A considerable quantity of garden pottery is made in California, either as an auxiliary product in the terra cotta plants or in smaller plants making a specialty of this class of ware. The body mix and manufacturing methods are similar to those used for making terra cotta.

Conduits: Electrical conduits are shaped by auger machines, using a mix similar to that used for sewer pipe. In California, they are usually dried in waste-heat tunnel driers. Round down-draft kilns are used at all plants.

Roofing tile: Roofing tile is popular in California on account of the prevalence of Spanish architecture. Hand-made or hand-finished machine tile is in considerable demand for the better class of homes, and machine-made tile is widely used on homes, apartment houses, hotels, schools and even on office and public buildings. Most of the hand-made roofing tile plants are small and have little equipment. Drying is done under sheds or in a barn, and firing is done in simple rectangular or vertical kilns, most of which are up-draft. There are a number of large plants making machine-made tile with an auger machine. Many of these use waste-heat tunnel driers. Beehive kilns are in general use at these plants, but one plant uses a tunnel kiln. Firing temperatures approximate cones 06 to 02 (1015° to 1125° C.). Several plants produce a hand-finished machine tile and finish the upper surface by hand before drying is complete. Such tile has nearly the same appearance as hand-made tile when laid on the roof, but is considerably cheaper. Present-day architectural design calls for a wide range of colors in roofing tile, as in face brick. With machine tile, the color range is secured by varying the proportions of buff- and pink-burning clays that are used with the red-burning clay body, and by sorting the different colors produced in different parts of the kiln. In the manufacture of hand-made tile, the mix is seldom varied in a given plant, but the color variations are obtained by normal variations in firing temperature in different parts of the kiln. In fact, the kilns are so small and so simple in design that it would not be possible to secure a uniform burn of the entire kiln. Individual tile usually show a considerable color difference between opposite sides or ends of the tile. This feature, together with the irregularity of outline, largely accounts for the artistic value of hand-made tile when applied to moderately small roofs. It should be noted, however, that hand-made tile can not be relied upon to make a water-proof roof, on account of high porosity and cracks in many of the tile. They are often laid over machine tile.

Flue lining: Many of the fire brick and architectural terra cotta plants in California and some of the sewer pipe and roofing tile plants make flue lining to supply the trade within their marketing territory. A siliceous refractory mix is used, similar to that used in architectural terra cotta or in low or medium-duty fire brick. Round shapes are made in a sewer pipe press, and square shapes are made in an auger machine or by hand pressing. Waste-heat tunnel driers or humidity driers are sometimes used, but a common method of drying is on floors in heated rooms.

Floor tile: There are a number of important plants in California that make vitrified floor tile by the dry-press process. English or Florida kaolin and English, Kentucky, or Tennessee ball clay are usually used in white tile, together with California or Arizona feldspar and California or Nevada silica, although Illinois silica or Belgian sand is used at times in place of California silica. Some plants have introduced California talc into white vitrified tile bodies with considerable success. Colored tile are made by substituting colored clays or by adding coloring compounds in the proper proportions. Power-driven presses are gaining in favor at the larger plants for the shapes and sizes most commonly used, but hand-presses are preferred at the smaller plants, and are used at all plants for special, or infrequently used, shapes. Specially designed tunnel kilns are in successful operation at one or two plants.

There has been a good market in California for rough-textured colored floor tile, and a number of small plants have been built to satisfy the demand. Most of these use a red-burning clay, or a mixture of buff- and red-burning clays, with grog or siliceous sand. Hand molding in plaster molds is extensively practiced, but competition has led to the use of tile augers in many plants. If desired, an undulating surface can be imparted to machine-made tile by hand treatment before drying. Oil stains are frequently applied after firing to modify the surface color or lustre of the tile. The active demand for this class of ware in recent years has stimulated artistic development, and the product from nearly every plant possesses an individuality of design, texture, and color. In a few plants, however, slavish copying of successful designs from other plants was noted.

Wall and fireplace tile: The artistic development of California decorative tile is an outstanding contribution to ceramic art in the United States. There is perhaps no other region in the world today that produces such a wide diversity of wall and fireplace tile, or that is so well prepared to create new designs for private homes, hotels, stores and office buildings. Several factors have contributed to this condition, among which are the following: (1) An abundance of suitable clays, cheap fuel and power, and low-unit labor costs which make it possible to produce certain types of tile so cheaply that they not only find an important local market, but can also be shipped to eastern points on a competitive basis. (2) An active state-wide building program that is based upon the necessity of providing for many new industries each year and for new homes for the thousands of people who annually enter the state from the east and middle west to become permanent residents of California. (3) The prevailing prosperity and resultant high standards of living which are more apparent on the Pacific Coast than in any other section of the United States. (4) The diversity of architectural design arising in part from the foregoing factors, and in part from the natural environment of California, where climatic conditions favor out-of-door life throughout the year, and where comparatively low land values in most residential districts make it possible for a home builder to acquire sufficient land to avoid the necessity for a cramped architectural style such as must be used in more congested centers of population. The dominant motive of California architecture is Spanish-American, the keynote of which is to be found in the missions that were established under Spanish rule in the latter part of the eighteenth and the first part of the nineteenth centuries. Suggested by this beginning the Spanish-Moorish, Mexican-Aztec, and Pueblo Indian styles have been extensively used. Those desiring a relief from these types, yet desiring to build in keeping with their local surroundings, have often chosen Italian designs. Still others, desiring destinctive effects, and sensing the possible over-development of Latin types in many districts, have used New England colonial, southern colonial, English, Norman, and other types, many of which are hybrids or are indistinguishable as formal styles.

Refractories: The manufacture of fire brick in California has now progressed to the point where practically all of the local demand for fireclay brick and special shapes is met by California products. Several manufacturers are making a fireclay brick with calcined clay grog that gives as good or better service as the best grades that are produced elsewhere in the United States. The demand for medium or low-duty fire brick is usually met by a quartz-grogged fireclay product. One manufacturer is developing a flint fireclay brick. Another manufacturer has been marketing a silica brick for the past two or three years. Mullite refractories are being manufactured at a plant in Los Angeles, using cyanite from a large deposit in the Imperial Valley desert. No commercial deposits of bauxite or diaspore have yet been discovered, so that the state is still dependent on eastern products where a diaspore brick is needed, as in linings for the hot zone of cement kilns. However, sufficient quantities of bone clay have been found on several properties in southern California to permit its use as calcined grog and as a portion of the plastic content in the manufacture of high-alumina brick.

The methods of manufacturing refractory ware in California follow the usual practices employed elsewhere. Most plants are equipped with auger machines for shaping the standard shapes. The better grades of brick are repressed. Some hand-molded standard brick are made, and are repressed in hand-operated presses. Special shapes are made by hand-molding. Drying is usually done in waste-heat tunnel driers, although a few humidity driers are in use, especially for the shapes that are difficult to dry. Round down-draft kilns are generally used for firing, and the firing temperature for most of the fireclay brick produced in the state is cone 11 (1325° C.). One of the most notable developments is the use of a tunnel kiln by the Vitrefrax company for firing mullite brick at cone 29 (1640° C.).

Tableware: Plain and decorated semi-vitreous table and hotel ware is made at a number of plants in California. Thus far, these plants have used imported clays, in conjunction with feldspar and silica from local sources. One plant, the Empire China Company, expects to go into production in the spring of 1928 on vitreous ware, using a California feldspar and silica and a Nevada china clay, together with a certain amount of Florida clay.[1] The manufacturing methods follow well-established practice.

Kitchen ware and stoneware: A number of potteries in California are manufacturing kitchen ware and stoneware. In most cases, all materials used in the body mix are obtained from local sources of supply. Slip clays for glazing have thus far been imported from other states. The usual manufacturing practices are followed.

Art pottery: There are a few small potteries devoted to the production of distinctive lines of art pottery. As the type of body and the plant practice is different at each of these, the reader is referred to the check list, figure 1, and to the plant descriptions in Chapter III for further details.

Red earthenware: The local demand for flower pots, ollas, earthenware household utensils and other red earthenware products is met by a number of plants, some of which specialize in one or more of these products.

Sanitary ware: A complete line of sanitary porcelain, with the exception of bath tubs, is made at three plants in California by the casting process, using imported clays, California or Illinois silica, and California feldspar. All three plants are equipped with tunnel kilns for both the biscuit and glost firing. Biscuit firing is usually at cone 11 (1325°C.), and the glost firing is at cone 6 (1230° C.). Three metal enameling plants are devoted to the manufacture of enameled cast-iron sanitary ware. Semi-porcelain plumbing accessories are made at three smaller plants. One of these uses a body made entirely from California raw materials.

Electrical insulators: The manufacture of high-tension electrical insulators probably presents one of the most difficult ceramic problems of modern industry. The industry is represented in California by one plant, that of the Westinghouse Electric and Manufacturing Company, at Emeryville (c.v., p. 45). California feldspar is the only local material used in the body mix. Semi-porcelain electrical accessories are being made at three small plants in California.

Thermal insulators: Although accurate statistics are unavailable for publication, the bulk of the diatomaceous earth insulating brick output of the United States, if not of the world, is produced in California. The Celite Products Company at Lompoc, and the Stockton Fire Brick Company at Stockton are the only producers at present. The production of sawn natural blocks of diatomaceous earth, at one time of importance, is now relatively small compared to the production of molded (hand or auger-machine) and fired shapes.

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[1] Personal communication from G. Ray Boggs, December 8, 1927.

STATISTICS.

BRICK AND HOLLOW TILE.

The brick and hollow tile statistics compiled by the State Division of Mines and Mining include all classes of brick. The detailed figures of production and value for 1926, by counties and by class of ware, are given in Table 2. This is a companion to Table 6, referred to later under pottery clay, in which the segregated figures for other clay products are given.

Table 3 gives statistics for the common brick industry of California, by years from 1896 to 1926 inclusive. The annual value of the common brick production is plotted to a ratio scale on Plate II. For comparative purposes, Plate II also includes the curves for the average unit value of common brick per thousand, and the gross annual value and the average unit value per barrel for cement during the same period. The rapid growth of the cement industry relative to that of the common brick industry is of special interest, as is also the comparative trend of prices in the two industries. The trend of cement prices reflects the economies of steady technical and mechanical progress in the cement industry, and the increasing size of plant units. The trend of common brick prices closely parallels the fluctuations in commodity prices and labor wages, as modified by fluctuations in the unit cost of fuel, as a high percentage of the cost of making common brick arises from labor and fuel costs, and there have been no important technical or mechanical improvements in brick manufacture during the period under review. The influence of the San Francisco earthquake of 1906 is strikingly shown by the decline of the common brick production and the continued rise of the cement production after a slight recession following the financial panic of 1907.

POTTERY CLAY.

The term 'pottery clay' as used in State Mining Bureau reports refers to all clay other than that used in the manufacture of common brick and hollow tile.[1] The production of pottery clay in California in 1926 is given in Table 4, and the production by years, from 1887 to 1926, inclusive, is given in Table 5. The production of pottery clay products in California during 1926 is given in Table 6.

[1] For a further elaboration of this definition see Cal. State Min. Bur. Bulletin No. 97, p. 94, 1926, or other annual statistical reports by the Bureau.

TABLE No. 2.

Brick and Hollow Tile Production for 1926, by Counties.

(From Bulletin No. 100, p. 70, 1927.)

County	Common		Fire		Glazed, pressed, fancy, vitrified, paving		Hollow building tile or blocks		Total value
	Amount M	Value	Amount M	Value	Amount M	Value	Tons	Value	
Alameda					3,692	$178,222	35,330	$356,242	$534,464
Butte	273	$4,316							4,316
Fresno	5,117	76,731	*		*		*		76,731
Kern	4,591	55,140							55,140
Los Angeles	219,473	1,913,573	[a]7,079	$480,316	[b]11,774	560,178	21,471	192,408	3,146,475
Orange	6,272	72,489							72,489
Riverside	*		9,017	398,735	3,731	134,175	*		532,910
Sacramento	12,850	178,900	*		*		*		178,900
San Diego	10,291	124,424	*		*		*		124,424
San Joaquin	6,269	106,942	*				*		106,942
Santa Barbara	430	6,785					406	10,291	17,076
Santa Clara	18,222	197,782							197,782
Alameda, Amador, Contra Costa, Humboldt, Imperial, Marin, Merced, Riverside, San Luis Obispo, Tehama, Tulare*	44,876	494,515							494,515
Alameda, Amador, Contra Costa, Fresno, Merced, Placer, Sacramento, San Diego, San Joaquin*			13,285	705,002					705,002
Contra Costa, Fresno, Placer, Sacramento, San Diego*					10,806	466,010			466,010
Contra Costa, Fresno, Merced, Placer, Riverside, Sacramento, San Diego, San Joaquin, San Luis Obispo, Tulare*							33,125	312,948	312,948
Totals	328,664	$3,231,597	29,381	$1,584,053	30,003	$1,338,585	90,332	$871,889	$7,026,124

*Combined to conceal output of a single operato rin each.
[a] Includes special silica brick.
[b] Includes Ferguson sewer liners.

Av. value per M
$6.11
5.74
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5.83
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7.35
7,18
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TABLE No. 2.

Brick and Hollow Tile Production for 1926, by Counties.

(From Bulletin No. 100, p. 70, 1927.)

County	Common		Fire		Glazed, pressed, fancy, vitrified, paving		Hollow building tile or blocks		Total value
	Amount M	Value	Amount M	Value	Amount M	Value	Tons	Value	
Alameda					3,692	$178,222	35,330	$356,242	$534,464
Butte	273	$4,316							4,316
Fresno	5,117	76,731	*		*		*		76,731
Kern	4,591	55,140							55,140
Los Angeles	219,473	1,913,573	[a]7,079	$480,316	[b]11,774	560,178	21,471	192,408	3,146,475
Orange	6,272	72,489							72,489
Riverside	*		9,017	398,735	3,731	134,175	*		532,910
Sacramento	12,850	178,900	*		*		*		178,900
San Diego	10,291	124,424	*		*		*		124,424
San Joaquin	6,269	106,942	*				*		106,942
Santa Barbara	430	6,785					406	10,291	17,076
Santa Clara	18,222	197,782							197,782
Alameda, Amador, Contra Costa, Humboldt, Imperial, Marin, Merced, Riverside, San Luis Obispo, Tehama, Tulare*	44,876	494,515							494,515
Alameda, Amador, Contra Costa, Fresno, Merced, Placer, Sacramento, San Diego, San Joaquin*			13,285	705,002					705,002
Contra Costa, Fresno, Placer, Sacramento, San Diego*					10,806	466,010			466,010
Contra Costa, Fresno, Merced, Placer, Riverside, Sacramento, San Diego, San Joaquin, San Luis Obispo, Tulare*							33,125	312,948	312,948
Totals	328,664	$3,231,597	29,381	$1,584,053	30,003	$1,338,585	90,332	$871,889	$7,026,124

*Combined to conceal output of a single operato rin each.
[a] Includes special silica brick.
[b] Includes Ferguson sewer liners.

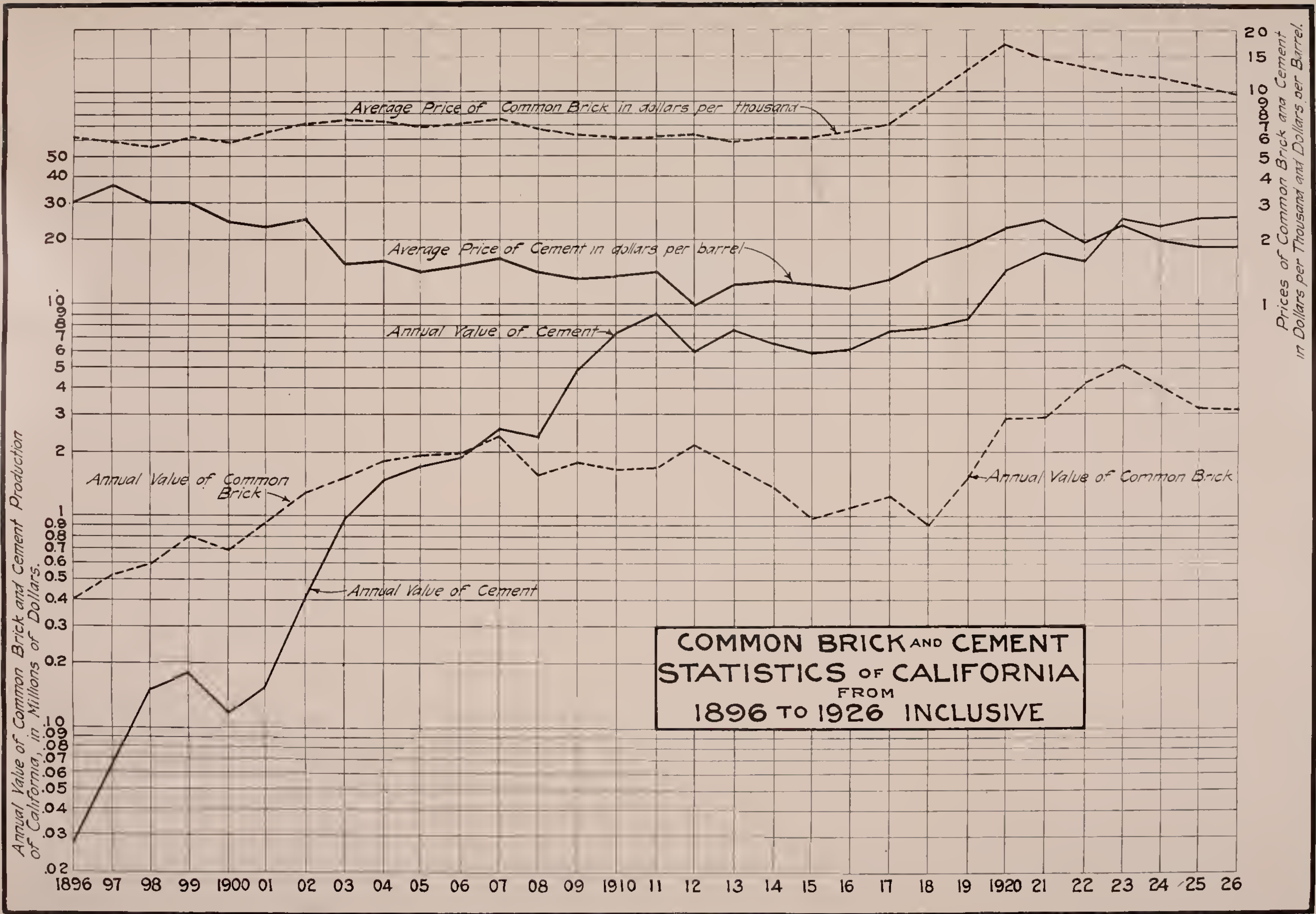
COMMON BRICK AND CEMENT STATISTICS OF CALIFORNIA FROM 1896 TO 1926 INCLUSIVE
Average Price of Common Brick in dollars per thousand
Average Price of Cement in dollars per barrel
Annual Value of Cement
Annual Value of Common Brick
Annual Value of Cement
Annual Value of Common Brick
Annual Value of Common Brick and Cement Production of California, in Millions of Dollars.
Prices of Common Brick and Cement in Dollars per Thousand and Dollars per Barrel.
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TABLE No. 2.

Brick and Hollow Tile Production for 1926, by Counties.

(From Bulletin No. 100, p. 70, 1927.)

			Glazed, pressed,	Hollow building	

TABLE No. 3.

Common Brick Production of California, by Years.*

Year	Production M	Value	Av. value per M
1896	74,240	$391,567	$6.11
1897	88,890	509,955	5.74
1898	108,076	598,823	5.54
1899	129,512	800,210	6.18
1900	119,906	698,583	5.83
1901	146,522	943,250	6.44
1902	181,040	1,291,941	7.14
1903	217,715	1,600,882	7.35
1904	256,898	1,843,936	7.18
1905	284,205	1,961,909	6.90
1906	278,780	1,962,866	7.05
1907	339,439	2,483,062	7.32
1908	236,383	1,593,814	6.74
1909	276,396	1,749,209	6.33
1910	280,265	1,694,312	6.05
1911	282,199	1,716,442	6.08
1912	349,797	2,198,303	6.28
1913	295,729	1,699,426	5.75
1914	221,243	1,356,885	6.13
1915	160,452	981,888	6.12
1916	168,826	1,107,940	6.56
1917	169,015	1,207,765	7.14
1918	96,732	912,205	9.43
1919	126,892	1,545,558	12.18
1920	163,782	2,823,304	17.24
1921	202,417	2,880,124	14.21
1922	323,625	4,363,629	13.48
1923	397,754	5,194,527	13.03
1924	335,203	4,124,385	12.30
1925	297,449	3,317,766	11.12
1926	328,664	3,231,597	9.82

* Data prior to 1920 from U. S. Geol. Surv. Min. Res., since 1920 from Cal. State Min. Bureau reports.

TABLE No. 4.

Production of Pottery Clay in California in 1926.

(From State Div. Mines and Mg. Bulletin No. 100, p. 97, 1927.)

County	Tons	Value	Used in the manufacture of
Alameda	5,870	$7,183	Drain, faience, flood, quarry and roofing tile, sewer pipe.
Amador	97,768	135,767	Architectural terra cotta, fire clay products, chimney and sewer pipe, refractories, drain, floor and roofing tile, and various.
Contra Costa	7,675	5,688	Architectural terra cotta, sewer pipe, faience and drain tile.
Los Angeles	[a]86,767	99,076	Architectural terra cotta, conduit, red earthenware, refractories, drain, faience, floor and roofing tile, chimney and sewer pipe, and oil well mudding.
Monterey	491	1,164	Floor and roofing tile.
Orange	13,150	38,989	Conduit pipe and stoneware, refractories, drain and roofing tile, and various.
Placer	104,250	147,241	Architectural terra cotta, chimney, sewer and conduit pipe, drain,, floor and roofing tile, sanitary ware, red earthenware, and various.
Riverside	58,528	178,383	Conduit and sewer pipe, red earthenware, refractories, roofing tile, and various.
Sacramento	1,548	2,310	Crushed brick, faience tile, et al.
San Bernardino	[b]2,268	10,605	Porcelain.
San Diego	[cd]30,187	58,269	Therapeutic clay, sewer pipe, faience, floor and roofing tile, and various.
Santa Barbara	1,100	1,700	Drain, floor and roofing tile.
Ventura	[a]373,000	93,250	Oil-well drilling mud.
Butte, Calaveras, Humboldt, Merced, San Luis Obispo, Santa Clara, Sonoma[b]*	18,859	26,884	Earthenware, porcelain, chimney and sewer pipe, drain and roofing tile.
Totals	801,461	$806,509	

* Combined to conceal output of a single operator in each.
[a] Includes clay and shale for oil-well drilling mud.
[b] Includes kaolin.
[c] Includes 'Cornwall' stone.
[d] Includes therapeutic clay.

TABLE No. 5

Pottery Clay Production of California, by Years.

(From State Div. Mines and Mg. Bulletin No. 100, p. 98, 1927.)

Year	Tons	Value	Year	Tons	Value
1887	75,000	$37,500	1907	160,385	$254,454
1888	75,000	37,500	1908	208,042	325,147
1889	75,000	37,500	1909	299,424	465,647
1890	100,000	50,000	1910	249,028	324,099
1891	100,000	50,000	1911	224,756	252,759
1892	100,000	50,000	1912	199,605	215,683
1893	24,856	67,284	1913	231,179	261,273
1894	28,475	35,073	1914	179,948	167,552
1895	37,660	39,685	1915	157,866	133,724
1896	41,907	62,900	1916	134,636	146,538
1897	24,592	30,290	1917	166,298	154,602
1898	28,947	33,747	1918	112,423	166,788
1899	40,600	42,700	1919	135,708	245,019
1900	59,636	60,956	1920	203,997	440,689
1901	55,679	39,144	1921	225,120	362,172
1902	67,933	74,163	1922	277,232	473,184
1903	90,972	99,907	1923	376,863	697,841
1904	84,149	81,952	1924	417,928	651,857
1905	133,805	130,146	1925	537,587	674,376
1906	167,267	162,283	1926	801,461	806,509
Totals				6,710,784	$8,442,643

TABLE No. 6.

Value of Pottery Clay Products Made in California During 1926.

(From State Div. Mines and Mg. Bulletin No. 100, p. 97, 1927.)

Product	Number of producers	Tons	Value
Architectural terra cotta	5	15,954	$2,361,524
Chimney pipe, terra cotta and flue lining	10	13,207	461,786
Drain tile	12	7,178	113,168
Roofing tile	24	73,984	1,917,415
Sewer pipe	10	100,689	2,910,567
Chinaware and semi-vitreous tableware	3	------	627,516
Sanitary ware	6	------	1,894,705
Red earthenware	6	------	198,308
Stoneware and chemical stoneware	6	------	434,772
Floor, faience, mantel, glazed and hand-made tile	27	------	2,867,772
Miscellaneous art pottery, bisque ware, brick dust, calcined clay, ceramic, mosaic wall tiles, conduit, conduit pipe, fire clay products, crushed brick and tile, garden furniture and pottery, high temperature cement, porcelain, gas radiants, and backs, cast stone, ground clay, fire clay and grog, broken tile and various	23	------	837,670
			$14,625,203

TOTAL ANNUAL VALUE OF CLAY PRODUCTS IN CALIFORNIA COMPARED TO THE TOTAL FOR THE UNITED STATES.

The figures of the annual value of clay products, and the number of producers reporting are given in Table 7, for California and for the entire United States during the period from 1896 to 1926, inclusive. The ranking of California among the states, and the production of California as a percentage of the total United States production are also shown in the table. The production figures are plotted on a ratio scale on Plate III. Both the California and the United States curves may be conveniently divided into four time periods: (1) From 1896 to 1907, a period of rapid growth, during which the United States production increased at an average of 8.7 per cent per year, whereas the California production increased at an average of 21.3 per cent per year. (2) From 1907 to 1915, a period of depression following the financial panic of 1907, the effect of which was exaggerated in its influence on the common brick and hollow tile industry of California by the San Francisco earthquake of April, 1906. During this period the average annual production of clay products in the United States remained nearly stationary, while that of California showed an average annual decrease of 5.7 per cent. A contributing factor to this condition, both in California and in the United States at large, was the rapid increase in the use of reinforced concrete, especially in the construction of large buildings in the major cities. (3) From 1915 to 1923, a period of rapid expansion and rising prices, but with a retardation of growth in 1917 and 1918 in the production of certain ceramic branches, such as architectural terra cotta, which were classed as nonessential and were unable to secure sufficient fuel or labor for maximum production, and a further period of retardation in 1921, following the post-war deflation that gained momentum in 1920. The latter effect is not noticed in the ceramic production of California. The average annual increase in the value of ceramic products in the United States during the eight year period was 12.7 per cent compared to 24.6 per cent for California. (4) From 1923 to 1926. The period is too short to permit accurate interpretation of trend, but a slowing down is apparent, both in California and in the United States at large.

The average annual rate of growth of the value of ceramic products in the United States for the entire period of 30 years from 1896 to 1926 was 6.0 per cent, compared to 12.3 per cent for California.

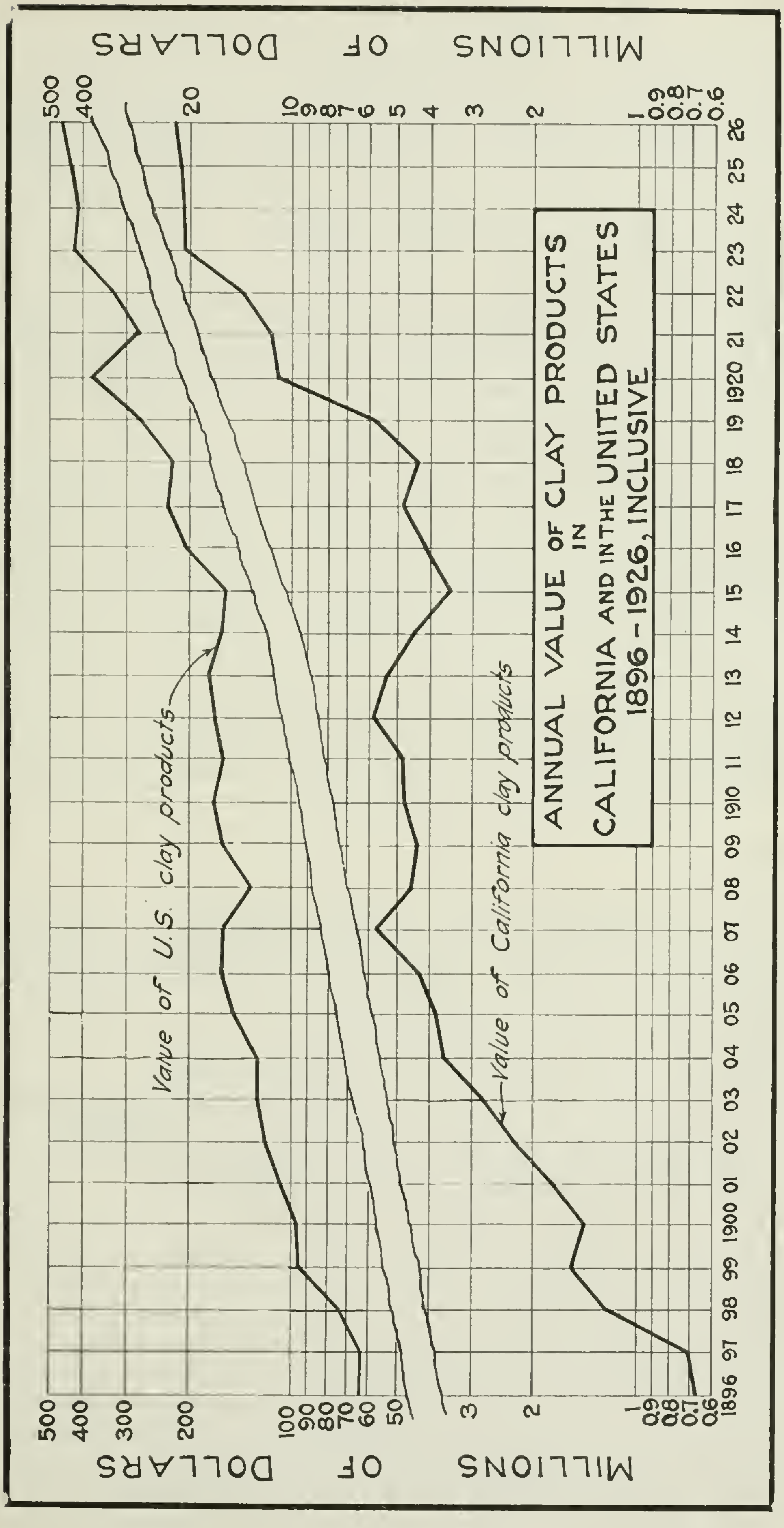
TABLE No. 7.

California and Total United States Production of Ceramic Products from 1896 to 1926.*

	California				United States	
Years	Value	No. of producers	Rank among states	% of total U. S. value	Value	Number of producers
1896	$680,207	91	21	1.08	$63,110,408	6293
1897	703,410	92	21	1.13	62,359,991	5424
1898	1,263,734	77	12	1.70	74,487,680	5971
1899	1,587,518	79	12	1.66	95,797,370	6962
1900	1,375,998	72	14	1.43	96,212,345	6375
1901	1,769,155	92	11	1.61	110,211,587	6421
1902	2,253,096	89	11	1.84	122,169,531	6045
1903	2,831,543	105	9	2.16	131,062,421	6034
1904	3,624,734	121	8	2.77	131,023,248	6108
1905	3,865,147	122	8	2.58	149,697,188	5925
1906	4,364,230	113	8	2.71	161,032,722	5857
1907	5,740,537	118	8	3.61	158,942,369	5536
1908	4,523,745	119	8	3.40	133,197,762	5328
1909	4,437,165	99	9	2.67	166,321,213	5068
1910	4,842,391	107	9	2.85	170,115,974	4915
1911	4,915,866	92	8	3.03	162,236,181	4628
1912	5,912,450	91	8	3.42	172,811,275	4284
1913	5,344,958	91	9	2.95	181,289,132	4065
1914	4,461,661	84	10	2.70	164,986,983	3860
1915	3,599,375	83	10	2.21	163,120,232	3636
1916	4,163,426	79	10	2.01	207,260,091	3412
1917	4,826,125	74	11	2.10	232,512,773	3153
1918	4,329,220	68	11	2.00	221,884,651	2783
1919	5,834,648	66	10	2.10	275,346,378	2776
1920	10,946,423	65	9	2.9	373,670,102	2716
1921	11,172,491	63	8	4.1	270,738,536	2449
1922	14,689,830	62	6	4.6	321,494,403	2098
1923	20,833,053	86	6	4.9	424,582,628	2441
1924	20,994,732	86	6	5.0	415,779,378	2353
1925	21,324,844	99	6	5.0	423,446,917	2417
1926	21,651,327	95	–	4.6	459,049,470	2391

* From U. S. Geol. Survey prior to 1920. Since 1920 from U. S. Bur. Mines, Min. Res.

PLATE III


ANNUAL VALUE OF CLAY PRODUCTS IN CALIFORNIA AND IN THE UNITED STATES 1896-1926, INCLUSIVE
Value of U.S. clay products
Value of California clay products
MILLIONS OF DOLLARS

Chapter III.

CLAY DEPOSITS AND CERAMIC PLANTS BY COUNTIES.

ALAMEDA COUNTY.

General Features.

Alameda County is on the eastern shore of San Francisco Bay and has a land area of 732 square miles, 500 of which are rich agricultural bottom lands devoted to farming and fruit growing. The principal cities are Oakland, Alameda and Berkeley. The population of the county is 344,177 (1920 census).

The county is traversed in a northwesterly and southeasterly direction by several mountain ranges, which together form the eastern group of the Coast Range mountains. These ranges become rugged and reach higher altitudes in the southeastern portion of the county, their continuation into Santa Clara County culminating in the Mount Hamilton range. The mountains consist largely of metamorphic sandstones, jaspers and serpentines of the Franciscan formation, together with sandstones and shales of Cretaceous and Tertiary age.

The mineral resources of Alameda County include asbestos, brick, chromite, clay, coal, limestone, magnesite, manganese, potash, pyrite, salt, soapstone, and crushed rock, sand and gravel. The principal commercial mineral products in the order of their relative importance are: miscellaneous stone, salt, brick and hollow tile.

Clay Resources.

There are excellent deposits of common clay suitable for the manufacture of common brick, hollow tile, and roofing tile at various places in the county, and a number of plants for manufacturing these products are in operation. The best and most extensive common clay deposits occur in the Livermore and Niles valleys.

High-grade clays were at one time mined near Tesla, on the eastern edge of the county, but there is no present production.

On account of favorable manufacturing and marketing conditions, a number of important ceramic plants have been established in the county, especially in Oakland, Alameda, Berkeley, Niles and Livermore, and a wide diversity of ceramic ware is produced.

California Bisque Doll Company. Mrs. H. T. Epperson, manager. Office and plant at 1175 San Pablo Avenue, Berkeley. Formerly the *California China Company.* This plant was built in 1906 for the manufacture of bisque doll heads, but there was no commercial output until 1919. It is said to be the only plant in the United States producing bisque doll heads on a commercial scale. A number of other ceramic products are made, such as salt and pepper shakers, art vases and bowls, and novelties. California raw materials are used whenever possible. The use of Clark and Marsh kaolin from near Calistoga (samples No. 190–192, pp. 261, 280) is of special interest. The clays are prepared by small scale apparatus, and most of the shapes are made by casting.

Firing is done in saggers in a small up-draft kiln, fired to cone 12 for biscuit ware, and to cone 7 to 9 for the glost firing.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 35 (California China Company).

California Faience Company (formerly *The Tile Shop*). C. R. Thomas and W. B. Bragdon, owners and operators, 1335 Hearst Avenue, Berkeley. At this plant, glazed art pottery, art tile, and inserts are made from a red-burning body, the composition of which varies from time to time, depending upon the clays that are available. Shale is purchased from the Richmond Pressed Brick Co. (sample No. 119, p. 325), and clay is sometimes obtained from the Angel Ranch deposit near Eureka (sample No. 181, p. 336).

The clays are prepared by ball-milling, and are pugged by hand. Most of the art pottery is shapped by casting, and the tile and decorative inserts are made by hand pressing in plaster molds. A gas-fired pie-baking oven is used to finish the drying, after air-drying is completed in the shop.

Two kilns are in use. One is a Calkins kiln, and the other is a round down-draft kiln, 13-ft. in diameter and 10-ft. high, with a continuous bag-wall extending nearly to the crown. The biscuit and glaze firing are done together, the kilns being set so that the ware to be biscuited receives the greater heat. Cone 04 is brought down in the biscuit zone of the kilns.

The company has been successful in establishing a small, but high-class market for its ware, and a considerable part of its output is shipped to Eastern points. Special orders are taken for ornamental garden and fountain pieces, as well as for pottery and tile.

Two or three men are employed in addition to the owners.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 37.

California Pottery Company. F. A. Costello, president; J. F. Creegan, secretary. Plant, 2265 East Twelfth Street, Oakland. (The company also operates a plant at Merced, see page 128.) This company was established in 1872. The products made at this factory are vitrified sewer pipe, chimney pipe, flue lining, garden pottery, lead pots for the paint industry, wall and floor tile (faience), roof tile, and stoneware. The clays used are Lincoln No. 1–6 (sample No. 146, p. 303), Ione sand (Shepard) (sample No. 128, p. 261), Valley Springs clay (samples No. 202–204, pp. 299, 337), a surface clay from Niles, similar to that used by the Niles plant of the W. S. Dickey Clay Manufacturing Co. (sample No. 265, p. 343), and some Nigger Hill clay from Calaveras County (sample No. 236, p. 263).

The sewer pipe, chimney pipe, flue lining and garden pottery and tile mixtures are prepared by dry-pan grinding, followed by wet-pan pugging. Sewer pipe is made in the usual presses. Chimney pipe, flue lining, and roofing tile are also made in a sewer-pipe press. Some of the roofing tile are hand finished, giving the appearance of hand-made tile. Floor tile, wall tile, and garden pottery are hand molded. Single-fire glazes are used.

The clay mixture for stoneware is prepared by blunging, filter pressing and pugging, followed by ageing for a suitable period. Most of the stoneware is jiggered.

Drying is done in a steam rack for the tile and stoneware, and other ware is dried on floors heated with waste heat from the kilns.

Eight round down-draft kilns are used, fired with oil, atomized with steam. Two or three are 30-ft., four are 28-ft. and two are 25-ft. in diameter. Stoneware is fired to cone 8 (2400° F. on pyrometer) and other ware is fired to 2100° F. The average firing time is four days, making the total cycle 8 to 9 days per kiln. Sixty men are employed.

In 1927, this company purchased the property formerly operated by the California Pressed Brick Company, and the plant was overhauled and newly equipped for the manufacture of brick and tile.[1]

Bibl: Cal. State Min. Bur., Bull. No. 38, p. 202; Prel. Rept. No. 7, p. 36.

N. Clark and Sons. A. V. Clark, president and general manager; G. D. Clark, secretary. Main office at 112–116 Natoma Street, San Francisco. Plant at Pacific Avenue and Fourth Street, Alameda. This plant has been in operation since 1889. The principal products are architectural terra cotta, sewer pipe, fire brick and face brick.

The company owns or controls deposits of all raw materials used in the body mixes at the plant. Sand and clay from Ione (see under Amador County) and a calcareous shale from a deposit at Walnut Creek (see under Contra Costa County) are the principal materials used.

The fire brick and face brick are made by the stiff-mud process, without repressing. Sewer pipe and terra cotta are made by the usual processes. Sixteen oil-fired round down-draft and muffle kilns are in use.

Part of the plant was destroyed by fire in July, 1917, but was rebuilt in 1919. Another fire occurred on September 16, 1927, which caused a shut-down during reconstruction.

Bibl: State Min. Bur. Bull. 38, p. 202; Prel. Rept. 7, p. 36.

W. S. Dickey Clay Manufacturing Company: N. A. Dickey, manager. Office, 604 Mission Street, San Francisco. Plant No. 18 is one mile west of Niles, and was formerly known as the California Brick Company. Hollow tile and paving brick are manufactured. A Haigh continuous kiln is used for firing. Plant No. 19 is at Livermore, and was formerly known as the Livermore Firebrick Works. Fire brick, fireclay refractories, face brick and sewer brick are manufactured.

The management refused permission to publish data on the two plants, and as much of the data previously published by the Bureau is obsolete, there is no need for repeating it here.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 35 (California Brick Company), and p. 37 (Livermore Firebrick Works).

Electrical Porcelain Works. Levi S. Baker, proprietor; Joseph Baker and Chas. Ball, officials. Office and plant at 2414–16 Sixth Street, Berkeley. Electrical porcelain insulating products are manufactured, using English china and ball clays, Florida kaolin, San Diego County feldspar and silica, and Ione and Lincoln fireclays. The ware is shaped by dry pressing, throwing, turning, machine-pressing, or casting, according to the nature of the shapes to be made. Two oil-fired

[1] Clay-Worker, July, 1927, p. 36.

kilns are used. One is 14 feet in diameter, and the other is 8 by 8 feet square.

Hidecker Tile Company. G. C. Hidecker, manager. The plant is at Twenty-fourth and Union streets, Oakland, and manufactures roofing tile only. Local clay from excavations in Oakland and vicinity is mixed with Lincoln clay (sample No. 147, p. 303) and Natoma clay (samples No. 210 and 212, p. 337). A Williams hammer pulverizer is used to disintegrate the clay, which is then screened through an 8-mesh screen, passed to a pug-mill, and finally to an auger machine, which is equipped with a hand-operated wire-cutter. The tile are dried on pallets in the open air.

Two up-draft oil-fired kilns are used. The larger of these holds 25,000 eighteen-inch tile, and the smaller holds 12,000 tile. The water smoking is done with wood-shavings and requires 24 hours. This is followed by four days firing with oil, to a finishing temperature ranging from 875° to 980° C. Eight to ten men are employed during the operating season of five to eight months.

Kraft Tile Company. A. Clay Myers, president; J. L. Kraft, C. H. Kraft, E. Ridgeway, and H. E. Leash, directors and officers. General office, 55 New Montgomery Street, San Francisco. Plant at Pabrico, two miles west of Niles.

This plant was built in 1926 to manufacture high-fired faience tile, using Lincoln fireclay and Ione sand. Augers are used for shaping the tile. Hot-air driers of the dehydrator type are used for drying. After drying, the tile are carefully trimmed to size in a special machine before applying the glazes. This produces a finished tile that falls within closer limits of size than is customary in most plants. The product is fired in round down-draft kilns. The output of the plant in July, 1927, was 1000 square feet of tile daily.

Miller's Oakland Art Pottery. Mrs. Isabelle Miller Burress, owner. Albert Van Cleve, manager, 2237 East Twelfth Street, Oakland. Sewer pipe, patent chimney pipe, flue lining, and drain tile are made at this plant. Yarn and Harvey clays (samples No. 124 and 133, pp. 298, 302) from M. J. Bacon, Ione, are used, together with excavation debris from Oakland and vicinity.

The clays are prepared in dry and wet pans, and the ware is shaped in steam presses. Drying is done on the floors of the building, without special provision for heating by waste kiln gases.

The firing equipment consists of five oil-fired round down-draft kilns, the largest of which are 22-ft. in diameter and hold 35 tons of ware. The firing schedule varies from 48 to 72 hours, depending on the ware, and the finishing temperature averages 2000° F. (1093° C.) with a maximum of 2100° F. (1149° C.).

Twenty-five men are employed.

Bibl: Cal. State Min. Bur., Bull. No. 38, p. 204 (Oakland Art Pottery).

M & S Tile Company. Owned by F. J. Thomas, G. L. Smith and J. M. Bettencourt. The plant is near the Oakland-Niles highway at Decoto. This plant was established in February, 1926, for the manufacture of hand-made roofing tile. A local surface clay (sample No.

264, p. 343) is used. The clay is similar to that used in the W. S. Dickey Company's hollow tile plant at Niles (sample No. 265, p. 343).

The clay is mined with the aid of a team and scraper. A small power-driven pug-mill prepares the clay for hand-molding. Drying is done on pallets under a shed. A rectangular oil-fired down-draft kiln, having a capacity of 5700 roofing tile, is used for firing. The firing schedule occupies 55 to 60 hours, and the finishing temperature is cone 06 (1005° C.).

Five men were employed at the time of visit, in September, 1926.

Muresque Tiles, Inc. Wm. F. Muir, president and manager; Chas. Orpin, secretary; 1001 Twenty-second Avenue, Oakland. This is a small plant for making hand-pressed floor, wall and mantel tile, and decorative inserts. Lincoln and Ione clays are used, which produce a buff or cream body. Matt glazes are used, which are buffed on a wheel after firing, producing effects similar to the well-known Batchelder tile, made in Los Angeles (see page 97). An oil-fired muffle kiln is used. No further details would be furnished by the company.

Remillard Brick Company. C. Remillard, president; R. C. Giroux, secretary. Office, 332 Phelan Building, San Francisco. The plant is one and one-half miles northeast of Pleasanton, on the main line of the Southern Pacific Railroad. The plant was established in 1889 and has been operated continuously since then. Common red brick are manufactured.

The clay deposit consists of a sandy loam, 25 feet thick, and is mined from a pit one-quarter mile from the plant by a drag-line scraper operated by an electric hoist. The clay is loaded into cars and hauled by motor to the plant. The soft-mud process is used. The brick are dried under sheds in the yard, and are fired in two 16-compartment Hoffman kilns, of 20,000 daily capacity each. Fifty men are employed during the season.

Bibl: Cal. State Min. Bur. Repts. XII, p. 381; XIII, p. 613; Bull. 38, p. 242; and Prel. Rept. No. 7, p. 37.

Technical Porcelain and China Ware Company. J. Pagliero, owner. Office and plant 420 Kains Avenue, Albany, via Berkeley. This is a small plant manufacturing porcelain bath-room fixtures by the casting process from a mixture of California clays. One square up-draft kiln is used for both biscuit and glost firing. Four men are employed.

Tesla: The coal and clay deposits of Eocene (Tejon) age in Corral Hollow, near Telsa, and extending for a short distance eastward into San Joaquin County, have been known since 1862. These deposits have been worked at various times in the past, notably during the period from 1897 to 1907. The coal was inferior in quality, and was costly to extract on account of steep dip and swelling ground. As late as 1919 an attempt was made to reopen the coal mine, at which time the property was purchased by the Beckman-Linden Engineering Corporation of San Francisco, and considerable sums of money were expended on equipment and development before it was clearly demonstrated that commercial success could not be expected under prevailing conditions. The principal activities in the past have centered around the Tesla

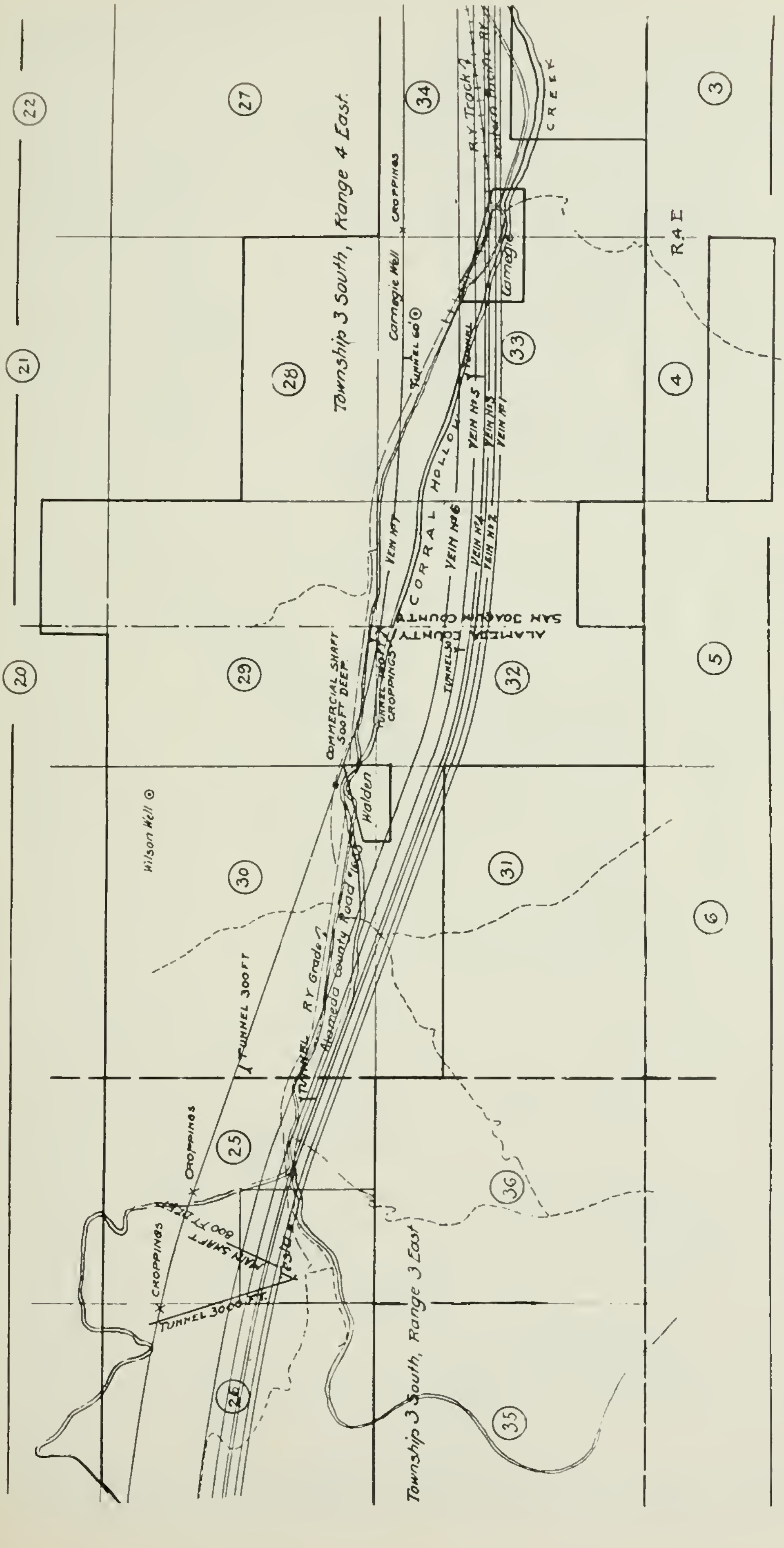


PLATE IV. Map of Tesla district, Alameda County. (Map by Beckman and Linden Engineering Corporation, October, 1919.)

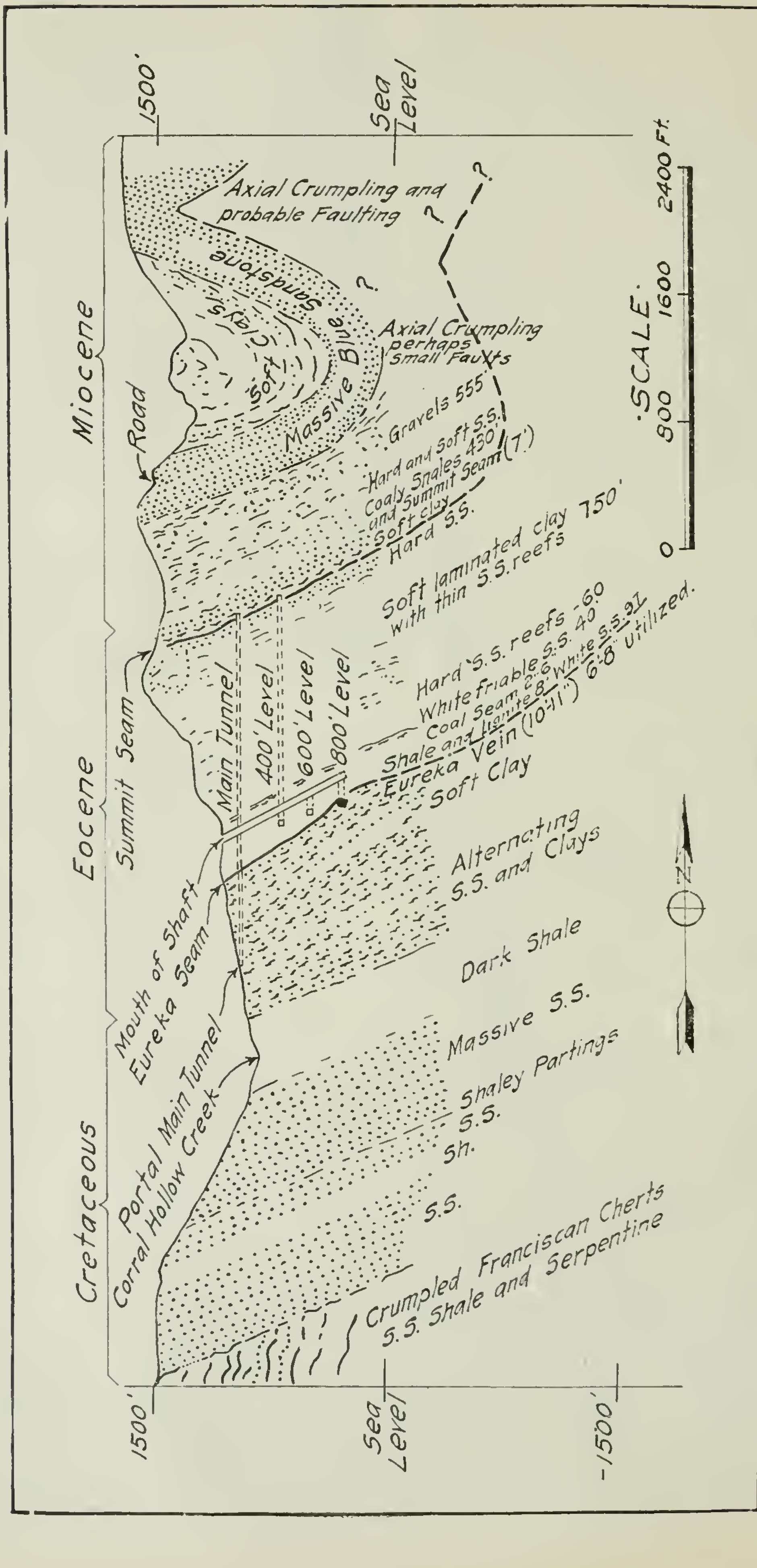


Plate V. Geologic section through main Tesla shaft. Details generalized. (Map by Beckman and Linden Engineering Corporation, October, 1919.)

mine, in the SE½ of Sec. 26, T. 3 S., R. 3 E., M. D. M., which followed what is known as the Eureka coal seam to a depth of 800 feet. Some work was also done on the Summit seam. See Plate IV for a surface map of the district, and Plate V for a geologic cross-section. In developing the coal deposits, extensive beds of clay were found. The clays were of various grades, ranging from high-grade plastic fireclay to red-burning sewer pipe and paving-brick clays and shales. Considerable quantities of high-grade quartz sand were also discovered. Two clay-working plants were established in the district, using clays that were obtained from the coal mine, and from tunnels and open-cuts nearby. The Carnegie Brick and Pottery Company produced sewer pipe in an 8-kiln plant in the S½ of Sec. 30, T. 3 S., R. 4 E., M. D. M., two miles east of Tesla, and also had a 45-kiln plant for producing fire brick, face brick, and terra cotta at Carnegie, four miles east of Tesla. These operations were discontinued in 1912, some years after the cessation of coal mining operations, as it was not possible to obtain an adequate supply of suitable clays from the workings near the surface after the coal mine was abandoned.

The district must still be considered as an important potential source of high-grade fireclays, as there seems little doubt that extensive prospecting would demonstrate the presence of many millions of tons of fireclay that would be equal, if not better, in quality to any refractory clays now being mined in California. There is little justification at present, however, for attempting to rejuvenate clay mining in the district, as the fireclay deposits at Ione, Amador County, and at Lincoln, Placer County, are adequate in quality and quantity for present needs, and are cheaply mined, mainly from surface workings, whereas underground mining under difficult conditions would be necessary if extensive operations were to be carried on at Tesla.

Ryan Ranch Deposit: Owned by Wm. Ryan, Livermore. In 1926 and 1927 a small open pit (see photo No. 2) was excavated on an outcrop of fireclay alongside the Livermore-Tesla road in the NW¼ of Sec. 26, T. 3 S., R. 3 E., M. D. M. The workings exposed a bed of white plastic clay 6 to 8 feet thick, underlain by white sandstone, and overlain by lignitic shale. The strike of the beds is nearly east-west, and the dip is about 65° north. Sample No. 259 was taken, and the test results on page 263 show it to be an exceptionally good grade of fireclay, that burns nearly white. The deposit is apparently a small remnant of Eocene enclosed in Miocene rocks, and there is little evidence of the continuity of the Eocene at this point.

Walrich Pottery. J. A. Wall, owner, 1285 Hearst Avenue, Berkeley. Art ware, porcelain specialties, decorative and mantel tile are made at this plant from a white semi-porcelain body, composed of Illinois silica, California (Campo) feldspar, English china and English ball clay. Translucent glazes are used, in a wide range of colors.

Most of the shapes are cast, although a few are hand pressed. A Calkins kiln, 20 in. by 36 in. by 20 in., heated with oil, is used for firing the ware. The biscuit ware is fired at cone 4, and the glost firing is at cone 1.

Westinghouse Electric and Manufacturing Company. J. W. Ryan, manager; G. M. Whisler, assistant manager; 6121 Green Street, Emeryville. This is a branch factory of the parent organization of Pennsylvania. It is devoted exclusively to the manufacture of high-voltage porcelain insulators and is the only plant of its kind in California. The raw materials used are Campo (California) feldspar, Ottawa (Illi-

PHOTO No. 2. Ryan Ranch clay deposit, near Tesla, Alameda County. (Sample No. 259.)

nois) flint, Kentucky ball clay, Georgia china clay, Ione and Lincoln (California) sagger clays.

The feldspar and flint are ground in a ball mill for two hours after which they are mixed with the blunged clays. From the blunger the slip flows successively through an agitator, 200 mesh screens, magnetic separator, agitator and then is pumped into a filter press where the

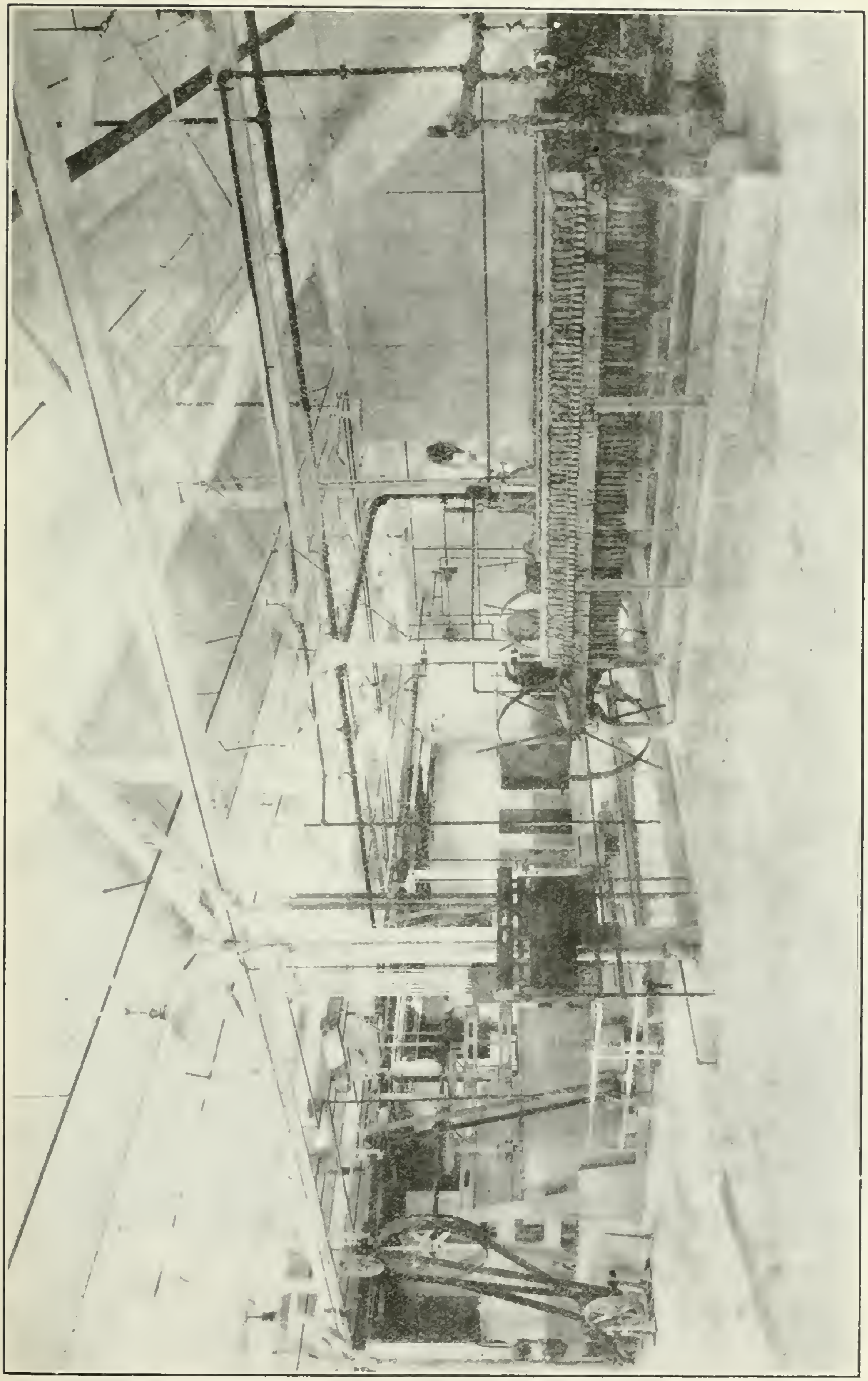


PHOTO No. 3. Filter-Press Room. Westinghouse Electric and Manufacturing Co., Emeryville, Alameda County.

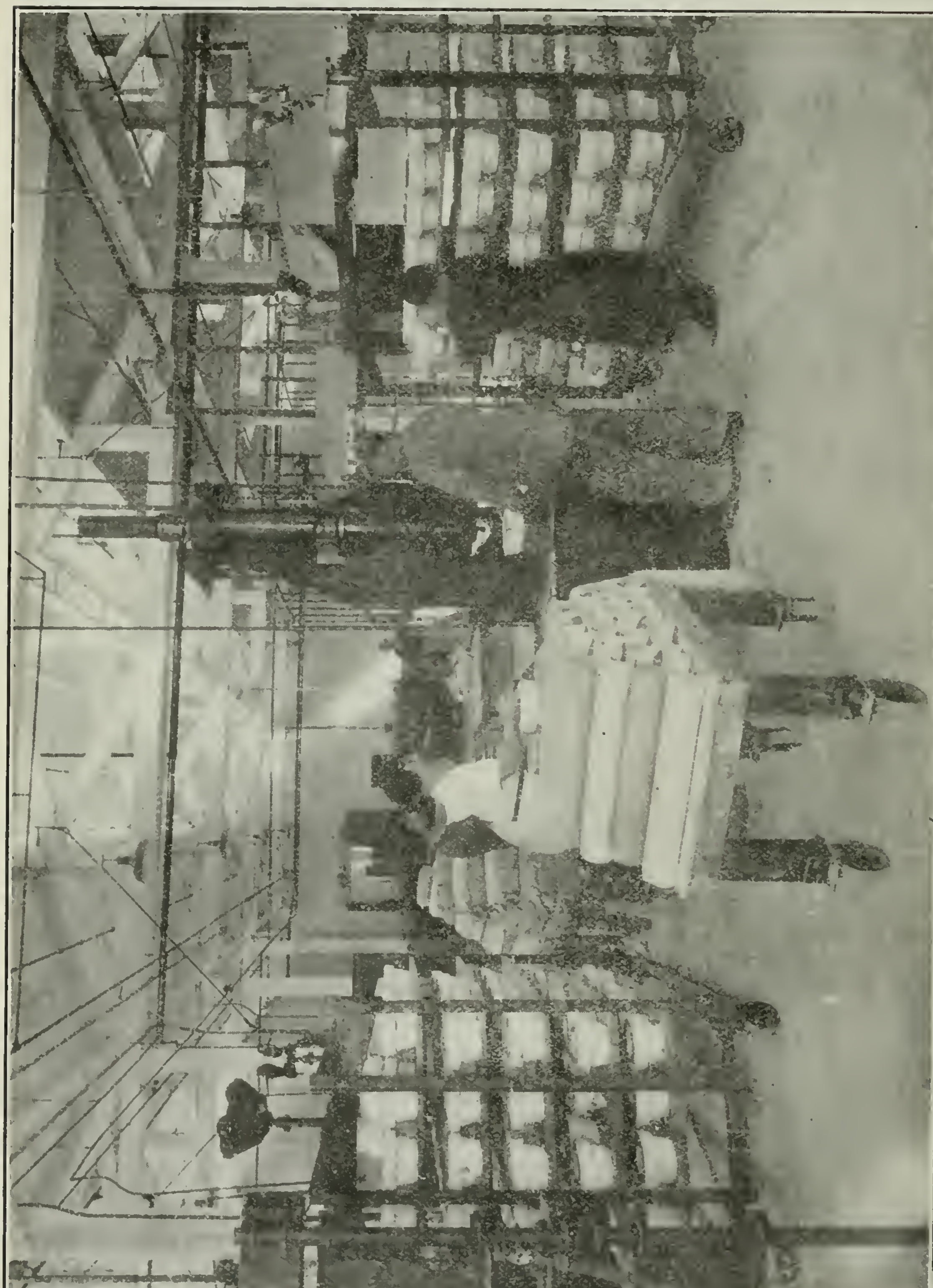


PHOTO No. 4. Hot-Pressing Room. Westinghouse Electric and Manufacturing Co., Emeryville, Alameda County.

excess water is removed. The filter press cakes are pugged and then stored in concrete cellars for about three weeks. The filter press room is shown on photo No. 3.

Before using, the clay is again pugged to the best size for the insulator being made. The pugs of clay are cut to correct length and shaped roughly by hand prior to placing in the plaster of paris mold which gives it the outer shape. The inside shape is made by the modern hot press method. A portion of the hot press room is shown on photo No. 4.

From the hot press, the mold and insulator go through a continuous-mold release dryer after which the insulator is easily removed from the mold. The next operation is trimming the surface next to the mold to include tie wire grooves, and improve the surface condition of the insulator.

Trimming is followed by the final drying in a tunnel-type humidity dryer which operates on a 60-hour schedule. After drying, an Albany slip glaze is applied and the insulators are ready for firing. Special colors can also be supplied for indicating phase, voltage, etc. These are white, blue, green, chocolate, black, etc.

For firing the insulators are placed in saggers which in turn are placed in one of four draft kilns. Each kiln is 16 feet in diameter and 12 feet high to the crown and the average burn is 800,000 cubic inches of ware. The firing is done with gas for the first few hours after which oil is used for the 60 hr. period. The temperature is controlled by means of recording pyrometers and pyrometric cones. The finishing temperature is cone 10 down (approximately 1260 degrees C.). The cooling period is about three days.

An average of sixty-five men are employed in this plant.

Woolenius Tiles. C. A. Elsenius, owner and manager, 1631 Woolsey Street, Berkeley. This is a small plant engaged in the manufacture of decorative tile, inserts, and mantel pieces, using a fireclay body made from Lincoln clay (sample No. 146, p. 303) and Shepard (Ione) sand (sample No. 128, p. 261). The clays are pulverized to 50-mesh, pugged, and regular shapes are made in a tile auger. Special designs are hand pressed. A thin matt glaze is fired on with the body, and is afterwards partly removed by buffing on a wheel. A rectangular down-draft kiln, heated with oil, is used for firing. The finishing temperature is from cone 5 to cone 7.

One or two men are employed besides the owner.

Bibl (Clay Resources of Alameda County): State Mineralogist's Repts. X, p. 91; XII, p. 39; XIII, p. 51; XIV, p. 607. Cal. State Min. Bur. Bulletin No. 38, pp. 202, 204–206, and 227; Prel. Rept. No. 7, pp. 35–37, 94. U. S. G. S. 22d Ann. Rept., Pt. III, pp. 501–504.

AMADOR COUNTY.

General Features.

Amador County lies to the east of the Sacramento Valley and extends from the lower foothills to the summit of the Sierra Nevada. It traverses the center of the famous Mother Lode gold belt, and is similar to El Dorado, Calaveras, Tuolumne and Mariposa counties in climate, physiography, geology and natural resources. Amador is the smallest county of the group, and contains 601 square miles. The population is about 8000. Gold and clay mining and stock raising are the principal industries. The county is well provided with good roads, connecting the principal towns with each other, and with the Sacramento Valley. A branch of the Southern Pacific Railroad extends from Galt to Ione, where it connects with the Amador Central, running to Martel and serving the gold mines in the vicinity of Jackson and Sutter Creek, the principal towns in the county. There is timber suitable for underground mining in the mountains. Electric power is supplied to most of the towns in the county by the Pacific Gas and Electric Company, and water is supplied by this company to the Mother Lode section of the county.

The geology and mineral resources of the county have recently been summarized by Logan:[1]

"White clay forms a conspicuous part of the Ione (Tertiary) beds, which extend across the entire west side of the county from north to south. This and other colored clays nearby form the basis of an important industry, supplying potteries in various parts of the state.

"Also associated with the Ione beds and usually within 100 feet or less of the surface, near Carbondale, Ione, Buena Vista and Lancha Plana, occur numerous deposits of brown lignite. This was mined at several places until a few years ago. . . .

"Farther east, alternating beds of Mariposa (Jurassic) black slate, amphibolite schist, serpentine and Calaveras (Carboniferous) rocks extend northwest, parallel to the axis of the mountain range of which they form the flank. In the amiphbolite schist numerous copper mines and prospects occur, but are all idle now. Chromite occurs in the serpentine, and many small lenses of limestone in the Carboniferous rocks. These formations begin about a mile east of Ione and extend for seven miles eastward, where the Mother Lode mines occur, in another belt of black Mariposa slate. This slate enters the county at Middle Bar bridge on Mokelumne River, running thence northwest through and beyond the county. With an average width of about one-half mile, and in many of the mine workings narrowing to only a few hundred feet, this slate belt and the immediately adjoining and at times intercalated areas of altered igneous rocks contain all the important gold quartz mines of the county.

"To the east of the Mother Lode the rocks are nearly all of Carboniferous age for a distance of ten miles, until an elevation of about 3000 feet is reached, where the granodiorite forming the core of the mountains appears. At Oleta in the northern part of the county and at Volcano much placer gold has been produced. A series of detached gravel bodies covered by rhyolite and andesite extends across the county between these two old camps. The gravel in this region represents remnants of Tertiary river deposits. In the western part of the county, near Ione, are accumulations of delta and shore gravel, deposited when the inland sea or gulf had its shores in that vicinity, during the time of the Ione disposition, which was at the same time as the formation of prevolcanic channels in the rivers of the Sierra Nevada. In places where it has been reconcentrated by later streams some of it has been rich enough to mine profitably. There are also beds of white and red sandstone in the Ione formations, which have been worked in the past. Marble occurs two miles east of Plymouth and eight miles east of Sutter Creek, enclosed in the Calaveras formation. Besides the numerous small bodies of limestone, there are two especially large areas, one at Volcano and one four miles northwest of that town. Asbestos, talc, ocher and low-grade iron ores also occur."

Clay Resources.[2]

The Ione-Carbondale district is noted for its high-grade fire clays and fire sands. Associated with the high-grade clays and sands are a number of important red-burning plastic clays. A fire brick plant has been in operation near Ione for many years. An experimental clay washing plant was operated a number of years ago on the N. Clark and Sons property near Carbondale (see Plate VI), and another washing plant was operated near Ione by the Philadelphia Quartz Company. Both of these operations were abandoned prior to 1921, but in February, 1927, a new plant was erected on the Carlile property by E. E. Tremain, lessee.

[1] Logan, C. A., Amador County; State Mineralogist's Report XXIII, p. 132, April, 1927.

[2] The report by Logan, *op. cit.*, was freely drawn upon in the preparation of this summary.

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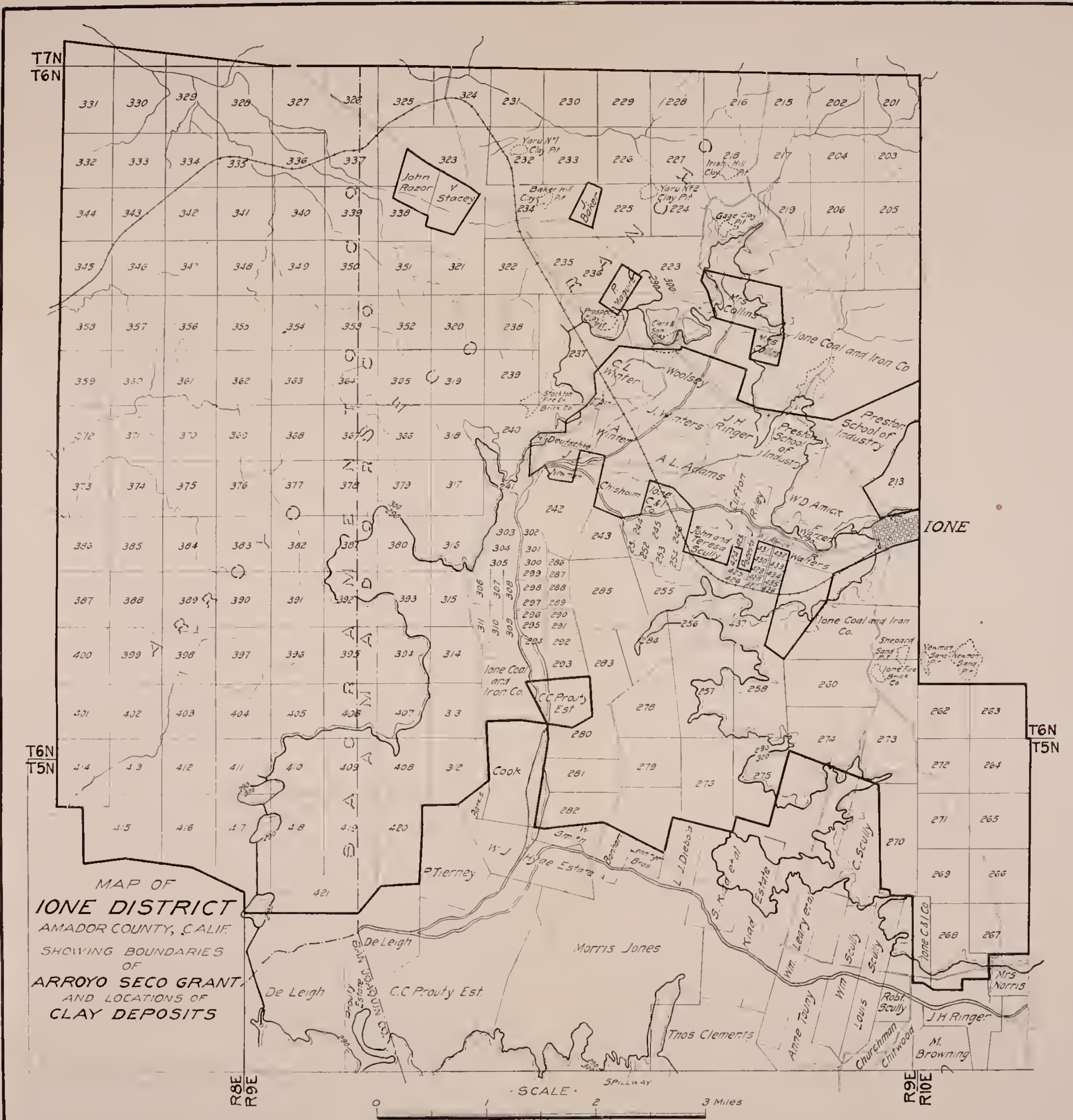

PLATE VI. Property map of Ione district. (By courtesy of S. E. Kieffer.)

Enough information has been obtained from these various washing operations to demonstrate the fact that it is possible to produce a quartz sand suitable for the manufacture of glass and sodium silicate, and for use as "flint" in porcelain bodies. The kaolin content of the sands is seldom in excess of 25%, and generally contains enough iron oxide to cause it to fire to a light-cream color, although in places it is sufficiently pure to fire to a satisfactory white color for use in white-ware bodies. Several factors adversely affect the establishment of a financially-sound washing operation in the district, among which may be mentioned the comparatively high freight rate to producing centers, the low cost of Belgian sand, which is delivered to California ports at a price of about $5 per ton, the low content of high-grade kaolin in most of the sands, and the fact that few important plants now using English or Florida kaolin would be willing to change to the use of local material unless assured of an ample supply of uniformly high-grade kaolin over a long period of years.

A new use for Ione sand is in making white cement. One large company has recently bought a sand property, and it is anticipated that others will follow.

The clays occur as a part of the Ione formation and are distributed over a length of 12 miles and a width of 4½ miles in the county, with extensions into Sacramento County on the northwest and into Calaveras County on the southeast. In most places the clays are covered by an overburden of soil, sand, tuff, volcanic breccia, and sandstone, varying from a few inches to a maximum of 20 feet over most of the deposits now being worked. The clay beds have a slight westerly dip. Lignite coal, interbedded with clay, is found at depths of 40 to 125 feet. The clay beds are not continuous, and the extreme limits of the probable boundaries of the deposits have not been determined, but enough mining and drill prospecting has been done to demonstrate the fact that there is an ample supply of clay for many years.

The contemporary theory of the origin of the clays has been well summarized by Logan.[1]

"The white clay apparently came from the rhyolite ash flows, which have been found directly over the older series of gold-bearing gravel channels in the Sierra Nevada. Probably a long enough period of erosion ensued after these initial ash outbursts to permit the carrying of the finer sized and lighter particles down the streams into the shore waters of the inland sea which then filled the Sacramento and San Joaquin valleys. Before the white ash was covered and preserved by later flows of darker colored breccia and ash, a large part of it was thus swept away.

"That the clay is of rhyolitic origin, possibly mixed with the quartz sand from those mysterious earlier rivers whose remaining sections now show such a remarkable amount of quartz cobbles, with scarcely any other rock, is substantiated by the analyses. The sandy clay carries about 70% silica, 20% alumina, 1.25% iron oxides, 0.3% CaO, and 0.2% MgO. Other samples where the percentage of silica is less, contain 32% to 34% dry weight of alumina. The amount of calcium is typically low and it is erratically distributed, sometimes as gypsum seams. As the percentage of iron increases the clay becomes mottled red and yellow, but the usual color is white, cream or light blue."

Arroyo Seco Grant.

Introduction.

The greater part of the Ione clay deposits lie within the boundaries of the Rancho Arroyo Seco, which was formerly owned by the McKissick Cattle Company, who leased many of the clay deposits to Bacon & Bacon (see *post*) and other operators in the district. In 1926 the grant was purchased by S. E. Kieffer, 57 Post Street, San Francisco,

[1] *Op. cit.*, p. 135.

who then leased the clay properties to G. A. Starkweather. Mr. Starkweather is operating some of the properties, but has subleased a number of them to various operators. A map of the grant, and of the surrounding property, showing the location of the principal clay deposits, is shown on plate VI.

Core Drilling.

During the seasons of 1925 and 1926, a large amount of core drilling was done in the Ione district under the direction of Mr. S. E. Kieffer, consulting engineer. Many of these holes penetrated the sand, clay and coal beds to depths of 150 feet or more. Through the courtesy of Mr. Kieffer, a number of core-drill clay samples were obtained for testing. The location of the holes from which these samples were taken is shown on the map, plate VI, and the approximate depth of the samples from the surface, as well as the approximate thickness of each formation, are given in table No. 8.

TABLE NO. 8.

Description of Core Drill Samples from Ione District.

Sample No.	Drill hole No.	Location of hole	Depth of top of sample from surface, feet	Thickness of formation, feet	General character of material
239	--	NE. cor Lot 254	37	25	Fire sand
240	--	E. side Lot 237	--	100(?)	Plastic fireclay
243	47	Lot 336	230	16	Sandy clay, poor quality
244	54	Lot 324	13	19	Plastic fireclay
245	55— 1	Lot 237	32	41	Plastic fireclay
247	55— 2	Lot 237	73	18	Plastic fireclay
246	55— 3	Lot 237	93	16	Plastic fireclay
248	56— 1	Lot 237	4	24	Plastic fireclay
249	56— 2	Lot 237	44	36	Plastic fireclay
250	56— 3	Lot 237	80	30	Plastic fireclay
251	57— 1	Lot 237	3	9	Plastic red-burning
252	57— 2	Lot 237	12	10	Plastic fireclay
253	57— 3	Lot 237	22	20	Pl. fireclay, nearly white
254	57— 4	Lot 237	42	26	Buff plastic fireclay
255	57— 5	Lot 237	68	46	Red plastic, cone 26
256	60	Lot 255	(near bottom)	—	Red plastic, cone 19–20
257	62	Lot 255	66	6	Pl. fireclay, nearly white
258	61	Lot 255	75(?)	10(?)	Buff plastic fireclay

It is not possible from the data available to establish continuity of the various beds of clay and sand represented by the core drill samples, but the presence of large reserves of high-grade clays is well demonstrated. Most of these clays, however, can not be mined under present conditions while large deposits of good material are still available for open-pit mining.

Active Deposits.

Gage Pit. The Gage pit, leased and operated by G. A. Starkweather, is in Lot 224 of the Arroyo Seco grant, two miles east of Lignite siding on the Southern Pacific Railroad northeast of Ione. The clay is dazzling white in color, slightly plastic, and has a talcy feel. It has been used by the West Coast Calcimine Co. The pit at the time of visit, in August, 1925, was 100 feet wide at the face, which had advanced 120 feet from the approach. The exposed clay bank was 12 feet thick. Mr. Bacon stated that the total average thickness of this clay is 16 feet. The clay is capped by less than three feet of volcanic breccia.

A view of this pit, looking eastward, is shown on photo No. 5. Sample No. 125 was taken for test, the results of which are given on page 273. The usual annual production is 600 tons, all mined and loaded by hand and hauled in auto trucks to Lignite.

Jones Butte Deposit. The Jones Butte clay mine, sub-leased from Mr. Starkweather and operated by the Stockton Fire Brick Co., is in Lot 240 of the Arroyo Seco grant, on the western slope of Jones Butte, also known to local inhabitants as Deutschke Hill. The mine is 1.5 miles by road from Edgar siding, on the Southern Pacific Railroad, two miles northwest from Ione.

A geological study of the deposit was made by C. N. Schuette, at one time in the employ of the Stockton company as a geologist and

PHOTO No. 5. Gage clay pit, near Lignite, looking eastward. (Sample No. 125.)

engineer. The successive formations, from the top of the hill downward, are lava, tuff, gravel, clay, and lateritic iron. The clay bed is lens shaped in the north-south section of the hill, and wedge shaped in the east-west section, thinning toward the east. The clay in the mining area covered by operations in August, 1925, was 8 to 10 feet thick and there was an additional 2-foot bed of extremely 'fat' or 'unctuous' clay in the roof. The floor has a general pitch toward the south, and mining is complicated by the presence of sharp rolls in the floor in places. The floor is generally red lateritic iron, but in places this is covered by a variable thickness of yellow plastic clay.

The mine is worked entirely by underground methods. The general plan, modified by local irregularities, is to run drifts in a general easterly direction on a slightly ascending grade on approximately 20-foot centers. The drifts are as small as is consistent with efficient driving and tramming, usually five by seven feet. Upon reaching the limit of the block to be mined, or the limit of workable thickness, the retreat is made by slabbing to the roof and slicing a five cut from each side of the drift, leaving a pillar approximately 5 feet in width to support the rooms while the retreat is in progress. The minimum extraction of clay in the minable area is thus 75% of the total. Where the roof is strong enough, the extraction can be increased by further pillar robbing.

At the working faces, mine cars are loaded by hand shoveling, and are trammed by hand for a minimum distance of 400 feet to a bin near the portal of the tunnel. From here the clay is drawn off into an auto truck for transportation to the car-loading bin at Edgar.

The mine is normally operated on a production schedule of four cars (total 200 tons) per week for a period of four months, or somewhat in excess of 3000 tons of clay per year. The number of men employed, including a foreman and a truck driver, is five.

Three samples were taken. No. 120 is the main 'Edwin' clay. The test results, page 272, indicate that it is one of the best plastic fire-

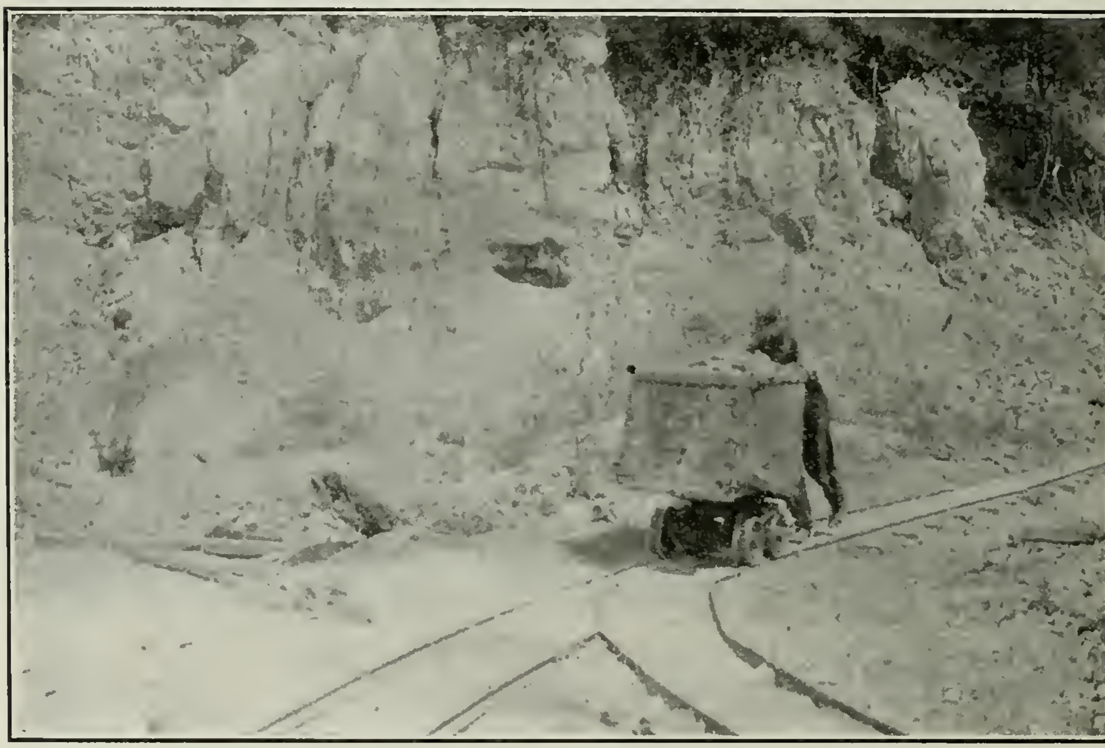

PHOTO No. 6. Jones Butte Mine, Arroyo Seco Rancho, facing eastward toward portal of tunnel. (Samples No. 120, 121 and 122.)

clays in California, but shows the high shrinkage and fire cracking typical of the Ione clays. Sample No. 121 is the 'unctuous' clay occurring in the roof of the mine. It was taken, and the test work done (see page 302), as a matter of general interest, although the known thickness of the bed is insufficient for commercial production. Sample No. 122 is the 'Laterite,' which has no present commercial value, but is considered of sufficient interest to warrant a record of its properties, which is given on page 328.

A view of the property near the portal of the tunnel is shown on photo No. 6.

Shepard Pit (leased by G. A. Starkweather). The Shepard sand pit is ¾ mile from Ione at Shepard spur on the Amador Central Railroad. The eastern boundary of the property adjoins the western boundary of the Newman sand pit. A view of the pit is shown on photo No. 8, from which the extent of open pit mining and the present method of underground mining by pillar and room can be seen. The sand has an average thickness of 16 feet. The capping of volcanic breccia

PHOTO No. 7. Barber or Shepard sand pit one mile east of Ione.

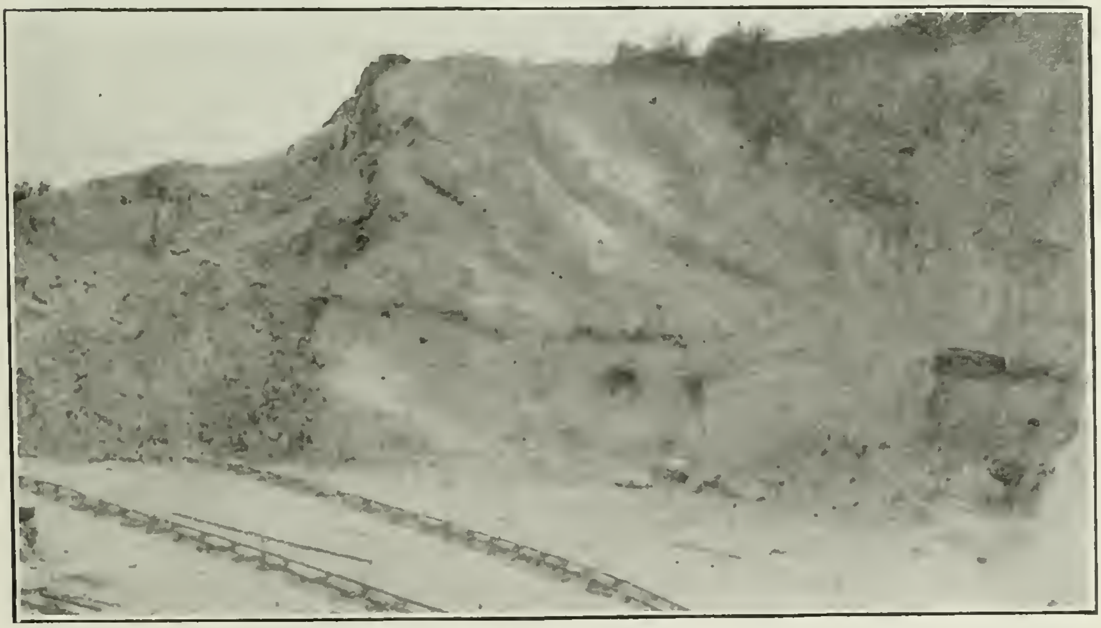

PHOTO No. 8. Sand pit subleased by the Ione Fire Brick Co. (Sample No. 140.)

is sufficiently strong so that rooms can be driven into the deposit nearly to the full height of the sand bed, and wide enough to permit the entrance of auto trucks to the loading face. Round pillars of sand are left at approximately 25 foot intersections, to support the back. The sand has been mined in this fashion over a considerable area. See photo No. 7.

Sample No. 128 was taken for test, the results of which are given on page 261. The sand is fine grained, nearly white, and contains enough clay to develop slight plasticity and bonding power. It is widely used by fire brick and terra cotta manufacturers as a fine grog. The normal output from the Shepard pit is 15,000 tons per year. At the present rate of mining, the reserve of sand in sight is sufficient for many years, although mining costs will be higher as mining proceeds farther from the openings into the rooms.

Photo No. 8 shows a nearby sand pit, subleased by the Ione Fire Brick Co., from which sample No. 140 was taken. See page 280.

Yaru Deposit. The Yaru clay pit, leased and operated by G. A. Starkweather, is located on lot 232 of the Arroyo Seco grant, 100 yards north of a siding at Lignite on the Southern Pacific Railroad, four miles northwest of Ione.

Photo No. 9 is a view of this pit. The overburden is less than three

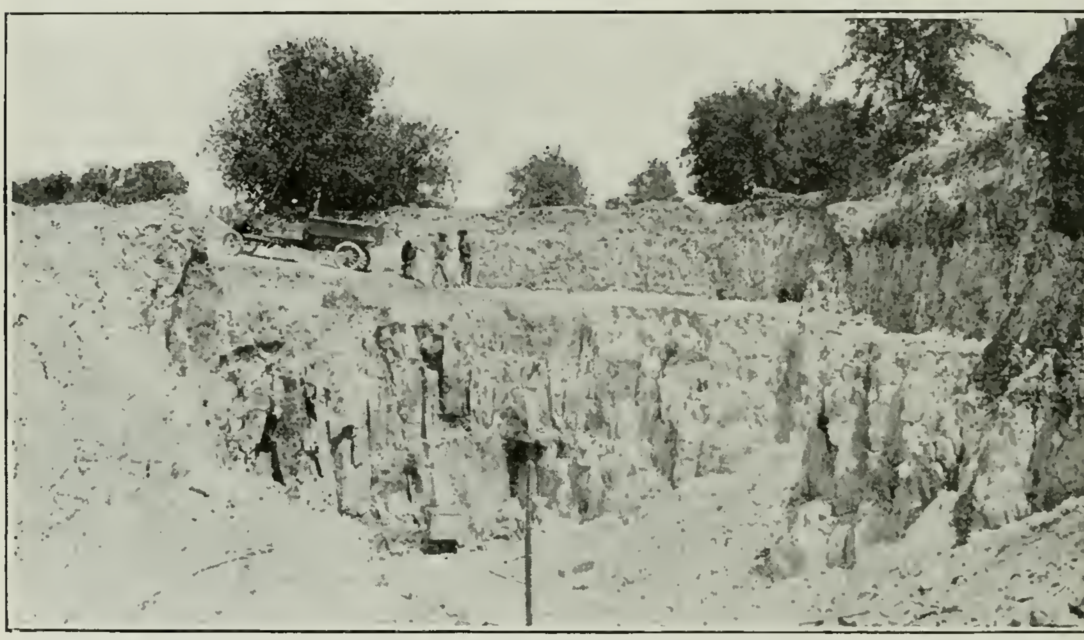

PHOTO No. 9. Yaru clay pit, Ione. (Samples No. 123, 124.)

feet in thickness. The upper bed (sample No. 123, p. 335), clearly shown in the photograph, is designated Yaru No. 2. It is a yellowish and blue-gray plastic fire clay 6 feet thick. The lower bed (sample No. 124, p. 302), is known as Yaru No. 1, and is somewhat lighter in color, but contains yellowish streaks along fracture planes, and occasional nodules of iron-stained sand. A car hoist is used to elevate the clay from the bottom of the pit to a hopper on the surface where it is dumped into a truck for the short haul to the railroad siding. The thickness of Yaru No. 1 exposed by mining operations is 25 to 30 feet. Borings in this clay are said to indicate a total thickness of 90 feet, but streaks of sand are encountered in places.

Total shipments of Yaru No. 1 and No. 2 are normally 4000 tons per year.

MISCELLANEOUS OPERATIONS.

Bacon & Bacon. Mark J. Bacon, manager, Ione. This firm is engaged in a general clay-mining business, working some properties for the owners under contract and also shipping to numerous consumers from pits which they own or lease. Twenty-five men, two steam shovels and six trucks are employed during the operating season from early in April to the end of the dry season.

Two of the properties owned by Bacon and Bacon are here described, the Bacon Red (Lane mottled) and the Chocolate pits.

BACON RED: This is on an 80-acre tract, comprising the NW¼ of Sec. 32, T. 6 N., R. 10 E., M. D. M., near the intersection of the Jackson highway and the Amador Central Railroad, 1.8 miles southeast of Ione. The clay is a fine-grained plastic, red-white mottled clay (sample No. 127, p. 335), and is quite characteristic of the region. It is mined from an open pit, 150 feet long at the face. In 1925 the pit had advanced 60 feet in from the starting point, and the exposed clay bank was 15 feet high, covered by shallow overburden of loose gravel. The overburden will gradually increase as the clay is followed into the hill, but the maximum thickness of overburden will probably not be excessive, as the hill is low, and has a gentle slope. The clay is evidently not bottomed by the floor of the pit, and it is stated that the total thickness of clay, as determined by boring, is nearly 40 feet.

The normal production from this pit is 1000 tons per year, all mined by hand. There is no siding at the pit, the clay being hauled in trucks to one of the loading platforms maintained by Mr. Bacon.

CHOCOLATE PIT: The chocolate pit is 3 miles north of Carbondale. Two varieties of clay are mined from this pit. The upper bed, 4 to 5 feet thick, is a chocolate-colored plastic clay (sample No. 137, p. 266) of special value in the manufacture of saggers. This is underlain by the Bacon bottom (sample No. 138, p. 280), a 4–5 foot bed of white-burning plastic clay occasionally used in sanitary ware bodies. The overburden is less than four feet thick, so that these clays can readily be quarried.

The production from this pit has been small, mainly on account of the length of haul compared to other varieties that have nearly the same properties. About 500 tons of chocolate and 100 tons of Bacon bottom are mined each year. The pit was 150 ft. long, and 40 ft. wide at the time of the visit in July, 1925.

Carlile Clay and Sand Deposit.[1] Mrs. Sarah E. Carlile, Ione, owner; E. E. Tremain, Buena Vista, via R. F. D., Ione, lessee. The property contains 60 acres on W½ NW¼ Sec. 8, T. 5 N., R. 10 E., M. D. M., four miles from Ione and 2.8 miles by road to the nearest railroad spur. The property was not worked prior to 1927.

In February, 1927, a plant was being erected to wash the sand and clay. A bed of white sandy clay, overlain by two to seven feet of brown clay, had been stripped over an area about 80 feet square. According to present plans, the clay will be dug by drag-line scraper. The washing and settling plant comprises several hundred feet of sluices with sand traps and eight large clay-settling tanks. The sand is expected to settle out on the way through the sluices and traps, leaving the clay in suspension, free from grit, to pass to the settling tanks, from which it will be drawn, after which it will be filtered and dried.

[1] Entire description by C. A. Logan, *op. cit.*, p. 136, who visited the property in 1927, after construction work had been started.

The estimated capacity is 10 tons a day. The sand is not at present being considered for marketing.

The author visited the property in 1926 before construction work had been started, and took a sample, No. 208, from a shallow open pit. The test results are on page 262.

N. Clark and Sons (see under Alameda County) own two important pits in the Ione district, the Clark sand pit and the Dosch clay pit.

CLARK SAND PIT: The Clark sand pit, owned by N. Clark and Sons of San Francisco and Alameda, is an 80-acre property in the SW¼ of Sec. 28, T. 7 N., R. 9 E., 1.8 miles by road northeast of Carbondale, and 0.8 miles northeast of the Harvey clay pit. The sand bed is 25 to 40 feet thick, and is overlain by a variable thickness of volcanic breccia. Most of the sand not requiring stripping has been removed by open pit methods, the pit covering more than an acre. Present mining is by the room and pillar method, similar to that used at the Shepard and Newman pits. The extent of the workings, size of rooms and pillars, and general plan is nearly the same as in the Shepard pit.

Some years ago an experimental washing plant was built near this pit, to study the economic possibilities of washing the sand to produce a high-grade clay and a white sand as separate products. The experiments were abandoned for various reasons, among them the lack of sufficient water, and the lack of profitable market for the sand.

Sample No. 134 was taken for testing, the results of which are given on page 261. These should be compared with the results on samples No. 128, 129, and 140.

The normal production of Clark sand is 5000 to 7000 tons. It is loaded by hand into trucks and hauled to Carbondale.

DOSCH PIT: The Dosch clay pit is in Lot 222 of the Arroyo Seco grant, near the Ione-Sacramento highway at a point three miles northwest of Ione, and one mile from Clarksona siding on the Amador branch of the Southern Pacific Railroad. The Dosch clay is the best known of the Ione clays, and production from this pit is considerably greater than from any other plastic clay deposit in the district.

Two varieties of clay are differentiated. The Dosch stripping, sample No. 135 (see p. 312), includes the upper beds that are more or less contaminated by surface infiltration of water carrying iron salts. The thickness varies, but is usually less than 10 feet. This clay is useful as an ingredient of sewer-pipe mixes. The Dosch clay, sample No. 136 (see p. 302), underlies this to a maximum thickness of 80 feet. It is a plastic fireclay, used for terra cotta, pottery, and stoneware. At the time of visit in 1925 and 1926, the pit was about an acre in extent, and the height of the face was 40 feet. Mining is by steam shovel, loading into 5-ton trucks. Four trucks are in service to haul the clay from the pit to Clarksona, where it is stored in a large covered warehouse, and loaded into railroad cars as needed for shipment. A supply of clay is thus available during the winter months, when mining is stopped.

The production is 4000 tons of Dosch stripping and 10,000 to 12,000 tons of the underlying Dosch clay per year.

W. S. Dickey Clay Manufacturing Company. The Fancher pit, under lease to the W. S. Dickey company, is on the northerly slope of Jackson Valley, one mile west of Buena Vista, 3.75 miles air line S. 3° E. from Ione, or 5.6 miles by road south of Wallon siding, on the Amador Central Railroad.

Photo No. 10-A is a view of this pit, taken on August 8, 1925. The stripping of loose sandy and gravelly soil attains a maximum thickness of 20 feet in the present pit, but will gradually increase as mining operations advance northward. Two varieties of clay are differentiated. The upper bed (sample No. 141), six to ten feet thick, is a yellowish fireclay, containing occasional iron stained boulders. This is underlain by at least 15 feet of hard blue-gray plastic clay (sample No. 142), which at the time of visit was not in use. The results of tests on these varieties are given on page 280.

The method of mining previous to 1927 is clearly illustrated in the photograph. Hand picking and light blasting was used to loosen the clay from the bank, where it was picked up by a tractor-drawn scraper, dragged up an incline, and dumped into a hopper over the tunnel,

PHOTO No. 10-A. Fancher clay pit, Jackson Valley, near Ione, leased by W. S. Dickey Clay Mfg. Co., facing northwest. (In 1925.) (Samples No. 141 and 142.)

from which it was delivered to an auto truck. A one-ton Ford truck is used for hauling the clay to Wallon siding. Beginning in 1927, the thickness of overburden has been such that the mining method was changed to tunneling.

Eckland Property. Mrs. C. Eckland, 1743 N. Hunter Street, Stockton, owner. This property consists of 80 acres, lying to the south of the Ione-Jackson highway at the point where it crosses the railroad, 1.5 miles east of Ione. The property is at present (1927) idle, but was at one time worked by Mr. Dennison of Ione. Yellow, pink, and red-mottled plastic clays are exposed in the walls of the abandoned pit, from which sample No. 213 was taken (see page 299). Wm. Haverstick of Ione supplied a sample (No. 209, p. 263) of white sandy clay from a 16-foot drill hole on the southwestern portion of the property. Almost the entire property is covered with an overburden of volcanic breccia, and insufficient prospecting has been done to determine the extent and character of the underlying clay beds.

Ione Fire Brick Co., J. T. Roberts, president and general manager, 12 Russ Building, San Francisco; Wm. Brown, superintendent at Ione. The Ione Fire Brick Co., a subsidiary of the Stockton Fire Brick Company, is located about two miles southeast of the town of Ione, on a spur track of the Amador Central Railroad. Machine-made fire brick are made, using a mixture of Lincoln clay, now secured from the pit of the Clay Corporation of California at Lincoln (sample No. 280, p. 305), and Ione clay, sand (sample No. 140, p. 280), and grog from pits near the plant.

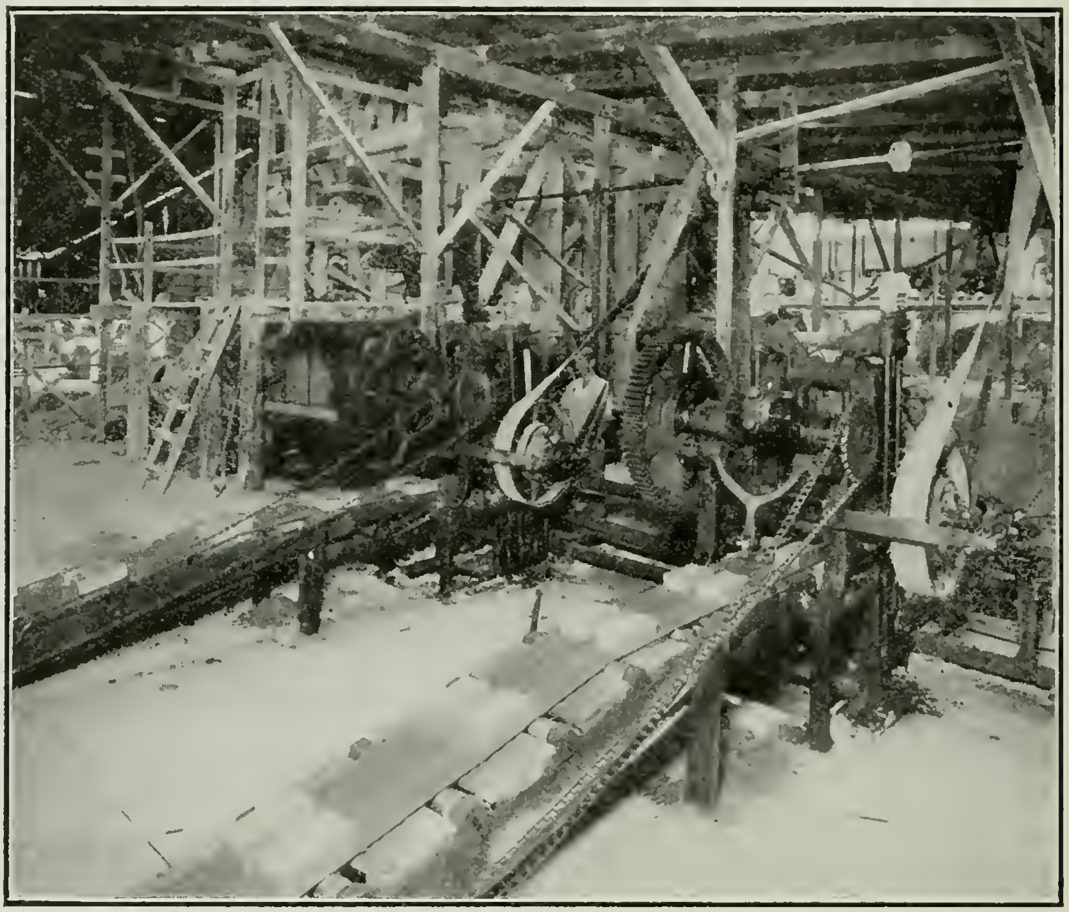

PHOTO NO. 10-B. Brick machinery in plant of Ione Fire Brick Company. (Photo by courtesy of the company.)

The mixture is prepared in a dry pan and pug mill, shaped in an auger machine, wire cut (side), and repressed. Drying is accomplished in air under sheds and in the open. Only such standard shapes as can be made on the auger machine are manufactured at this plant, there being no hand molding. Photo No. 10-B is an interior view of the plant, showing an auger machine and two represses, with off-bearing conveyors.

The firing equipment consists of five oil-fired round down-draft kilns, having a total capacity of 11,000 brick per day. The auger machine capacity is 20,000 brick per day, which makes it possible to prepare a surplus for storage to be fired during the winter months, when clay mining can not be economically carried on.

GROG: Grog for use in the plant of the Ione Fire Brick Company is mined from a small pit adjoining the Bacon red clay pit. A six to twelve foot bank is exposed, over a length of 100 feet. The material consists mainly of partly-rounded quartz gravel, most of which is under two inches in diameter. The interstices are partly filled with fine sand, with a small amount of clay. Iron staining is a prominent macroscopic feature, but the total iron content is not too high to permit the production of second-grade fire brick when used as the sole grog constituent.

SAND: The sand pit of the Ione Fire Brick Company is near the grog pit and is shown on photo No. 10-C.

May E. Newman Estate. Main office, 980 Bush Street, San Francisco. The pit is on a 150-acre property in Secs. 20, 30, and 31, T. 6 N., R. 10 E., M. D. M., on the Amador Central Railroad, one mile southwest from Ione, and less than a half mile northeast from the plant of the Ione Fire Brick Co.

The bulk of the output from this property up to date has been Ione sand, but plastic red clay beds have been found, and a small amount has been shipped. The main sand pit abuts the railroad tracks on its eastern boundary. The sand occurs in two separate beds each 10 to 15 feet thick and separated by a bed of carbonaceous sand from 6 to 30 feet thick. Volcanic breccia of variable thickness overlies the deposit. Open-pit mining was used at first, but practically all of the sand not covered by volcanic breccia has by this time been removed, and present mining is by underground methods, using the room and pillar method.

The general plan of mining, whenever a systematic lay-out is possible, is to drive rooms in the bottom of the upper bed approximately 10 by 10 feet in cross-section on 25 foot centers to the limit of the block of ground being mined, usually about 250 feet, then retreat by excavating to the roof, and by cutting across to adjacent rooms, finally reducing the pillars to approximately six feet in diameter. The sand is loaded by hand into small cars, which are dumped into a loading chute at the entrance of the mine. The loading chute delivers to mine cars which are in turn hauled up an incline and out of the pit by a car hoist, finally delivering the sand to a loading bin on the railroad siding.

Some of the lower sand bed has been mined and shipped from places where it has been exposed by open-pit mining. The present underground method does not leave the mine in a satisfactory condition for the recovery of the lower bed in the future, unless the capping of volcanic breccia can be utilized as grog, and the bed of carbonaceous sand is stripped. Seven or eight men are employed during the dry months, when an average of 9 cars per week is shipped. The annual output varies with demand, and is normally in excess of 6000 tons.

Since the above was written, the property was visited in 1927 by Mr. Logan, from whose report[1] the following additional notes are taken:

"The old pits, operated for years south of the track, have been worked up to the property line. A new pit has recently been started on the north side of the track. In vertical section, so far as opened, it shows from top to bottom 25 feet of overburden 10 feet of red mottled clay, and 15 feet of white sand. The red mottled clay now being shipped for testing (April 13) is said to carry a little more sand than the Bacon mottled clay. Nine men were employed on that date. Clay is mined by hand in an open pit and hauled in a small truck to the railroad cars, a few hundred feet away. It is thought this clay will prove suitable for tile. The white sand is stated to run 71% silica. If regular production starts, drifts will be run to avoid handling the overburden."

[1] State Mineralogist's Rep. XXIII, p. 141.

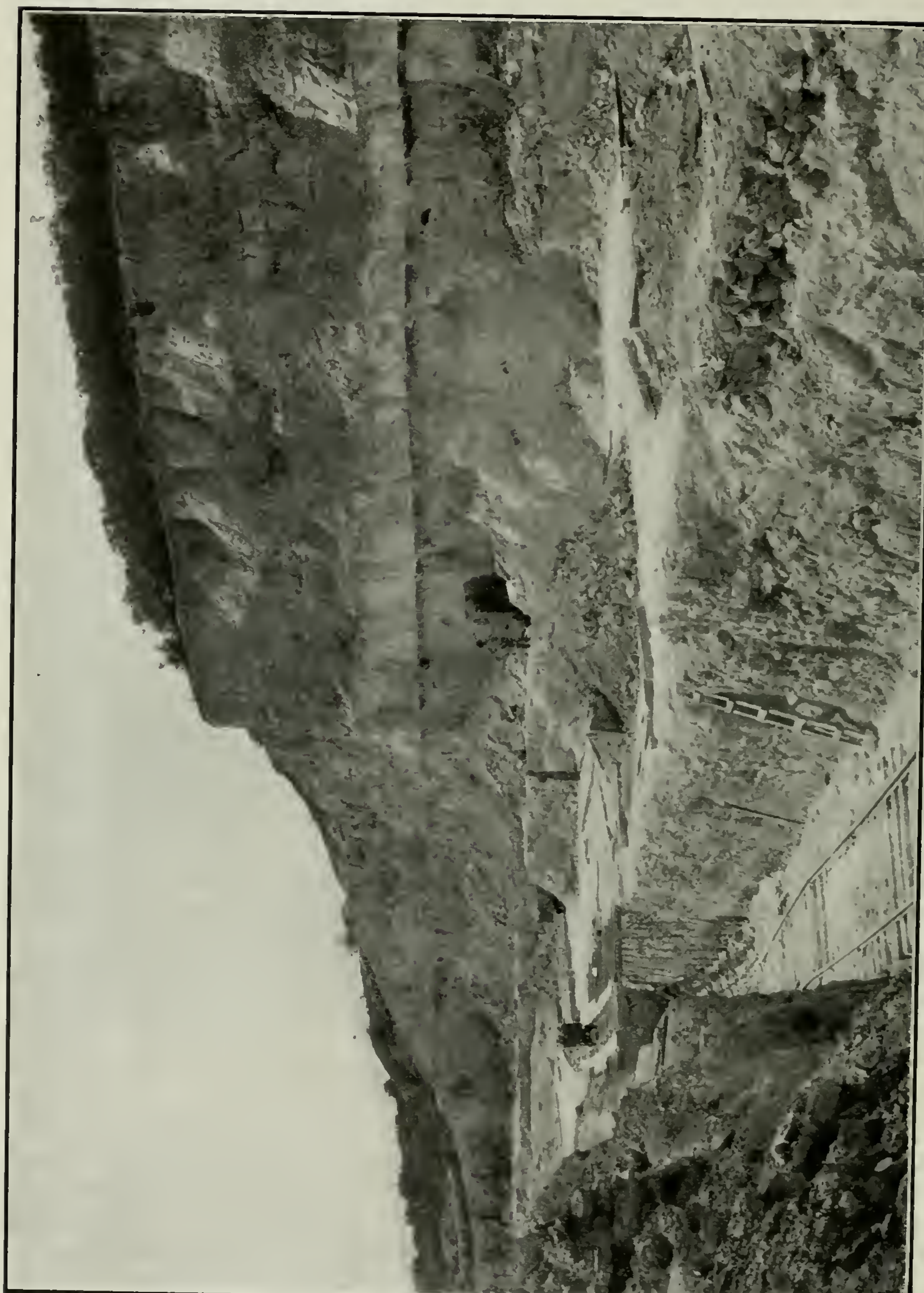

Photo No. 10-C. Sand pit of the Ione Fire Brick Company. (Photo by courtesy of the company.)

Three samples were taken from this property. No. 129 is sand from the upper sand bed, taken from the underground workings at the working face when visited on August 8, 1925. The test results are given on page 261. Sample No. 130 is representative of the carbonaceous sand, and was taken with the object of studying possible uses. The test results, page 290, on the untreated sand were unfavorable, and is unlikely that beneficiation, even if proved possible, would be of commercial importance in the immediate future. Sample No. 131 is from the deposit of red clay from the new pit, and is seen (p. 329) to be quite similar in its properties to the Bacon red (sample No. 127, p. 335).

Yosemite Portland Cement Company.[1] Main office, Pacific Building, San Francisco. This is known as the Harvey pit and is part of over 100 acres of land recently purchased from Fred Harvey. The pit is just east of the old Harvey coal mine, and one mile north of Carbondale. The land is in Secs. 32, 33 et al., T. 7 N., R. 9 E., M. D. M.

Bluish fireclay occurs with an overburden of from two to three feet of soil in which are found concretionary boulders of red iron oxide. The pit was formerly operated by hand methods, but in 1927 a plow and scraper, drawn by a tractor, were used for removing the overburden, and the clay was mined by a small steam shovel. The pit is now about 12 feet deep, and it is stated that borings have indicated a depth of 65 feet of clay, over an extensive area. Auto trucks are used to deliver the clay to the railroad.

The clay contains about 32% alumina, dry basis, and is used in the manufacture of white cement. It is also a useful sewer pipe and terra cotta clay.

Sample No. 133 was taken for test. The results are given on page 298.

Changes Since Former Reports.

The following important changes have occurred in the Amador County clay industry since the publication of Preliminary Report 7, and the Nineteenth Report of the State Mineralogist:

Amador Kaolin Company. Extinct.

W. D. Amick Property (formerly operated by the Philadelphia Quartz Co.). A white sand deposit containing from 20% to 30% of kaolin. A washing plant was built and operated during the World War. Now dismantled and idle.

McKissick Cattle Company. Former owner of Rancho Arroyo Seco, now owned by S. E. Kieffer and leased by G. A. Starkweather, as noted, *ante.*

Newman Clay Company. Now May E. Newman Estate.

Philadelphia Quartz Company. No longer operating in the county

Bibl. of Ione district: Cal. State Min. Bur. Report XIV, pp. 5–11; XXIII, pp. 134–144. Bull. No. 38, p. 206. Prel. Rept. No. 7, p. 38.

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[1] Logan, C. A., *op. cit.*, p. 138. (Under Pacific Portland Cement Company, Consolidated.)

BUTTE COUNTY.

General Features.

Butte County is in the north-central portion of the state, largely between the Sacramento and Feather rivers. Its western half is in the Sacramento River basin and its eastern half is in the foothills of the Sierra Nevada Mountains. The area of the county is 1722 square miles and its population is 30,030 (1920 census).

Among the mineral resources of the county are asbestos, barytes, chromite, gems, gold, limestone, marble, mineral water, platinum group, silver, and miscellaneous stone. The following are produced commercially at present: gold, miscellaneous stone, platinum, silver, mineral water, brick, copper, gems (diamonds), lead, natural gas, and soapstone.

Clay Resources.

Deposits of high-grade clay have been reported from numerous localities in Butte County, especially within a radius of 12 miles from Oroville, the county seat, but only one of these has been developed. Common brick clays are plentiful at many places in the valley region east of the Sacramento River, and northwest of the Feather River, and in some of the Neocene River channels at higher elevation.

Beginning at a point two miles north of Oroville, and extending northward for nearly eight miles to Pentz and Cherokee, the Ione formation has been traced.[1] The geologic history of this region has been summarized by Lindgren as follows:

"(1) Deposition of Chico formation (Upper Cretaceous); (2) epoch of erosion; (3) accumulation of lowest gold-bearing gravels (Eocene?); (4) deposition of Ione formation, underlying Table Mountain; (5) eruption of basalt of Table Mountain; (6) formation of high volcanic gravels of Table Mountain; (7) epoch of erosion; (8) deposition of tuff and lower gravels (late Pliocene) of Oroville; (9) epoch of erosion; (10) deposition of bench gravels of Oroville (Quaternary); (11) epoch of erosion; (12) deposition of present stream gravels. The epoch of erosion (item 7 above) following the formation of the high volcanic gravels in many places removed a part of the Ione formation and basalt before the deposition of tuff. The Ione formation itself was laid down on a very uneven surface."

As a result of the foregoing geologic history, it is possible that many of the occurrences of high-grade clay that have been reported are small and irregular, although in most localities thorough prospecting by drilling will be necessary in order to determine the size, shape, and quality of the deposit, as very little information can be gleaned by surface examination. So far as known, the only property in the Ione formation that has been well prospected is that of the Table Mountain Clay Products Co. near Wick, where a sufficient quantity of good clay was found to warrant the erection of a plant.

A number of localities south and southeast of Oroville were investigated, and samples were taken of some of the typical materials of possible ceramic utility. Some of these proved to be derivatives of the rhyolitic and andesitic flows, with little or no ceramic value. The nature of such deposits is discussed more fully in the descriptions of deposits in Nevada and Placer counties.

Some clay from settling-ponds left by the dredges that formerly operated near Oroville has been mined and shipped to various ceramic plants, especially to the Gladding, McBean & Co., plant at Lincoln,

[1] Lindgren, Waldemar, The Tertiary Gravels of the Sierra Nevada of California: Prof. Paper 73, U. S. Geol. Survey, p. 86, and Plate XV, 1911.

Placer County, but the new enterprise of the Natoma Clay Co., at Natoma, Sacramento County (see page 186), will doubtless render such operations unprofitable in Oroville.

One common brick plant near Palermo supplies the needs of this region for common building brick.

The *Lund Brick Yard* is on the Nelson E. Lund ranch, 3.6 miles by road east of the Palermo-Honcut road from a point 4.4 miles southeast of Palermo, a total of 13.7 miles by road southeast from Oroville. At the time of visit, on August 24, 1925, the first successful burn of common red brick had been completed. Mr. Lund expects to manufacture ruffled face brick if the local demand warrants.

The clay is mined by hand methods from a deposit of clay and silt that comprises the upper part of a Tertiary river channel deposit, parts of which were formerly hydraulicked for gold. Three distinct variations of sand-gravel-clay beds are exposed in the pit. The upper bed is from one to three feet thick, and consists of fine-grained red-colored plastic clay, with little sand and few pebbles. The middle bed contains more sand, and some fine gravel, and is from three to four feet thick. The lower bed, of unknown thickness, is too sandy to work alone, and contains considerable fine gravel, and some larger boulders. Each of these beds was sampled separately, under the sample numbers 178–, 1, 2, and 3, respectively, from the top down. The middle bed gives the best results for brick-making and the top bed is characterized by high shrinkage and danger of cracking during drying and firing. A reasonably uniform product can be obtained by including a sufficient proportion of the sandier bottom bed to offset the high shrinkage of the top bed, but on account of extreme and sudden variations in the character and thickness of each of the beds, this may be difficult unless a method of bedding and reclaiming is used in the plant. See page 325 for the results of test.

The plant is equipped with a bucket elevator for delivering the material from the pit to a roll crusher. This is followed by double pugging, and an auger machine of 20,000 brick daily capacity. Power is supplied by steam from an oil-fired boiler. The clay is worked in a softer state than is commonly used with auger machines. Drying is done under sheds. Care must be taken to avoid exposure of the brick to sun and hot wind during drying, as serious drying cracks may develop.

An oil-fired kiln is used for firing. Steam is used for atomizing the oil. In the 10-ft. by 20-ft. kiln in use at the time of visit, the firing required seven days, and the kiln cooled in four to five days.

The plant is operated as needed to supply the local demand.

Table Mountain Clay Products Co. L. F. Riley, president; H. M. Gamble, superintendent. Home address, Oroville. This company has acquired and developed a clay deposit in the SW¼ of Sec. 22, T. 20 N., R. 3 E., M. D. M., and at the time of visit on August 24, 1925, were constructing a plant for the manufacture of face brick, hollow tile, and roof tile. The plant lies 0.4 mile west of the Oroville-Pentz highway, from a point 5.9 miles by road northwest from the center of Oroville.

The property was prospected by means of auger holes, most of which varied from 14 to 22 feet deep. Clay was found under a large portion of the property, underlying a variable amount of basaltic capping. None of the holes penetrated to the bottom of the clay beds, and it is claimed that one hole was drilled to a depth of 72 feet without encountering a change of formation.

The overburden covering a large portion of the area is only 6 inches to 2 feet in thickness, and mining operations will at first be confined to this ground. Mining is done with horse scrapers, delivering the clay to belt conveyors which are extended as the pit advances.

The clay is crushed in rolls, mixed in a pug-mill, and the products are shaped on an auger-machine having a capacity of 40,000 brick per day. A dry pan may later be added ahead of the pug-mill. Drying is done under sheds in the open air. The kilns are fired with oil.

Sample No. 175 was taken for test, the results of which are on page 304.

Undeveloped Deposits.

Two samples were taken from alongside the Oroville-Quincy road. No. 176 (see page 325) is a decomposed igneous rock, considerably kaolinized, and badly iron-stained, from an exposure 4.3 miles by road southeast from the center of Oroville, in Sec. 13, T. 19 N., R. 4 E., M. D. M. The sample probably contains more iron oxide than would be found in the body of the deposit. The size of the deposit could not be estimated, but the occurrence is such as to indicate a good tonnage. The material is suitable for the manufacture of red brick. Another sample, No. 177 (see page 336), was taken from a road cut, 2.9 miles from the center of Oroville. It is high in volcanic ash, but contains enough alluvial clay and silt to make it usable to a limited extent in the manufacture of red brick, if mixed with a more plastic clay. The extent of the deposit was indeterminate.

An unsuccessful attempt was made to secure recent information regarding the deposits mentioned in previous reports of the Bureau.[1] All of these reports were made previous to 1906, and in the limited time available for the present investigation, it was impossible to find anyone in the various localities mentioned who had any knowledge of the existence of clay deposits, or who were able to give information regarding the former owners of these deposits. For the sake of completeness, these reported occurrences are listed hereunder, with such notations that seem of interest at the present.

Bohannon Ranch, Yankee Hill. Sec. 4, T. 21 N., R. 5 E., M. D. M. "Large body of plastic yellow clay, tenacious and refractory." This lies in the Big Bend of the Feather River, probably at an elevation of over 1000 feet above the bottom of the canyon. If of economic value, clay could be delivered by pack-train or tramway to the Western Pacific railroad, a distance of probably two miles. The result of inquiry among residents of Yankee Hill did not warrant an attempt to find the property. The mere fact that it was described as "yellow," and that it is in such an isolated region preclude the possibility of economic utilization for many years to come.

Biggs. (Max Brooks and Mr. Reed, reported owners). Sec. 19 and 30, T. 18 N., R. 3 E., "Light brown and white, brittle clay, about

[1] Cal. State Min. Bur. Prel. Rept. No. 7, p. 43, which summarizes the data given in Bulletin No. 38, p. 211.

one-half mile wide." This is now included in the Butte County Farms. Mr. H. H. Grimes, the manager, kindly undertook an inquiry among old-time residents and employees in the vicinity, and reported that nothing was known of such a deposit, and that the previous report may have referred to a wide belt of hard-pan that comes close to the alluvial surface of the ground over portions of the property.

Coal Cañon. Sec. 12, T. 20 N., R. 3 E., "A stratum of clay in a coal mine." This probably refers to an abandoned and inaccessible coal mine in the Ione formation underlying Table Mountain. The property is 2.5 miles northeast of the plant of the Table Mountain Clay Products Co.

Durbin Ranch. SW¼ Sec. 13, T. 21 N., R. 3 E., "Large deposit of refractory clay, with low plasticity. Total depth 100 ft." Also, "* * * a deposit of light-colored clay, more plastic than above in NE¼, Sec. 13." This would lie one mile north of Pentz. A reconnaissance of this section was made, without finding any material of value. Most of the section is covered with Tuscan tuff. The Ione formation outcrops to the south, and disappears under the Tuscan tuff.

Garden Ranch. SW¼ Sec. 22, T. 19 N., R. 3 E., 3 miles southeast of Oroville. "Extensive deposits exposed in road building." No material of value could be found on this area.

Snow Ranch, Lovelocks. SW¼ Sec. 31, T. 24 N., R. 4 E., "Light-colored clays of medium plasticity." A reconnaissance of this locality was made, and nothing of interest was found. Some partly kaolinized diabase (?) occurs in places, but is badly contaminated with iron. The region is too inaccessible to be of economic importance as a producer of any but the finest grades of clay.

CALAVERAS COUNTY.

General Features.[1]

Calaveras County lies on the west slope of the Sierra Nevada Mountains, the elevation ranging from 400 feet above sea level, where it joins San Joaquin County on the west, to 8000 feet where the eastern boundary rests on the summits of the Sierras adjoining Alpine County. Bounded on the north by Amador County and on the south by Tuolumne, it shares with them the advantage of a climate where snow seldom falls and practically never lies below 2500 feet elevation, and where mining may be carried on throughout the year under ideal weather conditions.

Water, power, and timber resources are plentiful. Several railroad branches connect the main towns with points in the San Joaquin Valley. Most points in the county at elevations under 2500 feet can be reached by automobile during the greater part of the year.

The principal mineral products of the county are gold and copper. Other minerals that have been produced are silver, produced as a by-product of gold and copper mining, limestone, mineral paint, clay, mineral water, asbestos, rock crystal (quartz), chromite, and miscellaneous stone.

[1] From Logan, C. A., Calaveras County: State Mineralogist's Report XXI, p. 135, 1925.

Geology.

The geology of the county is similar to that of Amador County and others in the Mother Lode belt. The Ione formation (Eocene) is found at numerous places, but is not so extensively developed, nor so well preserved as in Amador County. The following is a portion of the geological summary of the county as given by Logan:[1]

"The Neocene shore-line, as indicated by the Ione formation, covered the county from Lancha Plana through Valley Spring to Jenny Lind, and southward to Milton. The most westerly of the lode mining districts are the Hog Mountain-Gopher Range copper mining district, where copper ores occur in diabase and allied rocks, near the southwest corner of the county, and the Campo Seco copper district, where similar ores occur in amphibolite schist. In a depression called Salt Spring Valley, between the older crystalline rocks of Gopher Ridge and Bear Mountains, lies a belt of black Mariposa slate with interbedded lenses of amphibolite, with important copper deposits, which conform in strike with the direction of schistosity of the enclosing rocks. The Mother Lode belt of black Mariposa slate enters the county at Middle Bar, but aside from the Gwin Mine, which had reached a depth of 2850 feet before it was closed several years ago, little deep mining has been done in this district, though numerous quartz mines have been opened to depths of less than 1000 feet. There are many prominent veins in the granodiorite area of Mokelumne Hill, but the main belt passes southeast, a line of fissuring having passed into the amphibolite schist, in which rock were found the deep mines of Angels Camp and Carson Hill.

"The East Belt is a general name given to the gold-quartz mining districts in the great body of Calaveras (Carboniferous) rocks, lying east of the younger Mother Lode slate and east of the amphibolite schists accompanying the Mariposa slate. The Calaveras rocks are chiefly hard blocky siliceous and micaceous schists, quartzite, curly black slates and accompanying intrusive dikes, usually of basic character."

Clay Resources.

Various clay deposits in the Ione formation near Valley Springs and Helisma have been operated in the past. Some work has been done recently on a deposit of kaolinized talc schist in the Calaveras (?) formation.

The *California Pottery Co.*, of Oakland and Merced, own two deposits in Calaveras County, one at Nigger Hill, and the other at Valley Springs. Henry Ward of Valley Springs is superintendent.

NIGGER HILL: Near Nigger Hill, about three miles north of Valley Springs, a good deposit of white-burning kaolinized sericite schist has been discovered. A tunnel has been driven for 250 feet. The kaolinized zone is from 15 to 25 feet thick. The material has low plasticity, but is of use as a filler in white tile bodies.

Sample No. 236 (p. 263) was taken at the face of the tunnel, and Sample No. 237 (p. 263) was taken at the portal.

VALLEY SPRINGS CLAY PIT: This pit is ¼ mile northwest from Valley Springs on a spur track from the Valley Springs branch of the Southern Pacific Railroad. The property comprises 17 acres. Fireclay from the Ione formation is mined from an open pit, shown in photo No. 11. Two distinct varieties of clay are mined and shipped to the Merced plant of the company. One of these is classed as 'pink mottled,' (sample No. 202, p. 337), and the other is 'yellow' (sample No. 203, p. 337). The two varieties are somewhat intermingled, but can be separated by hand as mined. In the southern end of the pit, northward to the break in the face shown in the photo, the pink mottled predominates, and in the northern end of the pit, the yellow variety is more important. Some yellow sandy streaks traverse the clay, and in places small quantities of white clay are found.

[1] *Op. cit.*, p. 140.

The floor of the pit is approximately 200 ft. square, and the face varies from 10 to 30 feet high. The clay is loosened by hand drilling and light blasting, and is loaded by hand shoveling into wheelbarrows, which are dumped into a hopper. An inclined belt conveyor transports the clay from the hopper to a railroad car.

In a test pit five feet deep, just east of the track, pink mottled clay is exposed. Fifty feet farther east another test-pit was sunk, with the aid of a windlass, to a depth of 25 feet. Both pink-mottled and yellow clay were found to the bottom of the shaft. From the debris surrounding the collar of the test-pit it was estimated that the pink-mottled variety comprised about one-third of the material excavated. A third 25-ft. test pit was dug 100 feet north of the second one, and similar material was encountered, in addition to a bluish-white plastic clay, not entirely free from limonitic stains (sample No. 204, p. 299). This

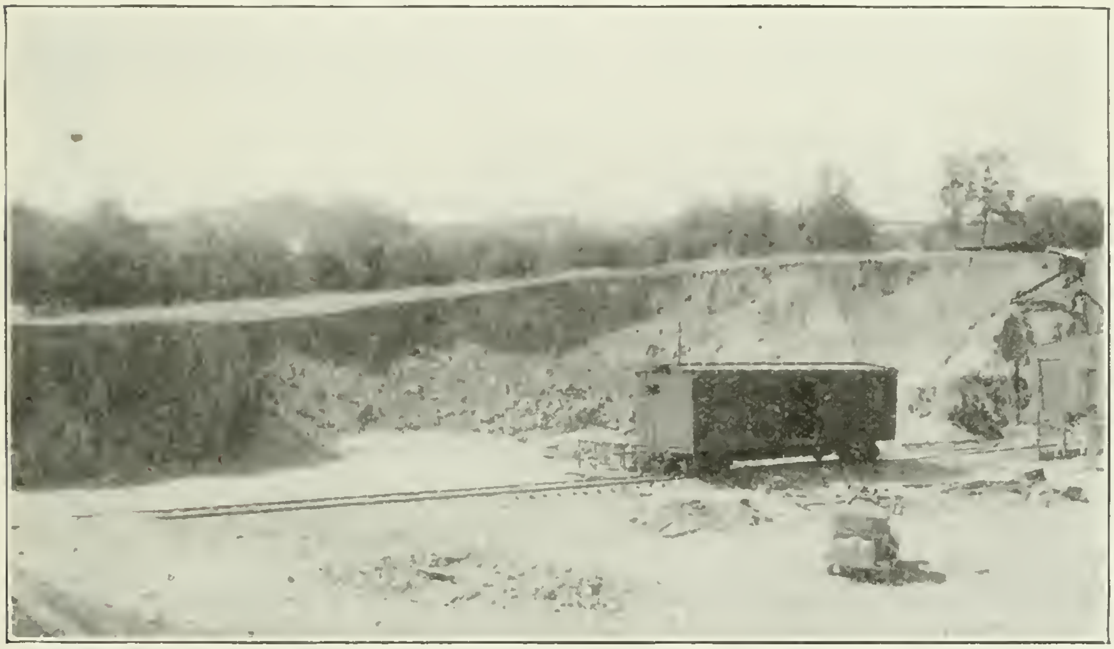

Photo No. 11. Valley Springs clay pit (California Pottery Co.), facing west. The track runs S. 25° E. The 5-ft. test-pit appears in the center foreground. (Samples No. 202–204.)

test-pit was bottomed in a yellowish sandy bed. From the evidence on the dump, the bluish-white variety of clay predominates at this point.

It is evident that the total thickness of useful clay is in excess of 50 feet, and the structural and topographic features are such as to warrant the expectation that these beds underlie an area of many acres.

Three men are employed during the operating season. In 1925, nearly 200 cars were shipped, at the rate of approximately four cars per week.

Helisma Fireclay Deposit. One-quarter mile north of Helisma (formerly Burson) station on the Valley Springs branch of the Southern Pacific Railroad is an abandoned fireclay pit formerly controlled by W. A. Houts, 202 Balboa Building, San Francisco. The present ownership of the property was not determined. The deposit is in the Ione formation. The total thickness of clay exposed in the pit varies from 8 to 15 ft. The upper part of the clay bed is a bluish-white clay with good plasticity, and the lower part is a greenish-white clay, with less plasticity. Both varieties of clay are traversed by thin limonitic seams a foot or more apart.

The main pit is 150 ft. long, 50 ft. wide and from 8 to 15 feet deep. The overburden, of volcanic breccia, increases from a few inches at the lower edge of the pit to 10 ft. at the upper edge. Two hundred feet to the west is a smaller pit 80 ft. long by 30 ft. wide, and a maximum of 10 ft. deep. The clay is similar to that in the larger pit, but contains more iron, and is more sandy.

The clay was formerly worked by hand loading into cars which were hauled up a gentle incline to a loading chute overlooking a railroad siding. All equipment has been removed from the property.

The probable extent of the clay bed beyond the existing exposures could not be determined without boring, on account of the overburden. Structural features are favorable to a continuance of the clay under the low hill on which the pit is located, but the overburden covering the top of the hill may be 20 ft. or more in thickness.

Sample No. 201. page 305. includes both types of clay from the main pit.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 43.

Penn Mining Co. During the operation of the copper smelter at Campo Seco, a kaolinized sericite schist overlying the copper beds was used in the smelter as a refractory. Since the smelter was closed down this material has not been utilized. The locality was visited on September 22, 1926, and a sample was taken from the abandoned open cut from which it was formerly obtained. The sample is No. 238 and the tests demonstrate that the plasticity and strength are low, and that the content of fluxes is high, causing fusion to begin at cone 9 (1285° C.). See page 316.

Bibl: State Min. Bur. Bull. 38, p. 211; Prel. Rept. 7, p. 43.

Texas Mining Company. J. P. Hoskinson, Valley Springs. This is an undeveloped property about two miles north of Valley Springs. Small exposures of sandy fireclay belonging to the Ione formation have been found, and some prospecting has also been done on an outcrop of kaolinized sericite schist of Calaveras (?) (Carboniferous) age. Sample No. 233 was taken of the fireclay, but was not tested, as the quality was obviously poor, and the continuity of the deposit is doubtful. Sample No. 234 and 235 were taken from two different exposures of the kaolinized schist. The test results of No. 235 are given on page 263. It is a white-burning refractory material of low plasticity, that would be useful as a filler in white ceramic bodies. No. 234 was not tested, as it is similar to No. 235.

COLUSA COUNTY.

General Features.

Colusa County lies on the west side of the Sacramento Valley. The west side of the county is in the foothills of the Coast Range, and the east side is in the basin of the Sacramento Valley. The area of the county is 1140 square miles, and the population is 9920 (1920 census). Colusa is the county seat and principal town.

The mineral resources of Colusa County are largely undeveloped. Occurrences of coal, chromite, copper, gypsum, manganese, mineral water, pyrite, quicksilver, sandstone, miscellaneous stone, sulphur, and in some places, gold and silver, are known. Of these, the only commercial production is of mineral water, sandstone, and miscellaneous stone.

Clay Resources.

Common clays suitable for the manufacture of brick are abundant, but there is at present no local industry. A brick yard was at one time operated at Colusa by George Smith.

Bibl: State Mineralogist's Rept. VIII, p. 159; State Min. Bur. Bull. 38, p. 242; Prel. Rept. 7, p. 44.

CONTRA COSTA COUNTY.

General Features.[1]

Contra Costa is one of the East Bay counties and is bounded on the west and north by the waters of San Francisco, San Pablo and Suisun bays and San Joaquin River. San Joaquin County is on the east and Alameda County is on the south.

The area of the county is 714 square miles, about half of which is under cultivation. The population in 1920 was 53,889. Its industrial and shipping activities are extensive. The county has approximately 70 miles of deep water-front on which are located nine port cities in which have been established many chemical and industrial works. Agriculture, stock raising, and to a lesser extent, mining, contribute to the prosperity of the county.

Topographically, Contra Costa County is distinguished by containing the most prominent landmark in the central coast counties, Mt. Diablo, which rises to an elevation of 3849 feet above sea level. This peak is in the eastern part of the two main ridges of the Coast Range Mountains, which strike northwesterly across the county. The western ridge lies close to the coast. Its crest is more regular but its highest peaks are less than 2000 feet in elevation. The western flank slopes gently toward San Francisco Bay. Between the eastern and western ridges lies San Ramon Valley, drained by San Ramon Creek, which flows northward into Walnut Creek and hence into Suisun Bay. Marsh Creek rises on the eastern slope of Mt. Diablo and flows northeasterly into the San Joaquin River. These are the two principal streams in the county. The northeastern corner of the county is included in the delta area of San Joaquin Valley and is elevated only slightly above sea level.

Geology.

That portion of the Coast Range within Contra Costa County has been studied by the Department of Geology and Paleontology of the University of California, and the southeastern portion has been mapped by Lawson.[2]

A nearly complete section of the Coast Range formations from the Franciscan to the recent are exposed within the county, but as the area is one of many faults, no single formation is continuous over a large

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[1] From Laizure, C. McK., Contra Costa County: State Mineralogist's Rept. XXIII, p. 2, 1927.

[2] Lawson, A. C., San Francisco Folio, No. 193, U. S. Geol. Survey.

area. The most abundant strata are sandstones and shales of Cretaceous and Tertiary age.

Contra Costa County is lacking in deposits of valuable metals, but its structural materials are important natural resources on account of their easy accessibility and proximity to the cities surrounding San Francisco Bay. Its coal deposits are of potential value. The most important minerals now produced are: cement, miscellaneous stone (crushed rock, sand, and gravel), and brick. Clay, limestone, mineral water, and foundry sand are also on the commercial list. Other mineral resources include asbestos, coal, copper, diatomaceous earth, manganese, and quicksilver.

Clay Resources.

Alluvial clay and silt are not abundant in those parts of the county that are favorably situated with respect to manufacturing and marketing conditions. However, there is an abundance of Tertiary clay shale

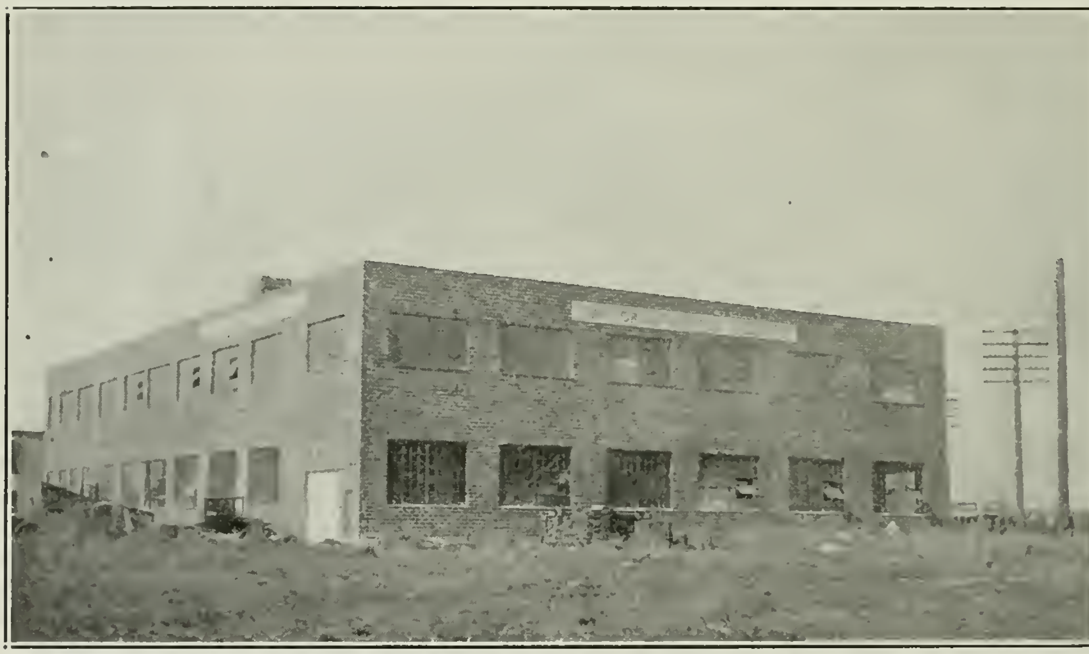

PHOTO No. 12. California Art Tile Co. plant, Richmond, Contra Costa County. (From State Mineralogist's Report XXIII, p. 7, 1927.)

in several of the formations that are widespread throughout the area, and a number of brick and hollow-tile plants have been established at various places.

No deposits of high-grade clays have thus far been discovered in the county, but on account of favorable manufacturing and marketing conditions, a number of important ceramic plants have been established in or near Richmond, and a wide diversity of ceramic ware is produced.

California Art Tile Company. J. W. Hislop, president; L. J. Hislop, secretary; W. A. Hislop, chemist; and C. E. Cummings, superintendent. Address, Box 1116, Richmond. This plant is at Twenty-seventh and Maine streets, Richmond, and was built in 1926 to replace a smaller plant that had been established in 1922. Decorative wall and mantel tile are made from a buff-burning fireclay body, and terra cotta glazes. Lincoln clay and Ione sand are used for the body. A view of the plant is shown on Photo No. 12.

The body mix is prepared by grinding in a 10-ft. dry pan, followed by a pug-mill. A tile auger with a patented cutter is used for making the regular shapes, and special shapes are hand pressed. Drying is done in a room heated by kiln gases. The glazes are applied by spraying before firing. Saggers are made at the plant in a sagger press.

The kiln equipment consists of three 30-ft. and one 24-ft. oil-fired, round down-draft kilns. The tile are fired to cone 8 to 10 in four days. The cooling time is also four days.

Forty men are employed at the plant. The rated output of the plant is 40,000 sq. ft. of tile per month.

Bibl: State Mineralogist's Report XXIII, p. 7, 1927.

N. Clark and Sons. At Oxley siding, on the Southern Pacific Railroad, ½ mile north of Walnut Creek, is a shale pit owned by N. Clark and Sons, 116 Natoma Street, San Francisco. The material is a thin-bedded, soft, nearly white, calcareous shale of Tertiary age (Miocene?), overlain unconformably by sand and gravel. It is used as a component of terra cotta and other mixtures in the company's plant in Alameda.

The deposit is worked by an open cut along a face that is approximately 200 feet long. At the southern end of the pit, the shale bank is 70 to 80 feet high above the floor of the pit, but the contact between the shale and the overlying gravel and sand dips toward the north, so that the shale disappears at the northern end of the pit. The shale is broken by hand drilling and blasting, and is delivered to a loading platform either by wheelbarrows or by horse-drawn scraper. A storage shed is provided for the winter supply when mining is stopped. Sample No. 200 was taken for testing, the results of which are on page 342.

Mr. Faber of Walnut Creek is mining under contract, and two or three men are employed during the operating season. About two cars per week are shipped.

Bibl: Cal. State Mining Bur. Prel. Rept. No. 7, pp. 44–46; State Mineralogist's Reports XVII, p. 49, and XXIII, p. 13.

Mastercraft Tile and Roofing Company. (Entire description by Laizure, *op. cit.*, p. 7.) C. V. and F. A. Mero, owners. Office, No. 1 Twentieth Street, Richmond. Cement roofing tile has been manufactured by this company for the past four years at its Richmond plant. During the past year (1926) hand-molded clay roofing tile has been added to their line. The clay tile plant is on San Pablo Canyon road, near San Pablo, but the clay is obtained near Richmond. Firing is done in a rectangular down-draft kiln using oil for fuel. Six men are employed.

Port Costa Brick Co. C. B. Berg, president; W. S. Hoyt, secretary; B. F. Ferrario, plant superintendent. General offices, 808 Sharon Building, San Francisco. The plant is located three-quarters of a mile east of Port Costa, at the edge of Carquinez Straits. The products are common brick and hollow tile.

A bank of interbedded bluish shale and red clay of Cretaceous (?) age is mined by a 1½-yard electric shovel in a large open cut 1000 feet from the plant. The clay is transported to the plant in 5¾-yard hopper-bottom side-dump cars, hauled by a gasoline tractor fitted with flanged wheels, or by an electric third-rail locomotive. The local material is used alone for the manufacture of brick, but is mixed with one part of Lincoln No. 8 (sample No. 148, p. 336) clay for each two parts of local clay for the manufacture of hollow tile. The Lincoln clay is necessary to secure sufficient die lubrication to prevent lamination and rupture to the clay as it passes from the auger machine. A sample of the local clay was taken for testing. See sample No. 199, page 326.

The clays are prepared by grinding in two No. 3 Williams pulverizers and three 9-ft. American dry pans. Revolving screens are used to remove rock inclusions. The pulverized clay is elevated to bins from which it is fed to the auger machines. A special Giant auger machine is used for brick, and an American No. 290 auger is used for tile. The brick auger is equipped with a Freese cutter, and the tile auger has a Chambers No. 5C rotary tile cutter.

In the summer, some ware is dried in air under sheds. The drier yard has a capacity of 1,000,000 brick, and drying is completed in 12 to 14 days. This method is not used in the winter, when all ware is dried in a 22-tunnel oil-fired drier. The drier has a capacity of 400 cars of 500 brick each, or 200,000 brick, and the drying period varies from four to six days. The dryer heat is supplied by an oil furnace, using Ray burners. Two 25-hp., 66-in. fans, one of which is used as a pressure fan and the other as an exhaust, force the heated air through the drier.

Firing is done in eleven field kilns and a Hoffman continuous kiln. The Hoffman kiln has 22 chambers, and has a total capacity of 400,000 brick. The monthly output of the kiln varies from 1,000,000 to 1,250,000 brick, which corresponds to a firing cycle of 15 to 18 days, of which time 85 to 100 hours is occupied by firing, following the water-smoking period. Petroleum coke or coal screenings are used for fuel. As a rule, the Hoffman kiln is set to a height of three or four feet from the bottom with brick, and then filled with hollow tile.

Both hollow tile and brick are fired in the field kilns. The local clay is tender during the water-smoking period, and coal firing is used during this stage, followed by oil during the actual firing period. The oil is atomized with steam, which is generated in a 125-hp., horizontal fire-tube boiler, equipped with a Johnson rotary oil burner.

The usual firing temperatures are between 1600 and 1750° F., for brick and 1850° F. for hollow tile.

The plant is operated by electric power from the lines of the Great Western Power Co. There is a connected load of about 900 horsepower, but only 400 is used at present. Fifty to sixty men are employed.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 45; State Mineralogist's Reports XVII, p. 50, and XXIII, p. 8.

Richmond Pressed Brick Company. (Described by Laizure,[1] supplemented by notes by the author.) The plant was erected by the Los Angeles Pressed Brick Company, but it became an independent company, affiliated with the United Materials Company, in 1921. S. W. Smith, president; W. S. Hoyt, secretary; F. M. Irving, plant superintendent. Home office, Sharon Building, San Francisco. The plant is at Point Richmond, near the Santa Fe-San Francisco ferry terminal, and is served by a spur track of the Santa Fe Railroad. See Photo

[1] Laizure, C. McK., Contra Costa County, State Mineralogist's Rept. XXIII, p. 8, 1927.

No. 13. The output includes pressed brick, fire brick, face brick, paving brick and red floor tile.

For the buff and other light-colored brick a portion of the raw materials used include clay and sand shipped in from Ione and Lincoln, as well as some sand from Antioch. Clay shale from the pit adjoining the plant is used for making dark-red brick. As the bank is high, the material, after blasting, drops largely by gravity to a loading bin. From here it is trammed a short distance in cars to the plant.

Fire brick and most grades of face brick are made by the stiff-mud process. Dry pans and a pug-mill are used to prepare the clay for the auger machine, which has a capacity of 100,000 brick per day. All of the fire brick, and certain grades of face brick are repressed before passing to the waste-heat tunnel driers. A specialty of the plant is red pressed brick, which is shaped by dry pressing, following dry-pan preparation of the clays.

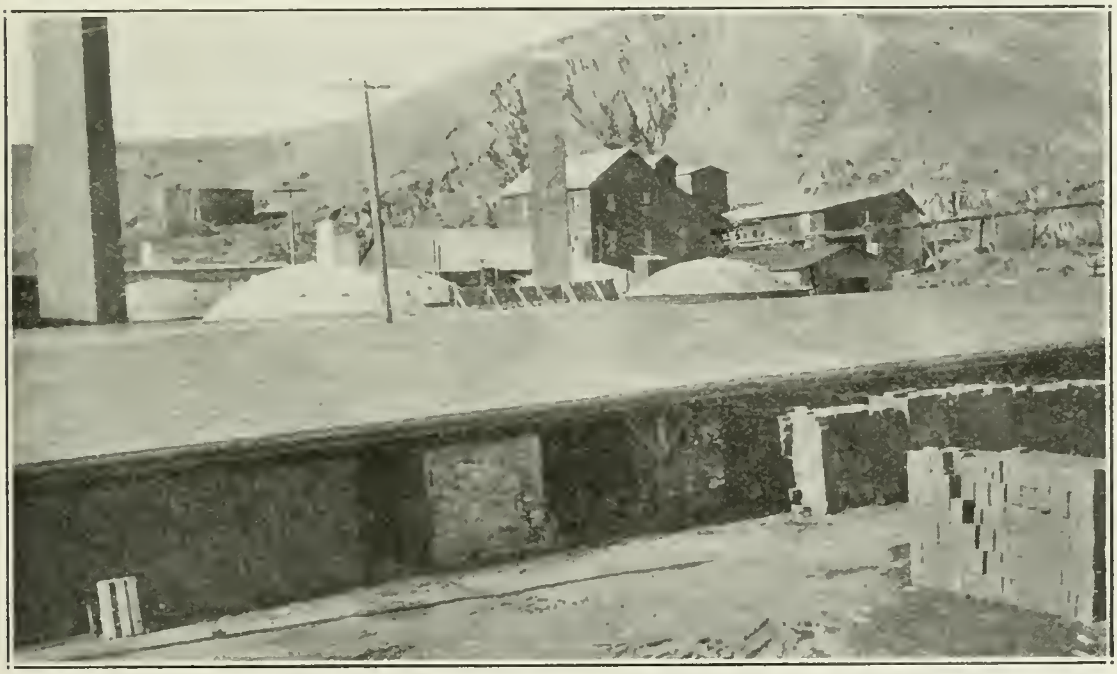

PHOTO No. 13. Richmond Pressed Brick Co. plant, with clay pit in background, Richmond, Contra Costa County. (Sample No. 119.) (From State Mineralogist's Report XXIII, p. 8, 1927.)

The firing equipment consists of six 36-ft. round down-draft kilns, using oil, atomized by compressed air. The red-burned ware is fired for nine days to finishing temperatures corresponding to cones 09 to 07 (930° to 975° C.), and the buff face brick and fire brick are fired to cones 7 to 9 (1210° to 1250° C.) in seven days. The kilns are equipped with pyrometers.

Electric power is used to operate the plant. Fifty-five men are employed. See sample No. 119, page 325.

Standard Sanitary Manufacturing Company. The Standard Sanitary Manufacturing Company of Pittsburgh, Pennsylvania, purchased the plants of the Pacific Sanitary Manufacturing Company in 1926, and have since constructed a new sanitary porcelain plant, known as Pacific Pottery, to replace two smaller plants formerly operated by the Pacific company. The Standard company is also continuing the operation of the enameling plant, now known as the Pacific Enamel Works, formerly owned by the Pacific company. These plants are in Richmond and San Pablo. F. A. Kales, Box W, Richmond, is general manager.

The two plants manufacture a complete line of porcelain and enameled sanitary ware, except porcelain bath tubs. Both plants are modern in every respect, and are designed for economy of production and close control of manufacturing methods to ensure uniformity of quality. Two tunnel kilns were installed in the new porcelain plant.

It is against the policy of the company to permit publication of details regarding the plant equipment and operation.

Bibl: State Min. Bur. Prel. Rept. 7, p. 44, 1920.

Extinct Companies.

Among the former brick companies that have ceased operations in the county are:

Mt. Diablo Pottery and Paving Brick Co.
Carquinez Brick and Tile Co.
Coast Firebrick Co.
Holland Sandstone Brick Co.
Diamond Brick Co.
Golden Gate Sandstone Brick Co.
Richmond Brick Co.
Gerlack Brick Co.

DEL NORTE COUNTY.

General Features.

Del Norte County, in the northwest corner of the state, is without rail connections, and is dependent upon light-draft vessels docking at Crescent City, auto stages, trucks, wagon and pack trains for transportation. Lumbering is the principal industry. Under such conditions, and with a population of less than 3000 (1920 census), the demand for clay products is so small that practically no clay industry has been developed, and no deposits of high-grade clay have yet been found that will warrant mining and shipment to outside points.

The geology and the physiographic features of the county have been well summarized by Laizure:[1]

"A low costal plain, three to five miles in width, extends from the vicinity of Smith River to a point a few miles south of Crescent City. East of and surrounding this area of Quaternary formations and extending from the Oregon line through Del Norte and south into Humboldt is a belt of Franciscan rocks, mainly sandstones and shales. The eastern boundary of this belt crosses Smith River just west of South Fork, and its contact with the succeeding zone of metamorphic and eruptive rocks marks the line between the Coast Range and the Klamath Mountains. This succeeding zone of metamorphics also extends through the county from north to south, widening out toward the north, where its width is about 15 miles. It is composed mainly of serpentine with unaltered masses of peridotite and many inclusions of 'diorite,' more or less altered. This belt is mineralized and most of the deposits of gold, copper, chromite, and platinum are associated with it. Between here and the eastern boundary there is another narrow belt made up largely of Franciscan schist and slate, intruded by deep-seated igneous and volcanic rocks. Serpentine again predominates along the boundary and extends over into western Siskiyou County."

Clay Resources.

Deposits of common clay suitable for brick manufacture occur at several points within a short distance of Crescent City, especially in

[1] Laizure, C. McK., Del Norte County: State Mineralogist's Report XXI, p. 282, July, 1925.

Elk Valley and along the Smith River. A small brick yard, with a wood-fired kiln, was at one time operated by Benjamin Howland, who used clay from the Musick property, in Elk Valley, 4.8 miles from Crescent City.[1] There is said to be a deposit of good pottery clay in Elk Valley,[2] but this could not be verified in the course of the present investigation.

Musick Property. This property lies 0.3 mile north of the Elk Valley road, from a point 4.5 miles from the center of Crescent City. The pit, now abandoned, is 25 feet in diameter, and three to four feet deep. A layer of black soil, less than one foot deep, overlies a yellow plastic clay, of unknown thickness and lateral extent.

Sample No. 180 was taken from this deposit. The test results are on page 326.

FRESNO COUNTY.

General Features.[3]

Fresno is one of the southern counties of the San Joaquin Valley. Madera and Merced counties are on the north, Mono and Inyo on the east, Tulare and Kings on the south, and San Benito, Monterey and San Luis Obispo on the west. The area of the county is 5977 square miles, or nearly three times that of the State of Delaware. The population is 128,779 (1920 census). The San Joaquin River separates Fresno from Madera County, and the eastern boundary runs along the summit of the Sierra Nevada Mountains. Along this line are numerous peaks exceeding 13,000 feet in elevation above sea level.

Adequate transportation is provided throughout the populous section of the county by two railroads—the Southern Pacific and the Santa Fe—each of which has many branches to important points. Power and water facilities are well provided for mining, industrial, and agricultural purposes.

The principal wealth of the county is in agricultural products, and the greater part of that portion of the county lying in the San Joaquin Valley is under cultivation. The most important mineral product is petroleum, the bulk of which is produced from the Coalinga field, and is responsible for placing Fresno County sixth in importance as a mineral producer among the counties of California. Miscellaneous stone is of secondary importance. Other commercial products are natural gas, granite, brick and hollow tile, gold and silver, and mineral water. Comparatively little mineral development has been done in the mountainous portion of the county, but occurrences of many useful minerals other than those noted above are known, among which are asbestos, barytes, chromite, copper, gems, graphite, gypsum, limestone, magnesite, marble, quicksilver, and tungsten.

Clay Resources.

No commercial deposits of high-grade clays have been discovered in the county. The alluvial silts of the San Joaquin Valley have been utilized for many years for the manufacture of common brick and hollow tile. There is, however, a scarcity of common clay of suitable plasticity for this purpose, and it has often been necessary to ship in

[1] State Mineralogist's Report XIV, p. 379, 1913–14.
[2] *Idem.*
[3] See State Mineralogist's Rept. XIV, pp. 429–432, 1914.

small quantities of this material to the brick yards from distant points. Two brick plants are at present (1927) in operation, one of which makes hollow tile and face brick in addition to common brick.

Craycroft-Herold Brick Co. F. J. Craycroft, president, 407 Griffith-McKnight Building, Fresno; Wm. Turner, vice president and superintendent. The plant is located at Crayold siding three miles west of Fresno. The products are common brick, ruffled and plain face brick, and hollow tile.

Some of the clay used in the plant is from a superficial valley deposit of plastic clay 6 miles south of Merced. The deposit is mined to a depth of 14 feet, and one car (50 tons) per day is used to mix with a local clay from a pit near the plant. The local clay is mined to a depth of five feet with a horse scraper. It is a valley silt, with insufficient plasticity to be used alone.

The plant is equipped with a 9-ft. dry pan and revolving screen for preparing the tile mixture, and a No. 4 Williams pulverizer for the brick mixture. The ground mixture is elevated to bins from which it is fed to the pug-mills by automatic feeders. An American No. 2 auger is used for tile, and an American No. 4 auger with a Freese cutter shapes the brick. Drying is generally under sheds, as under the prevailing conditions the waste heat drier with which the plant is equipped has insufficient capacity, and operating costs are higher than open-air drying. In the summer, when the atmosphere is hot and dry, the ware is dried in about seven days.

The face brick are fired in three 38-ft. round down-draft kilns. Common brick and hollow tile are fired in field kilns, having a capacity of 950,000 common brick each. The fuel is oil, atomized with steam. The firing period is 7 days, to a temperature of 1900° F., followed by 7 days cooling. Pyrometers are used to control the temperature of the down-draft kilns.

The capacity of the plant is 56,000 brick and 6,000 hollow tile per day. Electric power is used throughout the plant.

Bibl: State Mineralogist's Report XIV, pp. 433–434; Bull. 38, p. 242.

Pioneer Brick and Tile Company. T. W. Hasty, president and manager; Arthur Bentley, superintendent. Address P. O. Box 614, Fresno. The plant is at California and Peach avenues, south of Fresno. Common red brick is the only product.

A local valley clay is used, and it is mined to a depth of five feet with a Bay City gasoline shovel. Hardpan underlies the clay. The clay is delivered to a Potts disintegrator, from which it is carried by a belt conveyer to a pug-mill, followed by a Bonnett auger, equipped with a Freese cutter. The brick are dried in sheds, requiring from seven to ten days. Three open kilns are in use, fired with oil, atomized with steam. The kilns have a capacity of 1,060,000 brick each. The firing period is 5½ to 6 days, to a maximum temperature of 1550 to 1600° F., and cooling requires 4 to 5 days. One and one-half barrels of oil are used per thousand brick.

The capacity of the plant is 40,000 brick per day. Electric power is used for all machinery.

GLENN COUNTY.

General Features.

Glenn County lies on the west side of Sacramento Valley, north of Colusa, and south of Tehama. Its area is 1259 square miles, and the population is 11,853 (1920 census). Willows is the principal town. The western portion of the county is in the foothills of the Coast Range, and the eastern portion is in the basin of Sacramento Valley. In the foothills, deposits of chromite, copper, manganese, sandstone, and soapstone have been found. The only commercial mineral production in recent years is of sand and gravel.

Clay Deposits.

Brick clays are abundant, especially in T. 19 and 22, R. 3 W., M. D. M. The clays are chiefly sandy loam. No brick have been made since about 1895, but several yards were operated near Willows previous to that time.

Bibl: State Min. Bur. Bull. 38, p. 243.

HUMBOLDT COUNTY.

General Features.

Humboldt County, of which Eureka is the county seat and principal town, is on the north coast, between Del Norte and Mendocino counties. Although the harbor facilities at Eureka are excellent, the progress of the county was slow completed through to Eureka from the south.

The greater part of the country is rugged and mountainous. The ridges and spurs of the Coast Range traverse the county in a northwesterly direction, roughly paralleling the coast line. The coastal plain is narrow and along the greater part of the coast line is practically nonexistent.

The area of the county is 1259 square miles and its population is 11,853 (1920 census).

Geology.

The geology of the county has been summarized by Laizure[1] as follows:

"Sedimentary formations extend from the Mendocino County line north along the coast to a point about five miles north of Arcata. They cover a strip about 12 miles wide at the south end. Where the belt crosses the Humboldt Base Line, the formations have a width of 30 miles, gradually running out to a point at the north. In the southern part the rocks consist of massive marine sandstones, with some shale and limestone beds, all of Cretaceous age. The northern part is composed of clay shales and sandstone of Tertiary age, with small areas of Quaternary sands, gravels and clays, notably along the lower reaches of Eel River. The eastern boundary of these sediments runs a little west of north. The contact on the east and covering all the southeastern portion of the county, and extending northwest to Rocky Point above Trinidad there is a belt of Franciscan sandstone, chert, and serpentine, about 12 miles in width. A long, narrow strip of Cretaceous shales, with lenses of sandstone three to four miles wide, borders the Franciscan on the east. It enters the county on the southeast at Humboldt Base Line, trends northwest and passes out at Stone Lagoon, near Orick.

"All that portion of the county lying north and east of this belt is composed of Jurassic, Paleozoic, and pre-Cambrian metamorphic and intrusive rocks, including limestones, schists, slates, extensive masses of serpentine, diorite and other crystalline rocks. Most of the gold and copper deposits occur in this area."

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[1] Laizure, C. McK., Humboldt County: State Mineralogist's Report XXI, p. 295, July, 1925.

Clay Resources.

Common clay suitable for the manufacture of red-burning structural ware occurs in sufficient quantity for the needs of the county in the Quaternary sediments along the coastal plain and main streams. Some of the Tertiary formations also contain common clay of good quality. Four brick yards have been operated in the county at various times in the past, one at Fortuna, formerly owned by J. D. Thompson,[1] and three in Eureka, known as the Humboldt Clay Manufacturing Co., the Tracy Brickyard, and the Eureka Brick and Tile Co. Of these, only the last remains in operation, under the name of the Thompson Brick Co.

Pottery clay has been reported in various localities, but none of these have yet proved to be of economic importance. A salmon and pink-burning clay suitable for making earthernware pottery by the casting process has been found on the Angel Ranch, 18 miles from Arcata, and a few tons per year are used in the ceramic art department of the Humboldt State Teachers College. No white-burning clays nor fire clays have been reported from the county. None of the localities were visited where 'pottery' clays have been reported, as the known quality of the clay was not sufficient to be of economic value when the length of haul to possible points of use was considered.

Angel Ranch Clay. Through the courtesy of Mr. R. H. Jenkins of the Humboldt State Teachers College at Arcata, who has worked with a number of Humboldt County clays, a sample of pink or buff-burning pottery clay from the Angel Ranch was secured. The Angel Ranch is near Hungry Hollow, on the county road to Hoopaw, and the deposit is about 18 miles from Arcata, over a fair road. On account of the fact that the clay is not of sufficiently high quality to warrant commercial exploitation from a deposit at such a distance from cheap transportation, the locality was not visited, and little information was obtained regarding the extent of the deposit. See sample No. 181, page 336.

Freshwater Slough Deposit. South of Freshwater Slough, near the northeast corner of Sec. 36, T. 5 N., R. 1 W., H. M. is an exposure of grayish white plastic clay in a road cut. The clay exposure is two feet thick and 60 feet long, overlain by yellowish sandy soil, from three to ten feet thick. Boring or test-pitting would be necessary in order to determine the extent of the deposit. The material is suitable for the manufacture of common brick or hollow tile, as shown by the test results, sample No. 184, page 342.

Loofbourrow Deposit. On the property of Dr. T. L. Loofbourrow, First National Bank Building, Eureka, four miles south of Eureka, and one-quarter mile east of the highway is a deposit of fine-grained, excessively plastic clay with a bluish-gray color when dry. The age of the clay is thought to be Miocene. The clay has been prospected by two narrow open cuts, and by numerous hand-auger holes. One of the cuts is 50 feet long and the other, near by, is 12 feet long. They expose the top of the clay bed, which underlies from 10 to 15 feet of surface gravel and yellowish clay. It is stated that the auger holes

[1] State Mineralogist's Report XIV, p. 392, 1913–14.

demonstrated that the clay has an average thickness of 22 feet over four or five acres. See sample No. 185, page 342.

Bibl: State Mineralogist's Report XXI, p. 302, July, 1925.

W. A. Preston Property. "A bed of high-grade clay is found on the W. A. Preston holdings. Some of this has been used by R. H. Jenkins, of the Humboldt State Teachers College at Arcata, in the production of pottery and for experimental purposes."[1]

The Preston holdings (W. A. Preston, Box 387, Arcata) comprise 160 acres of patented land, the NE¼ of Sec. 28, T. 6 N., R. 1 E., H. M., adjoining the townsite of Arcata. Mr. Jenkins reports[2] that the deposit is not of sufficiently good quality to warrant exploitation at the present time.

Strong's Station. Mr. Malcolm B. Kildale, geologist, submitted a sample of bluish-gray plastic clay from near Strong's Station, on the Van Duzen River. This was tested under sample No. 211. See page 342. The deposit is stated to be extensive, but it is too far from the market to be of value, as it is only suitable for the manufacture of common brick.

Sunny Avenue (Eureka) *Deposit.* On Sunny Avenue, one block south of Myrtle Avenue, in north Eureka, is an exposure of gray plastic clay that is typical of the sedimentary deposits of the vicinity. The exposure of clay that was sampled is two feet thick, lying beneath a thin covering of sandy soil. The full thickness of the clay bed could not be determined from the exposures, but it is reasonable to expect a minimum of ten feet over an area of several acres, and it is likely that commercial deposits of similar material could be found in many places near Eureka or Arcata, if needed. The clay is suitable for the manufacture of red brick and building tile, as shown by the test results, sample No. 183, page 326.

Thompson Brick Company. J. D. Thompson, president and owner, Myrtle and Harrison streets, Eureka. This company was formerly known as the *Eureka Brick and Tile Co.* The property is on Eureka Slough, 1.5 miles from Eureka, and covers 6.18 acres. There is a wharf at the plant. Common brick, drain tile and hollow building tile are made from surface clay that occurs on the property. The drain tile is made in sizes from 3-in. to 12-in. diameter.

The clay is mined from an open pit with a Fordson tractor and a Fresno scraper. The pit has a maximum depth of 12 ft., but good clay is known to extend to greater depths. The clay bed is made up of irregular streaks of yellow, gray and black clay, with a varying proportion of sand. It is generally too plastic to be successfully used alone, and is mixed in the plant with a maximum of 15% of sand. The clay is dumped from the scraper into a hopper and from there it is elevated to the head of the plant in cars drawn by a cable hoist. Sample No. 182 was taken from the deposit. See page 326.

In the plant, the clay is passed through a disintegrator, followed by a pug-mill and a Brevan auger machine equipped with a wire-cutter. The brick or tile are air-dried under sheds. In the cool, moist atmos-

[1] State Mineralogist's Report XXI, p. 302, 1925.
[2] Private communication, August, 1926.

phere of the locality, drying often requires a period of four weeks, and is seldom completed in less than two weeks.

Firing is done in a 30-ft. round down-draft kiln, which has a capacity of 75,000 brick or the equivalent volume of tile. The water smoking is done with wood, for a period of 75 hours. The burn is finished with oil, atomized with steam, requiring 75 hours additional. The finishing temperature is 1850° F.

The machinery is operated by steam power, generated in oil-fired boilers. From five to eight men are employed during the season. The capacity of the plant is 1,000,000 brick or its equivalent per year, and the output is usually about half that amount. The selling price of brick, f.o.b. yard, is $20 to $22 per thousand. Photo No. 14 is a view of the plant.

Bibl: State Mineralogist's Report XXI, p. 301, 1925; Prel. Rept. No 7. p. 46, 1920.

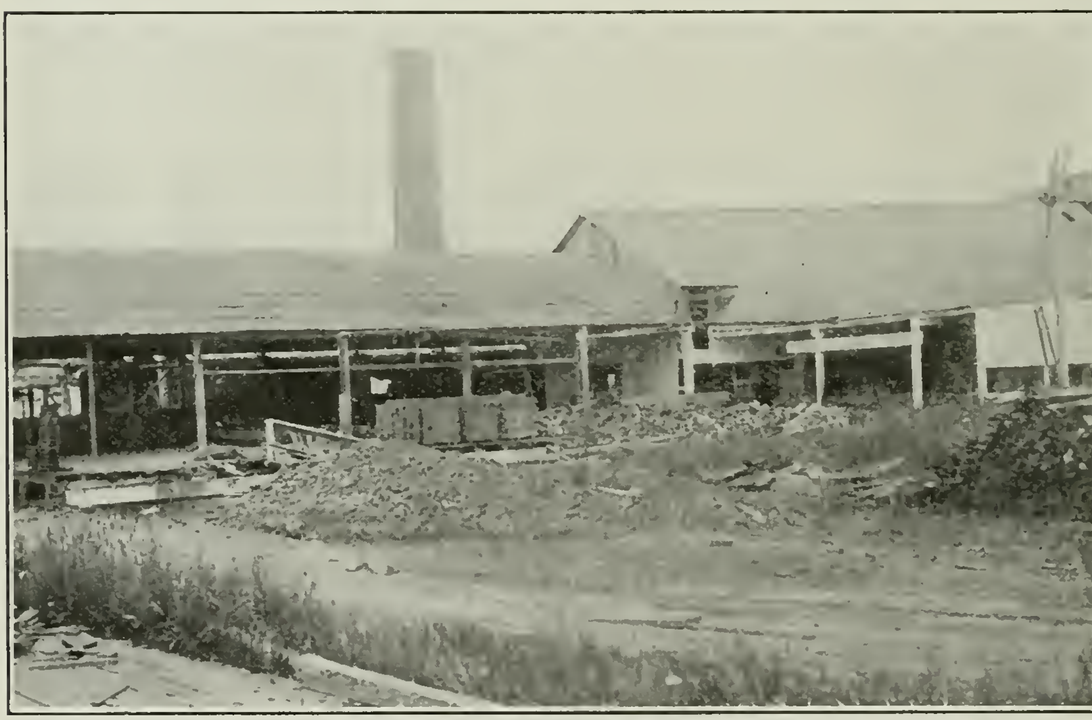

PHOTO No. 14. Plant of Thompson Brick Co., Eureka, Cal.
(Photo by C. McK. Laizure, State Mineralogist's Rept. XXI, p. 301.)

Weatherby Ranch Deposit. "There is a deposit of clay of unknown extent on property of the Hanify Lumber Company, four miles south of Elk River, under lease to Clarence Weatherby, Eel River, via Eureka. The strata exposed in a cut on a ridge through the property show clay underlain with two feet of fine volcanic ash. Underneath the ash is six feet of yellow clay, then two feet of lignite coal, with clay again below the coal. Some production of volcanic ash has been made, but the coal and clay have not been developed. The Hanify Lumber Company's railroad runs within ¼ mile of the deposit."[1]

[1] State Mineralogist's Report XXI, p. 302, 1925.

IMPERIAL COUNTY.

(By W. Burling Tucker, Mining Engineer.)[1]

General Features.

The principal industries of Imperial County are agriculture, stock raising and dairying. Its mineral resources are varied and extensive and the rapid and continued growth of the towns of Imperial Valley and the manufacturing industries of the Pacific coast have led to the development of deposits of structural and industrial materials throughout the county.

Imperial County is bounded on the east by the state of Arizona, north by Riverside County, west by San Diego County and south by Mexico. Its area is 4089 square miles, with a population of 43,383 (1920 census). The county is served by two railroads, the Southern Pacific and the San Diego and Arizona, each of which has several branches to important points. Two main paved highways afford easy access to the county from the north. The highway between San Diego and El Centro forms part of the coast route from Los Angeles to Imperial Valley, Yuma and Phoenix. The other route from Los Angeles is over the Valley Boulevard by way of Beaumont and Banning to Brawley and El Centro. The Blythe-Glamis route to Yuma and Imperial Valley is one of the main desert roads, which enters the county from the northeast at Palo Verde and runs southwest to Glamis, from which point the road follows the railroad north to Niland.

Physiography.

The most important feature of Imperial County is the broad and nearly level expanse of the Colorado River delta, which separates the Gulf of California from the Salton Basin and is known as Imperial Valley. The Salton Sea region is one of the interesting topographical features of the county. Diagonally across the region, from southeast to northwest, it extends as a great trough whose lowest point is nearly 300 feet below sea level. On the west side of this deep trough rise the Peninsular Mountains, whose culminating points are 10,000 feet above sea level. On the east side is a desert containing irregular ranges and undrained basins ranging in altitude from a few hundred feet to 5000 feet or more.

The eastern border of the territory is formed by the Colorado River, whose waters flow through a low valley and finally spread out over a huge delta as they enter the Gulf of California.

The surface of the central portion of the Salton Basin is very even and nearly flat; about its borders are alluvial slopes. In a number of places rocky masses protrude above the even surface of the basin as rocky islands project out of the sea. Such island-like features are formed by Borego, Superstition and Carrizo mountains, the Cargo Muchacho Mountains, Pilot Knob and a number of volcanic buttes 100 to 200 feet high south of Salton Sea.

The Sand Hills constitute an important feature of the physiography of Salton Basin. The sand hills east of Imperial Valley constitute the largest belt of dunes in this region and also one of the largest in the United States. They extend southeastward from the vicitity of Amos

[1] State Mineralogist's Report XXII, pp. 248–285, 1926. Such portions of this report were used, with a few slight alterations, as have a bearing on the clay resources of the county.

and terminate a few miles beyond the Mexican boundary, being about 40 miles in length and from two to six miles in width. The crests of some of the dunes rise in places 200 to 300 feet above the land on either side.

Another interesting feature of the Salton Basin is the old beach line which lies 40 to 50 feet above sea level and encircles Imperial Valley, the Salton Sea and part of Coachella Valley south of Indio.

Geology.

The most useful references on the geology of the region are Blake's original description of the Salton Basin,[1] and Mendenhall's papers on Coachella Valley and Carrizo Creek,[2] Fairbanks' report,[3] and U. S. Geol. Survey Water Supply Paper No. 497, 'The Salton Sea Region, California,' by John S. Brown. In the following notes on the geology of Imperial County excerpts are taken from the last-named paper:

According to most geologists who have worked in this region, the oldest rocks are probably of pre-Cambrian age. The pre-Cambrian rocks occur mainly in the desert mountains in the region between the Salton Basin and the Colorado River. They are commonly flanked by Tertiary or later sediments about the mountain borders and in large areas they are covered or intruded by Tertiary volcanic rocks. The rocks that can most certainly be referred to as the oldest series consist of granite and granitic gneiss. In this series probably belong the granite and schist that compose most of the Cargo Muchaco Range and the granite, slate, and schist that form the basements of the Picacho Hills and the eastern part of the Chocolate Mountains. On the western border of the desert in Carrizo Mountain, and on the top of Fish Mountain in the Carrizo Creek region, are beds of marble and some schist and sandstone which have been referred by Mendenhall and Fairbanks to the Paleozoic, with suggestion that they may be Carboniferous. Marble schist and gneiss of undetermined age in the Santa Rosa Mountains may belong to the same series of rocks as the Carrizo Mountain district.

Tertiary Sedimentary Deposits.

Sedimentary beds, believed to be of Tertiary age, occupy extensive areas along the southwest and northeast sides of the Salton Basin and presumably underlie practically the entire basin. The largest and best-known exposures southwest of Salton Sea are in Carrizo Creek Valley, around Yuba Well, south of the Santa Rosa Mountains and northeast of Superstition Mountain and Borego Mountain, and on the north side of Fish Mountain. The Tertiary beds consist of soft, poorly consolidated conglomerates, sand and clay containing in places a large amount of gypsum and some other saline materials. Part of the Tertiary beds in the region are marine and part terrestrial.

Tertiary and Quaternary Volcanic Rocks.

The volcanic rocks of this area are probably mostly Tertiary; some of them are Quaternary. They occur as flows interbedded with sedimentary beds in the Carrizo region, around Superstition Mountain, and in Iris Pass. The lavas are most prominent in the Chocolate and Palo

[1] Blake, W. P., Pacific Railroad Reports, Vol. V, 1853.

[2] Mendenhall, W. C., Ground waters of the Indio Region, Calif., with a sketch of the Colorado Desert: U. S. Geol. Surv., Water Supply Paper No. 225, 1909.

[3] Fairbanks, Harold W., Geology of San Diego, Orange and San Bernardino Counties: State Mineralogist's Report XI, pp. 76–120, 1892.

Verde mountains. The Palo Verde Mountains are entirely volcanic, being chiefly a mass of andesitic or rhyolitic flows. The Chocolate Mountains, from one end to the other, exhibit a great mixture of andesitic and rhyolitic flows with possibly syenite and trachyte in the west end.

The only volcanic material of unquestionably Quaternary age in this region is found in the vicinity of the mud volcanoes southeast of Salton Sea, where three or four small buttes of black obsidian protrude through the Quaternary silt.

Quaternary Deposits.

The Quaternary deposits immediately underlie nearly all the lowlands and have the largest areal extent of all the rock formations. They underlie the larger part of the Salton Basin and practically all of the Colorado River Valley. The valley fill consists of sand, gravel and clay washed down from the hills and mountains.

Mineral Resources.

Imperial County ranks as the forty-sixth county in the state's mineral production. It contains deposits of clay, copper, cyanite, gold, gems, gypsum, lead, manganese, marble, mineral paint, pumice, salt, silver, sodium, strontium, sulphur and talc, largely undeveloped.

Clay Resources.

Imperial County contains extensive deposits of river silt that has been used for the manufacture of common brick and tile.

Extensive exposures of Tertiary clays are found on the west margin of Imperial Valley toward Carrizo Creek. These clays are many miles in extent and of great thickness, but have not been prospected sufficiently to determine their value for commercial purposes. On these Tertiary clay deposits a number of locations have been made by the Columbia Cement Company, of Los Angeles, and the American Portland Cement Company, of San Diego. Of special interest to the ceramic industry is the extensive deposit of cyanite at Ogilby.

During the development of the towns of Imperial Valley, a number of local brickyards have been established and operated for a short time. The Simons Brick Company, described below, is the only operator in the county at present.

Full Moon Clay Deposit. The deposit is located on the southwestern slope of the Chocolate range of mountains, in T. 10 S., R. 16 E., S. B. B. and M., eight miles north of Iris siding on the Southern Pacific Railroad.

Holdings comprise five claims known as the Full Moon group. Owner, J. Thebo, of La Mesa, California.

The clay is a white talcose clay, showing a high alumnia content. The development consists of a number of open cuts along the surface outcrop. Analysis of clay made by A. J. Forget, of Los Angeles:

Silica (SiO_2)	27.93%
Alumina (Al_2O_3)	42.33%
Iron (Fe_2O_3)	1.92%
Lime (CaO)	0.53%
Soda	0.70%
Water (combined)	12.44%
Moisture	0.74%
Sulphur anhydride (SO_3)	13.39%
	100.00%

Simons Brick Company. Walter R. Simons, president. Main office, 125 West Third Street, Los Angeles. This company is the only manufacturer of brick and tile in the valley at the present writing and only operates the plant at intervals to supply the local demand. The brick plant is located about one mile southeast of El Centro.

The clay used is local silt of the valley, which is very fine and sticky. This deposit continues unchanged to a depth of 1500 feet as shown by local borings, but varies slightly in texture and the proportion of sand present, the variations in composition occurring every three or four feet. This variation enables the brick maker to mingle layers of different qualities and form a brick mixture of suitable character.

The material from the clay pit is delivered by scrapers to the hopper, from which it goes to a belt conveyor, and is elevated to a set of rolls. The material from rolls is elevated by bucket elevator to a screen. The through size from the screen goes to two stiff-mud brick machines. The brick and tile go to drying sheds, then are oil fired in open-field kilns.

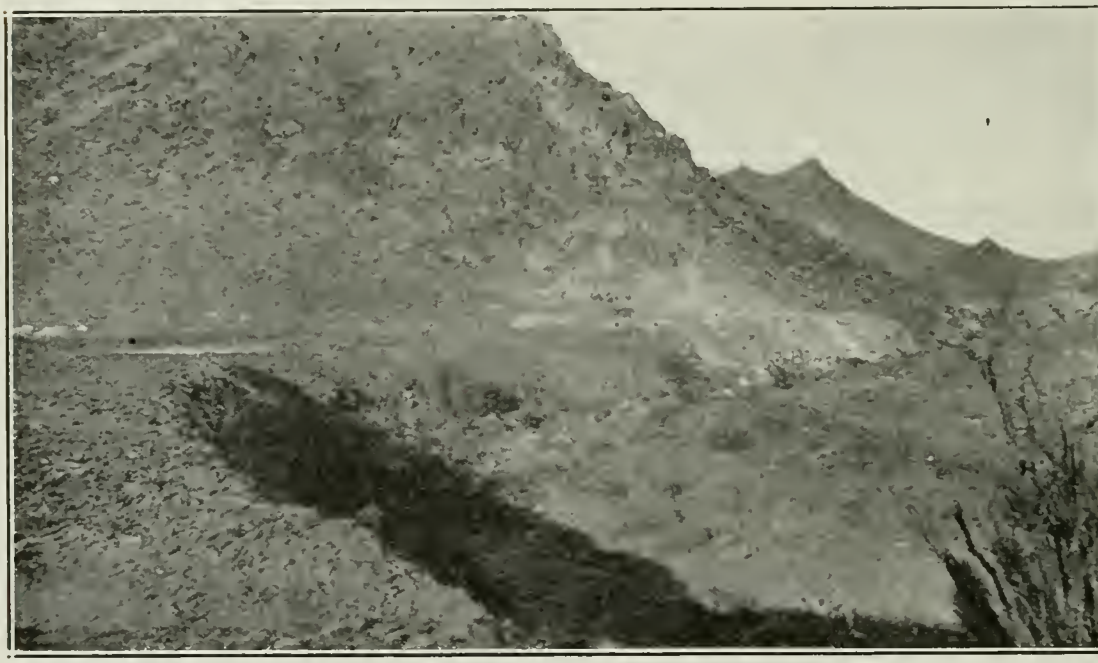

PHOTO No. 15. Vitrefrax cyanite deposit, Cargo Muchacho Range, near Ogilby, Imperial County. Photo by W. B. Tucker; State Mineralogist Rep. XXII, p. 270.

CYANITE AND DUMORTIERITE.

Cyanite ($Al_2O_3.SiO_2$) and dumortierite ($8Al_2O_3.B_2O_3.6SiO_2.H_2O$) are both aluminum silicates but with slightly different physical characteristics. Cyanite is an aluminum silicate of the same chemical composition as andalusite and sillimanite, but crystallizing in the triclinic system; occurs usually in long-bladed crystals rarely terminated; hardness, 5–7.25; gravity, 3.56–3.67; color, blue.

An extensive deposit of cyanite occurs near Ogilby, which is being developed by the Vitrefrax Company, of Los Angeles.

Dumortierite is a basic silicate of aluminum, with boron, but crystallizing in the orthorhombic system. It occurs usually in small prisms; color, blue, dark blue and violet-red; hardness, 7; gravity, 3.22–3.45.

Dark blue boulders of dumortierite have been found in the washes in the Picacho district about 25 miles from Ogilby. These metamorphic minerals are found in the schists and gneisses.

Ogilby Cyanite Deposits. The deposits of cyanite occur near the base of hills on the western slope of the Cargo Muchacho range of mountains, three miles northeast of Ogilby. Elevation 500 feet. Holdings comprise ten claims known as the Drifted Snow and Blue Bird groups, 200 acres. Owner, Vitrefrax Company, 5100 Pacific Boulevard, Los Angeles.

The first discovery of cyanite was made in a low, rounded hill one-eighth mile wide by one-half mile long, and probably consists of 25 per cent cyanite in a matrix of quartz. One-quarter of a mile farther east, a prominent vein of cyanite outcrops for one-half mile in length, at the foot of the Cargo Muchacho range. The vein, which occurs in a mica schist, is nearly vertical and varies from 10 to 200 feet in width. Open cuts and tunnels have been made along the deposit for a distance of over 500 feet along the strike. The most extensive showing has been found on the north end of the deposit. Here it outcrops for over 200 feet in width. Quartz is the gangue mineral, while small amounts of black tourmaline occur throughout the vein material. On the south end of the deposit, both walls of the vein have a selvage of talc.

Eight to ten men are employed in getting out material for shipment to the company's plant at Los Angeles, where it is being used in the manufacture of high-grade refractories.

INYO COUNTY.

(By W. Burling Tucker.)[1]

General Features.

Inyo County lies on the eastern border of the state, north of San Bernardino County. It is the second largest county in the state, with an area of 10,019 square miles. The population is but 7031 (1920 census). 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, and Salt Flat, in Death Valley, is 280 feet below sea level.

In recent years the county has become more accessible with the construction of several automobile highways which supplement the railway lines that already served important points.

Geology.

The general geology of the county has been described in detail in Report XV of the State Mineralogist, pp. 45 to 60, and a geologic map accompanies that report. Granitic rocks form the backbone of the principal mountain ranges. Paleozoic and Mesozoic metamorphic formations, principally crystalline limestones, quartzites, and schists are prominent in the eastern part of the county. These have been intruded by porphyry and diorite, and there have been numerous flows of rhyolite, andesite, and basalt. Tertiary sediments were deposited in the Death Valley region, and saline deposits formed from the evaporation of sea waters.

In the higher mountainous sections are found many vein-forming minerals, and in the lake beds of Death Valley saline deposits exist. The mineral resources include andalusite, antimony, asbestos, barytes,

[1] Inyo County, State Mineralogist's Report XXII, pp. 453–530, 1926. Portions of this article were abstracted for use in the present report.

borates, copper, dolomite, gems, gypsum, lead, marble, montmorillonite ('bentonite,' 'shoshonite' and 'amargosite'), soda, sulphur, talc, tungsten, and zinc. The principal products are lead, soda, borates, bentonite, and silver.

Clay Resources.

Extensive beds of Tertiary clay occur along the Amargosa River in the vicinity of Shoshone and Tecopa. These beds vary in thickness from 6 to 20 feet and in different localities are covered with an overburden of volcanic ash and gravel wash.

Fairbanks Clay Deposit. R. J. Fairbanks, owner, Shoshone.. The property is situated one mile southeast of Shoshone, on the west side of the Amargosa River. The holdings comprise 160 acres. Elevation 1600 feet.

The beds of clay trend north and south and are 6 to 8 feet thick, overlain by 4 to 6 feet of volcanic ash. The clay is green in color and quite plastic.

The Pacific Minerals and Chemical Company and Gladding, McBean and Company, of San Francisco and Los Angeles, also own deposits of clay located between Shoshone and Zabriskie.

KERN COUNTY.

General Features.[1]

Kern is the southernmost county in the San Joaquin Valley, and takes in the southern portion of the Sierra Nevada Mountains, includes a portion of the Coast Range in its western end, and to the south and east of the Sierras it encloses a large section of the Mojave Desert. The total area of the county is 8100 square miles. It is the third largest county in the state, and is bounded on the north by Tulare, Kings and Inyo, on the south by Los Angeles and Ventura, on the east by San Bernardino, and on the west by San Luis Obispo. It is characterized by greater variety and contrasts of topography, geology, climate, and resources than any other California county.

The northern part of the county is well provided with water and power for industrial, agricultural and mining purposes. In the southern part of the county, on the Mojave Desert, water is relatively scarce, but power can be secured for all important purposes from the lines of the Southern California Edison Company, now one of the largest power systems in the world. Transportation facilities are provided to important points in the county by the Southern Pacific and Santa Fe railroads, supplemented by a system of state and county highways.

The principal mineral product is petroleum, the production of which maintained for many years the supremacy of Kern County among all counties of California in the value of its mineral output. Kern was surpassed by both Los Angeles and Orange counties in 1923, but by Los Angeles only since then, for which petroleum also is responsible.

Among the commercial mineral products of the county, in addition to petroleum, are natural gas, borates, cement, brick and clay, gold and silver, salt, miscellaneous stone, and antimony. Other minerals that have been discovered or that have been worked in the past are: asphalt,

[1] State Mineralogist's Report XIV, pp. 471–475, 1914.

copper, fuller's earth, gems, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, potash, soapstone, soda, sulphur, and tungsten.

Clay Resources.

The alluvial silt of the San Joaquin Valley, in the vicinity of Bakersfield, has been in use for many years for the manufacture of common brick. As is the case in Fresno County, deposits of plastic common clay are scarce. The local silts have barely enough plasticity to permit the manufacture of a satisfactory grade of common brick by the soft-mud process. Two brick plants are in operation in Bakersfield.

A deposit of high-grade clay at Rosamond, near Mojave, has attracted attention for many years. It is possible that more extensive prospecting in the desert region will disclose other deposits of high-grade clays.

Bakersfield Rock and Gravel Company. A. H. Kaspe and W. J. Walters. It is reported [1] that this company was developing clay lands in 1927, in connection with its sand and gravel business. A conveyor system, storage bins, and loading equipment were to be installed, at a cost of $18,000. Further details are lacking at the time of going to press.

Bakersfield Sandstone Brick Company. James Curran, manager. Office and plant at 501 Sonora Street, Bakersfield. The company owns 40 acres of land.

Common red brick are manufactured from an alluvial silt which is mined to a depth of ten to twelve feet with a clam-shell excavator. The soft-mud process is used. The plant is equipped with a pug-mill and a Martin press. Drying is done on steel trucks, either in the open, or under sheds. As the plant is only operated during the dry season, drying is usually completed in seven days. Firing is done in field kilns, which are started with gas and finished with oil, atomized with steam. Thermo-electric pyrometers are used for recording temperatures. At the fire-holes, the finishing temperature is 2100° F., two feet above the arch it is 1840° F., and two feet below the top it is 1750° F.

The capacity of the plant is 40,000 brick a day, and 14 men are employed during the operating season.

Bibl: State Mineralogist's Rept. XIV, p. 477; and Prel. Rept. No. 7, p. 48.

Kern County Brick Co. Owned by King Lumber Co., Elmer King, president, Bakersfield. This property comprises 12 acres in Sec. 21, T. 29 S., R. 28 E., M. D. M., on the eastern outskirts of Bakersfield. The deposit is a sandy loam 25 feet thick, and has been used for the production of common brick since about 1900. The soft mud process is used, the equipment consisting of a disintegrator, pug-mill, and 6 mold press. Cable haulage is used to transport the brick from the presses to the drying sheds. Firing is done in oil-fired field kilns. The capacity of the plant is 37,000 brick per day, the annual production depending upon local demand. Ten men are employed.

Titus Clay Deposit. H. E. Titus of Rosamond owns two placer claims totaling 40 acres, comprising the NW¼ of the SE¼ of Sec. 11, T. 9 N., R. 13 W., S. B. M., covering a deposit of pottery clay of good

[1] Clay-Worker, May, 1927, p. 486.

quality. The distance by road from Rosamond is 4.8 miles in a direction slightly north of due west. The clay has been developed by an open pit, and by a 200-foot tunnel, now inaccessible.

The clay is enclosed in felsite porphyry, and is apparently a local alteration and decomposition in place, of a phase of this rock. Inclusions of porphyry in various stages of alteration are intermingled with the clay. The deposit has no definite stratification, but appears to lie in a nearly flat bed, overlain by a red-colored porphyry capping.

The known dimensions of the deposit is 300 feet wide, 700 feet long, and 50 feet deep, with unknown possibilities for extension in any of these dimensions. The property was formerly known as the Hamilton deposit. At various times during a period of over 10 years, clay has been mined from an open pit, and shipped to ceramic plants in the Los Angeles district, notably the Los Angeles Pottery Company and the Pacific Sewer Pipe Company both of which are now non-existent under their original names or ownership, and more recently to the Tropico plant of Gladding, McBean & Co. The clay has been used in stoneware and sewer-pipe mixtures, and a commercial test run has been made for terra cotta mixtures. It is likely that the property will eventually be acquired by one of the manufacturing companies, although at present development work has not progressed far enough to permit a prediction as to the probable tonnage and quality that can be expected beyond the known limits of present knowledge. Sample No. 114 was taken from this deposit, and the test results are given on page 312.

W. S. Webb of Rosamond owns a property one mile west of the Titus claims, on what is a supposed extension of the same clay bed. This property was not visited.

Merry Widow Mine. Mrs. Mary Y. Smith of Rosamond is the principal owner of the Merry Widow mine comprising two lode claims in the SW¼ of Sec. 8, T. 9 N., R. 12 W., S. B. M., 2.8 miles by road north of Rosamond, of which 1.6 miles is on the highway to Mojave. This is in the Rosamond gold mining district, now idle, but at one time a small producer of gold from narrow veins in granite porphyry and slate. Two samples were taken from an 800-foot tunnel on the Merry Widow property. One of these, No. 115, is footwall gouge from a drift on a vein encountered at a point 200 feet from the portal of the tunnel. The gouge is over five feet in thickness, and lies at an angle of 45 to 50°, dipping south. About 40 feet of this material, measured along the strike of the vein, is exposed in the drift. The test results, page 349, show that the clay has little value for ceramic purposes, on account of poor plasticity, red color, high shrinkage, fire splitting, and low fusion point.

The other sample, No. 116, was taken of the decomposed rock that occurs near the portal of the tunnel. It is evidently an altered granite porphyry. Test results, page 349, were even less favorable than those obtained on sample No. 115.

KINGS COUNTY.

General Features.

Kings County is in the south-central portion of the state, south of Fresno County. Its area is 1559 square miles, and the population is 22,031 (1920 census). The principal town is Hanford. The western edge of the county is in the foothills of the Coast Range. The rest of the county is in the basin of the San Joaquin Valley.

The mineral resources of the county are practically undeveloped. Deposits of fuller's earth, gypsum, mineral paint, natural gas, and quicksilver have been noted. The commercial production is almost negligible.

Clay Resources.

Common brick clays are reasonably abundant in the vicinity of Hanford and elsewhere in the county. Two former brickyards, the Clinker Brick Company and Trewhitt Brickyard, both near Hanford, were abandoned prior to 1911.

Bibl: State Mineralogist's Rept. XIV, p. 527, 1913–14; State Min. Bur. Bull. 38, p. 243; Prel. Rept. 7, p. 49.

LAKE COUNTY.

General Features.

Lake is one of the counties north of San Francisco Bay. It is bounded on the north by Mendocino and Glenn counties, on the east by Glenn, Colusa and Yolo, on the south by Napa, and on the west by Sonoma and Mendocino. It has an area of 1328 square miles, and its population is 5542 (1920 census).

The outstanding physiographic feature of the county is Clear Lake, which has been a prominent resort area for many years. Clear Lake is surrounded by rolling hills in which are many interesting geological features. The prevailing rocks in the county are the Franciscan (Jurassic) serpentines and slates and Tertiary volcanics. There is a small area of Pliocene, and an area of Quaternary near Clear Lake, besides some undifferentiated Tertiary formations at the southern extremity of Clear Lake.[1]

Mineral production in the past has been comparatively small, and has been largely confined to quicksilver and mineral water. Some of the leading minerals found in this section, in part as yet undeveloped, are borax, clay, copper, gems, gold, gypsum, mineral water, quicksilver, silver, and sulphur.

The entire county is but sparsely settled, and is without rail connections. Besides the production of minerals, the population is engaged in farming, stock raising, and the operation of summer resorts at the numerous mineral springs in the county, and on the shores of Clear Lake.

Clay Resources.

The county was visited by the author in September, 1925, and attempts were made to examine clay occurrences that had been reported previously by the Bureau,[2] in which had been mentioned a line of kaolin deposits near the Mount Sam Quicksilver Mine, and undeveloped deposits at Glenbrook, Kelseyville, Soda Bay, and Sulphur Bank. Inquiry was made among local inhabitants, and a number of localities were visited, but no evidence of these deposits could be discovered. As

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[1] Smith, J. P., The geologic formations of California: Cal. State Min. Bur. Bull. 72, and geologic map.

[2] Bull. 38, p. 361. Rept. IX, p. 303; XIV, 204. Prel. Rept. 7, p. 49.

time was not available for prospecting, the search was abandoned. It is obvious that only a deposit of exceptionally high-grade clay would have commercial value in this region, on account of the cost of transportation to market, and while the possibility that such a deposit may be found can not be entirely eliminated, it is unlikely.

Common brick clay is not abundant in this region, but there is little likelihood that a brick yard will ever be established on account of lack of market. A few samples of common clays were taken from deposits near Kelseyville, but only one of these, No. 188, was tested. This is a clay shale from an undeveloped exposure 1.4 miles southeast of Kelseyville on the Lower Lake road. The test results are on page 336.

LASSEN COUNTY.

General Features.

Lassen County is in the northeast portion of the state, south of Modoc, which is the northeasternmost county. Its area is 4531 square miles, and the population is 8507 (1920 census). It is a succession of mountain ranges and high-altitude plateaus, and is only partly developed. Almost the entire area of the county is covered with Tertiary and Quaternary lavas. In the valleys and around the shores of lakes are Quaternary sediments. Occurrences of copper, gems, gypsum, gold, silver, and sulphur are known. There is a small annual production of gold, silver and miscellaneous stone.

Clay Resources.

The county was not visited in the course of the present investigation. It is obvious that only clays having exceptional unit value could be commercially produced in the region. A deposit of clay is reported on the Anderson Ranch, at Hayden Hill, owned by H. P. Anderson, but details are lacking. Hayden Hill is a gold mining district. It is possible that kaolinization of some of the rhyolite tuffs, especially those high in alumina, that are known to occur in this district, may have resulted in the development of high-grade clays.

In Preliminary Report 7, p. 49 (1920), the following notes are given:

"J. E. Pardee, Susanville. Common brick clay. No recent production.

"A. E. Buehler, Susanville. Formerly operated a clay deposit, but no recent production."

No recent data are available.

LOS ANGELES COUNTY.[1]

General Features.

Los Angeles County is bounded on the north by Kern County, on the east by San Bernardino County, on the south by Orange County, and on the west by Ventura County and the Pacific Ocean.

The ocean shore line extends for about ninety miles. The county comprises 4067 square miles, a large part of which is mountainous. The population, according to the 1920 census, is 936,438.

The chief topographic features of the county are the mountain ranges, the valleys, and the great Los Angeles Plain which stretches

[1] Tucker, W. B., Los Angeles County, State Mineralogist's Report XXIII, p. 287, *et seq.* No data on the ceramic industry are given in this reference, but Mr. Tucker's general description of the county was freely drawn upon.

from the foothills to the sea. The highest peaks of the mountains are in the San Gabriel Range, in the northeastern part of the county, and are over 10,000 feet high. Other ranges in the county are the Santa Susana and Santa Monica. The San Gabriel Range is chiefly formed of crystalline rocks, with its central axis consisting of granite, with gneisses and schists on its flanks. The Santa Susana and Santa Monica ranges are chiefly formed of Tertiary sedimentary rocks.

There is only a small production of metals in Los Angeles County, its principal mineral wealth being in structural and industrial materials, petroleum, and natural gas. Since 1923, Los Angeles County has led all other counties of the state in the value of its mineral production, largely due to its petroleum production.

Among its mineral resources may be noted asphalt, barytes, borax, brick, clay, copper, diatomite, fuller's earth, gems, gold, gypsum, lead, limestone, marble, mineral paint, mineral water, natural gas, petroleum, glass sand, sandstone, serpentine, silver, soapstone, miscellaneous stone, and zinc.

Clay Resources.

Los Angeles county is especially fortunate in that there is an ample supply of common clay and shale for the manufacture of heavy structural ware, such as common brick, hollow tile, roofing tile, sewer pipe, etc. Close to the metropolitan area of the city of Los Angeles are numerous deposits of shale and loam that have been in use for many years for the manufacture of these products. Property values have increased to such an extent in recent years that many of these deposits have been sold for business or industrial purposes, but there are still a number of plants in operation within a radius of one mile from the business center of the city. In the outskirts of the city, on almost every side, within a radius of 20 miles from the downtown section, are numerous clay and shale deposits that are being utilized by the ceramic industry. Perhaps the most important of these deposits is in Santa Monica, where a number of brick yards have been established, and from which clay is mined for use in other plants of the county. The Santa Monica clay is not only suitable for the manufacture of common brick, but is extensively used in hollow tile, roofing tile, sewer pipe, electric conduit, face brick, and other structural ware bodies.

No high-grade clays are produced in the county. It is claimed that high-grade clays occur on the Malibu Ranch, north of Santa Monica (see under Malibu Pottery), but these have not been extensively prospected, and at this writing little information was available as to the extent and character of these clays.

On account of extremely favorable industrial conditions in the Los Angeles district, with a combination of cheap power, fuel and labor, adequate spur track facilities, equable climate, and an extensive market arising from the rapid growth of the region, there are a large number of ceramic plants in the county, and practically every commercial type of ceramic ware is being manufactured in one or more plants. The high-grade clays needed by the industry are largely obtained from the Alberhill-Corona deposits in Riverside County and from deposits in Orange and San Diego counties. The freight rate on clays from the Alberhill district is about $0.90 per ton, in carload lots, and the costs of mining are relatively low, so that most grades of clay from Alberhill can be delivered in Los Angeles at a cost of $2 to $6 per ton. Some Lincoln and Ione clays, from Placer and Amador counties, respectively, are shipped into Los Angeles for use in the manufacture of terra cotta, floor tile, stoneware, and pottery. English china and ball clay, and clays from Florida and Kentucky are also imported for the manufacture of whiteware and tile, at a cost of $14 to $25 per ton, delivered. Southern California abounds in deposits of feldspar and silica, especially in San Diego and Riverside counties, so that these materials may be secured by the local industry at comparatively moderate cost.

Descriptions of individual clay deposits and ceramic plants follow. The field work was done during the summers of 1925 and 1926, and the industry has been growing and changing rapidly, so that it is obviously impossible to present the latest information on all plants. Attempts were made by correspondence to bring all material up to date as of November, 1927, but in many cases no replies had been received at this writing. Mr. Tucker, of the Mining Division, rendered valuable service in obtaining data on a number of plants in November and December, 1927.

Acme Brick Company.[1] Thos. Kelley, president; R. L. Worthington, secretary. Office and plant in Santa Monica. The company owns 20 acres of land and manufactures common brick only. The deposit consists of 20 to 30 feet of red and yellow clay, overlain by two feet of soil. The clay is mined in an open pit by a gasoline shovel, which loads into 3-ton side dump cars. The cars are hoisted up an incline to a hopper at the plant.

The soft-mud process is used. The clay is ground in a dry pan, elevated by a bucket elevator to a ¼-inch impact screen, pugged in two pug-mills in series, and finally passes to the brick press, which has a capacity of 60,000 brick per day. The oversize from the screen is returned to the dry pan for regrinding.

Conveyors are used to transport the brick to and from the drier, which is heated by steam from two 150-h.p. oil-fired boilers. Drying is completed in from 24 to 36 hours.

Six oil-fired field kilns are in use, having a capacity of 600,000 brick each.

The plant operates throughout the year. Forty men are employed, and 135 h.p. of electric power are installed.

Alhambra Kilns, Inc. E. H. Ockerman, Alhambra. The company now operates two plants, one at Alhambra and the other at Santa Monica. The site of the Alhambra plant was visited by the author shortly after construction was started, in September, 1926. A request for recent information was addressed to the company on November 11, 1927, but no reply had been received at this writing. It is known that hand-made roofing tile and patio floor tile are being made.

American China Company. W. N. Reeves, owner, 2304 East Fifty-second Street, Los Angeles. This company specializes in single-burn, glazed tile, ready-set for soda fountains, fire places, etc. A portion of the tile used is made at the plant from Alberhill clays, principally E–101 and SH–4 (samples No. 11, p. 257, and 273, p. 273), and also

[1] Data supplied by W. B. Tucker, district mining engineer, December, 1927.

some clay from the Emsco pit near Corona. The balance of the tile is purchased from the California Clay Products Company.

The ware is burned for 24 hours in a gas-fired kiln having a capacity of 400 square feet of tile. The output of the plant varies with the demand up to 75,000 sq. ft. per year.

American Encaustic Tiling Co., Ltd. Frank A. Philo, general manager, Crawford Massey and Mr. Schreiber, ceramists. Los Angeles plant at 2030 East Fifty-second Street; Hermosa Beach plant at 700 Fifteenth Street. The Los Angeles plant was built by the West Coast Tile Company and purchased in 1919 by the American Encaustic Tiling Co., Ltd., a nationally known manufacturer of ceramic floor, wall, and decorative faience tile, with plants at Zanesville, Ohio, and Maurer, N. J., and with head offices at 16 East Forty-first Street, New York City. The Hermosa Beach plant was purchased by the company from the Prouty-line Products Company in 1925.

The company markets a complete line of vitrified and semi-vitrified glazed and unglazed floor, wall, and decorative faience tile. Both the Los Angeles and Hermosa Beach plants manufacture a large variety of colors in glazed, unglazed, and decorative tiles.

With such a diversity of products, it is natural that the raw materials in use at the plant cover a wide range. It has been found that in order to minimize plant difficulties, and to secure a uniformly high-grade product, it is necessary to use a good quality of English china clay, Florida kaolin, English and Kentucky ball clays, in practically all of the white or nearly-white burning mixtures, rather than to attempt to rely upon California materials. However, some of the clays used at the Los Angeles plant, and all of the clays used at the Hermosa Beach plant, are obtained in the State of California. Quartz and feldspar are obtained mainly from the large deposits owned by the company in Riverside County. The company also owns a deposit of 'Cornish Stone' (Sample No. 58), at Dehesa, San Diego County, which is used as an ingredient of a hard, white, vitrified tile, known under the trade name of "Kaospar."

The Los Angeles plant covers about 3½ acres and the Hermosa Beach plant about 2½ acres. Both plants are completely equipped, well arranged, and efficiently operated. At the Los Angeles plant all of the materials entering the plant are ground in mills suited to each material, and particular care is exercised to avoid contamination with iron. This necessitates the use of wood or porcelain liners in the pebble mills for grinding to pass 140-mesh screen. Imported Danish flint pebbles are used as local pebbles have proved to be lacking in hardness. After grinding, the mixtures are prepared by adding the proper amount of each material to double blungers. The 'pulp' is then treated in filter presses, dried in gas-heated dryers to about 10% moisture, broken through 20-mesh screen, tempered with sufficient moisture to insure the proper consistency for dry pressing, and stored in bins until ready for use.

Most of the tiles are formed by dry pressing, using either power-driven or hand-operated presses, depending upon the quantity of each size and color required as well as the shape of the tile.

At the Los Angeles plant the bodies are fired in 12 gas-heated beehive kilns, approximately 20 feet in diameter by 12 feet high. The firing schedule requires four to five days heating, and three to four days cooling, the maximum temperature corresponding to cone 11 (1285° C.). Upon the completion of this firing, the tiles that are to be glazed are transferred by truck to the glazing room which is in a separate building a short distance from the biscuit kilns. After applying the glaze mixture, the tiles are re-fired in a Harrop tunnel kiln which is approximately 250 feet long, 8 feet wide, and 8 feet high. The glost cycle occupies about 54 hours, reaching a maximum temperature corresponding to cone 01 (1110° C.). At the Hermosa Beach plant both the biscuit ware and the glazed ware are fired in five specially-designed tunnel kilns, the firing temperature being about the same as that used at the Los Angeles plant.

All temperatures are controlled by the use of a pyrometer, either of the intermittent or continuous recording type.

Each plant is equipped with a machine shop for making all ordinary repairs, and for making the dies used in the presses. A complete experimental laboratory, equipped with ball mill, mixing pans, blunger, filter press, etc., in charge of an experienced ceramic engineer, is maintained at each plant for the purpose of studying bodies and glazes, and to aid in the solution of operating difficulties.

Both plants together employ approximately 600 persons.

All tiles sold by the American Encaustic Tiling Co., Ltd., are made by them in their own plants in the United States of America.

Bibl: State Min. Bur. Prel. Rept. No. 7, p. 62 (West Coast Tile Co.).

American Refractories Company. F. E. Keeler, president; Earl McClintock, vice president; G. Ray Boggs, general manager and secretary-treasurer. Office and plant at 3232 Alosta Street, Los Angeles.

This company is engaged in the manufacture of fire brick for flue linings, kilns and boiler settings, and silica glass-tank blocks. One of the specialties is the manufacture of radiant stove backs.

The company controls the Hunter Ranch clay deposit in Orange County (samples 63 and 64), and purchases other clays from the Alberhill district.

The clays as received at the plant are stock piled, from which they are fed by wheelbarrows in the proportions desired for the various mixes to an 8-ft. dry pan. The dry pan product is elevated to a screen, which delivers oversize to the dry pan for regrinding, and undersize to a double-shaft and a single-shaft pug-mill in series. From the pug-mills, the plastic mix is fed to an American auger machine. All machine-made brick are repressed in a Raymond press. Some grades of brick, particularly the 'Arc' brand, are made by hand molding, and all special shapes and glass-tank blocks are hand molded.

After shaping, the ware is transferred on hand trucks to a waste-heat drying floor. Drying usually requires about three days.

The radiant stove backs are made by dry pressing, and are fired in two down-draft rectangular kilns, 7-ft. by 9-ft. and 6-ft. by 8-ft. in size. Brick and other shapes are fired in four 28-ft. round down-draft kilns. Natural gas is used for all firing. The round kilns are fired to cone 13 (1350° C.) in ten days and are cooled by the aid of exhaust fans in six days. Allowing five days for drawing and setting, the complete cycle requires 21 days.

The capacity of the plant is 15,000 standard 9-in. brick a day, or its equivalent in other ware. Twenty-five men are employed.

Angulo Tile Company. Plant No. 2; R. F. Angulo and Sons, owners. This company has two plants engaged in the manufacture of hand-made Mission roof and terrace tile. Plant No. 2 is at Reseda, Los Angeles County, and Plant No. 1 is in Santa Barbara (see under Santa Barbara County). The Reseda plant is the larger operation. Clay is obtained from a surface deposit adjoining the plant. A tile machine has recently (November, 1927) been added to the equipment. The company has a U. S. patent on a special method of making hand-made roofing tile. The plant is equipped with three kilns, fired with gas and oil.

Atlas Fire Brick Company. M. I. Power, president; C. J. Walters, vice president; Stuart Findley, secretary; Clifford Tillotson, manager. Office and plant at Boyle and Slauson avenues, Los Angeles.

This company specializes in the manufacture of silica brick and high-grade fireclay brick. In addition to standard straight fire brick and silica-brick shapes, the company is prepared to make all key and arch shapes, glass-tank blocks, and special shapes.

The raw materials in use include the Emsco white plastic fireclay (sample No. 70, p. 272) from Riverside County, German fireclay (sample No. 56, p. 297) and ganister from the company's deposit near Hicks, San Bernardino County. From 6000 to 12,000 tons of clay and 3000 to 4000 tons of ganister are used each year.

The mixtures are prepared by dry-pan grinding, followed by pugging. All clay brick mixtures are repugged, and then aged in a moist room for a period approximating two weeks. The silica brick are all hand molded. Special care must be taken with the large glass-tank blocks, to ensure thorough tamping during molding. Fire brick are made by either the dry press or wet process, the latter being by hand molding, followed by repressing.

All shapes are air dried, then fired in gas-fired round down-draft kilns. Fire brick are fired to cone 12 (1310° C.) and to cone 14 (1390° C.); glass-tank refractories to cone 12; and silica brick up to cone 18 (1485° C.). Seven kilns are in operation, and 40 men are employed.

Batchelder-Wilson Co. E. A. Batchelder and L. H. Wilson, owners. Office and plant at 2633 Artesian Street, Los Angeles. This company, formerly known as the Batchelder Tile Company, specializes in decorative tile for homes, and their artistic products have become well-known throughout the region west of the Rocky Mountains. The principal products are facing and paving tile for interior decorating. Some architectural terra cotta is produced for entrance ways and interiors.

The clays used are Hill blue (sample No. 9, p. 287), extra select main tunnel (sample No. 18, p. 321) and some pink mottled (sample No. 7, p. 328), supplied by the Alberhill Coal and Clay Company in Riverside County; Lincoln No. 1–6 (sample No. 146, p. 303), from the Lincoln Clay Products Company in Placer County; Bacon red (sample No. 127, p. 335), and Harvey (sample No. 133, p. 298), from Ione, Amador County, and a small quantity of Santa Monica clay (represented by sample No. 61, p. 341). Some bentonite from a deposit near Amboy, San Bernardino County, is used in the underglazing slip.

Six standard mixtures are used, grading in fired-body color from red to cream. The mixtures are prepared by jaw crushing, roller-mill grinding, and final pug-mill mixing and tempering. The batches are seasoned in moist rooms before pressing, a period of at least two weeks being preferred.

All of the products are hand moulded in plaster molds, which are made in the plant. The drying is in air, followed by automatic drying ovens. The total drying time is about 48 hours. After drying, an underglaze slip is sprayed on, followed by the color decorations, which are painted by hand.

The kiln equipment includes two 7 x 12 foot rectangular kilns, two 20-foot round down-draft kilns, and one 200-foot tunnel kiln, all gas fired. A great variety of colors from the same body and glaze is produced by varying the temperature and atmospheric conditions during firing. Pyrometers and cones are used on all kilns for controlling temperatures.

After firing, some of the tile are buffed on emery wheels to remove a part of the glaze. This is followed by several sprays of raw linseed oil, thus producing a pleasing mottled effect.

Monorail transportation is used throughout the plant.

A small testing laboratory, in charge of a ceramic graduate, is maintained.

J. A. Bauer Pottery Co. W. E. Bachman, president, 415 West Avenue Thirty-three, Los Angeles. This is a four-kiln pottery making a complete line of red flower pots, white stoneware, yellow bowls, crocks, vases, and ollas. Santa Monica clay (sample No. 61, p. 341) is used for flower pots and ollas, while Alberhill and Lincoln clays are used for the light-colored, vitrified stoneware bodies. Approximately 4000 tons of clay are consumed per year.

The clays are spray-washed to remove surface contamination, then pugged. Flower pots and some of the other ware are machine molded. For other products turning ('jiggering') or hand moulding are used. All of the smaller ware is dried in 24 hours, natural gas auxiliary heating being used in the drying room. White, yellow or cream glazes, where used, are applied by dipping before firing. A single firing matures both the body and the glaze.

The four kilns are of the round down-draft type, fired with gas, but equipped to burn oil if necessary or desirable. The red ware is burned to a temperature of 1850° F. in three to four days, and the cream body ware is fired to 2250° F. in about the same time. One of the kilns is ordinarily operating on the light colored body, and is equipped with pyrometric control.

At present this is the only plant in Los Angeles manufacturing flower pots. Not over half of the company's business is in flower pots, but this constitutes the largest single item. In order to permit the full time operation of the plant on a systematized plan, a stock of ware aggregating over $100,000 in value is constantly kept on hand.

Fifty men are employed.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 50.

California Brick and Tile Company.[1] (Formerly the Owens Brick

[1] Data supplied by W. B. Tucker, district mining engineer, December, 1927.

Company.) K. A. Miller, president; H. W. Broughton, secretary. Office and plant at 6159 Kester Street, Van Nuys. The company owns 20 acres of land, and manufactures common brick only.

The deposit consists of red and yellow clay, 20 to 30 feet thick, underlying an overburden of soil from one to two feet thick. The clay is excavated from an open pit by a gasoline shovel, which loads into 3-ton cars. A gasoline motor hauls the cars from the pit and delivers the clay to two hoppers at the plant.

From the hoppers the clay is delivered by two parallel belt conveyors to two dry pans. The product from the pans is elevated by two bucket elevators to two wire screens, which deliver the undersize to a central hopper, and return the oversize to the dry pans. From the hoppers, the clay is fed to a pug-mill, then to an auger machine, equipped with a wire cutter.

From the take-off belt following the wire cutter, the brick are loaded on drier cars. A 16-track tunnel drier is used, which is 120 feet long, 60 feet wide, and 6 feet high, and has a capacity of 75,000 brick per 60 hours. Two Hadfield-Penfield blowers, driven by a 50-h.p. motor, circulate heated air from an oil-fired furnace to the drier.

Six natural-gas-fired field kilns are in use, having a capacity of 750,-000 to 1,000,000 brick each.

Machinery in the plant is driven by a 160-h.p. Western gas engine. The plant operates throughout the year, and 40 men are employed.

California Clay Products Co. Victor Kremer, president. "Victor Kremer Enterprises, Inc.," 315 West Mutual Life Building, 321 West Third Street, Los Angeles. The plant is in South Gate. This factory manufactures an extensive line of glazed wall tile and ceramic floor tile. English china and ball clays are used in the white-burning bodies, but Lincoln clay (sample No. 146, p. 303) from Placer County and Cardiff fire clay (sample No. 36, p. 311) from the company's property in San Diego county are used in the cream, buff and darker-colored bodies.

The finer clays to be used in the manufacture of white bodies and other high grade ware, are prepared by blunging and filter pressing the ground material. Plastic clay mixtures are prepared in pug mills, and are well seasoned before use.

Dry-pressed floor and wall tile are made in hand-operated presses. Floor and wall tile with an undulating surface are produced by hand pressing of pugged clay in plaster molds. The latter are highly prized by architects to secure certain artistic effects, as the undulating surface gives the impression of wear resulting from long use.

Drying is done with hot air, produced by waste heat. The drying time varies from 24 to 36 hours depending upon the size of tile.

Monochrome glazes are applied by hand dipping in the glaze slip. Polychrome work is done with a glaze bulb. Some brush work is done in special cases.

All of the glazed tile are given a double firing. There are three biscuit kilns with a firing cycle of 72 to 90 hours to attain a maximum temperature of 2400° F. Three glost kilns are in use, with a firing cycle of 36 hours to 1800° F. The apparent discrepancy in the capacities of the biscuit and glost kilns is explained by noting that the tile are packed in sand in the biscuit kiln saggers, but must be supported on pins in the glost saggers, hence requiring more space per unit of tile area in the latter case.

Much of the work in the factory, such as applying glazes, removing loose dust from tile after dry pressing, packing and unpacking of saggers, etc., is of such a nature that women employees are used, men being employed only for the heavier duties, such as operating the presses, trucking, kiln setting or drawing, and firing.

City Brick Co. The plant is at 1900 West Manchester Avenue, (Eighty-sixth Street) and Western Street. This company makes common red brick only. The clay in use is a surface deposit of loose sandy loam, with just sufficient bonding power to permit the manufacture of a satisfactory building brick by the soft-mud process. The clay is mined in a shallow pit by horse scrapers, which deliver the material to an incline tram which dumps into a hopper feeding a disintegrator and pug mill, followed by a 6-brick press. The brick are carried to the drying sheds by rope conveyors. The dried brick are fired in gas-fired open kilns. Handling losses are apparently higher than in most plants, on account of the low strength of the brick in the plastic and dry state.

Claycraft Potteries, Inc. Gus Larsen, president; F. H. Roberts, vice president; W. C. Reordan, treasurer; Henry Prussing, secretary. Office and plant at 3101 South Fernando Road, Los Angeles. This company manufactures faience art tile, using an Alberhill clay body that matures at cone 5 (1180° C.) and applying glazes that mature at cone 4 (1050° C.).

The plant is equipped with two 8-ft. wet pans, two tile augers, a sagger press and three tile presses, one of which is power-driven and has a capacity of 900 tile per hour. All fancy pieces are hand-molded in plaster molds.

The ware is dried in three 6-ft. by 7-ft. by 25-ft. tunnel driers. The biscuit firing is done in three 220-ft. round down-draft kilns, gas fired. Three muffle kilns are used for the glost firing.

Twenty-five men are employed.

H. F. Coors Co., Inc., H. F. Coors, manager. P. O. Box 517, Inglewood. This plant is at 419 South Judah Street, Inglewood. It was established in December, 1925, for the manufacture of porcelain plumbing accessories and electrical specialties.

English china clay and Coors ball clay (sample No. 57, p. 264), Campo or Kingman feldspar, and various grades of silica are used in the body mixture, which is prepared by ball-mill grinding.

Some of the ware is dry-pressed, and some is cast. A hot-air drier is used. An 8-foot gas-fired round down-draft kiln is used for both the biscuit and the glost firing. A small muffle kiln is used for decorating, which consists principally of labeling faucet handles.

Davidson Brick Co. Nathan Davidson, owner, 5301 Chicago Avenue, Los Angeles. This is a well-equipped and well-arranged plant for manufacturing common red brick. The clay varies from an adobe to a soft clay shale. Mining operations have exposed a bank 60 to 70 feet high, and 300 feet long. The pit extends into a gently-sloping hillside above the plant. An electric shovel is used for mining and loading into dump cars, which are hauled to the plant by a gasoline locomotive.

Brick are made by the stiff-mud, side-cut process. A rope conveyor is used to deliver the brick to the drying sheds. Oil fired field kilns are used.

A sample (No. 60) of the more shaly variety of clay was taken as representative of the class of material to be expected in this district. The tests (p. 340) indicate that the drying and firing properties of the clay are not greatly different from those of the Santa Monica clay (sample No. 61, p. 341), which is widely used in Los Angeles County as an ingredient of sewer pipe, conduit, flower pot, and olla mixtures.

Empire China Company. Office and plant at Burbank. Mr. Morgan, superintendent. This is a well-equipped plant, containing seven round down-draft kilns that operated for a number of years for the manufacture of semi-porcelain hotel and dinner china. Experiments have been in progress for a number of months on the manufacture of vitreous dinnerware, and the management expects to start production of this ware during the spring of 1928, using a California feldspar and silica, Nevada china clay, and a certain amount of Florida clay.[1]

Emsco Refractories Company. E. M. Smith, president. Office and plant in Southgate, at Manchester Avenue and Atlantic Boulevard. This company was established in 1927, and was not visited by the author, such data as are included here having been supplied by the company. The company manufactures fire brick, silica brick and glass-tank refractories. The clays are obtained from El Toro, Orange County. (Hunter Ranch ?, see samples No. 63, 64 and 268, p. 260), and from the Emsco pit in the Alberhill district, Riverside County. Eight gas-fired kilns are in use.

Gladding, McBean and Company. Southern Division. Atholl McBean, president; Fred B. Ortman, vice president. Los Angeles office at 621 South Hope Street. In 1926 this company merged with the Los Angeles Pressed Brick Company. The Southern Division of the company includes the following plants: the Alberhill (see under Riverside County), Santa Monica and Los Angeles plants, all formerly owned by the Los Angeles Pressed Brick Company; and the Tropico plant. The company also owns the Goat Ranch clay deposit in Orange County (see under Orange County).

Los Angeles Plant. 952 Date Street, Los Angeles. This is the largest of the plants formerly owned by the Los Angeles Pressed Brick Company, and has perhaps the greatest manufacturing resources of the southern California plants of Gladding, McBean and Company. The products made at this plant are terra cotta, face brick, 'quarry' tile, and roofing tile. The plant is in the heart of the Los Angeles commercial district and all clay must be shipped in.

The terra cotta mixtures are the same as those in use at the Tropico plant, described below, and are prepared in the same manner by dry pans and pug-mills, followed by a variable period of seasoning in waste-heat humidifiers.

The face brick mixtures consist of varying proportions of Santa Monica red-burning clay and a number of varieties of Alberhill clay. The face brick production of this plant is the second largest in the

[1] G. Ray Boggs, private communication, December 8, 1927.

Gladding, McBean organization. A wide range of colors and textures are produced.

Quarry tile are hand made from mixes similar to those used for face brick, and are produced in a wide range of red colors. The product is known as 'Palacio' tile.

Practically all of the roofing tile produced by the Southern division and approximately 60% of that manufactured by all of the company's plants is made at the Los Angeles plant. Both machine and hand made tile are produced. The laboratory is constantly experimenting on new glazes and body mixes, and many distinctive effects have been produced.

The plant is well equipped. Practically all labor is performed mechanically and all moving of material is done by motor. There are 25 kilns, divided as follows: thirteen round down-draft kilns, four terra cotta muffle kilns, and eight rectangular mufflle kilns for enamel work.

Santa Monica Plant: Colorado Avenue and Twenty-fifth Street, Santa Monica. Formerly owned by the Los Angeles Pressed Brick Company. The products are roofing tile, hollow tile, flue lining, chimney pipe, quarry tile, and brick.

Most of the clay used is mined at the plant, which also supplies a large quantity of clay for the Los Angeles plant. The property includes 45 acres of clay land. The deposit is similar to that in use by other manufacturers in this area, including the Western Brick Co., the Simons Brick Co., and the Santa Monica Brick Co. On the Gladding, McBean property the clay is from 10 to 36 feet thick, dipping northwestward, and increasing in depth in that direction, presumably underlain by gravel. Sample No. 61 was taken from the stock pile in the plant, and is an index of the type of material mined by this company and others in the district. The test results are on page 341.

All products are made by the stiff-mud process, on auger machines. The quarry tile, known as 'Promenade' tile, is made in a wide variety of red tones, with here and there a purplish to greenish hue.

Twelve round down-draft kilns are operated.

Bibl: Bull. 38, p. 214 (L. A. P. B. Co.), and p. 217 (Western Art Tile Works (now the Tropico plant). Prel. Rept. 7, pp. 53–56 (Los Angeles Pressed Brick Co.), and pp. 56–57 (Pacific Minerals and Chemical Co., now the Tropico plant).

Tropico Plant: Located in Glendale. This plant was started in 1902 as the *Pacific Art Tile Company*, the first factory of its kind west of the Rocky Mountains. After several reorganizations, the plant was eventually acquired by Gladding, McBean & Company and in 1922 the name was changed to its present form. The principal products of the plant are sewer pipe, flue lining, architectural terra cotta, and faience tile.

Sewer Pipe: The sewer pipe mixture contains red-burning common clay from Santa Monica (sample No. 61, p. 341), Emsco red (sample No. 72, p. 328), and one or more other clays from various sources. The clay is prepared by dry pan and pug-mill, shaped in power-driven (steam) presses, dried on slatted floors, and fired in down-draft beehive kilns, fired with gas up to 1100-1300° F., and finished to cone 03, 1980° F., with oil. The smaller pipe is set two lengths high, and requires a firing schedule of 88 to 100 hours. The larger pipe is set three high, and requires a 120-hour firing schedule. The total kiln turnover is 10 to 11 days. Thirty-two kilns are in use for sewer pipe and flue lining, each with a capacity of approximately 40 tons.

Flue Lining: The principal ingredient of the flue lining mixture is the white Emsco clay (sample No. 70, p. 272).

Terra Cotta: The architectural terra cotta output of this plant is not large at present, at least not of the order of magnitude of the output at the Lincoln, Placer County, plant of the company. Essentially the same terra cotta mixtures are used at Tropico as at Lincoln, the Lincoln clay (sample No. 157, p. 304) being shipped to Tropico for the purpose. The terra cotta mixture is prepared by dry pans and pug mills, followed by seasoning in humidified rooms for at least 24 hours before pressing. Six kilns are in use for terra cotta, firing to cone 3 to 5.

Tile: The faience tile is made by dry pressing a buff-burning body similar to the terra cotta mixture, biscuited at cone 4, and glost at cone 05 and 06. The body is mixed and ground in dry pans, and shaped in screw presses, formerly operated by hand, but now entirely supplanted by power driven presses. At the time of visit, July, 1925, 5 bee-hive kilns were in use for tile. The biscuit kilns were operated on the same schedule as the terra cotta kilns, requiring 100–110 hours firing, while the glost kilns operated on a 20-hour firing schedule. The glost kilns use oil exclusively. A small tunnel kiln for tile has since been installed in order to secure more uniform results, and to decrease the time cycle.

Miscellany: This plant is continually progressing, and various improvements and economies are being added from time to time. Mechanical handling of materials is in use wherever it is economic. The present system of handling the ware is on hand trucks, running on tracks, in the shaping and glazing departments. A gasoline tractor is used for kiln-yard haulage. Recording pyrometers with base metal couples are used for temperature control of the kilns.

A laboratory is maintained to aid in the development of terra cotta glazes and bodies.

Bibl: Cal. State Min. Bur. Bull. No. 38, p. 217 (Western Art Tile Works); Prel. Rept. No. 7, p. 56 (Pacific Minerals and Chemical Co.).

Globe Tile and Porcelain Works. P. C. Boving (formerly of the Pomona Tile Company), president and general manager. This plant was established in 1927 for the manufacture of ceramic floor tile. The plant has 15,000 square feet of floor space, and the capacity is 3000 square feet of tile per day.[1]

H & H Tile Company. Ord Hagerman and V. K. Halieman. Represented by C. P. Johnson, Arcade Building, Los Angeles. This company was organized in 1927 with a capitalization of $30,000, to produce ceramic tile.[2] Further details are lacking at this writing.

Italian Terra Cotta Co. W. H. Robinson, owner. Office and plant at 1149 Mission Road, Los Angeles. This is claimed to be the only plant on the Pacific Coast exclusively engaged in the manufacture of sculptured terra cotta garden pieces.

[1] Clay-Worker, November, 1926, p. 390.
[2] Clay-Worker, August, 1927, p. 123.

The bodies are made from Alberhill pink mottled (sample No. 7, p. 328) and hill blue (sample No. 9, p. 287), and some Santa Monica clay (sample No. 61, p. 341), which produce a red body when fired. A slip glaze, light brown in color, is used on some pieces. The clays are prepared by dry-pan grinding followed by a pug-mill. After sufficient seasoning, the pieces are shaped by hand pressing in plaster molds and air dried before firing. A gas-fired round down-draft kiln is used for firing, the heating schedule ranging from 68 to 72 hours.

Many of the models are imported from Spain and Italy. The market for the products is not confined to the Los Angeles district, as the artistic value of the ware has often impressed visitors from other sections of the United States, and many pieces have been shipped to the eastern and middle western states.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 51.

K. & M. Pottery. M. C. Myers, president. Office and plant at 2318 East Fifty-second Street, Los Angeles..

This pottery makes stoneware from Alberhill clays, using the E–101, and the hill blue (sample No. 11, p. 257, and 9, p. 287) varieties. Ollas are also made from the pink-mottled clay from Alberhill (sample No. 7, p. 328).

The stoneware is made by turning and the glaze is applied to the dried ware before firing.

The plant is equipped with three round down-draft gas-fired kilns, 25 feet, 22 feet, and 15 feet in diameter, respectively. The annual wholesale value of the product is nearly $60,000.

Bibl: Cal State Min. Bur. Prel. Rept. No. 7, p. 51.

K and K Brick Company.[1] O. J. Cubach, president; H. D. Simons, secretary. Office, 801 Merchants National Bank Building, Los Angeles. This company owns a 38-acre property in Bishop Canyon, Los Angeles, and manufactures common brick.

The deposit consists of blue and gray plastic shale, 10 to 20 feet thick, underlying from two to five feet of adobe soil and gravel. The clay is mined by hand methods in an open cut, and is transported to the plant in small cars.

The stiff-mud process is used. The plant is equipped with a dry pan, screens, pug-mill, and a Raymond auger machine, with a wire cutter.

The brick are dried in open drying sheds, and are fired in six open field kilns. Both natural gas and oil are used as fuel.

The plant operates throughout the year and 35 men are employed. Power is supplied by a 250-h.p. boiler. The rated capacity of the plant is 75,000 brick per day.

Bibl: State Min. Bur. Prel. Rept. 7, p. 51.

La Cal Tile Company. Val Alden and Kittridge streets, Van Nuys. A recent report[2] states that this company was building a plant on the above site, at a cost of $70,000. Further details are lacking at this writing.

Linderman & Decker Company.[1] Address, Lomita. This is a firm

[1] Data supplied by W. B. Tucker, district mining engineer, November, 1927.
[2] Clay-Worker, March, 1926, p. 207.

of general contractors who own a 10-acre property at Harbor City that is now under lease to Mexicans, who are manufacturing hand-made roofing tile.

The deposit consists of 10 to 15 feet of red clay, overlain by one to to two feet of gravel. Hand methods of mining are used, and the clay is delivered to the tile plant by a horse-drawn dump-cart. The clay is prepared and the tile shaped by hand. Drying is done in the open air. A round gas-fired kiln is used for firing.

Long Beach Brick Company.[1] H. A. Havner, president; H. C. Armstrong, secretary. Office at 154 Elm Street, Long Beach. The company owns a 10-acre property at Harbor City, and manufactures common brick.

The deposit consists of red clay, 10 to 20 feet thick, covered by a maximum of two feet of gravel. The clay is mined by scrapers, and is transported to the plant by belt conveyors and Ford trucks.

The equipment includes a dry pan, elevators, screens, American auger machine, and wire cutter. Drying is done in open-air drying sheds. Rope conveyors are used to transport the brick to and from the drying yard.

Six open field kilns, fired with natural gas, are used. The plant usually operated during ten months of the year, employing 25 men. Electric power is used, the installed capacity being 200 h.p. The rated capacity of the plant is 45,000 brick per 8-hr. day.

Bibl: Cal. State Min. Bur. Prel. Rept. 7, p. 51.

Los Angeles Brick Co. A. A. Conger, president; E. W. Murphy, vice president; Henry Prussing, secretary; Gustav Larsen, director in charge of operations; W. C. Reordan, director in charge of sales. Home office, 1078 Mission Road, Los Angeles.

This company owns and operates three common-brick and hollow-tile yards in the Los Angeles district, and has recently built a plant at Alberhill to manufacture tile, fire brick, and other products (see under Riverside County, p. 174) from clays mined on their own properties, acquired through the purchase of the holdings of the California Clay Manufacturing Company.

The Los Angeles brick yards are the Mission Road plant, at the corner of Mission and Marengo streets, near the County Hospital; the Chavez Cañon plant, in Chavez Cañon, west of Adobe street; and the Seventh Street plant, at East Seventh Street, on the corner of Utah Street.

Mission Road Yard: This property comprises 15 acres. The clay is a surface material from 25 to 30 feet thick, underlain by five or six feet of sand. Common brick only are made at this plant, using the soft-mud, sand-mold process. The brick are air-dried, then fired in open field kilns, using gas as fuel. The average daily capacity of the yard is 80,000 brick. A Hoffman continuous kiln, fired with coal screenings was formerly in use, but has been dismantled. Rope conveyors are used to deliver the brick pallets from the presses to the drying yard.

Chavez Cañon Yard: This is a 26-acre property. The clay is a thin-bedded Puente (Lower Miocene) shale, forming a bank over 100

[1] Data supplied by W. B. Tucker, district mining engineer, November, 1927.

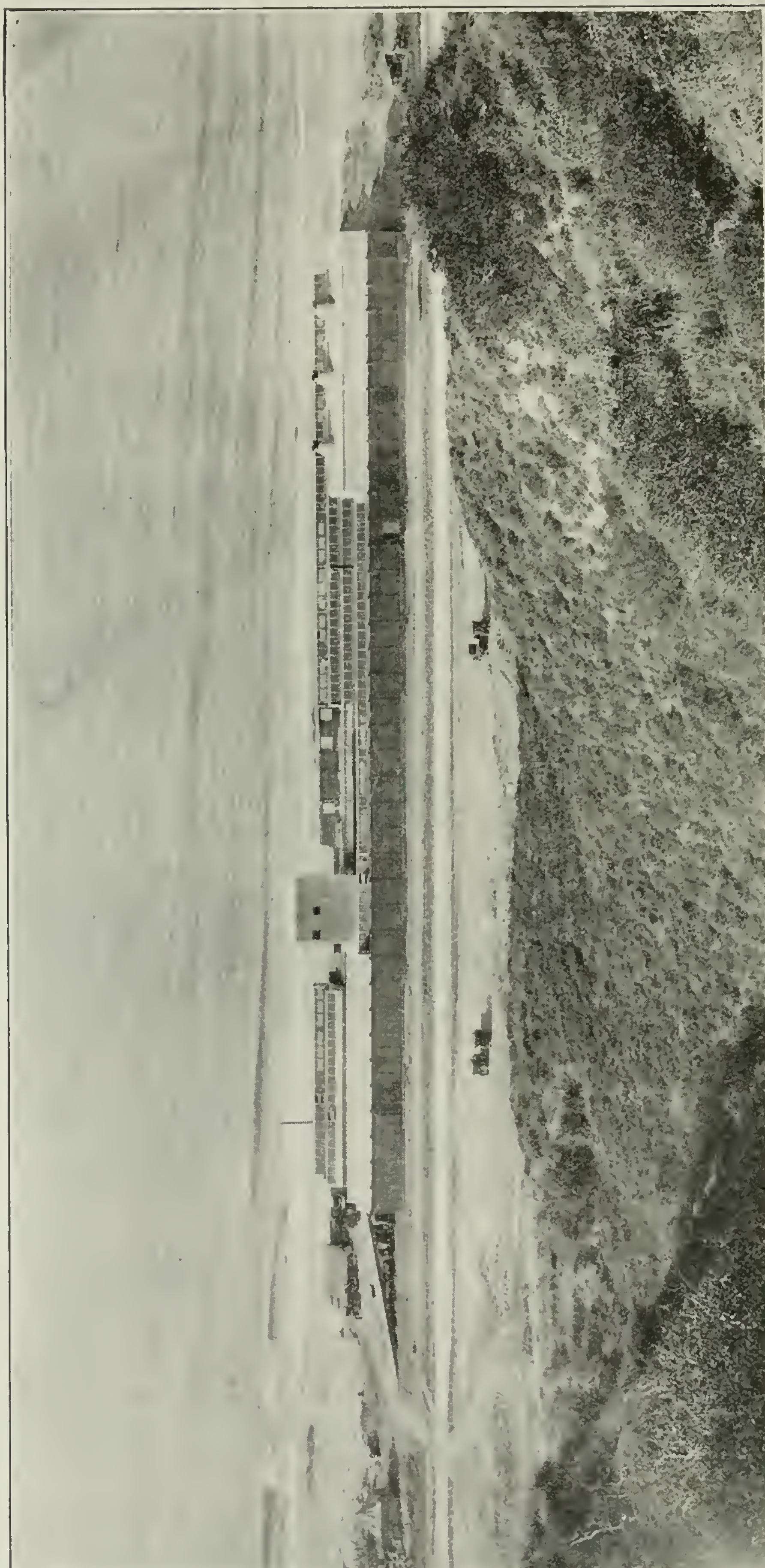

PHOTO No. 16. Malibu Pottery, on the Pacific Ocean, north of Santa Monica. Los Angeles County. (Photo by courtesy of the company.)

feet high, and dipping southward into the hill. The individual beds of shale vary from a very fine-grained plastic clay, to a sand, the different phases being present in such proportions as to make an excellent material for brick and hollow tile. The clay is mined by a team and scraper, dumped into a hopper, delivered to a car, which is hauled up into the plant by an electric hoist. The clay is ground in a dry pan, and fed by belt conveyors to pug-mills and auger machines. The bricks are dried in driers heated with steam from auxiliary boilers. Firing is done in open field kilns, with gas fuel. The capacity of the plant is 80,000 brick and 100 tons of hollow building tile per day.

Seventh Street Yard: This yard is 12 acres in area. The clay belongs to the upper portion of the Boyles Heights Terrace formation. The soft-mud process was used, followed by air drying, and firing in open field kilns. It is probable that this property will be sold, as it has become too valuable for industrial property to warrant its continuance as a brick yard.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 52.

Malibu Potteries. Owned and operated by the Marblehead Land Co.; R. B. Keeler, plant manager, P. O. Box, 518, Santa Monica. The plant is on the Coast highway, north of Santa Monica. The products of the plant are plain and decorated wall tile, made from a terra cotta body. A view of the plant is given on photo No. 16.

A variety of clays are used, including a number of clays from the Malibu Ranch, some Alberhill clays, and English ball clay. The mixes are prepared by grinding in a 4-ft. dry pan, elevating to a bin, screening, and pug-milling, followed by six weeks ageing. Most of the tile are shaped in a Muller tile auger, but some are hand-pressed in plaster molds. Saggers and tile setters are made at the plant, by hand.

A Carrier drier, operating on an 18-hour cycle, is used for drying the tile. The saggers and setters are dried in the open.

Three up-draft kilns are in use. On biscuit firing, 10,000 sq. ft. of tile can be loaded per kiln, and the entire firing cycle takes one week. The finishing temperature is 2300° F., which is reached in 96 hours from the start of firing. On glost firing, each kiln holds 5000 sq. ft. of tile, the finishing temperature is 1600° F., the firing occupies 48 hours, and the entire cycle takes four days. Normally, one kiln is on biscuit firing, one is on glost firing, and the third is used for either, according to conditions. The kilns are fired with oil, atomized by air.

Mission Brick Company.[1] Mrs. A. E. L. Anderson, 755½ Santa Monica Boulevard, Los Angeles, owner. Joseph F. Reutera, manager. Office and plant at 6140 Sepulveda Boulevard, Van Nuys. The product of the plant is common red brick. The property consists of five acres of land, containing a bed of red clay from 5 to 20 feet thick, overlain by from one to two feet of soil. Mining is done in an open pit, using scrapers which are hauled by a Fordson tractor to a hopper which feeds a belt conveyor delivering to a bin at the plant. The soft-mud process is used. The plant is equipped with a pug-mill and a Quaker brick press, which has a capacity of 20,000 brick per day. The brick are dried under sheds, to which they are transported in hand trucks.

[1] Data supplied by W. B. Tucker, district mining engineer, December, 1927.

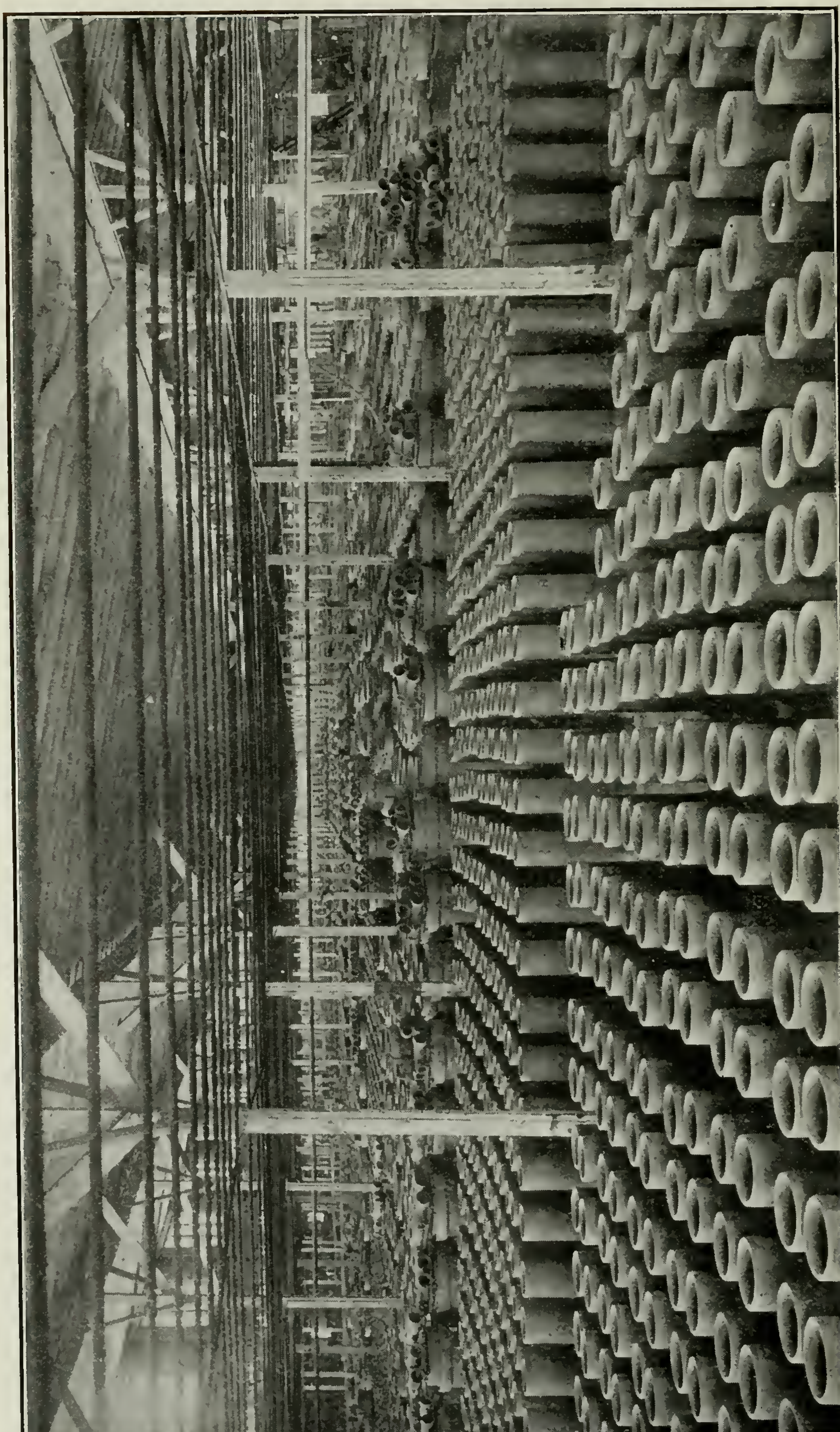

PHOTO No. 17. Drying floor, Los Nietos plant of Pacific Clay Products Company, Los Angeles County.
(Photo by courtesy of the company.)

Two gas-fired field kilns are used, having a capacity of 50,000 bricks each. Electric power is used in the plant, the installed capacity being 60 h.p. Twenty men are employed during the operating season, which is usually four months.

Mission China Company. Victor Kremer, president; Jas. Tiffany, manager. General offices at 321 W. Third Street, Los Angeles. Plant at 652 S. Griffin Avenue. This plant has been manufacturing semi-porcelain hotel and dinner ware for a number of years. The raw materials in use are English china and ball clay, Edgar (Florida) kaolin, and California feldspar and silica.

The body mix is prepared by screening through 150-mesh, blunging, filter-pressing, and pugging. Most of the ware is shaped by jiggering, but casting is used on the more complicated shapes. Steam drivers are used, operating on a 12-hour cycle. Saggers are molded by hand at the plant.

The biscuit ware is fired in two 17-ft. 6-in. up-draft kilns, to a finishing temperature of cone 8 (1225° C.), requiring 55 to 60 hours. The ware is then dipped in glaze, and fired in two 16-ft. glost kilns to cone 5 (1180° C.), in 30 to 35 hours. Two days are required for cooling both types of kilns. The paper transfer process of decorating is used, and the decoration is fired on at cone 016 (735° C.). Two decorating kilns are in use, which are fired in 12 to 14 hours, the entire cycle requiring 30 hours. All kilns are fired with natural gas.

Fifty men and women are employed in the plant. Most of the work is paid by piece rates, which are the same as those established in eastern potteries.

Pacific Clay Products Co.[1] William Lacy, president; Robert Linton, vice president and general manager; W. R. Fawcett, secretary-treasurer; Wm. McClintock, general superintendent. Main office, 1151 South Broadway, Los Angeles. This company owns and operates three factories in Los Angeles district and several clay properties in Riverside and San Diego counties. The present company supersedes the *Pacific Sewer Pipe Company* which was formed some years ago by consolidating several smaller companies situated in Los Angeles, Corona, and Elsinore, these smaller companies having started business around 1880 to 1885.

Clay Properties: The company owns and operates the following clay mines:

Name	Shipping point
Douglass	Alberhill, Riverside County
McKnight	Corona, Riverside County
Wildomar	Wildomar, Riverside County
[1]Hoist Pit	Elsinore, Riverside County
Kelly No. 1	Farr, San Diego County

[1] The company owns a one-half interest in this property.

In addition the company operates under lease several properties in Orange and San Diego counties; also owns and holds in reserve for future operations five additional tracts in Riverside and San Diego counties. The total clay lands owned outright total 625 acres. The bulk of the clays used in the company's plants come from its own mines, although some are purchased from the Alberhill Coal and Clay

[1] Description prepared by the company.

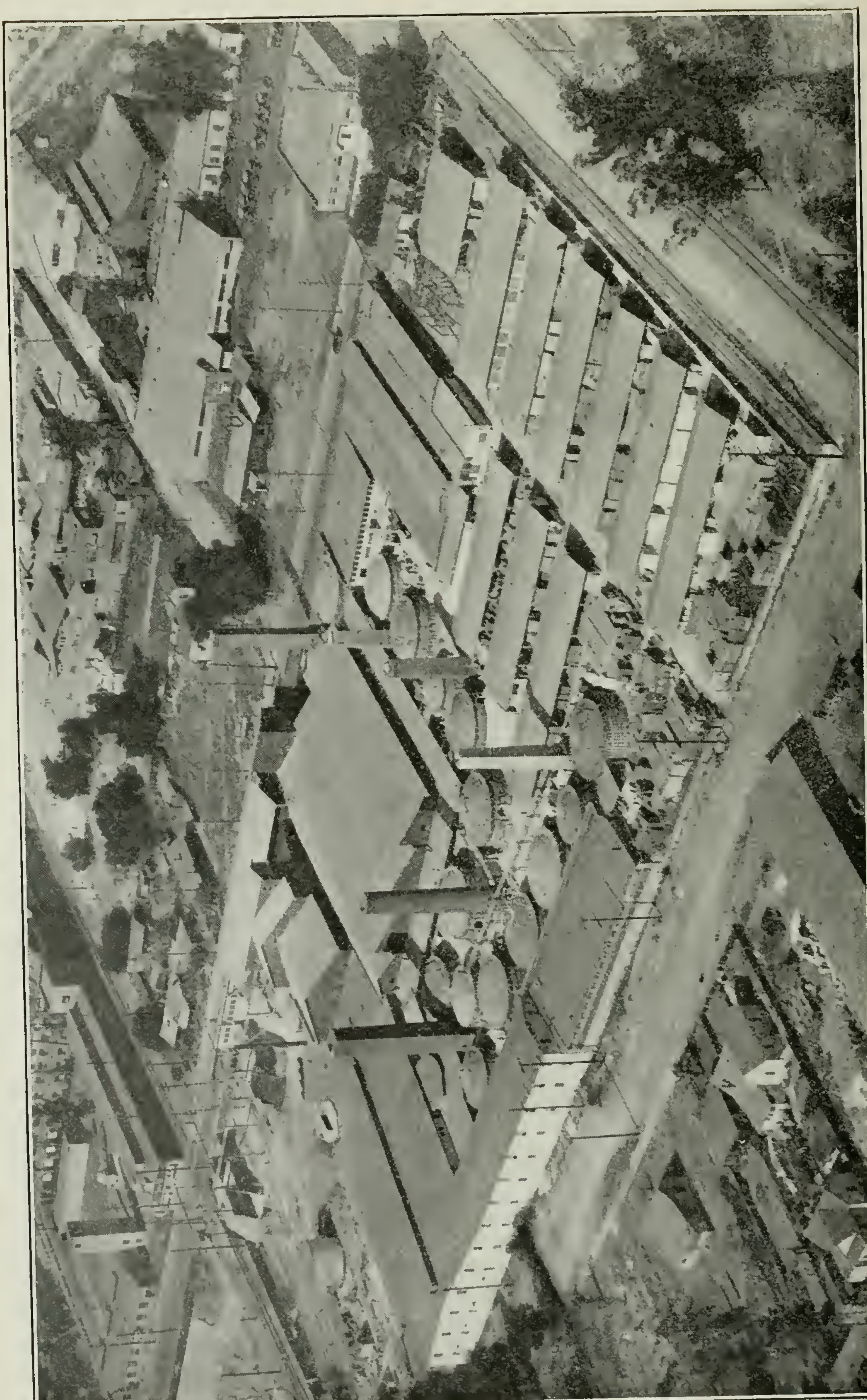

PHOTO No. 18. Airplane view, Lincoln Heights plant, Pacific Clay Products Co., Los Angeles. (Photo by courtesy of the company.)

Company, the Emsco Clay Company, and the Lincoln Clay Products Company. Many different clays enter into the manufacture of the various products made, which include sewer pipe, electrical conduit, face brick, enameled brick and tile, fire brick and refractory shapes, fireclay, flue lining and gas flues, drain tile, stoneware, earthenware water coolers and other articles.

PLANTS: Three factories are operated at present, viz, the Lincoln Heights plant, Avenue Twenty-six and Humboldt Avenue, Los Angeles; the Slauson plant, Slauson and McKinley avenues, Los Angeles, and the Los Nietos plant on the eastern edge of the Santa Fe Springs oil field. The plants have a combined capacity of over 90,000 tons of clay products per year. A plant at Terra Cotta, near Elsinore, and two plants at Corona were also formerly operated. General views of the Lincoln Heights and the Los Nietos plants are shown on photos No. 18 and 19.

LINCOLN HEIGHTS PLANT: J. L. Davies, superintendent. This factory was built about 1890 and was equipped to manufacture sewer pipe, brick and stoneware. At present it comprises a brick department producing face brick, enamel brick and tile, fire brick and refractory shapes and roofing tile; and a stoneware department making a comprehensive line of grey earthenware, ollas, mixing bowls, etc.

Clays for the stoneware are selected with especial reference to producing a body as dense and impervious as possible; for ollas, or self-cooling water jars, the body should be slightly porous, since the cooling comes from evaporation of water which percolates through the jar to the outer surface. The mixes are finely ground in a Raymond hammer pulverizer, the dust being lifted by a suction fan a height of 10 feet to the pug-mill feeder. The pugged clay is allowed to soak in the 'sweating room' for 24 hours or more, then goes to the jig rooms where there are 9 potters' wheels suitable for making all kinds of turned pottery up to a 12-gallon jar. The ware is dried in steam-heated dryers, then dipped in the proper glaze. Some of the stoneware is given a biscuit firing before glazing, but most of it is made at a single burning, using a slip glaze which matures at the same temperature as the body. The stoneware bodies mature at about cone 8, and are a cream or light yellow color. Saggers made at the plant are used for some of the ware, chiefly for support, but as much ware as possible is open fired. There are 5 kilns 20 to 24 feet diameter used for stoneware.

The brick department equipment consists of 3 dry pans, Hummer screens, 2 pug-mills, 2 auger machines, two 14-brick American cutters, 2 represses, 2 humidity dryers holding 40,000 brick each, an overhead traveling crane with clam shell for clay unloading, 2 electric lift trucks with pallets for handling brick, and 11 kilns 30 feet diameter. The capacity is 40,000 brick per day.

A view of the clay bins and unloading crane is shown on photo No. 20, and a pug-mill, auger machine and cutter is shown on photo No. 21.

The stiff-mud brick—comprising the rough and smooth texture wire cut face brick and re-pressed wire cut fire brick—are dried in the humidity dryers in 42 hours. About 6 days are required for the firing, the finishing temperature being about 2100°. Dry press brick go directly to the kilns without preliminary drying, and are burned to

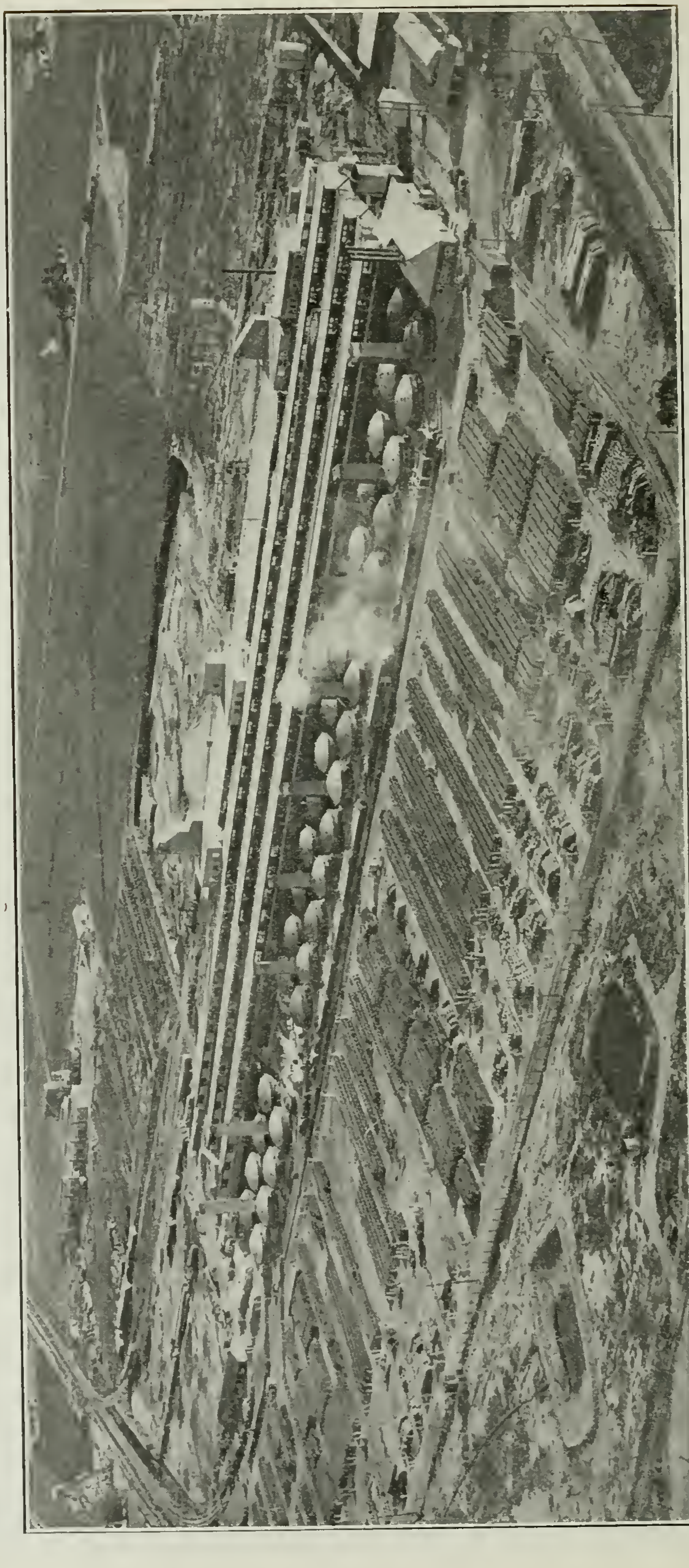

PHOTO NO. 19. Airplane view, Los Nietos plant, Pacific Clay Products Co., Los Angeles County. (Photo by courtesy of the company.)

about 2050°. Enamel brick are made on biscuit, or burned pressed brick, which are coated with enamel slips and burned a second time to mature the glaze.

A variety of very attractive shades of red, tan, grey and other colors is made in the wire-cut brick. Present architectural practice favors combining different shades and colors, following the impressionistic idea, and these combinations are proved very effective in lending distinction to face-brick buildings. The Pacific enamel brick is in wide demand and is shipped to all the Pacific Coast states as well as abroad.

A complete line of fire brick and refractories is also manufactured. Three grades of standard fire-brick are made, with softening points of

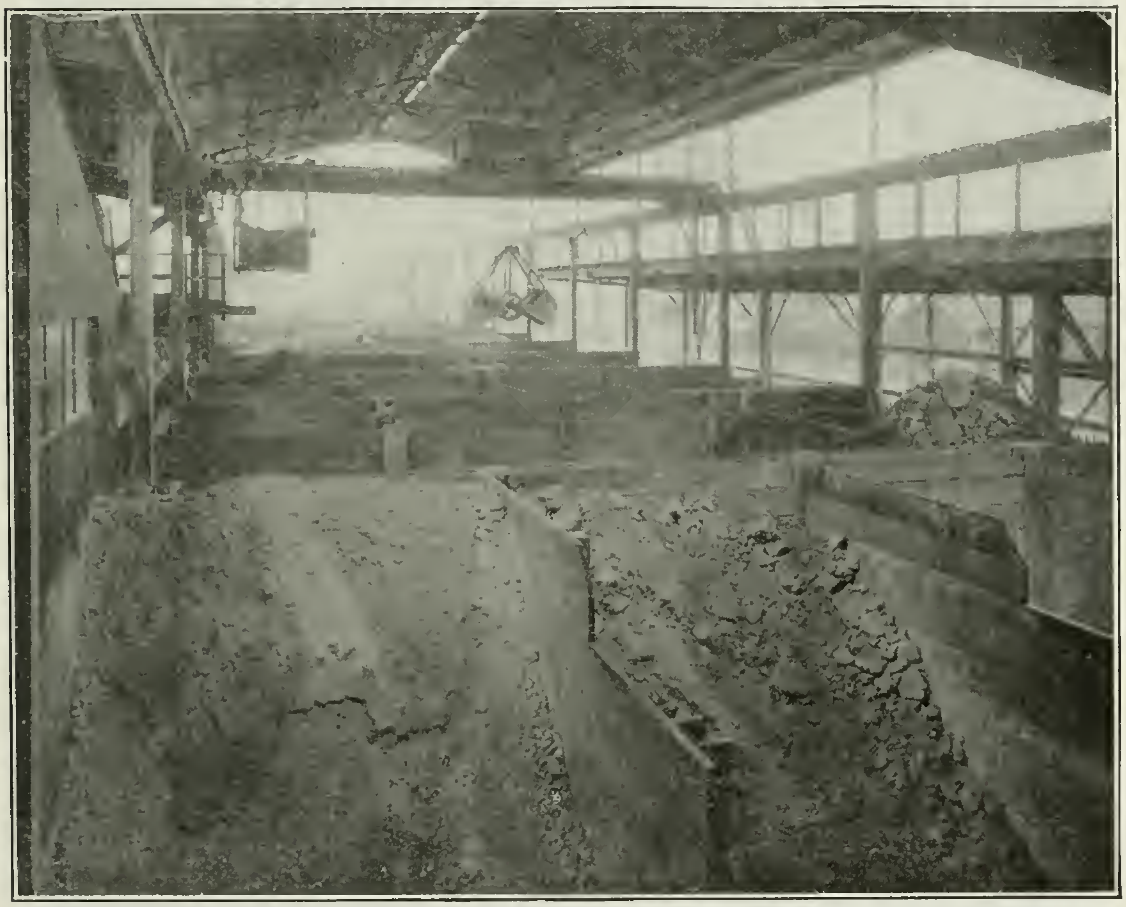

PHOTO No. 20. Clay bins and unloading crane, Lincoln Heights plant, Pacific Clay Products Co., Los Angeles. (Photo by courtesy of the company.)

about 3200° F., 3100° F. and 3000° F., respectively. The highest grade brick is hand molded, the others made on the auger machine and repressed. They are burned to about 2500° F.

Roofing tile are also made, using a combination Hummer machine. They are dried on waste heat drying floors and burned in the brick kilns.

Over 20 different clays are used at this plant, coming from Riverside, Orange, San Diego, Los Angeles, and Placer counties. The plant site comprises over six acres, and lies between main lines of the Santa Fe and Union Pacific railroads, having sidings from each. The plant is equipped to use either natural gas or fuel oil. Machinery is all motor-driven. About 130 men are employed.

The company's laboratories are located at this plant and are fully equipped for chemical and testing work. A high temperature testing kiln capable of heating up to 3400° F., is used for testing fire brick. Routine testing for color and shrinkage is regularly carried on. All kilns are equipped with pyrometers which are used for control in connection with Orton standard cones.

Los Nietos Plant: Cecil V. McClintock, superintendent. The Los Nietos factory is the largest and newest of the plants, and is situated

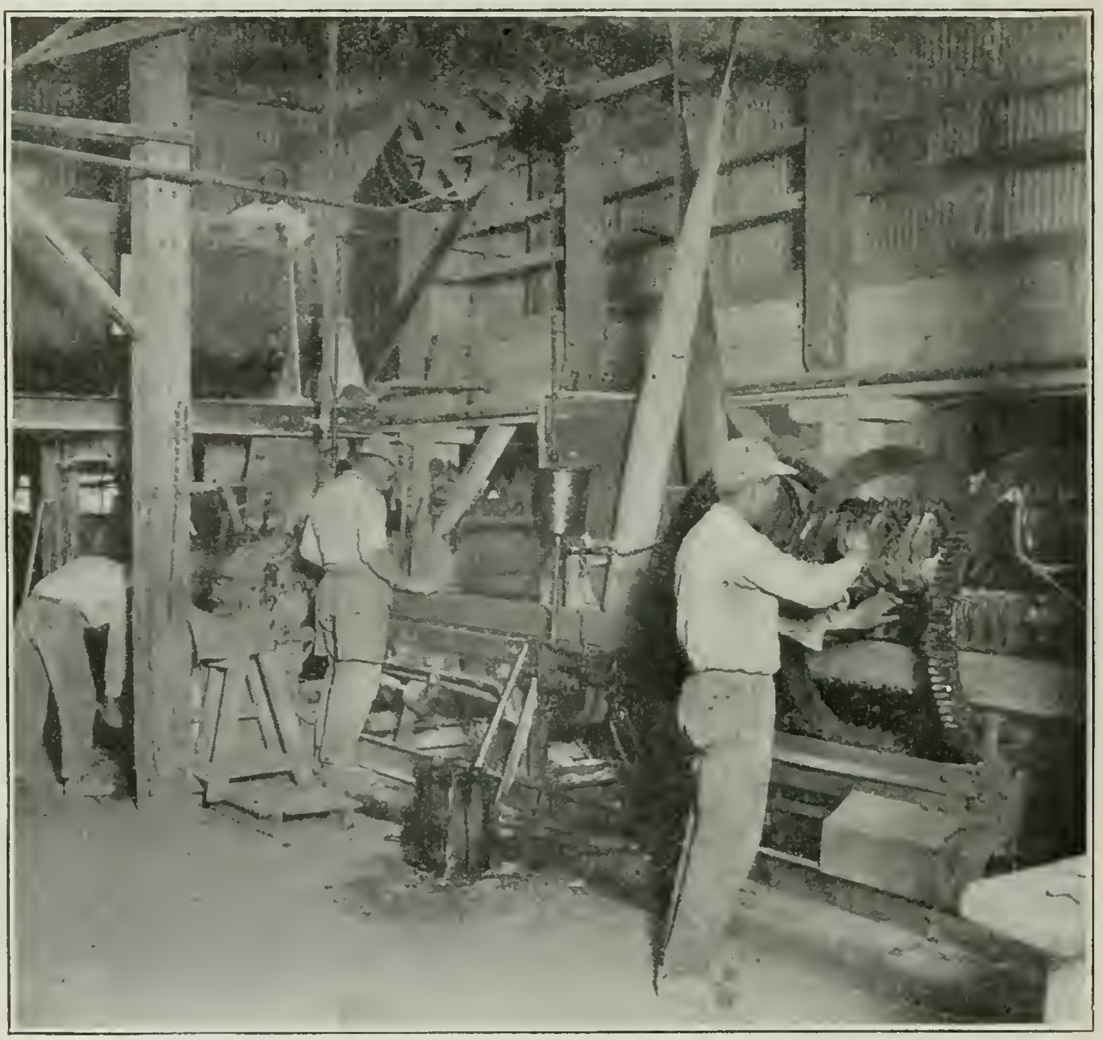

Photo No. 21. Pug-mill, auger machine and cutter, Lincoln Heights plant, Pacific Clay Products Co., Los Angeles. (Photo by courtesy of the company.)

on a 46-acre tract on the edge of the Santa Fe Springs oil field. It is a thoroughly modern, well-arranged plant. Sewer pipe is the principal product, but electric conduit segmental sewer blocks and lining blocks, drain tile and flue lining are also made.

The plant makes sewer pipe, electric conduit, roofing tile, drain tile, flue lining and gas flues. Clays are shipped in from Riverside and San Diego counties and some clay mined on the premises is also used.

The equipment comprises three 9-ft. American dry pans, 2 pulverizers, gravity screens, four 8-ft. American wet pans, one 14-ft. pug-mill, 3 sewer-pipe presses, 1 auger machine, and 36 circular down-draft kilns 30 and 34 feet diameter. Some of the dry and wet pans are shown on photo No. 22, and one of the sewer-pipe presses is shown on photo No. 23. The drying floor is 220 x 920 ft. and is shown on photo No. 17. There is a well-equipped machine shop and testing plant for sewer pipe. Steam is furnished from two 250-h.p. Babcock and Wilcox boilers, with three 150-h.p. tubular boilers as stand-by. Excepting the steam-driven sewer-pipe presses all equipment is driven by electric motors. Natural gas and oil are both used for fuel.

Clays are shipped in from Riverside and San Diego counties and used in connection with red shale mined on the premises. The clay track is elevated above the storage bins so that the clays are dumped

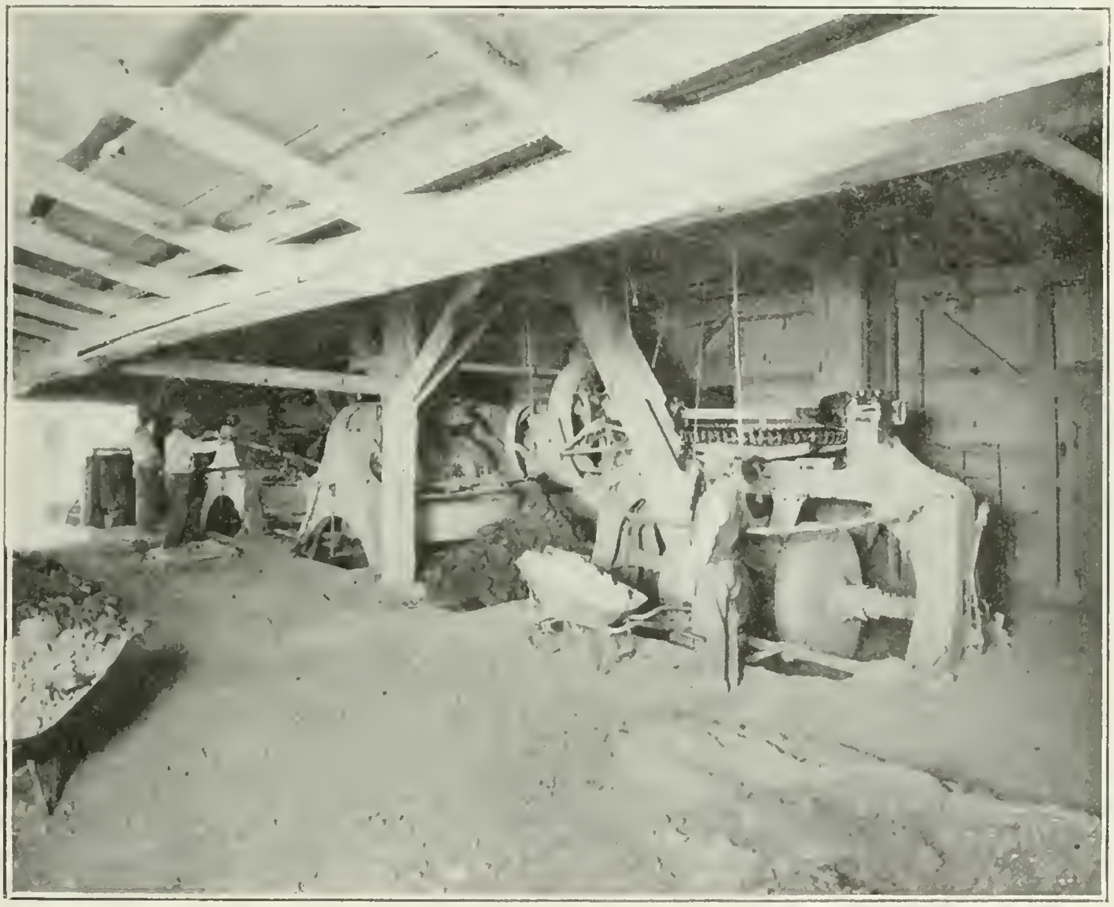

Photo No. 22. Dry pans and twin wet pans, Los Nietos plant, Pacific Clay Products Co., Los Angeles County. (Photo by courtesy of the company.)

directly from the cars at minimum cost. Some of them require fine grinding which is done by regrinding the oversize from the screens in pulverizers of the squirrel-cage type.

The drying room is equipped with steam-heating pipes overhead and underneath the floor, affording very satisfactory control. From 2 to 15 days is required to dry the ware, depending upon the size. Firing time varies likewise from 3 to 8 days. The bodies mature at 2100° F. to 2200° F. The salt glazing is done during the last two hours of the firing, *i. e.*, when the kiln is at maximum heat, by throwing a shovelful of salt into each fire-box every fifteen minutes. The salt volatilizes, is carried through and around the hot pipe, and as the vapor comes in contact with the clay the alkali in the salt combines with the silica of the clay to form the glaze on the surface.

All sizes of sewer pipe up to and including 30-inch are made. Segmental blocks for making sewers of larger size are also among the products. The plant employs 150 men.

The plant is served by both Santa Fe and Southern Pacific railroads, having sidings connecting directly with each.

SLAUSON AVENUE PLANT: Roy Lacy, superintendent. The Slauson Avenue plant was built about 1885. It is located on a tract of six acres on McKinley Avenue from Slauson Avenue to Fifty-third Street. It is served by the Santa Fe Railroad, the plant sidings connecting

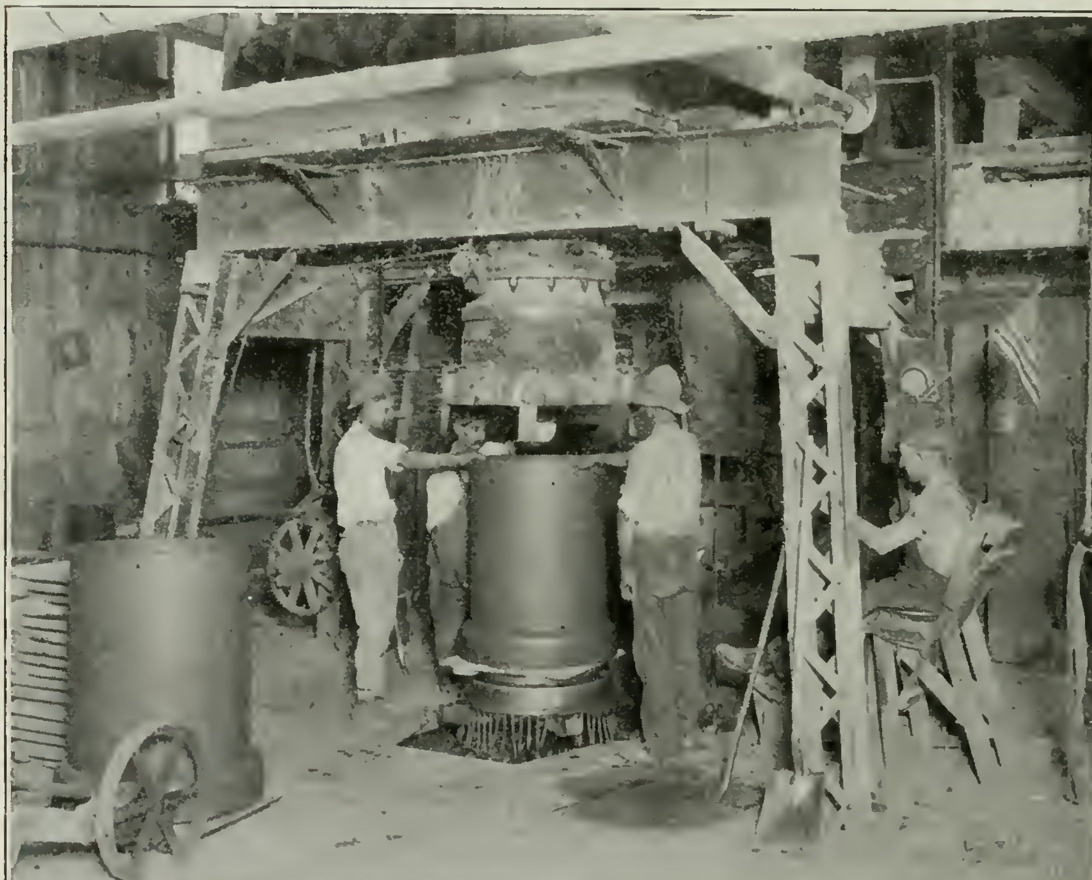

PHOTO NO. 23. Sewer-pipe press, Los Nietos plant, Pacific Clay Products Co., Los Angeles County. (Photo by courtesy of the company.)

with the tracks on Slauson Avenue. Equipment consists of a conveyor unloader for clay, 2 dry pans, pug-mill, double-shaft auger machine, and sewer-pipe press. There are seven 30-foot kilns and one 28-foot.

Pomona Brick Company.[1] E. G. Stahlman, president; H. F. Stahlman, secretary. Address, Pomona. This company owns a 10-acre property on West Ninth Street, Pomona, and manufactures common brick.

The deposit consists of red sandy clay, 8 to 20 feet thick, without overburden. The clay is loaded by a small steam shovel into trucks.

The plant equipment includes a dry pan, screens, pug-mills, and a

[1] Data supplied by W. B. Tucker, district mining engineer, November, 1927.

Potts brick press. The brick are conveyed to a drying yard on rope conveyors. Five field kilns, fired with natural gas, are in use.

The plant operates during about six months of the year, and employs 14 men during that period. About 110 h.p. of steam power are required. The rated capacity of the plant is 30,000 brick per 8-hr. day.

Bibl: Cal. State Min. Bur. Prel. Rept. 7, p. 58.

Pomona Tile Manufacturing Company, Third and Reservoir streets, Pomona. R. J. Schroeder, president and treasurer; C. V. Svendsen, superintendent. This company manufactures ceramic floor and wall tile, using Edgar clay from Florida, English china clay, California and Arizona feldspar, California silica, and some Santa Monica clay where red-burning bodies are required. Alberhill and Lincoln clays are used for saggers.

The tile are shaped in hand-operated dry presses. At the time of visit, July, 1925, two down-draft kilns were in operation, and a third kiln for increasing the capacity by 80% was under construction. Gas is used for fuel, with oil in reserve. The kilns are fired to cone 11.

The plant employs from 40 to 45 employees, mostly women and girls, who do the work of packing and unpacking the saggers, cleaning the tile after firing, and pasting them on paper.

Poxon Pottery. G. J. Poxon, president; Earl Lincoln, foreman. Offices 2300 East Fifty-second Street, Los Angeles. This pottery makes a complete line of plain and decorated table ware. All of the clays used are imported from England. The imports amount to about 1000 tons per year of ball and china clay. Feldspar and silica of the best quality are obtained from various sources in southern California, mainly from Riverside County.

After coarse-crushing to about ¼″ size, the silica and feldspar are mixed in the proper proportion with the clays, and the grinding is finished in a wet pulp. The mix is then passed to filter presses for the removal of excess moisture, and the filter cake is then ready for shaping.

Power-driven wheels are used throughout for all shapes that can be made mechanically. After shaping, the ware is dried for about three hours in gas-heated drying rooms, or for a longer time in the factory atmosphere.

The biscuit firing is done in gas-fired kilns at a temperature of 2300° F., for 70 hours. After cooling, the ware is dipped in the glazing material, and fired for 30 hours at 1800° F.

Some of the decorating is done by the paper-transferring process, while the higher-priced ware is hand-decorated. After decorating, the ware is fired for 12 hours at about 1100° F.

Seven gas-fired kilns are in use. The factory produces about 1500 dozen pieces per day, and employs 70 men and women.

Some ten years ago this plant used California clays, but found that the English clays gave better results. Kaolin from Hart, San Bernardino County, has been used recently, but is said to be too variable. Clay from Amador County has been tested with good results.

In 1926, the company built a new plant at Slauson and Miles avenues, in Vernon. It is understood that both plants will be operated, but further details are lacking at this writing.

St. Louis Fire Brick and Clay Co. Joseph Mesmer, president; A. J. Mesmer, superintendent. Office and plant at 2464 E. Ninth Street, Los Angeles. This company manufactures fire brick. Practically all of the clays in use at present are purchased from various sources, but the company owns a deposit near Corona that has been worked at various times in the past. The principal clays in use are the select main tunnel (sample No. 15, p. 264) and west blue (sample No. 23, p. 277) from Alberhill; the Emsco pink mottled (sample No. 71, p. 278) and the Lincoln, No. 1–6 (sample No. 146, p. 303). Some experiments were made with the Weiss clay from Glen Ellen, Sonoma County (samples No. 194 and 195, p. 262), but difficulties were encountered in securing satisfactory strength.

Both the auger and hand-pressing processes are in use, and the brick are fired in three down-draft bee-hive kilns, and two rectangular kilns, using oil as fuel.

Bibl: Cal. State Min. Bur. Prel. Rept. 7, p. 58.

Santa Monica Brick Company.[1] E. A. Douglas, president; F. M. Taylor, vice president and treasurer. Office and plant at Twenty-third and Michigan streets, Santa Monica. The company owns 10 acres of clay land and manufactures common brick, red face brick, roofing tile, and red floor tile.

The clay is a plastic, red-burning clay, underlying an extensive area from which numerous other manufacturers in the Los Angeles district secure clay for brick, hollow tile, roofing tile, and sewer pipe manufacture. There is no overburden. The deposit is now (1927) being worked by a power shovel against a 45-ft. bank, but the height of the bank may be increased in the future to 75 feet. The clay is transported to the plant in cars operated by an endless cable hoist.

The plant is equipped with a 60-h.p. 24-in. by 24-in. American disintegrator, a 150-h.p. American auger machine, having a rated capacity of 75,000 brick per day, an American automatic brick cutter, a 40-h.p. Fate-Root-Heath roofing-tile auger, having a rated capacity of 10,000 tile per day, and a hand-operated roofing-tile cutter, in addition to the necessary elevating and conveying equipment.

A hot-air tunnel drier is used, which operates on a schedule of 36 hours. Ten up-draft field kilns with permanent walls are used for firing. Both natural gas and steam-atomized oil are used. Normally, four kilns each with a capacity of 500,000, are used for firing brick, five kilns of 15,000 capacity each are used for roofing tile, and one kiln of 1000 sq. ft. capacity is used for floor tile. The brick are water smoked for three days, fired for four days, and allowed to cool for three days. Drawing and setting require about seven days. The finishing temperature at the end of the firing period is approximately cone 07 (975° C., or 1787° F.). The tile are water smoked for one day, fired for three days, and cooled in two days. One day is sufficient for setting and drawing.

The company also makes hand-made Mission roofing tile, which are dried in the open air.

The plant is operated throughout the year, employing 60 men. A total of 350 h.p. of electric power is installed in the plant. The rated

[1] Data supplied through the courtesy of the company.

capacity of the plant is 75,000 brick and 40 squares (100 square feet each) of roofing tile per day.

Simons Brick Co. Walter R. Simons, president; Robt. P. Isitt, vice president; H. B. Howeth, secretary; J. T. Crampton, treasurer. Office at 125 West Third Street, Los Angeles.

Boyle Plant: The Boyle plant of the Simons company occupies a 30-acre property at 1117 South Boyle Avenue, on the east bank of the Los Angeles River, a few blocks south of the Seventh Street yard of the Los Angeles Brick Co. This plant is now engaged in the manufacture of roofing tile exclusively. The clay deposits on the property have been worked out by past operations, at least to such an extent that it is more economical to ship clay to this plant from the company's large pit at Santa Monica. In order to produce the wide variety of colors demanded by the trade of today, varying amounts of Emsco white plastic (sample No. 70, p. 272) and other clays from the Alberhill district are mixed with the Santa Monica material. Most of the ware is red, and the mixture for this product contains 75% Santa Monica clay and 25% of a pink burning fire clay, such as Emsco pink mottled (sample No. 71, p. 278). Light pink, cream, and buff tile are produced by adding up to 90% of a light burning fire clay.

The tile are formed by the stiff-mud process, with Mueller machines. Drying under sheds requires nearly a week. Firing is done in 12 down-draft bee-hive kilns. The lighter-colored tile, containing more refractory clay than the red burned variety, are fired in one compartment of a double rectangular kiln, the dimensions of each compartment being 6 ft. by 20 ft. by 8 ft. A temperature of 2500° F. is required, and the heating period occupies three days. Kiln slabs, for supporting the tile during firing, are made of a mixture high in refractory clays, and are fired in the other compartment of the double rectangular kiln.

Santa Monica Plant: This plant is at Colorado Avenue and Twenty-sixth street, Santa Monica. The property consists of 24 acres. The clay is similar to that on other properties in the same area; see under Gladding, McBean and Company, Santa Monica Brick Company, and others. The soft-mud process is used and the brick are fired in oil-fired field kilns.

Simons Plant: The Simons plant is advertised as being the largest plant in the world exclusively devoted to the manufacture of common brick. It is situated on a 400-acre tract at Simons, on the main line of the Santa Fe Railroad, 1½ miles northeast of Montebello on the Southern Pacific Railroad.

The clay is of excellent quality for the manufacture of common brick, and occurs in a superficial bed averaging 16 to 18 feet in thickness, underlain by fine sand. The clay is mined by steam shovel, and hauled to the plant in 6-yard cars by gasoline locomotives. Sixteen soft-mud pug mills and Potts presses are arranged in units of two machines each at such positions in the yard as to provide ample room for drying sheds placed so as to secure the most economical transportation of the brick from the presses, and to the kilns. The brick are dried in from 7 to 10 days, depending upon the weather, and are fired in gas-fired field kilns. An 18-arch kiln will hold 756,000 brick, and a 30-arch kiln holds

1,250,000. Both sizes are in use, the choice depending on requirements at the time of setting.

The total capacity of the yard is 650,000 brick per day. The company has purchased a townsite, and has built homes for renting at a nominal rate to its 650 employees. Recreational facilities are provided, and every attempt is made to secure a permanent force of satisfied employees.

Standard Brick Co. J. V. Simons, president; R. G. Simons, vice president; H. W. Simons, secretary. Office at 102 Stimson Building, 129 West Third Street, Los Angeles. This company manufactures common red brick, and sewer brick, which are semi-vitrified common brick. Two yards are operated, one at Soto and Lugo streets, on the southern end of Boyle Heights, the other on Eucalyptus Street, in Inglewood.

Boyle Heights Plant: This property covers 8 acres. The material is a clay loam, 15 to 18 feet thick, underlain by sand. A steam shovel is used to mine the clay and load it into dump wagons, which are hauled to the dry pans. The brick are made in Potts soft-mud brick machines, and are dried in air under sheds, requiring from three to four days. Three or four gas-fired field kilns are maintained, depending upon the demand. The brick in the arches are carried to the semi-vitrification point, with less than 10% absorption, are sorted out after firing, and sold as sewer brick. The firing cycle is usually five and one-half days firing, and an equal time cooling. Mr. Welldon is foreman.

Inglewood: At Inglewood the clay is of much the same character as at the Boyle Heights plant, containing lenses of sand and fine gravel, underlain by coarse gravel. The same brick-making process is used here as in the Los Angeles yard. Mr. Paye is foreman.

Bibl: Cal. State Min. Bur. Prel. Rept. No. 7, p. 62.

Torrance Brick Company.[1] T. H. Reed, president; V. T. Pullman, secretary. Office address, Torrance. This company operates two plants.

Plant No. 1: This plant is on the Plaza del Almo Boulevard, Torrance, and produces common red brick only. The property comprises 15 acres, consisting of a 30-ft. bed of red and yellow plastic clay, overlain by about one foot of soil. The clay is mined by scrapers, which deliver to a hopper in the plant. From the hopper, the clay is elevated by a bucket elevator to rolls. The roll product is elevated by a bucket elevator to wire screens, which return oversize to the rolls for regrinding and deliver undersize to a pug-mill. The pugged clay passes to an auger machine, equipped with a wire cutter. The capacity of the auger is 60,000 brick per day.

The brick are transported to drying sheds in hand-trucks. Four open field kilns, fired with natural gas, are in use. The kilns have a capacity of 750,000 brick each. The plant operates throughout the year. Electric power is used, the installed capacity being 105 h.p. Thirty men are employed.

Plant No. 2. This plant is at Graves Avenue and Jackson Street, Monterey Park. Common brick, hollow tile, and red face brick are

[1] Data supplied by W. B. Tucker, district mining engineer, December, 1927.

produced. The property consists of 20 acres of clay shale, from 20 to 30 feet thick. The capacity of the plant is 60,000 brick per day, or its equivalent in other ware. Electric power is used, the installed capacity being 120 h.p. Forty men are employed.

Tudor Art Tile Company. H. C. Hill, C. J. Biddle, T. P. Cook, and Geo. Skee, owners. Geo. Skee, superintendent. Office address, 1204 Lane Mortgage Building, Los Angeles. Plant at 5848½ Santa Fe Avenue, Los Angeles. This company manufactures faience tile and inserts, using Alberhill clay. All special shapes are hand-molded in plaster molds, and an auger machine is used for standard tile shapes. Two gas-fired kilns are used. One is a rectangular semi-down-draft, 6-ft. by 8-ft. by 6-ft., fired to cone 01 (1145° C.) for biscuiting, and the other is a rectangular muffle glost kiln, 5-ft. by 6½-ft. by 12-ft., fired to cone 02 (1125° C.).

Clay-Worker reports[1] the organization of the *Tudor Potteries, Inc.*, with a capitalization of $50,000, by C. J. Biddle and M. L. Vincent. No further information was available at the time of going to press.

The Vitrefrax Company.[2] Harvey M. Brown, president; Geo. W. Clemson, vice president; C. V. Knemeyer, secretary; Ralph W. Brown, treasurer and general manager; Thomas S. Curtis, director of research. Office and plant at 5100 Pacific Boulevard, Los Angeles.

This company manufactures a broad line of ceramic materials for the porcelain, white-ware, and electrical isulator trade, as well as super refractories in the form of prepared grains, cements and finished raw materials, together with a line of finished refractory brick and shapes for the glass industry.

The company maintains an extensive research and development laboratory for fundamental investigations, as well as a control laboratory for physical and chemical control of its regular products.

In Imperial County, near Ogilby, California, the company owns and operates an immense deposit of cyanite, which forms the principal raw material for its mullite line of refractories and ceramic materials. In addition, the comany has under long contract abundant supplies of aluminum oxide at Marysville, Utah; high alumina clays from the Alberhill and Santa Margarita Ranch deposits; and contract control of what is believed to be the purest magnesium oxide resources in the United States.

The mullite products of the company constitute its most important line. The material is manufactured in several grades, one of which is made especially for the spark-plug industry. The highest grade of mullite products, trade marked 'Durox,' is manufactured by fusing a specially concentrated cyanite of great purity in the electric furnace at a temperature approximating 3000° C., whereby a yield of nearly pure mullite is obtained.

The most important application of the mullite refractory material in its highest state of purity is in the form of glass-house refractories, in which form the company's product is gaining important recognition. Excellent service is being obtained in many commercial installations on the Pacific coast, while an awakening interest in the east has caused

[1] July, 1927, p. 58.
[2] Copy prepared by the company.

orders to be placed by a number of prominent glass manufacturers within the past year.

For the general refractories trade, for use in heavy-duty boiler refractories and the like, a cheaper grade of mullite is manufactured and sold under the trade mark 'California Mullite.' This product readily competes in the eastern market with all other available sources, and has been pronounced after extensive tests to be equal to or the superior of any mullite available from the calcination of sillimanite, andalusite or cyanite.

Illustrations of the plant are shown in photos No. 24 and 25.

Bibl: Curtis, T. S., Super Refractory Manufacture. Ceramic Industry, July, 1926.

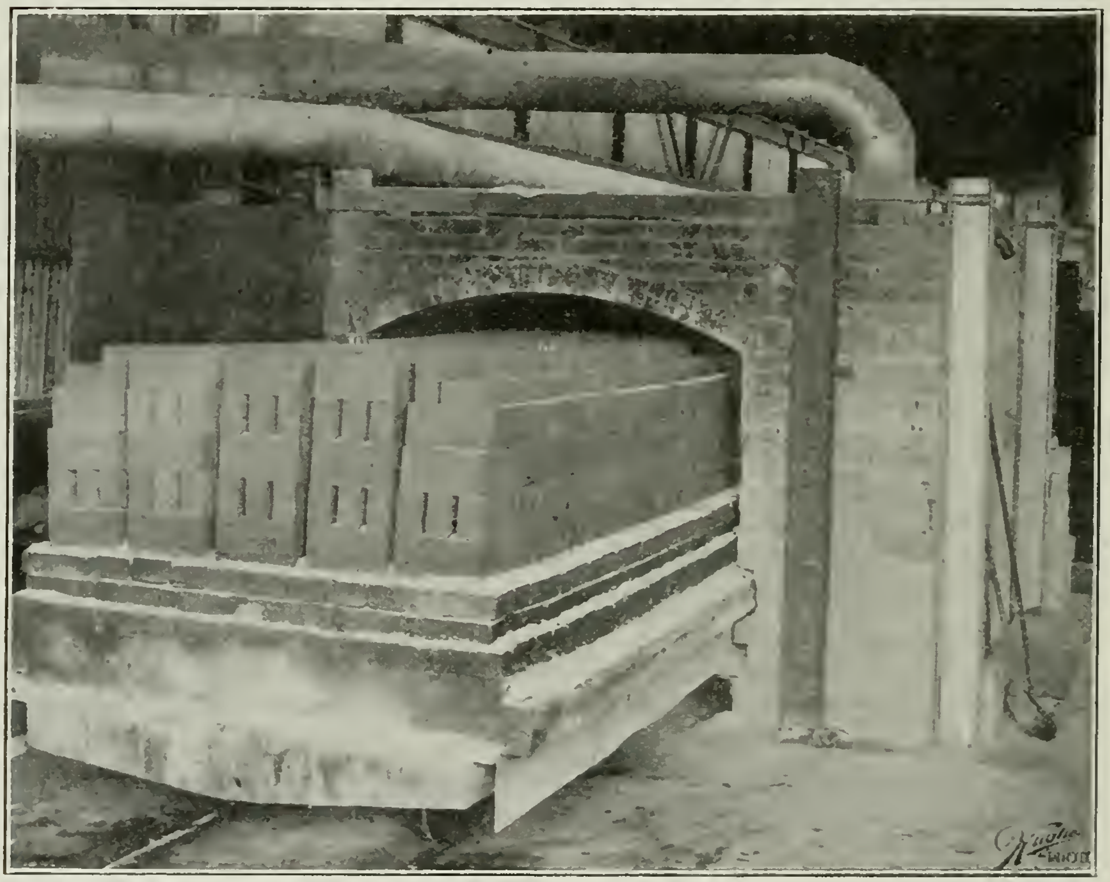

PHOTO No. 25. California Mullite brick being fired in tunnel kiln at Cone 28, Vitrefrax Co., Los Angeles.

Washington Iron Works. Eighth and Mateo streets, Los Angeles. This company operates a sanitary ware enameling plant. The plant was visited, but in justice to the company no details are published, as other manufacturers of this ware refused publication of data.

Western Brick Co. G. A. Wild, president; J. J. Lagomarsino, superintendent. Office at Room 605, 126 West Third Street, Los Angeles. This company manufactures common red brick only, using local clays. Plant No. 1 is at 1155 Lilac Terrace, on the southern side of Elysian Park. The capacity of this plant is 10,000,000 per year.

Plant No. 2, is at Twenty-sixth and Colorado streets, Santa Monica, covering the same clay formation as that occurring on the property of

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Marin County lies north of San Francisco, the Marin Peninsula and San Francisco Peninsula being separated by the Golden Gate. The

[1] From Laizure, C. McK., Marin County: State Mineralogist's Report XXII, p. 314, 1926.

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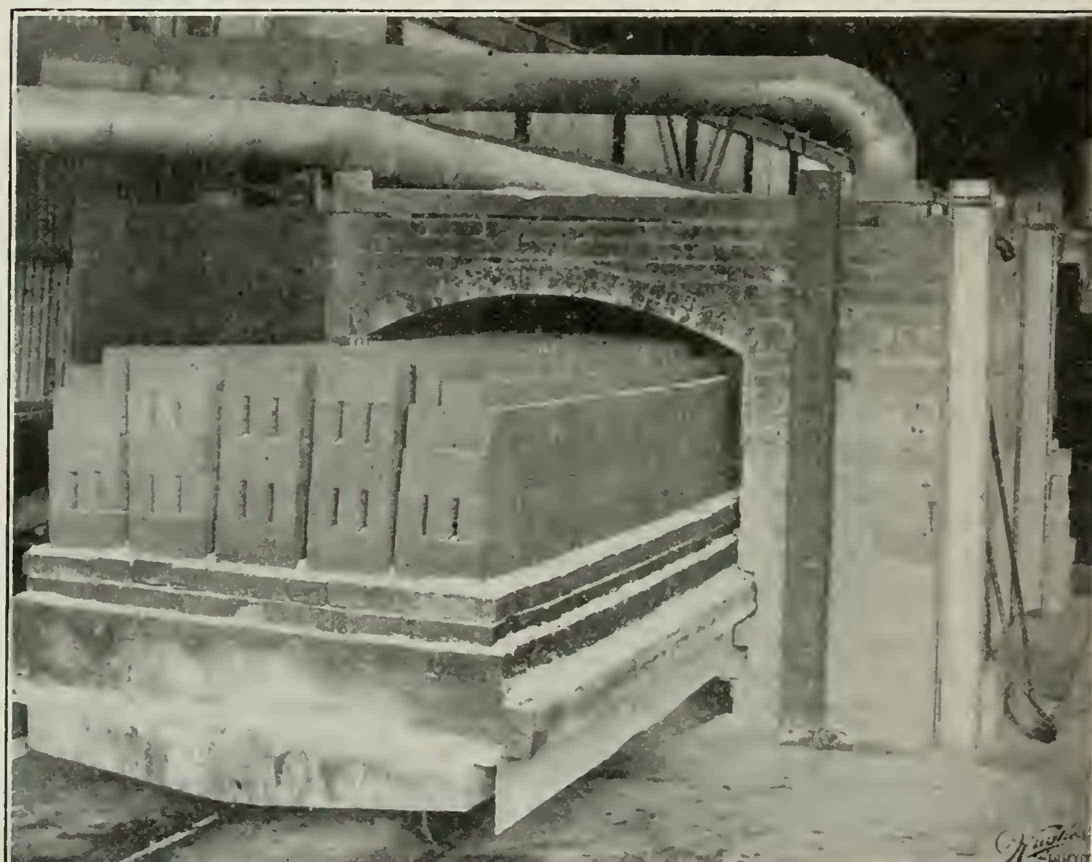

PHOTO NO. 25. California Mullite brick being fired in tunnel kiln at Cone 28, Vitrefrax Co., Los Angeles.

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Plant No. 2, is at Twenty-sixth and Colorado streets, Santa Monica, covering the same clay formation as that occurring on the property of

PHOTO NO. 24. Interior view of plant, Vitrefrax Company, Los Angeles. (Photo by courtesy of the company.)

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Plant No. 2, is at Twenty-sixth and Colorado streets, Santa Monica, covering the same clay formation as that occurring on the property of

the Los Angeles Pressed Brick Company and the Simons Brick Company. This plant has a capacity of 25,000,000 brick per year. Either oil or gas fuel is used for firing in open field kilns, the choice of fuel depending upon relative economy at the time.

Whiting-Mead Company. J. M. Bonner, secretary. Plant and office at 2260 E. Vernon Street, Los Angeles. The Whiting-Mead pottery is one of the largest on the Pacific coast in which sanitary porcelain is manufactured. A small quantity of garden pottery is also produced. The clays used are a white clay from Corona (No. 70, p. 272), hill blue (No. 9, p. 287), and pink mottled (No. 7, p. 328), from the Alberhill Coal and Clay Co., English china and ball clays, Nevada china clay from near Cuprite, in addition to silica and feldspar from San Diego County.

The casting process is used exclusively. The clay slip is piped to all parts of the casting room, which is on the second floor of the plant building. Waste-heat driers are used. The ware is fired in two Harrop tunnel kilns, each 365 feet long, using trucks 5-ft. by 5-ft. by 10-ft. After the biscuit firing in the first kiln, the ware is dipped in glaze, and is glost in the second kiln. The firing cycle in the two kilns is the same, 66 hours, so that the loading and unloading of the kilns can be synchronized. Precious metal thermocouples are used for temperature control in the kilns.

The company also operates a sanitary ware enameling plant on the same site. It is one of three such plants in California, the others being the Washington Iron Works of Los Angeles and the Pacific plant of the Standard Sanitary Manufacturing Company at Richmond.

MADERA COUNTY.

General Features.

Madera County is in the east-central portion of the state, and lies between Merced and Mariposa on the north and Fresno on the south, in a narrow strip, extending from the floor of the San Joaquin Valley on the west to the summit of the Sierra Nevada Mountains on the east. Its area is 2112 square miles, and the population is 12,203 (1920 census). Granite is the principal mineral product. Some miscellaneous stone, gold and silver are also produced. Occurrences of copper, iron, lead, molybdenum, pumice, and building stone are known.

Clay Resources.

Common brick clay is reasonably abundant in the valley section of the county. The Sunset Brick Company (also known as Dyer's Brickyard) operated at Madera for a time, but has been idle since about 1919.

Bibl: State Min. Bur. Bull. 38, p. 249; Prel. Rept. 7, p. 64.

MARIN COUNTY.

General Features.[1]

Marin County lies north of San Francisco, the Marin Peninsula and San Francisco Peninsula being separated by the Golden Gate. The

[1] From Laizure, C. McK., Marin County: State Mineralogist's Report XXII, p. 314, 1926.

Pacific Ocean bounds it on the west, Sonoma County and portions of San Pablo and San Francisco bays surround it on the north and east. The total area of the county is 529 square miles, and the population is 27,342 (1920 census).

The main line of the Northwestern Pacific railroad runs through the eastern side of the county, and a narrow-gauge branch traverses the western portion, passing through Point Reyes and continuing northward into Sonoma County.

Marin County is for the most part rugged and picturesque, the ridges having steep slopes with only a few small flat valleys. The main ridge trends northwesterly, culminating at the south in Mount Tamalpais, which overlooks both bay and ocean from an elevation of 2601 feet. From this main crest the drainage is both to the ocean and bay sides. Other notable topographic features are Tomales, Drakes, Bodega and Bolinas bays on the ocean side and Richardsons Bay on the inland side.

Geology.

The geology of the Marin Peninsula has been described by Lawson [1] and Osmont,[2] to which the reader is referred for a detailed discussion.

Geologically, the county is divided into two areas by the great San Andreas fault, which runs in a northwest direction from Bolinas Bay to Tomales Bay. The country lying east of the fault comprises about three-fourths of the county and is composed almost entirely of Franciscan rocks. These include massive sandstone, chert and intrusive bodies of serpentine and basalt. The Point Reyes Peninsula, which includes that portion of the county lying west of San Andreas fault, is composed mainly of Monterey shale, which is distinctly bituminous in places. Two small areas of volcanic rock are exposed near Inverness and Tomales Point.

The mineralization of the county is diversified, but the deposits that may be classed as economic resources are limited, though important on account of their proximity to the metropolitan bay area. The economic minerals are mainly structural and industrial nonmetallic products. Occurrences have also been noted of asphaltum, petroleum, chromite, coal, jasper, garnets, manganese, mineral water, and natural gas. A little copper ore was at one time shipped, and traces of gold and silver have been found. Salt has been produced.

Clay Resources.

No deposits of high-grade clay have been reported in the county, but there is an adequate supply of clay and shale suitable for the manufacture of red structural ware at numerous places in the county. Common brick and other products have been produced since 1870 and three plants have been in operation at various times in the past. One plant is at present steadily producing, and a second plant is under construction.

McNear Brick Co. E. B. McNear, president and manager; L. B. McNear, superintendent. Main office, 417 Berry Street, San Francisco. Manufacturers of common brick.

The clay pit and brick yard are at tidewater on McNear Point, four miles east of San Rafael. The present pit is 3000 feet from the plant.

[1] Lawson, A. C., San Francisco Folio, No. 193, U. S. Geol. Survey.
[2] Osmont, V. C., Bull. Dept. of Geology, Univ. of Calif., Vol. 4, No. 3.

in a bank of shale, slate, sandstone and clay in the face of a hill, underlain by Franciscan sandstone. The material sometimes requires blasting. It is delivered to a loading hopper by two electrically operated dragline scrapers operating on a 10% slope in favor of the load. The clay bank has the form of an arc of a circle, with a radius of 300 yards, and a center at the loading hopper. The unblasted bank stands at a height of 30 to 60 feet, and has a nearly vertical face. A view of the pit is shown on photo No. 26.

From the loading hopper, the clay is loaded by a chain conveyor into 2.5 cu. yd. side-dump contractor's cars. Trains of four cars each are hauled to the plant by a Baldwin Westinghouse electric trolley locomotive.

At the plant, the clay is fed to two 9-ft., dry-pans, elevated by a bucket elevator and delivered to a pug mill and auger machine, equipped with a wire cutter. Drying is done under sheds, and requires 15 days (average) in summer, and a longer time in winter. Firing is done in

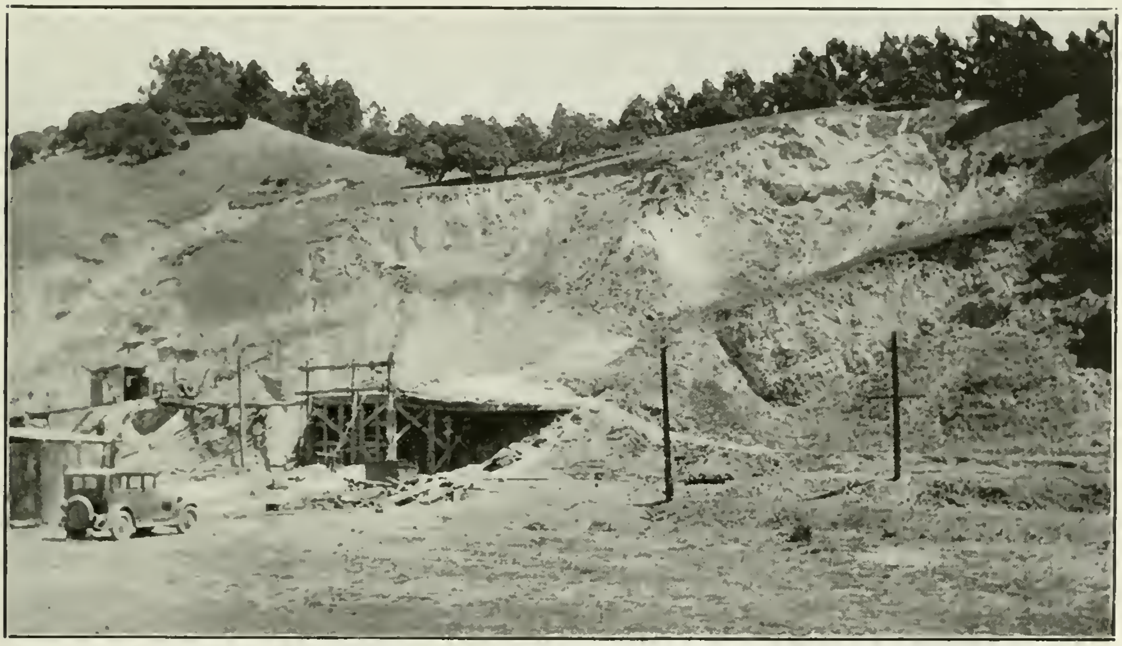


PHOTO No. 26. Clay and shale deposit of McNear Brick Company, showing loading hopper. Marin County. (From State Mineralogist's Report XXII, p. 318, 1927.)

two Hoffman continuous kilns, fired with coal screenings or oil coke. The kiln turnover period is 15 days, and actual firing requires from five to six days. The finishing temperature is 2000° F.

The capacity of the plant is 60,000 common brick per day. From 45 to 50 men are employed.

Sample No. 198 was taken from the dry-pan feed. The superintendent stated that the sample was somewhat leaner than the normal feed to the plant as it had rained the previous night, and only the more sandy clay can be handled when the ground is wet. The test results are on page 329. Occasional seams containing calcite are encountered in the pit. These can be included in the mix if they are well distributed in the feed to the plant.

Bibl: State Mineralogist's Reports VIII, p. 342; XII, p. 382; XIII, p. 615; XIV, p. 244; XXII, p. 317. Bull. No. 38, p. 249. Prel. Rept. No. 7, p. 64.

Louis Sbarbori,[1] 554 Broadway, San Francisco, has recently (1926) leased the Remillard property (see *post*) and was expected to begin the manufacture of floor tile during 1927. No further data are available.

Earlier Reports.

The status of operations or clay deposits noted in previous reports[2] is as follows:

Maillard Ranch. Lagunitas. Now owned by the Lagunitas Development Company, 833 Market Street, San Francisco. "Clay deposit on Spring Creek, about eight miles northwest of San Rafael." The deposit is still undeveloped, and is probably common clay.

Patent Brick Company. Gallinas Station. This plant has been dismantled, and the company is out of business. The Hidecker Tile Co., Twenty-fourth and Union streets, Oakland (see under Alameda County), occasionally crushes some of the old brick from this place for use in the manufacture of roofing tile.

Remillard Brick Company. Greenbrae. "Shale and sandstone, practically inexhaustible." This plant was dismantled about 1911. The company operates plants at Pleasanton, Alameda County, and at San Jose, Santa Clara County (q. v.).

Bibl (On Marin County clay resources): State Mineralogist's Reports V, p. 108; VIII, p. 342; XI, p. 253; XII, pp. 329, 382; XIII, pp. 506, 615; XIV, pp. 244–248; XXII, pp. 317–319. Bull. 38, p. 362; Prel. Rept. 7, p. 64.

MENDOCINO COUNTY.

General Features.

Mendocino County joins Humboldt County on the south and is bounded by the Pacific Ocean on the west. Its area is 3453 square miles, and the population is 24,116 (1920 census). Lying in the Coast Range, the greater part of the county is mountainous and heavily timbered, except in the southeastern portion, through which flows the Russian River. Lumbering is an important industry.

The rocks of the Coast Range within the limits of the county consist mainly of Franciscan (Jurassic), Chico (Upper Cretaceous), and various Tertiary sedimentary and metamorphic formations. The mineral resources are largely undeveloped. Occurrences of asbestos, chromite, coal, copper, graphite, magnesite, and mineral water are known, as well as traces of gold, platinum, and silver. Miscellaneous stone, coal and natural gas are produced in small amounts.

Clay Resources.

Common brick clays are available near the coast at the town of Mendocino, and also at Ukiah. Brickyards were at one time operated in these places, and at Talmage, near Ukiah, but there has been no production in recent years. The brickyard of U. N. Briggs, at Ukiah, has been out of business since 1922. The most recent production of common brick was at the Mendocino State Hospital, at Talmage. See below.

[1] Laizure, *op. cit.*, p. 319.
[2] Especially in Prel. Rept. 7, p. 64.

Mendocino State Hospital. Talmage.[1] A brickyard was operated here for a few years to manufacture brick for use in construction work at the hospital. The clay consisted of a local deposit of gravelly silt, about 10 feet deep, and covering an area of about one-half acre. It was mined with a plow and scraper. The plant is equipped with a disintegrator, conveyor, pug-mill, and auger machine, with a wire cutter. The lack of screening equipment reduced the capacity of the machinery to 8000 brick per day instead of 30,000, on account of gravel in the clay. Firing was done in open field kilns. The production cost of the brick was stated to be $11.50 per thousand. There has been no production since 1924, as it was found that concrete construction is cheaper, with cement at $2.28 per barrel, delivered.

Bibl: State Mineralogist's Rept. XIV, p. 415; State Min. Bur. Prel. Rept. 7, p. 64.

MERCED COUNTY.

General Features.[2]

Merced County is situated near the geographical center of the state. It is bounded on the north by Stanislaus County, on the east by Mariposa, on the south by Madera and Fresno, on the west by Santa Clara and San Benito counties. It has an area of 1995 square miles and supports a population of 24,579 (1920 census). Most of the land is cultivated, and much of it is irrigated, there being extensive irrigation systems covering the valley lands. Merced is essentially an agricultural county.

The greater part of the county lies within the San Joaquin Valley, and is composed of unconsolidated sands, gravels, and clays of Quaternary age. Along the eastern edge of the county there is a narrow belt of Tertiary formations, represented mainly by clays, shale and massive sandstone. On the western side of the county Cretaceous sandstones and shales appear, and as the western boundary of the county, near the summit of the Coast Range, is approached, Franciscan rocks of Jurassic age are exclusively in evidence. These consist mainly of slates, cherts, sandstones, schists, and serpentine.

Both metallic and nonmetallic minerals have been found and produced in Merced County. Among the former are gold, platinum, silver, copper, and a few pounds of lead. Crushed rock, gravel, sand, clay, and clay products are the chief nonmetallics. In addition to these the occurrence of a few other minerals has been noted, such as cinnabar (quicksilver), stibnite (antimony), barite, calcite, diatomaceous earth, magnesite, asbestos, manganese, coal, and soda niter, but for the most part these are entirely undeveloped and probably most of them do not occur in marketable quantities.

Miscellaneous stone, including crushed rock, gravel, and sand, cement, brick and tile, are at the present time the principal mineral products. Structural materials of this nature will contribute almost exclusively to the future mineral output of the county.

Clay Resources.

No commercial deposits of high-grade clay have been found in the county, notwithstanding intensive investigations on the part of the

[1] Information secured through the courtesy of Dr. Donald R. Smith.

[2] From Laizure, C. McK., Merced County: State Mineralogist's Report XXI, p. 173, *et seq.*, 1925.

California Pottery Company and the Yosemite Portland Cement Company. The latter company recently built a cement plant near Merced and conducted an elaborate search for high-alumina clay, low in iron, but were finally forced to import this material from the Ione district.

There are a few remnants of the Ione formation in the foothills of Merced County. These have not been thoroughly prospected, but there seems little reason to hope for commercial clay deposits in them.

Clay suitable for the manufacture of common brick and hollow tile is available in the vicinity of Merced. A brickyard operated in Merced from 1905 to 1910. The clays from various places are now being used by the California Pottery Company (see *post*), the Yosemite Portland Cement Company, and the Craycroft-Herold Brick Company of Fresno. The latter company mines clay from a deposit six miles south of Merced, and ships to its plant in Fresno.

California Pottery Co. F. A. Costello, president. General office, Mills Building, San Francisco. Plant at Merced. The company also operates a plant in Oakland, Alameda County. The Merced plant is in the southern outskirts of Merced, between the state highway and the Southern Pacific railroad. The products of the plant are roofing tile, hollow tile, and some 3-in. to 6-in. drain tile. Red, buff, and pink ruffled face brick were formerly made.

The local clay is mixed with clay from the company's pit near Valley Springs, Calaveras County (samples No. 202–204, pp. 299 and 337), and with red-burning clay from the Natoma Clay Company in Sacramento County (samples No. 210 and 212, p. 337). The local clay is a valley silt, and is mined to a depth of 10 feet with team and scraper from a pit adjoining the plant. It has insufficient bonding strength and plasticity to be used alone, and at least 35% of the Valley Springs clay, or an equivalent amount of Natoma clay must be mixed with it.

The plant is equipped with a 10-ft. Raymond dry pan, one American number 290 auger machine for hollow tile and face brick, one American No. 233 auger for roofing tile, a 20-tunnel American waste-heat drier, and eight 30-ft., oil-fired, steam-atomized, round down-draft kilns. The dryer cycle is 36 hours. When there is insufficient dryer capacity, some ware is dried on the drier floor. Each of the kilns has a capacity of 125 tons of hollow tile, 100 tons of Sierra roofing tile, or 90 tons of Spanish roofing tile. Firing requires 72 hours, to a maximum temperature of cone 4–5 (1170° C.) for buff-colored ware, and to cone 2 (1135° C.) for red-colored ware. Seventy-five per cent of the output of the plant during 1925 was roofing tile. The output of drain tile is very small.

The plant is handicapped by the fact that clay must be brought in from the north, and at the same time, the principal market for the products are to the north.

Forty-three men are employed.

M. Goldman[1] of Merced is the owner of large land holdings in the eastern part of the county, and it has been reported in the past that white clay, suitable for the manufacture of pottery, occurs on this property in the vicinity of Merced Falls. The holdings have not been thoroughly prospected, but the investigations that were made failed in find-

[1] Laizure, C. McK., *op. cit.*, p. 179.

ing any high-grade clay; the material being apparently a silt deposit of indefinite composition, rather than a residual clay.

Clay deposits have been reported from T. 5 S., R. 14 E. Their character and value have not been determined.

Bibl (Merced County clay resources): State Mineralogist's Reports, XIV, p. 605; XXI, pp. 175, 177–179. Bull. 38, pp. 217, 250; Prel. Rept. 7, p. 64.

MONTEREY COUNTY.

General Features.[1]

Monterey is one of the central coast counties, extending from the Pajaro River, which empties into Monterey Bay, south to the sixth Standard Parallel. It is bounded on the north by Santa Cruz County. San Benito, Fresno and Kings counties adjoin it on the east, and San Luis Obispo County bounds it on the south. Its area is 3330 square miles and its population 27,980 (1920 census). The main line of the Southern Pacific railroad, coast division, runs through the county, connecting it with San Francisco and Los Angeles, as also does the state highway, a concrete paved road. Connecting county roads are kept in good condition, and it is only in the more remote mountainous sections that economic transportation becomes a problem. The completion of the proposed road along the coast, connecting Monterey and San Luis Obispo, now open from the north to a point 18 miles beyond Big Sur and from the southern end as far north as Salmon Creek, will open up a large area which has heretofore been accessible only by water or steep trails, and one whose mineral resources are scarcely known.

Among the principal topographic features is the great central Salinas Valley, the largest of the intermountain valleys of the coast region, being about 100 miles long by 6 to 10 miles in width, and lying parallel to the coast. Between the valley and the coast rises the Santa Lucia Mountain Range, which culminates in a number of peaks, some reaching nearly 6000 feet above sea level. Along the eastern side of the valley, and with their crests forming the eastern boundary of the county, are the Gavilan and Diablo ranges. Among the smaller valleys are the San Lorenzo, San Antonio, Cholame, Carmel, and Nacimiento. In each of these the principal axis extends northwesterly, parallel with the general structure of the mountain ranges.

Geology.

The geology of most of Monterey County is described and mapped in Bulletin No. 69 of the State Mining Bureau, 'Petroleum Resources of California,' and the folio accompanying it. It is also shown in lesser detail on the Geological Map of California (1916).

The Santa Lucia Range has a core of granitic rock. This is exposed in Santa Lucia Peak at an elevation of 5967 feet, and throughout the territory between Carmel River and Sur River, either along the coast or in the river cuts. Limestone and gneiss overlie the granite in places, and make up Pico Blanco, Ventana Cone, Marble Peak, Twin Peak, and Cone Peak. Most of the area from Mill Creek southward to Three Peaks and bounded on the northeast by Nacimiento River is made up of Fran-

[1] Laizure, C. McK., Monterey County: State Mineralogist's Report XXI, p. 23, 1925.

ciscan sandstone and shale, with intrusions of serpentine. It is in the region of these serpentine intrusions and the later intrusive acid dikes that the important mineral deposits of the Los Burros district are found. The geology of the Los Burros district has been described in considerable detail by Hill.[1] There is evidence throughout of much faulting, and the precipitous coast follows a fault line. Monterey sandstone and conglomerate flank the mountains on the southwest side of Nacimiento River, and dip towards the valley. Most of the older sediments exposed east of the Nacimiento consist of Monterey shale, which is considerably folded east of Jolon.

Along the coast, resting unconformably on the granite and Franciscan rocks, are raised beach deposits. The settlement of Gorda is located on the most recent of these terraces. This terrace is noticeable in Willow Creek, one-half mile back from its mouth, and also along the coast north of Gorda. These terraces are important in relation to placer gold. It is thought that the placer deposits near Jolon originated in a similar manner.

In the northeastern part of the county, in the Gavilan Range, granite occurs associated with gneisses and schists. In places these rocks contact with massive beds of metamorphosed limestone, and dolomite is commonly associated with them. Feldspathic segregations give rise to commercial deposits of feldspar along the range as far south as the Pinnacles. In the vicinity of the Pinnacles there is a small area where volcanic activity has taken place and extrusive volcanic rocks are in evidence. Farther south Tertiary sandstone and shales predominate. A long, narrow belt of the Franciscan rocks, including slates, sandstones, and much schist and serpentine, extends from Priests Valley southeastward beyond Parkfield. Workable coal beds are exposed in the vicinity of Priests Valley and the principal quicksilver deposits occur in the Franciscan, not far from Parkfield.

The following commercial minerals are of record as occurring in Monterey County: Arsenopyrite, barite, bitumen (asphaltum), calcite (limestone and marble), chromite, cinnabar (quicksilver), clay, coal, copper, diatomaceous earth, dolomite, galena, garnet, gold, graphite, gypsum, magnesite, magnetite, malachite, metacinnabarite, molybdenite, orthoclase (feldspar), psilomelane (manganese), quartz, salt, serpentine (asbestos), and stibnite. Not all of these have been produced in commercial quantities, however, nor is it known that all occur in sufficient quantity to be of value. About ten other species of mineralogical interest only have also been noted.

Clay Resources.

No commercial deposits of high-grade clays have been discovered in the county. Common brick clays are not abundant, but there is little doubt that suitable deposits can be found if needed for local purposes. A clay pit and brickyard were at one time operated on a small scale at the south end of Salinas. The only clay-working operations in the county at present (1927) are two hand-made roofing tile plants, which are described below.

Arca Roofing Tile Plant. Joe Arca of Castroville owns and operates a small hand-made roofing-tile plant one mile east of Castroville on the

[1] Hill, J. M., The Los Burros District, Monterey County, California: U. S. Geol. Survey Bull. No. 735–J, 1923.

Salinas road. The property covers one acre. The clay deposit consists of 18 ft. of yellow plastic clay, underlying one foot or less of black adobe. See sample No. 117, page 324, for test data on the clay. The clay is mined by hand and is fed to a horse-driven pug-mill. After the pugged clay is aged for a few days, the tile are shaped by hand over wooden forms, and are then dried in air under sheds. The clay is excessively plastic, and in the cool moist climate of the region, drying is very slow. The tile are fired in an oil-fired rectangular up-draft kiln.

The capacity of the plant is 500 tile per day, and three or four men are employed.

Mr. Arca reports that good roofing tile clay occurs on the Martin ranch near the Carmel mission. It was used by the Indians in making roofing tile for the Mission. Mr. Arca attempted to establish his plant there but found that the land was too valuable.

Monterey Mission Tile Co. H. L. Watson, president; T. H. Bane, secretary treasurer. The new plant of the Monterey Mission Tile Company is near Seaside, and about two miles north of Del Monte. The property covers three acres. The products are red-burned roof tile, floor tile, and step tile, all of which are hand-made. The clay is mined by hand methods from the Thomas Field ranch on the Laguna Seco grant, at a point 5.5 miles toward Salinas from the junction of the Salinas road and the Santa Cruz road just north of Del Monte. The total haul to the plant is seven miles. The clay is a black adobe, 10 feet deep, covered with 2 feet of sandy soil. Sample No. 214 was taken from the clay in storage at the plant. See page 327.

At the plant, the clay is mixed with approximately 20% of grog consisting of ground rejects from the kiln, pugged in a Patterson vertical pug-mill, and aged for at least three days before molding. A 5-hp. motor drives the grog crusher and the pug mill.

The tile are shaped by hand with Mexican labor, and are dried under sheds. The drying time varies widely with climatic conditions, but usually requires at least two weeks, on account of the cool, humid atmosphere generally prevailing in this region.

The tile are fired in a cylindrical up-draft kiln, 13½ feet in diameter in the lower 6-ft. section, tapering to six feet in diameter in the upper 5-ft. section, and finally tapering to four feet in diameter at the throat. The kiln will hold approximately 600 roofing tile. It is fired with four oil burners, placed in pairs at opposite sides of the kiln. The oil is preheated to 120° F. in electric heaters placed in the pipe line, and is atomized with air from motor-driven blowers. Four base-metal thermocouples, with a multiple recorder, are used to control the firing, in addition to Orton standard cones. The maximum temperatures recorded at the end of firing are 1830° F. on the bottom, and 1470° F. on the top of the kiln. Firing requires 32 to 38 hours.

The product is distinctly different in appearance from machine-made tile, and from most of the hand-made tile produced in the state, on account of the irregular texture and the play of colors to be seen on each individual tile. The owners of the plant were formerly builders in the district, and the tile plant is the outgrowth of a local desire for more artistic effects than could be obtained with the tile previously on the market. Since the tile are made by an expensive process, they are only to be seen on some of the finest residences in Carmel and Pebble Beach.

From 8 to 10 men are employed when the plant is in full operation.

Bibl: State Mineralogist's Report XXI, p. 57, Jan. 1925.

Miscellaneous Deposits.

Echstine Deposit. Mrs. G. P. Echstine, Pleyto. In T. 24 S., R. 8 E., M. D. M. An occurrence of white plastic clay had been reported to the Bureau. The deposit was investigated in September, 1926, and was found to consist of a plastic clay that is grayish white when dry, but darkens considerably when wet, and fires to a red color. The property is difficult of access, and is some 18 miles from the railroad, hence the clay has no possible commercial value.

Heins Lake Deposit. Owner, Martha E. Bardin, Salinas. The bottom of Heins Lake, now dry, situated about two miles southeast of Salinas, is reported to be composed of blue clay. There is about 300 acres in the deposit, and it is said to average four feet in depth.[1] No investigation was made by the author.

Jens Deposit. Chualar. A supposed deposit of clay from which it was reported that several thousand tons had been shipped. An investigation showed that the material is low-grade feldspar.

Bibl (Clay resources of Monterey County): Cal. State Min. Bur. Bull. 38, p. 250; Prel. Rept. 7, p. 65; Rept. XXI, pp. 29 and 57.

NAPA COUNTY.

General Features.

Napa County, with a land area of 783 square miles, runs nearly to a point at both extremities. It is bounded on the east by Solano and Yolo counties and on the west by Lake and Sonoma counties. Its southerly end touches San Francisco Bay. The main drainage system of the county is that of the Napa Valley, which is a rich agricultural section, and is served by a branch line of the Southern Pacific railroad, extending from San Francisco Bay to Calistoga, in the northwestern corner of the county. Mt. St. Helena, a prominent landmark, is in the northwest corner, at the junction with Lake and Sonoma counties.

The principal geological formations in the county, in addition to Recent sediments in the valleys, are Franciscan (Jurassic) slates, sandstones and serpentine, Miocene sandstones and shales, and Tertiary volcanics.[2]

The principal mineral resources include quicksilver, mineral water, miscellaneous stone, and magnesite. Occurrences of diatomite, limestone, copper, iron, chromite, gold, silver, and mineral paint have been noted. A cement plant at one time operated at Napa Junction.

Clay Resources.

Common clays suitable for brick manufacture occur in the Napa Valley. Previous to 1890 there was a plant in operation near Napa,

[1] Laizure, C. McK., *op. cit.*, p. 29.

[2] Smith, J. P., The geological formations of California: Cal. State Min. Bur. Bull. 72, and Geological Map.

where brick and drain tile were made. The cement plant at Napa Junction used local clay in cement manufacture.

An interesting occurrence of kaolin is described at considerable length below, not so much for its present value, which is doubtful in the present state of development, but because of its significance in encouraging further prospecting for commercial deposits in this region.

Clark and Marsh Kaolin Mine. This property, referred to in a previous report[1] as a 'china clay' deposit, owned by W. R. Teale, has been acquired by J. R. Clark and C. L. Marsh of Calistoga. The property includes the following areas: S½, SE¼, Sec. 12, and N½ NE¼, Sec. 13, T. 8 N., R. 7 W., and the S½ SW¼, Sec. 7, NW¼ NW¼, Sec. 18, and the diagonal (NW.–SE.) NE½ NE¼ NW¼ Sec. 18, in T. 8 N., R. 6 W., M. D. M., a total of 300 acres. The principal workings lie near the top of a hill, 3.5 miles by road south of Calistoga. Some road grading is necessary before trucks can be run to the mine.

PHOTO NO. 27. Clark and Marsh Kaolin Mine. Main workings, facing west. Note scrub brush over deposit, and timber in left background on other formations. Calistoga, Napa County.

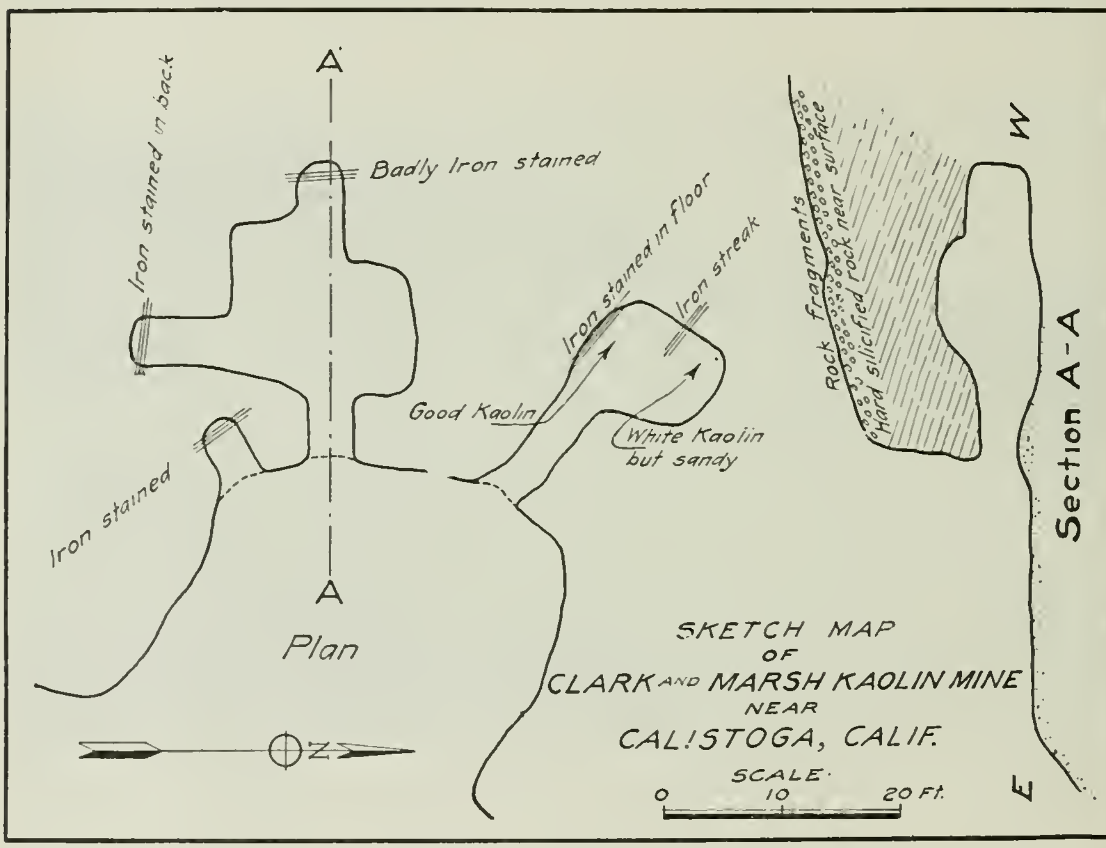
The deposit is a residual kaolin formed by the alteration of a rhyolitic rock that has a wide distribution in the region. This rock forms the crest of certain of the low hills south of Calistoga, and is distinguishable by its white color, and its hardness at the surface, where silicification has taken place. The debris covering the formation is very thin, and is composed of irregular grains and fragments of the silicified rock itself, with only enough soil to support a scattering growth of shrubs, principally manzanita, whereas the soil resulting from the decomposition of most of the other formations in the region is adequate to support a growth of heavy brush and trees. This characteristic is illustrated in photo No. 27, which is a view of the main workings.

Plate VII is a sketch map of the main workings, from which over 200 tons of kaolin have been removed, some of which has been shipped to

[1] Cal. State Min. Bur. Prel. Rept. No. 7, p. 65, 1920.

various clay products manufacturers for testing. An examination of the workings shows that the progress of kaolinization has been very erratic. The hard, silicified zone at the surface is from one to three feet thick. Below this, the kaolin varies from a non-plastic aggregate of partly-altered feldspathic grains, to a fine-grained mass that has fair plasticity. In places, following lines of fracture, the kaolin is heavily stained by iron-bearing minerals, but between these discolored areas, the mass of the material is practically white in color. The most discouraging feature of the workings is that most of the headings end in material that is badly iron-stained. It is estimated that 20% of the material exposed in the underground workings is contaminated with iron. The iron-stained portions are distributed in such a manner as

PLATE VII



to make hand-sorting necessary, rather than selective mining, if the material is to be mined on a commercial scale. The writer believes that the general conditions are sufficiently favorable to warrant more extensive prospecting near these workings, especially at greater depths below the surface.

From a point alongside a road about 1500 ft. north of the main workings, and at an elevation 400 feet below them, is a 72-ft. tunnel, having a direction of S. 75° W. Most of the material encountered in the tunnel is well kaolinized, but the mass of the material is slightly stained with iron. The best kaolin lies near the floor of the tunnel, in that portion between 25 and 50 feet from the portal. Nearer the face, the rock is not so well decomposed, and there is a large proportion of unaltered quartz and feldspar. It is possible that an extensive deposit of kaolin may be found by farther prospecting in this locality. No streaks of heavily iron-stained material were found in the tunnel, as in the workings near the top of the hill.

This deposit of kaolin has attracted considerable attention in the past from various clay products manufacturers, but none have felt warranted in incurring the expense of leasing or purchasing the property, and doing a sufficient amount of prospecting on it to determine the limits of workable material. It is one of the few localities in the state where high-grade residual kaolin has been found, and it is more accessible to marketing centers than the El Cajon Mountain deposit in San Diego County or the deposits at Hart, San Bernardino County, or even the sedimentary deposit on the Hunter Ranch, Orange County.

Sample No. 190 is representative of the average of the white kaolin exposed in the main workings. Sample No. 191 is from the same workings, but was taken from the iron-stained portions of the exposures. Sample No. 192 was taken as representative of the average white kaolin from the lower tunnel. The test results are on pages 261, 280 and 281.

Bibl (Clay resources of Napa County): State Min. Bur. Rept. XIV, p. 262; Prel. Rept. 7, p. 65.

NEVADA COUNTY.

General Features.

Nevada County is 12 to 20 miles wide and 80 miles long, reaching from the Sacramento Valley to the Nevada line. It is bounded on the north by Yuba and Sierra counties, on the east by the state of Nevada, on the south by Placer, and on the west by Yuba County. It contains 974 square miles, and its population is 10,860 (1920 census).

The mineral production of the county is mostly gold and silver. Some chromite, copper, granite, lead, and miscellaneous stone are also produced. Antimony, asbestos, barytes, clay, gems, iron, mineral paint, pyrite, soapstone, and tungsten also occur in the county.

Clay Resources.

Previous publications of the Bureau[1] have reported several clay deposits from the vicinity of Grass Valley, Nevada City and Colfax. Most of the localities mentioned and a few others that have been recently called to the attention of the Bureau were visited, but in no place was found a deposit of high-grade clay that would warrant exploitation under any commercial conditions that are likely to prevail for many years to come, although in a number of localities common brick clay of inferior quality occurs and in at least one locality, on the Sonntag Ranch, near Peardale (sample No. 169), a buff-burning clay with low shrinkage and fair strength was found.

The geology of this region has been described by Lindgren and others.[2] The few deposits of clay-like materials occur in the Tertiary superjacent series of sedimentary rocks and rhyolitic flows, and in many places are closely associated with the Neocene gold-bearing

[1] Prel. Rept. No. 7, p. 65.

[2] Lindgren, Waldemar, The Gold Quartz Veins of Nevada City and Grass Valley, California; Seventeenth Ann. Rept. U. S. Geol. Survey, Part 2, pp.1–262, 1896.

Lindgren, Waldemar, Tertiary Gravels of the Sierra Nevada of California: Prof. Paper 73, U. S. Geol. Survey, pp. 121, 159, 1911.

MacBoyle, Errol, Mines and Mineral Resources of Nevada County: State Mineralogist's Report XVI, Dec., 1918.

gravels. One of the most typical of these occurrences is the altered rhyolitic tuff (sample No. 172) in the Manzanita gravel pit, northeast of Nevada City. This is commonly described as 'pipe clay.' It is nearly white in color in the dry state, has good plasticity, but burns red and has a high drying and firing shrinkage. Other clays sampled in this region probably are variations of the same material, but mixed with varying proportions of decomposed granite and other products of decomposition of the bedrock series. In general, the better grade of clays differ from those found in Placer County from Alta to Gorge (page 158) in that they have a workable plasticity and workable firing properties, whereas all of the volcanic clays of Placer County thus far examined seem to be totally unsuited for ceramic uses.

The only known clay occurrence of possbile commercial interest in the county is that at Pine Hill, described below under Pine Hill Mine, and John Sweet Kaolin Deposit.

Banner Mountain. Sample No. 170: This was taken from near the Banner Mountain road, 1.0 mile east from the intersection with the Nevada City-Colfax road, in or near the NW¼ NE¼, Sec. 30, T. 16 N., R. 9 E., M. D. M. This probably corresponds to the deposit formerly reported under the name of E. M. Taylor.[1] The present owner of the adjoining property is W. E. Parsons, of Grass Valley. No development work has been done, but the deposit can be traced for several hundred feet, and is at least six feet thick, overlain by red andesitic soil. The material is a white clay shale, and the sample probably contains more iron than would be expected in the mass of the deposit, away from surface contamination. The test results are on page 315.

Beaser Ranch, Chicago Park. Sample No. 168: The sample was taken from an undeveloped deposit on the P. M. Beaser Ranch in the S½ S½ SW¼, Sec. 15, T. 15 N., R. 9 E., M. D. M. The clay is exposed along the side of a small creek bed. The extent of the deposit could not be determined, but it is at least two to three feet in thickness, and is overlain by nonplastic rhyolitic tuff. The deposit is within one-half mile of the narrow gage railroad connecting Colfax with Grass Valley. The test results are on page 313.

Manzanita Mine. Sample No. 172: This is a sample of 'pipe clay' from the Manzanita gravel pit, in the NE¼ SW¼, Sec. 6, T. 16 N., R. 9 E., M. D. M., 1.5 miles on the North Bloomfield road from the center of Nevada City. The clay occurs in beds from 3 to 6 ft. thick, interbedded with rhyolitic sandstone beds of approximately the same thickness. The total thickness of rhyolitic clay and interbedded sandstone is approximately 90 feet. This formation is overlain by 150 feet of andesitic tuffaceous breccia, and is underlain by 190 ft. of Neocene gold-bearing gravel, which in turn rests on the granodiorite bedrock. This occurrence and that represented by sample No. 171 probably corresponds to the occurrence previously described as lying in Sec. 6, T. 16 N., R. 9 E., near the Reddik and Odin mines.[2] The test results are on page 342.

North Bloomfield Road. Sample No. 171: This sample was taken from alongside the North Bloomfield Road, 1.8 mile northeast from

[1] Cal. State Min. Bur. Prel. Rept. No. 7, p. 65.
[2] *Op. cit.*

Nevada City, in the W½, Sec. 6, T. 16 N., R. 9 E., M. D. M. The ownership was not determined. Along the upper side of the road at this point is an exposure of moderately plastic, fine-grained clay, nearly white when dry, but greenish when wet. The bed is over 10 ft. thick and can be readily traced for over 300 feet. It is overlain by decomposed andesite. The test results are on page 329.

The *Pine Hill Mine*, now controlled by Ira J. Coe, 462 Mills Building, San Francisco, is on the northern half of Pine Hill in Sec. 13, T. 14 N., R. 7 E., M. D. M., one mile north of Wolf Post Office, and nine miles by road to a proposed railroad siding near Auburn. About two-thirds of this distance is on a paved highway. The property comprises 160 acres, including three patented claims, the Golden Gate, Golden Gate Extension, and Thrasher.

The mine was originally located and developed as a copper and gold prospect.[1]

Several well-defined veins have been found on the property. These contain some gold, silver, and copper, associated with quartz, pyrite, and limonite. The footwall of the principal vein is diabase, and the hanging wall is serpentine. Rhyolite and iron-stained porphyry are found in places. The rocks in the vicinity of the veins have been altered, and considerable kaolin has been formed, some of which is moderately pure. Four samples were taken from various points in the underground workings.

SAMPLE No. 159: This is a sample of nearly white kaolin that occurs as a gouge in a vein exposed by workings on the west side of Pine Hill, near its crest. At this point, a cross-cut tunnel, 50 feet long, was run to cut the vein. From near the end of the tunnel, a vertical winze, 26 feet deep, was sunk, which was continued as an inclined winze in the vein which has a dip of 31°, S. 35° E. The inclined winze is now filled with water and debris to within 60 feet of the bottom of the vertical winze, so that the total depth of the incline could not be determined. The material included in the sample was from the footwall gouge that is exposed in the incline throughout its accessible length. It was impossible to secure a sample entirely free from iron staining by infiltration from the overlying pyritic quartz, as the workings have been open for many years, and are usually flooded to the floor of the tunnel each winter. It is claimed that auger holes have been drilled into the footwall to a depth of 14 ft. without penetrating the kaolin, and that below the layer of surface contamination, the kaolin is uniformly white in color. It was not possible to verify this statement. No such thickness is exposed in the cross-cut. It is obvious that if the drill-holes had not been drilled at right angles to the dip of the vein, false indications of thickness would have resulted. Further exploration in these workings is necessary before any attempt can be made to predict the quantity and quality of kaolin that may be available. The test results, page 261, are favorable, but not as satisfactory as to color as in sample No. 160.

SAMPLE No. 160: This is a sample from the lower 10 feet of a 50-ft. vertical shaft near the top of the hill, 200 yards or more east of the

[1] MacBoyle, Errol, Mines and Mineral Resources of Nevada County: State Mineralogist's Report XVI, 1921.

West tunnel. The fired color and other ceramic properties of this material are satisfactory for many high-grade uses, as shown on page 261, and the occurrence of the deposit is such as to warrant the prediction that a commercial tonnage of uniform material would be disclosed by farther development. The material cut by the first 40 ft. of the shaft is similar in physical properties and in mineralogical constitution, but is light pink and yellowish in dry color, showing the presence of a higher proportion of iron oxide.

Sample No. 166: This is a picked sample of white kaolin, occurring as a gouge in a vein cut by a tunnel entering the North side of the hill, at a low level. The gouge is from two to four feet thick, and grades into altered country rock, similar in composition to sample No. 167. The continuity and homogeniety of this occurrence is doubtful. It is unlikely that this occurrence will be of importance, as continuity, homogeneity, and sufficient thickness for economic mining may be lacking. The test results are given on page 316. The fired color is not as good as in sample No. 160, and the fusion point is considerably less.

Sample No. 167: This is a composite sample from a cross-cut branch of the East tunnel. It is typical of the altered country rock of the hill, and occurs in abundance. The test results are given on page 315. It has weak plasticity.

Bibl: State Mineralogist's Report XVI, Nevada County, p. 88.

Sonntag Ranch, Peardale. Sample No. 169: The sample was taken from a drainage ditch on the south side of the You Bet road, 1.8 mile from Peardale station on the narrow gage railroad. The adjoining property to the south is owned by H. E. Sonntag, and is in the NE¼, Sec. 3, T. 15 N., R. 9 E., M. D. M. At this point a bed of white plastic clay crosses the road in an east-west direction, but is difficult to trace because of the overlying andesitic debris, which weathers to a red, plastic soil and obscures the underlying structure. No development work has been done. The clay bed is at least 4 feet thick. The sample was taken by digging a hole about one foot deep in order to avoid contamination from the andesite soil that has been washed over the outcrop, but even with this precaution, the sample contains more iron-bearing minerals than would be found in the mass of the deposit. Mr. Sonntag reports that the same clay was found in a spring on his ranch ½ mile to the west, but this could not be verified. It is not certain whether this deposit, or the one from which sample No. 168 was secured,[1] is the one referred to in previous reports[2] as occurring on the De Golia Ranch. The test results are on page 313.

John Sweet Kaolin Deposit. John Sweet of Wolf owns the south half of Pine Hill, consisting of 120 acres in Sec. 13, T. 14 N., R. 7 E., M. D. M. The same formations as those described under 'Pine Hill Mine' persist on this property, but very little development has been done. A 30-ft. vertical shaft has been sunk on the N½ NE¼ of the section, but this was not accessible at the time of visit in August, 1925. The general appearance of the material in the dump at this shaft

[1] See under Beaser Ranch, *ante*.
[2] Cal. State Min. Bur. Prel. Rept. No. 7, p. 65.

resembles that exposed in the 50-ft. vertical shaft on the Pine Hill property, from which sample No. 160 was taken, and the rather meager evidence available points to the conclusion that the kaolin was formed by the alteration of a diabase. A small sample, No. 158, was taken of the material lying on the dump, but was not tested.

An unsuccessful search was made for the deposits previously described at *Union Hill*, and that in Sec. 29, T. 17 N., R. 9 E., M. D. M.

Bibl (Clay resources of Nevada County): Cal. State Min. Bur. Bull 38, pp. 217–218, 250–251; Prel. Rept. No. 7, pp. 65–66.

ORANGE COUNTY.

General Features.[1]

Orange County is bounded on the east by Riverside County, north by San Bernardino and Los Angeles counties, west by Los Angeles County and the Pacific Ocean, and on the south by San Diego County. It comprises 795 square miles, about three-fifths of this area being valley land and the remaining two-fifths mountainous and foothill land. The population of the county is 61,375 (1920 census).

The Santa Ana Range of mountains is the line between Orange and San Bernardino counties, at the northeast corner of the former county. It is also the dividing line between Orange and San Diego and Riverside counties. This range also sends up a line of foothills westwardly along the seashore nearly half way across the county. All the western portion of the county is included in the Santa Ana Valley. The highest point of land has an elevation of 5675 feet above sea level, and is known as Santa Ana Peak.

The Santa Ana River comes into the county near the northeast corner and continues through it in a northwesterly direction, flowing into Newport Bay. Santiago Creek has its rise in the Santa Ana Range of mountains, and flows in a northerly and westerly direction, emptying into the Santa Ana River about two miles northwest of the city of Santa Ana. Aliso Creek has its rise in the same range, but on the southern slope of the mountains, and runs in a southwesterly direction, flowing into the ocean near Arch Beach, about twenty miles southeast of the mouth of the Santa Ana River. Trabuco, Mission Viejo, and San Juan creeks have their rise on the south side of the Santa Ana Range and come together near the sea, reaching the ocean at 'San Juan-by-the-Sea.' Coyote Creek marks the boundary of the county on the west.

Geology.

The formations of the region consist of a base of granitic and metamorphic rocks overlain by Cretaceous, Tertiary, and Pleistocene sediments.

The main portion of the Santa Ana Mountains is composed of ancient crystalline rocks, mostly slates of Jurassic age; along the western and southern flanks, rocks of Chico age are exposed, which in turn are overlain by small patches of the Eocene. In the Laguna Hills the formations exposed are mainly coarse sandstone of Eocene age. These are overlain along the edges of the hills by beds of sandstone and shale of the Monterey series. In the flat area running from Tustin to El Toro the dia-

[1] Tucker, W. B., Orange County: State Mineralogist's Report XXI, pp. 58–59, 1925.

tomaceous shale of the Monterey series is present, occupying a synclinal trough between the Santa Ana Mountains and the Laguna Hills. This condition continues southeast through the Capistrano district to the San Diego County line.

For detailed geology of Orange County the reader is referred to the reports by Bowers[1] and Fairbanks[2] in two of the earlier State Mineralogist's Reports.

Orange County is among the upper three counties in California in the value of its mineral production, the other two being Los Angeles (first in 1926) and Kern (second in 1926) counties. In all three cases, the principal product is petroleum. Of secondary importance in Orange County are natural gas, miscellaneous stone, clay, brick, gold, silver, copper, lead, and zinc. Besides these substances, occurrences of coal, gypsum, diatomite, sandstone, and tourmaline have been found in Orange County.

Clay Resources.

Low-grade clays for use in making red-burned structural ware are fairly abundant in the county, and plants seeking a location need have no difficulty in finding suitable material.

On the west side of the Santa Ana Range are deposits of high-grade clay that are apparently equal in geological age to the Eocene clays of the Temescal Valley (Alberhill-Corona district) in Riverside County. These deposits have been developed in recent years, and a number of exceptionally good varieties of fireclay are now being produced commercially. An especially interesting occurrence of flint fireclay occurs on the Goat Ranch, in Santa Ana Canyon, in the Upper Chico (Upper Cretaceous) formation.

American Silica Company. G. Ray Boggs, president. Office, Suite 1212 Pacific Mutual Building, Los Angeles. This company controls an important deposit of fireclay on the Hunter and Robinson ranches, 12 miles by road east of the town of El Toro. The Hunter Ranch lies in Sec. 11, T. 6 S., R. 7 W., S. B. M., and the Robinson Ranch is adjoining. At the time the property was visited, in August, 1925, some 1500 tons of clay had been mined from two different openings. Two samples were taken, No. 63 and 64. The test results are on page 260. Since 1925, the property has been extensively developed, and new deposits of valuable fireclays have been discovered, hence a description of the earlier developments is of little value at this time. Through the courtesy of Mr. Boggs, several samples of the clay that was in use in 1926 were secured, both as crude clay, and in mixes that were prepared for the manufacture of fire brick. See samples No. 266, 268 and 270, on pages 292, 260 and 282, respectively.

The clays are probably of Eocene age.

Brea Clay Products Company. C. M. Haaker, president; A. D. Yost, superintendent. Home office, Brea. The plant is on the eastern side of the town of Brea.

Operations commenced in the summer of 1925. Common red brick is manufactured from local surface clay which is mined to a depth of

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[1] Bowers, Stephen, Orange County: State Mineralogist's Report X, pp. 399–409, 1890.

[2] Fairbanks, H. W., Geology of San Diego County; also portions of Orange and San Bernardino counties: State Mineralogist's Report XI, pp. 113–118, 1893.

10 to 12 feet with a steam shovel. A drag-line conveyor delivers the clay to a belt conveyor which feeds a pug-mill and auger machine, equipped with a hand operated side cutter. After drying in the open and under sheds, the brick are fired in open oil-fired field kilns. A semi-Diesel engine is used for operating the plant.

The output at the time of visit in July, 1925, was 60,000 brick per day, and an increase to 80,000 was expected within a short time. The company also expected to produce hollow tile and roofing tile.

Sample No. 65 was taken for testing. See page 322.

Garber Brick and Tile Co. H. Garber, president, Olive. The company controls 6 acres, one-half mile east of Olive, on the Orange County Park road. Common brick, hand-made roofing tile, floor tile, roof dressing and a dust product for molding sand are manufactured.

All of the clay used is mined from a pit on the property. Material is transported from the clay pit by a drag scraper to the plant, where it passes through rolls, is elevated to storage bins. The brick are made by the soft mud process. A pug-mill prepares the clay for the brick press as well as for the tile plant. The brick are conveyed by a cable conveyor to drying racks. After drying, the brick are burned in field kilns, using natural gas as fuel.

Both roof and floor tile are hand molded, air dried under sheds, and fired in two down-draft kilns. The rated output of the plant is 2000 roof tile and 25,000 brick per day. The equipment includes a 30-h.p. boiler, Ingersoll-Rand compressor, Blake type crusher, screens and elevators. From 25 to 30 men are employed.

Bibl: State Mineralogist's Report XXI, p. 65.

Gladding, McBean and Company. Office of Southern Division at 621 South Hope Street, Los Angeles. This company, through its merger with the Los Angeles Pressed Brick Company, now owns the Goat Ranch, noted in previous reports[1] as containing an important deposit of flint fireclay. The location of the property is shown on Plate X, under Riverside County. The property consists of 1700 acres, and lies in an extremely rugged portion of the Santa Ana Mountains, south of Gypsum station on the Santa Fe railroad. The deposit lay idle for many years, but since 1925 considerable development work has been done, which has demonstrated the presence of large deposits of flint fireclay and red-burning shale in the Upper Chico (Upper Cretaceous) formation. A view of one of the fireclay exposures is shown on photo No. 28, and one of the red shale prospect pits is illustrated on photo No. 29.

The flint fireclay, when dry, is gray to black in color, and has a conchoidal fracture. The lighter-colored varieties have very much the appearance of chert, but can easily be scratched with a knife, and when ground with water, develop moderate plasticity.[2] It contains from 34% to 40% of alumina, and is highly refractory. Sample No. 282 was taken for testing, but should not be considered as representative of the deposit, as it is a grab sample from development workings. The results are on page 282. Sample No. 221 (page 330) of similar material,

[1] Prel. Rept. 7, p. 66, and Rept. XXI, p. 66. Listed under "Los Angeles Pressed Brick Company."

[2] In this connection, see Walker, T. C., The Effect of Fine Grinding on an Indurated Clay: Jour. Amer. Cer. Soc., Vol. 10, pp. 449–450, June, 1927.

but of much poorer quality and containing a high percentage of iron, was also tested.

The red-burning shale has been prospected at a number of points on the property. It is of value in the manufacture of red-burned vitri-

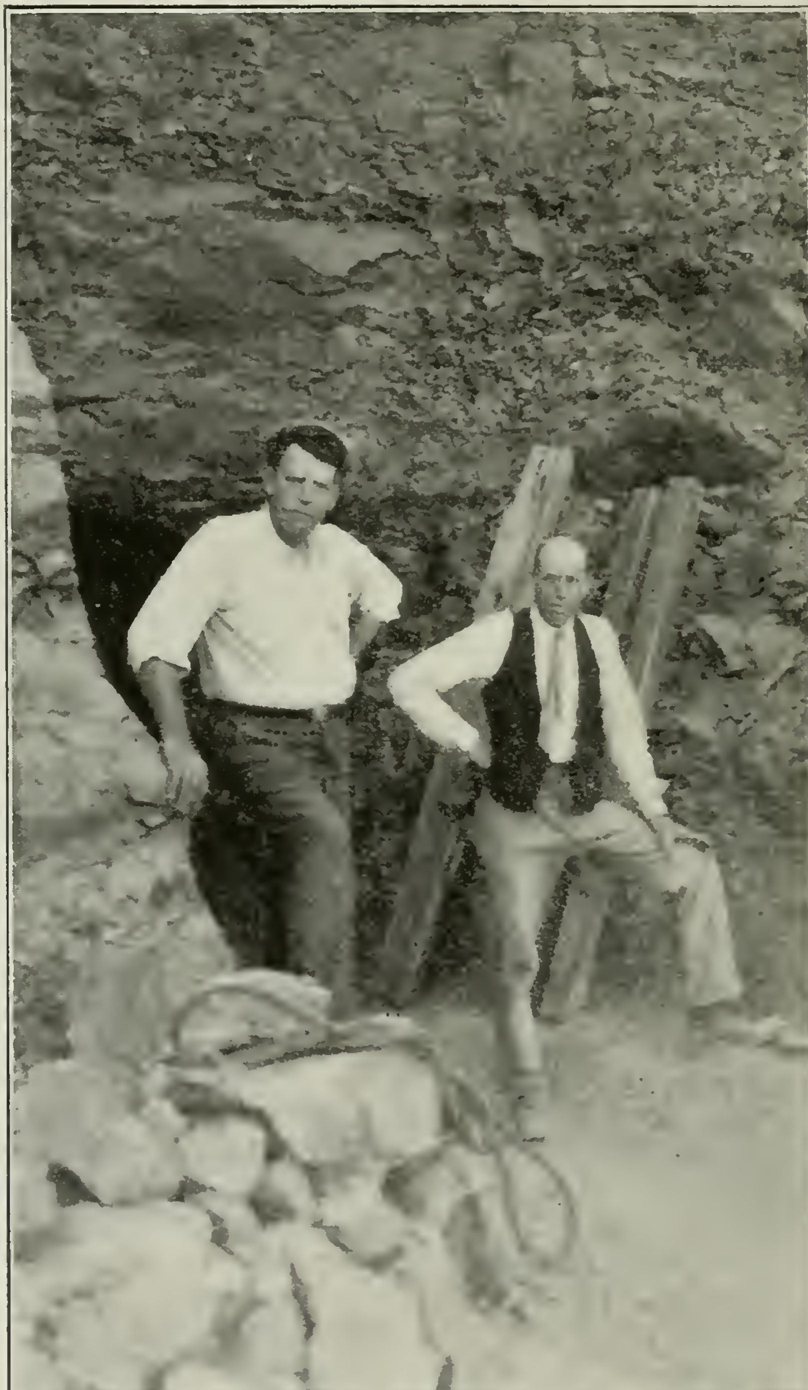

PHOTO No. 28. Flint fire clay at portal of tunnel, Goat Ranch, Gladding, McBean and Company, Orange County. (Sample No. 282.)

fied ware, such as sewer pipe and paving brick. Sample No. 223 (p. 343) was taken and tested.

La Bolsa Tile Company. G. W. Moore, president; A. W. Griffith, secretary and manager; E. R. Bradbury, superintendent. Home office, Huntington Beach. This company has been established for twenty years. The plant and clay pit are two miles north of Huntington Beach at Weibling siding on the Southern Pacific Railway, adjoining the northern edge of the Huntington Beach oil field. The company

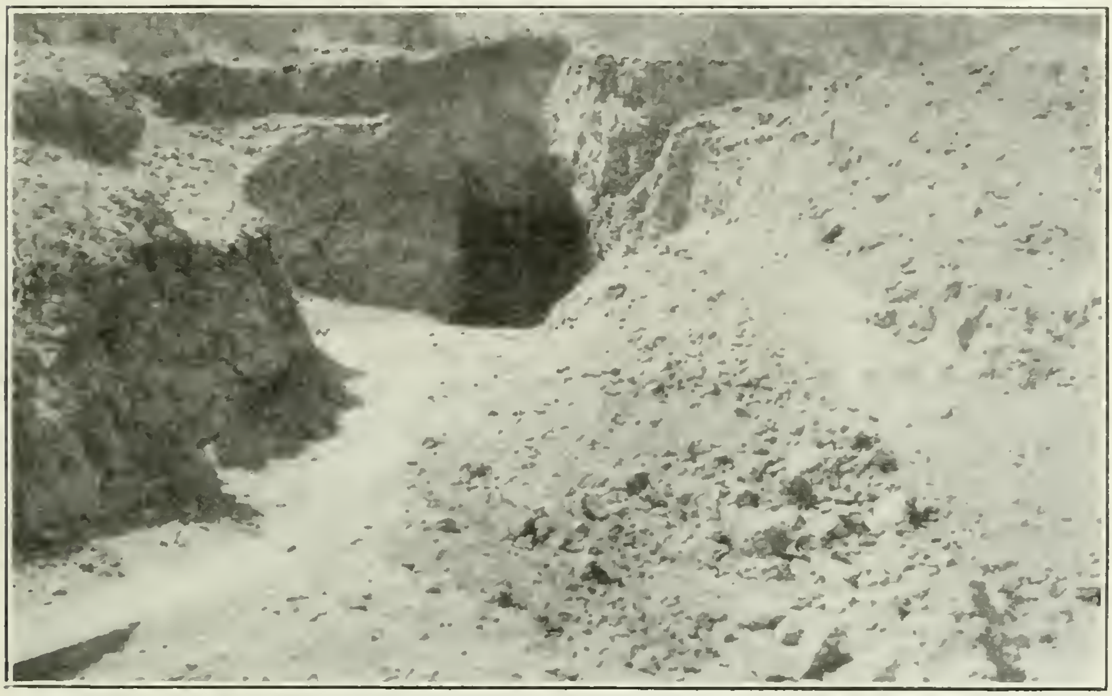

PHOTO NO. 29. M M 2 pit, Goat Ranch, Gladding, McBean and Company, Orange County.

PHOTO NO. 30. Plant of La Bolsa Tile Company, Weibling, Orange County. (From State Mineralogist's Report XXI, p. 65, 1925.)

owns 31 acres in Sec. 35, T. 5 S., R. 11 W., S. B. M. The products are drain tile from 3 to 20 inches in diameter, hollow building blocks, common brick, and more recently, ruffled face brick. Photo No. 30 is a view of the plant.

The clay is mined to a depth of five feet by a Fordson tractor, using a harrow for loosening and a scraper to deliver it to a hopper, which feeds a dry pan. An elevator delivers the ground material to a hopper which feeds a short pug-mill from which the clay passes to an auger machine. The plant is equipped with two auger machines which are used to shape all products except drain tile of 10 inches diameter or larger, for which purpose a vertical steam press is used.

The drying sheds are heated by hot air forced by a blower through flues under the floor. The air is heated either by the exhaust from the kilns or by exhaust steam. The drying sheds have a storage capacity of 60,000 tile. The drying cycle is from 24 to over 60 hours, depending on the size of the ware.

The plant is equipped with three 28-ft. down-draft kilns, with a capacity of 70 to 80 tons of material each, and one 32-ft. kiln, with a capacity of 100 tons. Natural gas is generally used as fuel, but the plant is equipped for oil firing when needed. The firing cycle is 72 to 80 hours to a maximum of 1650° F.

The finished products are dense and hard with a good red color. Ten men are employed.

Bibl: State Mineralogist's Report XXI, p. 66; Prel. Rept. No. 7, p. 66.

Olive Roofing Tile Co. Ramon Flores, owner. This is a small plant near that of the Garber Brick and Tile Company. Hand-made roofing tile is the only product. Surface clay from the property is utilized. One kiln is in use.

The plant is a Mexican operation, and as many as 24 men are employed at times.

Orange County Brick and Tile Company.[1] F. C. Krause, president; Charles Page, secretary; W. J. Carmichael, general manager. The company owns nine acres in Sec. 9, T. 4 S., R. 10 W., within the city limits of Anaheim.

The company is manufacturing building brick, and also produces sand for building purposes. The material used is unconsolidated sand. The sand is mixed with lime and cement in the following proportions: Common brick: lime 7½%, cement 2%. Face brick: lime 10%, cement 5%.

Material from the sand pit is transported by drag-line scraper to a hopper, from which it goes to a bucket elevator, elevated and then passed through a revolving screen. Here it is sized into three different sizes; the over-size and the minus 8-mesh going to storage bins, the fine sand to wet-grinding pan, where it is ground and then elevated to two bins, then sent on to the mixer from which it is fed to two American clay brick rotary presses. One press has a capacity of 8000 brick, the other 17,000 brick. The brick then are loaded on to cars and given 10-hour heat treatment under 125 pounds pressure in two Hardinge cylinder driers. These driers are 80 feet long by 6 feet in diameter. Heat for cylinder driers is furnished by 70-h.p. boiler, oil being used as fuel. The other equipment is driven by electric motors. Ten men are employed.

[1] By W. B. Tucker, *op. cit.*, p. 66. While not a ceramic operation of the type being considered in this report, this description is included here as of general interest, as it is typical of similar operations in various parts of the state.

The Vitrefrax Company (*O'Neill Ranch* Fire Clay Deposit). On the Rancho de Santa Margarita, the greater portion of which is now owned by the Jerome O'Neill family, are several excellent showings of high-grade fireclay, one of which has been leased and developed within the last few years through the efforts of the Vitrefrax Company of Los Angeles. This deposit is 10.2 miles by road east of San Juan Capistrano, in Gabino Cañon, close to the San Diego County line. The material consists of a white and blue-gray fireclay high in alumina, and quite free from iron stains. It is known locally as a bone clay, and in fact corresponds in analysis to that of typical bone clays, but without the distinctive pisolitic structure of the type clays. The fireclay bed is overlain by a thin bed of black carbonaceous plastic clay, which separates it from the overlying loosely consolidated sandstone. Underlying the fireclay is a mottled plastic clay, similar in general appearance to the Alberhill pink-mottled variety. The thickness of the

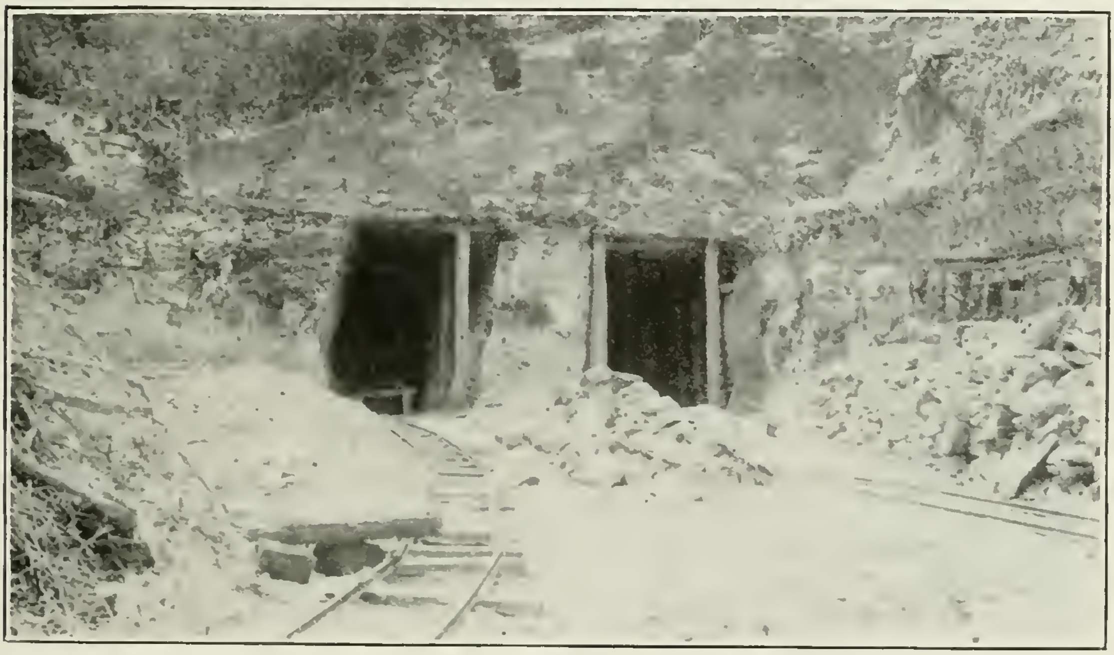

PHOTO No. 31. Vitrefrax Co. Entrance to upper chamber workings, O'Neill Ranch clay deposit, Orange County. (Sample No. 62.)

fireclay, as exposed in the workings, is from 10 to 15 feet. The bed is flat-lying, with a slight westerly dip. A view of the deposit is shown on photo No. 31.

The clay is recovered by chamber mining, using posts where needed to support the overburden. At the time of visit, in July, 1925, an area of 70 by 25 feet had been mined and a 100-foot tunnel had been driven to the west of the chambers, and at a lower level, with the object of providing for gravity loading of small mine cars, by means of a raise to the clay bed. One of these raises had been driven nearly to the roof of the clay, and demonstrated that the total thickness of clay above the tunnel is nearly 20 feet.

At several other localities in the vicinity are exposures of various grades of clay. It is likely that in the future, important clay beds will be developed and mined.

Sample No. 62 was taken for testing. See page 259.

Bibl (Clay resources of Orange County): Repts. XV, 519; XXI, pp. 65–67. Prel. Rept. 7, pp. 66–67.

PLACER COUNTY.

General Features.[1]

Placer County extends from the Sacramento Valley on the west for a distance of 80 miles to the Nevada state line on the eastern slope of the Sierra Nevada, including the larger part of Lake Tahoe. The total area is 1395 square miles. The elevation increases gradually from near sea level on the west to mountain peaks 8000 to 9000 feet high along the summit of the range on the east, then descends to 6225 feet along Lake Tahoe. There is a corresponding variation in climatic conditions. The western part of the county below an elevation of 2500 feet supports most of its industries and nearly all of the population of about 20,000. In this region snow seldom falls below 2000 feet elevation and never lies on the ground below that elevation. The county seat, Auburn, is at an elevation of 1360 feet, and the district from there westward through Newcastle, Penryn, Loomis and Rocklin is the most important deciduous fruit producing area in the state, Newcastle being the leading shipping point. The soil is mainly decomposed granite and granodiorite on the west and amphibolite schist and diabase near Auburn and to the east, until the granodiorite of the high mountains is reached.

The Ogden route of the Southern Pacific system traverses the county from the Sacramento line to the summit of the Sierra Nevada, passing through the principal towns, and the Oregon branch of the same railroad, leaving the main line at Roseville, passes northward through Lincoln, serving the farming and clay working industries there. Two state highways run about parallel to the two lines of railroad, one eastward from Sacramento over the mountains, and the other northward from Roseville along the east side of Sacramento Valley. A third state highway runs north from Auburn to Grass Valley and Nevada City, in Nevada County.

Taking its name from the Spanish, because of the richness of its surface gold placers, the county showed a great diversity of mineral resources at an early date, and was distinctly a mining county until about 1890, when fruit raising began on a large scale for eastern shipment. Lumbering and the summer grazing of cattle in the higher mountains have been less important industries.

Gold has been the principal mineral product of the county, but since 1920 the value of the pottery clay and brick production has exceeded that of the gold production. Since 1922, the value of pottery clay alone has been greater than that of gold. Other mineral products that have been produced commercially in recent years include miscellaneous stone, granite, silica (quartz), chromite and copper. Small tonnages of asbestos, manganese ore, magnesite, mineral paint and soapstone have been shipped at various times, and the limestone production of the county was at one time of importance.

Clay Resources.

A remnant of the Ione formation, containing valuable clay deposits, occurs on the edge of the Sacramento Valley at Lincoln. Since 1875,

[1] Logan, C. A., State Mineralogist's Rept. XXIII, pp. 235–237, 1927.

this area has been a clay producing and clay working center. Present production from the district is between 125,000 and 150,000 tons annually. Other remnants of the Ione formation occur at various places in the county, and clays have been found in other formations, but none of these have led to the discovery of commercial deposits. On account of the fact that the active clay working industry centers about Lincoln, the discussion of the clay resources of the county is divided into two sections: the Lincoln District, and Miscellaneous Deposits.

Lincoln District.

At Lincoln is one of the three most important clay deposits in the state. The deposits underlie a group of low hills that rise to a maximum of 80 feet above the alluvial plain of the Sacramento Valley. The clays are a remnant of the Ione formation which was protected from erosion by a capping of andesite-agglomerate. As shown by C. N. Schuette,[1] and illustrated in the vertical section through a portion of the property of the Clay Corporation of California, plate IX, the upper clay beds have been removed by erosion a short distance beyond the limits of the present lava cap. Since the period of erosion, gravel, sand, and soil from the rivers and flood plains of the Sacramento Valley have raised the floor of the valley to its present level.

In some places the recent deposits abut against the margin of the lava cap, and in other places they lie against the gently-sloping surface of erosion of the upper clay beds, thus affording some exposures of clay which aided in the original discovery and development of the deposits.

The clay beds lie practically horizontal, and are characterized by remarkable uniformity in thickness and quality over large areas. Several different beds can be differentiated and are of sufficient thickness to permit separate mining. The ceramic properties of the clays may be summarized as follows: The drying and firing shrinkage is high, but shrinkage takes place with little danger of cracking. The fusion point lies between cone 28 and cone 33; fired colors range from light buff to light red; knife hardness develops near cone 1; vitrification is well advanced (less than 3% absorption) at cone 13; and fired strengths are good, but with the highly-grogged mixtures necessary to avoid excessive shrinkage, the body strength may not be so high as is desired. The principal uses are for architectural terra cotta, fire brick and stoneware.

Clay Corporation of California. John T. Roberts, president. Home office, Rialto Building, San Francisco. The mining property of the Clay Corporation of California, a subsidiary of the Stockton Fire Brick Company, has recently been described by C. N. Schuette.[2] The description that follows is partly based on Mr. Schuette's article, and partly upon notes made by the writer when the property was visited on August 13, 1925, and again on June 25, 1926.

The property is in Sec. 4 and 9, T. 12 N., R. 6 E., M. D. M. The area is covered by andesite-agglomerate from its southern boundary to

[1] Engineering Principles Applied to Exploitation of a Clay Deposit, Eng. and Min. Jour.-Press, Vol. 121, p. 964, June 12, 1926.
[2] *Op. cit.*

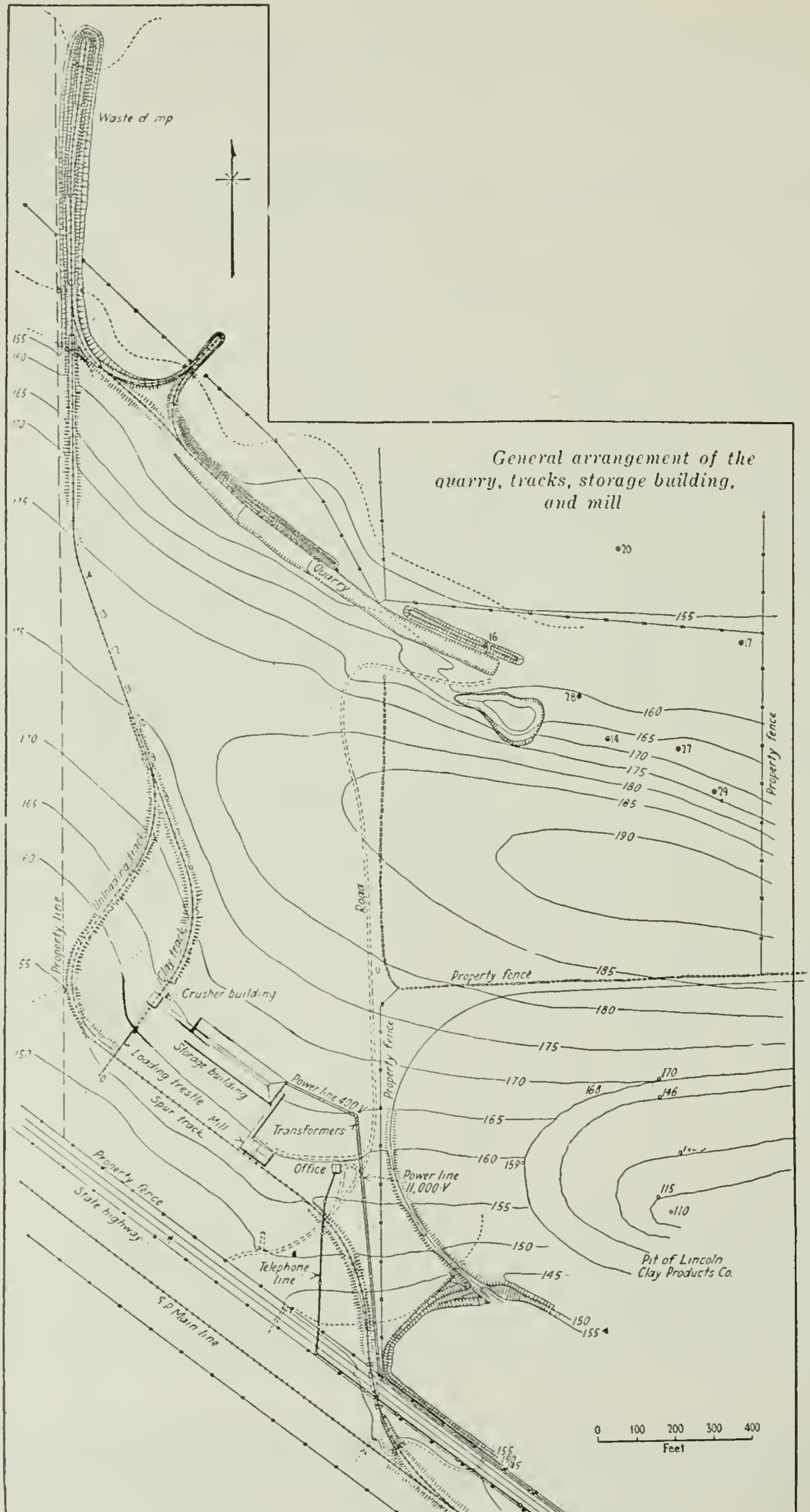

PLATE VIII. General arrangement of quarry and plant of the Clay Corporation of California, Lincoln, Placer County. (Reprinted by permission of Engineering and Mining Journal.)

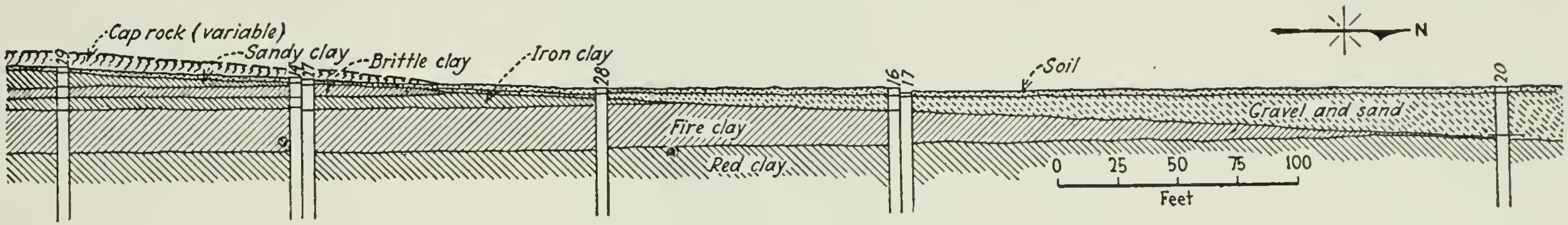

PLATE IX. Vertical section of clay beds on Clay Corporation of California's property, near Lincoln, showing drill holes. (Reprinted by permission of Engineering and Mining Journal.)

a line roughly parallel to and approximately 1600 ft. north of the Lincoln-Marysville highway. Drilling and test pitting shows that all of the clay beds exposed in the adjoining property of the Lincoln Clay Products Co. on the south persist on an even grade, thickness, and character under the area covered by the lava flow, but that they do not persist northward as they had been removed by erosion before the deposition of the valley sediments. This condition is shown in the generalized north-and-south cross-section, plate 9. Over 1,000,000 tons of clay corresponding to the Lincoln Clay Products Co. No. 1–6, have been developed.

The general arrangement of the quarry and plant is shown on plate VIII. Since the stripping is as thick or thicker than the underlying clay, the trackage was laid out to place the waste dump as near the pit as possible. The quarry starts on the north slope of the hill and is carried parallel to the trend of the hill, thus giving a pit face of sufficient

PHOTO No. 32. End-cut during preparation of pit of Clay Corporation of California, at Lincoln, Placer County. (Samples No. 152 and 153.)

length to yield a full season's tonnage at one cut. The pit face is 1700 feet long.

The pit equipment consists of a ¾-cu. yd. gasoline shovel, an 8-ton gasoline locomotive, ten 3-yd. rocker dump cars, and two flat cars. Thirty-pound rail and 36-in. track grade is used, with a maximum of 2% grade. Photo No. 32 shows the shovel at work during the preparation of the pit.

The clay storage plant was designed with the object of securing a thorough mixing of the clay as received from the pit, and to remove as much water as possible before shipping. The clay is crushed to 2½ in. in a 21 by 42 in. single-roll crusher. The crusher discharge is carried by an 18-in. belt conveyor to the top of the storage building, where it is spread in a thin layer over the surface of the bin by a self-propelled, self-reversing tripper. Drying by the hot summer air sweeping through the building is very effective. A concrete reclaiming tunnel under the floor of the storage building is equipped with hand-operated gates to discharge the clay to an 18-in. belt conveyor, which carries it to a cross-tunnel at one end of the building, where the clay is delivered to an inclined-belt conveyor, 18 in. wide, running up to the top of the three 50-ton storage bins in the mill building.

From the end bin the clay can be drawn directly into railroad cars on the spur track. From either or all of the bins, the clay can be fed by apron feeders to a chute leading to a five-roller low-side Raymond mill. The pulverized clay is blown to a cyclone collector in the top of the mill building, and is delivered to any one of three 50-ton bins, which are fitted with three sacking spouts each. The sacked clay is stored in the building while awaiting shipment.

The pit is operated in the dry season between May and December. The minimum operating force consists of the superintendent, two men on the shovel, two men on haulage, and two men to operate the plant. Two or three extra men may be required from time to time, and at the beginning of the season a track gang is employed for two weeks to prepare the track for the season's operation. Two men attend to shipping and pulverizing in the winter.

The capacity of the plant, from pit to storage, is three 5-car trains per hour, or slightly over 540 tons per 8-hr. day. The maximum capacity of the storage building is 18,000 tons. The total annual capacity of the plant when operated as described is 50,000 tons. This could be increased without extra equipment by two-shift operation during the summer, with storage of pulverized clay, as well as crushed clay, at the beginning of winter.

The storage and pulverizing plant require 192 hp., distributed as follows:

Unit	Horsepower of driving motor
21 by 42-in. single-roll crusher	40
18-in. conveyor, 366 ft. long	20
18-in. reclaiming conveyor, 265 ft. long	15
18-in. cross conveyor to mill building, 172 ft. long	15
Bin feeders	2
Raymond mill	60
Raymond mill fan	40
Total	192

Miscellaneous electric power used on the property include a compressor for operating rock drills, a pump for draining the pit, and a lighting system.

SAMPLES: At the time the pit was sampled, on August 13, 1925, the cut had not been carried to the bottom of the bed that corresponds to the No. 1–6 clay (sample No. 146, p. 303) on the pit of the Lincoln Clay Products Co. Two samples were taken, however, both of which overlie the No. 1–6 clay. In 1926, a sample of prepared clay was obtained from the company, and was tested under No. 280.

No. 152 is a plastic clay lying in a 6-ft. bed beneath the capping. The test results are given on page 304. No. 153 (p. 299) is a less plastic clay from a 3 to 4 ft. bed underlying No. 152. It is one of the clays included in the No. 0 (sample No. 145, p. 291) clay of the Lincoln Clay Products Co. No. 280 is more representative of the material available during the normal operation of the pit. (See page 305.)

Gladding, McBean and Company. Lincoln Plant. Atholl McBean, president; A. L. Gladding, vice president. General offices, 660 Market

Street, San Francisco. Chas. Gladding, manager at Lincoln. The Lincoln plant of Gladding, McBean & Co. was established in 1875, and has operated continuously since that time. The company was incorporated in 1886, and has steadily expanded the scope of its operations until at the present time it is the largest clay products manufacturing organization west of the Mississippi Valley. The company now owns three large plants, one at Lincoln, one at Glendale, Los Angeles County, and the third at Auburn, Washington. It has recently acquired control of the Los Angeles Pressed Brick Co., operating several large plants in southern California, and of the Denny-Renton Clay and Coal Co. of Seattle, Washington, operating two plants in Washington and one at Portland, Oregon.

The Lincoln plant specializes on architectural terra cotta, fire brick, face brick, roofing tile, sewer pipe, chimney pipe, and garden pottery. A fine example of the use of architectural terra cotta manufactured at

PHOTO No. 33. Clay pit of Gladding, McBean & Co., at Lincoln, Placer County.

Lincoln is the new Russ Building in San Francisco. Photo No. 1 (frontispiece) is a view of this building. Many other important buildings on the Pacific Coast have been faced with terra cotta from one of the company's plants.

CLAY DEPOSIT: The company owns 480 acres of clay land in Sec. 9 and 10 of T. 12 N., R. 6 E., M. D. M. The present working pit, shown in photo No. 33, is in the SE¼ of Sec. 9. A section through the pit is as follows:

Section Through Pit of Gladding, McBean & Co., at Lincoln.

Sample No.	Test data on page	Character of material	Thickness, feet
		Lava: Andesite-agglomerate	8
155	325	Pit sand: Iron-stained clay, sand and fine gravel	10
		Sand and gravel, not usd	15
156	299	Fire-proofing clay, corresponding in quality and thickness to L. C. P. Co., No. 0, sample No. 145	7
157	304	Terra cotta clay, corresponding in quality and thickness to L. C. P. Co., No. 1–6, sample No. 146	15

Data were not available for definitely determining the correlation with the clay beds exposed on the properties to the north, but it seems probable that the fire-proofing clay, sample No. 156, corresponds to the No. 0 clay of the Lincoln Clay Products Co., sample No. 145, and that the terra cotta clay, sample No. 157, corresponds to the No. 1–6 clay, sample No. 146. The overlying sand and gravel beds in the Gladding, McBean pit would indicate that the lava cap was laid down on this area before these beds were eroded, whereas to the north most of the material overlying the clay beds had been removed before the deposition of lava, and in some places the upper clay beds themselves had been partly encroached upon by erosion. However, the bed underlying the terra cotta clay is of similar material, which indicates either that the No. 7 and No. 8 clays of the Lincoln Clay Products Co. are absent here, or that the correlation does not hold.

Mining: The clay is mined by steam shovel in benches, as shown on photo No. 33. The pit is over 1100 ft. long. Waste is carried to the dump, and clay to the plant, on an industrial railroad, with a steam locomotive and 5-ton dump cars. The production of clay is at the rate of approximately 500 tons per day during the dry season. Water that runs into the pit during the winter is pumped out at the beginning of each dry season, and little pumping is ordinarily required during the summer.

Plant: The plant occupies a 25-acre tract, on the northern edge of the town of Lincoln, and nearly one mile southeast of the clay pit. An airplane view of the plant is shown on photo No. 34. In addition to clays from the local pit, clay and sand from Ione, clay from Natoma, quartz from various sources, and grog are used in the body mixtures. In the design and operation of the plant, extreme care is used to ensure uniformity of raw materials, and accuracy of body proportioning. Upon being delivered to the plant, all materials are stock-piled separately in a covered shed. A 4-ton traveling crane reclaims the materials and delivers them to one of nine small bins, which feed four dry pans, operated to grind through a 14-mesh screen. The ground materials, still separate, are then elevated to storage bins. The body mixtures are proportioned from these bins by means of disc feeders.

The terra cotta body mixture contains approximately 50% terra cotta clay, 10.0% non-plastic clay, and 40.0% grog, by volume of minus 14-mesh material.[1]

The body mixture is prepared by double pugging, and the average water content of the wads is 26%. The wads are aged under damp burlap in cool rooms before being sent to the pressers, but the minimum aging period is often only two or three hours. The pressing room has no unusual features. All of the terra cotta and garden pottery are shaped by hand pressing in plaster molds.

Terra cotta, roofing tile and electrical conduit are dried in Carrier ejector humidity driers, which are designed to give accurate control over the four factors of time, temperature, humidity and velocity during drying. The drying cycle in use at the time of visit on August 14, 1925, was as follows: The drying atmosphere began with five hours at 120° F. and 60% humidity was increased by steps to 212° and 50%

[1] Larkin, P. G., and Curry, E. R., Notes on Terra Cotta Body Shrinkage, Jour. Am. Cer. Soc. Vol. 8, p. 113, 1925.

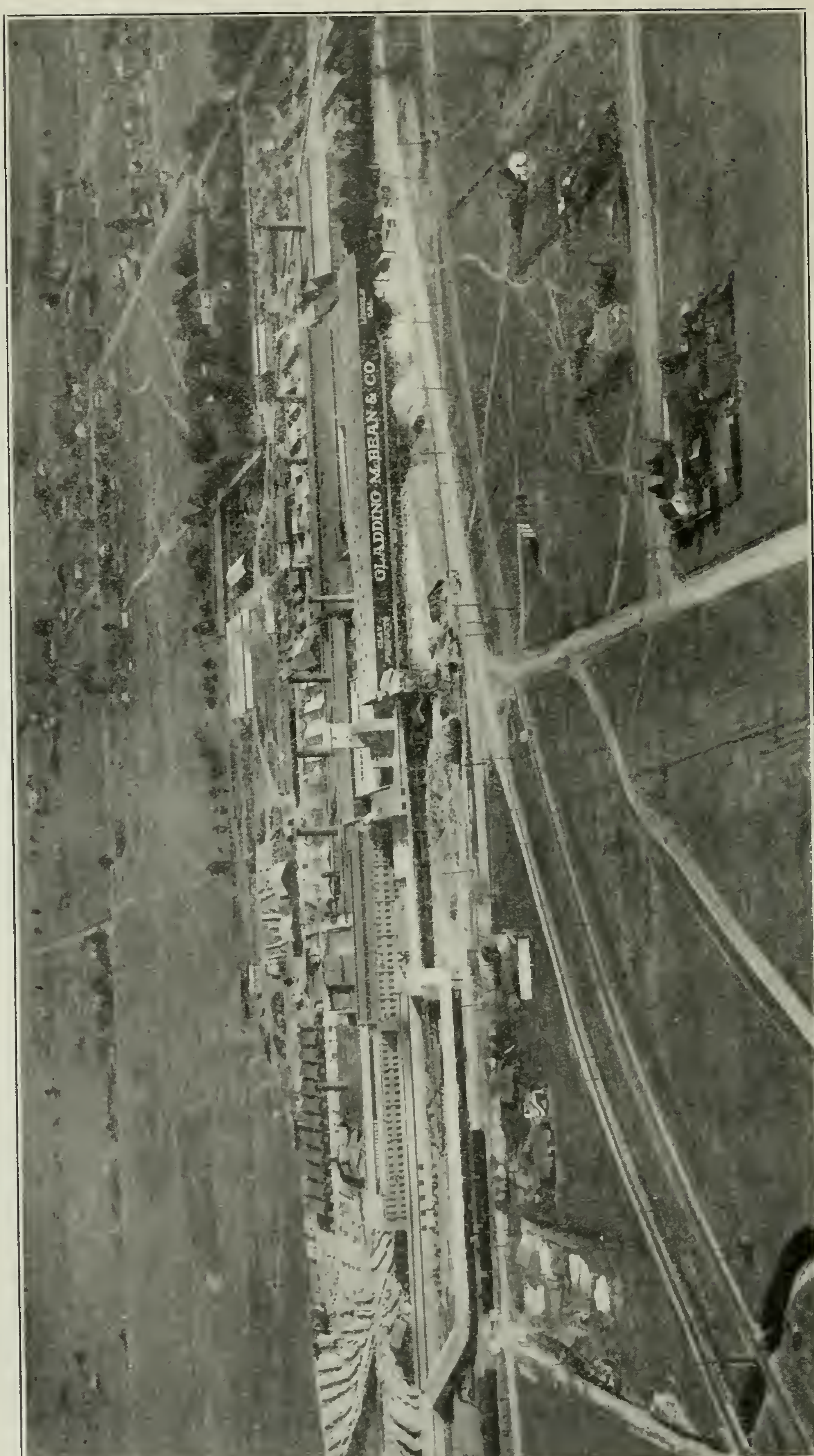

Photo No. 34. Airplane view of Gladding, McBean & Co. plant at Lincoln, Placer County. (Photo supplied through the courtesy of the company.)

humidity, in a period of five hours, then was held at 212° F. with gradually decreasing humidity for 12 hours, and the ware was finally drawn about one hour later. The average drying cycle thus occupied 23 hours. Waste-heat tunnel driers are used for firebrick and face brick.

Eleven down-draft oil-fired muffle kilns are in use for terra cotta firing. The body and glaze mature together at cone 4 (2000° F.), with a heating schedule of nearly four days. Four days are allowed for cooling, and three days for unloading and setting for the next burn, making the turn-over time 11 days. The average total linear shrinkage, on a plastic basis, is 6.9%. The body color is buff.

Fire brick are made from a mixture of terra cotta clay (sample No. 157), ground fire brick grog, and quartz. The brick are shaped in a side-cut auger-machine. Three round down-draft kilns are usually in use for firing fire brick. The firing cycle occupies five to six days firing, and about an equal time cooling. The finishing temperature corresponds to cone 11 down, or 1285° C.

Face brick are made from local materials, using all three of the materials mined in the company's pit, proportioned according to colors desired. Practically all the face brick produced in the plant is buff or cream color. An auger machine shapes the brick, which are either end- or side-cut. They are fired to 2200° F. in round down-draft kilns, four of which are usually in use for this class of ware.

The sewer pipe mixture contains 'fire-proofing clay' (sample No. 156), Ione sand and grog. Electrical conduit is made from the same mixture, with the addition of some Natoma clay (sample No. 212, p. 337). Twelve round down-draft kilns are in service on these two classes of ware, firing to a maximum temperature of 1200° C. in about seven days, including the salt glazing period, then cooling for a nearly equal period.

Roofing tile is made from a mixture of local materials and Natoma clay. Drain tile is made from a similar mixture. Both are shaped on an auger machine. The roofing tile is fired in a tunnel kiln, 363 feet long, with a 43 hour cycle to a maximum temperature of cone 3 (1145° F.). Studies made at the plant have demonstrated a saving of 50% of the fuel consumption of a round down-draft kiln for this class of ware.

In addition to the products already mentioned, flue lining is manufactured. Four round down-draft kilns are in use for firing this product.

All the firing is done with oil fuel, atomized by compressed air. A complete pyrometric control of all kilns ensures uniform firing conditions, and economy of fuel. Electric power is used throughout the plant.

The plant contains an architectural and sculpturing department, a drafting department, and a ceramic laboratory. As in most plants specializing in architectural terra cotta, the staff of the ceramic laboratory spend the greater part of their time developing glazes.

About 600 men are employed in the plant, of whom a large proportion are on piece work. A summary of the kiln equipment and the approximate annual capacity of various classes of ware are given in the following table:

Kiln Data and Approximate Annual Capacity of Gladding, McBean & Co. Plant at Lincoln.

Class of ware	No. of kilns	Type of kiln	Max. temp., °F.	Firing time, days	Annual capacity
Architectural terra cotta	11	Muffle d.d.	2000	3.75	12,000 tons
Sewer pipe and conduit	12	Round d.d.	2190	7	20,000 tons
Face brick	4	Round d.d.	2190	6	3,200 M
Fire brick	2	Round d.d.	2370	6	1,600 M
Chimney pipe	4	Round d.d.	1830	4	3,000 tons
Drain tile	Set with other ware				
Roofing tile	1	363 ft. tunnel	1975	43 hrs.	12,000 tons
Garden pottery	Occasional				

Lincoln Clay Products Co. M. J. Dillman, president, Lincoln. The Lincoln Clay Products Company has no manufacturing plant, and is exclusively engaged in the mining of clays.[1] The property is located two miles northwest of Lincoln, in the N½ of Sec. 4, T. 12 N., R. 6 E., M. D. M. It has been in operation for over thirty years.

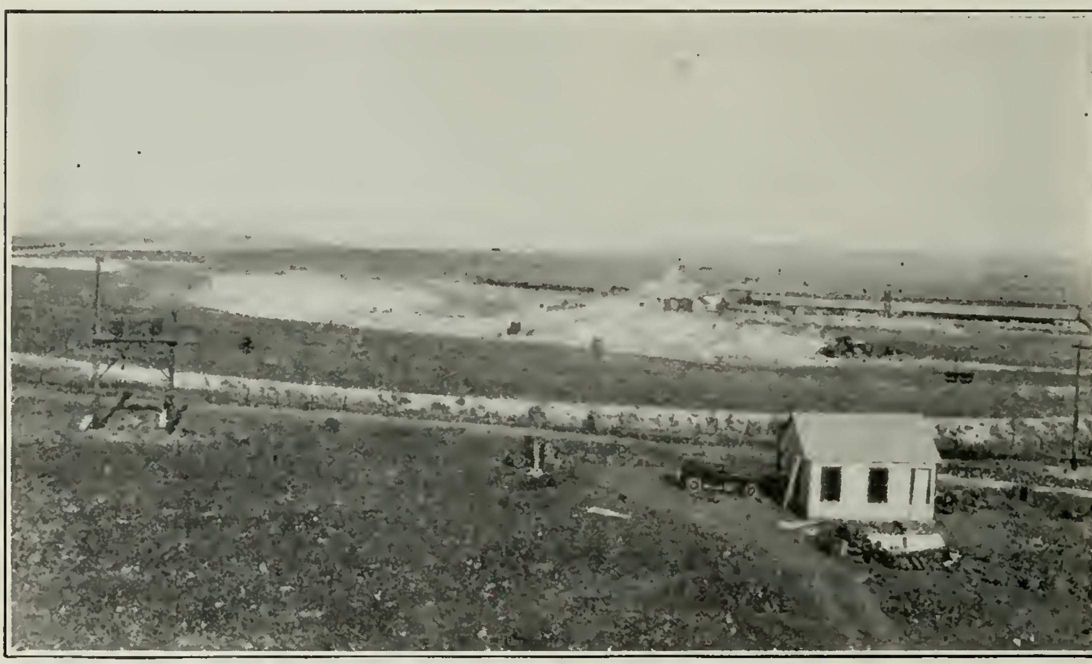

PHOTO NO. 35. General view of the pit and plant of the Lincoln Clay Products Co., looking south from the top of the storage building of the Clay Corporation of California. The Clay Corporation's office building is in the right foreground.

The pit is worked in benches by a combination of a spiral approach and an incline as shown in photos Nos. 35, 36 and 37. Benches are established on the bottom of each clay bed, or series of beds, that is to be mined separately. Gasoline locomotives are used to haul train-loads of stripping or clay from the upper beds and an incline hoist is used to remove the clay that is mined near the bottom of the pit. The pit is over 1200 feet long and 600 feet wide and the maximum depth is 60 feet.

The clay is loosened by hand drilling and blasting. A 1½ cu. yd. gasoline shovel is used for loading clay from the thicker beds, and hand loading is used on the thinner beds. Five gasoline locomotives are in service. Two of these weigh three tons and the others weigh four, six,

[1] A clay-working plant is contemplated in the near future.

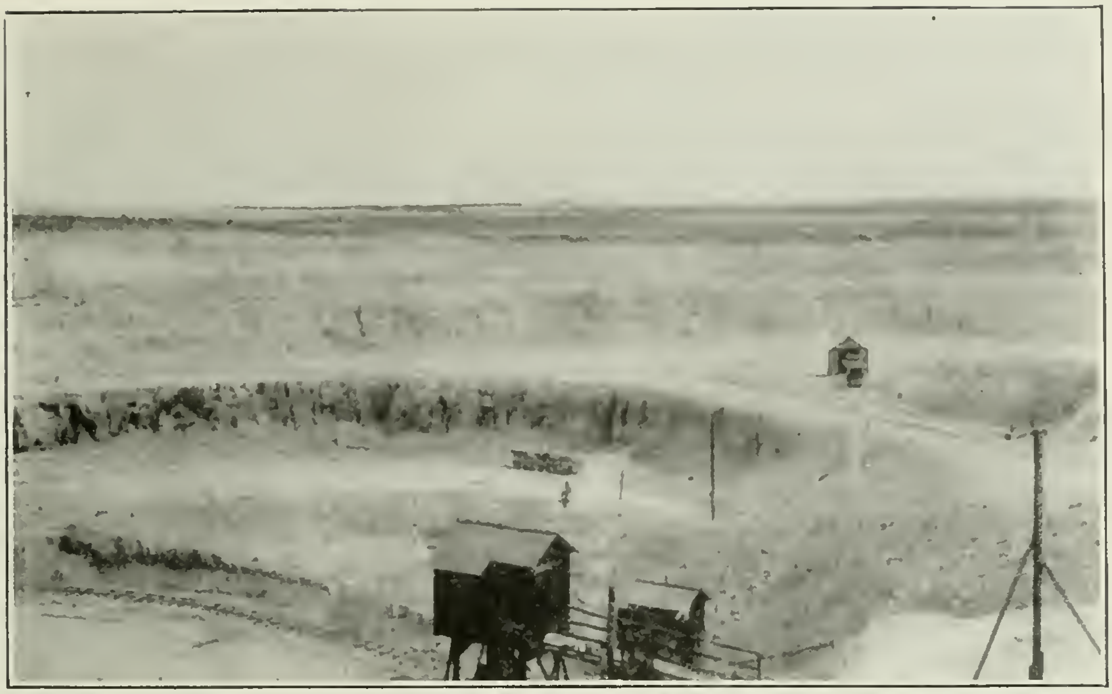

PHOTO No. 36. Eastern end of pit of Lincoln Clay Products Co., near Lincoln. Samples No. 145 to 150 were taken from the pit.

PHOTO No. 37. Western end of pit of Lincoln Clay Products Co. with clay grinding and storage plant of the Clay Corporation of California in the middle background.

and eight tons, respectively. A centrifugal pump is used to remove run-off water from the pit.

A section through the pit follows:

Sample No.	Test data on page	Class of material	Average thickness, feet
		Soil and gravel	1– 3
		Lava	1– 6
145	291	No. 0 clay: Face brick body	8
146	303	No. 1–6 clay: Terra cotta body	15
147	303	No. 7 clay: Tile, face brick, sewer pipe. High in iron	12
148	336	No. 8 clay: Higher in iron than No. 7	6
149	298	No. 9 clay: Similar to No. 1–6	8
150	291	No. 10 clay: Similar to No. 9	22

A large storage shed, shown in photo No. 35, provides storage of clay during the rainy season, allows for fluctuations in mining and shipping during the season, ensures a certain degree of mixing to minimize the effect of local variations in the quality of clay, and permits seasoning of clay for those customers who so desire.

In the fall of 1918 a washing plant was built for the purpose of investigating the commercial possibilities of marketing a washed product. The clay was ground in a Graupner centrifugal mill, mixed with water, and settled in vats. The thickened slip was dipped out by hand and sun-dried in shallow trays. The principal effect of this process was to eliminate a certain proportion of the sand that is present in the raw clay, thereby producing a finer grained clay that has a more uniform, but greater, shrinkage. On account of high freight rates on washed clay, compared to crude clay, and because of the fact that the washed clay did not possess sufficient advantages in use, washing was discontinued after a brief period. In order to permit a study of the properties of the washed material, Mr. Dillman kindly gave the writer a sack from the warehouse. This is sample No. 151, and the test results are given on page 303.

An average of 12 men are employed. The annual output varies with market demands, but is usually in excess of 50,000 tons. The selling price of the clay, f. o. b. cars at the plant, averages $1.75 per ton.

Miscellaneous Deposits.

Previous publications[1] by the State Mining Bureau have reported occurrences of clay at various points along or near the line of the Southern Pacific Railroad, from Alta to Gorge. The most promising of these were visited in August, 1925, and were in each case found to be derivatives of the andesitic tuff-breccias, rhyolite tuffs, or volcanic ashes that are remnants of the great Tertiary volcanic deposits that at one time completely covered the basement rocks of the west slope of Sierra Nevada Mountains, before the more recent period of tilting and stream cutting that has resulted in the present topography. Rock decomposition and alteration has progressed to a varying degree in many of these materials, with the result that in places there are extensive beds of fine-grained, white, greenish-white, or yellowish-white material having a certain degree of plasticity that are often mistaken for useful clays. They are, however, of no value for ceramic purposes, on account of high drying and firing shrinkage, low cohesion in the partly-dried condition which results in serious cracking during drying,

[1] Prel. Rept. No. 7, p. 67–73.

low fusibility, and dirty yellow or red firing colors. Even if they can be successfully dried without cracking, the excessive shrinkage will cause warping, and they are practically impossible to fire without splitting. A characteristic feature that renders easy the field elimination of such materials is the spongy, sticky plasticity developed upon the addition of water, coupled with the large amount of water that the material will absorb to develop this 'plasticity,' usually amounting to over 75% of the solids by weight.

As representative of this class of material, samples No. 161 to 165, inclusive, were taken, and two of them, No. 161 and 163, were submitted to a portion of the ceramic tests.

Sample No. 161 was taken from a 50-foot railroad cut, 1 mile west of Gorge, between mile 157 and 158 on the railroad. The bed sampled was 6 to 8 feet thick, and is exposed for a length of over 300 feet in the cut. It is overlain by 12 feet (maximum) of overburden on the south side of the cut, consisting of gravel and decomposed andesite, and is underlain by white rhyolitic tuff (?). The sample developed sticky plasticity with 71.5% water, and with less water was merely spongy without much cohesion. The test pieces all split badly during drying, and while hard, were very brittle. The calculated linear drying shrinkage, based on dry length, was 28.5%. It was not possible to obtain the dry transverse strength of the undiluted material, and the test pieces were not fired.

Samples No. 162, 163, and 164 were taken from successive beds (top to bottom) of material exposed along the highway 0.9 mile above Baxter, or 2.1 miles above Towle. Each bed is approximately 2.5 feet thick, and the series is exposed for a distance of over 100 feet. It is overlain by from 0 to 3 feet of white sand tuff. Some tests were made on No. 163, but the others were discarded. The plastic working properties of sample No. 163 are similar to those possessed by sample No. 161, except that the presence of a larger amount of non-plastic material somewhat modifies the stickiness. The water of plasticity is 67.1%, the calculated linear shrinkage, dry basis, is 18.4% and the total drying and firing shrinkage to cone 06 (1005° C.) is 22.1 per cent of the plastic length. Visible drying cracks did not develop, but the erratic results obtained from dry transverse strength tests indicates the presence of lines of weakness. All of the fired pieces cracked badly. (See page 350.)

Sample No. 165 was from a railroad cut 1100 feet above (east) of Alta station, described and illustrated in Preliminary Report No. 7, page 73. The exposed face is 35 feet thick and 600 feet long, consisting of alternating layers of fine grained yellowish plastic 'clay,' and of a sandier and whiter variety of the same material, overlain by red decomposed andesite varying from two to eight feet in thickness. The portion sampled was from a yellowish plastic bed varying from four to ten feet in thickness, midway between the top and bottom of the exposure. No tests were made other than pugging a small portion of the material with water and noting its general similarity to the materials represented by samples No. 161–164.

Valley View Mine. Owned by Judge J. B. Landis and Ed. Gaylord, of Auburn. This property is in SE¼ Sec. 12 and NE¼ Sec. 24, T. 13 N., R. 6 E., M. D. M., eight miles by road northeast of Lincoln.

Under the name of Whiskey Hill or Harpending Mine, it was worked for gold in the sixties, but later developed into a copper property. In the lower workings, sphalerite and pyrite increased in quantity and the

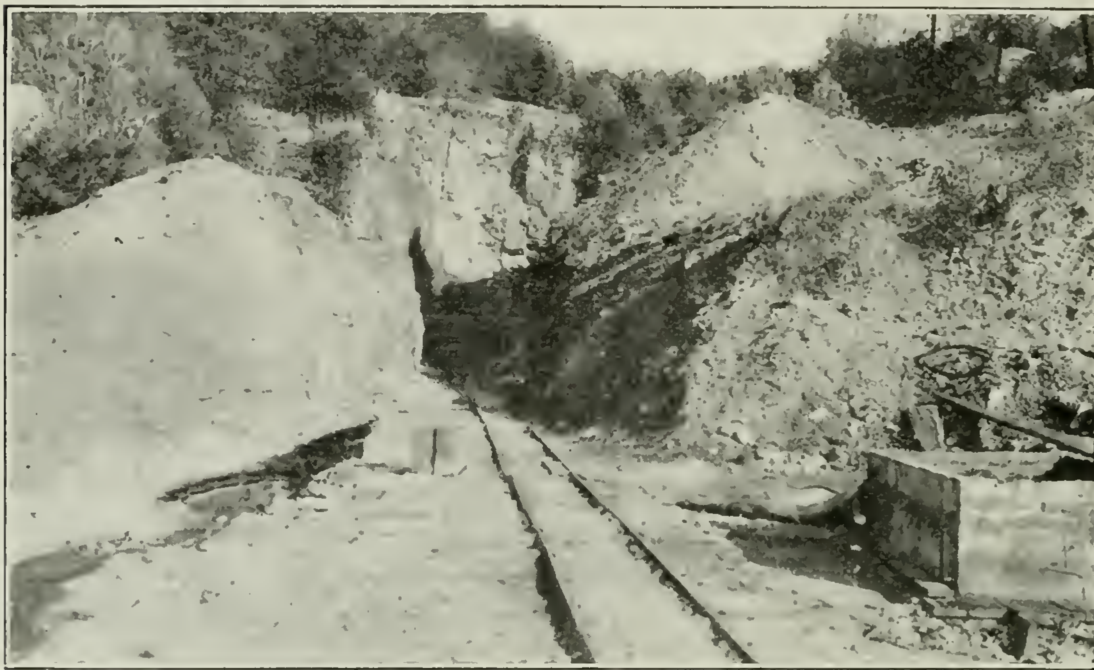

PHOTO No. 38. Valley View Mine, Placer County. Portal of lower tunnel. (Sample No. 261 from glory hole that connects with the tunnel.)

PHOTO No. 39. Valley View Mine, Placer County. Upper workings. (Sample No. 262 from bank to left (east) of center of view.)

copper minerals decreased. There has been no production since 1918. The ore occurs in part in altered dikes which intrude the amphibolite schist country rock. In the upper workings, still accessible through a tunnel, a glory hole, and an open cut, the dike rock has been kaolinized.

The degree of kaolinization and the percentage of iron vary considerably in different parts of the exposures, but in places the material is well kaolinized, has fair plasticity, and is comparatively free from iron.

Photos No. 38 and 39 are views of the property. Three samples were taken. No. 261 (p. 328) was taken from an underground chamber that connects by a chute to the tunnel, the portal of which is shown on photo No. 38. The sample represents a small kidney of kaolinized material, exposed over an area about 10 feet square, and at least 4 feet thick. A peculiarity of the sample is that while it is distinctly red-burning, it has a softening point of cone 28 (1615° C.). No. 262 (p. 350) was taken from the open cut shown in photo No. 39, and is representative of the material from the bank to the left (east) of the center of view. This material has little or no ceramic value. No. 263 (p. 292) is a sample of white kaolin from the same open cut. It occurs as small isolated pockets, some of which are clearly shown on the right-hand side of photo No 39 as white patches. The material is nearly white-burning, has fair plasticity, and a high softening temperature (cone 32–33, about 1720° C.). Unfortunately, there is little indication that large bodies of equally good material will be found on the property.

Bibl (Valley View Mine): Cal. State Min. Bur. Bull. 50, p. 174. Rept. XV, pp. 327–330; XXIII, pp. 246–247 and 286.

RIVERSIDE COUNTY.

General Features.

Riverside County lies in the southern portion of the state. It is bounded on the north by San Bernardino County, on the east by the state of Arizona, on the south by Imperial and San Diego counties, and on the west by Orange County. The county has an area of 7420 square miles and a population of 60,297 (1920 census). It is the fourth county in size and the seventh in regard to the total value of mineral output (1925).

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 San Bernardino and San Jacinto mountains are the most prominent ranges, the peaks of which rise to more than 10,000 feet above sea level. On the western edge of the county, and separating it from Orange County, is the Santa Ana Range.

Geology.

A detailed study of the geology of Riverside County has not yet been made. In the desert areas of the eastern portion of the county, the principal formations, besides Quaternary gravels, are pre-Cambrian and Paleozoic metamorphics; some Tertiary sediments, mostly Pliocene; and various plutonic and volcanic rocks. In the western portion of the county, near Orange County, are extensive areas of Triassic, Upper Cretaceous, Eocene and Miocene age.[1]

[1] Smith, J. P., The geologic formations of California: State Min. Bur. Bull. 72 and Geological Map. See also for bibliography up to date of issue in 1916.

The mineral resources of the county include brick, cement, clay, coal, copper, feldspar, gems, gold, gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, salt, soapstone, silver, miscellaneous stone, and tin. In 1925, seventeen different minerals were commercially produced, the most important being, in the order of their production, cement, miscellaneous stone, brick and hollow building tile, pottery clay, silica (quartz), granite, feldspar, and lead.

Clay Resources.

The Alberhill-Corona district in western Riverside County is one of the three most important clay producing areas in the state. The clay deposits extend in a belt along the Temescal Valley for fifteen miles from Elsinore on the southeast to Corona on the northwest. The clays were laid down in Eocene time, when the Temescal Valley was an arm of the sea opening northward into the valley of western San Bernardino County and extending southerly to Temecula. The width of the basin is from one to two miles, and the depth in places is over 600 feet. A property map of the district is given on plate X.

The general character of the deposits is well described in the following excerpts from an article by the late J. H. Hill,[1] then president of the Alberhill Coal and Clay Company, the largest producer in the district:

"At the Alberhill pits, the clays present a wide diversity of color, character, and degree of consolidation. An extraordinary variety is found, including siliceous fireclays, ball clays, plastic white- and buff-burning clays, highly aluminous and very refractory clays, numerous red-burning clays, and an extensive bed of material from which a china clay is obtained by washing. A bed of lignite coal ranging from two to eleven feet in thickness occurs conformably with the clay strata, and adjacent to this the best fireclays are found. The strata are regular and persistent, and dip to the southwest with an average value of 10 degrees, with local variations due to an undulatory or wavy folding.

"Minor local disturbances appear to have prevailed at intervals during deposition of these clays, and coarse sandy beds are interspersed with fine-grained plastic clays. In these sandy beds, the coarse silica sand is often intermixed in a sporadic and irregular fashion with the accompanying clay substance. Mottled clays apparently due to simultaneous deposition of different kinds of sediments derived from separate sources are also found. The beds in general seem to indicate that long quiescent periods during which fine-grained clays were laid down were preceded and followed by stormy periods when frequent freshets or strong tidal currents brought in coarse silica sand and granite debris from surrounding highlands. The top soils of the region consist of debris of disintegrated granite, and vary from a few inches to many feet in thickness.

"Owing to the masking of the surface by the layer of disintegrated granite material, the total extent of the Alberhill deposit has not yet been fully determined. However, a large number of bore holes have been put down on widely separated portions of the property, and in every case clays of good quality were found to the full extent of the hole in depth. From this and other evidence, it seems quite probable that the entire mass of the small mountain, above the valley floor and for an unknown depth, is clay. A few isolated occurrences of shale have been noted. Exploration to date has been sufficient to indicate beyond doubt that the quantity of readily available clay is so vast as to be inexhaustible for all practical purposes. * * * The hill comprising the deposit is about two and one-quarter miles long and one mile in width, with an average elevation of 1680 feet. The main line tracks of the railway * * * are at an elevation of 1277 feet. * * * The present pits are all somewhat above the level of the railroad tracks."

While Mr. Hill's estimate of clay reserves may have been somewhat optimistic, in the light of more recent work which indicates that the deposits lie in the form of a synclinal trough against the eroded surface of the mountain ranges on each side of the valley, it is substantially true that the supply of readily available clay is sufficient to last for many years, even at increased rates of production. Considering the district as a whole, the principal deposits lie on the eastern side of the

[1] Clay deposits of the Alberhill Coal and Clay Company: State Mineralogist's Report XIX, pp. 185–210, 1923.

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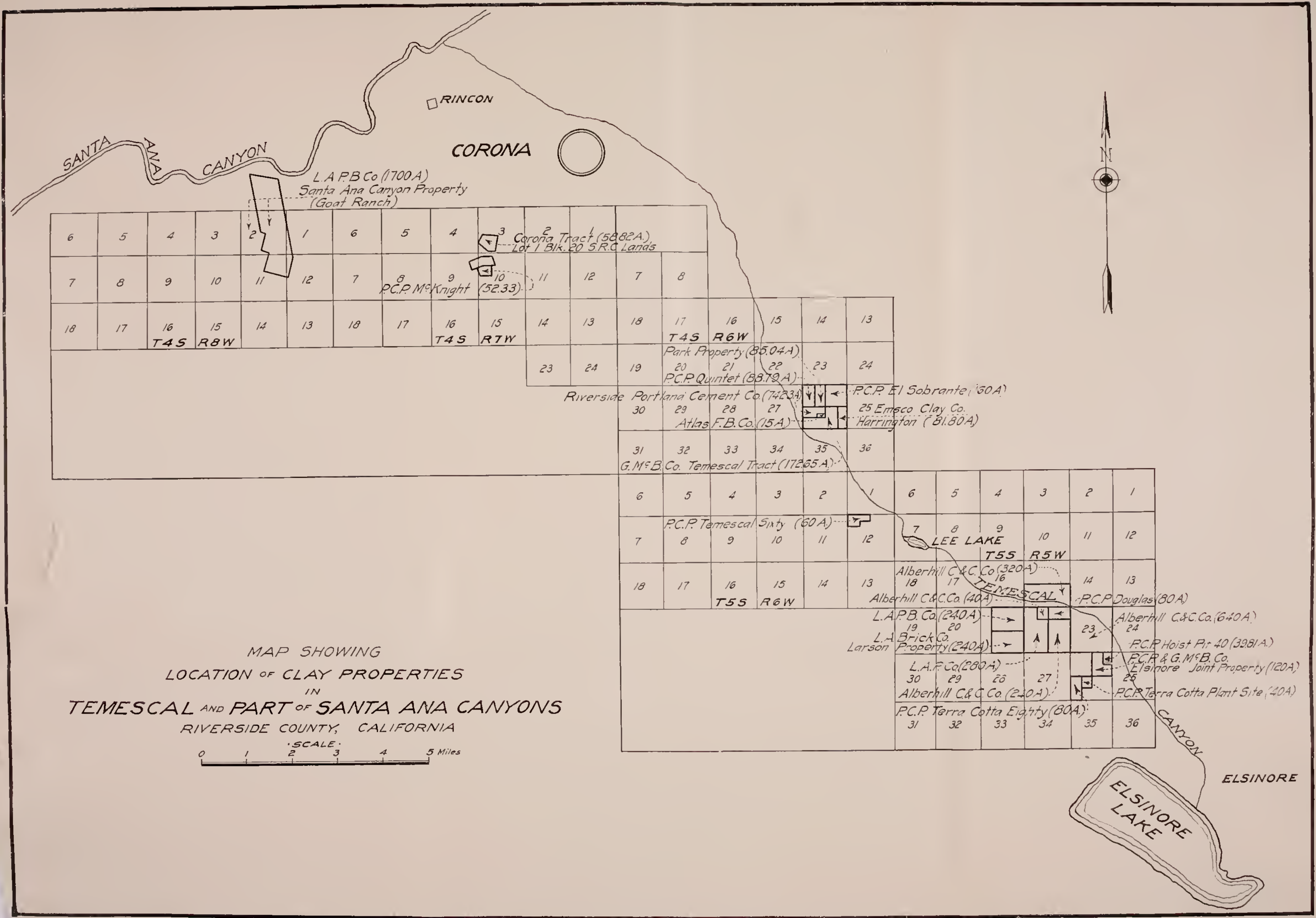

Plate X. Property map of Alberhill-Corona district, Riverside County. (By courtesy of Robt. Linton.)

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valley, but deposits in the floor of the valley and toward the western side are of importance at a number of places. Folding, faulting, and erratic deposition are most pronounced on the eastern side of the valley in the vicinity of Alberhill. The Emsco deposit, on the same side of the valley, at an elevation of about 200 feet above the floor, and about six miles to the northwest of Alberhill (see map, plate X), shows little evidence of structural complexity, and the character of the material in the different beds is uniform over a large area. This same condition prevails at most of the west side pits, except the McKnight pit (Pacific Clay Products Company), near the northern limit of the clay belt, west of Corona, where the structure is more complex.

Most of the promising clay land in the district has been purchased or leased by various companies. The acquisition of property has been particularly active since 1924, when it became apparent that a railroad connection was to be made from Alberhill to Corona. This line is now

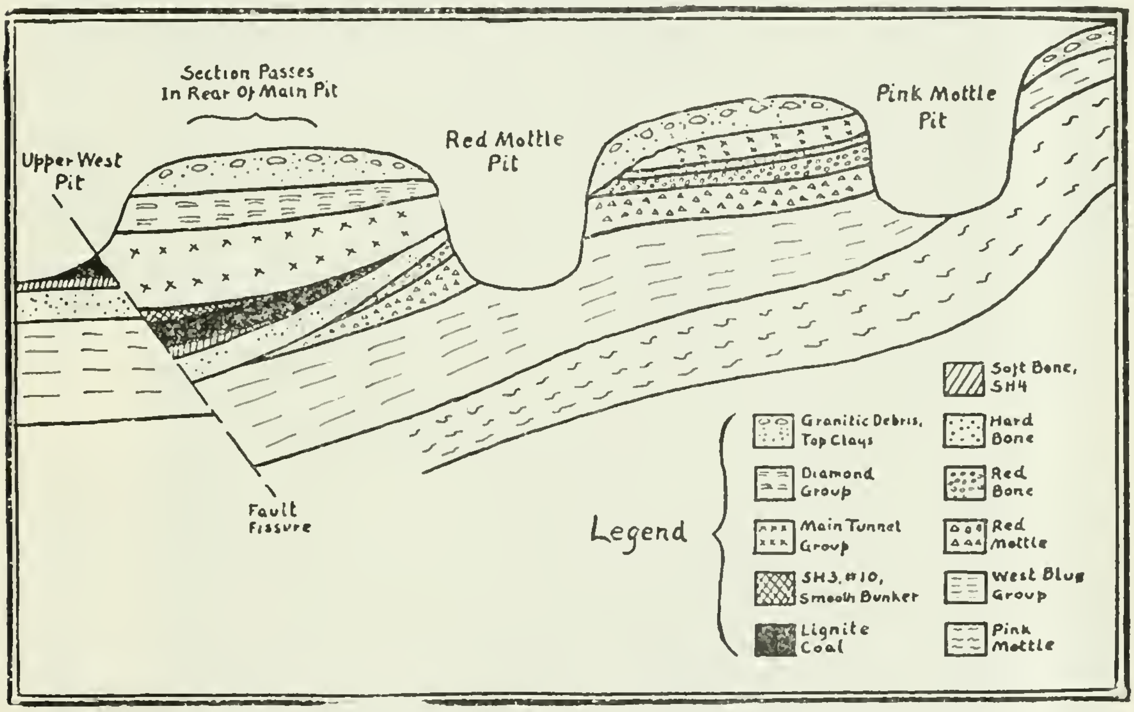

PLATE XI. Diagrammatic section of strata at Alberhill, in a general west-east line. (From State Mineralogist's Report XIX, p. 196, 1923.)

completed, and has not only resulted in a decrease in the freight rate from Alberhill to Los Angeles, but has eliminated long truck hauls throughout the district.

Outside of the Alberhill-Corona district, few commercial clay deposits have been found in the county. Common clays are sufficiently abundant near the more populous parts of the county to serve all requirements for the manufacture of common brick. The desert portions of the county have not been thoroughly prospected for clays, and there is a chance that in the future a few interesting deposits will be discovered.

Alberhill Coal and Clay Company. Chas. Biddle, general manager, Alberhill, California. This company owns nearly 2000 acres of property, parts of which are leased to other companies. The principal holdings are shown on plate X. The company was originally organized to work the coal beds that occur here, and for 13 years previous to 1895 the property was developed solely as a coal mine. The production

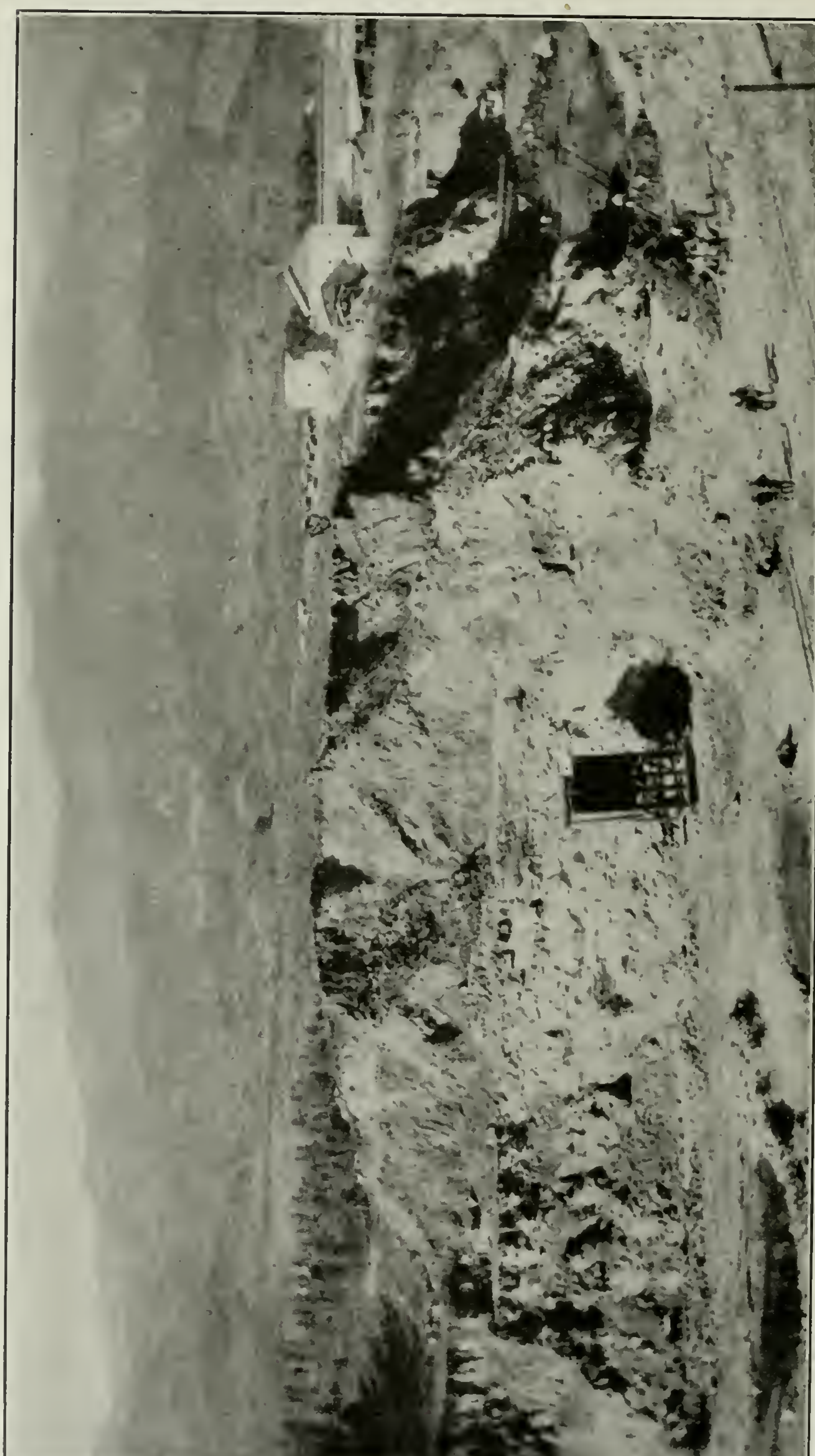

PHOTO No. 40. Southwest wall of the main pit of the Alberhill Coal & Clay Company. The heavy stratum of clay directly behind the bunker is main tunnel fire clay. In the background is Plant No. 4 of the Los Angeles Pressed Brick Company. Riverside County. (From State Mineralogist's Report XIX, p. 187, 1923.)

of clay started in 1895 and it has been continuous since. The company has no clay-working plants, but sells clays to many manufacturers throughout California, particularly in the Los Angeles district. More than thirty varieties of clay are mined and marketed.

PHOTO No. 41. Alberhill Coal & Clay Company. Cut connecting main and west pits. The Alberhill plant of Gladding, McBean & Company (formerly Los Angeles Pressed Brick Company) is in the background. Riverside County. (From State Mineralogist's Report XIX, p. 189, 1923.)

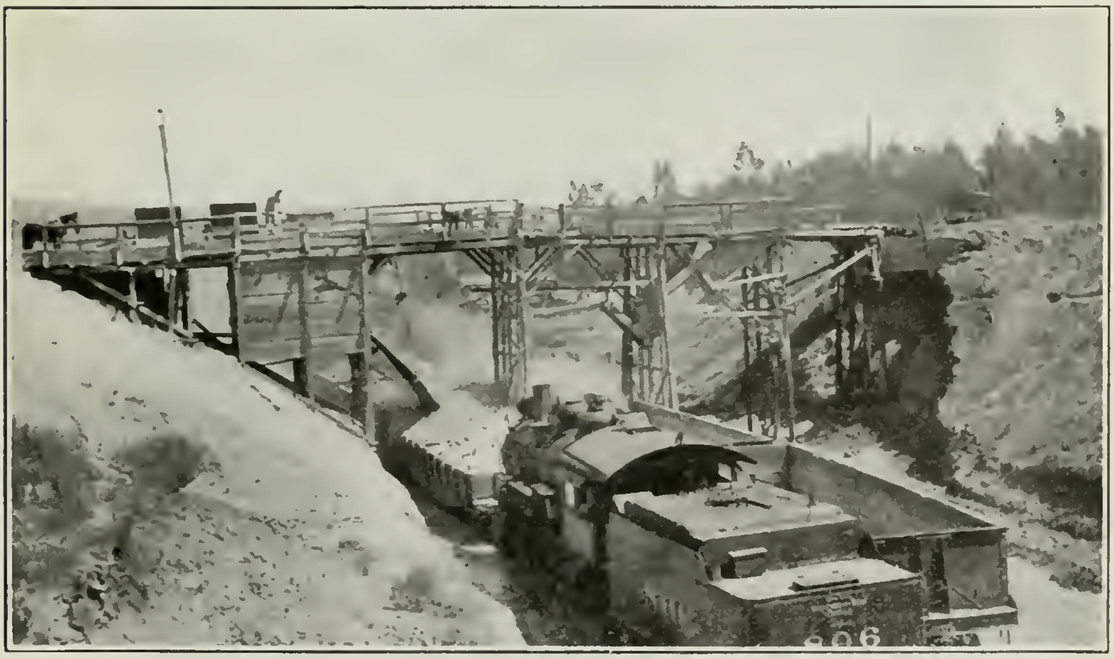

PHOTO No. 42. Alberhill Coal & Clay Company. One of the loading trestles. Riverside County. (From State Mineralogist's Report XIX, p. 191, 1923.)

The operations of the company were described by the late J. H. Hill in an earlier report[1] by the Bureau. For the sake of completeness, this article is freely used in the present report, with some additional

[1] Hill, J. H., *op. cit.*

Photo No. 43. Lower portion of the west pit of the Alberhill Coal & Clay Company. Near the bunker is the mouth of the west tunnel, which extends for over 1000 feet under the upper workings to the west pit, connecting to the surface by numerous glory holes. Riverside County. (From State Mineralogist's Report XIX, p. 194, 1923.)

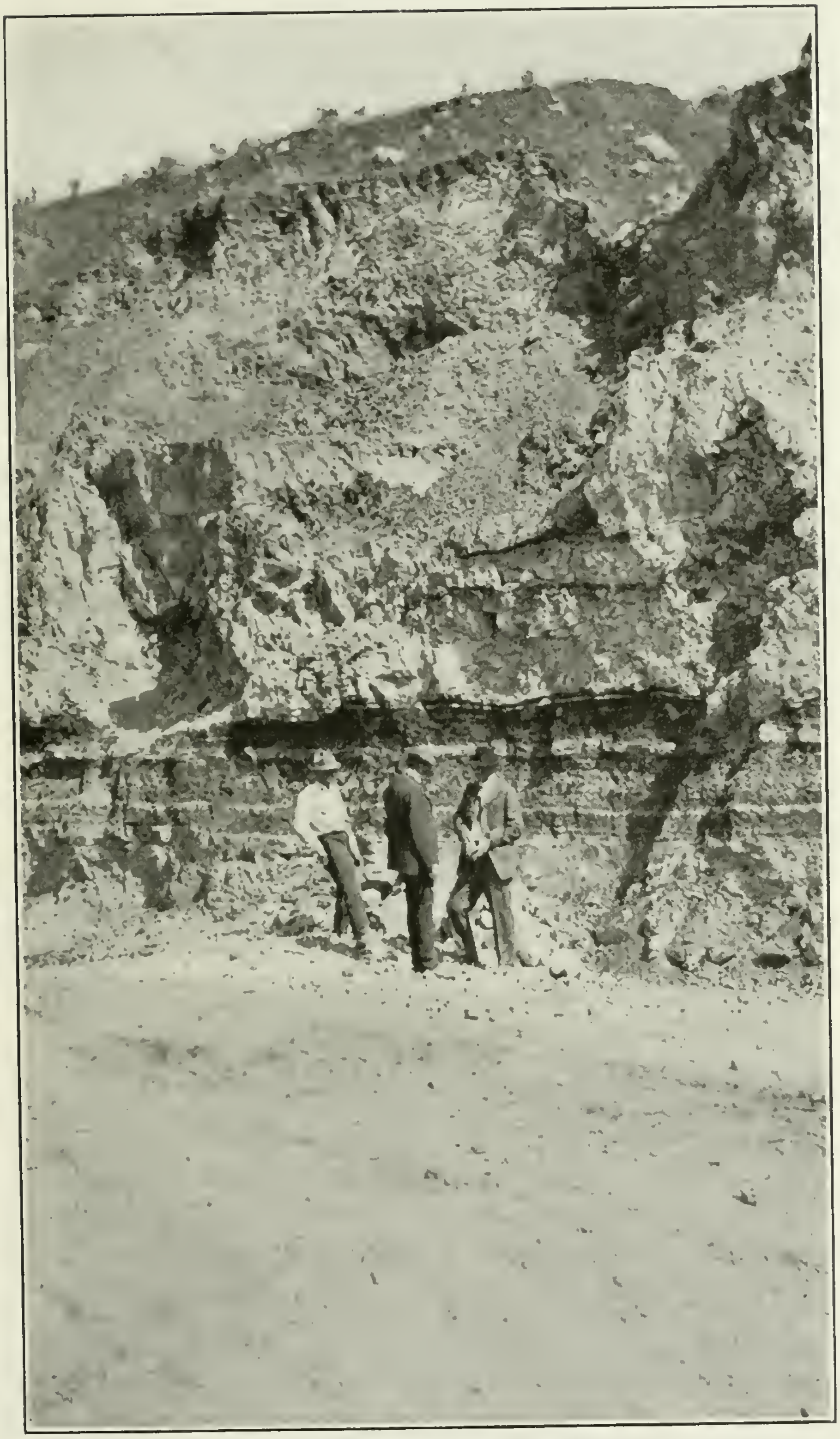

Photo No. 44. Alberhill Coal & Clay Company. Riverside County. An exposure of lignite coal. The clay stratum directly below the coal is SH-4 (sample No. 273) ; that directly above is SH-3 (sample No. 28). (From State Mineralogist's Report XIX, p. 200, 1923.)

details on recent developments. The reader is referred to Mr. Hill's article for further details not covered herein.

Geological Section. An idealized geological section of the Alberhill pits, as prepared by Mr. Hill, is shown on plate XI. This sketch is broadly generalized, and may be considered as a composite of the various beds, in their normal stratigraphic sequence. There is perhaps no locality on the property where the series is complete, as some of the beds are thicker in one place than in another, and other beds are entirely lacking in places. Burchfiel [1] gives the following cross-section as being fairly representative:

No. of feet	Kind of strata
3	Soil
20	Yellow top clay
6	Yellow main tunnel clay
34	Main tunnel clay
6	Coal
4	Bone clay No. W–105
4	Clay between bone and blue clays
12	Select west blue clay
8	West tunnel blue clay
–	Shale

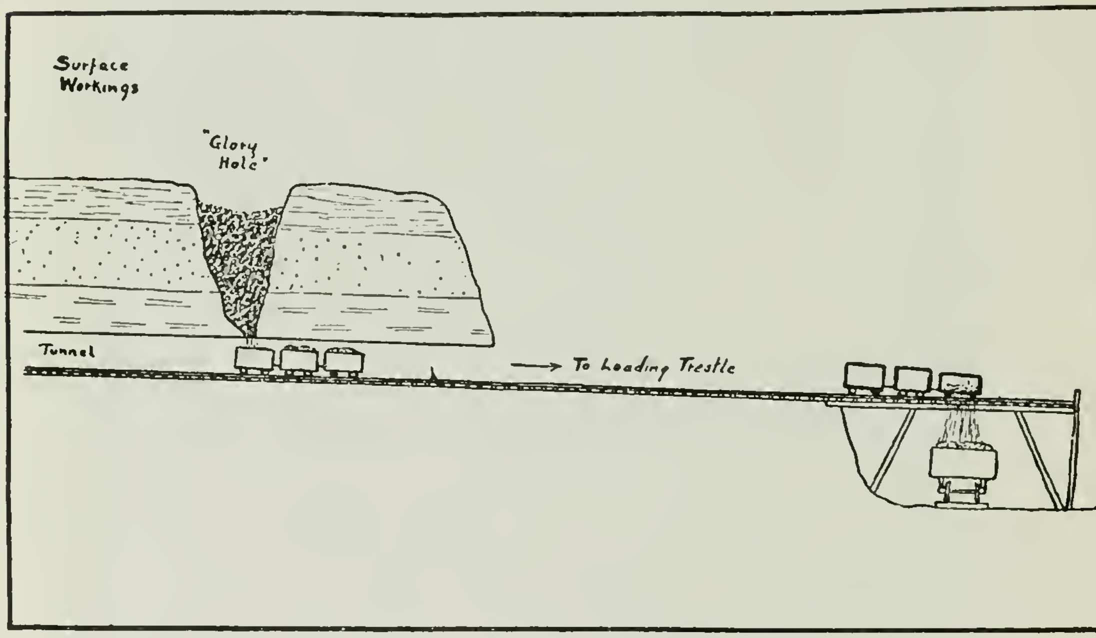

Plate XII. Handling and storage of clay by the "glory-hole" method. (From State Mineralogist's Report XIX, p. 193, 1923.)

Photos No. 40, 41, 43 and 44, all from Mr. Hill's article, illustrate various topographic and geologic features on the Alberhill property.

Mining Methods. Wherever possible, the clays are mined by open-pit methods. The clays stand well in vertical banks up to 40 or 50 feet in height. As operations are scattered, all loading is by hand. Glory-hole mining is used at various places. Underground mining by room-and-pillar methods is used where the overburden is thick, or where it is desired to mine special varieties of clay without removing overlying beds. In 1926, extensive underground operations were started for mining the 'hill blue' clay, and it is expected that most of the production of this important variety will be obtained from these workings in the future, rather than from open pits.

Plate XII, by Hill, illustrates the general method of glory-hole mining. Photos No. 40, 41, 43 and 44 illustrate various features of the

[1] Burchfiel, B. M., Refractory clays of the Alberhill, California, Deposits: Jour. Amer. Cer. Soc., Vol. 6, p. 1167, 1923.

mining operations, and photo No. 42 shows one of the loading trestles and bins for delivering the clay to railroad cars.

At many of the pits, wheelbarrows are used to deliver the clay to a loading chute, from which it is delivered by gravity into trucks for hauling to the railroad. At other pits, small mine cars are loaded by hand, and are trammed by horses to the dumping points. In the glory holes and underground workings, mine cars are used. These are trammed by hand, with horses, or by electric trolley locomotives, depending upon the length of haul and average daily production of the working.

The total production of clay from the company's property is about 15,000 tons annually, and prices (f.o.b. Alberhill) range from $1.25 per ton for the poorer varieties, such as yellow stripping, to $5.50 per ton for some of the selected varieties of white-burning clay. Most of the varieties sell for $2 to $3.50 per ton. The clays enter into the manufacture of a great diversity of products, ranging from china to heavy structural wares. The diversity of clays makes it possible to produce many specialized wares. This is particularly true of the refractory and face-brick branches of the clay industry.

Samples. Twenty-six samples from this property were tested. For convenience of reference, these are grouped below according to the clay classification adopted in this report, which is fully described in Chapter IV.

Sample Record, Alberhill Coal and Clay Company.

Fired color	Clay class number	Clay sample number	Page reference	Local nomenclature	Cone fusion
White	1	11	257*	E–101 china clay	28–29
		12	257*	E–102 china clay	26–27
	2	15	264*	Select main tunnel	30–31
		28	264*	SH–3	30
		29	264*†	Main tunnel (M.T.)	30–31
	3	273	273*†	SH–4 (ball clay)	34
Buff	5	17	277*†	W–105 bone clay	34
		23	277*	West blue	29
	6	9	287*	Hill blue (1925)	29
		14	287	A–clay	31
		27	287*	No. 10	30–31
		272	292	Hill blue, M.T. (1926)	29
	7	13	296	Extra select M.T.	29–30
		271	301	Hill blue, lower tunnel	31–32
		274	302	Hill blue, upper tunnel	30
	9	19	311	Diamond	23
		25	311*†	West tunnel blue	16
	10	16	311*†	Select west blue	18
Red	12	8	321	Red clay No. 2	19–20
		18	321	Clark tunnel mottled	19
		24	321	West tunnel mottled	18–19
		26	321*	West yellow	not det.
	13	7	328*	Pink mottled	17
	14	10	334*	Hill blue green	14–15
		21	334	Sagger	23
		22	335	Yellow Owl cut	17

* The properties of these varieties are also given by Hill, *op. cit.*. The E–101 and E–102 varieties are discussed under "D.C. clay."
† The properties of these varieties are also given by Burchfiel, *op. cit.*

Emsco Clay Co. (Harrington Pit). Location: The Emsco Clay Company of Los Angeles has leased from John Harrington the Harrington clay pit, in Sec. 35, T. 4 S., R. 6 W., in the Temescal Cañon, 10.5 miles by road southeast of the center of Corona, and 7 miles by road southeast of a loading siding on the southeastern side of Corona.

PHOTO NO. 45. Emsco Clay Co., Harrington pit, facing east, 8 miles SE. from Corona, Riverside County. The shovel is standing on top of the 'Harrington No. 5' fireclay (sample No. 70) and is digging pink mottled clay (sample No. 71).

The newly completed railroad connection from Alberhill to Corona passes within 1½ miles of the property. The property under lease comprises 80 acres, and lies on the east side of the valley, 300 feet above its floor. It has been operated intermittently for many years, formerly by the now extinct Independent Sewer Pipe Co., who hauled the clay in wagons to the Chase railroad spur, south of Corona, for shipment to Tropico. It was later under lease to the Alberhill Coal and Clay Co., who did not actively develop the property, as the combined transportation costs to Los Angeles were considerably greater than from Alberhill, where the principal deposits of this company are located.

Development and Mining: A section of the deposit, from top to bottom, as exposed by existing workings, is as follows:

Sample No.	Test results on page		Thickness
--	---	Stripping, of sandy soil, with some clay	2–10 feet
73	323	"Bone" clay, over 35% alumina	4 feet
71	278	Pink mottled	16 feet
72	328	Red, high in iron	2– 4 feet
70	272	White, known as select Harrington No. 5	7 feet
69	323	Red Horse	40–50 feet

The clay beds are quite uniform in quality, but varying in thickness of individual varieties, over the greater part of 40 of the 80 acres under lease. The greatest demand is for the white plastic clay, but the production of this variety is limited by the amount of pink mottled that can be marketed. The Atlas Fire Brick Company uses the entire output of the white plastic clay. The other clays are marketed to Los Angeles consumers, especially to Gladding, McBean and Company and to the Pacific Clay Products Company.

The present (1926–27) mining is being done with a Thew type 0, ¾-yd. gasoline shovel in an open pit about 100 feet square with a 40- to 50-foot bank. Trucks are used to haul the clay from the floor of the pit to a loading bin and chute where it is loaded into larger trucks for the seven-mile haul to the railroad. Photo No. 45 is a view of the pit, and No. 46 shows the loading chute.

Considerable quantities of clay have been mined in the past from open cuts extending along the east side of the present workings, and running up the hill with the clay which dips about 10° to 15° toward the south. There are several tunnels from these pits. To the west, about one-quarter mile from the active pit, it is extensive open cut and chamber workings from which pink mottled and white plastic clay has recently been mined.

Three to four cars per day are being mined and three men are employed at the pit, exclusive of truck drivers.

Gladding, McBean and Company. Office of Southern Division at 621 S. Hope Street, Los Angeles. Through its merger with the Los Angeles Pressed Brick Company in 1926, this company now controls important clay lands and a clay working plant at Alberhill, in addition to the Temescal Tract already owned by the company prior to the merger.

Alberhill Clay Property. The clay property in which the plant is located totals 520 acres, in Secs. 21 and 22, T. 5 S., R. 5 W., as shown on plate X by legends L. A. P. B. Co. and L. A. P. Co. This property adjoins the Alberhill Coal and Clay Company's property on the east.

The main tunnel pit adjoins the Alberhill company's main tunnel pit, and is shown on photos No. 40 and 47. Clay from this pit is loaded by hand into side-dump mine cars, and hauled by electric trolley locomotives across a trestle to the plant on the west side of the railroad, or to railroad bins for shipment to the Los Angeles plants of the company. The principal clay obtained from the pit is main tunnel fireclay, which is used in the manufacture of fire brick.

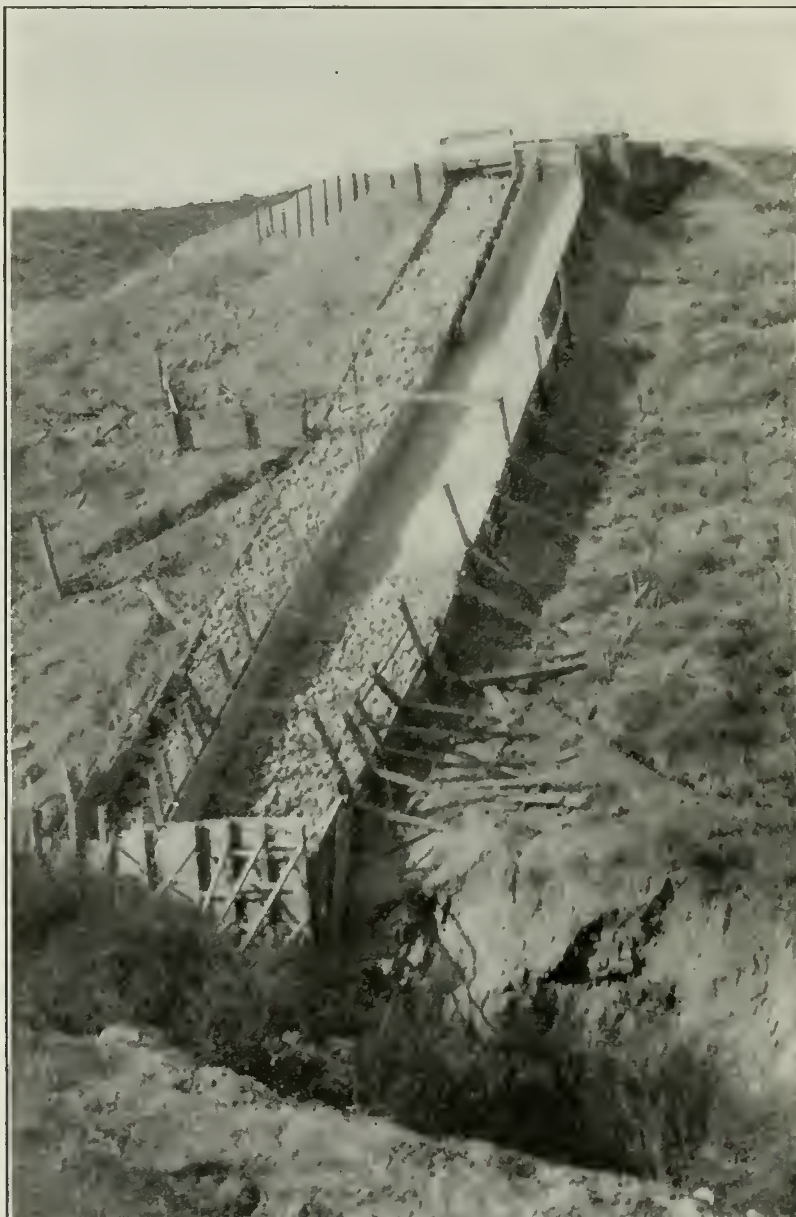

PHOTO NO. 46. Loading chute, Emsco Clay Co. (Harrington pit), Riverside County.

About a half mile southwest of the main pit is the Sloan pit, from which a number of varieties of clay are produced. A representative cross-section of this pit is given by Burchfiel[1] as follows:

No. of feet	Strata
40	Overburden and yellow top clay
30	Sloan clay
6	Sloan No. 5 clay
4	Sloan bone clay (1923)
50	Red clay

[1] *Op. cit.*, p. 1173.

This pit was still an important producer when the property was visited by the author in 1925 and 1926. The clay was being mined by hand methods, and was transported to the plant by auto trucks.

Various other pits have been opened up by the company.

Sixteen samples from the property were tested. No. 90 to 100, inclusive, are practically all from the main pit, and should be compared with similar varieties from the Alberhill company's property. No. 101 to 105, inclusive, are from the Sloan pit. For convenience of reference, they are arranged in the following table according to the clay classification adopted in this report, which is fully described in Chapter IV.

Sample Record, Gladding, McBean Co., Alberhill Pits.

Fired color	Clay class number	Clay sample number	Page reference	Local nomenclature	Cone fusion
White	1	91	260	Main tunnel sand	30–31
		103	260*	Sloan bone	35
	2	90	265	Main tunnel fireclay	31
		93	265	Select main tunnel	30–31
	3	96	272	No. 10	32
		98	272	Bone (W–105?)	35
Buff	5	104	279*	No. 5 Sloan	34–35
	6	92	289	Yellow main tunnel	28
		97	290	Smooth bunker	31
		102	290	Sloan sand	29
	7	101	298	Sloan white	30
	9	94	311	West blue	17
		95	311	Select west blue	18
		99	312	Tile	26–27
Red	12	100	323	Yellow stripping	14 plus
		105	324	Sloan red	18 plus

* Burchfiel, *op. cit.*, p. 1174, gives data on No. 5 Sloan, and states that the Sloan bone is "practically identically the same as the bone clay No. W–105." He also gives data for the yellow top clay from the Sloan pit.

The total clay production from all of the pits on the company's Alberhill property is about 500 tons per day, much of which is shipped to the company's plants in Los Angeles.

Alberhill Plant. The principal products of the Alberhill plant are fire brick and other fireclay refractories, face brick, and hollow tile. Hand-molded roofing tile is also made. The face brick, fire brick, and hollow tile are made by the stiff-mud process, after preparing the clays in dry pans. Most grades of fire brick are repressed. Waste-heat tunnel driers are used. All ware is fired in round down-draft kilns, of which there are twelve, of various sizes from 32 to 38 feet in diameter.

The plant is well arranged, and well equipped to handle all materials in so far as is feasible.

A well-equipped field laboratory is maintained for the study of raw materials and for research on the technical problems arising in the plant.

Temescal Tract. This property, totaling 173 acres, is west of the Emsco Clay Company's property, 0.4 mile east of the Corona-Elsinore highway, and 25–30 feet above the floor of the valley.

Development. The principal pit is 800 feet long, 500 feet wide and a maximum of 150 feet high. Red, pink-mottled and blue plastic clays have been mined. The varieties were apparently badly mixed, and the present exposures in the face of the bank do not offer much encouragement for expecting a satisfactory supply of uniform material. Some development work is being done in a tunnel at an elevation about 100 feet higher than the pit and it is stated that good clays were found underlying the Emsco clays.

At the times of visit, in 1925 and 1926, the pit was idle, but was being held in reserve for the future.

J. D. Hoff, of Elsinore, owns a clay property in Sec. 22, T. 5 S., R. 5 W., on which some prospecting has been done, by core-drilling and

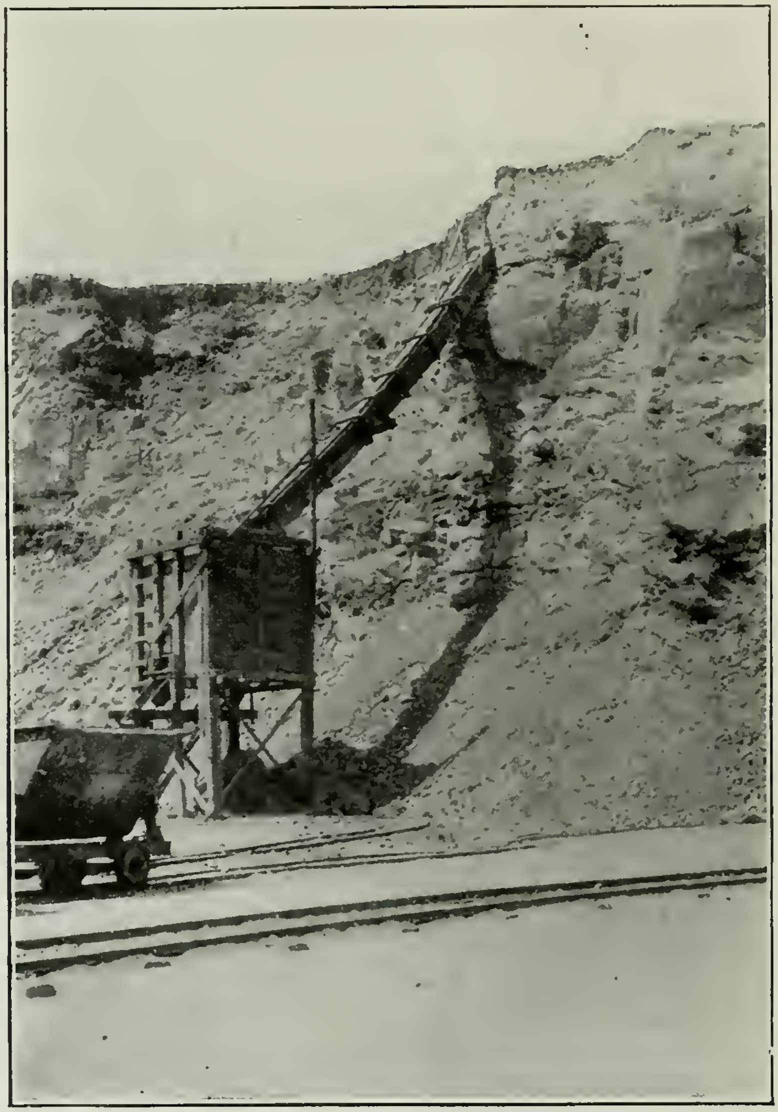

PHOTO No. 47. Gladding, McBean and Company (formerly Los Angeles Pressed Brick Company), Alberhill, Riverside County. Main tunnel pit leased from the Alberhill Coal & Clay Company. (See also photos No. 40 and 41.)

test-pitting. A number of samples were sent to the Stanford laboratory by Mr. Hoff, but none of these were large enough to test. The general appearance of some of the samples is the same as that of certain clays from other properties in the district. Mr. Hoff expects to build a clay-working plant near Alberhill in the near future.

Los Angeles Brick Co. Gustave Larsen, director in charge of operations; Harvey Gardner, plant superintendent at Alberhill. Main office, 1078 Mission Road, Los Angeles. This company acquired the holdings of the former California Clay Manufacturing Company in the Alberhill district, and built a plant at Alberhill in 1925 for the manufacture of face brick, fire brick, roofing tile, floor tile, and hollow tile. The manufacture of other products is contemplated by the company.

The property at Alberhill consists of the SE¼ and the E½ SW¼ Sec. 21, T. 5 S., R. 5 W., S. B. M., and other nearby property totaling 720 acres. This lies to the west of the principal holdings of the Los Angeles Pressed Brick Co. Most of the clays that are being mined at present are from the western limb of the synclinal trough in which the clays of the district lie. The clays include most of the varieties that typify the Alberhill district, and occur in the same irregular fashion, without notable continuity of individual strata. There is apparently, however, a more extensive deposit of high-grade bone clay on this property than in any other known locality in California.

Clay Deposits: A number of pits have been opened on the property, but at the time of visit, in July, 1925, and September, 1926, it was not possible with the data at the writer's disposal to definitely establish the stratigraphic correlations between the various pits, nor between the nearby pits of other operators. A number of samples were taken on both occasions. No. 74 to 87, inclusive, were taken in 1925, and No. 229 to 232 inclusive, in 1926. Vertical sections through the "East," "West," and "Main" pits are given in the following tables. Photo No. 52 shows the East pit as it appeared in September, 1926.

Vertical Section, East Pit, Los Angeles Brick Co.

(From top to bottom.)

Sample No.	Page No.	Local name or number	Principal uses	Thickness, feet
---	---	Stripping	Sometimes for face brick	0–10
---	---	Pink-mottled	Face brick, tile	15–20
---	---	No. 1 red	Face brick, tile	10
230	300	No. 9	Fire brick	15

Vertical Section, West Pit, Los Angeles Brick Co.

(From top to bottom.)

Sample No.	Page No.	Local name or number	Principal uses	Thickness, feet
--	---	Tile clay	Hollow tile, roofing tile	6
81	289	No. 25	Fire brick and pottery	10
76	288	No. 23	Fire brick and pottery	10
77	278	No. 20	Pressed brick, fire brick	20
79	278	Fireclay	Fire brick	10
80	297	Plastic pink and yellow	Fire brick and pottery	?
78	288	No. 10	Fire brick	20

Vertical Section, Main Pit, Los Angeles Brick Co.

(From top to bottom.)

Sample No.	Page No.	Local name or number	Principal uses	Thickness, feet
85	298	Pink mottled	Fire brick, sewer pipe, tile, pottery	Up to 30 ft.
86	279	No. 26 bone	Fire brick	6
85	298	Pink mottled	See above	Up to 10 ft.
83	297	Red clay	Hollow tile, roofing tile	12–15
84	289	P. M. fireclay	Fire brick	10–20

A number of samples were taken from undeveloped or partially developed beds. For convenience, these are given in the following table:

Miscellaneous Samples. Los Angeles Brick Co.

Sample No.	Page No.	Local name or number	Name of pit from which sample was taken	Principal uses	Thickness, feet
74	278	West bone	West bone pit	Fire brick ____	4– 6
75	335	Red No. 2	West bone, underlying No. 74	Tile and face brick _______	?
87	279	Smooth bone	100 yd. E. of main pit, overlying No. 86	Fire brick ____	15
232	281	Smooth bone	?	Fire brick ____	6
231	281	High-alumina bone	?	Fire brick ____	4
82	315	Clay shale	Blue pit	Tile and face brick _______	10–20
229	300	No. 7	No. 7 pit	Fire brick ____	34

Note.—Samples No. 231 and 232 were supplied by Mr. Gardiner in September, 1926. Name of pit from which sample was taken was not given.

The areal extent of these various clays can not be definitely determined in the absence of core-drilling data. Enough evidence is at hand, however, to warrant the statement that many of the beds are practically continuous over areas in excess of 300 acres, although it is doubtful if the clay in an individual stratum will be uniform in quality over such an area.

Mining: The clay is mined from the various open pits by hand methods and is transported to the plant by auto trucks.

Plant: Face brick, both plain and ruffled, is the principal product of the Alberhill plant. Fire brick is being made in increasing amounts and a special high-alumina fire brick is being manufactured from the bone clays that occur on the property. Photos No. 48 to 51 show various views of the plant, and photo No. 52 is a view of the east pit.

The clays as they are received from the pits are ground in dry pans, and elevated to separate steel bins for each variety of clay. From the bins, disc feeders are used to feed an augur machine, which is equipped with an automatic cutter. Repressing is applied on ware that requires it. A 32-tunnel waste-heat drier operates on a 48-hour cycle.

Firing is done in four 32-ft. and eight 34-ft. round down-draft kilns, fired with air-atomized oil. Buff and cream face brick and all firebrick are fired to cone 11, and red face brick are fired to cone 10. Four days is allowed for firing, four days for cooling, three days for drawing, and two days for setting. Each kiln is therefore fired about twice a month.

One hundred and twenty-five men are employed in the plant, and twenty in the pits.

Pacific Clay Products Company. Robt. Linton, general manager, 1151 S. Broadway Street, Los Angeles. This company, which has a number of manufacturing plants in Los Angeles County, owns and operates several clay properties in Riverside County. The location of the properties in the Alberhill-Corona district is shown on plate X, page 162.

Douglas Pit. This is an 80-acre tract consisting of the N½ of NE¼ Sec. 22, T. 5 S., R. 5 W., S. B. M., adjoining the active pits of the Alberhill Coal and Clay Co. on the north. A view of the pit is shown in photo No. 53. The pit is mined by hand methods, using shovel and wheelbarrow to deliver the clay to small loading chutes for loading the trucks which haul it to the railroad bins.

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Miscellaneous Samples. Los Angeles Brick Co.

Sample No.	Page No.	Local name or number	Name of pit from which sample was taken	Principal uses	Thickness, feet
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75	335	Red No. 2	West bone, underlying No. 74	Tile and face brick	?
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232	281	Smooth bone	?	Fire brick	6
231	281	High-alumina bone	?	Fire brick	4
82	315	Clay shale	Blue pit	Tile and face brick	10–20
229	300	No. 7	No. 7 pit	Fire brick	34

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PHOTO No. 48. General view of Alberhill plant, Los Angeles Brick Company. (Photo by courtesy of the company.)

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Sample No.	Page No.
74	278
75	335
87	279
232	281
231	281
82	315
229	300

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The clays are similar to those on the adjoining Alberhill and the Gladding, McBean properties. Four samples were taken, as described in the following table, which is arranged as a vertical section from top to bottom of the known deposits:

PHOTO NO. 49. Los Angeles Brick Company, Alberhill plant, during construction. Riverside County.

PHOTO NO. 50. Los Angeles Brick Company, Alberhill plant, tunnel driers, during construction. Riverside County.

Sample number	Page reference	Clay class number*	Local nomenclature	Thickness of bed, feet
108	290	6	Upper Douglas	5
109	266	2	Douglas main tunnel	4
110	298	7	Douglas	7
111	315	10	Lower Douglas	50–70

* Refers to clay classification, described fully in Chapter IV.

Hoist Pit. This is a 40-acre property, consisting of the NE¼ of NE¼ Sec. 26, T. 5 S., R. 5 W., and lies southeast of the active workings of the Alberhill company. The principal varieties of clay exposed in this pit are known as Hoist Pit blue (sample No. 112, p. 324) and Hoist Pit

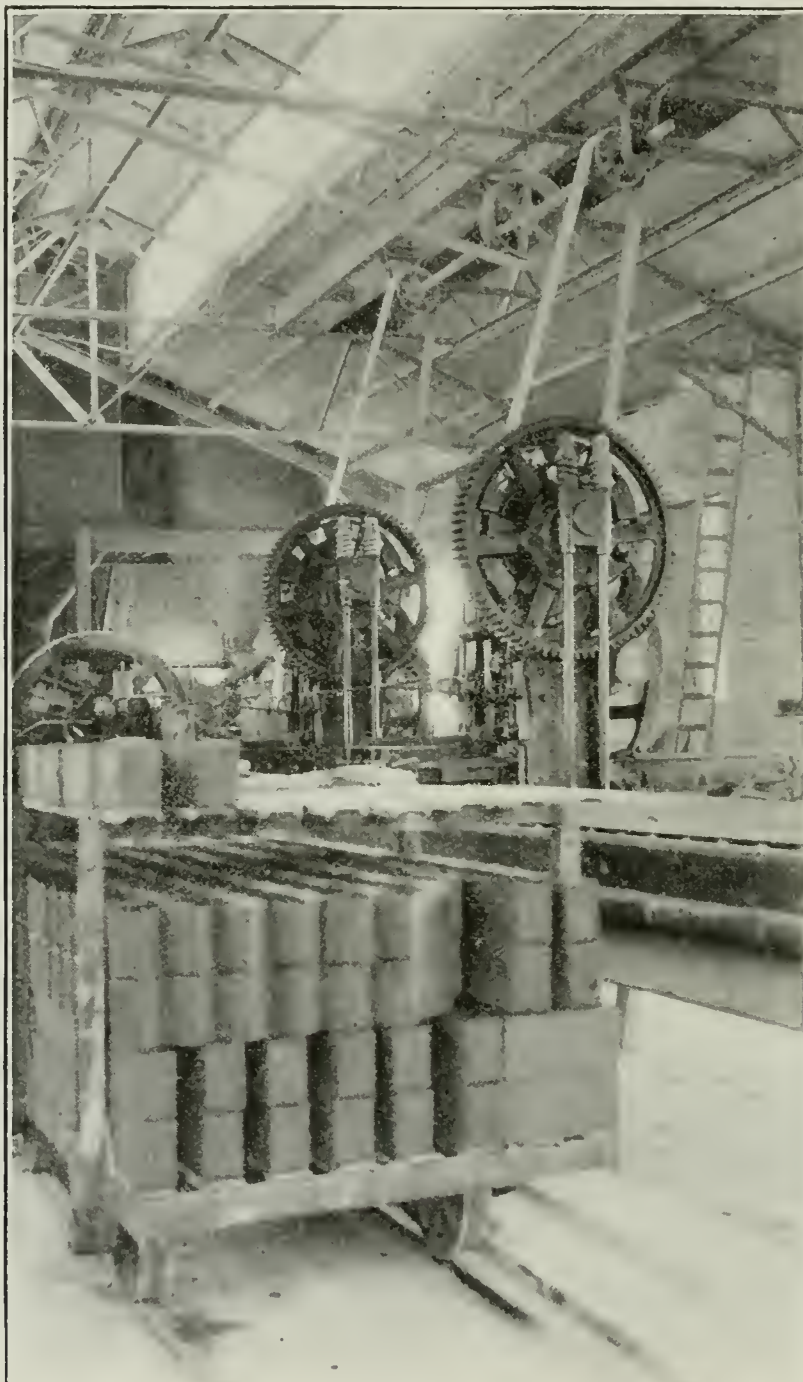

Photo No. 51. Los Angeles Brick Company, Alberhill plant, showing drier cars and brick represses. Riverside County.

red (sample No. 113, p. 324). The blue clay is about 40 feet thick and overlies the red clay, which is about the same thickness. Both varieties are red-burning plastic clays, of particular value in the manufacture of sewer-pipe.

McKnight Clay Pit. The McKnight clay pit, 3.5 miles by road southwest of Corona, Riverside County, in Secs. 3, 9 and 10, T. 4 S., R. 7 W., S. B. M., has been known and worked for over 30 years.

Description of Deposit and Workings. The deposit is composed of two typical varieties of clay; an upper bed, 60 feet thick, of red-burning plastic clay, used in the manufacture of sewer pipe, electric conduit, and hollow building tile, and a lower bed of fire clay, 30 feet thick, used for fire brick and flue lining. The sewer-pipe clay is represented by sample No. 66, page 277, and the fireclay by sample No. 67, page 277. From 2 to 4 feet of stripping overlies the clay beds.

The present workings attack the clay beds from exposures on the northerly side of a steep hill, into which the clay dips at an angle of approximately 35°. The fire clay is mined through a lower tunnel, 410 feet long, having its portal 500 feet east of an upper tunnel and

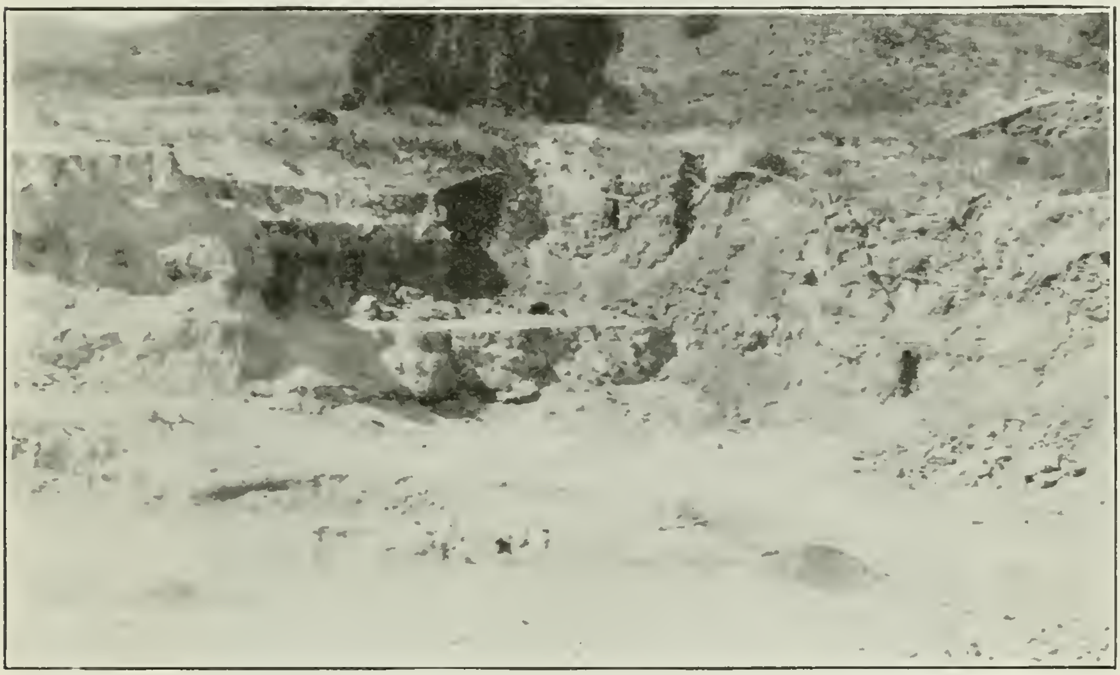

Photo No. 52. East pit, Los Angeles Brick Co., Alberhill, Riverside County.

70 feet lower in elevation. The two tunnels are connected by a raise, and clay is mined by room and pillar methods, dumped into the raise, and drawn off into small mine cars in the lower tunnel. The rooms in which the fire clay is mined are about 15 feet high, and connect with an open pit and tunnel at a still higher level from which the red sewer pipe clay is being mined. Extensive workings of a similar character, especially to the southeast, attest the active mining of this deposit over a long period of years. The southeastern portion of the deposit has been exhausted. It is known that the fire clay pinches out to the westward, but there is apparently a good tonnage of the sewer-pipe clay remaining.

All mining and loading is by hand methods. Each of the two working levels is equipped with a bin for receiving the clay from small mine cars and storing it for the light truck which is used for hauling 1.7 miles to a siding on the southeastern edge of Corona. At the time of visit, July 16, 1925, the output was 50 tons per day, of each clay.

WILDOMAR KAOLIN DEPOSIT. The Pacific Clay Products Company owns a deposit of non-plastic, quartzose, white-burning kaolin located ¼ mile east of the Inland Highway, from a point 2.6 miles southeast of Wildomar. The property comprises 18 acres, in R. 3 W., T. 7 S., S. B. M.

The material has been exposed by stripping in two places, about 150 feet apart. It lies in a bed from 30 to 42 inches thick dipping 30° west, forming the side slope of a low hill that rises above the valley floor. The southerly exposure is 100 feet long, and has been mined

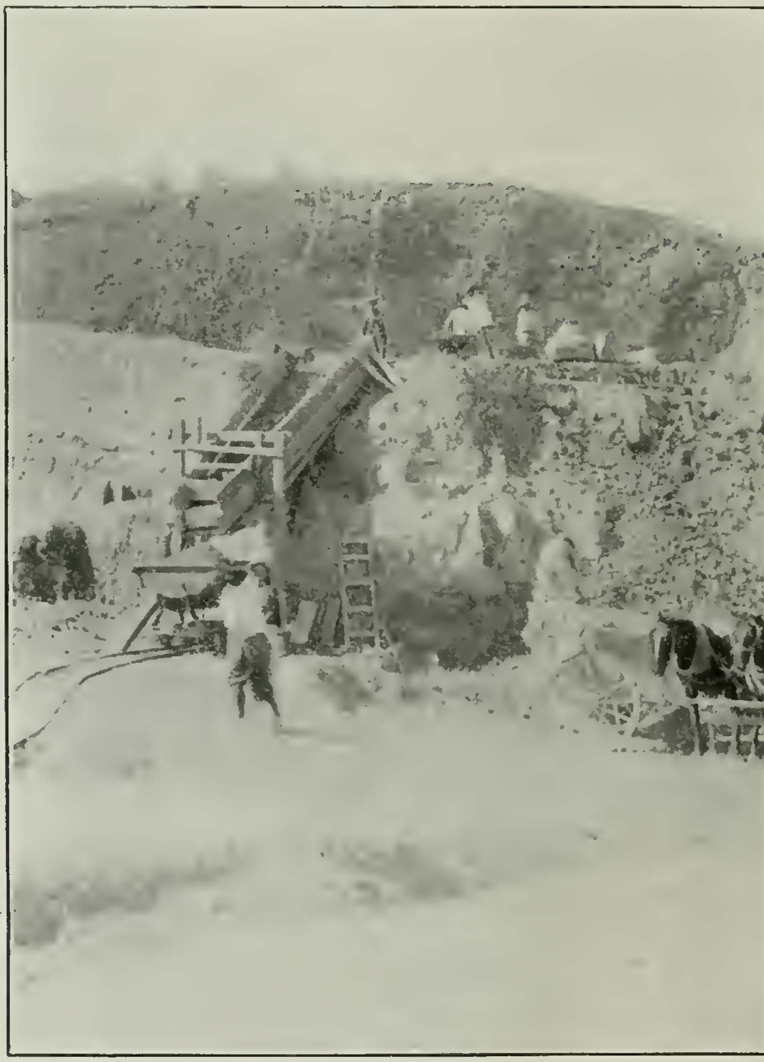

PHOTO NO. 53. Douglas pit, Pacific Clay Products Company at Alberhill, Riverside County.

for 50 to 60 feet above the valley, and for a length of 50 feet. A shaft has been sunk to follow the bed beneath the valley floor. Access to the shaft was not convenient at the time of visit on July 21, 1925. The northern exposure is 70 feet long by 50 feet wide, and about half of the exposed material has been mined.

A thin layer of debris overlies the deposit, so that tracing beyond the stripped exposures is not possible without excavation or boring.

MISCELLANEOUS PROPERTIES. The company also owns the following properties in the Alberhill district: Quintet, consisting of 88.79 acres, in the W½ NW¼ Sec. 26, and El Sobrante, 160 acres, comprising the NE¼ Sec. 26, both in T. 4 S., R. 6 W.; Temescal Sixty, 60 acres, comprising the NW¼ NW¼ and N½ NE¼ NW¼ Sec. 12, T. 5 S., R. 6 W.; Terra Cotta Eighty, 80 acres, comprising the W½ SW¼ Sec. 26, and Terra Cotta Plant Site, 40 acres, comprising the NE¼ SW¼ Sec. 26, in T. 5 S., R. 5 W. In addition, the company owns a half interest with Gladding, McBean and Company in the Elsinore Joint Property, 120 acres, comprising the W½ NE¼ and the SE¼ NE¼ Sec. 26, T. 5 S., R. 5 W. Little or no development work has been done on these properties.

Hancock's Brick Yard.[1] C. P. Hancock and Son, owners, 1330 Lemon Street, Riverside. This yard, for the manufacture of common red brick only, is located on the southern outskirts of the city of Riverside. Clay is mined with a steam shovel from a 10- to 20-foot bank of red clay near the plant. The brick are molded by the stiff-mud process, and fired in gas-fired field kilns. The capacity of the plant is 43,000 brick per day. The length of the operating season depends upon local demand. Twenty men are employed.

Prado Tile Company. Losse and Romedas, owners. At Prado, two miles west of Corona. This is a plant for manufacturing hand-made roofing tile and Mexican pottery. The clay is mined from a local deposit and is pugged by treading. The ware is dried in air, and is fired in an oil-fired, rectangular up-draft kiln, holding about 1000 tile (4 squares of 100 square feet). About 10 men are employed at the plant when operating. The price of the tile, at the plant, was $17 per square in 1926.

Temescal Water Company. (?) A small pit in pink-mottled clay was opened up during the season of 1926 on a property in Sec. 35, T. 4 S., R. 6 W., about a mile southwest of the Emsco pit. The ownership of the property could not be determined, as no work was being done at the time of visit, in September, 1926. It is said to belong to the Temescal Water Company, and that it was being developed by 'Doc' Meyers. The pit had been opened by an open cut, 25 feet wide and 40 feet long. A horse scraper was used for removing overburden, and the clay was mined by hand methods. The only clay exposed was pink mottled, a sample of which was taken. See No. 218, page 329. The extent of the deposit could not be determined, but the clay could be traced around the hill for a distance of about 200 yards.

J. W. Wilson of Vidal, a station on the Parker cut-off of the Santa Fe Railroad, in San Bernardino County, has located 26 claims on an extensive clay deposit in a playa three miles by road south of Vidal in Riverside County.

The clay varies in color from nearly white to pinkish and blue-grey. The beds have a total thickness of at least 20 feet over the entire area, except where recent erosion has removed portions of the deposit. In many places, however, thin beds of unconsolidated sandstone, from less than inch to several inches in thickness, are interbedded with clay beds from one to three feet in thickness. The sandstone beds contain many poorly preserved fossils, notably sharks teeth, and small clam shells less than an inch in diameter. The clay beds are overlain by varying thicknesses of loosely consolidated sand and fine gravel, but

[1] Supplemented by data obtained by W. B. Tucker, November, 1927.

there are large areas where erosion has removed practically all of this capping, and has exposed the clay beds.

Samples No. 42 and 43 were taken for test. The results, given on page 340, indicate that the clay is unsuited for general ceramic purposes, although its extremely fine grain, and high plasticity, may indicate certain special uses.

Bibl (Clay resources of Riverside County): State Mining Bureau Bull. 38, pp. 221–224 and 252–253; Prel. Rept. 7, pp. 74–91. Rept. XV, pp. 559–574; XIX, pp. 185–219. Also Jour. Amer. Cer. Soc., Vol. 6, pp. 1167–1175, 1923.

SACRAMENTO COUNTY.

(By C. A. Logan and W. F. Dietrich.)[1]

General Features.

Sacramento County is almost in the geographic center of the state, and lies principally in the Great Central Valley, with the eastern part of the county rising into the foothills of the Sierra Nevada Mountains. The elevation varies from 30 feet above sea level at Sacramento (Southern Pacific depot) to about 900 feet above the sea on the east side of the foothills. The Sacramento and American rivers unite just northwest of Sacramento city limits, the former flowing south and forming the western county line. Cosumnes River traverses the southeastern part of the county, flowing into Mokelumne River on the southern county line.

The county and capital city are served by two transcontinental railways, the Western Pacific and Southern Pacific, which cross the county from north to south. The Central California Traction Company's line from Sacramento to Stockton connects with the Santa Fe system, and the San Francisco-Sacramento electric railway runs southwest to Oakland and San Francisco. A third electric interurban line, the Sacramento Northern, runs north as far as Chico. Three regular steamer lines ply between Sacramento and San Francisco on the river, giving freight and passenger service, besides which there are numerous other river cargo carriers. Two large power companies, Pacific Gas and Electric Company and Great Western Power Company, supply electric power, and the former company and Sacramento Gas Company supply gas. Transportation and power needs are thus well supplied. State highways radiate in all directions from Sacramento.

Sacramento County has been an important gold-producing district for a long time. Previous to the enactment of the anti-debris laws there was considerable hydraulic mining in the Folsom district and the gold production from this source and from drift mining was as high as half a million dollars a year. In 1899 gold dredging began and gold production reached its peak between 1909 and 1919, the maximum yield being over two and a half million dollars in 1919. From now on, production from the gold dredges will decline rather rapidly.

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[1] Mr. Logan's report on Sacramento County was made in 1925. See State Mineralogist's Report XXI, pp. 1–22. Mr. Dietrich visited some of the clay plants in the county in 1925 and 1926 and has added certain details to Mr. Logan's descriptions, especially to that referring to the Natoma Clay Company. He also added notes on the Michigan Bar clay deposits. In 1927, Mr. Logan visited the plant of the Valley Brick Company, and supplied the description that is included here.

As a by-product industry, utilizing the waste rock piles of the dredged land, the rock-crushing industry has become important and has grown rapidly with the increased use of concrete. Sand and gravel are also dredged in large quantities from the American River bed.

Brick, tile, and a great variety of clay products are produced, using local clay mostly. Natural gas is supplied for domestic use, in part from wells. Granite is quarried, and platinum metals and silver are recovered as by-products of dredging.

Clay Resources.

A few deposits of high-grade clay occur in the southeastern part of the county, adjoining Amador County. These are part of the Ione formation, which is so productive of clays in the vicinity of Ione. The deposits were worked a number of years ago, and were the basis for establishing one of the first clay-working plants in California, but have been idle for many years, and present exposures are insufficient to warrant development, in view of the lack of cheap transportation facilities in this area.

There are adequate supplies of common clay in the county, suitable for the manufacture of red structural ware. The gold-dredge silt now being mined by the Natoma Clay Company is of particular interest. The proximity to the important deposits of high-grade clays of Lincoln, Placer County, and Ione, Amador County, has encouraged the establishment of a number of clay plants in or near Sacramento.

Cannon and Company (formerly *Sacramento Clay Products Company*). Owner, Cannon and Company, a close corporation. D. A. Cannon, president and general manager. Main office, 400 Forum Building, Sacramento. The plant and clay beds are at Ben Ali siding, four miles from Sacramento, on what was formerly a part of Rancho del Paso, adjoining the Southern Pacific main line and state highway. There are about two hundred acres in the holdings. A view of the plant is shown on photo No. 54.

About sixty per cent of the clay used in the plant is mined on the property. White clay and sand are brought from Lincoln and Ione deposits for making fire brick and are mixed in desired proportions with the local clay for making other products.

The clay on the property is a firmly consolidated yellowish-brown sandy clay, red-burning, and locally called 'hardpan.' It is covered by a layer of reddish sandy loam, which is worked and marketed separately for molding sand. The 'hardpan' layer varies in thickness but the entire bank is similar in quality, and is worked to a depth of fifteen to twenty feet.

Clay is dug by a steam shovel and horse scrapers, loaded in cars and hoisted to the plant, where it is dumped and aged under cover. It is fed by an auger feed to two dry pans for grinding, after which a bucket elevator lifts it to a Hum-Mer electric screen, screening to the desired size depending on the product to be made. The clay then passes to storage bins, pug-mills, and brick or tile machines. The stiff-mud process is used. The products manufactured include face brick, interlocking and hollow tile, fire brick, hollow tile, Roman brick and other special shapes and sizes. The shrinkage of the local clay is one in thirteen, which is low compared with the white clays used, and

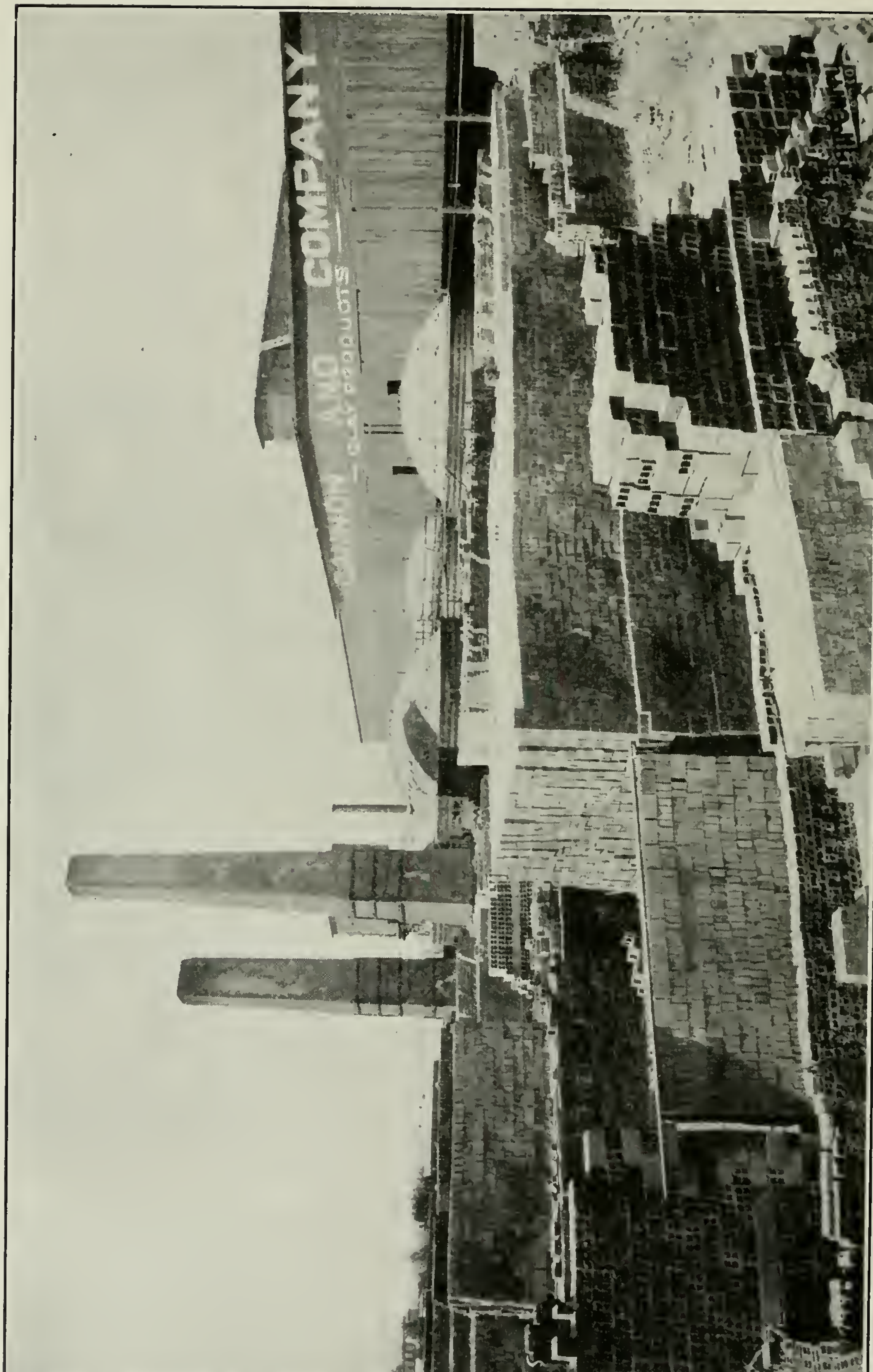

PHOTO NO. 54. Cannon and Company's plant, Ben Ali, Sacramento County. (From State Mineralogist's Rept. XXI, p. 6, 1925.)

shrinkage of different products varies with proportions of the clays employed. Fusibility of the fire brick is above 3000° Fahrenheit and the face brick 2100° to 2200° Fahrenheit. For burning the brick and tile there are five down-draft round kilns, each with a capacity of 70,000 to 80,000 bricks. The bricks are burned five days and tile two and one-half to three days. Clay working machinery is operated from a main drive, using a 200-h.p. electric motor, and crude oil fuel is used for the kilns and steam shovel. There is a spur track to the plant from the railroad main line. Thirty-five to forty men are employed and the plant has a capacity of 10,000 to 12,000 tons a month.

Interlocking tile is used for bearing walls. This tile and the face brick have been used in the new California State Life Building and in other large buildings recently erected in Sacramento.

Bibl: State Mineralogist's Reports XV, p. 404; XXI, p. 7.

Michigan Bar Clay Deposits. In the vicinity of Michigan Bar, 6.5 miles north of Carbondale, are a number of exposures of clay belonging to the Ione formation. Attempts have been made at various times to develop these deposits, but on account of the distance from railroad transportation and the lack of large exposures of uniformly high-grade clay, no recent commercial production has been attained. The most promising showings are in Sec. 2, T. 7 N., R. 8 E., M. D. M., on the south side of Cosumnes River, 2 miles east of Bridge House. Van Vleck and Sons of Michigan Bar own the north half of the section, as well as large acreages to the south and east, some of which may cover deposits of future value. Geo. Cutter of Sacramento owns the NE¼ of the SE¼ of the section; C. E. Bundock of Michigan Bar owns the S½ of the NW¼ of the SE¼ of the section. The ownership of the remaining portions of the section was not determined.

Portions of the area investigated were formerly the scene of hydraulic gold mining operations, especially near the eastern side of the section, and extending over parts of section 1. Gravel still remains over portions of the area, in places to a depth of 20 feet. On the Geo. Cutter property, hydraulic mining has exposed a bed of white plastic clay (sample No. 143), underlying the remnants of gravel at that point. The clay bed has a dip of 7° west, following the slope of the hill. The total exposed thickness of clay is as much as 20 feet in places, but it was not possible to find a continuous and uniform stratum of clay that is not seriously contaminated with a network of hard, weather-resisting stringers of siliceous limonite. The erosion in the 45 to 50 years since hydraulic mining days has left the iron-bearing stringers in sharp relief on the exposed clay beds. At one point, near the center of the Cutter property, the clay is not greatly contaminated over an area about 50 feet square, and for a thickness of three to four feet. A sample, No. 143, was taken from this exposure, in order to indicate the possible utility of clay of such quality, if it could be found in sufficient abundance. The test results are given on page 274.

Just north of the Geo. Cutter property, on the eastern portion of the Van Vleck land, a stream bank affords a good exposure of a fine-grained, white- to cream- and buff-burning clay. The exposed thickness of the bed varies from 3 to 6 feet, extends for 200 feet in length, and can be traced in cross-gullies for at least 100 feet back from the bank of the stream. This bed apparently underlies the clay exposed in the gravel pits. Sample No. 144 was taken for testing, the results of which are given on page 273.

It is entirely possible that prospect drilling over this area, and in adjoining properties, might disclose clay deposits of commercial importance, but in view of the minimum truck haul of 6.5 miles to Carbondale, or 12 miles to the Western Pacific Railroad in the Sacramento Valley, it is unlikely that serious work will be done until some time in the future.

Muddox Pottery. H. C. Muddox Company, owner; H. C. Muddox, president. Office and plant at Thirtieth and L streets, Sacramento.

This company operates a plant for the manufacture of sewer pipe and chimney ware. They own some land at Carbondale, Amador County, where they dig clay, and also buy some common clay locally.

Bibl: State Mineralogist's Report XXI, p. 10.

Natoma Clay Company. This company was organized to produce clay from the settling basins that have resulted from gold dredging operations in the Natoma dredging area. The clay consists of the fine clay and silt that is carried by the reject water from the dredge ponds. This water is passed into shallow basins which were previously formed by the dredge, and the clay and silt are completely settled before the water is returned to the main stream. During the years of dredge operation in this district, many millions of tons of clay have been artificially produced in this fashion. The individual basins are trough-shaped, and are generally less than 30 feet deep, ranging from 75 to 100 feet wide at the surface. The sides of the troughs are formed by boulder piles on an angle of repose of approximately 45°, or by vertical banks of unmined gravel. Some of the basins are one and a half miles or more in length. Much of the clay area has been prospected by hand-augers, and in one summer's prospecting alone, over 6,500,000 tons were proved.

The clay is extremely fine grained, yet contains a sufficient proportion of non-plastic matter to impart desirable ceramic properties to the mass. The proportion of non-plastic matter, and the fineness of grain varies from place to place, but in any given basin there is a remarkably uniform gradation from top to bottom, with the finer material nearer the surface, making it possible to mine two or three different grades of material.

Many laboratory and full-scale tests have been made on the clay, and it has been found to be particularly useful where an excellent range of dark-red colors and a fine even texture is desired. High dry strength, and a long vitrification range, coupled with very low porosity when vitrified, have been thoroughly demonstrated. For the results of tests by the writer on two different samples, see No. 210 and 212, page 337.

Mining operations were started in the summer of 1926, on the Alder Creek pit, half a mile from a spur track of the Southern Pacific Co., and one and a half miles south of Natoma. The clay is mined by an Insley 10-ton gasoline shovel, loading into contractor's dump cars on a narrow-gauge track. See photo No. 55. Haulage to the loading bins at the siding is done with a gasoline locomotive.

Bibl: State Mineralogist's Report XXI, p. 3.

Panama Pottery. Owner, Panama Pottery Company, Inc., a close corporation. Victor Axelson, president; Andres Anderson and Gustav Johanson, principal owners. Address, post office box 797, Sacramento. The plant is just south of Sacramento city limits near Twenty-first Street road. See photo No. 56.

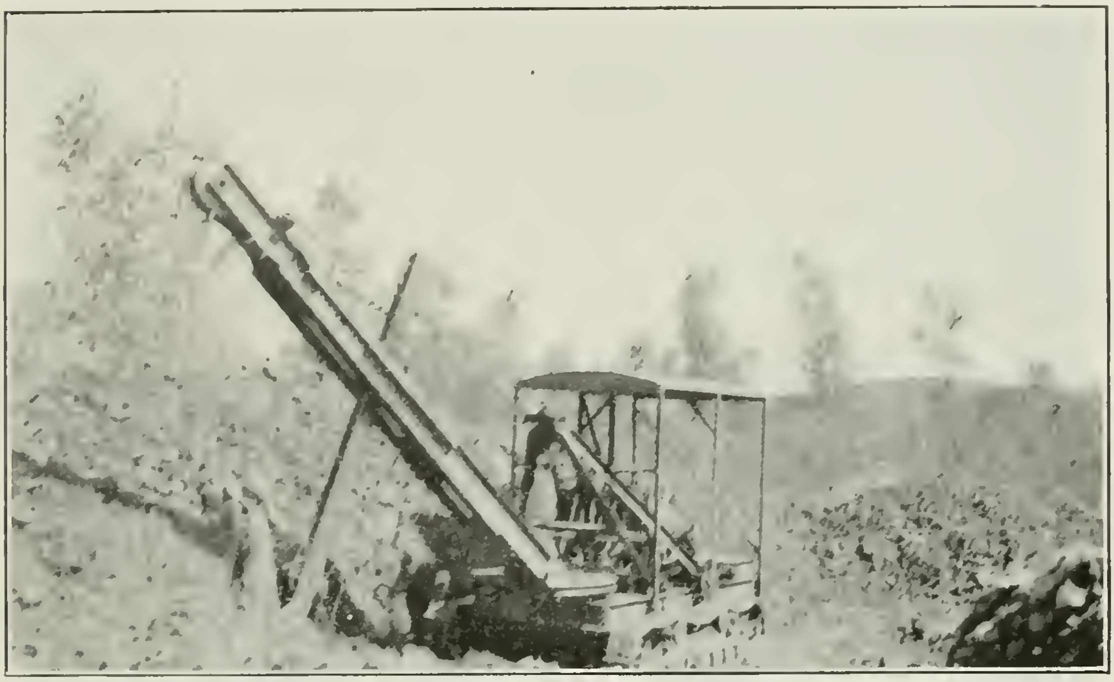

PHOTO NO. 55. Electric shovel in preliminary cut. Natoma Clay Co., at Natoma, Sacramento County.

PHOTO NO. 56. Panama Pottery Company's plant, near Twenty-first Street road, just south of Sacramento. (From State Mineralogist's Report XXI, p. 8, 1925.)

This company owns no clay deposits at present, but buys red-burning clay locally and white clay from Lincoln and Ione. The products of the plant are houshold stoneware, including jars, water coolers and filters, jugs, mixing bowls, pitchers, etc. Fancy garden pottery and common and fancy flower pots are also produced. The company has patented a new one-piece mold for embossed flower pots and are exclusive makers of this line which is made from cream-burning clays. See photo No. 57.

Clay for the various products is crushed in a dry pan and elevated to a 30-mesh shaking screen. It is then tempered and run through the pug mills, aged and run through the pug mill again. After molding, it stands for a short time on shelves and is taken thence to the dryer. White ware is burned 48 to 52 hours at a temperature of 2200 degrees Fahrenheit, and red ware 37 to 42 hours at a temperature of 1800 degrees Fahrenheit.

Equipment at the plant includes two pug mills, a dry pan, glaze grinder, one flower-pot machine, three jolly wheels, shaking screen, and two down-draft kilns with a total capacity of 16,000 gallons of stoneware. Crude oil is used for firing the kilns, and electricity for power.

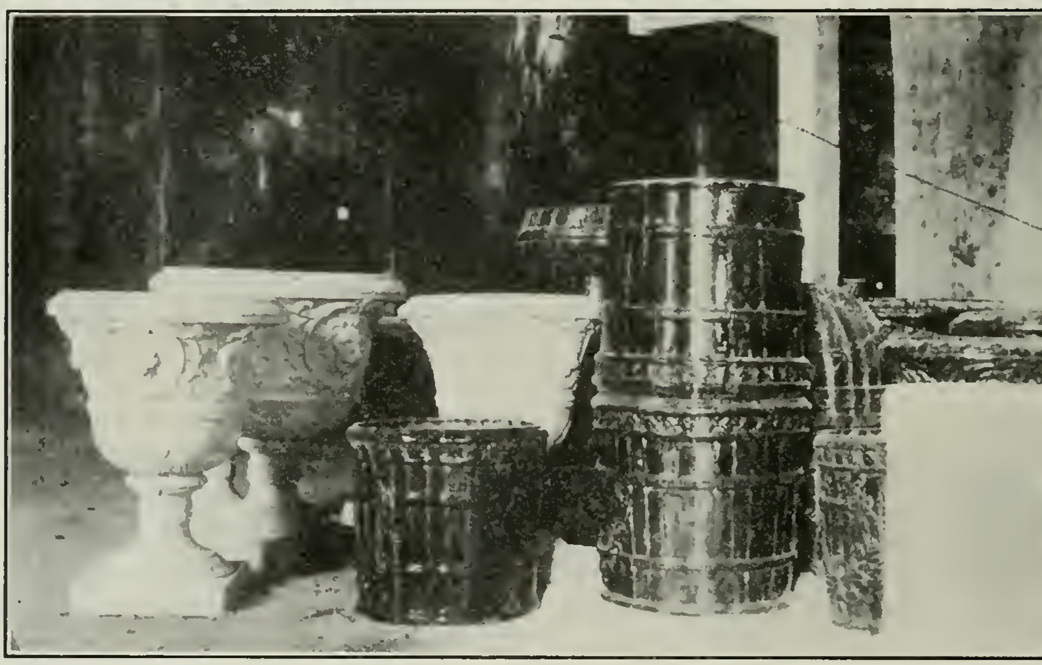

Photo No. 57. Fancy garden pottery, manufactured by Panama Pottery Company, Sacramento. (From State Mineralogist's Report XXI, p. 8, 1925.)

Sixteen men are employed. About ten days are required for a complete run, from setting to the time of drawing. The market for the goods is mostly in central California and deliveries are nearly all by automobile truck.

Bibl: State Mineralogist's Report XXI, p. 7.

Sacramento Brick Company (formerly *Riverside Brick Yard*). This is a stock company, subsidiary to Sacramento Navigation Company. W. P. Dwyer, president; A. J. Foster, general manager; H. K. Johnson, secretary. Main office, Front and N streets, Sacramento. The brick plant is three miles south of the Sacramento city limits, near Sacramento River.

The company makes common brick exclusively. The deposit is clay, sand, and loam, with no hardpan, and is worked about 16 feet deep by a steam shovel and drag-line scraper. Clay is loaded into four-ton side dump cars and hauled in trains by dinkey locomotives to the plant, where it is dumped into rolls, elevated to the pug mill and tempered. It passes thence to a soft-mud brick machine where bricks are pressed and dusted with ground red grog from an outside grog grinder and storage bin. From the brick machine the bricks pass by wire cableway to steam-rack dryers, where they are dried in about 18 hours. They are then burned in open-draft field kilns for seven days at a temperature of 1700° to 1750° Fahrenheit. The kilns contain from 400,000 to 500,000 bricks each. The shrinkage in burning is about 6%. The plant has a daily capacity of 60,000 bricks and employs a crew of sixty men. Crude oil is used for burning bricks, for the steam shovel and locomotives, and electric power is used for operating machinery. The direct operation of the brick machine requires only three or four men. The company has another plant between the present site of operation and the river, but this has been abandoned. It was formerly operated at a daily capacity of 125,000 bricks during the dry season only, but the present operations are carried on steadily.

Bibl: State Mineralogist's Reports XV, p. 403; XXI, p. 9.

Valley Brick Company. Main office, 809 J Street, Sacramento. Plant two miles southeast of Sacramento city limits, near S. P. and Central California Traction Company lines to Stockton. H. J. McClatchy, president; A. M. Weston, secretary; H. F. Goss, plant superintendent.

The property includes 40 acres of clay land and equipment for making common red brick. The deposit has an average depth of 20 to 22 feet, of which the upper 12 feet is yellowish-brown clay and the balance sandy clay. Near the surface, and covered by only a thin layer of loam, occurs about two feet of 'hardpan,' which is tight and difficult to dig. Clay is dug with an Erie shovel and loaded on cars which are hoisted up an incline to the grinding floor. After grinding the clay is stored in a bin. Rolls, previously used for grinding, are being replaced now by two 9-ft. dry pans. The stiff-mud process is used, employing a Freise auger machine, and wire cutter. Green brick are dried six to eight days.

Field kilns of up-draft type, containing about 180,000 brick each and using for fuel crude oil which has been atomized by air under 80 pounds pressure, have been in use heretofore. Brick was water smoked for three days and burned three days thereafter, reaching a maximum temperature of 1750° during the latter half of the burning. Eight Furman kilns, with a capacity of 600,000 brick each, will be built soon, and the other changes will increase the brick-making capacity from 42,000 to 63,000 daily. The season for digging clay and making brick extends from April to November. A new steam plant of 300-h.p. capacity is being built, and steam will be substituted for air to atomize the fuel oil. During the busy season 30 men are employed.

Bibl (Clay resources of Sacramento County): State Min. Bur. Bull. 38, pp. 225–226 and 253; Prel. Rept. 7, p. 91; Rept. XXI, pp. 2–10.

SAN BENITO COUNTY.

(By C. McK. Laizure and W. F. Dietrich.)[1]

General Features.

San Benito is one of the central counties situated between Monterey, a coast county, which adjoins it on the south and west, and Merced and Fresno, two of the great San Joaquin Valley counties, which bound it on the northeast. Santa Clara County and a corner of Santa Cruz adjoin it on the north.

The county extends southeasterly from Pajaro River for 70 miles with an average width of 20 miles. Its area is 1392 square miles and the population, most of whom reside in or near the few towns along the railroad in the northern part, is 8995 (1920 census).

About one-fourth of the county is government land. Most of the remainder was long held in the form of large land grants and immense ranchos. As may be expected, cattle-raising early became an important industry and it still is of prime importance. In later years some of these ranchos have evolved into fruit orchards and small farms, due to irrigation and intensive cultivation of the valley lands. As a result, fruits and vegetables, dairy and poultry products, as well as hay, grain, and live stock, have become important sources of wealth. Mining has been carried on since 1858, the total recorded mineral production to date approximating $30,000,000.

Transportation facilities are limited. There is a branch of the Southern Pacific railroad from Gilroy, via Hollister, the county seat, to Tres Pinos. The main coast line of the Southern Pacific also touches the county at Logan, after passing through Pajaro Gap. The 'California Central,' a line 8 miles in length, connects the Old Mission Portland Cement Company's plant with the Southern Pacific at Chittenden. Other parts of the county are served by auto stages from Hollister and Tres Pinos. The southern section can be reached equally as well through Coalinga or Mendota on the San Joaquin Valley side or from King City and San Lucas on the west. Excellent highways join Hollister with Merced on the valley highway route and with San Juan Bautista on the coast route of the highway system. The road to the interior is by way of Pacheco Pass.

The famous Santa Clara Valley penetrates the northern end of the county as far as Hollister. From this point the narrow valley of San Benito River continues southeasterly to the southern boundary. This river and its chief tributary, Tres Pinos Creek, with many smaller streams flowing in from east and west practically drain the entire area. Numerous smaller mountain valleys are found along the flanks of the two ranges of the Coast system, which roughly parallel one another and dominate the topography.

Geology.

There is considerable literature on the geology of portions of San Benito County, but most of the detailed geologic studies have been

[1] Mr. Laizure studied the mineral resources of this county in 1926. See State Mineralogist's Report XXII, pp. 217–247. His general description of the county and his notes on the clay resources were revised for the purposes of the present report by Mr. Dietrich, who visited the county in August, 1925, and made an unsuccessful attempt to find some of the deposits of high-grade clay that had been previously reported. Mr. Dietrich also added notes on the deposit at Paicines.

confined to those sections considered to be possible oil-bearing territory or to the quicksilver mining districts, and no single geologic report fully covers the county.

The general geology as shown on the geologic map of California published by the State Mining Bureau in 1916 is briefly outlined in the following paragraphs.

The Gavilan Range on the western side is composed of ancient granitic rocks associated with crystalline schists and limestones. Dolomite and more rarely barite deposits occur with the limestone and have been developed from San Juan Bautista southerly to Cienaga Valley. Farther south in a small area surrounding the Pinnacles National Monument, which in itself is an example of intense vulcanism, fine-grained volcanic rocks occur. In the southwestern portion of the county, from Topo Valley south and east to San Benito River, the formations exposed are sedimentary rocks of Tertiary age, which include numerous gypsum beds, some bituminous sandstones and diatomaceous earth.

On the northeastern side of the river the Diablo Range rises abruptly, and from near Hernandez south and east beyond San Carlos Peak it is made up of Franciscan rocks, chiefly serpentine but with much red chert, sandstone, slate and schist near the river. From Idria northwesterly nearly to Llanada, Cretaceous and Tertiary rocks make up the main range. From Llanada northward to the northern end of the county the Diablo Range is typical of the Coast Mountains, consisting of serpentine, chert, metamorphic sandstone, slate and schist. Quaternary and late Tertiary sediments comprise the valley area surrounding Hollister, and sandstone, shales, sands, gravels and clays are much in evidence along San Benito River as far south as Hernandez.

San Andreas fault, a dominant structural feature of the geology, enters the county near Chittenden and runs southeasterly along San Benito River as far as the town of San Benito. From here it crosses a low divide into Rabbit Valley, and from there it follows Bitterwater Creek to its junction with Lewis Creek and then continues southward up Lewis Creek.

An extensive and diversified number of mineral substances are found in San Benito County. Both metallic and nonmetallic minerals are included in its resources, but commercial production has been limited and many deposits have remained entirely undeveloped on account of their distance from railroad transportation. Neglect of mining opportunities may also be due in part to the fact that many deposits are on private lands, whose owners are interested in other lines of activity.

Quicksilver production has given San Benito its reputation in the mining world, as it ranks among the oldest and most important quicksilver producing counties. The New Idria mine, in the southern part, is the largest single producer of quicksilver in the state. Since 1918, however, the value of the county's annual output of quicksilver has been exceeded by that of cement. Crushed rock production closely follows quicksilver in annual value of output. Other mineral products which have been produced in greater or lesser amounts are: antimony, asbestos, asphalt, bituminous rock, brick, chromite, coal, dolomite, gems, gypsum, lime and limestone, magnesite, manganese, and mineral water.

Barite, clay, copper, diatomaceous earth, feldspar, gold, iron, montmorillonite, petroleum, strontium, and volcanic ash also occur here, but the commercial value of these deposits is not as yet established A number of other mineral species are represented in the county, but their occurrence is of mineralogical interest only.

Clay Resources.

There have been a number of reported occurrences of high-grade clay in the county, but none of these have been of sufficient economic interest, in view of the comparative isolation of the county from industrial centers, and the lack of cheap transportation from the reported occurrences, to warrant serious investigation.

The larger valleys of San Benito River and its tributaries contain ample supplies of common clay suitable for the manufacture of heavy structural ware. The Paicines deposit, described herein, is typical of these. There has been no commercial output of clays, as such, in the county, and the only clay material being utilized at the present time (1926) is that mined by the Old Mission Portland Cement Company for the manufacture of cement at their plant at San Juan Bautista.

Abbe Ranch. There is a deposit of clay containing considerable sandy material on the C. H. Abbe Ranch, 12 miles south of Paicines on the Idria road. This clay fuses at a rather low temperature, but does not crack or swell. It appears to be an impure montmorillonite. The bed stands practically vertical and cuts across a ridge from top to bottom.

A white kaolinized rock that slowly breaks down in water, forming a slightly plastic clay with a comparatively low fusing point, is exposed in a cut along the San Benito road about 18 miles south of Tres Pinos. This variety of clay could probably be utilized in the ceramic industries. It is undeveloped.

The Alpine Quicksilver Mining Company in 1915 burned about 260,-000 brick in field kilns on lower Clear Creek near Hernandez for use in building their reduction furnace. The clay was dug locally. Some of these brick still remain along the road and appear to be of good quality.

W. T. Maeder, 554 Sixty-sixth Street, Oakland, California, has submitted a sample of siliceous clay, possibly a fireclay, from the Bitterwater section. Undeveloped.

M. A. Martin, formerly of Hollister, located some clay which burns white, or nearly white, near the head of Willow Creek in T. 15 S., R. 6 E.

Dr. J. M. O'Donnell of Hollister owns a deposit along Bird Creek, three miles south of Hollister. The bed is exposed for a considerable depth in several of the gulches, and a well was sunk 80 feet without reaching the underlying rock. The clay is light grey in color, very plastic and without grit. It burns to a cherry red and is said to be suitable for pottery use.

Paicines Clay Deposit. In Sec. 36, T. 12 S., R. 6 E., M. D. M., 0.3 mile south of Paicines on the San Benito road is an exposure of yellow plastic clay of probable Pliocene age. A road cut at this point exposes a bank 6 feet high, but the deposit is probably at least 20 feet thick, and covers an area of many acres, with little or no overburden. Similar deposits occur in various other localities in the San Benito Valley.

See sample No. 118, page 341.

H. V. Underwood of Hollister has submitted samples of plastic clay of fairly-high alumina content found at several points in the county.

Bibl (On San Benito County clay resources): State Min. Bur. Bull. 38, p. 226; Prel. Rept. 7, p. 91; Rept. XXII, pp. 228–229.

SAN BERNARDINO COUNTY.

General Features.

San Bernardino, with an area of 20,157 square miles, is by far the largest county in the state. It is bounded on the north by Inyo County, on the east by the states of Nevada and Arizona, on the south by Riverside County, and on the west by Los Angeles and Kern counties. The population is 73,401 (1920 census).

The topography of the county consists largely of mountains and desert, and is characteristic of the Great Basin, which has been described by many geologists. The famous Mojave Desert is almost wholly confined within the limits of the county, but extends southward into Riverside County. Most points in the county can be reached with comparative ease by railroad or highway.

The geology of the entire county has never been studied in detail, but many interesting reports have been made by various members of the U. S. Geological Survey, and others, on different areas in the county. A large part of the county is covered by Tertiary and Quaternary volcanics, and Quaternary gravels, but many other formations are present, particularly in the numerous mountain ranges. Chief among these are pre-Cambrian and Paleozoic metamorphics, and various Tertiary formations, principally Miocene.

The mineral resources are varied, and the aggregate production places the county in fifth place (1926) among the counties of the state in the value of its mineral products. Cement is the most important product, and there are three plants in the county. Other mineral products are borates, calcium chloride, clay, copper, fuller's earth, gold, lead, lime, limestone, mineral water, petroleum, potash, salt, silver, soda, miscellaneous stone, talc, and tungsten concentrates. Occurrences of asbestos, barytes, gems, granite, gypsum, iron, manganese, marble, mineral paint, nitre, soapstone, strontium, vanadium, and zinc are known.

Clay Resources.

Deposits of high-grade clay occur at a number of localities in the county. Two or three of these have been developed. The most interesting deposits are those in the Hart Mountains, described below under H. F. Coors and Standard Sanitary Manufacturing Company. A plastic kaolin of exceptional quality has been developed on these properties. It is likely that more intensive prospecting will disclose hitherto unknown deposits of a similar type.

Common clays are sufficiently abundant in the vicinity of San Bernardino to serve all purposes, and the apparent lack of suitable deposits elsewhere in the county is of no importance, because of the fact that these areas can never be expected to support a large population.

Two ceramic materials of special interest occur in San Bernardino County, convenient to railroad transportation. These are ganister and talc schist. A large ganister deposit is being worked by the Atlas Fire Brick Company of Los Angeles in Sec. 31, T. 9 N., R. 3 W., four miles from Hicks Station on the Santa Fe railroad, between Victorville and Barstow. It is the equivalent of Pennsylvania ganister in the manufacture of silica brick. The talc schist occurs in Sec. 29, T. 19 N., R. 4 E., 13 miles northeast of Newberry Station on the Santa Fe railroad. It is being mined by John J. Kennedy of Daggett, and is in use as an ingredient of white tile bodies in a few Los Angeles plants.

H. F. Coors Deposit. Owned by H. F. Coors, Inglewood. The property consists of 7½ unpatented mineral claims in the old mining town of Hart. The claims cover parts of Secs. 13 and 24, T. 14 N., R. 17 E.,

PHOTO No. 58. H. F. Coors Kaolin Deposit, Hart, San Bernardino County. (Sample No. 57.)

S. B. M. The clay is a white-burning ball clay, possessing the properties of a mixture of china clay and ball clay. It occurs as an alteration of an eruptive rock relatively high in alumina and low in alkalis and iron.

At the time of visit, in June, 1925, the property was idle, but enough development work had been done in two different places, one of which is shown in photo No. 58, to demonstrate the presence of an extensive deposit of uniform material. The trench shown in the photo was 150 feet long, 8 feet deep, and 15 feet wide. Ten to fifteen feet vertically below the bottom of the trench, a 100-ft tunnel had been driven. At another point on the property, about 200 yards to the southeast, a 65-ft. tunnel, originally driven in the search for gold, had been enlarged at the face into a room 20 by 12 feet in section, by 8 feet high, exposing similar material to that present in the cut.

Since 1926 Mr. Coors has been mining from the deposit to secure clay for his plant in Inglewood (see under Los Angeles County).

Sample No. 57 was taken for testing, the results of which are on page 264.

Gladding, McBean and Company. Office of Southern Division at 621 S. Hope Street, Los Angeles. This company owns a deposit of buff-burning clay, 4.2 miles by road northeast of Bryman, a station on the Santa Fe railroad between Victorville and Barstow. The clay is mined from an open cut, which at the time of visit, in June, 1925, was 40 feet wide and 100 feet long. The bank was 40 feet high at the face of the pit. From 100 to 150 tons per year were being mined and shipped to Los Angeles for use in the manufacture of face brick.

Sample No. 55 was taken for testing. The results are on page 314.

R. H. Holliman and D. Murphy have located 12 mineral claims covering extensive outcrops of clay beds in Sec. 14, T. 12 N., R. 14 E., S. B. M., on the western slope of the Mid Hills, which connect the Providence Mountains on the southwest with the New York Mountains to the northeast. By the existing road, the deposit is 13 miles southeast of Cima, but a road with easy down-grade could be built from the deposit to the Los Angeles and Salt Lake Railroad line south of Cima. This road would be from six to seven miles in length.

On the area covered by the claims there are three distinct beds of white semi-plastic clay, each of which is from six to fifteen feet thick and can be traced intermittently for some 2000 feet on the strike.

The clay shows the general characteristics of an impure kaolin, and is evidently derived from a highly feldspathic granite that is abundant in this locality. The quality of the clay as exposed on the surface and in the shallow workings is widely variable and it is likely that considerable development work will be needed in order to prove the existence of sufficiently large bodies of material of uniform quality to warrant commercial production.

Development: The development work consists, in part, of a shaft ten feet deep from the bottom of which ten feet of drifting has been done. The clay bed at this point is steeply tilted and the attempt was made to cut it by a 120-foot tunnel 25 feet below the outcrop, but so far as the work had progressed at the time of visit on June 18, 1925, the material encountered in the tunnel was inferior in quality to that exposed nearer to the surface.

The other two clay beds lie higher up on the mountain, and no development has been done. The upper beds lie nearly horizontal.

The geology is somewhat complex in this area. There are a number of rhyolitic flows, as well as a few remnants of sedimentary formations, principally sandstone and limestone.

Sample No. 46 was taken for testing. The results are on page 349.

Millet Clay Deposit. An extensive, but undeveloped deposit of clay occurs near the southern boundary of the west half of Sec. 31, T. 9 N., R. 3 W., S. B. M., owned by M. J. Millet and J. J. Kennedy of Daggett. The clay is exposed on the surface one-third of a mile south of a ganister deposit that is owned by the Atlas Fire Brick Company of Los Angeles. Several shallow pits and short tunnels have been excavated, giving indications of a clay bed 10 to 20 feet thick and extending discontinuously for a distance of nearly one-half mile, with an east-west strike.

It is impossible to estimate from the present state of development the probable tonnage and uniformity of the occurrence. Sample No. 53 was taken for test, and the results given on page 288 are sufficiently encouraging to warrant further investigation. The sample was taken from a shallow exposure made in a small cut, and it is not unlikely

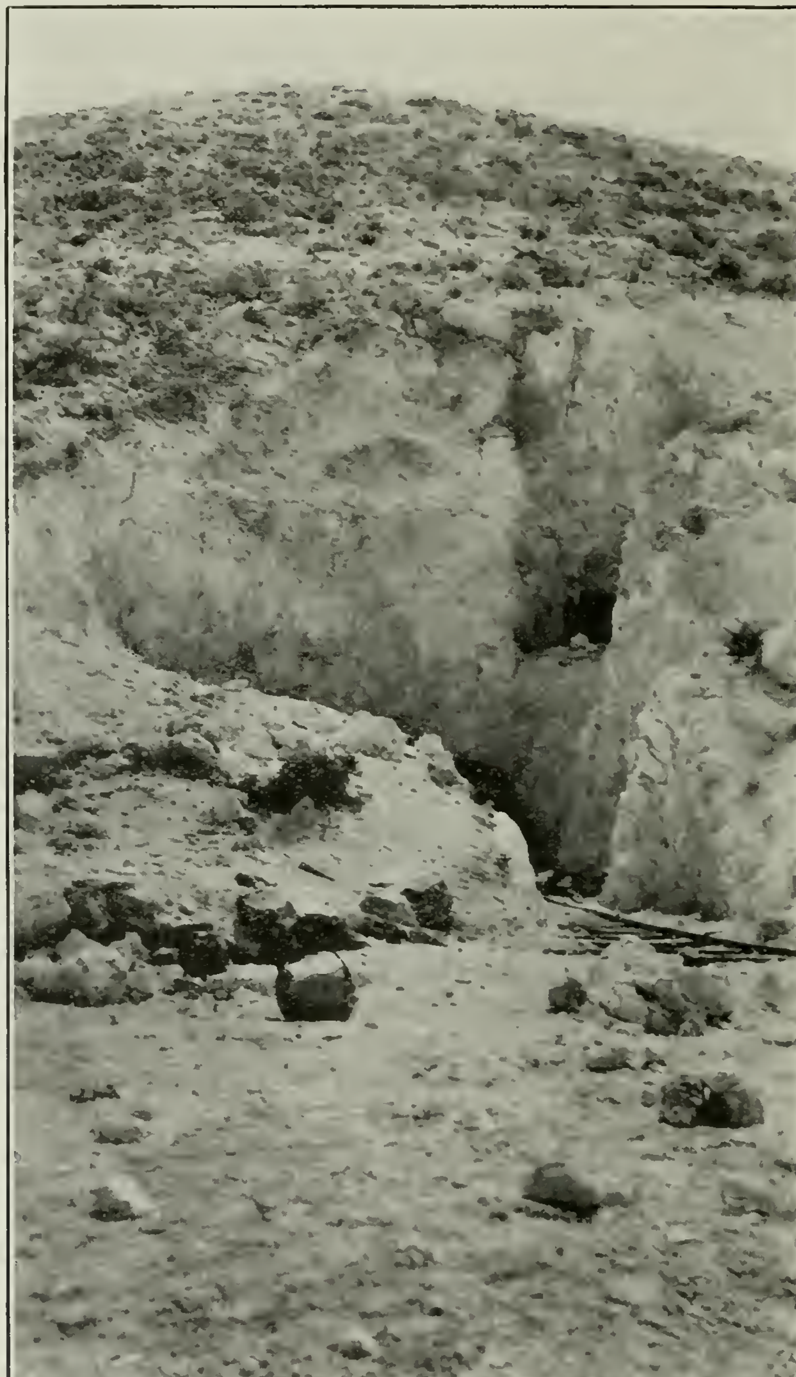

PHOTO No. 59. Pacific Kaolin Mine. Standard Sanitary Co. Upper workings. (Sample No. 45.)

that it shows more contamination with surface debris than would be found at points further beneath the present surface.

Standard Sanitary Company. One-half mile south of the old gold-mining town of Hart, the Standard Sanitary Company owns a deposit of white-burning ball clay that is being exploited by underground methods.

The clay is the result of alteration of a feldspathic igneous rock, the original nature of which was not determined. The enclosing and overlying rocks are rhyolite. The total extent of the deposit is unknown, but the height is from 60 to 70 feet, the width at least 50 feet, and the length over 200 feet, as exposed on the surface and in the workings. The dimensions given probably represent but a small proportion of the total material available.

Development and Mining: The development work consists of two sets of workings. The upper workings, now abandoned, lie up the slope of the hill some 30 feet vertically above the present tunnel level. The upper workings consist of an open cut extending into several underground chambers from which clay has been mined. See photo No. 59.

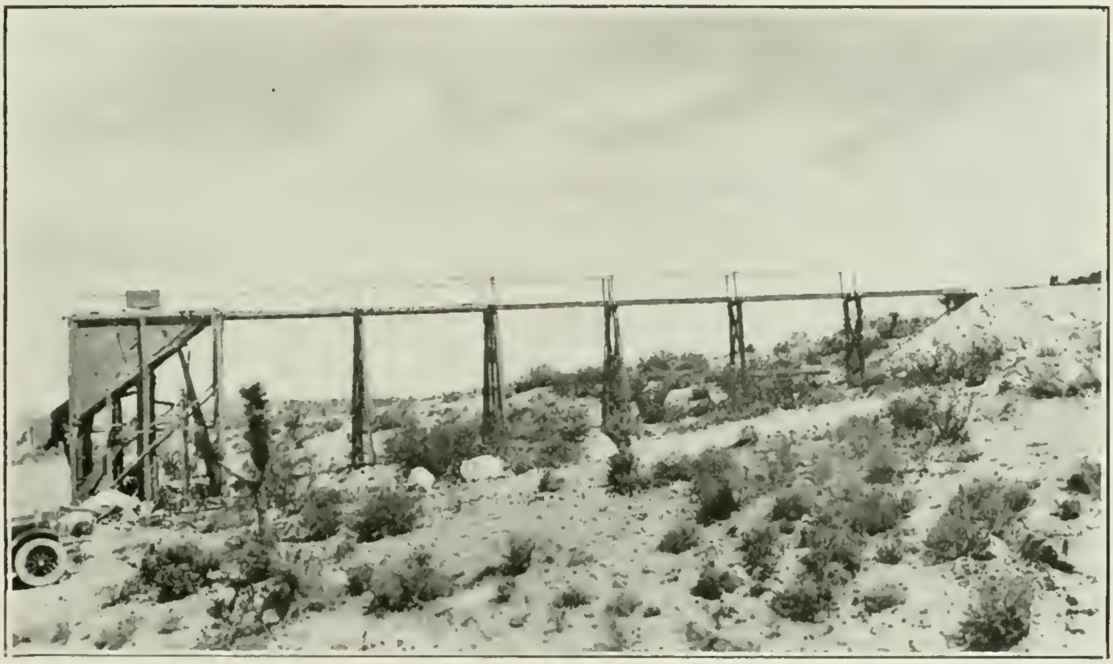

Photo No. 60. Pacific Kaolin Mine. Standard Sanitary Co. Trestle and bin on lower tunnel level. (Sample No. 44 taken from face of stope.)

The lower tunnel was driven in order to provide better facilities for breaking and loading the clay, and to permit more systematic mining. At the time of visit on June 17, 1925, this tunnel had been driven 150 feet in length and shortly after entering the hill, it had been gradually enlarged to a chamber which at the face was 30 x 30 feet in section.

The clay requires light blasting but is sufficiently soft so that hand augers can be used for most of the drilling, with the aid of hand-hammer drilling in the harder portions. The broken material is hand-loaded into mine cars and hand-trammed to the loading bins outside of the portal of the tunnel. See photo No. 60. A motor truck is used for hauling to Ivanpah, a distance of 15 miles over a rough road, but one that has a uniform down-grade in favor of the load.

At the time of visit, four men were working, including the foreman and the truck driver. The production varies from 15 to 20 tons per day.

This property is worked for three or four months of the year. During the idle period the same crew is employed at the company's feldspar property near Campo, San Diego County.

Samples No. 44 and 45 were taken for testing. The results are given on page 264.

Bibl (Clay resources of San Bernardino County): Cal. State Min. Bur. Bull. 38, pp. 226–227, 253–254; Prel. Rept. 7, pp. 92–93; Rept. XV, pp. 860–862. The most important references on the geology of the county are: Darton, N. H., et al., Guide Book of the Western U. S., Part C, U. S. G. S. Bull. 613; Ball, Sidney H., Geologic Reconnaissance of Southwestern Nevada and Eastern California, U. S. G. S. Bull. 308.

SAN DIEGO COUNTY.

General Features.[1]

San Diego was discovered in September, 1542, by Juan Rodriguez Cabrillo. This discovery of the San Diego region by Cabrillo was followed by the establishment of the first Franciscan Mission in California on June 16, 1769, by Padre Junipero Serra. The location of this mission at San Diego led to the early settlement of the Pacific coast and is of special prominence in the early history of California.

The principal industries are agriculture, stock raising, dairying, and commercial fisheries. The mining industry is relatively undeveloped, although the mineral resources of the county are varied and extensive. The rapid and continued growth of the city of San Diego and the manufacturing industries on the Pacific coast have led to the development of deposits of structural and industrial materials throughout the county.

San Diego is bounded on the east by Imperial County, north by Riverside and Orange counties, west by the Pacific Ocean, and south by Mexico. Its area is 4221 square miles and its population 112,248 (census of 1920).

The county and the city of San Diego are served by two railroads, the Santa Fe and the San Diego and Arizona. The Santa Fe railroad enters the county at San Onofre and follows the coast line to San Diego, connecting the lattter with the city of Los Angeles. From the main trunk line there is a branch line from Los Angeles Junction, known as the Fallbrook branch, that runs as far as Fallbrook; another branch line runs from Oceanside to Escondido, giving railroad transportation to an important citrus belt. The San Diego and Arizona railroad runs along the border of Mexico and the county, connecting San Diego with Imperial Valley at El Centro. The Cuyamaca branch of this line runs from San Diego to Lakeside, affording transportation for El Cajon Valley and other interior points. From the port of San Diego regular steamer lines ply between San Diego, Los Angeles, San Francisco, Seattle.

San Diego has a wonderful system of highways and good roads which give access to all parts of the county. Two main paved highways from Los Angeles to San Diego parallel the coast. The coast route follows the coast line, and the inland route is via Riverside, Fallbrook and

[1] This and the subsequent paragraphs on geology are abstracted from a recent report by W. Burling Tucker, State Mineralogist's Rept. XXI, pp. 325–327, 1925.

Escondido to San Diego. Two paved highways connect Imperial Valley with San Diego. Five scenic highways, stretching out from San Diego like ribs of a huge fan with its northern tip at Oceanside and its southern tip at Campo, within one mile of the Mexican border, afford easy access by automobile to all parts of the San Diego Mountains. Each one of these intersects the road, forming the outer rim of the fan, which traverses practically the entire Incopah Range from northeast to southwest, a distance of more than 170 miles. The total mileage of all the fan-shaped routes is nearly 600 miles.

The topographic features of the county consist of a series of parallel ranges of granite, with a southeast trend, including the southeastern continuation of the San Jacinto Range of Riverside County. Among these granite ranges are valleys occupied by parallel belts of metamorphic rock, chiefly slate and mica schist, with some quartzite and lentils of limestone. These have a general northwest strike, with steep dips to the east, and extend from Mexico into Riverside and Orange counties. The Cuyamaca and Laguna Mountain ranges extend northwest and southeast, and are over 5000 feet high at many points. Cuyamaca Peak has an elevation of 6515 feet, and Laguna Mountain an elevation of 6500 feet. These are intrusions of diorite and gabbro which occur at intervals in the granite area. Southwesterly from this elevated belt the altitudes decline toward the coast. West of the granite area is a belt of volcanic felsite and tuff that extends northwest some 40 miles from the Mexican line. The belt is only a few miles wide, for the most part being buried beneath mesa formations. It is exposed at many points, forming the peaks of Otay, San Miguel, and Black Mountains. The mesas of Tertiary deposits which occur on the west flank of the crystalline formations gently slope seaward, from an altitude of about 500 feet at its eastern margin to an elevation of about 300 feet near the coast line. From the main divide the surface slopes steeply eastward toward the Salton Basin.

The principal valleys of the county are those occupied by the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay, and Tia Juana rivers. They are characterized by wide, flat, gently-sloping floors, bordered by steep slopes or bluffs several hundred feet high, and they contain streams that rise far back in the mountain area. All these streams flow to the ocean. El Cajon Valley, Santa Maria Valley, and Warner Valley are comparatively flat tracts, some of them surrounded by steep mountain walls, and cover many square miles, within the highland area, and form the broad valleys.

Geology.

The geology of San Diego County has been described in detail by W. A. Goodyear in the Eighth Annual Report of the State Mineralogist, pp. 516–628, for the year 1888; by Harold W. Fairbanks in the Eleventh Report, pp. 76–120, for the year 1892; by Dr. F. J. H. Merrill in the Fourteenth Report of the State Mineralogist, pp. 637–645, for the years 1913 and 1914; in Water Supply Paper No. 446, U. S. Geological Survey, 'Geology and Ground Waters of the Western Part of San Diego County.'

The formations of San Diego County are granites and other igneous crystalline rocks, of several ages, metamorphic strata of great age, possibly Carboniferous or older, and sandstone, shales, conglomerates, sands, gravel, and clays of Mesozoic and Tertiary age.

The granites upon which the metamorphic rocks rest, and by which they are intruded, are of several types. These granites are in turn intruded here and there by basic rocks of the diorite and gabbro types. The latter are cut at many points by pegmatite dikes, which also appear as intrusives in the schists and in the granites. Two areas of these basic intrusives form substantial mountain ranges, one traversing the Cuyamaca Grant from north to south, and forming three peaks, of which the southermost, 6515 feet high, is known as Mount Cuyamaca. Ten miles southeast is a diorite ridge, known as Laguna Mountain, of which the summit attains an altitude of over 6500 feet.

On the southwest flank of the granite area is a volcanic flow, a few miles wide, extending northwest some 40 miles from the Mexican boundary. This area is largely overlain by Tertiary formations. The principal rocks exposed are felsite, tuffs, and volcanic conglomerates. The metamorphic formations are mica schists, slates, quartzites, and limestone; the mica schists are well exposed at Julian and on the west flank of the Laguna range of mountains. The Cretaceous strata exposed in this region are of the Chico series and appear in the bluffs on Point Loma and at La Jolla, as described by Harold W. Fairbanks in the Eleventh Report of the State Mineralogist, p. 95.

The earlier Tertiary or Eocene deposits appear at the surface from Los Peñasquitos Canyon northward to Buena Vista Creek; the later Tertiary deposits are exposed from Los Peñasquitos Canyon southward to the Mexican boundary, and from Buena Vista Creek northward to the north boundary of the county. The earlier Tertiary or Eocene beds are made up of white sandstone, underlain by alternating layers of shale, sandstone, and thin layers of clay and shale, limestone and sandstone, and marl and calcareous material.

The principal mineral products of San Diego County are miscellaneous stone, feldspar, brick and hollow building tile, granite, and pottery clay. Other minerals that have been produced in recent years are mineral water, gems, gold, silver, fuller's earth (Otaylite), lime, magnesium chloride, salt, and silica. Occurrences of bismuth, lithia, marble, nickel, soapstone, and tin are known. Potash has been produced from kelp.

Clay Resources.

Important commercial deposits of fireclay and pottery clay, mainly of Eocene and Pleistocene age, occur in northern San Diego County, in the vicinity of Carlsbad and Cardiff. Some of the fireclays are similar to the famous Gros-Almerode clays of Germany. On the top of El Cajon Mountain, in the southern part of the county, is an interesting deposit of residual kaolin, which was worked for a short time, but has little commercial value on account of its inaccessibility. It serves as a valuable guide to further prospecting in the region.

Red-burning shales suitable for the manufacture of common brick, paving brick, and hollow tile are reasonably abundant in the vicinity of San Diego, but softer clays that can be used without grinding are not plentiful in locations close to the center of consumption (principally the city of San Diego). Deposits of Miocene Tertiary clays on the eastern margin of the county were noted in an earlier report.[1] These are as yet commercially inaccessible, and but little is known of their properties.

The feldspar and quartz deposits of San Diego County are of particular interest to the clay-working industry. The greater part of the feldspar used in California is produced at Campo.

California Clay Products Company and *Mission China Company.* Victor Kremer, president. Offices, 315 Western Mutual Life Building, Los Angeles. These companies own a fireclay property in Sec. 4, T. 13 S., R. 3 W., S. B. M., 8 miles by road in a northeasterly direction from Cardiff, and two miles northeast of the property of Gladding, McBean and Company (*q. v.*).

The holdings of the California Clay Products Company consist of the Pearl and the Dorothy Ann placer claims, comprising 20 acres each; and the Mission China Company owns two adjoining claims known as the Robert Charles and the Thomas Hewitt, also 20 acres each. All these claims are patented.

The clay is a white, semi-plastic fireclay. It does not develop sufficient plasticity to be used alone, and is of value principally for its refractoriness. It is used in Los Angeles by the California Clay Products Company, as an ingredient in the manufacture of saggers, and also in San Diego by the Vitrified Products Corporation. These companies are controlled by the Victor Kremer Enterprises, Victor Kremer, president.

DEVELOPMENT AND MINING: A number of test pits and trenches have been dug, exposing clay over a considerable area. Mining is being done on the Pearl claim, where a loading bin has been built and a small open cut, 30 by 40 feet in area, has been excavated. The exposed bank of clay is 10 to 12 feet high. One carload per week is being mined and trucked to Cardiff.

Sample No. 36 was taken for testing. See page 311.

Bibl: State Mineralogist's Report XXI, p. 355.

El Cajon Kaolin Deposit. The deposit is located on Cajon Mountain, at an elevation of 2500 to 2700 feet, 4½ miles in a direction N. 55° E. from Lakeside. It is now owned by the *American Pottery Company* (?) of Los Angeles. The holdings comprise two claims in T. 14 S., R. 2 E., S. B. M., on or near Sec. 29, approximately one mile west of El Cajon Peak, but practically on top of the range.

The kaolin was formed by alteration in situ of an alaskite or similar pegmatitic derivative, containing but small quantities of ferro-manganesian minerals. The extent of alteration varies widely within comparatively short distances, so that the resultant material ranges from slightly-plastic kaolin containing an excess of free quartz and undecomposed feldspar, to extremely plastic, fine-grained, thoroughly-hydrated kaolin. Exposures of such material have been made at various points on the mountain, indicating that they occur in a zone that has a general northeast strike.

The deposit has been developed by a number of tunnels, shafts, and open cuts, the principal tunnel having been driven in a northwesterly

[1] State Mineralogist's Report XIV, p. 685.

direction for a distance of 75 feet, to a point 50 feet below the surface. This tunnel is connected by means of a raise to a small open pit, or glory hole. The material exposed by these workings shows all of the variations indicated above, with six feet of thoroughly altered, plastic kaolin near the face. During 1914 and 1916, some kaolin from these workings was shipped to the faience tile plant of the former California China Clay Products Company at National City. The total quantity shipped probably did not exceed 400 tons, to judge from the extent of the workings. The material was packed by mules over a rough and steep trail to a point on the San Diego River, then hauled by wagon to Lakeside, at a cost said to have been $7.50 per ton, exclusive of mining. Due to its inaccessibility, there has been no work on the deposit since 1916, excepting annual assessment work.

Two samples, Nos. 37 and 38, were taken and tested, the results of which are given on page 259.

Bibl: State Mineralogist's Report XXI, p. 354.

Gladding, McBean and Company. Office of Southern Division at 621 S. Hope Street, Los Angeles. This company owns a deposit of clay, of Eocene and Pleistocene age, on the Las Encinitas Ranch in the townsite of Olivenhain. The property includes a portion of Lot 18, and adjoins the property of the Vitrified Products Corporation (*q. v. post*) on the west.

At the time of visit, on June 9, 1925, the clay was being mined from an open cut, the floor of which was about 75 feet square. The bank was 30 feet high at the face of the pit. Mining was by hand, loading into small mine cars, which were trammed over a trestle to a bin, from which auto trucks were loaded. Three or four cars per week were being mined during part of the year, the annual production being 5000 to 7000 tons, which was used in the company's plants in Los Angeles. The clay is a red-burning material, with good plasticity, and is useful in face brick and sewer pipe mixes. Sample No. 35 was taken. The test results are on page 322.

Since the property was visited, it is understood that considerable drilling and other development work has been done, with the result that excellent deposits of fireclay have been found, in addition to the red-burning clay already known. The fireclays are said to closely resemble the Gros-Almerode clays of Germany.

H. T. Morris of Escondido owns a deposit of clay one mile south of Richland Station on the Escondido Branch of the Santa Fe Railroad.

The clay occurs in a low hill and is covered by black adobe soil. The deposit has not been developed and good exposures of the fresh clay are lacking. The deposit is apparently at least 15 feet in thickness, and underlies several acres of land. The attempt was made some time ago to make common red brick from this clay, but it was unsuccessful largely because of improper mixing, tempering, and firing of the brick. Some specimens of earthenware made from this clay can be seen in the Chamber of Commerce exhibit at Escondido.

Sample No. 41 was taken for testing. See page 348.

Bibl: State Mineralogist's Report XXI, p. 355.

National Brick Company. William Mulford, president; Edward Harrie, Jr., secretary. Offices and plant are located at Twenty-fourth Street and National Boulevard, National City. The holdings of the company comprise 13 acres, under lease from S. Christian, of National City. The company is manufacturing common red brick from adobe clay. The clay is hauled by scrapers to a hopper, from which it passes to a set of rolls, where the clods are broken up. It is then conveyed over a belt conveyor to a pug-mill, from which it passes to a brick press.

The brick are dried in sheds. The dried brick are fired in open oil-fired kilns. The plant is driven by a 50-h.p. electric motor, and has a capacity of 36,000 brick per day. Fifteen men are employed.

Old Mission Tile Company. W. C. Mitchell, president; J. F. Keenan, secretary; P. O. McCarthy, treasurer. Office and plant in North San Diego. This company was organized in 1927 with a capitalization of $50,000, to manufacture hand-made roofing and promenade tile.[1] Further details are lacking.

Pacific Clay Products Company. Wm. Lacy, president; Robert Linton, vice president and general manager. Offices, 1151 South Broadway Street, Los Angeles. Three miles east by road from Farr Siding, which is on the Santa Fe Railroad one mile south of Carlsbad, is one of the clay properties owned and operated by the Pacific Clay Products Company of Los Angeles. The property was formerly a part of the Kelley Ranch, and comprises 25 acres.

The clay beds are exposed on a low rounded hill. The upper 10 to 15 feet consists mainly of a white plastic vitrifying clay which is used in a mix for the manufacture of face brick and other products. This clay is slightly iron-stained, and is mixed with a small quantity of bluish plastic clay.

Underlying the bed of white clay is a bed of mixed yellow and blue clay of undetermined thickness. This clay is also plastic and will doubtless be extensively utilized as development of the property advances.

Development and Mining: The clay has been prospected by means of a number of test pits on the property. Mining was formerly done with horse scrapers and plows and with a wheel scraper drawn by a tractor but more recently a "Bear Cat" shovel has been installed. See photo No. 61. A bench has been established for mining the upper bed of white clay separately from the yellow clay. The exposed bank of white clay is 275 feet long. A motor truck is used to haul the clay to Farr Siding. The production is 20,000 tons per year.

Sample No. 39 of the white clay, and sample No. 40 of the yellow clay were taken for testing. See pages 296 and 322.

Other remnants of this same clay bed occur in various places on the Kelley ranch. Some test pits have been dug, but no deposit as satisfactory in quality or extent as that owned by the Pacific Clay Products Company has been disclosed.

Bibl: State Mineralogist's Report XXI, p. 356.

San Diego Tile and Brick Company. Wm. Roffe, president and manager. Office in San Diego. This company controls 100 acres of land in Rose Canyon. The clay pit and brick yard are on the west side

[1] Clay-Worker, August, 1927, p. 123.

of the canyon, 3.2 miles by road north from Balboa Avenue, Coast highway. The material used is a Tertiary shale, which is for the most part thin-bedded, moderately hard, and generally yellowish or yellowish gray in color. The same formation persists on the west side of the canyon for several miles.

The clay is scraped into chutes alongside of the Rose Canyon Road, at a point 50 feet vertically above the yard. The clay bank at present exposed is about 75 feet high at its highest point, and 300 feet long. Practically no overburden is present. Common red brick and hollow building tile are made by the stiff mud process. Drying is done partly in the open air and partly under shed. The dried brick are fired in open oil-fired kilns. The plant is operated as required to supply the local demand.

Sample No. 30 was taken for testing. See page 339.

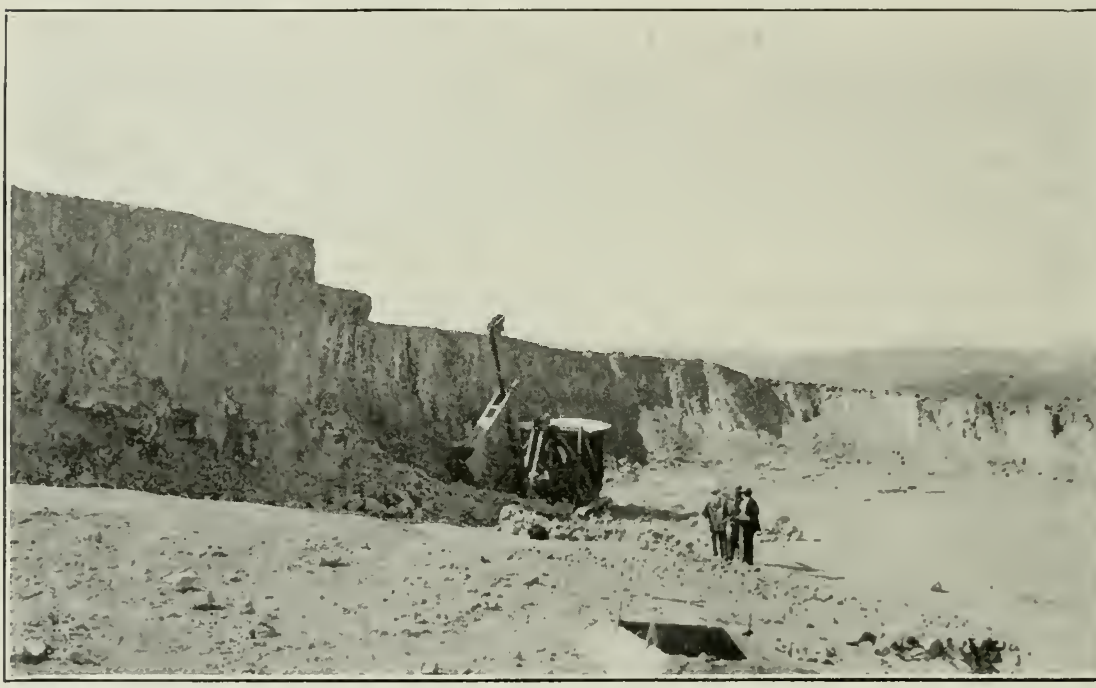

Photo No. 61. "Bear Cat" shovel at Kelly No. 1 mine, Pacific Clay Products Co., Farr siding, San Diego County. (Samples No. 39 and 40.) (Photo by courtesy of the company.)

Union Brick Company. J. W. Rice, secretary. Offices, 3565 Third Street, San Diego. The plant is 1.1 miles north of Balboa Avenue, Coast Highway, on El Camino Real through Rose Canyon. It is about two miles south of the yard of the San Diego Brick and Tile Company. The shipping point is Ladrillo Station on the Santa Fe Railroad.

The clay, while apparently belonging to the same stratigraphic series as that of the San Diego Tile & Brick Company's deposit, is somewhat different in character, and consists mainly of a loose conglomerate composed of pebbles and boulders of all sizes up to two feet in diameter, intermingled with loose yellowish clay. Underlying this material is a bed of plastic clay shale, blue-gray in color.

The clay is mined with Fordson tractors and scrapers which dump the material into a chute leading to the brick yard located in the bottom of the canyon. Common red brick only is made at this point which is equipped with dry pan and two electric-driven presses. Oil-fired open field kilns are used. It is said that the clay has very little shrinkage during the brick-making process.

Sample No. 31 was taken for testing. See page 340.

Vitrified Products Corporation. Victor Kremer, president; George Kummer, general manager; John F. Keenan, superintendent. Sales office, 522–24 Spreckels Building, San Diego; general offices and plant in North San Diego. This plant started operations in November, 1923, to make semivitreous hollow tile, building tile, and brick. The company owns two clay deposits, one at Linda Vista, the other near Cardiff.

CARDIFF DEPOSIT: This is a deposit of fireclay on the Las Encinitas Ranch in the townsite of Olivenhain. The holdings consist of a portion of lot 18 in Rancho Las Encinitas, and comprises 16.6 acres. The property formerly belonged to the Wiro family, and is known to local

PHOTO NO. 62. Wiro Mine. Fireclay deposit east of Cardiff, San Diego County, owned by the Vitrified Products Co. of San Diego. (Sample No. 34.)

inhabitants as the *Wiro Mines.* It is 5.7 miles by road from Cardiff in an easterly direction.

The fireclay has been exposed by two small open cuts, each of which is about 50 feet square, with a bank of 15 to 20 feet in height. The bed of fireclay is from 10 to 12 feet thick, and is overlain by a thin layer of soil and yellow, sandy clay. The beds are nearly horizontal. Sample No. 33 was taken from the north pit, and sample No. 34 is from the south pit, and the test results are on page 287. See photo No. 62.

Underlying the fireclay is a bed of soft, loosely consolidated sandstone containing clay as filling material. The fire clay is moderately hard and varies in color from a buff to blue-gray and light purple.

At the time of visit (June, 1925), one to two cars per week were being mined and shipped from a siding one mile south of Cardiff.

LINDA VISTA DEPOSIT: This deposit is located on the south side of the Santa Fe Railroad at Mile 251, about two miles north of Linda Vista Station, in Sec. 9, T. 15 S., R. 3 W., S. B. M.

The holdings include the $N\frac{1}{2}$ and the $NE\frac{1}{4}$ of the $SW\frac{1}{4}$ of the section, a total of 360 acres, most of which is apparently underlain by the clay beds.

At the time of visit on June 9, 1925, the deposit had been opened by an electric shovel along a face 300 feet long and 50 feet high, adjacent to and adjoining the railroad tracks. The material is a clay shale, light yellow in color, and the individual strata are from a fraction of an inch to one or two feet in thickness. Two or three beds of siliceous sandstone about one foot thick are interbedded with the clay shale. These are sorted from the clay whenever possible. In places the clay is more sandy than in others, but is seldom too sandy for satisfactory use. The overburden is thin, varying from 6 inches to 3 feet in thickness. The same formation is quite extensive in this locality and can be traced for at least a mile along the Santa Fe tracks toward Linda Vista. The total thickness of the clay beds is probably not less than 100 feet.

At the time of visit about 200 tons per week were being shipped to the San Diego plant. When the plant is operating at full capacity, 300 tons per week are shipped.

Sample No. 32 was taken for testing. See page 322.

San Diego Plant: At the plant in North San Diego hollow tile and building tile are made by mixing 25% of the Cardiff fireclay with 75% of the Linda Vista clay. The material is crushed to $\frac{1}{8}$ inch and is fed from the crusher bin into a trough mixer, where it is tempered with water. The tempered clay passes through an auger machine and the tile are cut with an automatic wire cutter. The green tile are then hand-loaded on triple-deck trucks and trammed to the drying shed.

When not working at full capacity, the drying is completed in three or four days, but when crowded to capacity only one day is allowed for this part of the process. The drying is finished in oil-fired drying ovens where the heat is controlled according to the amount of moisture remaining in the tile. At times the dryer temperature is so high as to scorch the wooden platforms of the trucks.

The common brick are fired in open field kilns, using oil as fuel. The other shapes are fired in oil-burning round down-draft kilns. The firing temperature is from 2000° to 2100° F. for $4\frac{1}{2}$ to 5 days. An equal period is allowed for cooling. The firing range of the clays in use is 200° F. The brick and tile are remarkably uniform in color, which is a pink bordering on red. There is very little difficulty with lost ware and all of the products are strong and free from cracks. The drying shrinkage amounts to 1 in $11\frac{1}{2}$, and there is no cracking during the drying of the tile which are placed on the side rather than on end. The firing shrinkage is exceptionally low.

The capacity of the plant is 50,000 brick and 50,000 hollow tile per day.

Bibl: State Mineralogist's Reports XIV, pp. 685–688; XX, p. 369; XXI, pp. 354–358. Bull. 38, pp. 227, 254.

SAN FRANCISCO COUNTY.

The area of San Francisco County is 43 square miles, and the population is 506,676 (1920 census). The only mineral production in the county is crushed rock, sand and gravel. A number of brick yards at one time operated in the county, but land is now more valuable for other purposes.

The only ceramic plants in the county are an art ware pottery at 2928 Baker Street, San Francisco, owned and operated by *Jalanivich and Olsen*, and a dental porcelain laboratory at 830 Market Street, known as *Tara's Porcelain Laboratory*. Jalanivich and Olsen are making an attractive line of glazed pottery, using a buff-burning body and lead glazes. Their output is all hand-molded on a potter's wheel. It is fired in a round kiln, approximately 3-ft. inside diameter, of their own design and built by the gas company, city gas being used for fuel. The clay, from California sources, is fired up to 2000° and the glaze to 1600°–1700°.

SAN JOAQUIN COUNTY.

General Features.[1]

The county lies mainly in the great valley of the same name in the central portion of the state. It is bounded on the north by Sacramento County, on the east by Amador, Calaveras, and Stanislaus. The latter county extends around and adjoins it on the south also. Contra Costa and Alameda counties lie west of it.

Stockton, the county seat and largest city, has water transportation facilities, as well as rail. The area of the county is 1448 square miles, and its population is 79,905 (1920 census). By far the greatest part of its area is made up of farm lands; the so-called 'delta' region adjacent to Stockton being noted for its rich peat soil and heavy crops.

The most extensive geological formation exposed consists of unconsolidated sands, gravels and clays of Quaternary age, which compose the nearly-level valley floor. The western edge of this formation follows closely the Southern Pacific railroad line down the west side of the valley from Bethany to Vernalis. The corner of the county, southwest of the railroad, is composed of marine sandstone, and diatomaceous and clay shales of Tertiary and Cretaceous ages in the northern part. Its south half is rugged and broken, as the Franciscan rocks, typical of the Coast Range, including slates, cherts, limestones and sandstones, with much schist and serpentine, are exclusively in evidence.

Unconsolidated sands, gravels and clays extend practically to the county line on the eastern side of the valley, the only other rocks exposed being two small areas of extrusive volcanic rocks, just east and north of Bellota.

Comparatively few mineral substances are found in San Joaquin County, and of these the most important are nonmetallic structural and industrial materials and natural gas. Gold, silver and platinum have been obtained by dredging in Mokelumne River. Clay and clay products accounted for more than half the total mineral production of the county in 1923.

Clay Resources.

Common clays suitable for the manufacture of brick are abundant in the county, and two brick yards are in operation. High-grade clays were at one time produced near the San Joaquin and Alameda county line, in the vicinity of Tesla and Carnegie, and were utilized at the

[1] Laizure, C. McK., State Mineralogist's Rept. XXI, p. 184.

plant of the Carnegie Brick and Pottery Company, which has been dismantled for many years. See under Alameda County for further details.

One of the important fire brick plants of the state, that of the Stockton Fire Brick Company, is operating in Stockton. The plant is strategically situated with respect to the clay mines of Amador and Placer counties, and is within the range of cheap transportation to the marketing centers.

San Joaquin Brick Co. I. F. Stine, secretary-manager; Ernest Rossi, plant superintendent. Home office, 33 South El Dorado Street, Stockton. The property is located on a 60-acre tract on Roberts Island, six miles by road southwest from Stockton. Common red brick is the sole product. The clay is an extremely sandy bottom-land loam. The water level lies within six feet of the surface, so that economical mining has always been a serious problem. A horse-scraper is used above the water level, dumping through trap doors into horse-drawn cars operating on a light industrial track. A gasoline locomotive was purchased and tried in place of horses for haulage, but the track was not of sufficient weight to obtain satisfactory results.

Below the water level, the clay is excavated with a Marion steam shovel mounted on a barge. The clay is dumped along the bank, and allowed to dry in the air before it is reclaimed by the horse scraper.

The soft-mud process is used for shaping the brick. The clay is given a double pugging before passing to a 6-mold press. A continuous rope conveyor takes the brick from the press to the drying sheds. The sandiness of the clay is indicated by the fact that the drying period in warm weather is only three days, with a maximum of five days in cooler weather.

A Hoffman continuous kiln burning coal screenings is used for firing. The kiln is 175 feet long, with 12-ft. by 12-ft. chambers. The firing cycle is 14 days, and the capacity is 24,000 brick per day. The machinery is operated by electric power. The total installed capacity of the motors is 100 horsepower. Forty men are employed.

Bibl: State Mineralogist's Report XXI, p. 188.

Stockton Brick and Tile Co. Ralph Wilcox, president; Paul Weston, secretary; G. Birtolini, plant superintendent. Home office, 245 North El Dorado Street, Stockton. The plant is on McKinley Avenue near the southern boundary of the city of Stockton, about one-half mile west of the Municipal Baths. A Southern Pacific spur track runs to the plant. The plant was built in 1921. Common brick and some hollow building tile are manufactured, using surface clay from the property.

The clay is a bottom-land deposit of yellowish sandy loam and is mined to a depth of 15 feet below the surface by horse-drawn scrapers. The clay is found at greater depths, but is below the water level. The scrapers deliver the clay to a dry pan, from which the crushed product is elevated by a bucket elevator to a pug-mill and auger machine. The brick are taken from the wire-cutter belt by hand and loaded on trucks which are trammed by hand to oil-fired tunnel driers.

Firing is done in a Hoffman continuous kiln. The capacity of the kiln is 450,000 brick, and 25,000 brick are set and drawn each day. Coal screenings from Utah coal are used as fuel. The coal holes are spaced three feet apart. One man on each 8-hr. shift attends to the firing. The fires must be carefully controlled, as the kiln is too short for successful firing if irregular fluctuations in temperature are permitted. Natural stack draft is used.

In order to keep the plant in continuous operation during the year, it is customary to shape 40,000 brick, or the equivalent volume of brick and hollow tile, per day, during the summer and fall. Half of this output of green ware is stored for firing during the winter months, so that it is not necessary to operate the pit or the auger machine during the wet season.

The plant employs 25 men during the summer and about 15 men during the winter. The annual output is over 3,000,000 brick, or an equivalent volume of brick and hollow tile. The hollow tile production is never a large proportion of the total. All machinery is operated by electric power.

Bibl: State Mineralogist's Report XXI, p. 188.

Stockton Fire Brick Co. John T. Roberts, president; Percy T. Cleghorn, secretary; E. H. Horner, plant superintendent. Main office, 12 Russ Building, San Francisco. Plant address, P. O. Box 314, Stockton.

The company's plant is just west of the Southern Pacific railroad at the foot of S. California Street, Stockton. See photos No. 63 and 64. The output includes several different grades of fireclay brick and special shapes, high-temperature fireclay cement, and diatomaceous insulating brick. The company owns or leases deposits of most of the raw materials in use at the plant, the most important of these being Edwin clay (No. 120, p. 272), from Jones Butte near Ione; Ione sand (No. 140, p. 280), from the pit of the Ione Fire Brick Co., and Lincoln fireclay (sample No. 280, p. 305), from the newly developed pit of a subsidiary company, the Clay Corporation of California. Quartz for grogging some of the grades of fire brick is purchased from various California sources, mainly in Placer County, and diatomaceous shale for the manufacture of insulating brick and special shapes is purchased from producers in Santa Barbara County.

The principal grades of fire brick are as follows: 'Gasco XX,'' quartz grogged, auger-made, single pressed; 'Stockton,' quartz grogged, auger-made, repressed; 'Gasco R,' quartz grogged, auger-made, repressed; and 'Carnegie,' which is grogged with calcined fireclay, hand-made in sanded molds, and repressed. The 'Carnegie' brick is the best grade of standard brick being produced at present for resisting high temperatures under adverse load and spalling influences. Among the specialties regularly produced are a high-grade checker-brick which is made from a mixture grogged with calcined clay and shaped on an end-cut auger machine, and runner-brick, made from a similar mixture, formed on an auger-machine, and then passed to a specially designed machine for making the joints and cutting the side-holes.

The mixtures are prepared by dry-pan grinding, followed by pug-mill tempering for the material that is to be hand-molded.

All of the shapes except runner brick are dried in waste-heat tunnel driers. The runner brick, which require especially uniform drying on all sides during the shrinkage period, are dried in a Carrier ejector humidity drier, which is operated on a 13 to 15 hr. schedule, beginning

PHOTO No. 63. Plant of the Stockton Fire Brick Company, at Stockton, San Joaquin County. (Photo by courtesy of the company.)

with a three-hour period at 145° F. and 40% humidity, and finished at 240° to 250° F. with steadily declining humidity. The brick are set on the drier cars in a direction parallel to the direction of the air current in the drier, so that the air passes through and around the brick simultaneously, thus drying the inside and outside of the brick at the same rate.

The manufacture of diatomaceous insulating brick, known by the trade name 'Diatex,' is becoming an increasingly important part of the operations of the plant. Standard 9-in. brick and many special shapes are made. They are hand molded from diatomaceous shale containing sufficient clay for bonding. Slow and careful uniform drying is neces-

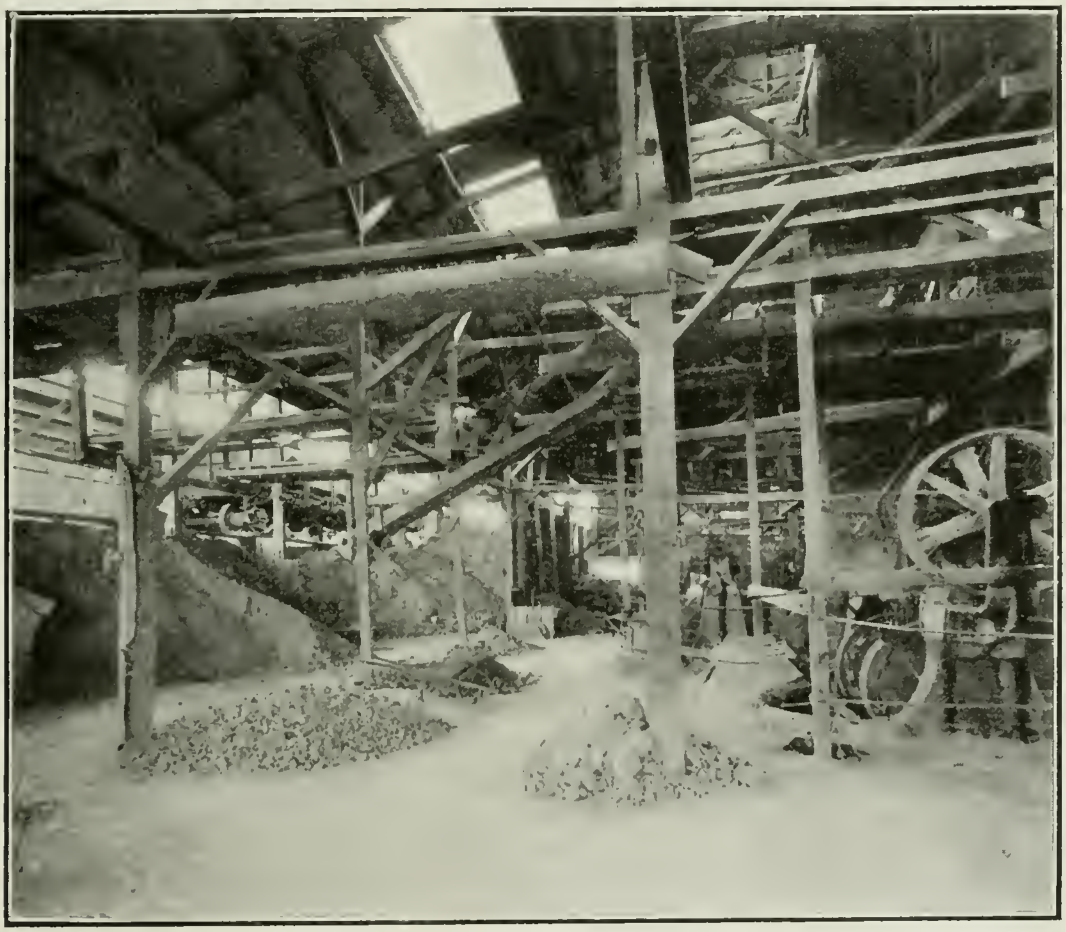

PHOTO No. 64. Clay bins and dry pans in plant of the Stockton Fire Brick Company. (Photo by courtesy of the company.)

sary to avoid loss by warping or cracking. In connection with the development of this product a conductometer, the principle of which has been described by R. D. Pike,[1] was constructed in the laboratory, for the purpose of comparing the heat conductivities of the various experimental mixtures.

The fireclay products are fired in 12 oil-fired round down-draft kilns, which are of various sizes from 12-ft. to 32-ft. in diameter, with capacities ranging from 80 to 400 tons each. The usual firing cycle is seven to eight days firing, to a temperature of 1370° C., corresponding to cone 11 down, followed by a cooling period of equal length.

[1] Pike, R. D., Need for more refractory heat insulators: Proposed conductometers for measuring thermal conductivity: Jour. Amer. Cer. Soc., 5, 554, August, 1922.

The insulating brick are fired in four 12-ft. by 23--ft rectangular kilns.

Base-metal thermocouples with automatic recorders are installed in all kilns for the accurate control of the firing cycle.

The plant is noteworthy for the high degree of technical control to which all operations are subjected, and for the continual improvements that are being made in the processes of manufacture and in the quality of the finished product, through the cooperation of an efficient technical staff and a progressive management.

An average of 110 men are employed.

Bibl (Clay resources of San Joaquin County): State Min. Bur. Bull. 38, pp. 227–228; Prel. Rept. 7, pp. 94–95; Rept. XIV, pp. 607–610, and XXI, pp. 188–190.

SAN LUIS OBISPO COUNTY.

General Features.[1]

San Luis Obispo County borders on the Pacific Ocean and occupies a position midway between San Francisco and Los Angeles. It is bounded on the north by Monterey County, on the east by Kern and on the south by Santa Barbara. It contains 3334 square miles and has a population of 21,893 (1920 census). The coast line of the Southern Pacific railroad passes through the county from north to south. The railroad follows Salinas River Valley through Paso Robles to a point near Santa Margarita, thence it crosses the Santa Lucia Range via Cuesta Pass, reaching San Luis Obispo at the foot of the grade, and the ocean near Pismo. It continues south along the ocean shore, giving through transportation. The Pacific Coast railroad (narrow gauge) connects Port San Luis with San Luis Obispo and continues to Santa Maria and other points in Santa Barbara County. The paved coast highway closely parallels the Southern Pacific railroad through the county.

From Santa Margarita fair dirt roads extend to the eastern part of the county, but McKittrick, in Kern County, is a nearer railroad point to this section. Steamer service is available at Port San Luis. This harbor is the terminus of pipe lines from the San Joaquin Valley oil fields and is an important loading point for oil tankers.

The Coast Range mountain system traverses the county from northwest to southeast. Within the county this mountain block consists of three main ranges, the Santa Lucia Mountains, the San Luis Range, and the San Jose Range.

The geology of that portion of the county from the southern boundary to latitude 35° 30′ N. and from the coast to longitude 120° 30′ W. has been described and mapped in detail by H. W. Fairbanks.[2] A discussion of the geology of the county with relation to petroleum resources will be found in Bulletins No. 69 and No. 89 of the State Mining Bureau. A folio of geologic maps accompanies Bulletin No. 69.

As indicated on the Bureau's geological map of the state, the Santa Lucia Range from San Luis Obispo northwestward to the northern boundary line is made up of Franciscan rocks, including slates, cherts,

[1] From Laizure, C. McK., San Luis Obispo County: State Mineralogist's Rept. XXI, pp. 499–501, 1925.

[2] Fairbanks, H. W., San Luis Folio, No. 101: U. S. Geological Survey.

limestones, and sandstones, with much serpentine and many dikes and intrusions of deep-seated igneous rocks. On the flanks of the range are narrow belts of Cretaceous sandstone and shales. Southeast of San Luis Obispo the formations are mainly Tertiary marine sandstones and diatomaceous shales. Unconsolidated sands, gravels, and clays extend from Pismo to Santa Maria River and well up the valley of the Santa Maria. East of Santa Margarita there is a large area in which granite predominates. The balance of the county lying east and north of the Santa Lucia Range consists almost entirely of sedimentary rocks of Tertiary age, shales, sandstones, tuffs, and gravels with an area of Quaternary sediments comprising Carrizo Plain.

Among the mineral resources of the county, both developed and undeveloped, are asphalt, bituminous rock, brick, chromite, coal, copper, diatomite, gypsum, iron, limestone, marble, mineral water, onyx, petroleum, quicksilver, soda, and miscellaneous. Miscellaneous stone, petroleum, brick, and mineral water are the principal commercial mineral products at present.

Clay Resources.

There are no known deposits of high-grade clays in this county, but red-burning clays suitable for making brick occur in the valley silts of recent origin at various places. Since the population of the county is small, the demand for clay products is limited, and a single common-brick plant at San Luis Obispo supplies the market of the county as well as of a few nearby towns in Santa Barbara and Monterey counties. The territory to the south is supplied by brick yards in Santa Barbara, while plants in San Jose furnish brick for the communities in Monterey and San Benito counties.

San Luis Brick Works. Owned and operated by Faulstick Bros., San Luis Obispo. This plant, formerly known as the San Luis Brick Company, is located one mile south of town, near the lines of the Southern Pacific and Pacific Coast railroads. The clay is a yellowish loam, with little or no overburden. The proportion of sand is sufficient to prevent excessive shrinkage and cracking in the brick-making process, yet is not so high as to interfere with the binding properties of the clay. The clay is mined to a depth of 15 feet by hand shoveling into dump cars, which are hauled up an incline by a steam winch, to dump through a hopper into a 10-foot dry pan. After screening, the fines pass to a pug-mill, then to an American Clay Machinery Co. auger machine equipped with a Freese cutter. The oversize from the screen is returned to the dry pan.

The brick are dried in the open without auxiliary heat. This requires an average of three weeks. Burning is done in open field kilns, usually with 18 arches, each kiln containing 590,000 brick. Heat is supplied by oil, with steam atomization. Firing requires five days, and cooling about three weeks.

The plant operated three months during the season of 1925, producing about 1,500,000 brick. Twenty-eight men are employed when in full operation. See photo No. 65.

Bibl: State Mineralogist's Report XXI, p. 505.

Santa Margarita. Two miles south of Santa Margarita is an extensive undeveloped deposit of red-burning shale. The deposit is easily

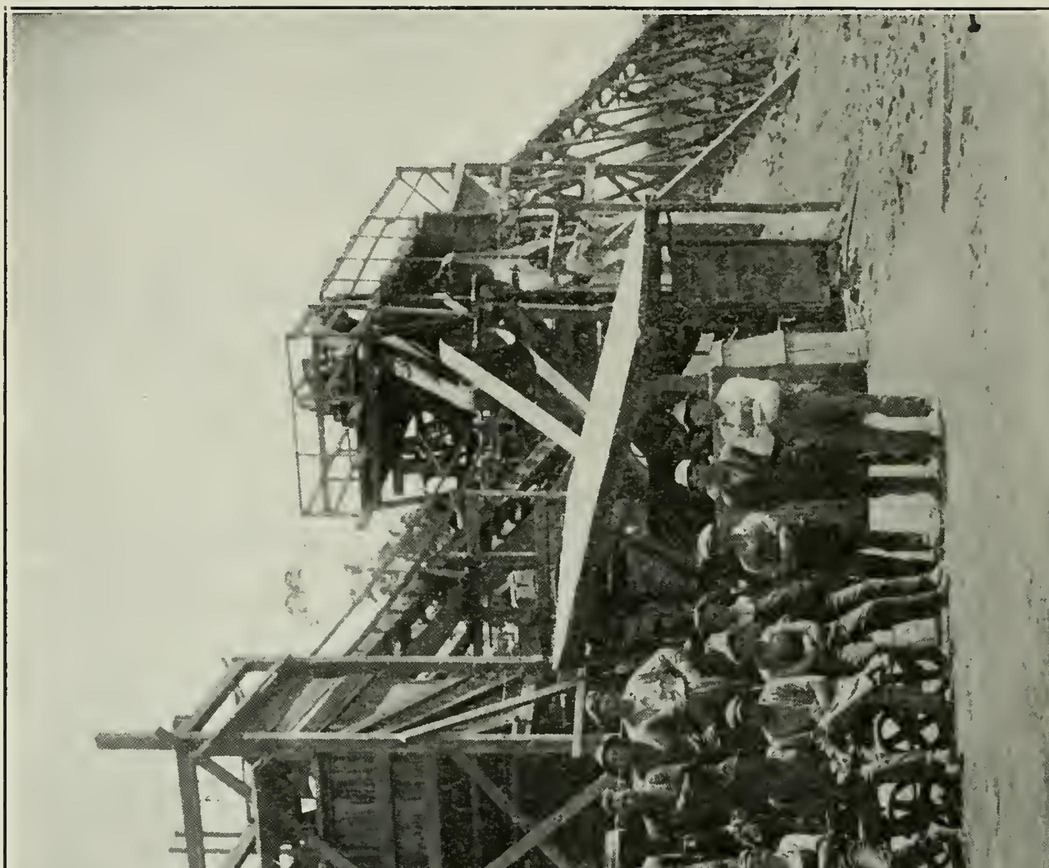

PHOTO NO. 65. Plant of San Luis Brick Works, San Luis Obispo. (Photo by courtesy of the company.) (From State Mineralogist's Report XXI, p. 506, 1925.)

accessible at a point 2.0 miles (by road) south of the center of Santa Margarita, where it lies in a broad belt between the state highway and the Southern Pacific railroad for a distance of at least one-half mile. The strike of the beds is S. 25° E., and the dip is 75° NE.

Two samples were taken. No. 216 was taken from a road cut, 2.0 miles from Santa Margarita. Sample No. 217 was taken from the same formation, 2.5 miles from Santa Margarita, and 0.3 miles north of the northern boundary of the Santa Barbara National Forest. The test results are on page 327. The material would be well suited for the manufacture of vitrified red-burned structural ware.

Bibl (Clay resources of San Luis Obispo County): State Min. Bur. Bull. 38, p. 255; Prel. Rept. 7, p. 95; State Mineralogist's Rept. XV, p. 679; XXI, p. 505.

SAN MATEO COUNTY.

General Features.

San Mateo County lies on the San Francisco Peninsula, south of San Francisco city and county. Its southern boundary adjoins Santa Clara and Santa Cruz mountains. Its area is 447 square miles, and the population is 36,781 (1920 census).

Aside from a narrow strip of alluvial plain along the shores of San Francisco Bay, the entire county is mountainous, as the western spur of the Coast Range extends through the county. The principal geological formations exposed in the mountainous portion of the county are Franciscan (Jurassic) sandstones, jaspers, serpentines, etc.; Chico (Upper Cretaceous), Pliocene and Miocene sedimentary deposits, mainly sandstones and shales, and granite.

The most important mineral products are cement, miscellaneous stone, and salt. Jasper, magnesium chloride, natural gas, petroleum, and potash are also produced. Small amounts of barytes, chromite, diatomite, and quicksilver have also been found.

Clay Resources.

No high-grade clays have been reported in the county. Deposits of clay and shale suitable for brick making are plentiful.

The only clay-working plant in the county is that of the West Coast Porcelain Manufacturers, described below. The Steiger Terra Cotta and Pottery Works, and the Baden Brick Company, mentioned in earlier reports, were dismantled many years ago.

West Coast Porcelain Manufacturers. Henry Weiss, president and general manager; Ed. Durant, plant manager; T. B. Gotham, superintendent and ceramist. The plant is near Millbrae station on the Southern Pacific Railroad. Vitreous sanitary porcelain is the only product. The body, which contains 50% clay and 50% flint and feldspar, is made from English china and ball clay, Tennessee ball clay, Ottawa or Illinois sand and feldspar from Campo, San Diego County. Alberhill bone clay is used in the sagger mix, as the aluminous structural clay; Ione clays as the binders.

All of the ware is shaped by casting, and the slip room is one of the most modern and best equipped in the West. Special precautions are taken to secure uniformity of grinding and proportioning and freedom from contamination.

The body is prepared by the dry-mix process. Three 30-hp. Crossley dry pebble mills are used for grinding the Ottawa sand and feldspar. Seven hours grinding is necessary for each batch of sand or feldspar. The English ball clay is passed through a disintegrator to crush it to less than $\frac{3}{8}$ in. diameter. The Tennessee ball clay does not require previous crushing. The dry pulverized materials are stored in bins from which they are weighed out for the casting slip batches. Three double casting slip blungers are used for the preparation of the slip, which weighs 30 oz. per pint. The discharge from the blungers is passed over a Ding magnetic separator to remove any particles of metallic iron, then through a 100-mesh screen, and finally to Crossley slip agitators below the floor of the slip room. From the agitators the slip is pumped to the casting room.

A small blunger and a 70-leaf round-rail filter press are used to retreat the scrap body-mix from the casting and drying departments. This is necessary in order to remove the alkali which is added to all slips as a deflocculator, and which, if left in the rejected material, would build up in the casting slip to the point where blisters would form on the ware during firing.

The glaze batches are ground in a Crossley, style B pebble mill, 8 feet diameter and 5 feet 8 inches long, driven by a 20-hp. induction motor. When ground, the slip is passed through a 100-mesh screen, and is pumped into a Patterson single-action glaze agitator, where it is kept in suspension until drawn off for use. A magnetic separator is used to remove any particles of iron that might accidentally have been introduced into the glaze.

The casting slip is piped to all parts of the casting floor, where the ware is cast in the usual manner in plaster molds.

Waste-heat driers are used. After drying, the ware is loaded into saggers in preparation for the biscuit firing.

The firing equipment consists of two 366-ft. tunnel kilns, operated on a 48-hour cycle. The biscuit kiln is fired to a maximum of cone 11, which corresponds to 1205° C. on the recording pyrometer. After cooling from the biscuit kilns, the glaze is applied by dipping, and the ware is sent through the glost kiln, which is fired to cone 6, corresponding to 1150° C. on the pyrometer. Oil fuel, atomized with air, is used on both kilns. The capacity of the kilns is 400 pieces per 24 hours.

Saggers are made by machine at the plant. Alberhill bone clay has proved a better structural clay in sagger manufacture than Ione clay. The Ione clay body burns too tight, and losses from cracking after repeated use are high, but used as a binder it is more or less satisfactory.

The company has recently developed a line of crystalline-glaze artware, and many attractive shapes and color schemes are being produced.

The plant has a well-equipped laboratory, and through careful technical control the products of the plant are of remarkably high quality and free from defects. The plant employs 150 men.

Bibl (Clay resources of San Mateo County): State Min. Bur. Bull. 38, pp. 228–229, 255; Prel. Rept. 7, pp. 95–96.

SANTA BARBARA COUNTY.

General Features.[1]

Santa Barbara County consists of 2740 square miles, including the islands of San Miguel, Santa Rosa, and Santa Cruz, which are located twenty miles off the coast. It is bounded on the north by San Luis Obispo County, on the east by Ventura County, on the south by the Santa Barbara Channel, and on the west by the Pacific Ocean.

The population, according to the census of 1920, was 41,097, and is now estimated as over 50,000. The city of Santa Barbara, the county seat, with a population of over 30,000, lies on the shores of the channel. Santa Maria is the second community in Santa Barbara County and has a population of over 5000.

Much of Santa Barbara County is hilly and mountainous; the Santa Ynez, a low range of mountains, follows the trend of the coast across the southern part of the county, and the San Rafael, a higher range, strikes through the center of the county and extends almost to its northern limits. These mountains, with their foothills and spurs, impart to the whole county a rugged and diversified aspect.

The principal valleys are the Santa Maria, Los Alamos, Lompoc, Santa Ynez, and Cuyama. These fertile areas are well adapted for the growing of cereal crops and citrus fruits and cattle raising.

The principal drainage systems of the county are the Santa Maria and Santa Ynez rivers.

The county is traversed by the Southern Pacific railroad, which follows the coast line, with branch lines from Guadalupe to Betteravia, and from Surf to Lompoc. The Pacific Coast railroad, a narrow-gauge line, runs from Port Hanford, in San Luis Obispo County, through Santa Maria to Los Olivos, with branches from Santa Maria to Betteravia and Sisquoc. Santa Maria Valley railroad connects with the Southern Pacific railroad west of Santa Maria and runs southeast through the Santa Maria Valley to Leonard.

The coast route of the state highway enters the county north of Santa Maria, and runs the length of the county, connecting Santa Barbara city with Los Angeles and San Francisco. Different laterals from this railway afford transportation for auto trucks and stages to interior towns.

Geology and Mineral Resources.

The principal geological formations exposed in Santa Barbara County are Tertiary shales and sandstones, including those of Eocene, Miocene, and Pliocene age. Quaternary sediments also cover a large area, especially in the western part of the county. There is a small area of Franciscan (Jurassic) in the center of the county, and a larger area of Cretaceous (Undifferentiated) in the north-central part of the county.

Santa Barbara County owes its position of fifteenth in the state in regard to its mineral output to the presence of productive oil fields within its boundaries. The total value of its mineral production during

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[1] From Tucker, W. Burling, Santa Barbara County: State Mineralogist's Rept. XXI, pp. 539–540, 1925.

the year 1926 was $2,583,548; of this amount the value of natural gas and petroleum was $1,772,678.

Among its mineral resources, both developed and undeveloped, are: Asphalt and bituminous rock, barytes, brick, chromite, copper, diatomaceous earth, gilsonite, gold, gypsum, limestone and lime, manganese, mineral water, natural gas, oil shale, petroleum, sandstone and the stone industry.

Clay Resources.

No commercial deposits of high-grade clays have been found in the county. Common clay is fairly abundant, and several brick yards and a roofing tile plant are in operation.

Angulo Tile Company, Plant No. 1. R. F. Angulo and Sons, owners. Address P. O. Box 128, Santa Barbara. This company has two plants for the manufacture of hand-made roofing tile and terrace tile. Plant No. 1 is on Central Avenue, between Modoc Road and the state highway, Santa Barbara, and Plant No. 2 is at Reseda, Los Angeles County (see under Los Angeles County. At *Plant No. 2* a local surface clay is mined from an area immediately adjoining the plant. The plant is equipped with three kilns, fired with oil.

L. L. Brentner. Carpinteria. The property is west of the coast highway, 14 miles north of Ventura, and four miles south of Carpinteria. Ten acres were at one time under lease to the Builder's Supply Company of Santa Barbara, who operated a plant for the manufacture of common brick. It is understood that the property is now idle (1927). The clay beds are nearly vertical, have an east-west strike, and are about 200 feet thick. The material is a light-colored thin-bedded shale, with quartz, limestone, and sandstone boulders, which were partly removed by screening. A drag-line scraper was used for mining. The plant is equipped with crushing machinery to deliver a 20-mesh product to the brick plant, which consists of a 14-ft. pug-mill and an auger machine, with a wire cutter. The brick were dried in the open and fired in oil-fired field kilns.

Sample No. 3 was taken for testing, the results of which are on page 348. The material is not of good quality for the manufacture of brick.

Bibl: State Mineralogist's Rept. XXI, pp. 546–547, 1925.

Muengenberg and Whitiker. R. Muengenberg and E. H. Whitiker, of 230 de la Guerra Street, Santa Barbara, are operating two of the brick yards formerly operated by the Builder's Supply Company in Santa Barbara and Montecito.

The Santa Barbara plant, formerly the Parker Brick Company, is on West Montecito Street, one-half mile from the Southern Pacific railroad tracks. Common red brick, hollow building tile, and drain tile are made from clays obtained from pits on the plant site and from other sources in the vicinity. The stiff-mud process is used. The ware is dried in the open, and fired in oil-fired field kilns. Sample No. 1 was taken for test, the results of which are on page 338. The sample was taken from the pug-mill, and is typical of the class of material available in the district, and for which the plant has been designed, rather than being representative of a specific clay bank.

The Toro Canyon plant, formerly the Toro Canyon Brick and Tile

Company, is in Toro Canyon, near Montecito. There is an ample supply of plastic clay, intermingled with blocks of soft, yellow sandstone. The clay is mined from a shallow side-hill open cut with tractors and scrapers. Common red brick, hollow building tile, and roofing tile are made. Drying is done under sheds and in the open, and oil-fired field kilns are used for firing. Sample No. 2 (see p. 338) was taken.

Bibl: State Mineralogist's Repts. XV, p. 735; XXI, pp. 546–547. Bull. 38, p. 256. Prel. Rept. 7, p. 96.

SANTA CLARA COUNTY.

General Features.

Santa Clara County lies in the west-central portion of the state. It is bounded on the north by San Mateo and Alameda counties, on the east by Stanislaus and Merced, on the south by San Benito, and on the west by Santa Cruz and San Mateo. The area of the county is 1328 square miles, and the population is 100,588 (1920 census). The principal towns are San Jose, Palo Alto, Santa Clara, and Gilroy, all of which lie in a broad valley between two parallel ranges of the Coast Range system of mountains. This valley is noted as one of the most productive fruit-growing sections in California.

The geological formations that are most widespread in the county are Quaternary sediments in the valleys, and Franciscan (Jurassic), Cretaceous, Miocene, and Pliocene formations in the mountains.

The New Almaden district, about 15 miles south of San Jose, was for many years famous as a quicksilver producer, but the production has declined in recent years owing to the exhaustion of the mines. The following mineral products are produced commercially: brick, clay, limestone, magnesite, mineral water, natural gas, petroleum, quicksilver, and miscellaneous stone. Of these miscellaneous stone, brick, and quicksilver are the most important, in the order given. Occurrences of chromite, manganese, and soapstone are known.

Clay Resources.

No commercial deposits of high-grade clays are known in the county. Common clays suitable for the manufacture of brick and tile are abundant throughout the valley portions of the county. On account of favorable manufacturing and marketing conditions, a number of clay-working plants have been established in and near San Jose and Santa Clara. Some of these plants use common clay from extensive deposits along Coyote Creek within the city limits of San Jose. The clay bed is from 15 to 20 feet thick.

Garden City Pottery Company.[1] H. M. Stammer, president; D. Raymond, vice president; N. J. Mahan, secretary. Office and plant at 560 N. Sixth Street, San Jose. This company was established in 1904, under the name of the Garden City Pottery. The products of the plant are flower pots and stoneware. Lincoln clay is used for the stoneware, and a local red clay, from Coyote Creek, is used for flower pots. The stoneware mix is prepared by grinding, washing, and filter-pressing, followed by pugging. After shaping, the ware is dried in steam-heated drying rooms for a period of three or four days.

[1]Data obtained by D. R. Irving, Stanford University.

Firing is done in four round down-draft kilns. Two of the kilns are 20 feet, and the other two are 18 feet in diameter. They are fired with oil, which is atomized with steam. The stoneware is fired to 2200° F. (about cone 5) in 72 hours, and the flower pots are fired to 1800° F. (about cone 07) in 48 hours.

The plant operates throughout the year and employs 30 men.

Bibl: State Min. Bur. Bull. 38, p. 229; Prel. Rept. No. 7, p. 96.

Gilroy Brick and Tile Company. Chas. Bolfing, Gilroy. Mr. Bolfing built and operated a small common brick plant for a few years on his ranch about one mile north of Gilroy, using a clay shale obtained from a deposit on the Redwood Retreat Road, about eight miles from Gilroy. The plant was not commercially profitable, and has been partly dismantled.

Kartschoke Clay Products Company. G. Kartschoke, president and manager. Plant at 1098 S. Third Street, San Jose. The principal products of the plant are sewer pipe, flue lining, and patent chimney pipe. The plant is also equipped to make machine-made roofing tile. The clays are obtained from banks along Coyote Creek, with the addition of some clay that is purchased from the Yaru deposit in Amador County.

The clays are ground in a dry pan and elevated to a double-shaft pugmill, from which the mix passes to an American sewer pipe press. Drying is done in a building which is heated by steam during the winter. Four to five days are usually required for drying.

The ware is fired in three oil-fired round down-draft kilns, 22 feet, 26 feet and 28 feet in diameter, respectively. Cone 2 (1165° C.) is reached in 80 to 90 hours, the entire cycle, including setting and drawing, requiring about two weeks.

Bibl: State Mineralogist's Rept. XIII, p. 618; State Min. Bur. Prel. Rept. 7, p. 97.

J. B. King, of Skyland, P. O., Wrights Station (Santa Cruz County). It is reported that there is a "fine, large deposit of pottery clay" on this property. No investigation was made. As the locality is relatively inaccessible, near the summit of the Santa Cruz Mountains, the clay would need to be of exceptional quality to be of commercial importance.

Platt's Premier Porcelain, Incorporated.[1] H. D. Melvin, president; A. A. Baker, vice president; N. E. Wretman, secretary. Office and plant on Lafayette Street, Santa Clara. This company makes sanitary porcelain from a mixture of English china and ball clays, Arizona feldspar, and California silica. The feldspar and flint are received at the plant in pulverized form. The mixes are prepared by blunging and filter-pressing. The ware is shaped by the casting process, although hand-pressing was formerly used, and is dried in steam-heated rooms for a period of one week. Three 16-ft. round up-draft ('bottle') kilns are used for firing. These use oil fuel, atomized with steam. The biscuit ware is fired to cone 9 (1250° C.) in 36 hours, and the glost ware is fired to cone 8 (1225° C.) in 30 hours. The plant was idle during 1927, but expected to resume operations early in 1928.

[1] Data obtained by D. R. Irving, Stanford University.

Remillard Brick Company. C. Remillard, president; R. C. Giroux, secretary. Office, 332 Phelan Building, San Francisco. This company has operated a brickyard at Pleasanton, Alameda County, for many years, and has recently established a plant in San Jose, on Storey Road, on the eastern edge of town. Common red brick are made from a local clay, using open field kilns for firing. The plant is operated for about eight months during the year.

San Jose Brick and Tile Company. J. J. Jamiesen, president; R. L. Richards, secretary-treasurer. Address P. O. Box 274, San Jose. The plant is on Fruitvale Avenue, and the property comprises 35 acres. Common red brick is manufactured. The clay deposit consists of a 30-ft. bed of red-brown plastic clay overlain by three to five feet of soil. The clay is mined and delivered to the plant by a drag-line scraper.

The plant is equipped with an E. M. Freeze K-B brick machine, which has a capacity of 75,000 brick per day and is driven by a 150-h.p. electric motor. An industrial car system is used in the drying and kiln yard. Drying in open racks requires from seven to eight days. One round down-draft kiln and two down-draft continuous kilns are used for firing. Coal screenings are used as fuel. The firing schedule of the continuous kilns is as follows: three days water smoking, four days firing and ten days cooling.

The plant is usually operated for nine months of the year, employing 50 men, and using 345 h.p. of electric power. The average fuel consumption is 300 lb. of coal per thousand brick.

San Jose Tile Company. A partnership, consisting of L. W. Austin, D. W. Wallace, L. F. Wallace, W. D. Rice, and L. H. Bruns. The plant is at 333 S. Eighteenth Street, San Jose, on the banks of Coyote Creek. Hand-made floor, wall, and mantel tile are manufactured, using a red-burned body consisting largely of clay from the Natoma Clay Company in Sacramento County. Local clay from Coyote Creek and some Lincoln and Ione materials are used to a certain extent. The equipment consists of a disintegrator and pug-mill, and a rectangular kiln, burning oil. The kiln is equipped with a pyrometer. The firing period is from 40 to 48 hours, finishing at cone 5 (1180° C), or higher.

An excellent market has been established for the ware, and the plant is expected to grow rapidly.

S & S Tile Company. A. L. Solon and F. P. Schemmel, owners. Office and plant at 1881 S. First Street, San Jose. This company specializes in the manufacture of decorative tile, both glazed and unglazed, from a buff, or red-colored body. Local clay from Coyote Creek is used in conjunction with Lincoln clay and Ione sand. Biscuit rejects and kiln dirt are used as grog.

The clays are mixed in batches on the floor, fed to a Jeffrey swing-hammer mill, and elevated to a bin, from which they are fed by a disc feeder to a pug-mill. A Muller auger is used for shaping all plain tile, whereas fancy tile is hand-pressed in plaster molds. Some dry-pressed tile are made at times. A specially designed waste-heat drier is used. To secure partial humidification, the drier is arranged so that the hot air can be retained in closed circuit. Drying requires three days. Two oil-fired round kilns are used. These are 18 and 22 feet in diameter, respectively. They are fired to cone 2 (1135° C.) in 48 hours. Cooling requires four days. Both kilns are equipped with base-metal thermocouples. All glazed ware is biscuited first, then glazed. About eight men and six women are employed.

SANTA CRUZ COUNTY.

General Features.[1]

Santa Cruz County borders on Monterey Bay and the Pacific Ocean, south of San Mateo County, and north of Monterey County. Its area is 435 square miles, and the population is 26,269 (1920 census). The greater part of the county is rugged and mountainous.

The geology of most of the county is described in U. S. Geological Survey, Santa Cruz Folio, No. 163, by J. C. Branner, J. F. Newsom, and Ralph Arnold. The principal sedimentary formations are of Miocene and Pliocene age. There is an extensive area of quartz-diorite, and smaller areas of metamorphic schist, marble, and limestone.

The mineral production of the county includes cement, lime, limestone, and miscellaneous stone, and bituminous rock.

Clay Resources.

Common brick clays occur along the San Lorenzo River and at other points. In the early nineties, two brickyards were in operation near Santa Cruz, but these have long since been dismantled. Clay is being mined at Tank Siding, 1.8 miles southwest of Glenwood, and at Davenport, for use in the manufacture of cement at the plant of the Santa Cruz Portland Cement Company, at Davenport.

Bibl: State Mineralogist's Repts. X, p. 625; XII, p. 383; XIII, p. 619; XVII, p. 234; XXII, pp. 78–79. Prel. Rept. No. 7, p. 97.

SHASTA COUNTY.

General Features.

Shasta County lies at the northern end of the Sacramento Valley. Redding, the county seat, is on the Shasta line of the Southern Pacific Railroad, 175 miles north of Sacramento, and is the principal railroad and supply point for Shasta and Trinity counties. The Pacific highway connecting California and Oregon, traverses the county in a north and south direction, paralleling the Southern Pacific railroad in the Sacramento River Canyon.

The area of Shasta County is 3858 square miles and the population in 1920 was 13,311. The southern portion of the county adjacent to the Sacramento River is open and rolling, and is devoted to farming and stock raising. The northern and western portions of the county are mountainous, and the eastern portion is a succession of rising plateaus covered by recent volcanic flows. Most of the important mineral deposits of the county are confined to the western half. The Pit River, which joins the Sacramento River near Redding, is an important source of hydro-electric power. Timber is an important resource of the county, especially in the eastern portion.

Shasta County is characterized by the variety of its geologic formations, and the diversity of its mineral resources. Copper, gold, zinc

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[1]See Laizure, C. McK., Santa Cruz County: State Min. Bur. Rept. XXII, pp. 68–93, 1926.

and iron are the principal metals that have been produced in the county. The limestone resources are very extensive, but to date have not been exploited on a large scale. Extensive beds of low-grade lignite occur in the central part of the county. These have been investigated many times in the past, and an attempt is now being made to place them upon a sound commercial basis.

Clay Resources.

There is at present no clay industry in the county. At various times in the past, brick yards have been operated at Redding and Anderson, to supply local needs, but these have been idle for many years. There is an abundant supply of clay and silt suitable for common-brick manufacture in the flood plain of the Sacramento River south of Redding, and along other streams in the county.

No commercial deposits of high-grade clays have yet been discovered in the county. It is possible that with the serious development of the lignite properties northeast of Oak Run, mainly in T. 33 N., R. 1 W., M. D. M., refractory clays may be encountered, as the lignites occur in the Ione formation, which is the important source of terra cotta and fireclays in Placer and Amador counties. A small sample of micaceous kaolin, slightly tinged with iron, was supplied by Mr. I. J. Johnson, of the Johnson Iron Works, Redding, but no data could be secured as to the source of this material, except that it was found on a property some 20 miles northeast of Palo Cedro.

For convenience of reference, the following descriptions of common-brick clay deposits are abstracted from previous publications of the Bureau:

State Mineralgist's Report XXII, p. 131, 1926; Prel. Rept. No. 7, p. 98, 1920.

Holt and Gregg, J. N. Gregg, president, Kennett. A brick plant was formerly operated at Anderson, in Sec. 17, T. 30 N., R. 4 W., M. D. M. The deposit was 15 feet thick.

Block 29, Redding Grant, 1¼ miles south of Redding. Clay bed six feet thick. A brick kiln was operated here many years ago.

Redding Brick and Tile Company formerly operated a deposit on 40 acres in Sec. 19, T. 31 N., R. 5 W., M. D. M., and made brick in small kiln at Redding.

Redding Homestead Deposit is on the Sacramento River east of Cottonwood. Deposit is a mile long by one-fourth mile wide and contains 30 feet of clay, covered by 15 feet of sand and gravel. Undeveloped. No recent information available.

Southern Pacific Company owns an undeveloped clay deposit in Sec. 19, T. 32 N., R. 4 W., M. D. M.

In addition to the foregoing, a deposit of fireclay is reported in Sec. 24, (34?) T. 34 N., R. 5 W., M. D. M., that was at one time operated by Holt and Gregg for use as kiln lining. No recent information since the report of 1920.

SISKIYOU COUNTY.

General Features.

Siskiyou County borders on the state of Oregon in a sparsely-settled mountainous portion of California. The total area of the county is 6256 square miles, and the population (1920) is 18,500. The county is traversed by the Shasta line of the Southern Pacific railroad. The principal industries of the county are lumbering, stock-raising and farming. The mineral industry of the county is not at present of great importance, although in the past the county has been celebrated for its placer mines, and during the late war it was an important source of chromite. The geology and mineral resources of the county have been discussed in a recent report.[1]

Clay Resources.

On account of the remoteness of the county from the centers of population and the small population within the county itself, none but exceptionally high-grade clay deposits could have commercial value. A deposit of 'pottery clay' 16 ft. thick has been reported[2] in Sec. 8, T. 43 N., R. 6 W., near Gazelle. A careful search for this deposit was made in August, 1925, and local inhabitants were questioned concerning it, but no knowledge of such a deposit could be obtained. The report probably refers to a deposit of yellow plastic clay that occurs on the property. A deposit of fireclay in the roof of a coal mine in Sec. 26, T. 46 N., R. 6 W., has also been reported[3] but could not be verified. The coal mine referred to is now inaccessible.

Common brick clays occur in irregular alluvial deposits at various places in the county. Some of these, near Yreka, Etna Mills, and Fort Jones have been used in the past for producing brick for local use during the early construction periods of the larger towns in the county. None of the brick yards have been operated for many years, and have long since been dismantled. If at any time in the future it should become necessary to manufacture small quantities of red brick in the county, enough clay of satisfactory quality could probably be found, but it is unlikely that large deposits of uniformly good material will be encountered.

For convenience of reference, the previous reports of the bureau on common clay deposits in Siskiyou County are summarized below, but as these reports are over 20 years old, the names of the men who were formerly associated with the deposits are omitted here, as few of them can now be found.

T. 43 N., R. 9 W., M. D. M. Surface clay deposits were reported in Sec. 2, 11, 21 and 32, in the vicinity of Fort Jones, Greenview, and Etna. These clays have been used for brick making.

Sec. 27, T. 45 N., R. 7 W. Bricks were once manufactured from a reddish clay near Yreka.

Near Montague a small quantity of brick clay has been found.

Bibl: Cal. State Min. Bur. Bull. 38, p. 230 and 257, 1906; Prel. Rept. No. 7, p. 98, 1920 (a copy of the material in Bull. 38).

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[1] State Mineralogist's Report XXI, pp. 413–498. 1925.
[2] Prel. Rept. No. 7, p. 99.
[3] *Op. cit.*, p. 98.

SOLANO COUNTY.

General Features.[1]

Solano County radiates in a northeasterly direction from San Pablo Bay, an arm of San Francisco Bay. Its area is 822 square miles, and the population is 40,602 (1920 census). About 80 per cent of the land is arable and the balance is mountainous. Cretaceous and Tertiary sediments, and late Tertiary (probable) lavas are found in the mountainous portion of the county. The rest of the county is covered with Recent alluvium.

Among the mineral resources of Solano County are cement, clay, fuller's earth, limestone, mineral water, natural gas, onyx, quicksilver, salt and miscellaneous stone. Recent production has been confined to cement, miscellaneous stone, mineral water, onyx and travertine. The only cement plant in the county was closed down in November, 1927, and is available as a stand-by plant.

Clay Resources.

Common brick clays are abundant in the argicultural section of the county. A number of clay-working plants, including a pottery at Benicia and brick and tile plants at Vallejo, were active a number of years ago.

Steiger Brick and Tile Company (formerly the Vallejo Brick and Tile Company). Plant two miles northwest of the center of Vallejo. This is the latest attempt to operate a brickyard in the county, and operations were discontinued in 1923. The plant is equipped for the manufacture of brick and hollow tile. The clay deposit is a yellow shale, an analysis of which is reported by Laizure[2] as follows:

Loss on ignition	8.03%
Silica	57.83%
Alumina	19.52%
Iron oxides	7.46%
Calcium oxide	1.24%
Magnesium oxide	2.06%
Alkalies (by difference)	3.86%
	100.00%

Clay from a bank at the base of the hills near Goodyear Station was utilized about 20 years ago in a pottery.

Bibl: State Mineralogist's Repts. VIII, p. 631; XIII, p. 619; XIV, p. 300; XXIII, pp. 204–205. State Min. Bur. Bull. 38, p. 258. Prel. Rept. No. 7, p. 99.

SONOMA COUNTY.

General Features.[3]

Sonoma County is situated north of Marin County and San Pablo Bay, extending eastward from the Pacific Ocean, which it borders for 50 miles, to the crest of the Coast Range, which forms the boundary separating it on the east from Lake and Napa counties. Mendocino County bounds it on the north. The land area of the county is 1577

[1] See Laizure, C. McK., Solano County: State Mineralogist's Rept. XXIII, pp. 203–213, 1927.
[2] *Op. cit.*, p. 204.
[3] From Laizure, C. McK., Sonoma County: State Mineralogist's Rept. XXII, pp. 327–329, 1926.

square miles, and the population is 51,990 (1920 census). There are no improved harbors on the coast side, but water shipping facilities are available in the southern portion, which borders the bay. The Northwestern Pacific railroad traverses the county from south to north through the central valley, with branch lines into Sonoma Valley, to Sebastopol and to the Russian River region around Guerneville, Duncan Mills and Cazadero. A narrow-gauge branch also extends from Marin County northward through Valley Ford to Monte Rio in the western part. A line of the Southern Pacific railroad from Napa Junction in Napa County traverses the Sonoma Valley and terminates at Santa Rosa. The Petaluma and Santa Rosa electric system also gives service to the southern portion of the county. The paved 'Redwood Highway' of the state system closely parallels the Northwestern Pacific railroad through the county. Its main laterals are also paved or well-kept graveled roads.

The county produces a great variety of agricultural products, and dairying and stock-raising are important sources of wealth. Its mineral deposits have been exploited more or less continuously since the sixties, and although it can scarcely be classified as a 'mining' county, metals and nonmetallic minerals exceeding $11,000,000 in value have been produced to date. Its resources are still far from exhausted.

Many health-giving mineral springs are found here, and its resorts have made the county one of the favorite playgrounds of central California.

Situated in the midst of the Coast Range, its topographic features include level valleys, low rolling hills and rugged mountains, with deep-cut canyons. The drainage of the southern portion is to the bay, while that of the northern two-thirds is to the Pacific Ocean, chiefly by the Russian River and its tributaries. The main valley area, beginning at the bay, extends through the center of the county for about 60 miles, with an average width of 25 miles, but narrowing toward the northern end. Numerous smaller valleys separate the lesser spurs and ridges of the main range.

Geology.

Sonoma County is not covered by any of the United States Geological Survey Folios, and the geologic literature on this area is fragmentary. The general geology has been described in part by Osmont,[1] and by Vander Leck,[2] in its relation to possible oil production. The geology of the quicksilver ore deposits has also been covered in considerable detail by various writers.

As shown on the State Mining Bureau's geological map of the state, the Franciscan rocks of the Coast Range cover probably three-fourths of Sonoma County, extending in a broad belt from the Marin County line northwesterly the entire length of the county and beyond. This belt of metamorphic rocks widens toward the north. It consists mainly of sandstone, with smaller amounts of limestone, slates, cherts, schist, and much serpentine. Bordering the coast from Salmon Creek north, is a belt of Cretaceous sandstone and shale a few miles in width. Tertiary sedimentary rocks are exposed in a small area around Valley

[1] Osmont, V. C., A Geological Section of the Coast Ranges North of San Francisco: Bull. Dept. of Geol., University of California, Vol. 4, No. 3, pp. 39–87.

[2] Vander Leck, Lawrence, Petroleum Resources of California: State Min. Bur. Bull. 89, pp. 36–38.

Ford. The main valley area is composed of Quaternary sands, gravels, and clays along the Russian River from Cloverdale to Healdsburg. These formations narrow at Windsor and then widen again between Forestville and Santa Rosa and continue south through Sebastopol and Cotati nearly to Petaluma. The lowlands area around the mouth of Petaluma Creek and Sonoma Creek is also of Quaternary age. Most of Sonoma Valley, the Sonoma Hills and the area surrounding Santa Rosa on the east and north is made up of Tertiary sediments consisting of fine and medium sands, clay and shale. Late volcanic lavas cover a considerable area in the neighborhood of Mount St. Helena. They also appear along the eastern boundary of the county, on the west side of Sonoma Valley, and near Petaluma. The lavas are mainly andesitic, but in places grade into basalt. Volcanic tuffs are found interbedded with the Tertiary sediments at many points.

Among Sonoma County's mineral resources are chromite, clay, copper, graphite, diatomite, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone. Of these, miscellaneous stone, quicksilver, mineral water, pottery clay, building stone (tuff) and manganese ore were produced in 1925.

Clay Resources.

There has been in the past a considerable output of brick and clay in Sonoma County, but no clay-working plants are active at present. Common clays are sufficiently abundant for all probable needs of the county.

A number of deposits of high-grade clay have been reported from time to time, but only one of these, the Weiss deposit, has been developed sufficiently to be of interest.

Beltane. Sample No. 197 (see p. 291) was taken from a deposit that is exposed in a cut on a side road, 1.3 miles northwest of the state highway. The side road branches from the main highway at a point 0.5 mile north of Warfield Station. The deposit is probably near the eastern edge of Sec. 2, T. 6 N., R. 6 W., M. D. M., about two miles east of Beltane Station. The clay is buff-burning and refractory. The extent of the deposit and its ownership were not determined. This should not be confused with the Weiss clay, described below, which is sometimes known as 'Beltane clay.'

Weiss Deposit. J. H. Weiss, Glen Ellen, owner. This is a deposit of white, moderately plastic, kaolin fireclay, in Sec. 3, T. 6 N., R. 6 W., M. D. M., less than a mile by road east of Beltane station on the Southern Pacific. The deposit has been worked at various times in the past, and over 2000 tons have been shipped to clay products manufacturers and to the Santa Cruz Portland Cement Company for experimental purposes. Five cars were mined and shipped in June, 1925, by Frank A. Asbury, lessee, of 753 Banning Street, Los Angeles, and was tried in several fire-brick plants in the Los Angeles district, notably by the St. Louis Fire Brick and Clay Company.

The appearance of the deposit and the extent of development work is shown in photo No. 66. The tunnel is said to be 100 feet long, with various secondary workings, but it is now caved near the portal. Borings from the floor of the pit are said to have encountered clay of quality equal to that exposed in the workings, to a depth of 20 to 30 feet. There is a smaller abandoned pit 100 feet to the east, in which clay of a similar nature is exposed.

The origin and structural relations of the deposit was not definitely determined, but all available evidence points to the theory that it is an alteration in place of a flat-bedded, fine-grained aplitic rock. The overburden of several feet of soil, and the thick vegetation make tracing of the clay beyond the development faces difficult.

About 400 yards to the north, and at a slightly higher elevation, is a prominent exposure of a rock containing quartz and a high proportion of feldspar. Some of this rock has been mined from an open cut, and the exposed bank is over 40 feet high. The rock has been tried as a fire-brick grog by several plants. Near the top of the bank, the rock is similar in color and aggregation to the clay from the pit to the south, but is hard and non-plastic. The more typical rock from the lower part of the bank closely resembles a chert. It is harder than steel, has

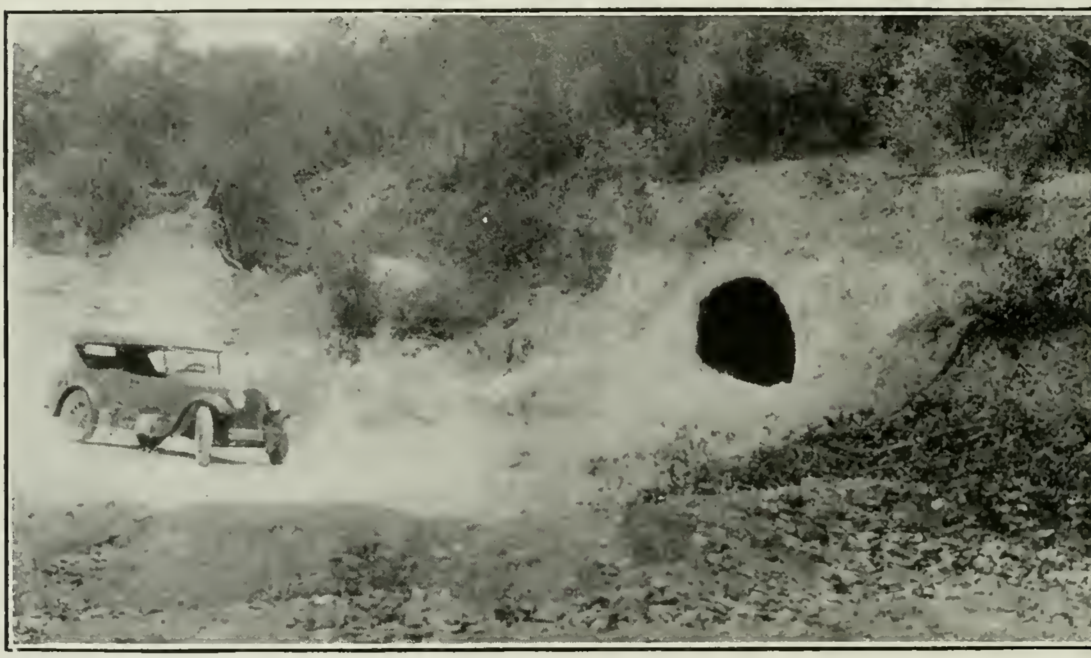

PHOTO No. 66. Weiss clay deposit, facing northwest. Near Glen Ellen, Sonoma County. (Samples No. 194 and 195.)

a dull waxy luster, and contains isolated quartz and altered feldspar crystals, and scattered discontinuous veinlets of quartz.

Sample No. 194 is a general sample from the clay pit. Sample No. 195 is a selected sample of the whiter clay from the pit and from the tunnel, near the portal. It represents from 10% to 15% of the clay exposed in the workings. The test results are on page 262.

Bibl: State Mineralogist's Reports VIII, p. 635; XII, p. 384; XIV, pp. 316–318; XXII, p. 332. Bull. 38, p. 258; Prel. Rept. 7, p. 99.

STANISLAUS COUNTY.

General Features.[1]

Stanislaus County is situated in the San Joaquin Valley between San Joaquin County on the northwest and Merced on the southeast. It is

[1] From Laizure, C. McK., Stanislaus County: State Mineralogist's Rept. XXI, pp. 200–201, 1925.

bounded on the northeast by Calaveras and Tuolumne counties, and by Santa Clara on the southwest side. Stanislaus County contains 1486 square miles, and its population is 43,557 (1920 census). The greater part of its acreage is arable, and about one-half is capable of irrigation. The various branches of agriculture and stock-raising are the principal sources of wealth.

The county extends across the San Joaquin Valley in a northeasterly direction from the summit of the Mount Diablo Range on the west to the foothills of the Sierra Nevadas on the east. The central portion is composed of unconsolidated sands, gravels and clays. Bordering this formation on the northeast, with the line of contact a little above Oakdale and Waterford, is a belt of older Tertiary clays, shales and sandstones. This Tertiary belt extends to and comes in contact with the slates, limestones and other rocks of the Jurassic along a line which closely follows the northeastern boundary of the county. On the southwest, the low foothills of the Coast Range are made up of Cretaceous sandstones and shales. The extreme western portion is rugged and composed of Franciscan formations, typical of the Coast Range; consisting of altered slates, cherts, massive sandstone, schists and serpentine. Deposits of magnesite, manganese, and quicksilver occur in this area.

Gold has usually been the chief mineral product of Stanislaus County, but gold was exceeded in value in 1918–1919 by manganese, and in 1921–1923 by miscellaneous stone. Gold, platinum, and silver are obtained mainly by dredging. Quicksilver and manganese are other metals found here also. Among its nonmetallic resources are clay, ocher, magnesite, silica, and miscellaneous stone, including crushed rock, gravel and sand. Other minerals occur, but the deposits in most cases have not been sufficiently developed to determine their commercial value.

Clay Resources.

Deposits of common clay, suitable for the manufacture of common brick, occur abundantly in the county, and have been worked at various times in the past near Modesto, Grayson, Newman, and Patterson, but there have been no recent operations.

The Craycroft brickyard at Modesto operated between 1908 and 1916, but is now dismantled. In 1918 and 1919 Martin Kelch made brick from a clay deposit having a maximum thickness of 20 feet, on the Waterford road, about one mile east of Modesto.

No deposits of high-grade clay are known to occur in the county. The Cummings Ranch deposit, described below, has been noted in various reports of the Bureau. On investigation, it was found to have little or no commercial value.

Cummings Ranch Clay Deposit. On the property of J. H. Cummings of Patterson, in Sec. 20 and 21, T. 5 S., R. 7 E., M. D. M., is an undeveloped deposit of hard, white clay-shale. The deposit occurs near the edge of the foothills west of Patterson, near the ranch house of W. J. Hammond. The deposit is exposed on the hillside 200 yards northwest of the ranch house. The total distance by road from Patterson is 5.9 miles. The shale occurs in a bed from 10 to 15 feet thick having a strike of N. 50 W., and dipping 45° NE. The overburden of shale, sandstone and soil varies from a few feet to over 15 feet in thickness.

Sample No. 205 was cut from a five-foot portion of the bed that was whiter in color than the rest. The test results are on page 299.

Bibl (Clay resources of Stanislaus County): State Mineralogist's Repts. XVII, p. 253, and XXI, pp. 204–205; State Min. Bur. Prel. Rept. 7, p. 99.

SUTTER COUNTY.

General Features.

Sutter County lies north of Sacramento County, mainly between the Sacramento and Feather rivers. Its area is 608 square miles, and the population is 10,115 (1920 census).

The outstanding topographic and geologic feature of Sutter County is the Marysville Buttes, which occupy a circular area about 10 miles in diameter in the north-central portion of the county, and rise to a maximum elevation of 2128 feet above sea level. The rest of the county is flat and is covered with deep alluvial soil. The Buttes consist of a core of andesite with intrusions of rhyolite surrounded by upturned Ione (Eocene) sedimentary strata overlain by andesite tuff and breccia.[1] The mineral production of the county is practically nil, and consists principally of crushed rock.

Clay Resources.

Clay beds of considerable extent have been reported to occur in the sedimentary Eocene strata of the Marysville Buttes. A reconnaissance of the region was made by the author in August, 1925, but no further information could be obtained, even after considerable search and local inquiry.

Bibl: State Mineralogist's Rept. XV, p. 258; State Min. Bur. Prel. Rept. No. 7, p. 100.

TEHAMA COUNTY.

General Features.

Tehama County is in the upper part of the Sacramento Valley. It extends east to the summit of the Sierras, and west to the crest of the Coast Range. Its area is 3166 square miles, and the population is 2551 (1920 census). The Sacramento River flows through the center of the county, from north to south.

The eastern half of the county is covered with sheets of lava, which had their origin from and around Lassen Peak. The central part of the county shows an extended plateau of gravels, sands and clays, which extend to the serpentines and metamorphic rocks of the Coast Range.

Among the mineral resources of Tehama County are brick, chromite, copper, gold, manganese, marble, mineral water, salt, and miscellaneous stone. Brick and miscellaneous stone are the only commercial products at present.

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[1] Turner, H. W., and Lindgren, W., Marysville Folio No. 17, U. S. Geol. Surv., 1895.
Lindgren, W., U. S. Geol. Surv. Prof. Paper No. 73, pp. 23–25, 1911.
Watts, W. L., Cal. State Min. Bur. Bull. 3, pp. 9–10, 1894.
Cooper, J. G., Cal. State Min. Bur. Bull 4, pp. 36–45, 1894.
Dickerson, R. E., Bull. Dept. of Geol., Univ. of Calif., Vol. 7, No. 12, pp. 257–298; pls. 11–14, April, 1913.

Clay Resources.

Common brick clays are abundant in the Sacramento Valley portion of the county, especially near the river. A brickyard has been operating intermittently at Red Bluff for many years.

Banks of clay of fine quality are reported in the *Flournoy* district.[1] Flournoy is in T. 24 N., R. 5 W., about fourteen miles west of the Southern Pacific railroad at Corning. No investigation was made of this occurrence.

O'Connor Brothers Brickyard. Address, Red Bluff. The clay deposit and brickyard are on the Reed Tract, in Sec. 29, T. 27 N., R. 3 W., M. D. M. The deposit covers an area of over 19 acres, and is from 8 to 12 feet thick,, underlain by gravel. The soft-mud process is used, a small brick press being operated by horse power. The brick are fired in open field kilns. The plant is operated intermittently to supply the local demand.

Bibl: State Mineralogist's Rept. XV, p. 260; State Min. Bur. Bull. 38, pp. 258–259; Prel. Rept. 7, p. 100.

TULARE COUNTY.

General Features.

Tulare County is in the southern San Joaquin Valley, and is bounded on the north by Fresno, on the east by Inyo, on the south by Kern, and on the west by Kings County. It has an area of 4856 square miles, and the population is 59,031 (1920 census).

The western half of the county lies in the San Joaquin Valley, and the eastern half is in the Sierra Nevada, culminating in a number of peaks along the summit at elevations exceeding 14,000 feet above sea level. The rocks in the mountains are mainly granites and other plutonics, whereas the valley is covered with Quaternary sediments. Various metamorphic and sedimentary rocks are found in the foothills.

Climatic, soil and water conditions in the foothills and in the San Joaquin Valley section of the county are especially favorable to the growth of citrus fruits. This and other agricultural pursuits, including stock raising and dairying, are the principal industries of the county.

The mineral resources of the county include brick, clay, copper, feldspar, graphite, gems, limestone, magnesite, marble, quartz, glass-sand, soapstone, miscellaneous stone, and zinc. The commercial mineral products are brick, granite, lime, limestone, magnesite, natural gas, and miscellaneous stone, of which magnesite and granite are the most important.

Clay Resources.

Common clay of good quality for the manufacture of red-burned structural ware is plentiful in the valley and foothill section of the county. One brickyard has been in operation for a number of years.

A deposit of buff-burning refractory clay has been found eight miles southeast of Ducor, but has not been developed commercially. See under Sears Clay Deposit.

[1] Clay-Worker, August, 1926, p. 131.

Sears Clay Deposit. W. A. Sears, of Porterville, owner. Eight miles southeast of Ducor, in Secs. 26, 27, 35, T. 24 S., R. 28 E., M. D. M. This locality was visited in September, 1925, but the author was unable to meet Mr. Sears, or to find the deposit by personal search or by inquiry among residents in the locality. Later, Mr. Sears sent a number of samples of clay from the property. These were tested under numbers 283-A, 283-B, 284, and 285. See pages 314, 316, and 282. A description of the deposit was given in Preliminary Report No. 7, p. 100, and is quoted below:

"The clay bearing strata extend about one-half mile south of White River and about two miles in length along the south bank of the river. An overburden of gravel and clay 6 to 8 feet thick overlies a bed of white and blue plastic clay. A number of small cuts have been made along the south bank of the river. These pits show a white clay 6 to 8 feet thick overlying a blue plastic clay. The strata of clay beds have a general northwest strike. The development of this deposit has been only superficial, so the depth of the clay bed has not been determined. The clay is suitable for tile, sewer pipe, fire brick, vitrified brick and terra cotta."

S. P. Brick and Tile Co. W. D. Trewhitt, president; H. W. Shields, secretary-treasurer; H. G. Hayes, superintendent. General office, 435 Rowell Building, Fresno. The plant is three-quarters of a mile south of Exeter, in Sec. 14, T. 19 S., R. 26 E., M. D. M. The property comprises 20 acres, all of which is underlain by workable clay to a depth of 12 to 18 ft., underlain by coarse gravel. The products of the plant are common brick and hollow tile.

The clay is mined by a ½-yd. electric shovel, having a capacity of 200 tons per eight hours. The clay is passed through a roll disintegrator, from which it is elevated, screened, and passed to an American pug-mill and auger machine, equipped with a Freese cutter. Some of the ware is dried under sheds, and some in a waste-heat drier. The drying sheds have a capacity of 550,000 brick, and drying is usually completed in three weeks. The waste-heat drier has a capacity of 135,000 brick, and the drying period is three days.

The brick and tile are fired in open-field kilns. The fuel is oil, atomized with steam. The firing period is 5½ days, and the kiln turnover cycle is 12 days. Two round down-draft kilns are available, but are not used, as they are more expensive to operate than the field kilns.

The capacity of the plant is 8,000,000 brick, or the equivalent volume of brick and hollow tile, per year.

Valencia Heights Shale Deposit. C. H. Weed, of Porterville, owner. The deposit is six miles east of Porterville, in Sec. 34, T. 21 S., R. 28 E., M. D. M., and consists of black clay shale, almost a slate. The shale is 1500 to 2000 feet in width, and cuts through a serpentine belt. The strike of the beds is northwest and the dip is 75° SE. Sample No. 206 was taken from a road cut, 5.3 miles from Porterville. The test results are on page 327.

Bibl: State Min. Bur. Prel. Rept. 7. p. 101.

Former Operations.

The Pioneer Brick Company and the McKnight Firebrick Company, mentioned in Preliminary Report No. 7, pp. 100–101, are out of business.

VENTURA COUNTY.

General Features.[1]

Ventura County is bounded on the north by Kern County, on the east by Los Angeles County, on the south by Los Angeles County and the Pacific Ocean, and on the west by Santa Barbara County. The total area is 1878 square miles. The population as shown by the census of 1920 was 28,724.

The city of Ventura, originally called San Buenaventura, is the county seat, and is located on the shores of the Santa Barbara Channel. The cities of Oxnard, Santa Paula, and Fillmore are next in importance.

Ventura County is essentially an agricultural and stock-raising county. The increasing production of petroleum in the past few years, however, is rapidly bringing it forward on the list of mineral-producing counties.

The northern portion of the county is characterized by the convergence of several important mountain ranges, which make of it a high and rugged region. The more mountainous and rugged parts of Pine Mountain and Topatopa Mountain form what is considered one of the roughest and most inaccessible regions in California. Its lofty peaks range in elevation from 6000 to 9000 feet. To the northwest extend the San Emigdio Mountains, which form the connection between the Coast Range and the Sierra Nevada Mountains. To the west extend the San Rafael Mountains, while farther southward the Santa Ynez Mountains diverge from this group, running westward through Santa Barbara County.

The southern part of the county is characterized by a series of parallel folds, the axes of which lie east and west, forming low mountain ranges of no great continuity. The principal valleys are Santa Clara, Ojai, Simi, and Las Posas.

The two principal drainage systems of the county are the Santa Clara River and the Ventura River. Next in importance, but subordinate to these is Calleguas Creek, which drains the Simi and Las Posas valleys.

The county is traversed by the Southern Pacific railroad, with a branch line from Ventura to Ojai. At Montalvo, five miles east of Ventura, the main line divides into two branches, one going to Los Angeles via Las Posas and Simi valleys, the other through the Santa Clara Valley, joining the San Joaquin Valley line at Saugus.

With the exception of the higher mountainous areas, the county is easily accessible by roads, the main arteries being paved. Access to the gold and borax districts is obtained over the state highway from Bakersfield to Los Angeles via Tejon Pass.

Mineral Resources.

Ventura was the fourth county in the state in respect to the value of its mineral production in 1926. Petroleum and natural gas are the principal products. The only other products, in 1926, were miscellaneous stone, brick, and clay. Undeveloped resources include asphalt, borax, diatomite, gypsum, limestone, mineral water, mineral paint, molding sand, phosphates, and sandstone.

[1] From Tucker, W. Burling, Ventura County: State Mineralogist's Report. XXI, pp. 223–225, 1925.

Geology.

The rocks of the Ventura region fall into three classes: a metamorphic and granite complex, which is commonly referred to as the 'basement' complex, a series of sedimentary rocks, and a series of igneous extrusive and intrusive rocks.

The metamorphic rocks are all of pre-Jurassic age and have been intruded by granite that is probably of the same age as that of the Sierra Nevada, which is considered to be late Jurassic or early Cretaceous.

The sedimentary rocks, which in this region form the greater percentage, range in age from Upper Cretaceous to Recent.

The igneous rocks are practically all of Miocene age and are mainly andesite, dacite, basalt, andesite breccia, and associated mud flows.

Clay Resources.

Common clays are sufficiently abundant in Ventura County to serve all purposes. Two brickyards are operated as needed to supply the local market.

No high-grade clays have been reported in the county.

Anderson and Hardison. This is a common brick plant, 2.7 miles north of Santa Paula, on the Ojai Valley road. The clay is obtained from an extensive deposit of sandy clay and is mined by a tractor-drawn scraper. The clay is prepared by crushing and screening, and the brick are shaped by dry pressing. So far as known, this is the only brickyard in California using the dry-press process of making common brick. Gas-fired field kilns are used.

Sample No. 6 was taken for testing. The results are on page 339.

Bibl: State Mineralogist's Rept. XXI, p. 237.

People's Lumber Company. C. E. Bonistell, general manager. Office in Ventura. Clay pit and brickyard on the Ventura Avenue road, two miles north of Ventura. The clay is mined from an extensive deposit of Pliocene (Fernando ?) age, which is also utilized as an oil-well mud. Two varieties of clay are found: a yellow clay, sample No. 4, p. 338, which is considered best for use in making brick, and a bluish clay, sample No. 5, p. 339, which is more fine-grained and plastic, and is especially desirable for use in the oil fields. Common brick, red ruffled brick, drain tile, roofing tile, and hollow building tile are made, by the stiff-mud process. Open field kilns are used for firing, and natural gas is available as fuel.

Bibl: State Mineralogist's Repts. XV, p. 759, and XXI, pp. 236–238. Bull. 38, p. 259; Prel. Rept. 7, pp. 101–102.

YOLO COUNTY.

General Features.

Yolo County is in the Sacramento Valley, bounded by Sutter on the east and Colusa on the north. Its area is 1014 square miles, and the population is 17,105 (1920 census). The western edge of the county is in the foothills of the Coast Range, and the rest of the county is in the basin of the Sacramento River.

The only commercial mineral resource at present is miscellaneous stone. Quicksilver was at one time produced. Deposits of iron and sandstone have been noted.

Clay Resources.

Common brick clay is abundant near Winters, Woodland, and Capay. Small quantities of brick were made, chiefly at Woodland and Winters, in the eighties, using deposits of clay and clayey loam.

Bibl: State Mineralogist's Rept. X, p. 791; XIV, p. 367. State Min. Bur. Bull. 38, p. 259; Prel. Rept. 7, p. 102.

YUBA COUNTY.

General Features.

Yuba County lies in the north-central part of the state and borders the east side of the Feather River. It is bounded on the northwest by Butte and Plumas counties, on the southeast by Placer and Nevada counties, and on the east by Sierra County. Its area is 625 square miles, and the population is 10,375 (1920 census).

Since its boundaries extend from the floor of the central valley of California to the middle western slope of the Sierra Nevada Mountains, Yuba County includes diversified topography and climate.

Geology.[1]

The general geology of Yuba County is similar to that in Nevada and Placer counties. The main central portion of the county consists generally of gabbro-diorite and granodiorite, which in turn grade into metamorphic, amphibolitic rocks. Schists and slates in places overlie the igneous rocks and are intruded by serpentine in the northern part of the county. Alluvial sands and gravels cover the entire western portion of the county, while auriferous gravels, in places, lie along the old channel courses.

The areal geology of Yuba County has been covered by U. S. Geological Survey Folios No. 17, 18 and 43.

Yuba County is still an important producer of gold, which is recovered by dredging and hydraulic mining. Other mineral products are miscellaneous stone, silver, natural gas, and platinum.

Clay Resources.

High-grade clay in small quantities has been mined from the J. F. Dempsey Ranch (see below) near Smartsville. Common clays suitable for the manufacture of red-burned structural ware are plentiful in the vicinity of Marysville.

Dempsey Ranch Kaolin Deposit. A deposit of kaolin fire clay occurs on the ranch of J. F. Dempsey, in the E½ of Sec. 3, T. 15 N., R. 6 E., M. D. M., 2 miles southeast from Smartsville. The clay occurs as irregular bunches exposed in small chamber workings at the end of a 100-foot tunnel. The clay was evidently formed by the alteration in place of diabase or a similar intrusive rock which penetrates the serpentine mass of the hill in which the deposit occurs. The clay is badly contaminated with limonitic iron in most of the exposed workings, but occasional bunches of 5 to 10 tons can be found that are quite free from

[1] From State Mineralogist's Rept. XV, p. 420.

iron. It is doubtful if a commercial quantity of white kaolin could be found.

J. V. Chown of Oakland at one time held a lease on the property, and shipped 150 tons of kaolin for the manufacture of fire brick. The kaolin was found to be satisfactory for this purpose, but on account of the isolation of the property, expensive mining, and the irregular occurrence of the clay, it was not possible to compete with other sources of material. The kaolin was hauled 20 miles to Marysville, over a rough road, at a cost of $5 per ton for haulage alone.

Sample No. 173 was taken for testing. The results are on page 313.

Durst Ranch. One-half mile east of Wheatland. This locality was not visited, but a note on the occurrence of clay on this property was given in earlier reports as follows: "Shipments of clay were occasionally made, before 1905 . . . to Gladding, McBean and Company at Lincoln. . . . The black clay loam used was 6 feet deep and overlain by 18 inches of soil. Deposits similar to that on the Durst Ranch are abundant in the valley portion of Yuba County."[1]

Marysville Brick Company. This plant is a short distance north of Marysville, on the Feather River. A local surface clay is used for the manufacture of common brick. The plant was not visited and no details are available for publication. The production in 1925 was 1,100,000 brick.[2]

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[1] State Mineralogist's Rept. XV, p. 424, 1915–16, evidently abstracted from Bull. 38, p. 230, 1906.

[2] Clay-Worker, February, 1926, p. 139.

CHAPTER IV.

CLAY TESTS AND THEIR INTERPRETATION AND THE CLASSIFICATION OF CLAYS.

FIELD TESTS.

While no field tests of clays were made in preparing this report, the prospector or clay miner often wishes to determine the possible economic value of clays before incurring the labor or expense of securing adequate samples and sending them to clay plants or commercial laboratories for testing. If samples are sent to clay plants it is usually necessary to send material to more than one plant, as a clay may be rejected by one operator as not being suitable for his ware or his plant routine, but this same clay may be eminently suitable in some other plant.

The following simple field tests for making a rough preliminary classification of clays, from the Third Report of the West Virginia Geological Survey, have been quoted many times, but are of such general interest to prospectors and others who are searching for clays in the field, that they are repeated here.

1. A small lump of clay may be roasted in the flame of a gas stove. If it turns red or brown, the percentage of iron is high, probably more than four per cent.

2. By tasting the clay, bitter salts, such as alum and epsom, may be detected, or such salts may occur as white coatings on the outcrops of the clay in the bank. These salts are apt to form white wash coats on the finished brick, injuring their appearance. Sand may be detected by grit against the teeth. A rough idea of the percentage of such sand may thus be made.

3. A good idea of its plastic qualities may be obtained by working the moist clay with the fingers. A good test for pottery clay is to thus moisten it, and determine whether it can be worked into a definite shape, and whether or not it will retain its form when dry without cracking.

4. Shrinkage: A rough brick can easily be made and dried, and a good idea of the shrinkage arrived at. If it cracks or crumbles when dry or shrinks out of shape, its value is very doubtful. For this test, however, the clay should be ground thoroughly, tempered with water, and dried slowly.

5. If carbonates of lime are present, a few drops of hydrochloric acid will cause effervescence or bubbling, as the carbonic acid gas passes off. Very high percentages of lime are apt to ruin the clay. Good fire bricks are made of clay low in lime content.

6. The slaking of clays, or the crumbling down in tempering is tested by dropping a lump of clay in a cup of water. Some clays slake in a very few minutes, and so are easily tempered.

7. The color of a finished clay product is largely determined by the amount of iron present. It is not always possible to predict the color of the burned ware from the color of the clay. It is true that red clays will usually burn red, but blue clays or those of other shades also commonly burn red or buff. The color of the raw clay is often due to organic matter which is combustible, and will be consumed in the burning.

While the above tests may not prove absolutely the quality of any given clay, at the same time they furnish considerable valuable information in regard to it, and may be used to advantage by the owner of a deposit which has never been developed. If these simple tests seem to give positive results it may then be well worth while to get in touch with buyers and consumers.

LABORATORY TESTS.

The methods of testing used for this report followed the standards or tentative standards of the American Ceramic Society,[1] in so far as it was possible to do so with the equipment and funds available.

These methods or their equivalent have been followed in a number of recent state reports on clays.[2] Only such explanation of the testing methods and their interpretation is given here as is necessary to an understanding of the text of this report and to indicate the divergences from the recommended methods. The reader is referred to the literature for further details.

Preparation of Samples.

The weight of the sample collected in the field was usually approximately fifty pounds, but a number of them were smaller, owing to special difficulties of securing proper samples or of transporting them. In sampling, the usual precautions were taken to secure material that was representative of the clay that would actually be mined. Notes on the macroscopic character of the material sampled were made at the time of sampling, and are recorded in the description of the sample, if of special interest. All foreign matter that normally would not be mixed with the clay, or that would be removed by screening before the clay is used in a clay-working plant, was removed from the sample before shipment to the laboratory.

In the laboratory, the entire sample was crushed to pass a 20-mesh screen, by passing through a laboratory jaw-crusher, followed by passing through a set of rolls. One sample, a flint fireclay (sample No. 282), was further crushed in a pebble mill to develop maximum plasticity.

Sufficient water was added to the ground clay to permit the mixture to be worked into a plastic condition. The attempt was made to maintain a uniform consistency, so that all determinations of water of plasticity and drying shrinkage would be comparable, but with a series of clays of widely-varying plastic properties, it is impossible to attain a high degree of uniformity in the plastic state, without the use of more elaborate methods than the scope of the investigation warranted.

After thoroughly working (wedging) the plastic mass, it was covered

[1] Report of the Committee on Standards, American Ceramic Society, Reprint from Yearbook, 1921–22, Ohio State University, Columbus, Ohio. Price fifty cents.

[2] Wilson, Hewitt, The Clays and Shales of Washington, Their Technology and Uses, Bull. No. 18, University of Washington, Engineering Experiment Station, Seattle, Washington, October, 1923.

Skeels, F. H., and Wilson, Hewitt, Preliminary Report on the Clays of Idaho. Bull. No. 2, Department of Mines and Geology, Idaho, 1920.

Parmelee, C. W., and Schroyer, C. R. Further Investigations of Illinois Fire Clays, Bull. No. 38, pp. 273–417. Illinois Geological Survey, 1922.

Reis, H., The Clays of Kentucky, Ky. Geol. Surv. Series VI, Vol. 8, Frankfort, Ky., 1921.

with wet sacking and seasoned for at least 24 hours before test pieces were prepared.

Test Pieces.

The test pieces were shaped in brass molds, 1¼ in. by 1¼ in. by 8 in., inside dimensions. Full length bars were used for dry transverse-strength tests, and test pieces for drying and firing data were made by cutting the bars into four pieces. A minimum of four 8-in. bars and sixteen 2-in. test pieces were made for all important clays of which there was a sufficiently large sample. The plastic weight and volume of three test pieces were determined as soon as they were molded. All volume measurements were made in a Goodner mercury volumeter.[1]

Drying.

The test pieces and bars were thoroughly air dried in the laboratory, then heated in an automatic electric oven for five hours at a temperature between 64° C. and 76° C. and finally at 105 to 110° C. for at least 12 hours. They were then transferred to a desiccator, where they remained until needed for dry weight and volume measurements, and for the dry transverse-strength test.

Plastic and Drying Properties.

Plasticity: Notes on plasticity and molding properties were made at the time the test bars were molded. There is no satisfactory standard test or even a standard nomenclature to describe the plasticity of a clay in unambiguous terms. The term 'good plasticity' means a different condition to the common brick worker than it does to a stoneware worker. In general, the plasticity terms used in this report bear some relation to the typical uses of the clay in question. The words 'short,' 'weak,' 'crumbly,' 'smooth,' and 'sticky' are used wherever they serve to clarify the meaning of the more general words 'poor,' 'fair,' 'good,' and 'excellent.'

Some shales and indurated clays can be rendered more plastic by fine grinding.[2] The test data on such clays are of little value without particular reference to the preliminary preparation of the sample.

Water of Plasticity: The water of plasticity is the amount of water required to render a clay readily workable. It is calculated as a percentage of the weight of the dry clay bar, according to the following formula:

$$\text{Per cent water of plasticity} = \frac{\text{plastic weight—dry weight}}{\text{dry weight}} \times 100 \qquad (1)$$

Shrinkage Water: The water that is removed from a clay while it is shrinking from the plastic to the dry state is called the shrinkage water. It is calculated as follows:

$$\text{Per cent shrinkage water} = \frac{\text{Plastic volume—dry volume}}{\text{dry weight}} \times 100 \qquad (2)$$

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[1] Goodner, E. F., A Mercury Volumeter, Jour. Am. Cer. Soc. Vol. 4, p. 228, 1921.

[2] Walker, T. C., The Effect of Fine Grinding on an Industrial Clay. Jour. Am. Cer. Soc., Vol. 10, p. 449, June, 1927. (A Southern California clay was used in this study.) See also the results on sample No. 282, this report, page 282.

Pore Water: Pore water is that portion of the water of plasticity that is retained in the pores after shrinkage ceases. It is calculated as follows:

$$\text{Per cent pore water} = \text{per cent water of plasticity} - \text{per cent shrinkage water} \qquad (3)$$

Clays in which the percentage of shrinkage water is high may have excessive or sticky plasticity, and usually must be carefully dried to prevent warping or cracking. According to A. V. Bleininger,[1] the ratio of pore to shrinkage water should not exceed 1.00 for bond clays, nor 0.75 for strong heavy plastic clays.

Shrinkage: Drying shrinkage is most accurately determined by determining the volume shrinkage, then calculating the linear from the volume shrinkage. Volume shrinkage is calculated as follows, in percentage of dry volume.

$$\text{Per cent dry volume shrinkage} = \frac{\text{plastic volume} - \text{dry volume}}{\text{dry volume}} \times 100 \qquad (4)$$

The linear drying shrinkage, in per cent of dry length, is calculated as follows:

Calculated linear drying shrinkage =

$$\left[\sqrt[3]{1 + \frac{\text{dry volume shrinkage}}{100}} - 1\right] \times 100 \qquad (5)$$

In addition to calculated values of linear drying shrinkage, direct measurements were made by means of shrinkage marks on the 8-in. bars. These measurements are not reported, as they are inaccurate, and serve only as an approximate check on the calculated values.

For many purposes, the drying shrinkage is expressed in per cent plastic volume or length. Either of these may be calculated from the data given in this report by means of the following formulæ:

Volume drying shrinkage, per cent plastic volume =

$$\frac{\text{volume drying shrinkage, per cent dry volume}}{100 + \text{volume drying shrinkage, per cent dry volume}} \times 100 \qquad (6)$$

Linear drying shrinkage, per cent plastic length =

$$\frac{\text{linear drying shrinkage, per cent dry length}}{100 + \text{linear drying shrinkage, per cent dry length}} \times 100 \qquad (7)$$

Linear drying shrinkage, per cent plastic length =

$$\left[1 - \sqrt[3]{1 - \frac{\text{vol. dry. shrink., \% plastic vol.}}{100}}\right] \times 100 \qquad (8)$$

For convenience in making the large number of calculations for this report, tables of values were prepared for equations (5) and (8). As will be noted later, equation (8) is the proper form to use for the calculation of linear firing shrinkage, in per cent of dry volume.

Dry Transverse Strength: The dry modulus of rupture was determined on practically all of the clays tested. The 8-in. dried test bars

[1] Bleininger, A. V., Properties of American Bond Clays, etc., U. S. Bur. of Standards, Tec. Paper No. 144, p. 51, 1920.

were of such a length that one 5-in. break and two 3-in. breaks could be obtained on each bar. The bars rested on ½-in. rollers, and the pull stirrup also was equipped with a roller-bearing surface, so that the danger of shear breaks was minimized. No difference was noted in the average values obtained on the 5-in. and the 3-in. breaks. At least ten breaks were made on all clays of which sufficient material was available for making the requisite number of test bars. A variation of plus or minus 15% from the average modulus of rupture was allowed, and at least eight out of ten breaks came within these limits, unless noted in the text by the approximation symbol (±). Where necessary, the tests were repeated until a set of consistent results was obtained.

The modulus of rupture is calculated by the following formula:

$$\text{Modulus of rupture, lb. per sq. in.} = \frac{3 \times \text{breaking load in pounds} \times \text{distance between supports in inches}}{2 \times \text{breadth in inches} \times (\text{depth in inches})^2} \quad (9)$$

On the stronger clays, especially on the 3-in. breaks, it was necessary to use a lever with a ratio of 2.86. The lever ratio is multiplied by the breaking load to determine the breaking load at the point of application for use in equation (9).

A nomograph was used to minimize the calculations involved.

The following classification of clays by modulus of rupture is used in the text of this report:

	Low	Medium low	Medium	Medium high	High
Modulus, lb. per sq. in.____	0 to 100	100 to 200	200 to 400	400 to 800	above 800

This is the same classification as that suggested by Watts [1] for bonding strength (*q. v.* below) and is an elaboration of that used by Parmelee and Schroyer.[2]

Bonding Strength: The modulus of rupture of dried bars containing equal parts of clay and standard Ottawa sand [3] is known as the bonding strength. It is of importance in all clays that are to be used with non-plastic material. A few bonding strength determinations were made for this report. See samples No. 83, 273 and 280, pages 297, 273 and 305. It was intended to include more of these determinations, but it was found that to do so would unnecessarily delay the publication of this report. For an especially interesting comparison between dry modulus of rupture and 'bonding strength,' the reader is referred to the test results of Parmelee and Schroyer.[4] It will be noted that in some cases the bonding strength is higher than the dry modulus, but that in general the addition of 50% of sand to a clay lowers the transverse strength by 30% to 60% of its original value.

Fineness: The percentage of non-plastic material remaining on a 200-mesh (0.0029 in. aperture) screen was determined for most of the clays tested. Fifty grams of the clay was taken, broken in a mortar and passed through a 10-mesh screen. The sample was placed in an

[1] Watts, A. S., Classification of Clays on a Ceramic Basis. Jour. Am. Cer. Soc., Vol. 3, p. 247, 1920.
[2] Parmelee, C. W., and Schroyer, C. R., *op cit.*, p. 293.
[3] Standard sand is sized between the limits of minus 20-mesh (0.0328 in. aperture) and plus 28-mesh (0.0232 in. aperture). It is used in the testing of cement.
[4] *Op. cit.*

Erlenmeyer flask with 150 cc. of distilled water and 1 cc. of ammonia. The pulp was thoroughly shaken, let stand for 18 hours, and agitated for 10 minutes in a shaking machine such as that commonly used in the phosphorus determination in steel. The pulp was transferred to a 200-mesh screen, and all undersize was washed through the screen with a fine jet. The oversize was dried and weighed, and the result reported in per cent of plus 200-mesh material.

Firing Properties.

Firing Treatment: A test piece of each clay was fired to each alternate cone number from cone 010 to cone 13, except where insufficient

Photo No. 67. Assay laboratory, Stanford University, showing muffle furnaces in which test pieces were fired.

material was available to make enough test pieces for the complete series. In addition, most of the refractory clays were fired to cone 15. Denver Fire Clay Company oil-fired assay muffle furnaces were used for all firing from cone 010 to cone 13. These furnaces, shown on photo No. 67, were very satisfactory for the purpose, as the temperatures could be readily controlled, and since ten furnaces were available, it was possible to place one or two sets of 30 samples in each muffle. If two sets of test pieces were placed in the same muffle, the set in the rear of the muffle was fired to two cones higher temperature than the set in the front, and the two sets were separated from each other by a full sized fire brick. This method of firing eliminated most of the transferring of test pieces to a cooling furnace that is a disagreeable and unsatisfactory feature of most test work of this kind. The bottom tiers of test pieces were kept from contact with the muffle floor by placing them on small fireclay saddles. The furnace that was used for firing to cones 11 and 13 was equipped with a Carbofrax muffle, and with Carbofrax stools and muffle protector plates. It was difficult to fire to these temperatures without flashing the test pieces.

A Fisk [1] pre-mix gas-fired kiln was used for firing to cone 15. This furnace, shown on photo No. 68, has a 12-in. circular firing chamber,

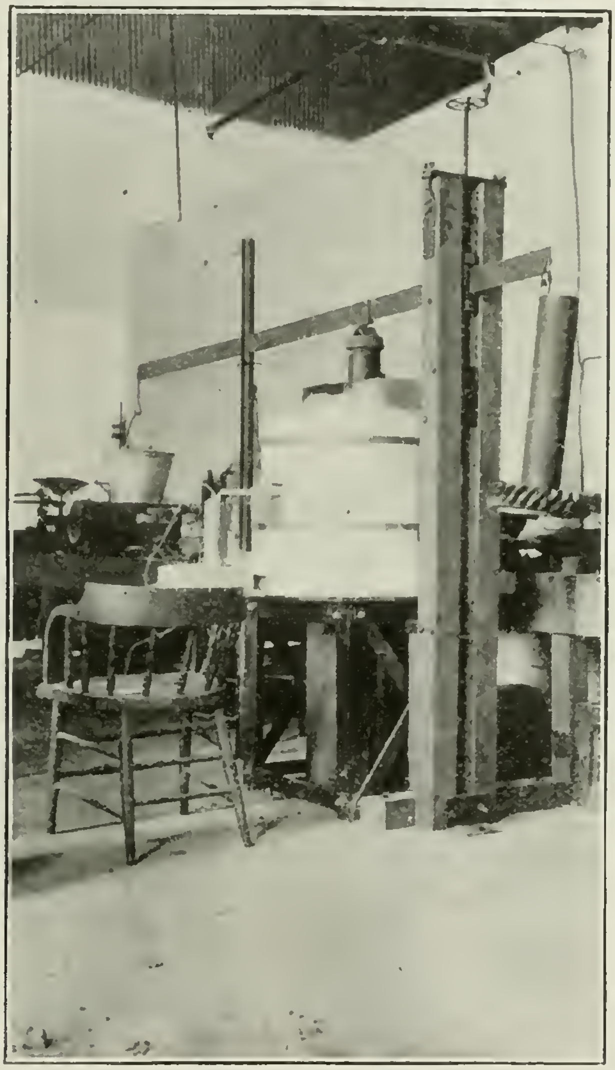

PHOTO No. 68. Fisk pre-mix gas-fired laboratory kiln, in ceramic laboratory, Stanford University. This is used as a load and spall furnace and for firing tests to a maximum temperature of cone 30 (1650° C.). All cone 15 tests were fired in this kiln.

and is capable of accurate temperature control and good heat distribution. The same furnace is used for load and spall tests of refractories, and is suitable for test work up to cone 30 (1650° C.).

Pyrometric Control: Temperatures were controlled with the aid of base-metal or precious-metal thermocouples, in addition to Orton standard pyrometric cones alongside the test pieces. The firing schedule

[1] Fisk, H. G., A Practical Gas-Fired Test Furnace for Plant Use. Jour. Am. Cer. Soc., Vol. 9, p. 151, March, 1926.

was at a rate 50% faster than the fastest schedule recommended by the American Ceramic Society, averaging approximately 90° C. per hour, but at a slower rate during the water-smoking period, a faster rate between the range of 600° C. and 100° C. below the desired finishing temperature, and a slower rate again at the finish. While this schedule caused more shattering and splitting of some of the test pieces than would have been the case if a slower schedule had been followed, the data on shrinkage and porosity at various firing temperatures are comparable with each other, and can be correlated with the results that have been reported by other investigators.[1] In the final analysis, no laboratory tests of clays can be interpreted in a strict quantitative sense with the results obtained in commercial practice, and the purpose of the small-scale tests is to tentatively classify a given clay according to its commercial uses with the minimum expenditure of time and money. The final decision as to the utility of a clay and the methods of working it to obtain the best results, must always be determined in a commercial plant, where the shaping, drying and firing can be done on full-sized ware.

For convenience of reference, the end points of Orton cones are given in degrees Centigrade and Fahrenheit, in table No. 9.

TABLE No. 9.

End Points of Orton Pyrometric Cones, in Centigrade and Fahrenheit Degrees (Heated in Air).

(From Fairchild, C. O., and Peters, M. F., Characteristics of Pyrometric Cones, Jour. Amer. Cer. Soc., Vol. 9, p. 738, 1926.)

	End point			
	Heated at 20° C./hr.		Heated at 150° C./hr.	
Cone No.	° C.	° F.	° C.	° F.
022	585	1085	605	1121
021	595	1103	615	1139
020	625	1157	650	1202
019	630	1166	660	1220
018	670	1238	720	1328
017	720	1328	770	1418
016	735	1355	795	1463
015	770	1418	805	1481
014	795	1463	830	1526
013	825	1517	860	1580
012	840	1544	875	1607
011	875	1607	905	1661
010	890	1634	895	1643
09	930	1706	930	1706
08	945	1733	950	1742
07	975	1787	990	1814
06	1005	1841	1015	1859
05	1030	1886	1040	1904
04	1050	1922	1060	1940
03	1080	1976	1115	2039
02	1095	2003	1125	2057
01	1110	2030	1145	2093
1	1125	2057	1160	2120
2	1135	2075	1165	2129
3	1145	2093	1170	2138
4	1165	2129	1190	2174
5	1180	2156	1205	2201
6	1190	2174	1230	2246
7	1210	2210	1250	2282
8	1225	2237	1260	2300
9	1250	2282	1285	2245
10	1260	2300	1305	2381
11	1285	2345	1325	2417
12	1310	2390	1335	2435
13	1350	2462	1350	2462
14	1390	2534	1400	2552
15	1410	2570	1435	2615
16	1450	2642	1465	2669
17	1465	2669	1475	2687
18	1485	2705	1490	2714
19	1515	2759	1520	2768
20	1520	2768	1530	2786
23	In Arsem		1580	2876
26	furnace at		1595	2903
27	600° C. (=1080° F.)		1605	2921
28	per hr.		1615	2939
29			1640	2984
30			1650	3002
31			1680	3056
32			1700	3092
33			1745	3173
34	1755	3191	1760	3200
35	1775	3227	1785	3245
36	1810	3290	1810	3290
37	1830	3326	1820	3308
38	1850	3362	1835	3335
39	1865	3389		
40	1885	3425		
41	1970	3578		
42	2015	3659		

[1] See in this connection: Brown, G. H., and Murray, G. A., The Function of Time in the Vitrification of Clays, Trans. Am. Cer. Soc., Vol. XV, p. 193, 1913.

Firing Shrinkage: The shrinkage resulting from firing may be expressed as the per cent volume or linear shrinkage, in terms of plastic or dry volume or length. The data in this report are given in terms of volume and linear shrinkage, dry basis, and in the written summaries of each clay, the maximum total linear shrinkage, plastic basis, is given. The equations for calculating these various methods of expressing fired shrinkage from the volume determinations are as follows:

Volume firing shrinkage, per cent dry volume =

$$\left[\frac{\text{dry volume—fired volume}}{\text{dry volume}}\right] \times 100 \qquad (10)$$

Linear firing shrinkage, per cent dry length =

$$\left[1 - \sqrt[3]{1 - \frac{\text{volume firing shrinkage, \% dry volume}}{100}}\right] \times 100 \qquad (11)$$

(See equation 8)

Total linear shrinkage, per cent plastic length =

$$\left[\frac{(\text{lin. dry shrink., \% dry length} + \text{lin. firing shrink. \% dry length})}{100 + \text{lin. dry shrink., \% dry length}}\right] \times 100 \qquad (12)$$

All fired volume measurements were made in the mercury volumeter after saturating the test pieces with water[1] and weighing them for the absorption and apparent porosity calculations. In this way, the volume measurements approximate the bulk, or outside, volume of the test pieces, as the mercury does not readily enter the small pores and displace water, during the short time of contact in the volumeter. However, some mercury undoubtedly enters the larger of the open pores (excluding from consideration all vugs, cavities and drying or firing cracks), hence the calculations of volume and linear firing shrinkage, as well as those of absorption, apparent porosity, apparent specific gravity, and apparent density, are slightly erroneous.

Absorption: The absorption of fired test pieces was determined by noting the weight of water absorbed by boiling the piece in distilled water for two hours.

$$\text{Per cent absorption} = \left[\frac{\text{saturated weight—dry fired weight}}{\text{dry fired weight}}\right] \times 100 \qquad (13)$$

Apparent Porosity: Apparent porosity is the ratio between the volume of the unsealed pores and the volume of the whole piece (=bulk volume). It is calculated from the following equation:

$$\text{Per cent apparent porosity} = \left[\frac{\text{saturated weight—dry fired weight}}{\text{fired volume}}\right] \times 100 \qquad (14)$$

Apparent Specific Gravity: Apparent specific gravity or bulk specific gravity is the relation between the weight of a mass of material as a whole and that of a volume of water equal to the volume of the solid material plus the sealed pores[2]. No values of apparent

[1] The pieces were boiled in distilled water for at least two hours, then allowed to cool in the water. Before weighing, the surplus water was removed from the surface of the test pieces with a damp cloth.

[2] Searle, A. B., The Chemistry and Physics of Clays and other Ceramic Materials, p. 203.

specific gravity are given in this report, but they may be calculated for the fired test pieces from the absorption and apparent density, if these are not zero, according to the following equation:

$$\text{Apparent specific gravity} = \frac{\text{per cent apparent porosity} \times 100}{\text{per cent absorption} \times (100 - \text{per cent app. porosity})} \qquad (15)$$

Apparent Density: Apparent density or bulk density is the relation between the weight and volume of an article or material as a whole (including any pores or voids) and that of the weight of an equal volume of water[1]. Values of apparent density are not given in this report, but if the absorption and apparent porosity are not zero, the apparent density can be calculated as follows:

$$\text{Apparent density} = \frac{\text{per cent apparent porosity}}{\text{per cent absorption}} \qquad (16)$$

True Specific Gravity: True specific gravity is the relation between the weight of a substance and the true volume of the grains of which the material is composed. On porous materials, which may contain sealed pores, the sample must first be ground to a fine powder to remove all pores.. The true specific gravity of the powder is then determined by means of a specific gravity bottle or pycnometer. No such determinations were made for this report, nor can they be calculated from the data available. In many cases, the apparent specific gravity closely approximates the true specific gravity.

Softening Point.

The softening point of a clay or ceramic mixture is defined as that temperature (usually expressed in cone numbers) at which a standard tetrahedron of the clay when mounted and heated in a manner hereafter described, will bend until it touches the base upon which it stands. The standard tetrahedron is the same size and shape as the small Orton standard pyrometric cones, 7 mm. along the edge of the base and 30 mm. high. The word 'cone' is in general use to describe these tetrahedra. The test cones are mounted on a plaque of refractory material, and are embedded not more than 2 mm. in the plaque, at an angle of 75° from the horizontal.

The terms 'fusion point' or 'deformation point' are often used interchangeably with 'softening point.' 'Fusion point' should be used to indicate the temperature at which complete loss of the original shape occurs, and 'deformation point' is best applied to the temperature at which alteration of the original shape begins.

The softening-point determinations recorded in this report were made in an oxy-acetylene furnace, after a design by Hewitt Wilson.[2] An illustration of the furnace is given in photo No. 69.

Six cones were placed on each plaque, which were usually made from alundum cement. The cones were arranged in two rows of three each, back to back, and were spaced as close together as possible. The

[1] Searle, *op. cit.*
[2] Wilson, Hewitt, An Oxygen-Acetylene High-Temperature Furnace. Jour. Am. Cer. Soc., Vol. 4, p. 835, 1921.

four cones at the corners were Orton standard cones, and the two middle cones were of the clay to be tested. Preliminaries were first run, with four different standard cones in the corners, and usually with different unknown cones in the middle positions. A final check was always made with two cones of the same clay in the middle positions, a pair of standard cones of one number on one side, and a pair of standard cones of the next higher (or lower) number on the other side of the plaque.

After the furnace was heated to the desired temperature, each fusion normally required from three to six minutes. All cones of clays tested for this report were biscuited at 1800° F. before setting

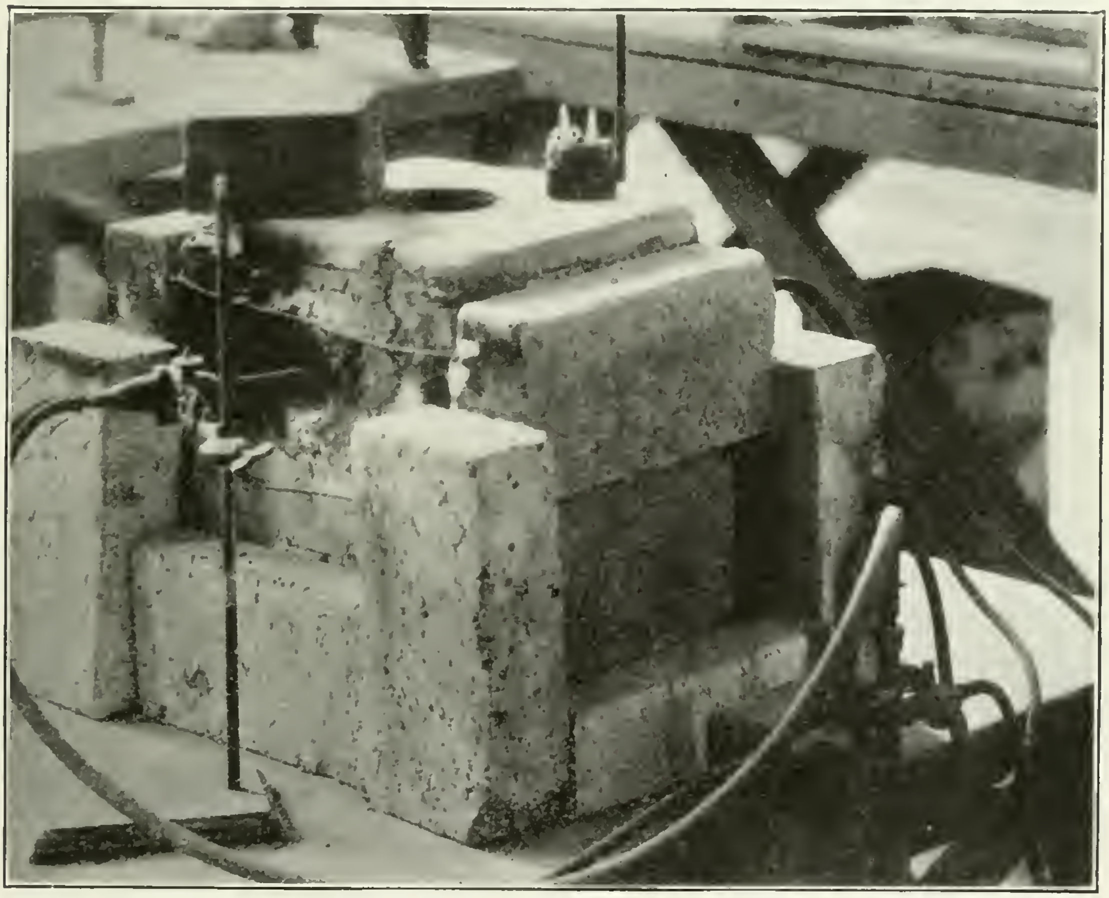

PHOTO NO. 69. Wilson oxy-acetylene cone fusion furnace in ceramic laboratory, Stanford University. (After design of Prof. Hewitt Wilson.)

in plaques for the softening-point determination. If this is done, and if the plaques are dried, and pre-heated by placing on top of the furnace, they may be introduced into the hot furnace without danger of spalling.

The results are reported to the nearest half-cone number, using the notation A–B (*e.g.*, 31–32) to signify that the softening point lies nearer to A$\frac{1}{2}$ than to either A or B. Closer estimation, such as A —, A +, B —, or B +, was not considered to be justified by the limits of accuracy of the method itself, and leads to indefiniteness in that such notations might be read to signify 'less than' or 'greater than,' without setting the maximum or minimum range of the values as reported.

For the purposes of this bulletin, all clays having a softening point of cone 27 or higher are classified as refractory, and those which fuse at cone 33 or above are considered to be highly refractory.[1]

Texture, Structure, and Hardness.

Texture: The texture of dried and fired test pieces is reported as fine-, medium-, or coarse-grained, depending upon the average size of the grains in the mass, and as close- or open-textured, depending upon the grading of the grains. This classification is used in order to permit a distinction between those clays that may contain a large proportion of non-plastic grains that approximate uniform size, and those that contain clay and graded non-plastic grains in such proportions as to give a closely knit, dense texture.

Structure: The structure of fired test pieces is reported as granular, stony, homogenous (with textural qualifications), or heterogeneous (with textural qualifications). The soundness of a fired test piece is indicated by such terms as sound, hair-cracked (the development of what many ceramic workers term 'crow-feet'), shattered, or as containing one or more small or large cracks.

Hardness: The hardness of the fired test pieces is reported as greater or less than finger-nail ($=2\frac{1}{2}$ in Moh's scale) or steel ($=5\frac{1}{2}$ in Moh's scale). The hardness of dried clays is reported as very soft, soft, medium, equal to the finger-nail, or greater than the finger-nail.

Color.

The natural and fired colors of clays and ceramic products are too often expressed in indefinite terms that can not be duplicated by other investigators. Since the fired color of a clay or clay mixture is one of its most important properties, some standard scale of colors should be used. For that reason, more attention is paid in this work to an accurate designation of color than is customary in similar publications. While the colors obtained under laboratory firing conditions are not exactly the same for each firing temperature as would be obtained in commercial kilns, the color possibilities of a given clay are clearly indicated by the laboratory tests.

The two principal standard color scales in use in the United States are the Ridgway[2] and the Munsell[3] systems.[4] For reasons hereafter noted, the Ridgway system is used in this bulletin. Since this is, so far as is known, the first time that either system has been used in a bulletin of this nature, a brief explanation of color terms and of each of the systems is given, together with an approximate correlation of parts of the two systems with each other.

To adequately express a color, three variables must be used:[5] (1) Hue, or the series of spectrum colors and their intermediates, through

[1] Parmelee, C. W., and Schroyer, C. R., *op. cit.*, p. 281.

[2] "Color Standards and Color Nomenclature," by Robert Ridgway. Published by A. Hoen and Company, Baltimore, Maryland, 1912. Price $12.

[3] "A Color Notation," by A. H. Munsell, 7th edition, 1926 (price $2), and "Atlas of the Munsell System," 1915 (price $25), both published by the Munsell Color Company, Baltimore, Maryland.

[4] Lenchner, Theodor, "A Study of Color and Its Application to Ceramic Art," Jour. Amer. Cer. Soc., Vol. 10, p. 538, July, 1927, in which a combination of the Munsell and the Prang (an earlier work) systems is proposed.

[5] In preparing this paragraph, Munsell's "A Color Notation" was freely drawn upon.

red, orange, yellow, green, blue and violet. Hue can be accurately expressed by determining the wave length of the light waves of each color sensation. (2) Tone or value, by which a light color is distinguished from a dark one. When white is added to a color, various tints result, and when black is added, the shades are produced. Tone can be measured by means of a photometer, and is expressed scientifically in terms of the amplitude of the light waves reflected by the color. (3) Chroma, by which strong colors are distinguished from weak ones. It is the effect produced by adding neutral gray to a hue of any given tone. Scientifically, it is the purity of one wave length separated from all others.

Ridgway Color Standards: The key to the Ridgway classification consists of 36 hues, which include the six fundamental spectrum colors, red, orange, yellow, green, blue, and violet, which are connected by intermediate hues. The chromatic scale forms the horizontal line of the entire series of charts. The vertical scale on all charts, except the carbon-gray series, represents the tone (Munsell's "value") or luminosity. That is, the proportion of black or white which is mixed with the full color.

The first series of Ridgway's plates contains the pure colors. This series is repeated five times with successively increasing amounts of neutral gray, but with some hues omitted in the last three series. These series are designated "broken color scales" by Ridgway, but Munsell's term "chroma" is to be preferred.

The complete designation of a color from Ridgway's charts therefore involves the use of three symbols: (1) an arabic numeral to designate the hue; (2) the superscript (′ to ′′′′′) to indicate the chroma; and (3) a lower-case letter to designate the tone (or value). Thus, 5′k is a hue containing 60% red and 40% orange, shaded with 70.5% of black, and the whole mixed with 32% of neutral gray. The result is a brick red. It is possible to interpolate between the Ridgway colors whenever an exact match can not be found, and these can be designated by the alternate symbols that are omitted from the color charts. No attempt was made to express the clay colors in this bulletin closer than the nearest Ridgway number.

Expressed in common color names, the Ridgway hues 1, 3, 5 and 7 either of tone "b" or unaltered as to tone, are "red"; 9, 11, 13 and 15 of the same tones are "orange"; and 17, 19, 21 and 23 of the same tones are "yellow." Colors that would be classed as "pale" or "very light" are of tone "f." "Pink," "light orange," "light yellow," "buff," etc., are tone "d." The "i" tones, as well as the "k" tones in hues 1, 3 and 5, are those that would be designated as "dark." The "k" tones, except in hues 1, 3 and 5, are "browns"; for example, "red-brown." The "m" tones are "dark-browns." With respect to chroma, the pure spectrum series is purer than will be found in most ceramic products, although many glazes fall into this class. The (′) series includes most glazes, especially matt glazes, as well as the more brilliantly colored red- and pink-burning bodies. The (′′) series includes the greater portion of all pink-, buff-, and red-burned clay products. The (′′′) series includes colors that are generally too dull for artistic purposes. The (′′′′) and the (′′′′′) series are decided grays, of little interest in decorative wares.

Munsell Color Standards: The Munsell system uses the conception of a sphere to evaluate the three color constants. Each of the constants is theoretically divided into ten equal parts. Hue is the horizontal scale around the circumference of the sphere, and is designated by an upper-case letter representing an abbreviation of the color, as red (R), yellow-red (YR), Yellow (Y), etc. These letters are preceded by a numeral from 1 to 9 to represent the position of the color in the scale of hues. For example, "5R" is the "middle hue" of red. These symbols are followed by a fraction, the numerator of which designates the value and the denominator of which designates the chroma. "Value" is represented as the vertical axis of the color sphere, with white (value 10) at the top and black (value 0) at the bottom, but samples are shown only for values 2 to 9, inclusive. "Chroma" is traced by radii at right angles to the vertical axis of the sphere. An approximation of Ridgway's 5′k is given in the Munsell system as 7R 3/7 but the nearest color actually shown on the charts is 5R 3/7, which lies between Ridgway's 1′k and 1′m.

Ridgway vs. Munsell: The Ridgway system was chosen for this work in preference to the Munsell system for the following reasons: (1) Ridgway's system includes 1115 named and systematized colors, whereas the Munsell Atlas contains but 340 different colors, which, however, are completely duplicated in two different arrangements, and partly duplicated in two other arrangements. (2) The Ridgway system has 36 colors in the scale of hues, whereas the Munsell system presents but 10 different hues. Each system uses the same number of subdivisions in the scale of tone. While the Munsell system provides for a maximum of 10 divisions of chroma compared to 6 for the Ridgway charts, not all of these divisions are used on all tones and hues in either system and the average chroma scale has approximately the same number of divisions in each system. As noted by by Lenchner[1] the Munsell system would be greatly improved by the addition of more hues. (3) The Ridgway charts are bound in an octavo book, of approximately one-third the bulk and weight of the Munsell Atlas, yet each color has an area of 0.5 sq. in., compared to 0.4 sq. in., and the minimum space between each color sample is $\frac{1}{4}$ inch, compared to $\frac{1}{8}$ inch on the Munsell charts. These are important factors influencing the efficiency of use of the two systems for the purpose of matching colors. The charts in either system may be removed from the book, and mounted side by side on a wall or table, preferably under glass. In this case, the Ridgeway charts occupy a minimum space of 10.3 sq. ft., and the Munsell charts occupy 11.2 sq. ft. When so arranged, the Ridgway system still possesses a distinct advantage in the time required to match a color and record it accurately. (4) All of the Ridgway colors are named, as well as numbered. This is frequently of value in preparing written descriptions, and for other purposes. (5) The Ridgway system costs less than half as much as the Munsell system, and there is no difference in the life of the colors when exposed to light, hence replacements of Ridgway's charts can be made more cheaply when the colors have faded.

A tabulation of the Ridgway colors most frequently used in this report is given in Table No. 10, with an approximation of the corres-

[1] *Op. cit.*

ponding Munsell color. This comparison was made visually by three persons [1] independently, and average values are reported. This correlation makes no claim to scientific accuracy but approximates the result that would be obtained by the average user of either set of charts.

TABLE No. 10.

Visual Correlation of Certain Ridgway Colors with Munsell Colors.

Ridgway symbol	Approximate Munsell equivalent	Ridgway symbol	Approximate Munsell equivalent	Ridgway symbol	Approximate Munsell equivalent
5'i	7R 5/9	3"d	1R 7/4	17"f	2YR 8/4
k	7R 3/7	b	4R 6/5	d	6YR 8/4
m	6R 3/4	_	3R 5/7	b	7YR 7/7
7'f	7R 8/4	i	5R 4/5	_	7YR 6/5
d	8R 7/6	5"f	3R 7/3	i	7YR 5/5
b	8R 6/8	d	5R 7/4	19"f	7YR 8/3
_	9R 5/8	b	5R 6/5	d	9YR 8/5
i	9R 4/7	_	5R 5/7	b	9YR 7/7
k	9R 4/6	i	7R 4/5	_	9YR 6/7
m	7R 3/4	k	7R 3/4	i	9YR 5/6
9'f	8R 8/4	m	7R 3/3		
d	9R 7/5	7" f	6R 8/3	1'''f	6RP 8/2
b	1YR 6/7	d	7R 7/4	d	6RP 7/4
_	1YR 6/8	b	9R 6/5	b	9RP 6/4
i	2YR 5/7	_	9R 5/7	5'''f	9RP 8/2
k	1YR 5/7	i	9R 4/5	d	9RP 7/3
m	9R 3/4	k	9R 4/4	b	3R 6/4
11'f	9R 8/4	m	8R 3/4	_	3R 5/4
d	3YR 8/5	9"f	6R 8/4	i	3R 4/4
b	3YR 7/7	d	9R 7/6	9'''f	4R 8/2
_	3YR 6/8	b	9R 6/5	d	4R 8/2
i	3YR 5/7	_	9R 5/6	b	4R 6/4
k	4YR 4/5	i	1YR 5/5	_	6R 5/4
m	5YR 3/5	k	1YR 4/3	i	8R 4/4
13'f	5YR 8/5	m	1YR 3/4	k	8R 3/4
d	3YR 8/5	11"f	7R 8/3	13'''f	5R 8/1
b	3YR 7/7	d	2YR 7/5	d	5R 8/2
15'f	4YR 8/5	b	1YR 6/6	b	7R 7/3
d	6YR 7/7	_	1YR 5/6	_	1YR 5/4
b	7YR 7/8	i	2YR 5/6	i	2YR 4/4
17'f	7YR 8/5	13"f	9R 8/3	k	3YR 4/3
d	7YR 8/5	d	3YR 8/5	17'''f	5YR 8/2
b	9YR 7/8	b	3YR 7/7	d	3YR 7/3
19'f	5Y 8/6	_	3YR 6/6	b	4YR 6/3
		i	3YR 5/6	_	7YR 6/3
1"f	2R 7/3	15"f	9R 8/4	i	7YR 5/3
d	8RP 7/4	d	4YR 8/5	k	8YR 4/2
b	1R 7/5	b	3YR 6/6	21'''f	4Y 8/2
_	3R 5/5	_	4YR 6/6	d	6Y 8/3
3"f	3R 7/3	i	5YR 5/5		

Color Classification of Clays: The clays described in this report are classified as to color into four groups, following Parmelee and Schroyer,[2] but definitely fixing the boundaries of each group by the use of Ridgway's colors. The classification is as follows:

I. Clays Burning White or Cream Colored, not Calcareous. Into this group are placed all clays that fire at the highest firing temperatures used, to tones nearer to white than Ridgway's ''f'' tones. There is need for an extension of standard color nomenclature into this range,[3] but in lieu of a well-established system, the terms ''yellowish- white,'' ''pinkish-white,'' ''grayish-white,'' etc., are used in this report. All of the clays in this group fire to colors that are sufficiently good to permit the use of the clay in stoneware bodies, most of them can be used to some extent in sanitary ware and electrical porcelain, if other

[1] Prof. F. G. Tickell, Stanford University, Mrs. Bernice L. Tickell, and the author.

[2] Parmlee, C. W., and Schroyer, C. R., "Further Investigations of Illinois Fire Clays," Ill. Geol. Surv. Bull. No. 38, p. 278.

[3] See in this connection: Lofton, R. E., A Measure of the Color Characteristics of White Papers, U. S. Bur. Std. Tech. Paper 244, 1923.

properties are suitable, and a few are white enough for use, when washed free from sand, in place of English china clay.

II. Buff-Burning Clays. Into this class are placed all clays that fire to tones corresponding to Ridgway's "f" tones, all "d" tones from hue 9 to 19, inclusive, and all "b" tones from hue 15 to 19, inclusive. Exceptions are noted in group IV.

III. Clays Burning Red, Brown, or Other Dark Colors. Into this group are placed all clays, excepting those of group IV, that fire to colors darker than those of group II.

IV. Clays burning Dirty White, Cream White, or Yellowish White. The clays of this group are mainly calcareous or magnesian, and color is not an important criterion.

Chemical Analysis.

The relative value of chemical analyses in the study of clays has been well summarized by Hewitt Wilson[1] as follows:

"Chemical analysis provides its most effective usefulness, in the case of the high-grade clays, in estimating the degree of purity of the white-burning, kaolin-like materials and the alumina-silica-flux ratio in the fire clays, but in the case of the red- and brown-burning structural-ware clays, the impurities furnish the most important data. We can but guess the fired color, strength, shrinkage, porosity, and vitrification range from the analytical data and for these properties, must rely on practical firing tests. If the chemical analysis is complete, however, it gives a good idea of the troublesome materials present, *i.e.*, those which cause early fusion, short vitrification range, scumming, and troublesome gases which delay oxidation. It happens that the usual commercial chemical analysis does not include carbon and sulphur and other troublesome impurities except when combined with water of chemical combination and called 'ignition loss' or 'volatile matter.' Likewise, a complete chemical analysis of the complicated silicate mixture called 'clay' is a difficult analytical procedure, and many hundreds of the analyses are inaccurate.

"In studying clays of the whiteware and fire-clay type, a knowledge of the chemical composition is always desirable, but it must be assigned a secondary value because of the influence and modification of the physical properties. Clays of the fire-clay type must primarily have a composition corresponding to refractory clays. But this is not enough. For instance, there are in the United States a large number of clays of practically the same composition as the imported European plastic fire clays, so highly prized for glass-pot, brass, and steel-crucible work, but which fail completely in satisfying the physical, dry, and fired requirements. A cone fusion test costs less in time and money than a chemical analysis. The best way to determine the refractory value of a clay, having given only the chemical analysis, is to translate it to terms of cone fusion.

"When physical tests of clay bodies are not satisfactory and changes are desired, the chemical analysis will often locate the trouble and indicate the proper remedy."

Relatively few chemical analyses were made for the purpose of this report. A few typical samples were selected from those clays whose ceramic properties were studied in the laboratory, and analyses were made in the Stanford University ceramic laboratory, using the methods recommended by the American Ceramic Society.[2] Practically all of these analyses were made in duplicate or triplicate, and exceptional precautions were taken to insure accuracy, especially in the determinations of alumina and silica, which are so often inaccurately reported. A few analyses of laboratory samples were made by K. W. Baum, of the Stevenson Engineering Company. Analyses of various California clays were submitted by some of the clay manufacturers in the state, or were found in the literature. Where these apply to definite clay beds that were sampled by the author, the analyses are included under the clay sample number to which they refer. It must be understood, however, that such analyses were not made on the same sample as that which was tested in the laboratory, hence some of them do not correlate

[1] Ceramics, pp. 45–46. McGraw-Hill Book Co., 1927.

[2] Report of the Committee on Standards, Amer. Cer. Soc., reprint from Yearbook, 1921–1922.

very well with the ceramic properties noted. Another group of analyses is included of clays not studied by the author. Most of these are from the San Joaquin Valley, and were contributed by K. W. Baum.

For convenience of reference, the analyses are grouped according to the clay classification used in this report, and are to be found near the end of Chapter V.

Classification of Clays.

The clay classification used in this report is essentially that of Parmelee,[1] but is presented in a simplified form. This classification is based upon the physical properties that determine the important uses of a given clay. The modified classification follows, with notations to correlate it with that of Parmelee.

I. CLAYS BURNING WHITE OR CREAM COLORED, NOT CALCAREOUS.[2]

A. Open-burning clays, *i.e.*, having an apparent porosity of 6% or more at cone 15.

The dividing line between open-burning and dense-burning clays is placed at 5% in Parmelee's classification. In this report the dividing line is at 6% in order to make some allowance for the more-rapid firing cycle used.

Parmelee states "still distinctly porous at cone 15."

1. Low strength, dry modulus less than 200 lb. per sq. in., *e.g.*, residual kaolins and sandy fireclays.

It is not clear whether Parmelee intends to include sandy fireclays in this group.

2. Medium and high strength, dry modulus exceeding 200 lb. per sq. in., *e.g.*, secondary kaolins.

Open-burning clays are valuable in the manufacture of pottery because of good color or good strength and good color. They are often highly refractory, and may be of value for special refractories.

B. Clays burning dense, *i.e.*, have less than 6% apparent porosity between cones 10 and 15.

Parmelee states "becoming nearly or completely non-porous between cones 10 and 15."

3. Generally, but not always, refractory.

Parmelee divides this group into three subdivisions, as follows:

"a. Non-refractory clays.

"3. Good color, medium to high strength, medium shrinkage. Uses: Pottery, including certain whiteware, porcelain, stoneware.

"4. Poor color, medium to high strength, medium shrinkage. Uses: Stoneware, terra cotta, abrasive wheels, zinc retorts, face brick, saggers.

"b. Refractory clays.

"5. Good color, medium to high strength, medium shrinkage. Uses: Refractories, especially for glass, if they do not overburden seriously for 5 cones higher. Also uses as stated in Parmelee's No. 3."

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[1] Parmelee, C. W., and Schroyer, C. R., Further Investigations of Illinois Fire Clays, Ill. Geol. Surv. Bull No. 38, pp. 278–9, 1922.

[2] The color limitations used in this report are given on page 251.

C. Dense-burning clays, *i.e.*, having less than 6% apparent porosity between cones 5 and 10.

Parmelee states ". . . become nearly or completely non-porous between cones 5 and 10 and do not overburn seriously at 5 cones higher than the temperature at which minimum porosity is reached."

4. Generally, but not always, refractory.

Parmelee divides this group into five classes, as follows:

"a. Non-refractory clays.

"6. Good color, medium to high strength, medium shrinkage, usually reach minimum porosity between cones 5 and 8. Type: Ball clays. Uses: Pottery, whiteware, porcelain, and stoneware.

"7. Poor color, medium to high strength, medium shrinkage. Uses: Stoneware, terra cotta, abrasive wheels, zinc retorts, face brick, saggers.

"b. Refractory clays.

"8. Non-porous or practically so at cone 5; do not seriously overburn for 12 cones higher; highly refractory; softening point at cone 31 or higher; bending strength minimum 325 pounds per square inch. Use: Graphite crucibles for melting brass.

"9. Non-porous at about 1275° C. (cone 8), not overfiring at 1400° C. or higher. Strength and softening point as above. Use: Steel crucibles.

"10. Become dense at about 1275° C. (cone 8). Do not overburn below 1425° C. Bonding strength, 250 pounds per square inch or higher. Softening point, cone 29 or higher. Use: Glass pots."

II. BUFF-BURNING CLAYS.

A. Refractory clays (softening point, cone 27 or above).

a. Open-burning, *i.e.*, having a porosity of 6% or more at cone 15.

Parmelee states ". . . porosity of 5% or more at cone 15 or above."

5. Low strength. Usually high in non-plastic material.

6. Medium and high strength.

Parmelee uses four subdivisions to cover (5) and (6) as follows:

"Indurated—non-plastic or slightly plastic unless it has been weathered. Type: Flint clay.

"11. Normally aluminous; maximum alumina 40%. Uses: Refractories.

"12. Highly aluminous; alumina exceeds 40%. Type: Diaspore clay. Uses: Refractories, abrasives.

Plastic.

"13. Normally siliceous; maximum silica not exceeding 65%. Uses: Firebrick and other refractory wares, terra cotta, sanitary ware, glazed and enameled brick (see specific requirements).

"14. Siliceous; having a silica content above 65%. Type: Many of the New Jersey fire clays. Uses: Firebrick and other refractories."

b. Dense-burning between cones 10 and 15, *i.e.*, attaining an apparent porosity of 6% or less within that range.

Parmelee states ". . . a minimum porosity of 5% or less . . ."

7. Generally medium to high strength.

This is Parmelee's class 15, and is explained as follows:

"15. Medium to high strength. Do not overburn for 5 cones higher than point of minimum porosity. Uses: Glass pots and other refractories; also used for firebrick, saggers and miscellaneous refractories, architectural terra cotta, sanitary ware, enameled and face brick."

c. Dense-burning, *i.e.*, attaining a porosity of 6% or less at cone 10 or lower.

Parmelee states ". . . a porosity of 5% or less . . ."

8. Generally medium to high strength.

Parmelee divides this group into three classes, as follows:

"16. See (Parmelee's) 8.

"17. See (Parmelee's) 9.

"18. See (Parmelee's) 10.

"These three classes, 16, 17 and 18, are used also for zinc retorts, firebrick, saggers, and miscellaneous refractories, architectural terra cotta, sanitary ware, enameled and face brick."

B. Non-refractory clays.

a. Open-burning, *i.e.*, do not attain a porosity of 6% or less at any cone lower than cone 10.

Parmelee states ". . . a porosity of 5% or less . . ."

9. High or medium strength. Uses: Architectural terra cotta, stoneware, yellow ware, face brick, sanitary ware.

10. Low strength. Use: Brick.

Classes (9) and (10) correspond to Parmelee's 19 and 20, respectively.

b. Dense-burning, *i.e.*, attain an apparent porosity of less than 6% at cones lower than 10.

Parmelee states ". . . a porosity of less than 5% . . ."

11. Generally medium or high strength.

This is Parmelee's class 21, and is described as follows:

"21. High or medium strength. Uses: Architectural terra cotta, stoneware, abrasive wheels, sanitary ware, face brick, paving brick."

III. CLAYS BURNING RED, BROWN, OR OTHER DARK COLORS.

A. Open-burning clays, *i.e.*, those that do not attain an apparent porosity of 6% or less at any temperature short of bloating or fusion.

Parmelee states ". . . do not attain low porosity at any temperature short of actual fusion."

12. Medium or high strength. Uses: Brick, drain tile, hollow blocks, flower pots, pencil clays, ballast.

13. Low strength. Use: Brick.

Classes (12) and (13) correspond to Parmelee's 22 and 23, respectively.

B. Dense-burning clays, *i.e.*, those that attain an apparent porosity of 6% or less at any temperature short of bloating or fusion.

Parmelee makes no special statement to qualify the meaning of "Dense burning," but the definition follows from III–A, above.

a. Having a long vitrification range (4 cones).

Parmelee requires a 5–cone vitrification range, but the data of this bulletin do not permit such a segregation, as only alternate cone numbers were studied.

14. Generally medium or high strength. Uses, if medium or high strength: Conduits, sewer pipe, face brick, roofing tile, paving brick, promenade tile, architectural terra cotta, and similar ware. If low strength: Common brick, floor tile, dust body in various wares.

Parmelee makes two classes, 24 and 25, divided as to medium to high strength or low strength, with the uses practically as indicated above.

b. Having a short vitrification range (less than 4 cones).

15. Generally medium to high strength. Uses: Common brick, face brick, hollow tile, flower pots.

This is Parmelee's class 26, described as "High or medium strength," with the same uses as given above.

c. Fusing at a low temperature, approximately cone 5, to form a glass.

16. Slip clays.

This is Parmelee's class 27. No clays were found in California in this class, but room is left in the classification in case any are found in the future.

IV CLAYS BURNING DIRTY WHITE, CREAM WHITE, OR YELLOWISH WHITE.

17. Generally containing calcium or magnesium carbonate or both. Seldom reach very low porosity. Have a very short heat range. Use: Common brick, or may be worthless.

This is essentially Parmelee's class 28, which is described as follows:

> "28. Containing calcium or magnesium carbonate or both. Never reach very low porosity. Have a very short heat range. Use: Common brick."

The foregoing classification is not presented as being preferable for general use to Parmelee's more complete one, but it serves the purposes of this bulletin better, in that the tests on the California clays were not sufficiently comprehensive to permit the degree of refinement of clay classification that characterizes Parmelee and Schroyer's report. For example, bonding-strength determinations are necessary in order to segregate Parmelee's classes 8, 9 and 10, and 16, 17 and 18; firing tests to cone 19 or 20 are necessary to fully determine the properties of a clay for his classes 5, 8 and 16; chemical analyses are necessary in order to segregate his classes 11, 12, 13 and 14, and firing to each cone number, instead of to alternate cone numbers, is required in order to separate the red-burning clays having a long vitrification range from those having a short range. To complete the data for a satisfactory allocation of clays according to Parmelee's classification, would have required more than twice the amount of work than that represented by the testing for this bulletin, without considering the extra field work that should be entailed to secure thoroughly representative samples of entire clay beds. It is questionable if 50-pound field samples, unless obtained by quartering down a number of larger channel-cut samples, or by combining a number of coredrill samples, are sufficiently reliable to warrant more elaborate tests than have been made.

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[1] The Clays and Shales of Washington, Their Technology and Uses. Bull. Univ. of Wash., Engin. Exp. Sta., No. 18, p. 203, *et seq.*

Parmelee makes two classes, 24 and 25, divided as to medium to high strength or low strength, with the uses practically as indicated above.

b. Having a short vitrification range (less than 4 cones).

15. Generally medium to high strength. Uses: Common brick, face brick, hollow tile, flower pots.

This is Parmelee's class 26, described as "High or medium strength," with the same uses as given above.

c. Fusing at a low temperature, approximately cone 5, to form a glass.

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PHOTO No. 70. Cabinet of fired test pieces, ceramic laboratory, Stanford University.

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CHAPTER V.

RESULTS OF LABORATORY TESTS.

Table No. 11 is a complete classified list of all samples tested. The fired test pieces, samples of dried bars (salvaged from the dry transverse-strength tests), and lump and ground samples of all the clays are kept in an accessible file in the ceramic laboratory at Stanford University. Photo No. 70 shows the case containing the fired and dried test pieces. These files may be of interest to clay workers who wish to select clays for specific purposes, and it is hoped that new clays can be added from time to time as they are disclosed in prospecting and mining operations.

Tests are included on two clays from outside of the state that are being used in local plants. These are No. 56 in class 7, a German plastic fireclay, and No. 59 in class 2, the Edgar kaolin from Florida. Tests were made on English china and ball clay but the detailed data are not included herein. The china clay was found to belong to class 1, and the ball clay belongs in class 4. The data on the English clays and the Edgar kaolin correlate closely with those given by Hewitt Wilson.[1]

The page numbers cited in the descriptive text, following the clay sample number, refer to the pages containing the description of the deposit from which the sample was taken.

I. WHITE- OR CREAM-BURNING NON-CALCAREOUS CLAYS.

A. Open-Burning, More Than 6% Apparent Porosity at Cone 15.

1. Low Strength.

No. 11 (p. 163). Riverside County. Alberhill C. & C. Co. "E–101 China Clay." This is a sandy clay of the kaolin type, and is principally used in stoneware bodies. See also No. 12. It contains 33.0% of + 200-mesh sand, which is mainly quartz, but there are enough ferro-magnesian minerals to cause red and black specks when fired. The plasticity is good, though short, the dry strength is low, and the dry condition is weak, crumbly and sandy. The colors are: Dry and wet, yellowish white; from cone 010 to cone 1, 13″f; above cone 1, buff-white, considerably nearer to white than Ridgway's "f" tints. Finger-nail hardness is developed at cone 04, and at cone 13 the hardness is still slightly less than steel. The total linear shrinkage, plastic basis, at cone 15, is 11.4%. The softening point is cone 28–29. The best firing range is from cone 3 to cone 13. The clay could be washed to remove non-plastic impurities, which would eliminate the specking, and increase the plasticity and strength, as well as lower the vitrification point, but as no large bodies of this variety have been found, washing at the mine is not warranted.

No. 12 (p. 163). Riverside County. Alberhill C. & C. Co. "E–102 China Clay." This is similar in every respect to No. 11, but is of slightly poorer quality, as it contains more impurities, and the fired colors are darker. The percentage remaining on 200-mesh is 22.6.

[1] The Clays and Shales of Washington, Their Technology and Uses. Bull. Univ. of Wash., Engin. Exp. Sta., No. 18, p. 203, *et seq.*

TABLE No. 11.

Key to Classification of Clay Samples Tested.

I. White or cream-burning				II. Buff-burning							III. Red-burning					IV. Dirty white
A. Open + 6% A. P. at cone 15—		B. Dense —6% A. P. at cones 10-15	C. Dense —6% A. P. at cones 5-10	A. Refractory (cone 27+)				B. Non-refractory (cone 27—)			A. Open		B. Dense			(Calcareous)
				a. Open-burning		b. Dense bet. cones 10-15	c. Dense at cone 10	a. Open +6% A. P. at cone 10—		b. Dense						
Low strength	Med.-high strength	Refractory	Refractory	Low strength	Med.-high strength			High-med. strength	Low strength		Medium or high strength	Low strength	a. Vitr. range 4 cones	b. Short vitr. range	c. Fusing to form a glass	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
11	15	70	125	17	9	13	121	19	16		8	7	10	1		3
12	28	96	143	23	14	39	124	25	55	166	18	72	21	2		41
37	29	98	240	66	27	56	136	36	82		24	122	22	4		46
38	44	120		67	33	80	146	94	88		26	131	75	5		115
62	45	144		71	34	83	147	95	111		32	171	123	6		116
63	57	273		74	53	85	151	99	167		35	198	127	30		163
64	59			77	76	101	152	114	170		40	218	148	31		205
91	90			79	78	110	157	135	238		65	256	177	43		262
103	93			86	81	133	175	168	269		69		181	60		
128	109			87	84	149	201	169	284		73		188	61		
129	137			104	92	153	252	173			100		202	89		
134				126	97	156	280	255			105		203	118		
159				138	102	204		283A			112		210	172		
160				140	108	213		283B			113		212	184		
190				141	130	229					117			185		
194				142	139	230					119			200		
195				191	145	245					155			211		
208				192	150	246					176			223		
209				231	197	247					178			264		
235				232	257	248					180			265		
236				233	258	249					182					
237				244	263	253					183					
259				250	266	254					199					
268				270	272	271					206					
				282		274					214					
				285							216					
											217					
											221					
											251					
											261					

Finger-nail hardness is developed at cone 02, and knife hardness at cone 12. The total linear shrinkage, plastic basis, at cone 12 is 12.2%. The softening point is cone 26–27. The best firing range is from cone 3 to cone 13.

No. 37 (p. 201). San Diego County. El Cajon Mountain. The sample is representative of the more kaolinitic phase of a residual kaolin deposit, of which No. 38 is a more general sample. It is not entirely free from fine quartz and feldspar grains, and also contains some ferro-magnesian minerals which appear as numerous black specks in the fired clay. The proportion of + 200-mesh sand is 13.0%. The plasticity is workable, but is weak and sticky. The dry strength is medium low, and in the dry state the sample is soft and crumbly. Slow drying is necessary to avoid drying cracks. The colors are nearly white, with a pinkish tinge at low cone numbers, and a yellowish tinge when fired above cone 1. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Fine cracks appear at high temperatures. The total linear shrinkage, plastic basis, at cone 15, is 20.9%. The softening point is cone 34. This clay could be washed to remove the ferro-magnesian minerals, but the deposit is too small and irregular, and too isolated for commercial operations. It was at one time mined on a small scale and the clay was used in the manufacture of Faience tile, and some attempts were made to use the material as a substitute for English china clay in whiteware bodies.

No. 38 (p. 201). San Diego County. El Cajon Mountain. This is a general sample of the residual kaolin deposit from which sample No. 37 was taken. It contains 57.0% of + 200-mesh grains, most of which are undecomposed quartz and feldspar, but there is a smaller proportion of ferro-magnesian minerals than in sample No. 37. It effervesces slightly in hydrochloric acid. The plasticity is poor, the dry strength is medium low, and the dry and fired structure is coarse and granular. The colors closely approximate white, with a faint pink hue. Steel hardness is not developed at cone 13. The total linear shrinkage, plastic basis, at cone 13, is 4.75%. The softening point is cone 32–33. The best structure and color is obtained by firing above cone 7. The amount of kaolin that could be extracted by washing was not determined, but not over 20% could be expected.

No. 62 (p. 145). Orange County. East of San Juan Capistrano, on the O'Neill ranch. "White bone." This is a plastic fireclay that usually contains over 45% of alumina. Although the pisolitic structure of the raw clay is lacking, or is but poorly developed, it may be classed as a bone clay on account of its high alumina content, and its ceramic properties. The plasticity is short, the dry strength is low, and the dry condition is medium hard, medium-grained, and open-textured. The residue on 200-mesh is 46.4%. The colors are nearly white throughout, with a pink hue at low firing temperatures, changing to yellowish white at higher firing temperatures. Scattering yellow and brown iron specks appear at high temperatures. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 1. Light crow-foot cracks appeared in all pieces fired above cone 1. The fired texture is granular and open. The total linear shrinkage, plastic basis, at cone 15, is 17.5%. The softening point is cone 34. The best firing range is above cone 1, and well vitrified structures are obtained at cone 11 or above.

No. 63, 64 and *268* (p. 140). Orange County. 12 m. E. of El Toro. Hunter ranch deposit. These three samples, from different portions of the Hunter ranch, are practically identical in all respects. The material consists of an admixture of high-grade china clay and quartz sand, in the proportion of approximately 35% clay. No. 63 contains 54.4% of + 200-mesh sand, and No. 64 contains 63.6%. In places, a small amount of hornblende occurs in the clay, which must be removed by washing, if the clay is to be used in whiteware bodies. The most important use at present is in the manufacture of high-grade fire brick, at the plant of the American Refractories Co., of Los Angeles, but Mr. H. F. Coors has stated [1] that he believes that the washed clay could be substituted in any ceramic body to replace 75% of the English china clay now in use. The by-product from washing would yield a quartz sand, which, if hornblende is removed by tabling, would be suitable for glass manufacture. All three samples were tested by the usual methods, without washing. The plasticity is weak, the dry strength low, and the dry condition is coarse, sandy, open and friable. The colors are nearly white, with a pinkish hue at low firing temperatures, changing to yellowish above cone 1. Steel hardness is not developed within the firing range employed. The fired structure is coarse, granular, and weak. The total linear shrinkage, at cone 13, is 4.0% for No. 63, 5.1% for No. 64, and 5.2% for No. 268. The softening point in all cases is cone 33.

No. 91 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Main Tunnel Sand." This belongs to the same group as No. 13, 15, 29, 84, 91, 96 and 229, but has a larger proportion of sand than any of the others. It contains 55.0% of + 200-mesh sand. The plasticity is weak, the dry strength is medium low, and in the dried state it is friable, coarse-grained and open-textured. The colors are: dry, 13''''f; wet 17''''i; cones 010 to 13, pinkish white at the lower temperatures, changing to yellowish white at the higher temperatures. Steel hardness appears at cone 9. The fired structure is sound, and coarsely granular. The total linear shrinkage, plastic basis, at cone 13, is 3.1%, which is a slight expansion over the dried condition. The softening point is cone 30–31. This material is used with more plastic clays in firebrick and terra cotta mixes.

No. 103 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Sloan Bone." See also No. 74, 86, 87, 231, and 232 in class 5, and No. 98 in class 3. This is a white bone clay of exceptional purity. It contains 46.2% of +200-mesh material. The plasticity is weak, the dry strength is low, and in the dried condition it is soft, friable, and open-textured. The colors are: dry, grayish white; wet, 17'''f; cone 010, 15''f; cones 08 to 13, fades to pinkish white at cone 1, then to yellowish white at cone 13. Finger-nail hardness is present at cone 010, and steel hardness at cone 3. All fired test pieces are hair-cracked, and one or two of them broke into two pieces. Less than 10% absorption is obtained at cone 9. The total linear shrinkage, plastic basis, at cone 15, is 16.9%. The softening point is cone 35.

[1] Private communication, July, 1925.

No. 128 (p. 54). Amador County. Ione. Arroyo Seco Grant. "Shepard Sand." This is one of the 'fire-sands' for which the Ione district is noted. The material consists of a fine-grained quartz-mica-feldspar sand with sufficient fireclay to render it weakly plastic. It contains 48.4% of +200-mesh sand, and a high percentage of the—200-mesh material is non-plastic. The dry strength is low, and in the dried condition it is very soft. The colors are nearly white with a slight yellowish hue throughout. Finger-nail hardness appears at cone 02, but steel hardness is not developed on firing to cone 15. The fired structure is sound, and fine-granular. The total linear shrinkage, plastic basis, at cone 15 is 6.7%. The softening point is cone 32. The sand has important uses as an ingredient in fire brick, terra cotta, pottery, etc.

No. 129 (p. 62). Amador County. Ione. "Newman Sand." This is almost identical in its properties to No. 128, except that it contains a lower percentage of fluxing impurities, and has a softening point of cone 33–34. The percentage of +200-mesh sand is 55.4.

No. 134 (p. 58). Amador County. Ione (Carbondale). N. Clark & Sons. "Clark Sand." This is fire-sand, nearly identical in its properties to No. 128 and 129, with a softening point of cone 32–33. It contains 55.8% of +200-mesh sand.

No. 159 (p. 137). Nevada County. Wolf. Coe property. Pine Hill Mine. See also No. 160, 166 (class 11), and 167 (class 10). This is a plastic impure kaolin that has not yet been used commercially. It contains 12.4% of +200-mesh sand. The plasticity is fair, though somewhat 'rubbery' and weak. The dry strength is medium low, and in the dried condition it is medium hard, fine-grained, and open-textured. The colors are: dry, yellowish-white; wet, 19″f; cone 010, 17″f, decreasing with increasing temperature to yellowish white at cone 1 and above. Steel hardness is developed at cone 5. The fired structure is sound, and stony, except for light hair-cracks at cones 11 and 13. The fired surface texture is smooth. The total linear shrinkage, plastic basis, at cone 15 is 18.8%. The softening point is cone 32–33. The best firing range is from cone 1 to above cone 13. If this clay were found in sufficient abundance, it might find important uses in the manufacture of pottery, tile, and fire brick.

No. 160 (p. 137). Nevada County. Wolf. Coe property. Pine Hill Mine. See also No. 159, 166 (class 11), and 167 (class 10). This is similar to No. 159, but contains more non-plastic matter, and burns to a whiter color. The plasticity is smooth, but not strong, the dry strength is low, and in the dried condition it is soft-fine-grained, and open-textured. The colors are: dry, 13‴f; wet, 13‴d; cones 010 to 1, 1‴f; cones 3 to 9, whiter than 9‴f; cones 11 and 13, grayish white. Steel hardness is not developed within the firing range studied, up to cone 15. The fired structure is sound, fine-granular, and smooth-textured. The maximum total linear shrinkage, plastic basis, at cone 13, is 11.7%. The softening point is cone 32–33. If it could be placed on the market cheaply, this clay would find use in pottery, tile, and fire brick manufacture.

No. 190 (p. 133). Napa County. Calistoga. Clark and Marsh kaolin. This is a residual kaolin, hand-sorted to remove iron-stained impurities. A large proportion of the sample consists of non-plastic kaolin in the form of hard grains, and some quartz is present. The percentage remaining on 200-mesh is 41.4. The plasticity is poor, the dry strength is medium low, and in the dried condition it is medium hard, coarse-grained, and open-textured. The colors are nearly white throughout, with a slight pinkish hue in the raw condition and when fired below cone 3, and a slight yellowish hue when fired above cone 3. The fired structure is weak, granular, rough-textured, and with a tendency to crack. Steel hardness does not develop within the firing range studied, up to cone 15. The total linear shrinkage, plastic basis, at cone 15, is 12.0%. The softening point is cone 31–32.

Professor Hewitt Wilson tested a sample from this deposit, and has supplied the following notes:[1] "The fusion was cone 34, indicating a high degree of purity, and a high degree of refractoriness for a kaolin fire brick, superior to that now on the market.

"For white chinaware, it will be necessary to use 15 to 20% of a plastic white-burning clay like a ball clay, 20–25% Calistoga clay, 20% feldspar, and 35–40% ground quartz. This gave (with Washington materials) satisfactory results as to molding, drying, firing and white color."

It is apparent that the sample tested by Prof. Wilson differed somewhat from that tested by the writer.

No. 194 (p. 227). Sonoma County. Glen Ellen. J. H. Weise property. This is a white-burning kaolin, with fair plasticity and low dry strength. It contains 34.8% of +200-mesh material. In the dried condition it is soft, medium-grained, and open-textured. Approximately 25% of quartz sand is present, together with a small proportion of ferro-magnesian mineral grains. The colors are: dry, 11′f; wet, 11′d; cone 010, 9″f, gradually fading to nearly white at cone 7 and higher, except for widely scattered black specks. Steel hardness is not developed within the firing range studied. The fired structure is sound, weak, granular, and open, and the surface texture is slightly rough. The total linear shrinkage, plastic basis, at cone 15, is 6.1%. The softening point is cone 32. This clay could be washed free from quartz, and used in the manufacture of a kaolin fire brick, but would require the addition of a refractory bond clay in order to secure sufficient dry and fired strength. It might also be used in tile and porcelain bodies, in place of a portion of the china clay usually used, if the ferro-magnesian minerals were removed by washing.

No. 195 (p. 227). Sonoma County. Glen Ellen J. H. Weise property. This is a hand-picked sample of the whitest material in the pit from which No. 194 was taken. It is more plastic than No. 194, has better dry strength, better fired color, and higher refractoriness. The residue on 200-mesh is 30.2%. Very few iron specks can be found. The total linear shrinkage, plastic basis, at cone 15 is 9.9%. The softening point is cone 33. A peculiarity of both of these samples is that the firing shrinkage is greater at cone 9 that at cone 13, but the shrinkage increases again at cone 15.

No. 208 (p. 57). Amador County. Ione. Wm. Haverstick. This is a sample of Ione sand supplied by Mr. Haverstick. It is somewhat

[1] Personal communication, September, 1925.

more plastic and burns whiter than other samples that were tested (see No. 128, 129 and 134). The total linear shrinkage, plastic basis, at cone 15, is 8.6%. The softening point is cone 32. The sample contains 28.2% of +200-mesh sand.

No. 209 (p. 59). Amador County. Ione. Sample supplied by Wm. Haverstick. This is a sand containing a higher proportion of clay than the more typical samples (see No. 128, 129 and 134), hence possessing better plasticity and greater shrinkage. The residue on 200-mesh is 15.8%. The color is good, but green scumming is especially noticable. Steel hardness is developed at cone 9. The total linear shrinkage, plastic basis, at cone 15 is 15.2%. The softening point is cone 32.

No. 235 (p. 70). Calaveras County. Valley Springs. Texas Mining Company. This is a kaolinized sericite-talc schist that has sufficient plasticity to permit molding or pressing. The dry strength is low, and in the dried condition it is soft and friable. The colors are: dry, 17″f; wet, 15″d; cone 06 to 1, 13″f; cones 5 to 13, pinkish-white. Finger-nail hardness is developed at cone 1. The fired structure is sound, weak, and fine granular. The total linear shrinkage, plastic basis, at cone 13, is 14.6%. The softening point is cone 30–31. The material could be used as a nonplastic ingredient in white floor and wall tile.

No. 236 (p. 68). Calaveras County. Nigger Hill. "Kaolin." This is an impure kaolin that has resulted from the alteration of a sericite-talc schist. The plasticity is fair, the dry strength is low, and in the dried condition it is soft, friable and fine-grained. The colors are: dry, nearly white; wet, grayish white; cones 06 to 13, nearly white. Finger-nail hardness is developed at cone 06, and steel hardness at cone 5. The fired structure is sound, medium strong, and fine-granular. The total linear shrinkage, plastic basis, at cone 13, is 20.9%. The softening point is cone 29–30. The material can be used as a nonplastic ingredient in white tile bodies.

No. 237 (p. 68). Calaveras County. Nigger Hill. Sericite-talc schist. This is similar to No. 235, but contains a slightly higher percentage of iron. The total linear shrinkage, plastic basis, is 14.5% at cone 13. The softening point is cone 27–28.

No. 259 (p. 45). Alameda County. Tesla. This is a white-burning fireclay with excellent plasticity and medium low dry strength. It contains 1.6% of +200-mesh sand. In the dried condition it is soft, fine-grained and close-textured. The colors are: dry, 17‴f; wet, 15″f; cones 010 to 04, pinkish white; cones 02 to 9, nearly white; cones 11 to 15, yellowish white. Steel hardness is developed at cone 3, and less than 10% absorption at cone 11. The fired structure is stony and smooth-textured. A few small cracks appear in some of the fired test pieces. Slight blistering is noted at cone 13. The total linear shrinkage, plastic basis, is 20.4% at cone 15. The softening point is cone 34–35. This is one of the best fireclays tested and if it can be found in commercial quantities, it will undoubtedly be in great demand for fire-brick, whiteware, and tile.

No. 268. This sample has already been described (see No. 63, p. 260).

2. Medium to High Strength.

No. 15 (p. 163). Riverside County. Alberhill C. & C. Co. "Select Main Tunnel." See also No. 13 (class 7) and 29. This clay is hand sorted from the main tunnel fireclay bed, in order to make a marketable grade that is intermediate in quality between the run-of-mine material (No. 29) and the extra-select main tunnel clay (No. 13). It is used principally in the manufacture of fire brick. It is fine-grained, with excellent plasticity, medium high dry strength, and good dry condition. It contains 11.3% of plus 200-mesh sand. The colors are: dry, 13‴f; wet, 17⁗b; fired, cream white, considerably whiter than Ridgway's "f" tone. Finger-nail hardness is developed below cone 010, and steel hardness is reached at cone 5. The total linear shrinkage, plastic basis, at cone 15 is 11.7%. The softening point is cone 30–31. The best firing range is from cone 5 to cone 15.

No. 28 (p. 163). Riverside County. Alberhill C. & C. Co. "SH–3." This is a clay with excellent plasticity, medium dry strength, and a fine grained, close-textured dry condition. It contains 11.2% of +200-mesh sand. It is used for art title and architectural terra cotta. The colors are: dry, 13‴f; wet, 13‴d; cone 010 to cone 1, 17″f; cone 3 and above, the pink gives way to yellow, and the tone is nearer white than Ridgway's "f" tone. Finger-nail hardness is developed below cone 010, and steel hardness at cone 7. Vitrification is not well advanced at cone 13. The total linear shrinkage, plastic basis, at cone 13, is 10.0%. The softening point is cone 30. The best firing range is from cone 3 to cone 13 or above. If this clay were more plentiful, it would find a wide use in art title, terra cotta, and similar products.

No. 29 (p. 163). Riverside County. Alberhill C. & C. Co. "Main Tunnel." See also No. 13 (class 7) and No. 15. This is the run-of-mine main tunnel fireclay, and differs from the selected varieties, No. 13 and No. 15, mainly in that it contains more sand and more coloring matter. The percentage remaining on 200-mesh is 37.2. The clay is widely used in fire brick, art title, architectural terra cotta, and for similar purposes. It has a good working plasticity, but the plastic strength is low. In the dry condition it is medium hard, with a coarse, open texture, and the dry strength is medium. The colors are: dry, 17‴f; wet, 17‴d; cones 010 to 04, 13″f; cones 02 to 3, 13‴f; cones 5 to 13, nearer white than 17‴f. Finger-nail hardness appears below cone 010, but steel hardness does not develop within the firing range of the tests. The total linear shrinkage, plastic basis, is 5.6%, at cone 15. The softening point is cone 30–31. The best firing range is from cone 5 to cone 15 and above.

No. 44, 45 and *57* (p.196 and p. 194). San Bernardino County. Hart. No. 44 is from the lower tunnel, and No. 45 is from the upper tunnel of the deposit owned by the Standard Sanitary Manufacturing Co., while No. 57 is from a similar deposit in the same district, owned by H. F. Coors. They are white-burning clays that may be classed as china-ball clays, as they possess the properties of a mixture of china and ball clays as usually used in porcelain and whiteware bodies. No. 44 contains more quartz than the other two samples. It contains 33.4% of +200-mesh material. No. 45 contains 28.2%, and No. 57 contains 21.8%. All three samples contain a small proportion of undecomposed ferro-magnesian minerals, which is readily removed in the usual processes of slip preparation. Enough colloidal iron is present in No. 44 and 45 to impart a yellowish tint to the fired clay, but No. 57 is the whitest clay that was tested, and has a distinctly better color than English china clay or Edgar (Florida) kaolin. The plasticity of all three samples is excellent and the dry strength is exceptionally high. Finger-nail hardness is present in the dry state, and steel hardness develops at cone 06. Although the softening point is cone 30 for No. 44 and 45, and cone 29 for No. 57, bloating begins at cone 11 to 13. The maximum total linear shrinkage, plastic basis, is 9.5% at cones 3 to 5 for No. 44, 16.0% at cone 15 for No. 45, and 14.8% at cone 11 for No. 57. Small firing cracks are found in some of the test pieces of No. 45, fired above cone 3, but all test pieces of No. 44 and 57 are sound. The tendency of these clays to bloat when used in porcelain bodies to be fired above cone 8 is their most serious defect, and has prevented their continued use in two sanitary ware plants that formerly used them in place of Eastern or English clays. No. 44 and 45 are now used in the enameling plant of the Standard Sanitary Manufacturing Co., and No. 57 is used in the manufacture of electrical and plumbing accessory porcelain, in the plant of the H. F. Coors Co. The best firing range is from cone 06 to cone 8 to 11.

No. 59. Edgar kaolin (Florida), used by the American Encaustic Tiling Company. This is a white-burning kaolin, with smooth and strong plasticity, medium dry strength, and a soft, fine grained, close-textured, dry condition. Some finely divided mica is present, but the sample contains only 0.6% of +200-mesh material. A faint pink color can be noted when fired below cone 1, but at higher temperatures the color closely approximates pure white. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 3. The fired structure is stony, and with the firing schedule used, all test pieces had deep crow-foot cracks, which, however, were not continuous enough to cause disintegration. The total linear shrinkage, plastic basis, at cone 15 is 24.8%. The softening point is cone 34–35. The best firing range is from cone 1 to above cone 15.

No. 90 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Main Tunnel Fire Clay." This should be compared with No. 13 and 229 (class 7), 15, 29, 84 (class 6), 91 (class 1), and 93, *post*. No. 90 contains 17.4% of +200-mesh sand. The plasticity is excellent, the dry strength is medium, and in the dried condition it is medium hard, fine grained and close-textured. The colors are: dry, 17''''d; wet, neutral gray k; cones 010 to 13, pinkish white, changing at the higher temperatures to yellowish white. Finger-nail hardness is developed below cone 010, and steel hardness appears at cone 11. The fire structure is sound and fine-granular. The total linear shrinkage, plastic basis, at cone 13, is 10.7%. The softening point is cone 31.

No. 93 (p. 171). Riverside County. Alberhill. G., Mc.B. & Co. "Select Main Tunnel." The properties of this clay are almost identical with those of No. 90, except that it is finer-grained, has lower porosities, and the colors are slightly whiter throughout. The sample contains 1.0% of +200-mesh sand. Steel hardness is developed at cone 1. The total linear shrinkage, plastic basis, at cone 13, is 11.8%. The softening point is cone 30–31. It is a useful clay for terra cotta, faience tile, face brick and fire brick, and may be used in stoneware and pottery.

No. 109 (p. 176). Riverside County. Alberhill. P. C. P. Co. "Douglas Main Tunnel." This is from an extension of the formation from which the Alberhill Coal and Clay Company's "Main Tunnel" clays are mined, see No. 13 (class 7), 15, and 29, but is more closely related to the G., McB. Co. "Main Tunnel Fire Clay," No. 90, in its ceramic properties. It contains 22.6% of +200-mesh quartz sand, and a small proportion of ferro-magnesian minerals. The plasticity is very good, and the dry strength is medium high. In the dried condition it is medium hard, and has a medium fine grain and close texture. The colors are: dry, 13″f; wet, 15″d; cones 010 to 1, 7″d; cone 3, 7″f; cones 5 to 13, whiter than 17″f. Finger-nail hardness appears below cone 010, and steel hardness develops at cone 5. The fired structure is sound and fine granular, with a slightly rough exterior. The total linear shrinkage, plastic basis, at cone 13, is 9.7%. The softening point is cone 30–31. The principal uses for this clay are for fire brick, face brick and stoneware.

No. 137 (p. 57). Amador County. Ione. M. J. Bacon. "Chocolate." This is a plastic fire clay that is occasionally marketed as a sagger clay. It contains 7.0% of +200-mesh sand. The plasticity is excellent, the dry strength is medium, and in the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 13″f; wet, 9″d; cone 010, 13″f, fading to yellowish-white at cone 02, and continuing to cone 13 without appreciable change. Yellow scumming is especially noticeable. Steel hardness is developed at cone 11. The fired structure is sound, fine-granular, and with a slightly roughened surface texture. The total linear shrinkage, plastic basis, at cone 15 is 16.2%. The softening point is cone 32.

TABLE No. 12.

I. White- or Cream-Burning Non-Calcareous Clays.

A. Open-burning, more than 6% apparent porosity at cone 15.

1. Low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
11	8.4	18.8	27.2	94	14.5	4.7	28–29
12	10.6	21.6	32.2	49	17.8	5.6	26–27
37	16.7	29.7	46.4	141	24.4	7.5	34
38	5.6	18.3	23.9	109	9.6	3.1	33
62	7.3	20.0	27.3	94	12.2	3.9	34
63	5.5+	11.85	17.40	69	11.0	3.5	33
64	5.7	12.0	17.7	84	11.2	3.5	33
91	5.5	10.9	16.4	194	11.0	3.5	30–31
103	5.0	22.5	27.5	69	8.0	2.6	35
128	8.9	19.5	28.7	29	15.2	4.9	32
129	7.7	14.1	21.8	33	14.2	4.4	33–34
134	6.8	17.3	24.1	17–	12.1	3.9	32–33
159	13.3	21.4	34.7	135	21.5	6.8	32–33
160	11.5	30.4	41.9	84	16.5	5.3	32–33
190	19.9	33.3	53.2	171	25.9	7.9	31–32
194	14.1	34.7	48.8	95	18.7	5.9	32
195	14.4	29.3	43.7	188	20.5	6.4	33
208	9.2	17.7	26.9	±50	16.1	5.1	32
209	12.9	17.8	30.7	±90	22.5	7.1	32
235	6.6	31.7	38.3	Low	9.3	3.0	30–31
236	13.3	30.6	43.9	34	19.2	6.0	29–30
237	6.4	25.9	32.3	33	9.8	3.1	27–28
259	15.7	19.5	35.2	120	26.5	8.1	34–35
268	6.0	11.9	17.9	90	11.8	3.8	33

2. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
15	12.2	13.3	25.5	467	23.4	7.3	30–31
28	12.1	14.0	26.1	356	22.7	7.1	30
29	8.0	11.8	19.8	242	15.8	5.1	30–31
44	18.7	13.6	32.3	1375	34.8	10.5	30
45	26.9	15.5	42.4	1562	49.4	14.0	30
57	23.3	13.3	36.6	1744	44.4	13.0	29
59	20.9	24.0	44.9	221	32.6	9.9	34–35
90	13.8	16.0	29.8	370	24.4	7.5	31
93	14.3	16.9	31.2	350	25.2	7.8	30–31
109	12.9	13.4	26.3	437	25.0	7.7	30–31
137	17.0	20.6	37.6	211	28.1	8.5	32

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Dry shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 13.

I. White- or Cream-Burning Non-calcareous Clays.

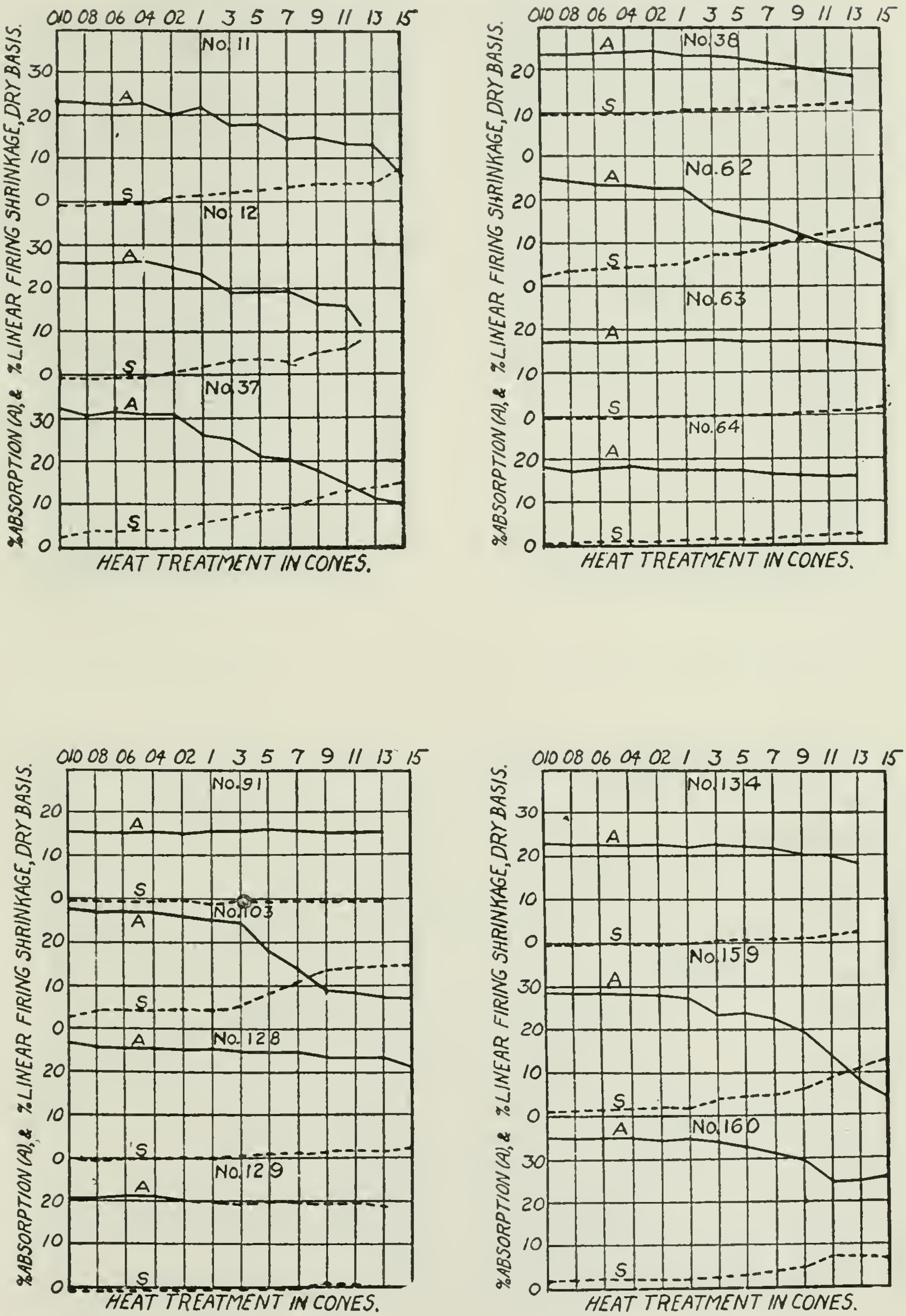
A. Open-burning, more than 6% apparent porosity at Cone 15.

1. Low strength. 2. Medium to high strength.

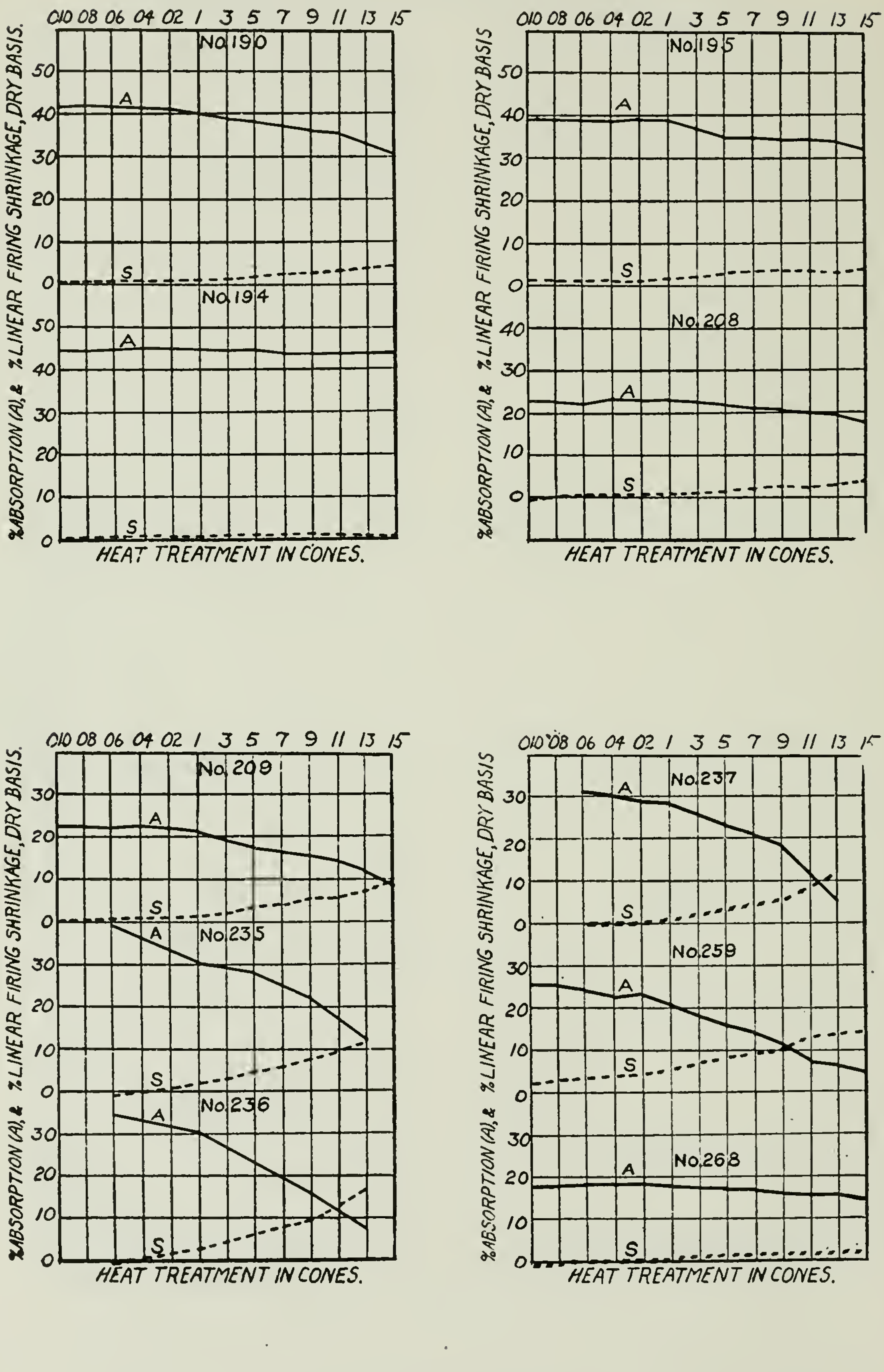
Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
1	11	—2.3	37.1	—2.6	36.6	—1.2	36.5	—1.4	37.4	+2.3	34.5	2.9	36.2	6.4	31.2	6.9	30.7	9.9	27.6	12.3	27.8	12.6	25.2	13.1	24.9	20.0	12.7
	12	—1.9	39.8	—2.1	39.8	—1.3	40.3	—1.3	40.6	+1.7	39.2	4.6	37.0	9.1	33.3	9.1	33.2	7.9	33.1	13.7	29.6	15.5	29.1	20.3	21.8	------	------
	37	8.0	45.0	11.2	44.6	11.6	45.6	12.6	45.0	12.6	45.1	17.1	41.2	19.9	40.3	24.9	36.0	25.8	35.4	31.3	32.2	34.0	28.7	36.4	22.5	38.4	20.9
	38	—0.7	38.1	—0.6	38.0	—0.3	38.5	—0.3	39.2	—0.6	39.1	+1.2	38.1	+1.9	37.8	2.1	37.4	2.4	35.9	3.5	34.2	3.5	33.4	5.4	31.8	------	------
	62	8.2	39.5	10.0	38.9	13.4	39.8	12.2	40.3	13.9	38.3	14.1	38.5	21.1	32.4	21.6	33.0	26.2	28.0	28.6	25.0	32.0	20.4	34.2	18.4	37.0	14.8
	63	—1.6	30.6	—1.2	30.8	—0.8	31.6	—0.6	31.9	—0.5	31.8	—0.1	31.8	+0.1	31.6	—0.1	32.2	—0.1	31.6	+0.9	31.5	+0.8	31.6	+1.9	30.9	4.6	33.8
	64	+0.1	32.2	1.2	31.3	1.6	32.0	1.6	33.3	1.2	32.5	1.6	32.5	1.7	32.0	2.5	31.1	3.2	30.5	5.3	30.2	5.4	29.8	5.2	30.0	------	------
	91	—1.9	29.1	—1.8	29.5	—1.7	29.6	—1.5	29.5	—1.6	29.1	—4.0	28.9	—1.9	29.3	—1.6	29.9	—1.4	29.6	—0.6	28.9	—0.7	28.6	—0.8	28.7	------	------
	103	6.9	42.2	11.5	42.3	11.5	43.2	11.5	43.0	12.3	42.2	11.8	41.0	14.6	40.3	23.2	33.2	29.2	27.7	34.5	19.8	36.5	19.1	37.6	16.3	37.9	16.0
	128	—0.1	41.1	—1.0	40.2	—0.1	40.3	0.0	40.4	—0.1	43.3	0.0	40.9	+0.9	40.2	1.2	42.8	2.3	42.8	4.4	38.9	4.2	38.7	4.2	38.5	6.1	36.5
	129	—1.7	35.8	—2.8	35.0	—1.2	36.2	—1.2	36.1	—1.3	34.9	—1.4	34.7	—0.5	35.1	—0.5	34.8	—0.1	34.5	+0.5	34.2	+0.1	34.4	+0.1	33.7	------	------
	134	—0.8	38.1	—0.8	37.8	—0.4	37.2	—0.7	37.4	—0.8	37.9	—0.4	37.2	+0.8	37.3	+0.5	37.2	+0.8	36.8	2.7	35.2	4.2	34.4	5.7	32.5	------	------
	159	2.3	42.7	3.6	42.8	4.0	42.9	4.3	43.1	4.6	42.4	5.6	41.8	11.5	38.6	12.3	38.5	13.4	37.6	16.8	34.6	24.2	26.2	29.5	15.1	34.6	8.3
	160	5.3	48.5	5.2	48.1	5.5	48.1	5.9	48.6	5.7	47.5	5.5	48.2	6.9	47.6	7.7	46.8	10.7	45.0	12.4	44.2	18.8	39.2	19.7	38.7	17.5	39.6
	190	0.9	50.5	1.2	51.0	0.9	50.8	1.2	50.7	1.4	50.3	2.0	49.9	4.3	49.0	5.8	48.7	7.7	48.0	8.2	47.5	9.1	47.0	11.9	45.0	14.4	42.8
	194	0.0	54.0	0.7	54.7	0.9	54.8	0.6	54.9	0.6	54.9	0.6	54.8	0.9	54.6	1.0	54.7	1.8	54.2	2.7	54.0	2.1	53.3	1.2	53.2	1.9	52.7
	195	2.9	51.0	3.1	50.8	3.0	51.2	3.4	50.8	3.7	51.5	4.7	51.2	6.3	49.9	*9.3	*48.5	†9.9	†48.4	11.0	47.8	9.7	47.5	9.2	47.2	11.8	45.7
	208	—0.3	37.1	0.0	37.3	+0.4	37.1	1.0	38.6	0.8	38.0	1.4	38.0	2.4	37.7	4.2	36.5	5.6	36.0	6.8	35.5	7.5	35.0	9.4	34.1	11.0	31.7
	209	0.0	35.9	+1.1	36.2	1.9	36.5	2.4	37.0	3.3	36.2	4.7	35.2	6.7	33.7	10.8	31.0	13.3	29.9	15.0	28.2	16.5	27.0	20.0	23.5	25.1	17.4
	235	------	------	------	------	—1.8	50.8	------	------	------	------	+5.5	43.8	------	------	13.1	43.2	------	------	19.9	36.5	------	------	31.7	23.6	------	------
	236	------	------	------	------	—0.3	47.1	------	------	------	------	+7.1	43.7	------	------	17.0	37.1	------	------	26.0	28.3	------	------	41.2	16.4	------	------
	237	------	------	------	------	—1.3	44.8	------	------	------	------	+3.2	42.5	------	------	9.8	38.0	------	------	16.1	32.4	------	------	31.6	11.7	------	------
	259	8.1	40.0	9.3	40.4	10.2	40.5	11.7	38.7	12.1	38.9	15.5	35.4	20.2	32.4	*22.4	*30.0	†26.2	†27.5	29.0	22.7	34.2	15.9	------	------	36.5	10.3
	268	—0.7	31.7	—0.3	32.8	+0.1	32.9	0.1	33.0	0.2	33.4	0.1	33.0	0.7	32.1	*2.0	*31.0	†2.3	†30.5	4.0	30.2	4.5	29.6	4.8	29.9	5.7	28.5
2	15	+0.8	30.9	1.4	28.8	2.0	29.0	1.7	29.6	4.3	27.9	6.3	25.8	7.6	24.4	8.0	24.2	9.6	23.3	10.1	22.2	9.6	23.1	15.1	16.1	------	------
	28	—0.1	30.1	+0.9	29.8	+0.9	31.6	1.4	30.8	1.8	30.1	6.1	26.6	6.9	26.8	7.3	25.9	7.8	26.0	8.5	24.0	9.9	24.0	10.3	21.9	------	------
	29	—4.3	29.4	—1.7	29.4	—1.6	30.4	—1.3	30.1	—0.6	30.0	—0.6	29.6	0.0	29.1	+0.1	29.5	1.2	28.6	1.4	28.6	1.2	28.0	1.5	28.0	2.5	25.3
	44	—2.1	32.3	—2.0	31.8	—1.9	31.2	—1.6	31.8	—1.3	31.8	—0.6	32.6	0.0	32.0	0.0	31.6	—1.4	31.8	—5.2	33.0	—6.9	33.3	—7.6	33.7	------	------
	45	—3.2	35.0	—1.3	32.8	+0.6	31.8	1.0	31.6	4.2	29.5	4.3	28.1	4.5	27.4	4.9	27.0	5.1	25.8	6.1	26.0	8.9	23.8	12.1	20.7	------	------
	57	—3.1	29.8	—0.5	23.7	+0.5	22.4	1.6	21.7	5.1	20.4	5.7	20.3	9.1	18.1	9.7	17.2	10.4	10.1	10.3	10.5	10.8	6.7	1.6	15.8	------	------
	59	6.3	45.3	6.3	44.9	11.5	44.9	11.4	44.7	12.8	44.3	13.6	44.0	------	------	19.2	39.7	28.6	31.9	30.3	30.0	31.4	29.3	39.5	17.6	43.6	13.9
	90	0.6	36.6	—0.1	36.2	+0.8	36.4	1.1	36.8	2.9	36.3	5.4	34.9	6.1	34.5	7.2	34.1	8.5	32.9	9.8	31.0	10.9	29.9	11.6	29.4	------	------
	93	1.5	34.0	1.4	33.8	2.4	35.1	3.4	36.5	4.5	33.7	5.1	32.9	6.4	32.3	8.8	31.0	9.4	30.4	12.0	28.1	13.7	25.7	14.1	26.0	------	------
	109	—0.6	30.1	—0.1	31.0	0.0	31.2	0.0	31.2	+1.4	30.7	2.1	29.7	1.9	29.9	4.1	28.5	5.5	27.6	5.4	27.4	6.6	26.2	7.9	24.6	------	------
	137	4.2	38.0	3.9	37.2	4.4	38.0	4.1	36.9	5.3	36.9	6.9	36.4	10.1	33.8	12.0	32.9	16.8	29.2	19.3	26.7	18.0	27.8	------	------	25.8	16.1

% V. S.=Firing shrinkage, per cent dry volume. % A. P.=—Per cent apparent porosity. *Cone 5+. †Cone 7—.

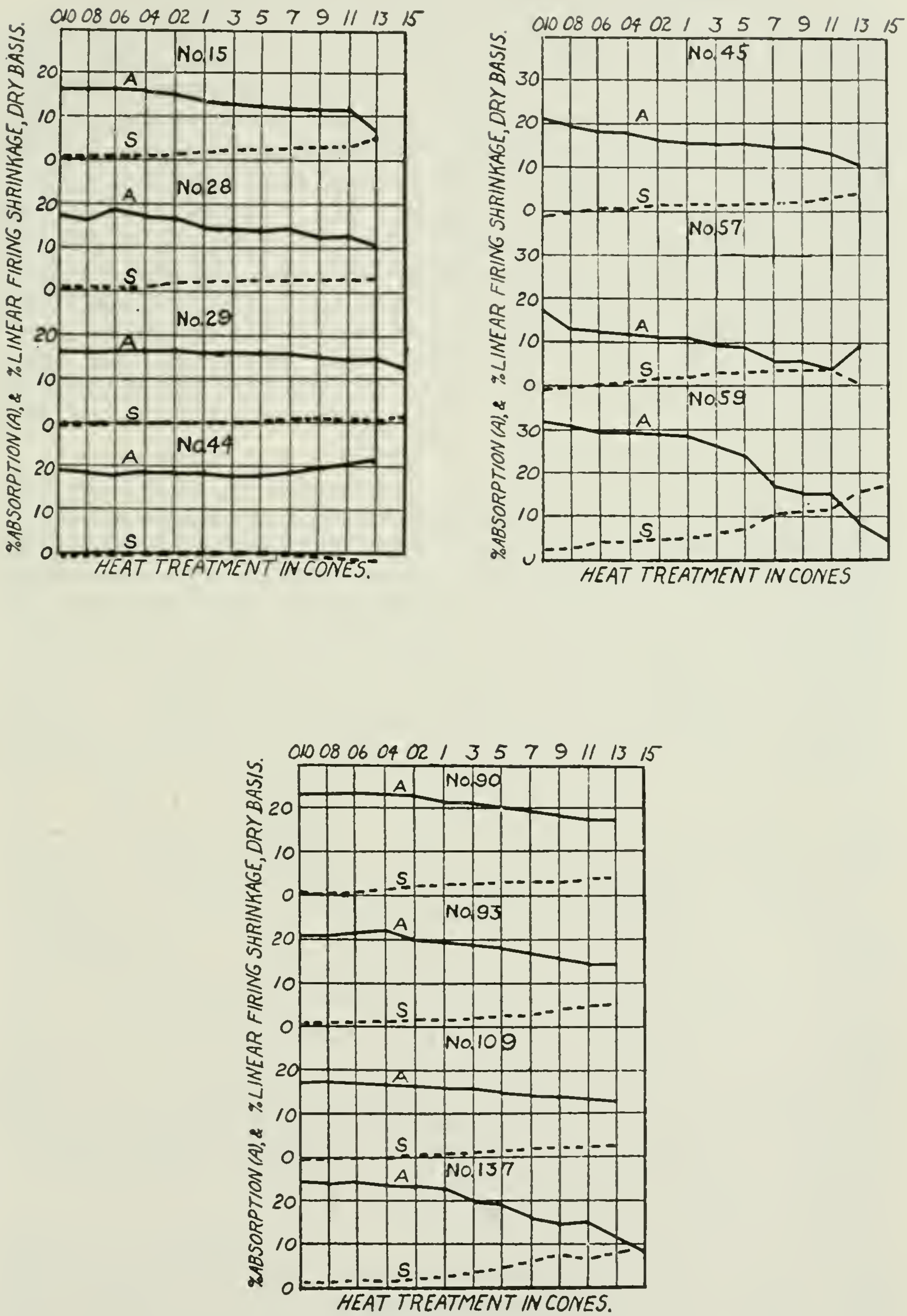
Absorption and linear shrinkage curves for clays of class 1.



Absorption and linear shrinkage curves for clays of class 1.



Absorption and linear shrinkage curves for clays of class 2.



I-B. Dense-Burning, Less Than 6% Apparent Porosity Between Cones 10 and 15.

3. Generally Refractory, Softening Point Cone 27+.

No. 70 (p. 169). Riverside County. Emsco Clay Co. "White Plastic." This is a white burning, plastic fireclay, similar in its general properties to No. 56 (class 7), a German fire clay, but with lower dry strength, higher firing shrinkage, higher softening point, and whiter color. It contains 6.4% of +200-mesh sand. It has a strong and smooth plasticity, medium low dry strength, and in the dry state it is soft and fine-grained. The colors are: dry, 13″f; wet, 17‴d; cones 010 to 1, 11″f; above cone 1, nearly white, but with a faint yellowish hue. Finger-nail hardness is developed below cone 010, and steel hardness at cone 02. Deep cracks developed in firing, but the pieces did not shatter sufficiently to fall apart. The total linear shrinkage, plastic basis, at cone 15 is 17.8%. The softening point is cone 32. The principal use of the clay at present is in the manufacture of fire brick, but its white color, fineness of grain, and excellent plasticity should make it desirable for Faience tile and other uses.

No. 96 (p. 171). Riverside County. Alberhill. G., McB. & Co. "No. 10." This is a white-burning clay with excellent smooth plasticity, that is extensively used in terra cotta bodies. It contains 1.2% of +200-mesh sand. The dry strength is medium, and the dried condition is medium hard, fine grained, and close textured. The colors are: dry, 17⁗d; wet, 17⁗b; cones 010 and 08, 13″f; cones 06 to 13, buff white. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions under 10% are obtained at cone 9. The fired structure is sound and stony, and the texture is smooth. The total linear shrinkage, plastic basis, is 16.0% at cone 15. The softening point is cone 32. The best firing range is from cone 1 to above cone 13.

No. 98 (p 171). Riverside County. Alberhill. G., McB. & Co. "Bone." See also No. 74, 86, 87, 231, and 232 in class 5 and No. 103 in class 1. In the natural state, the pisolitic structure of this clay is not so well developed as in some of the other bone clays from the district. It contains 30.0% of +200-mesh sand. The plasticity is spongy and weak, the dry strength is low, and in the dried condition the clay is soft, friable and open-textured. The colors are: dry, 13″f; wet, 17⁗b; fired, from cone 010 to cone 15, pinkish to yellowish white, finishing at a color that is whiter than that of No. 96. Finger-nail hardness appears below cone 010, and steel hardness is present at cone 3. All fired test pieces are hair cracked. The surface texture of the fired tests is smooth. The total linear shrinkage, plastic basis, at cone 15 is 18.3%. The softening point is cone 35. The calcined clay is especially valuable as a fire-brick grog.

No. 120 (p. 53). Amador County. Ione. Jones Butte. Arroyo Seco Grant. Leased by the Stockton Fire Brick Co. "Edwin Fireclay." This is one of the best of the Ione fireclays. It contains 30.2% of +200-mesh quartz-mica sand. The plasticity is 'soapy' and moderately strong, the dry strength is low, and in the dried condition the clay is soft, medium-grained, and close-textured. Some fine-grained sand is present. The colors are: dry, 17″f; wet, 17‴d; cones 010 to 02, 11″f; cones 1 to 5, pinkish white; cones 7 to 15, grayish white.

Steel hardness is developed at cone 3. Less than 10% absorption appears at cone 9. All test pieces develop a network of hair cracks on firing, but do not disintegrate. The total linear shrinkage, plastic basis, at cone 15 is 23.0%. The softening point is cone 34. The calcined clay is used as grog, and the raw clay as a plastic agent, in the manufacture of heavy-duty fire brick.

No. 141 (p. 185). Sacramento County. Michigan Bar. Van Vleck property. This is similar to No. 143 (class 4), but contains more impurities. It contains but 0.6% of +200-mesh sand. The plasticity is smooth and strong, the dry strength is medium low, and in the dried condition it is medium hard, fine-grained, and close textured. The colors are: dry, 17″f; wet, 17″d; cones 010 to 06, 13″f; cones 04 to 1, 17″f; cones 3 to 15 whiter than 19″f. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 7. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 15 is 20.6%. The best firing range is from cone 1 to cone 15.

No. 273 (p. 163). Riverside County. Alberhill. A. C. & Co. "SH–4." This clay is classed by California consumers as a ball clay, on account of its smooth and strong plasticity, its good bonding strength, nearly white fired colors, and good vitrification range within commercial firing limits. It is very similar to the Florida kaolin (see No 59, class 2). The proportion of + 200-mesh sand is 4.6%. The dry strength is medium, and in the dried condition it is medium hard, fine-grained, and close textured. With 50% of —20-mesh to +30-mesh Ottawa sand, the bonding strength is 70 lb. per sq. in. There is slight effervescence in hydrochloric acid. The colors are: dry, 9‴f; wet, 17‴; cones 010 to 06, 11″f; cones 04 to 5 whiter than 11″f; cones 7 to 13, nearly white. Steel hardness is developed at cone 02, and less than 10% absorption at cone 9. The fired structure is stony and badly shattered at all cone numbers, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 15, is 22.4%. The softening point is cone 34. It is used in stoneware and whiteware bodies.

I–C. Dense-Burning, Less Than 6% Apparent Porosity Between Cones 5 and 10.

4. Generally Refractory, Softening Point Cone 27+.

No. 125 (p. 53). Amador County. Ione (Carbondale). Arroyo Seco Grant. "Gage." This is a white, fine-grained clay, with a talcy feel, and smooth, but weak, plasticity. The dry strength is low, and in the dried condition it is soft and friable. The colors are dry and wet, white with a greenish hue; cones 010 to 9, pinkish white; cones 11 and 13, nearly white. The plasticity of the clay is not entirely destroyed until cone 06 is reached, at which point finger-nail hardness appears. Steel hardness develops at cone 5. Less than 10% absorption appears at cone 5, and vitrification is complete at cone 11. Slight bloating is noticeable at cone 13. From cone 06 to cone 9 the structure is stony, and above cone 9 it is glassy. No firing cracks develop. The maximum total linear shrinkage, plastic basis, is 19.8%, at cone 11. The softening point is cone 30. The best firing range is from cone 5 to cone 11. The clay has been used in the manufacture of calcimine, and is suggested as a possible ingredient of white tile and stoneware bodies.

No. 143 (p. 185). Sacramento County. Michigan Bar. Property of Geo. Cutter. This is a fine-grained, cream-burning, plastic clay, quite similar to No. 144 (class 3). It is not now in use, but was used many years ago as a stoneware clay. The plasticity is smooth and strong, the dry strength is medium, and in the dried condition it is medium hard, fine-grained and close-textured. The colors are: dry, pinkish white; wet, 21‴f; cones 010 to 1, pinkish white; cones 3 to 7, 19″f; cones 9 to 13, 21‴f. Steel hardness is developed at cone 1. The fired structure is sound, and stony, and the surface texture is smooth. Less than 10% absorption is obtained at cone 5. The maximum total linear shrinkage, plastic basis, at cone 11, is 23.2%. The softening point is cone 32. When used alone, the clay warps seriously both during drying and firing, but will stand much abuse without cracking. The best firing range is from cone 1 to cone 11.

No. 240 (p. 52). Amador County. Ione. Core drill sample, East side of Lot 237, Arroyo Seco Grant. This is a cream-burning clay. The dry strength is medium, and in the dried condition it is soft, friable, fine-grained, and close-textured. The colors are: dry, 15″f; wet, 1‴f; cones 010 to 02, 13″f; cones 1 to 7, 21‴f; cones 9 to 13, 23⁗′f. Steel hardness is developed at cone 02, and less than 10% absorption at cone 1. The fired structure is stony, and one or two small cracks are present in each fired test piece. The surface texture is smooth. The maximum total linear shrinkage, plastic basis, at cone 13, is 23.6%. The softening point is cone 32–33. The long vitrification range is especially to be noted. The possible uses are as a refractory bond clay in fire brick, terra cotta, faience tile, and stoneware. It is the equivalent of the well-known Dosch clay, No. 136 (class 8), and has a slightly better color.

TABLE No. 14.

I. White- or Cream-Burning Non-Calcareous Clays.

B. Dense-burning, less than 6% apparent porosity between cones 10 and 15.

3. Generally refractory, softening point cone 27+.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
70	12.8	18.7	31.5	171	21.9	6.9	32
96	13.7	15.9	29.6	398	25.0	7.7	32
98	6.5	20.9	27.4	81	10.8	3.4	35
120	6.8	29.6	36.4	93	9.9	3.1	34
144	17.7	22.1	39.8	165	29.4	8.9	31
273	15.6	21.9	37.5	249*	25.7	7.9	34

* Bonding strength, with 50% of Ottawa sand (—20–,+30-mesh) is 70 lb. per sq. in.

C. Dense-burning, less than 6% apparent porosity between cones 5 and 10.

4. Generally refractory, softening point cone 27+.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
125	11.7	31.1	42.8	26	16.5	5.3	30
143	22.5	21.7	44.2	245	36.8	11.0	32
240	20.6	22.3	42.9	335	33.7	10.2	32–33

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 15.

I. White- or Cream-Burning Non-Calcareous Clays.

B. Dense-burning, less than 6% apparent porosity between cones 10 and 15.

3. Generally refractory, softening point cone 27+.

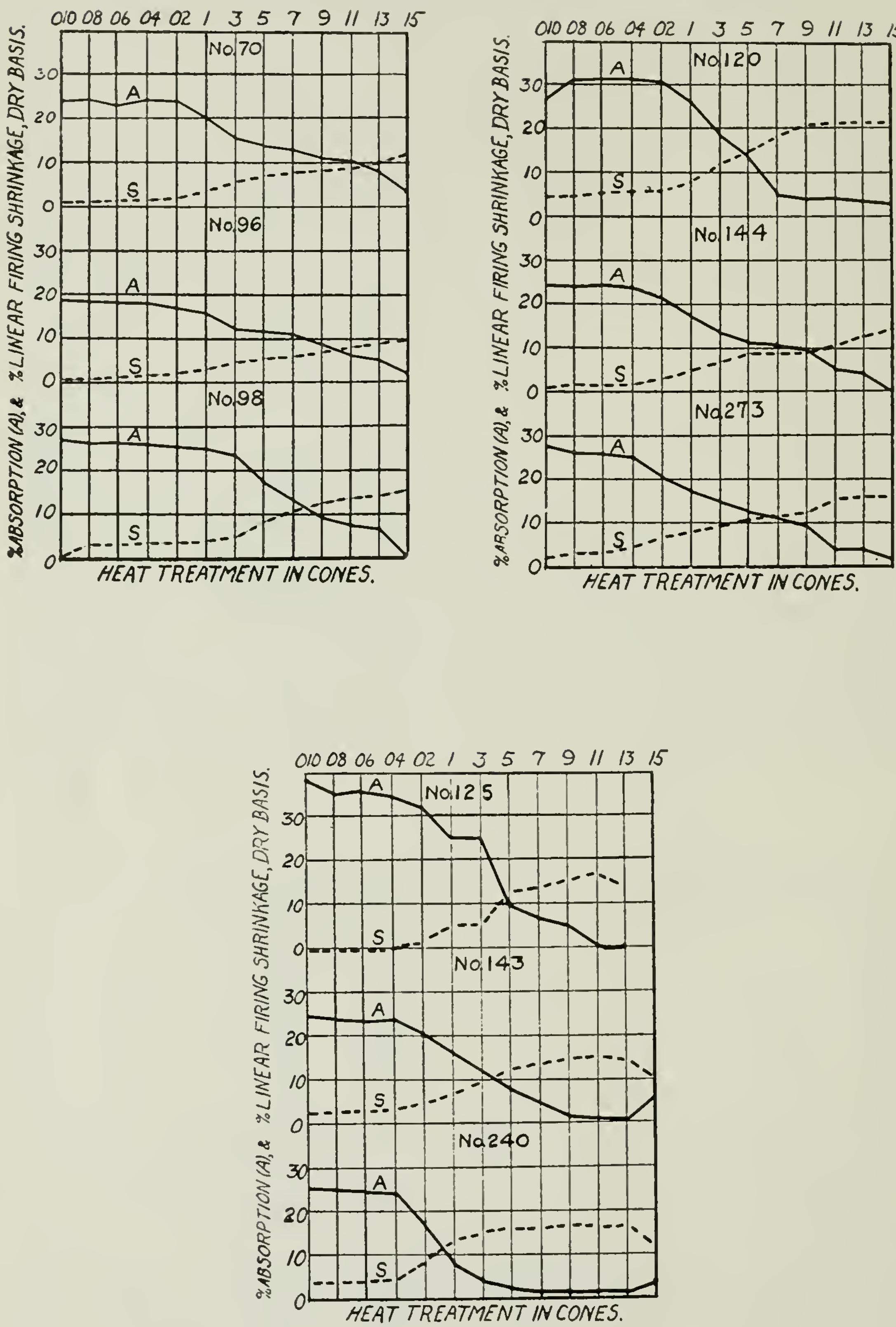
C. Dense-burning, less than 6% apparent porosity between cones 5 and 10

4. Generally refractory, softening point cone 27+.

Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
3	70	2.2	37.8	3.4	38.6	4.5	38.0	4.5	39.4	6.1	38.7	10.4	34.7	16.6	30.1	19.7	26.6	21.1	25.1	23.5	22.8	21.0	21.0	26.8	17.9	32.0	5.2
	96	+1.9	31.7	3.7	31.9	3.9	31.6	4.4	31.2	5.3	30.2	8.2	28.4	13.5	23.6	15.0	22.9	16.4	21.1	18.2	18.2	21.6	12.6	23.5	10.6	26.0	1.1
	98	0.6	41.4	9.3	42.0	9.6	42.2	10.6	42.7	10.5	41.5	10.9	40.7	12.7	40.0	22.1	32.1	28.6	26.6	33.3	19.9	36.1	16.7	37.6	15.3	39.5	0.5
	120	15.0	39.8	14.1	45.3	15.4	46.3	16.0	46.3	16.5	46.1	22.5	41.9	31.9	33.8	37.0	27.4	46.2	10.7	49.5	8.6	49.4	9.9	59.4	7.7	50.0	6.0
	141	3.1	37.4	4.4	37.4	4.5	38.6	5.0	37.7	8.2	35.5	14.8	29.8	20.3	25.0	21.6	21.2	25.2	19.9	26.7	17.8	28.8	9.7	32.6	7.7	35.6	0.0
	273	5.6	42.0	10.0	41.5	10.0	41.4	12.4	40.5	19.0	36.0	22.5	32.0	26.4	27.6	29.5	25.3	31.2	23.6	32.9	29.6	39.1	8.1	39.9	8.5	41.2	3.6
4	125	—2.0	50.5	—1.6	46.3	—0.4	47.6	—0.7	46.2	+5.3	44.4	14.0	38.7	14.0	37.7	32.6	18.5	34.9	14.0	38.2	9.4	29.9	0.0	35.4	0.0	...	
	143	7.0	38.6	7.1	37.9	7.9	37.0	8.5	38.2	11.6	34.8	18.4	30.0	26.2	22.7	33.0	14.9	35.7	8.8	36.8	1.7	38.2	0.0	37.7	0.0	25.0	8.5
	240	9.2	39.9	9.1	40.0	10.5	39.4	11.7	39.3	23.5	28.2	31.4	14.2	38.9	6.1	38.9	3.7	39.3	2.2	10.8	1.6	39.8	2.2	40.5	1.6	29.2	6.4

% V. S.—Firing shrinkage per cent dry volume. % A. P.—Per cent apparent porosity.

Absorption and linear shrinkage curves for clays of classes 3 and 4.



II. BUFF-BURNING CLAYS.

A. Refractory Clays, Softening Point Cone 27+

a Open-Burning, More Than 6% Apparent Porosity at Cone 15.

5. Low Strength.

No. 17 (p. 163). Riverside County. Alberhill C. & C. Co. "Bone." A medium-grained bone clay, with a decided, but not well-developed pisolitic structure in the crude state. It is used in the manufacture of fire brick, high-temperature cement, and to some extent in saggers. It contains 29.0% of + 200-mesh grains, has short plasticity, and dries rapidly to a soft, rough textured condition, with medium low dry strength. The colors are: dry, 13''''d; wet, 13''''i; cones 010 to 06, 17''f; cone 04, 17'''f; cones 02 to 5, whiter than 17'''f; cones 7 to 13, 17'''f. All test pieces fired above cone 02 were 'crow-footed.' Finger-nail hardness is developed below cone 010, and knife hardness appears at cone 5. The total linear shrinkage, plastic basis, is 18.5% at cone 15. The softening point is cone 34. The best firing range is above cone 5. The principal value of this clay is to increase the refractoriness of fire brick bodies.

No. 23 (p. 163). Riverside County. Alberhill C. & C. Co. "West Blue." This is one of the more important Alberhill clays, and is widely used for light-pink and buff face brick, for sewer pipe, and in fire brick to decrease porosity. It contains 11.0% of + 200-mesh sand. The plasticity is excellent and the dry strength is medium low. In the dry condition the clay has a medium hardness, a fine grain and a close texture. The colors are: dry, 17''''f; wet, 21''''; cones 010 to 04, 5'f; cone 02, 11''f; cones 1 and 3, 13''f; cones 5 to 9, 17''f; cone 11, 17''d; cones 13 and 15, 15''b, with prominent iron specking. Finger-nail hardness is developed at cone 08, and steel hardness at cone 3. The maximum total linear firing shrinkage, plastic basis, at cone 13, is 13.7%. Slight bloating is apparent at cone 15. The softening point is cone 29. The best firing range is from cone 1 to cone 13. A pleasing mottled texture can be produced by flashing.

No. 66 (p. 179). Riverside County. Corona. McKnight pit. Pacific Clay Products Co. "Red McKnight." This is a buff-burning clay containing a large proportion of non-plastic material. It is suitable for face brick manufacture, and as an ingredient of sewer pipe mixes. The plasticity is good, though weakened by the presence of 54.4% of + 200-mesh sand. The dry strength is medium low, and the dry condition is coarse, open, soft and friable. The colors are: dry, 9''; wet, 9''i; cones 010 to 02, 9'b; cone 1, 9'd; cone 2, 11'd; cone 5, 9'f; cones 7 and 9, 9''d; cones 11 and 13, 15''d. Finger-nail hardness develops below cone 010, and steel hardness at cone 7. The fired condition is sound, open, granular, and medium strong. The total linear shrinkage, plastic basis, at cone 13, is 5.6%. The softening point is cone 28. The best firing range is above cone 5.

No. 67 (p. 179). Riverside County. Corona. McKnight pit. Pacific Clay Products Co. "McKnight Fire Clay." This is a sandy fire clay with fair plasticity, medium low dry strength, and a granular, friable, dry condition. It contains 64.2% of + 200-mesh sand. The colors are: dry, 13''''d; wet, 13''''i; cones 010 to 7, 17''f; cones 9 to 13, nearly

17‴f. Steel hardness is not developed within the firing range studied, up to cone 15. The fired structure and texture is weak, coarse-grained, and friable. The total linear shrinkage, plastic basis, at cone 15 is 7.2%. The softening point is cone 33. For best results in firebrick manufacture, this clay should be mixed with a more plastic fire clay.

No. 71 (p. 169). Riverside County. Emsco Clay Co. "Pink Mottled." This is a buff-burning plastic fire clay that is especially valuable as a face-brick clay. The plasticity is smooth and strong, without stickiness, the dry strength is medium low, and in the dried state it is soft, fine-grained and open-textured. The sample contains 11.0% of +200-mesh sand. The colors are: dry, 7″d; wet, 7″; cones 010 and 08, 5′f; cone 06, 9″f; cone 04, 7″f; cone 02, 13″f; cone 1, 15″f; cones 3 and 5, 17″f; cones 7 to 1, 17‴f; and cone 13, 17″d. A good range of pinks, buffs, and creams is covered. The fired exteriors, especially above cone 5, are lightly mottled with iron specks. Finger-nail hardness is developed at cone 010, and steel hardness at cone 5. The fired structure is sound, stony and strong. The total linear shrinkage, plastic basis, at cone 13, is 13.1%. The softening point is cone 30–31. The best firing range is from cone 04 to above cone 13.

No. 74 (p. 174). Riverside County. Alberhill. Los Angeles Brick Co. "Bone." See also No. 86, 87, 231 and 232 in the same class, No. 98 in class 3, and No. 103 in class 1. In the natural state, this clay has a well developed pisolitic structure, and is hard and brittle. It is used in the manufacture of high-grade fire brick. The sample contains 47.6% of +200-mesh sand. The plasticity is spongy and weak, the dry strength is low, and the dried condition is soft, friable, and open-textured. The colors are: dry, 11′d; wet, 11′i; cones 010 and 08, 7′d; cones 06 and 04, 5′f; cones 1 to 5, 9′f; cones 7 to 11, 15′f; cone 13, 13′d. Finger-nail hardness is developed at cone 08 and steel hardness appears at cone 1. All fired test pieces have deep hair cracks, but do not disintegrate. The total linear shrinkage, plastic basis, at cone 15 is 24.6%, most of which takes place during firing. The softening point is cone 33–34. The clay is especially valuable as a grog in fire brick mixtures after calcination at cone 11 to 15.

No. 77 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Gray No. 20." This clay is very similar to No. 76 (class 6), but contains more silica, is finer-grained, and has a stronger fired structure. It is used in face brick and fire brick. It contains 6.6% of +200-mesh sand. The plasticity is excellent, the dry strength is medium low, and the dried condition is medium hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 13‴f; cone 010 to 04, 13″f; cones 02 to 13, 17‴f, or slightly whiter. Steel hardness appears at cone 1. All fired structures are sound, and above cone 1 are stony. Absorption below 10% is obtained at cone 7. The maximum total linear shrinkage, plastic basis, at cone 13, is 16.3%. Bloating begins above cone 13. The softening point is cone 30–31. The best firing range is from cone 1 to above cone 13.

No. 79 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Fire-clay." This is a buff-burning, sandy fireclay with low plastic strength, and medium low dry strength. It contains 48.4% of +200-mesh sand. In the dried condition it is friable, coarse-grained and open-textured.

The colors are: dry, 17″f; wet, 13‴b; cones 010 to 04, 9″f; cone 02, 11″f; cone 1, 13″f; cone 3, 17″f; cones 5 to 15, 17‴f. Very few black specks appear on firing. Finger-nail hardness appears below cone 010, but steel hardness is not reached below cone 15. The fired structure is sound, coarse-grained, and open-textured. The total linear shrinkage, plastic basis, at cone 15 is 5.4%, most of which takes place during drying. The softening point is cone 31–32. The best firing range is above cone 9.

No. 86 (p. 174). Riverside County. Alberhill. L. A. B. Co. "No. 26 Bone." See also No. 74, 87, 231 and 232, to which this clay is closely related. The plasticity is spongy and weak, the dry strength is low, and the dried condition is soft, friable, and open-textured. The sample contains 57.8% of +200-mesh material. The colors are: dry, 17‴d; wet, 19″; cones 010 to 5, 9′d; cones 7 to 11, 15′f; cone 13, 17″d. Finger-nail hardness is developed at cone 08, and steel hardness appears at cone 1. Test pieces have hair cracks, when fired above cone 1, but do not disintegrate. The total linear shrinkage, plastic basis, at cone 13, is 12.3%. The softening point is cone 33–34.

No. 87 (p. 174). Riverside County. Alberhill. L. A. B. Co. "White Bone." See also No. 74, 86, 231 and 232. This variety is now designnated "Smooth Bone," and is closely similar to sample No. 232. It contains 31.0% of +200-mesh material. The plasticity is better than that of No. 86, the dry strength is low, and the dried condition is soft, friable and open. The colors are: dry, 17″f; wet, 17‴f; cones 010 to 06, 7′f; cones 04 to 13, pinkish and yellowish white. Finger-nail hardness is developed at cone 08, and steel hardness at cone 3. All fired test pieces are lightly hair-cracked. Less than 10% absorption is obtained at cone 11. The total linear shrinkage, plastic basis, at cone 15 is 18.3%. The softening point is cone 34.

No. 104 (p. 171). Riverside County. Alberhill. G., McB. & Co. "No. 5 Sloan." This is a plastic fireclay, high in alumina. The dry strength is medium low, and the dried condition is soft, medium-grained, and open-textured. It contains 32.2% of +200-mesh sand. The colors are: dry, 17″f; wet, 13″d; cones 010 to 02, 7″b; cone 1, 11″f; cones 3 to 9, 17″f; cones 11 and 13, 13‴f. Numerous small iron specks are visible when fired to cone 11 or above. Finger-nail hardness appears below cone 010 and steel hardness at cone 1. All fired test pieces are lightly hair cracked, and those that were fired at the higher temperatures fell apart into two or more pieces. The surface texture of the fired pieces is smooth. Less than 10% absorption is obtained at cone 5. The maximum total linear shrinkage, plastic basis, at cone 13, is 23.6%. The softening point is cone 34–35.

No. 126 (p. 52). Amador County. Ione. Arroyo Seco Grant. "Baker." This is a plastic fireclay containing 19.6% of +200-mesh quartz and undecomposed feldspar grains. The plasticity is good, the dry strength is low, and in the dried condition it is soft, friable and medium-grained. The colors are: dry, 17‴f; wet, 17‴d; cones 010 to 9, 17″f; cones 11 and 13, 17‴f. Steel hardness does not appear within the firing range studied (cones 010 to 15). Less than 10% absorption appears at cone 11. All fired test pieces are hair-cracked. The total linear shrinkage, plastic basis, at cone 15 is 19.5%. The softening point is cone 33–34. The best firing range is above cone 9.

No. 138 (p. 57). Amador County. Ione. M. J. Bacon. "Bacon Bottom." This clay has a smooth plasticity, medium-low dry strength, and in the dried condition it is soft, fine-grained and open-textured. It contains 4.2% of +200-mesh sand. The colors are: dry, 13″f; wet, 17″f; cone 010, 17″f; fading to pinkish white at cone 02, and to yellowish white at cone 5; cones 11 to 15, 19″d. Scattered iron specks are noticeable at cones 11 to 15. Finger-nail hardness is approximated at cone 010, and steel hardness is reached at cone 11. The fired structure is sound and fine-granular, and the fired surface is slightly rough. The total linear shrinkage, plastic basis, at cone 15 is 18.1%. The softening point is cone 29–30. The clay may be used in sanitary porcelain bodies to replace part of the flint and china clay ordinarily used.

No. 140 (p. 56). Amador County. Ione. Arroyo Seco Grant, Ione Fire Brick Co. "Sand." This is a fire-sand, nearly identical in its properties to No. 128 (class 1) with a softening point of cone 32. It contains 45.0% of +200-mesh sand. The fired colors are: cones 010 to 04, 7″b; cone 02, 7″d; cone 1 to 7, 17″ d; cones 9 and 11, 19″d; cone 13, 19″f.

No. 141 (p. 58). Amador County. Jackson Valley. Ione. Leased to W. S. Dickey Clay Manufacturing Co. This is a high-grade plastic fireclay, yet it contains 38.8% of +200-mesh material. The plasticity is fair, the dry strength is low, and in the dried condition it is soft, medium-grained and open-textured. The colors are: dry 1⁗f; wet, light gull gray (9)f; cones 010 to 06, 7″f; cone 04, 17″f. With increasing temperature, yellow replaces pink, and at cones 11 and 13, the color approximates 19″f. Steel hardness is not developed within the range of temperatures studied (up to cone 15). The fired structure is granular, and hair-cracked, and the texture is slightly rough. The total linear shrinkage, plastic basis, at cone 15, is 14.1%. The softening point is cone 34. This is one of the best fireclays in the state, and brick made from this clay, with a calcined grog of the same material, are exceptionally good.

No. 142 (p. 58). Amador County. Jackson Valley. Ione. Leased to W. S. Dickey Clay Manufacturing Company. This is similar to No. 141, but contains more coloring and fluxing impurities. There is 35.8% of +200-mesh sand. The dry strength is medium low. The colors are: dry, 17″f; wet, 15″d; cones 010 to 06, 7″b; cones 04 and 02, 7″d; cone 1, 7″f; cone 3, 9″f; cone 5, 9‴f; cone 7, 17‴f; cones 9 to 13, 17″d. Steel hardness is developed at cone 3. The fired structure is coarse-granular, and lightly hair-cracked, with a roughened surface texture. The total linear shrinkage, plastic basis, at cone 13 is 14.7%. The softening point is cone 32–33. Except for lower refractoriness, this clay is more workable than No. 141, on account of greater strength and less fire-cracking.

No. 191 (p. 133). Napa County Calistoga. Clark and Marsh. Average sample. This is similar to No. 190 (class 1), but contains more iron, and has even less plasticity and fired strength. The colors are:

dry, 17′d; wet, 11′b; cones 010 and 08, 9′b; cone 06, 9′d; cones 04 to 5, 7′d; cone 7, 9′f; cones 9 to 13, 17‴f. The total linear shrinkage, plastic basis, at cone 13, is 8.1%. The softening point is cone 30–31.

No. 192 (p. 133). Napa County. Calistoga. Tunnel below Clark and Marsh property. This sample contains a much higher proportion of plastic matter than No. 190 or 191, but at the same time contains sufficient iron to give pale buff fired colors. The residue on 200-mesh is 26.2%. The plasticity is fair, the dry strength is medium low, and in the dried condition it is medium-hard, fine-grained, and open-textured. The colors are: dry, pinkish white, wet, 17″f; cone 010, 13″f; fading to pinkish white at cone 3, then changing to 17‴f at cones 11 to 15. Steel hardness is not developed within the firing range studied, up to cone 15. The fired structure is medium-strong, fine-granular, and at high firing temperatures is slightly hair-cracked. The surface texture is slightly roughened. A few iron specks are present. The total linear shrinkage, plastic basis, at cone 15 is 17.1%. The softening point is cone 31.

No. 231 (p. 174). Riverside County. Alberhill. L. A. B. Co. "High Alumina Bone." See also No. 74, 86, 87, and 232. In the natural state this clay has a well-developed pisolitic structure. The plasticity is spongy and weak, the dry strength is low, and in the dried condition it is soft, coarse, and open. The colors are: dry, 9″d; wet, 11″b; cones 010 and 08, 9′d; cones 06 to 02, 9″f; cones 1 to 5, 17″f; cones 7 to 13, 19″f. Finger-nail hardness is developed at cone 1, but steel hardness is not present at cone 15. The fired structure is crumbly and weak at low firing temperatures, and hair-cracked at higher temperatures. The total linear shrinkage, plastic basis, at cone 15, is 19.6%. The softening point is cone 34–35.

No. 232 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Smooth Bone." See especially No. 87, to which this sample is closely similar, except that it is more plastic, and less than 10% absorption is obtained at a lower firing temperature, cone 9, instead of at cone 11. The total linear shrinkage, plastic basis, at cone 15 is 20.6%. The softening point is cone 34–35.

No. 239 (p. 52). Amador County. Ione. Core drill sample, Lot 254. Arroyo Seco Grant. A sandy clay with fair plasticity and low dry strength. It contains 58.0% of +200-mesh sand. In the dried condition it is soft, fine-grained, and open-textured. The colors are: dry, 1⁗f; wet, 15′′′′′b; cones 1 and 5, 9‴f; cones 9 and 13, 17‴d. Steel hardness is not developed at cone 13. The fired structure is sound and fine-granular. The total linear shrinkage, plastic basis, at cone 13, is 3.1%. The softening point is cone 31. The material could be mixed with a more plastic clay for the manufacture of firebrick.

No. 244 (p. 52). Amador County. Ione. Core drill hole No. 54, Arroyo Seco Grant. This is similar to No. 240 (class 4), but contains a larger proportion of fine sand and ferro-magnesian minerals. The plasticity is good, but with a tendency to stickiness. The dry strength is medium low, and in the dried condition it is soft, fine-grained, and open-textured. The colors are: dry, pinkish white; wet, 1′′′′′f; cone 1, 19″f; cones 5 and 9, 17″d; cone 13, 17⁗d. Steel hardness is present at cone 1, and less than 10% absorption appears at cone 5. Blistering was noted at cone 13, although the softening point is cone 31–32. The fired structure is stony, and sound, except for a few small cracks at cone 13. The surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 20.8%, at cone 9. It could be used in terra cotta and faience tile bodies.

No. 250 (p. 52). Amador County. Ione. Core drill No. 56–3, Arroyo Seco Grant. This sample contains but 1.4% of +200-mesh sand. The plasticity is good, without stickiness, the dry strength is medium-low, and in the dried condition it is soft, fine-grained, and open-textured. The colors are: dry, grayish white; wet, carbon gray; cone 1, nearly white; cones 5 and 9, 19″f; cone 13, 17″d. Steel hardness and less than 10% absorption are developed between cone 1 and cone 5. In the fired condition the non-plastic grains are well cemented in a groundmass of clay. Numerous fine, but deep, cracks appear in the fired test pieces. The surface texture is moderately rough. The total linear shrinkage, plastic basis, at cone 13, is 14.7%. The softening point is cone 31. It is a suitable material for terra cotta, tile, and fire brick bodies.

No. 270 (p. 140). American Refractories Co. "Arc Fire Clay." This is a sample of fireclay from which the "Arc" brand of fire brick is manufactured. There is slight effervescence in hydrochloric acid. The plasticity is excellent, the dry strength is medium low, and in the dried condition it is soft, medium-grained, and open-textured. It contains 32.0% of +200-mesh sand. The colors are: dry, 13‴d; wet, 13‴b; cones 010 to 06, 9″f; cones 04 and 02, 15″f; cones 1 to 7, yellowish white; cones 9 to 13, 19″f. The surface is slightly mottled with iron specks above cone 9. Steel hardness is developed at cone 11. The fired structure is sound, and granular, and the surface texture is rough. The total linear shrinkage, plastic basis, at cone 13, is 12.8%. The softening point is cone 32.

No. 282 (p. 141). Orange County. Santa Ana Canyon. Goat Ranch. G., McB. & Co. "Flint Fire Clay." This sample was prepared by wet pebble-mill grinding through 200-mesh, followed by seven days' ageing in the plastic state, with frequent pugging. This produced good plasticity. The dry strength is medium low, and in the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 17⁗f; wet, 21⁗d; cones 010 to 04, 13″f; cones 02 to 9, nearly white; cones 11 and 13, 17″d. Steel hardness is developed at cone 5 and less than 10% absorption at cone 13. The fired structure is fine-granular, and the surface texture is smooth. All test pieces are shattered, but most of them remain in one piece. The total linear shrinkage, plastic basis, at cone 15 is 18.0%. The softening point is cone 33.

No. 285 (p. 232). Tulare County. Ducor. W. A. Sears deposit. See also No. 283–A and B, class 9, and 284, class 10. This is the most satisfactory of the clays that were tested from this property. The material is an impure kaolin, has fair plasticity, and medium-low dry strength. In the dry condition it is medium hard, fine-grained, and open-textured. The colors are: dry, cream white; wet, 15 b; cones 010 to 06, 9″f; cones 04 to 5, 17″d; cones 7 and 9, 15″d; cones 11 and 13, 13″d; cone 15, 15″d. These are suitable buffs for face brick, but the surface is badly contaminated with yellow staining. There is no evidence of vitrification up to cone 15, the upper limit studied. The fired structure is sound, fine-grained, and open-textured, without great strength. The total linear shrinkage, plastic basis, at cone 15, is 10.8%. The softening point is cone 30–31. The clay might have uses as a refractory filler in face brick and terra cotta.

TABLE No. 16.

II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

a. Open-burning, more than 6% apparent porosity at cone 15.

5. Low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
17	9.3	20.1	29.4	136	15.8	5.1	34
23	11.8	19.3	31.1	161	20.3	6.2	29
66	7.1	10.3	17.4	185	14.6	4.7	28
67	5.6	9.0	14.6	142	11.7	3.7	33
71	9.6	16.4	26.0	131	17.2	5.2	31
74	5.6	23.2	28.8	97	9.1	3.0	33–34
77	12.7	18.0	30.7	±190	22.5	7.0	30–31
79	5.9	11.7	17.6	163	11.8	3.8	31–32
86	6.8	19.9	26.7	76	11.7	3.7	33–34
87	8.0	14.9	28.4	76	13.5	4.1	34
104	12.4	24.0	36.4	178	19.7	6.2	35
126	13.0	25.4	38.4	95	19.7	6.2	33–34
138	18.2	25.8	44.0	160	27.9	8.4	29–30
140	7.8	18.0	25.8	46	13.5	4.4	32
141	5.6	23.0	28.6	92	8.9	2.9	34
142	6.5	21.3	27.8	178	10.7	3.4	33
191	13.9	30.2	44.1	180	18.9	6.0	30–31
192	15.4	27.1	42.5	143	22.0	6.9	31
231	5.1	22.8	27.9	41	8.1	2.6	34–35
232	8.1	21.7	29.8	58	13.3	4.3	34–35
239	4.4	13.9	18.3	50	8.4	2.8	31
244	20.4	20.1	40.5	±190	34.1	10.3	31–32
250	11.0	17.4	28.4	179	19.4	6.1	31
270	11.1	17.5	28.6	183	19.7	6.2	32
282	12.9	17.0	29.9	±113	23.5	7.3	33
285	10.7	44.0	54.7	130	11.8	3.8	30–31

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 17.

II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

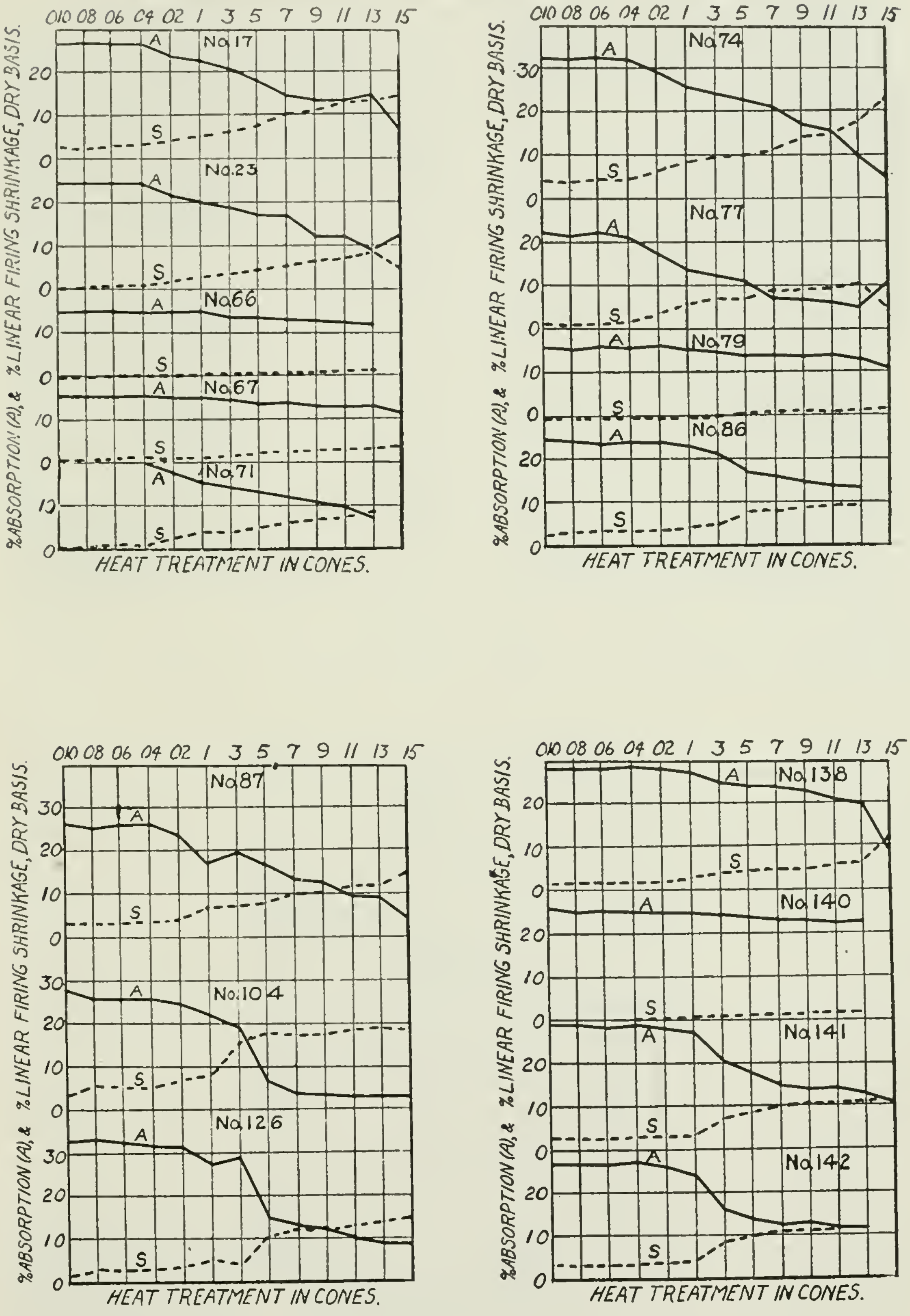
a. Open-burning, more than 6% apparent porosity at cone 15.

Class No.	Clay No.	Cone 010 % V. S.	Cone 010 % A. P.	Cone 08 % V. S.	Cone 08 % A. P.	Cone 06 % V. S.	Cone 06 % A. P.	Cone 04 % V. S.	Cone 04 % A. P.	Cone 02 % V. S.	Cone 02 % A. P.
5	17	+7.6	41.2	5.5	42.0	8.6	42.7	8.5	42.5	12.1	40.0
	23	0.1	38.0	1.7	38.2	1.7	38.6	1.9	39.5	6.2	36.3
	66	—0.8	28.0	—0.7	29.1	—0.3	29.1	+0.1	29.1	+0.1	28.8
	67	1.0	28.4	2.7	29.2	2.7	29.8	3.0	29.7	3.6	28.7
	71	0.3	34.0	0.9	31.0	2.3	36.6	2.5	34.2	7.6	30.2
	74	12.0	48.2	11.8	48.0	13.2	49.4	13.4	49.3	18.2	47.0
	77	3.0	36.2	2.8	35.9	3.4	37.0	5.2	36.1	10.5	31.4
	79	—2.0	28.9	—2.0	28.8	—1.8	29.8	—1.7	29.6	—1.5	29.6
	86	7.1	39.2	9.0	39.1	10.0	39.2	9.4	40.2	9.5	40.3
	87	8.3	41.5	8.0	40.8	8.8	41.7	8.9	41.8	11.0	39.6
	104	8.5	42.6	14.1	41.8	14.7	42.0	14.5	41.9	16.7	40.6
	126	4.3	47.0	7.8	47.0	8.2	46.9	8.4	46.3	10.1	45.8
	138	4.0	40.6	4.7	41.2	4.9	41.5	4.7	41.6	5.2	41.3
	140	0.0	40.3	0.0	39.9	0.0	40.2	0.2	40.4	0.4	40.0
	141	7.8	44.5	8.1	44.8	8.3	44.2	8.6	44.4	9.0	43.8
	142	9.2	42.5	8.6	42.8	9.3	43.0	9.0	43.0	10.3	42.5
	191	1.2	48.8	1.2	49.3	1.4	49.3	1.6	49.5	2.3	49.3
	192	5.2	44.1	6.7	44.2	7.0	44.3	8.4	43.7	10.4	44.0
	231	10.0	48.5	12.2	48.7	13.6	49.8	13.7	50.0	.....	.....
	232	8.2	40.9	11.8	40.4	13.2	40.6	13.3	41.1	16.9	38.3
	239	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	244	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	270	1.8	39.2	3.1	39.6	3.2	39.1	5.5	38.6	5.6	38.5
	282	8.7	34.9	.....	.....	9.4	34.8	9.1	34.4	12.2	32.2
	285	5.4	44.2	5.3	44.2	9.2	42.8	13.0	41.7	15.6	42.0

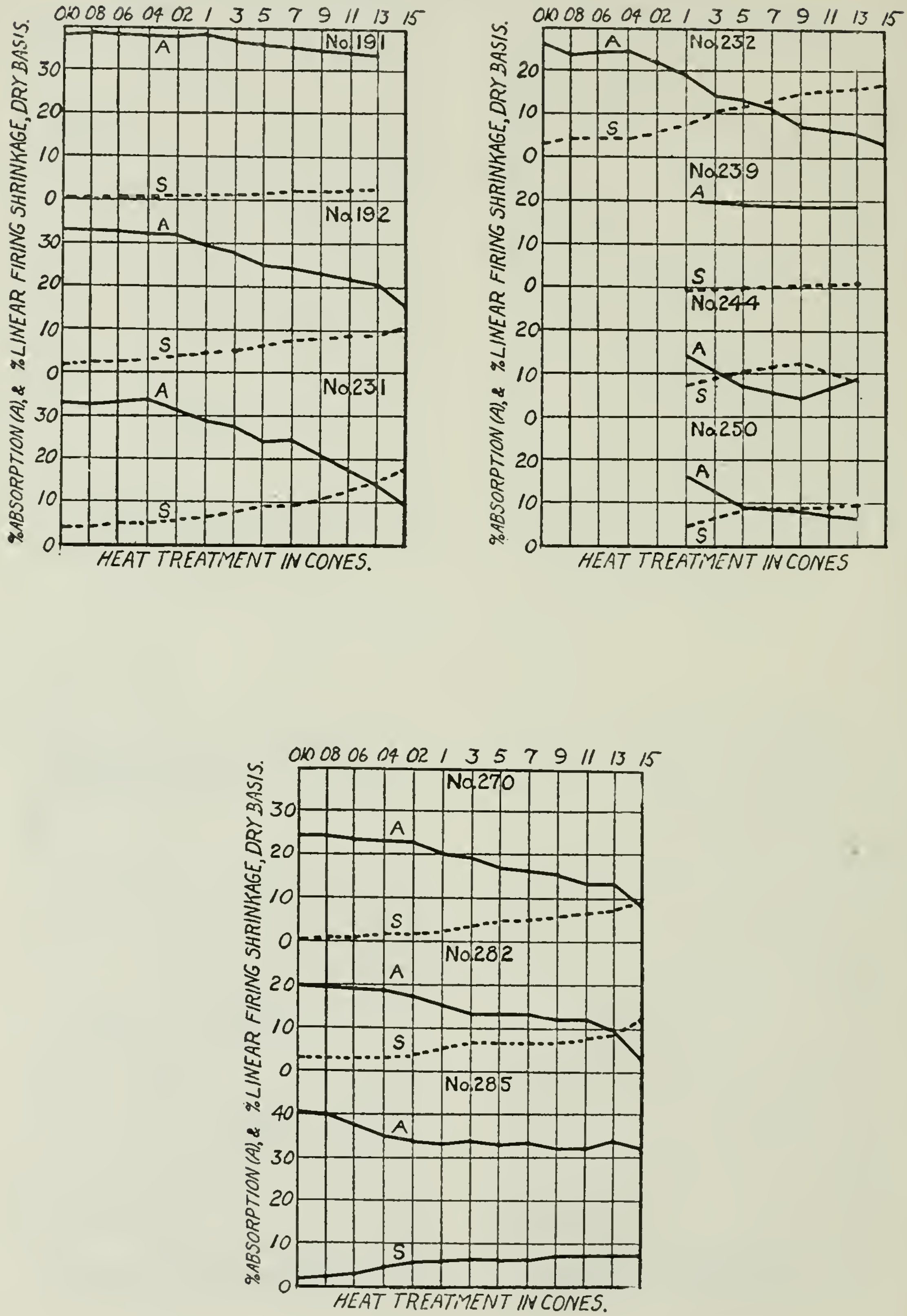
Clay No.	Cone 1 % V. S.	Cone 1 % A. P.	Cone 3 % V. S.	Cone 3 % A. P.	Cone 5 % V. S.	Cone 5 % A. P.	Cone 7 % V. S.	Cone 7 % A. P.	Cone 9 % V. S.	Cone 9 % A. P.	Cone 11 % V. S.	Cone 11 % A. P.	Cone 13 % V. S.	Cone 13 % A. P.	Cone 15 % V. S.	Cone 15 % A. P.
17	13.1	38.9	17.0	36.6	21.0	33.3	27.1	28.2	29.2	26.9	33.1	29.2	32.8	30.0	37.0	16.0
23	8.3	34.5	10.2	33.5	13.5	32.2	14.2	30.7	18.8	24.9	19.3	23.7	23.2	18.6	14.5	22.2
66	+0.5	29.5	1.4	27.6	2.1	26.8	2.5	25.8	2.7	26.0	2.9	25.1	3.4	24.2	.....	.....
67	3.5	26.6	4.7	28.1	*6.0	*26.7	†6.3	†26.7	7.8	26.2	7.9	25.8	8.7	26.0	10.9	23.4
71	10.8	28.1	12.2	27.0	14.3	25.2	16.9	23.1	18.3	21.8	19.2	20.0	23.6	15.0	.....	.....
74	23.2	44.0	25.8	41.7	27.2	41.2	30.2	39.1	36.3	31.5	37.9	35.4	44.3	22.7	52.7	7.7
77	16.6	26.0	19.3	23.6	20.3	22.4	25.0	15.8	25.1	14.9	25.6	14.5	28.0	11.2	.....	.....
79	—1.2	30.5	—0.7	29.1	+0.5	28.2	1.8	27.0	2.0	26.6	1.5	26.8	2.0	25.2	5.4	21.5
86	11.3	39.4	13.6	37.4	*21.4	*31.7	†21.8	†30.8	23.8	28.2	25.0	27.2	24.6	26.6	.....	.....
87	20.1	30.9	20.1	34.9	22.2	31.5	26.9	26.0	27.8	24.7	31.2	20.9	32.2	20.4	38.6	10.4
104	19.0	38.1	22.4	35.6	38.8	16.5	13.6	6.9	43.2	7.9	45.8	6.2	46.6	6.4	45.4	6.1
126	13.7	43.0	11.7	44.1	29.0	28.5	32.5	21.9	32.1	23.7	31.4	20.2	36.4	18.9	37.4	19.7
138	7.0	40.9	10.8	39.1	12.9	37.8	13.2	38.1	14.6	37.2	15.9	35.8	16.7	33.1	30.1	17.6
140	‡1.6	‡39.6	#1.4	#39.5	2.6	38.5	3.2	37.7	5.0	38.0	5.2	37.7	5.2	37.6	.....	.....
141	10.1	43.1	20.2	35.9	23.2	31.8	26.8	27.8	27.6	27.5	28.4	28.2	28.7	25.9	30.9	21.4
142	12.7	40.7	24.0	31.0	26.7	27.3	29.5	25.3	29.5	25.9	30.4	24.2	31.4	24.1	.....	.....
191	2.3	49.2	3.8	48.3	5.1	48.0	5.5	17.6	6.4	17.3	7.0	46.8	7.7	46.3	.....	.....
192	12.9	42.5	15.1	41.0	18.7	38.6	20.9	37.8	21.7	37.2	23.9	35.8	21.6	34.6	30.5	28.8
231	18.1	46.5	21.2	45.0	§25.2	§11.5	x25.5	x12.0	29.1	38.0	33.7	33.8	38.0	29.6	43.8	22.4
232	21.1	34.7	28.6	28.0	§32.4	§27.5	x32.6	x25.6	37.9	16.2	39.4	14.3	40.5	13.2	43.2	8.0
239	—1.6	35.0	.....	.....	—0.8	34.4	.....	.....	+0.3	33.7	.....	.....	1.3	33.6	.....	.....
244	19.7	26.2	.....	.....	28.8	15.0	.....	.....	33.3	8.8	.....	.....	23.3	17.0	.....	.....
250	13.7	30.0	.....	.....	22.7	18.9	.....	.....	23.2	17.4	.....	.....	25.8	14.5	.....	.....
270	9.1	35.8	10.9	34.5	*14.7	*31.7	†15.0	†31.0	17.3	29.2	19.9	26.7	20.5	26.4	26.0	18.9
282	15.3	29.4	19.0	26.7	19.0	26.7	19.4	26.6	20.5	25.0	21.7	21.8	24.6	21.0	32.2	7.3
285	17.5	41.8	17.7	42.3	17.9	41.8	18.0	43.0	19.6	42.0	20.2	42.2	20.2	44.1	22.6	42.8

% V. S.=Firing shrinkage, per cent dry volume. % A. P.=Per cent apparent porosity. *Cone 5+. †Cone 7—. ‡Cone 1+. #Cone 3—. §Cone 6—. xCone 6+.

Absorption and linear shrinkage curves for clays of class 5.



Absorption and linear shrinkage curves for clays of class 5.



6. Medium to High Strength.

No. 9 (p. 163). Riverside County. Alberhill. C. & C. Co. "Hill Blue." See No. 271, and 274 in class 7, and 272 in this class, which are better samples of the material that will be available in the future. This is a smooth, fine grained, buff-burning refractory clay with good plasticity, and medium high dry strength. It contains 4.8% of +200-mesh sand. It is used in art tile, stoneware, terra cotta, and sagger bodies, and represents one of the most widely used of the Alberhill clays. The colors are pinkish and buffish white, approximating Ridgway's "f" tone. Finger-nail hardness is developed below cone 010, and steel hardness at cone 02. Vitrification is well advanced at cone 13. The maximum total linear shrinkage, plastic basis, is 13.3% at cone 13. Bloating is apparent at cone 15. The softening point is cone 29. The best firing range is from cone 04 to cone 13, and hard, strong bodies with absorptions below 10% are obtained above cone 3.

No. 14 (p. 163). Riverside County. Alberhill C. & C. Co. "A–Clay." This is a pink and buff-burning plastic clay used in the manufacture of face brick. It contains 19.2% of +200-mesh sand, develops excellent plasticity, has a good dry structure, and medium high dry strength. The colors are: dry, 17‴d; wet 17‴b; cone 010, 9′f; cones 08 to 04, 5′f; cone 02, 11″f; cones 1 to 5, 13″f; cones 7 to 9, 17″f; cone 11, 17″f; cone 13, 15″d. Finger-nail hardness is developed below cone 010, and steel hardness at cone 3. The total linear shrinkage, plastic basis, is 11.1% at cone 13. The softening point is cone 31. The best firing range is from cone 3 to cone 13 or above. A wide range of buff and pink colors can be secured in the normal kiln run.

No. 27 (p. 163). Riverside County. Alberhill C. & C. Co. "No. 10." This is a pale buff-burning clay with excellent smooth plasticity, medium-high dry strength, and a medium-hard, fine-grained, close-textured dry condition. It contains 2.6% of + 200-mesh sand. It is used in sagger, art tile and dry-pressed brick mixtures, and was formerly used in architectural terra cotta. The colors are: dry, 13‴f; wet, 13‴k; cones 010 to 1, 15″f; cone 3, 17‴f; beyond cone 3, to cone 15, increasing yellow, decreasing pink, with scattered fine brownish and black specks. Finger-nail hardness appears below cone 010, and steel hardness at cone 3. The total linear shrinkage, plastic basis, at cone 13 is 16.1%. Bloating is apparent at cone 15. The softening point is cone 30–31. The best firing range is from cone 3 to cone 13. The smooth texture, light colors, and excellent plastic, drying and firing qualities of this clay make it especially desirable for many purposes.

No. 33 (p. 205). San Diego County. Cardiff. Vitrified Products Co. See also No. 34. This is a light-colored fireclay, of Pleistocene (?) age, containing 41.0% of + 200-mesh sand. It is used for fire-brick and for buff or cream face brick. It has weak plasticity without stickiness, medium-high dry strength, and in the dry state it is hard, with a granular structure. The colors are: dry and wet, yellowish white; cones 010 and 08, 13‴f; cone 06, 17‴d; cones 04 and 02, 15″d; cones 1 to 13, 17″d. These colors, coupled with a granular texture, make pleasing effects for buff and cream face brick. Finger-nail hardness appears below cone 010 and the hardness at cone 13 is slightly less than steel. The total linear shrinkage, plastic basis, at cone 13, is 8.6%.

The softening point is cone 30. The best firing range is from cone 1 to above cone 13.

No. 34 (p. 205). San Diego County. Cardiff. Vitrified Products Co. See also No. 33. This clay is from another part of the same bed from which No. 33 was taken, and is similar to it in every respect, but has less sand, more iron, stronger plasticity, and slightly greater shrinkage. It contains 31.0% of +200-mesh sand. The colors are: dry, 9‴f; wet, 9‴d; cones 010 to 04, 7″f; cone 02, 1″d; cones 1 to 7, 15″d; cones 9 and 11, 17″d; cone 13, 17″b. Steel hardness appears at cone 13. The total linear shrinkage, plastic basis, at cone 15, is 11.5%. The softening point is cone 31. The best firing range is from cone 1 to cone 15.

No. 53 (p. 195). San Bernardino County. Hicks. Millet and Kennedy. This is a buff-burning, plastic fireclay of Tertiary age from an undeveloped deposit. The plasticity is good, the dry strength is medium high, and the dry condition is hard and close grained, with a heterogeneous texture caused by the presence of non-plastic grains of a different color than the clay portion. The sample contains 10.4% of + 200-mesh material. The colors are: dry, nearly white; wet, 19″f; cones 010 to 1, 11″f; cones 3 to 9, 17‴d; cones 11 and 13, 17‴f, mottled, with slag spots. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 02. The fired structure is sound throughout, and vitrification is well advanced, but not complete, at cone 15. The maximum total linear shrinkage, plastic basis, at cone 13, is 20.1%. The softening point is cone 30. The best firing range is from cone 04 to cone 13. The clay is suitable for the manufacture of pink and buff face brick, and as a bond clay in fire brick. It is possible that material of improved quality can be found if the deposit is developed.

No. 76 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Gray No. 23." See No. 77, class 5. This is a plastic buff-burning fireclay that is particularly useful in sagger and pottery mixes. The clay contains 2.2% of + 200-mesh sand, the plasticity is excellent, the dry strength is medium, and the dried condition is medium hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴d; cones 010 and 08, 7′f; cones 06 and 04, 9′f; cone 02, 13″f; cones 1 to 13, 17‴f, or slightly whiter. The fired colors are good buffs and creams for face brick, faience tile, and similar products. Finger-nail hardness is developed below cone 010, and steel hardness at cone 1. The fired structure is sound and stony, and smooth textures are obtained. Absorptions below 10% are obtained at cone 9. The maximum total linear shrinkage, plastic basis, is 15.6%, at cone 11. The softening point is cone 29. The best firing range is from cone 1 to cone 13.

No. 78 (p. 174). Riverside County. Alberhill. L. A. B. Co. "No. 10." This is a dark colored, buff-burning, plastic fireclay, containing carbonaceous matter. It is used for fire brick and face brick. The sample contains 16.2% of + 200-mesh sand. The plasticity is excellent, the dry strength is medium-high, and the dried condition is medium-hard, medium fine-grained and close-textured. The colors are: dry, 13⁗d; wet, 13⁗i; cones 010 to 04, 9′f; cone 02, 13″f; cones 1 to 13, between 17‴f and 21‴f, although slightly whiter at some cone numbers. Scattered yellowish specks appear at low firing temperatures, which darken and become more prominent at high temperatures. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions above 10% are found above cone 8. The fired structure is sound and above cone 02 is stony. The total linear firing shrinkage, plastic basis, at cone 13, is 17.1%. Slight bloating was noted at cone 15. The softening point is cone 29. The best firing range is from cone 1 to cone 13. The plasticity, dry and fired strength, and wide vitrification range at commercially attainable temperatures are the most valuable properties of this clay.

No. 81 (p. 174). Riverside County. Alberhill. L. A. B. Co. "No. 25." This is a plastic fireclay, similar to No. 76, but with more coloring matter, and a higher proportion of clay substance. It is used for face brick and fire brick. It contains only 1.8% of +200-mesh sand, the plasticity is smooth and strong, the dry strength is medium high, and the dry condition is medium soft, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴b; cones 010 to 1, 11′d; cones 3 and 5, 11′f; cones 7 to 11, 17‴f; cone 13, 17″f. These are suitable buffs and tans for face-brick manufacture. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions below 10% are obtained at cone 7 and above. The total linear shrinkage, plastic basis, at cone 13, is 15.8%. The softening point is cone 28. The best firing range is above cone 1.

No. 84 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Main Pit Fireclay." This is a plastic fireclay, similar to the "Main Tunnel" clays mined by the Alberhill C. & Co. Co. and by G., McB. & Co., see samples No. 15, 29, 90, and 93 in class 2, and No. 13 and 229 in class 7. It contains 11.0% of +200-mesh sand, the plasticity is smooth and strong, the dry strength is medium, and the dry condition is soft, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴d; cones 010 to 13, 9′f to 17′f. Green staining is pronounced. Finger-nail hardness develops below cone 010, and steel hardness at cone 3. Less than 10% absorption is obtained at cone 5. Vitrification is well advanced at cone 13. With the exception of a few cracks that resulted from the rapid firing schedule used, the fired test pieces are sound. The total linear shrinkage, plastic basis, at cone 13 is 12.2%. The softening point is cone 28. The best firing range is above cone 3. The clay may be used in fire brick, face brick, faience tile, stoneware, and pottery mixes. The color is not white enough for whiteware bodies.

No. 92 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Yellow Main Tunnel Clay." This is a plastic, buff-burning clay that can be used in fire brick and face brick. It contains 16.8% of +200-mesh sand. The plasticity is smooth and strong, the dry strength is medium-high, and in the dried state it is medium hard, fine-grained, and close-textured. The colors are: dry, 17″d; wet, 17″; cones 010 to 02, 7′d; cones 1 to 7, 7′f; cones 9 to 13, 17″d. Scattered slag spots appear above cone 9. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions under 10% are found at cone 11. The fired structure is sound, and at high temperatures, is stony. The total linear shrinkage, plastic basis, at cone 13, is 13.6%. The softening point is cone 28.

No. 97 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Smooth Bunker." This is a buff-burning terra cotta clay with excellent plasticity and medium high dry strength. There is slight effervescence in hydrochloric acid. In the dried condition it is soft, fine-grained, and close-textured. It contains 15.6% of +200-mesh sand. The colors are: dry, 13''''d; wet, 17''''d; fired, from cone 010 to cone 13, 13''f to 17'''f. The color at cone 13 is deeper than in No. 96 (class 3), and a few iron specks appear which are not present in No. 96. Finger-nail hardness appears below cone 010, and steel hardness at cone 02. The fired structure is sound and stony, and the texture is slightly rough. Absorptions under 10.0% are obtained at cone 11. The total linear shrinkage, plastic basis, at cone 13, is 11.4%. The softening point is cone 31. The best firing range is from cone 1 to cone 13.

No. 102 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Sloan Sand." This is a sandy fireclay with fair plasticity, medium dry strength, and a medium-hard, medium-grained, open-textured dried condition. It contains 30.6% of +200-mesh sand. The colors are: dry, 17''f; wet, 15''; cones 010 to 02, 9''b; cone 1, 9''d; cones 3 to 11, 13''d; cone 13, 17''d. At cones 11 and 13, scattering gray and brown specks appear. Finger-nail hardness appears below cone 010, and steel hardness develops at cone 3. The fired condition is sound, granular, and rough-textured. The total linear shrinkage, plastic basis, at cone 13, is 9.7%. The softening point is cone 29. The clay is suitable for the manufacture of face brick, and as an ingredient in low-grade fire-brick mixes.

No. 108 (p. 176). Riverside County. Alberhill. Pacific Clay Products Co. "Upper Douglas." This is a deep buff-burning sewer-pipe clay with good plasticity, high dry-strength, and in the dried condition it has finger-nail hardness, and a fine grained and close texture. It contains 5.8% of +200-mesh sand. The colors are: dry, 17''f; wet, 13''d; cones 010 to 02, 11'd; cone 1, 15'd; cones 3 to 13, 15''d. Steel hardness is developed at cone 1. Less than 10% absorption is developed at cone 3. Vitrification is complete at cone 11, after which bloating begins. The fired structure is sound and stony. The maximum total linear shrinkage, plastic basis, is 20.0%, at cone 11. The softening point is cone 27–28.

No. 130 (p. 62). Amador County. Ione. "Newman Carbonaceous Sand." This is a fire sand high in carbonaceous matter for which no uses have been found. Some iron compounds are present which are partly soluble in the mixing water, and cause discoloration by efflorescence. The residue on 200-mesh is 16.0%. More clay is present than in No. 129 (class 1), resulting in better plasticity, and medium dry strength. The interior colors are: dry, 15''''b; wet, 15''''m; cones 010 to 1, 15''b; cones 3 to 5, 13''b; cones 7 and 9, 13''b. The efflorescence has a 5'i color from cone 010 to cone 1. Steel hardness is approximated at cone 3. The fired structure is sound, fine-grained, and open textured. Light hair-cracks appear on the surface of test pieces fired above cone 3. The total linear shrinkage, plastic basis, at cone 9, is 11.6%. The softening point is cone 27.

No. 139 (p. 52). Amador County. Ione. M. J. Bacon. "Bacon Blue." This is a fine-grained, cream-burning, plastic clay that is suitable for stoneware manufacture. It contains 1.4% of +200-mesh sand. The plasticity is very good, the dry strength is medium low, and in the dried condition it is medium-hard, fine-grained, and open-textured. The colors are: dry, 13''''f; wet, 17''''f; cone 010, 17''f, changing to pinkish white at cone 02, then to cream-white up to cone 9; cones 11 and 13, 19''d. Finger-nail hardness is approximated at cone 010, and steel hardness develops at cone 7. Less than 10% absorption is developed at cone 9. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 17.7%. Bloating is pronounced at cone 15. The softening point is cone 29–30. The best firing range is from cone 5 to cone 11.

No. 145 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "No. 0." This variety of the Lincoln clay contains a large proportion of sand, and enough iron to give buff and pink colors on firing. It effervesces slightly in hydrochloric acid. The plasticity is good, the dry strength is medium-high, and in the dried condition, it is medium soft, medium-grained, and open-textured. The colors are: dry, 17''f; wet, 17''d; cones 010 to 02, 11'f; cones 1 to 5, 13'f; cones 7 to 13, 17'f. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 9. The fired structure is sound, and consists of sand particles imbedded in a clay ground mass. The fired surface texture is rough, and at high firing temperatures, the surface is mottled. The maximum total linear shrinkage, plastic basis is 17.7% at cone 13. Slight bloating develops at cone 15. The softening point is cone 30–31. The best firing range is from cone 1 to cone 13. The clay is used in face brick mixes, and could be used for the cheaper grades of fire brick, and in terra cotta.

No. 150 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "No. 10." For all practical purposes this clay is identical to No. 149 (class 7) although the dry strength is 25% higher, and the porosities are somewhat higher. No blistering can be detected when fired to cone 13, but bloating is apparent at cone 15. The total linear shrinkage, plastic basis, at cone 13, is 20.6%. The softening point is cone 32.

No. 197 (p. 227). Sonoma County. Two miles east of Beltane. This clay, from an undeveloped deposit, has good plasticity, but with a tendency to sponginess, medium-high dry strength, and in the dried condition it has finger-nail hardness, is fine-grained, and open-textured. A tendency to crack during drying was noted. The colors are: dry, yellowish white; wet, 19''f (yellow-buff); cones 06 and 02, 17''f; cone 1, 17''b; cone 3, 17''d. The fired colors are too yellowish for good face-brick effects. Steel hardness was not developed at cone 3, which was the highest temperature studied. The fired structure is sound. The total linear shrinkage, plastic basis, at cone 3, is 12.3%. The softening point is cone 27–28. More data are needed before a prediction of possible uses can be made, but the clay seems worthy of further investigation.

No. 257 (p. 52). Amador County. Ione. Core drill hole No. 62, Arroyo Seco Grant. This is one of the best of the core-drill samples that were tested. The plasticity is good, with a tendency to stickiness, the dry strength is medium high, and in the dried condition it is medium-hard, fine-grained, and close-textured. There is slight effervescence in hydrochloric acid. The colors are: dry, 17''''d; wet, 13''''k; cone 1, nearly white; cones 5 and 9, buff-white; cone 13, 17''f. Steel hardness is developed between cone 1 and cone 5, and less than 10% absorption between cones 9 and 13. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 18.7%. The softening point is cone 31–32. This clay is suitable as a refractory bond clay in fire brick, terra cotta, and tile, and might be used in stoneware bodies.

No. 258 (p. 52). Amador County. Ione. Core drill hole No. 61, Arroyo Seco Grant. This is a sandy clay containing a large proportion of ferro-magnesian mineral grains. The residue on 200-mesh is 18.8%. The plasticity is fair, but sticky, the dry strength is medium, and in the dried condition it is medium-hard, medium-grained, and open-textured. The colors are: dry, grayish white; wet, 1'''''f; cones 1 and 5, 17''f; cone 9, 17''d; cone 13, 17''b. At cone 9 and above, numerous slag pits appear. Steel hardness is developed between cones 1 and 5, and less than 10% absorption slightly above cone 5. The fired structure is sound, moderately strong, and granular. The total linear shrinkage, plastic basis, is 14.2%, at cone 13. The softening point is cone 28–29.

No. 263 (p. 159). Placer County. East of Lincoln. Valley View Mine. This is a plastic kaolin that burns nearly white. It contains 1.2% of + 200-mesh material. The plasticity is good, but with a tendency to stickiness, the dry strength is medium high, and in the dried condition it is medium-hard, fine-grained, and close-textured. The colors are · dry, pinkish white; wet, 17''f; cones 08 and 04, 15''f; cone 1, whiter than 17''f; cones 7 and 13, slightly whiter than 17'''f. It can nearly be classed as a white-burning clay. Steel hardness is developed at cone 7 and less than 10% absorption at cone 9 (approx). The fired structure is sound, stony, and smooth-textured. The total linear shrinkage, plastic basis, is 21.4%, at cone 13. The softening point is cone 32–33. This clay is suitable for use in terra cotta, wall tile, and possibly in fire brick.

No. 266 (p. 140). American Refractories Co. "Amreco Fire Clay." This is a sample of fireclay from which the "Amreco" brand fire brick is manufactured. It contains 32.8% of + 200-mesh sand. The plasticity is excellent, the dry strength is medium, and in the dried condition it is medium-hard, medium-grained, and medium-textured. The colors are: dry, 17'''d; wet, 13'''b; cones 010 to 06, 9''f; cone 04, 15''f, first fading with increasing temperature, then becoming more yellowish; cones 11 and 13, 17'''f. Slight mottling is produced at high temperatures by the presence of iron minerals. Steel hardness is developed at cone 9. The fired structure is sound and moderately strong. The surface texture is slightly rough. The total linear shrinkage, plastic basis, at cone 15, is 11.8%. The softening point is cone 32.

No. 272 (p. 163). Riverside County. Alberhill. A. C. & C. Co. "Main Tunnel Hill Blue." See also No. 9 in this class and No. 271 and 274 in class 7. This sample contains more sand and fluxing impurities than the other three samples of "Hill Blue" clay. The percentage of +200-mesh sand is 37.0. The plasticity is good, the dry strength is medium, and in the dried condition it is medium-hard, coarse-grained, and open-textured. There is slight effervescence in hydrochloric acid. The colors are: dry, 13''''f; wet, 15'''''f; cones 010 to 1, 13''f; cones 3 to 9, 17''f; cones 11 and 13, 17''d. Steel hardness and less than 10% absorption are developed at cone 11. A mottled and heterogeneous fired structure is produced by the presence of a large percentage of ferro-magnesian minerals. The fired structure is sound, and the surface texture is rough. The total linear shrinkage, plastic basis, at cone 13, is 9.8%. The softening point is cone 29.

TABLE No. 18.

II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

a. Open-burning, more than 6% apparent porosity at cone 15.

6. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
9	12.6	13.3	25.9	770	24.8	7.7	29
14	11.6	12.4	24.1	420	22.6	6.9	31
27	15.5	14.8	30.3	458	28.6	8.6	30–31
33	10.6	11.4	22.0	550	20.7	6.4	30
34	9.0	13.6	22.6	449	17.5	5.5	31
53	25.2	19.1	44.3	795	42.4	12.3	30
76	13.5	18.1	31.6	240	23.9	7.4	29
78	17.4	19.4	36.8	462	29.1	8.8	29
81	16.7	16.8	33.5	414	30.0	9.1	28
84	11.4	12.7	24.1	326	22.5	7.0	28
92	15.0	13.5	28.5	480	28.8	8.7	28
97	11.8	14.1	25.9	412	22.3	7.0	31
102	9.9	14.0	23.9	271	19.0	6.0	29
108	27.1	13.1	40.2	±1118	52.3	15.0	27–28
130	14.2	22.9	37.1	387	22.5	7.1	27
139	16.5	17.8	34.3	201	28.7	8.7	29–30
145	17.4	21.0	38.4	447	29.1	7.8	30–31
150	20.7	18.5	39.2	337	35.7	10.7	32
197	33.7	31.9	65.6	529	44.9	13.2	28
257	21.8	19.5	41.3	403	36.7	11.0	32
258	9.7	16.1	25.8	217	18.1	5.7	28–29
263	21.5	20.0	41.5	417	36.2	10.8	32–33
266	8.9	15.2	24.1	231	16.4	5.2	32
272	10.2	12.5	22.7	348	19.8	6.2	29

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 19.

II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

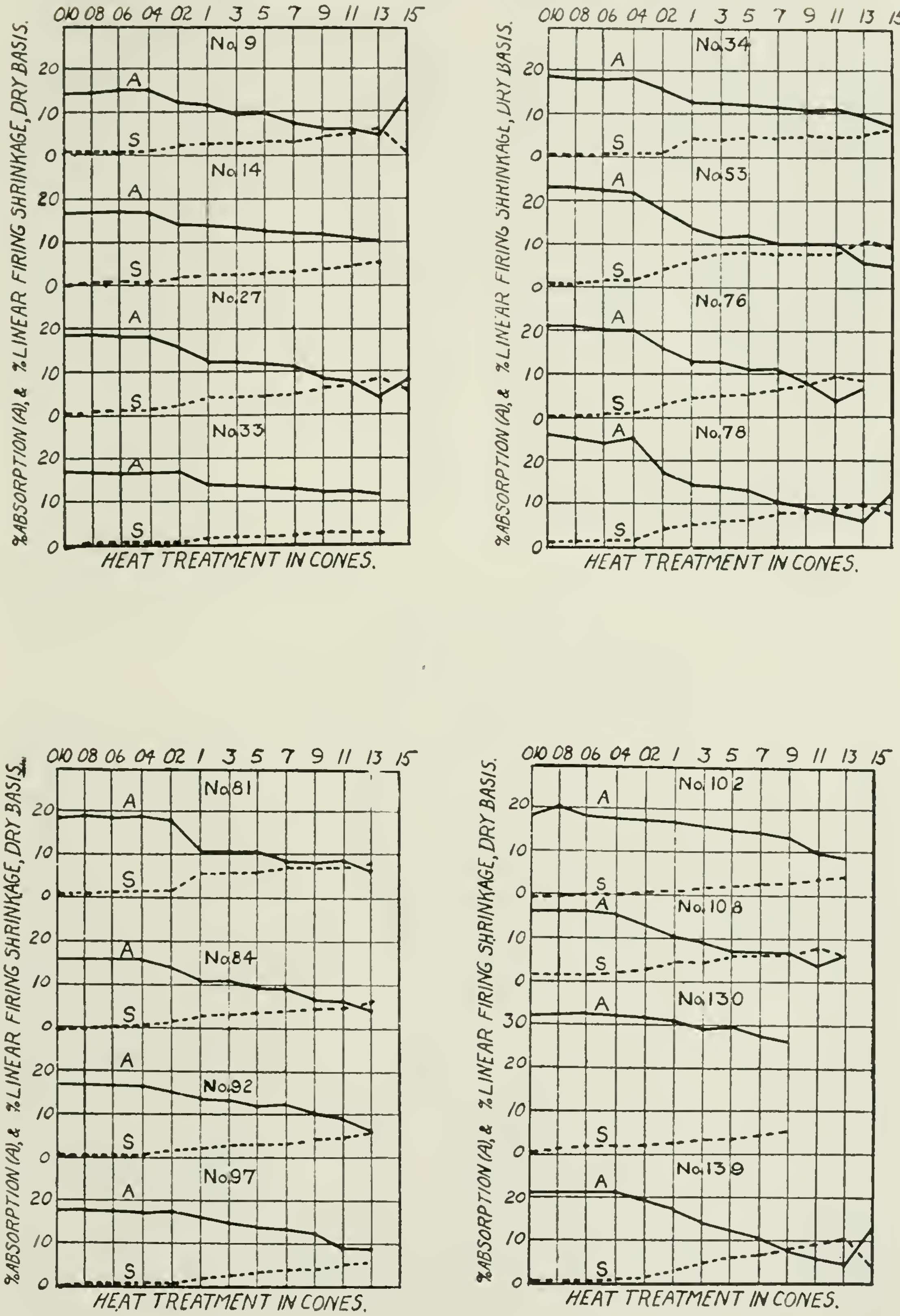
a. Open-burning, more than 6% apparent porosity at cone 15.

6. Medium to high strength.

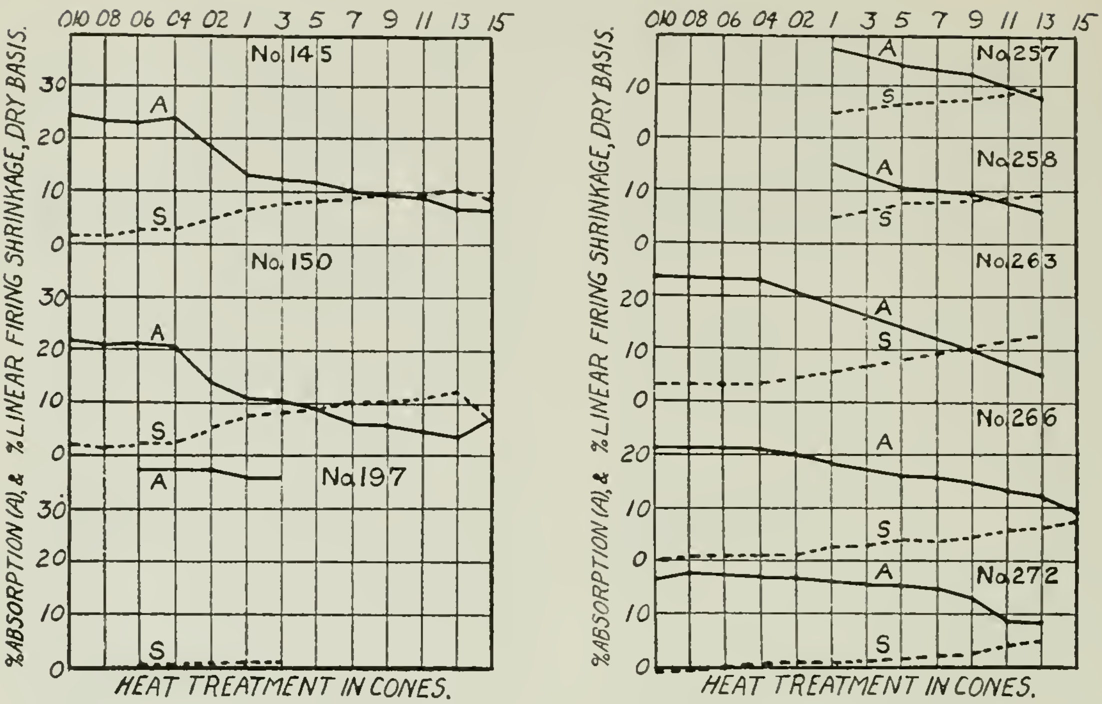
Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
6	9	0.6	26.7	1.5	27.0	2.2	27.8	3.0	27.9	7.3	23.2	8.1	22.7	8.7	18.4	10.3	19.9	10.3	15.5	12.8	12.4	15.1	12.8	18.5	10.2	4.5	25.2
	14	0.0	31.0	1.7	31.0	2.0	31.0	2.4	31.5	6.3	27.4	7.5	27.3	7.3	26.5	9.3	24.5	10.8	21.2	10.0	24.0	13.1	22.5	14.4	20.6	------	------
	27	1.0	32.4	2.9	32.6	3.7	32.0	4.7	32.0	7.0	28.6	13.3	23.5	13.5	23.8	14.5	23.4	15.0	22.6	18.3	17.4	19.8	15.2	24.5	8.8	16.2	15.7
	33	—0.3	31.1	+0.3	31.0	+0.6	31.1	+0.6	31.1	+0.7	31.3	5.2	27.4	5.7	27.2	6.0	26.8	6.4	26.1	7.3	25.2	7.3	25.2	8.0	21.5	------	------
	34	2.0	34.2	1.7	32.9	2.4	33.0	2.7	32.6	6.9	30.0	12.0	25.6	12.6	25.2	12.9	24.8	13.4	23.8	15.5	21.8	15.1	22.3	16.5	20.0	18.5	16.7
	53	2.9	36.6	3.7	36.1	4.8	36.0	5.7	35.9	12.4	30.6	18.9	25.3	21.1	22.5	21.0	23.6	21.6	20.0	22.2	20.3	22.4	20.1	27.8	12.0	26.0	11.4
	76	1.5	35.3	1.6	35.4	2.7	34.5	2.6	34.2	9.8	30.0	13.5	24.4	14.6	21.4	16.5	22.0	18.9	20.9	20.3	17.5	23.5	7.5	23.2	13.7	------	------
	78	2.7	38.5	2.5	37.5	3.8	36.6	4.2	37.6	12.1	28.5	15.2	26.3	16.5	25.3	17.7	23.2	21.6	19.0	21.9	17.7	24.0	14.9	26.7	11.7	20.9	22.6
	81	3.3	31.9	3.7	33.4	4.1	32.2	4.6	32.4	6.4	30.1	16.5	21.8	17.0	21.0	17.0	21.2	19.7	16.6	19.7	16.3	19.5	17.1	22.5	13.3	------	------
	84	—0.8	29.4	—0.3	29.2	+0.6	29.0	+0.8	29.4	4.0	26.8	‡8.6	‡21.8	9.1	21.7	*10.7	*18.9	11.1	18.2	13.0	14.1	13.6	12.5	17.0	8.8	------	------
	92	0.9	30.2	0.5	29.8	1.6	30.4	1.1	30.2	5.0	28.2	‡7.4	‡26.0	#7.3	#26.0	*9.1	*23.7	†9.4	†24.2	12.1	20.4	12.9	19.3	17.3	13.4	------	------
	97	—0.1	30.7	+1.4	31.6	1.4	31.5	1.8	31.4	2.6	31.4	4.9	29.9	7.2	27.8	8.6	26.4	9.8	25.6	x10.5	x23.5	13.9	18.2	14.8	17.7	------	------
	102	—1.5	31.9	—0.9	35.5	—0.1	32.8	—0.1	32.0	+1.0	32.3	2.4	30.6	4.6	29.3	5.6	27.8	7.1	27.0	7.0	26.0	10.8	19.8	12.4	18.1	------	------
	108	4.7	29.3	4.4	29.4	4.9	29.5	5.8	28.1	9.6	24.6	13.5	20.8	13.5	19.4	*17.5	*15.3	†17.7	†14.8	18.0	14.3	22.0	8.4	17.1	13.1	------	------
	130	2.4	44.5	4.3	46.0	5.1	46.2	5.3	45.8	6.0	45.7	6.9	45.0	10.2	43.9	10.3	41.4	12.0	42.9	15.2	41.0	------	------	------	------	------	------
	139	1.6	34.5	1.9	34.6	1.8	34.3	2.0	34.5	4.2	33.2	8.6	30.4	13.7	25.4	16.0	23.4	18.3	21.2	22.4	15.5	24.6	11.7	23.3	8.8	13.2	23.4
	145	4.7	38.8	5.0	38.5	6.0	37.7	7.0	38.6	14.0	32.8	21.5	25.6	22.5	24.2	23.0	23.3	21.9	20.4	25.5	19.5	26.4	17.9	28.4	14.6	24.9	12.9
	150	5.5	35.4	4.1	34.2	6.4	35.6	6.3	31.0	15.4	26.5	21.2	21.6	22.4	20.3	21.5	18.2	28.4	13.8	28.8	13.7	29.9	11.1	32.0	9.1	19.0	13.5
	197	------	------	------	------	1.4	47.5	------	------	1.6	47.5	2.1	45.7	2.1	46.2	------	------	------	------	------	------	------	------	------	------	------	------
	257	------	------	------	------	------	------	------	------	------	------	13.6	31.4	------	------	18.5	26.1	------	------	20.9	22.5	------	------	26.4	15.6	------	------
	258	------	------	------	------	------	------	------	------	------	------	15.2	29.0	------	------	22.2	22.2	------	------	23.0	20.9	------	------	25.3	13.0	------	------
	263	------	------	8.6	39.5	------	------	------	------	------	------	16.5	33.6	------	------	------	------	25.7	24.2	------	------	------	------	33.8	11.6	------	------
	266	0.1	36.0	1.7	36.9	1.9	36.9	9.7	38.8	3.4	35.3	6.8	33.3	8.3	32.0	*10.7	*30.5	†11.0	†30.0	13.1	28.2	16.3	25.6	17.2	24.6	20.0	19.8
	272	—0.6	31.0	—0.4	31.9	—0.1	32.0	+1.1	31.5	2.8	30.4	3.1	30.2	3.7	29.4	4.5	29.4	4.7	28.5	6.6	25.5	11.5	17.5	12.2	17.2	------	------

% V. S.=Firing shrinkage, per cent dry volume % A. P.=Per cent apparent porosity. ‡Cone 1+. *Cone 5+. #Cone 3—. †Cone 7—. xCone 9—.

Absorption and linear shrinkage curves for clays of class 6.



Absorption and linear shrinkage curves for clays of class 6.



b. Dense-Burning, Less Than 6% Apparent Porosity Between Cones 10 and 15.

7. Mainly Medium to High Strength.

No. 13 (p. 163). Riverside County. Alberhill C. & C. Co. "Extra Select Main Tunnel." See also No. 15 and 29 in class 2. This clay is hand sorted from the main tunnel fireclay bed, in order to prepare a grade for the market that has better fired colors than the run-of-mine material, but for some undetermined reason the sample is distinctly inferior as to color, compared to No. 15 and 29. It is used principally in the manufacture of art tile, and to some extent in firebrick. It has excellent plasticity, medium dry strength, and a sandy, open texture in the dry condition. It contains 2.6% of +200-mesh sand. The colors are: dry, 17''''f; wet, 17''''b; cones 010 to 06, 11'f; cone 04, 17''f; cones 02 to 13, 17'''19'''f. Finger-nail hardness is developed below cone 010, and steel hardness is approached at cone 7, but vitrification is not complete until cone 15 is reached. The total linear shrinkage, plastic basis is 14.5% at cone 15. The softening point is cone 29–30. The best firing range is from cone 7 to cone 15.

No. 39 (p. 203). San Diego County. Near Carlsbad. Pacific Clay Products Co. "Kelley Ranch White." This is a buff-burning clay with excellent plasticity, suitable for the manufacture of face brick and fire brick. It contains 2.6% of +200-mesh sand, has medium dry strength, and in the dry state it is soft, fine-grained, and dense. The colors are: dry, 11''; wet, 5''; cones 010 to 04, 7''f; cone 02, 5''f; cone 1, 9''f; cone 3, 13''f; cones 5 and 7, 17''f; cones 9 and 11, 17''d; cone 13, 15''d. A pleasing assortment of buffs, creams, and yellow-browns is obtained by varying the firing conditions. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 1. The fired structure is sound, fine-grained, and above cone 1, it is stony.

The total linear shrinkage, plastic basis, at cone 15 is 17.9%. The softening point is cone 29. The best firing range is from cone 1 to cone 15.

No. 56. German fireclay, used by Atlas Fire Brick Co. This is a fine-grained clay with a smooth and strong plasticity, medium-high dry strength, and a hard, fine-grained, close-textured dry condition, with a slight tendency to laminate. It contains 2.8% of +200-mesh sand. The colors are: dry, whiter than 17''''f wet, 17''''f; cones 010 to 1, somewhat whiter than 17'''f; cones 3 and 5, 19''f; cones 7 to 13, 17'''f. The fired structure is stony, and with the firing schedule used, one or more large cracks developed in many of the test pieces. Finger-nail hardness develops below cone 010, and steel hardness at cone 06. Absorptions below 10.0% appear at cone 1. The total linear shrinkage, plastic basis, at cone 13, is 11.9%. The softening point is cone 27. The best firing range is from cone 06 to cone 13 and above. The clay is particularly well suited for use as a firebrick bond.

No. 80 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Plastic Pink and Yellow." This is a buff and gray-burning refractory clay, containing but 2.6% of +200-mesh sand, and with smooth and strong plasticity. The dry strength could not be accurately determined without adding sand, as incipient lines of weakness are developed during air-drying. With 50% of —20-mesh to +30-mesh Ottawa sand, the bonding strength is 56 lb. per sq. in. In the dried condition, it is medium soft, fine-grained, and close textured. The colors are: dry, 13''d; wet, 13''; cones 010 to 04, 7'd; cones 02 to 5, 7''d; cone 7, 9'''f; cones 9 to 13, 17''''f. Steel hardness is developed below cone 010, absorptions of less than 10% are present at cone 3 or above, and vitrification is complete at cone 9. All fired test pieces are severely shattered, and broken into several pieces. The fired structure is stony and brittle. The maximum total linear shrinkage, plastic basis, was noted at cone 9, 25.0%, but on account of the serious shattering of the test pieces at cones 11 and 13, which invalidated the accuracy of measurement, it is likely that the true value of the shrinkage at these latter temperatures is higher than at cone 9. The softening point is cone 33. The clay is similar in many respects to No. 273 in class 3 (Alberhill S11—4), except that it contains more iron. It is a useful bond clay in buff-burned ware, but can not be used alone.

No. 83 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Main Pit Red." This is a plastic, light-red-burning clay of value in the manufacture of roofing tile, face brick, hollow building tile, and similar products. It contains 11.6% of +200-mesh sand, and has a smooth and strong plasticity. The dry strength is medium, and the dried condition is medium hard, dense, and fine-grained. The colors are: dry, 5''b; wet, 5''; cones 010 to 02, 5'd; cones 1 to 5, 7'd; cones 7 to 13, 11''d. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions below 10% appear at cone 5. The fired structure is dense and stony, and is sound up to cone 3. At higher temperatures, the test pieces are broken into two or three pieces. The total linear shrinkage, plastic basis, at cone 13, is 18.3%. The softening point is cone 29. The best firing range is from cone 1 to cone 5, but slow firing to cone 13 will doubtless result in sound structures and thorough vitrification.

No. 85 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Pink Mottled." This is a plastic, buff-burning clay that has wide uses in sewer-pipe, hollow-tile, pottery, flower pot, and face brick mixes. The plasticity is excellent, the dry strength is medium, and the dry condition is soft and fine-grained. It contains 3.4% of +200-mesh sand. A tendency to laminate was noted. The colors are: dry, 7″d; wet, 9″b; cones 010 to 04, 9′b; cone 02, 7′d; cones 1 to 5, 7′f; cone 7, 11′f; cones 9 to 13, 13′f. Finger-nail hardness is developed below cone 010, and steel hardness at cone 1. Less than 10% absorption is present at cone 7. The total linear shrinkage, plastic basis, at cone 13, is 18.3%. The softening point is cone 31–32. The best firing range is above cone 1.

No. 101 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Sloan White." This is a buff-burning face brick or fire brick clay with excellent plasticity, medium dry strength, and a medium hard, fine-grained, close-textured, dry condition. It contains 7.0% of +200-mesh sand. The colors are: dry, 17‴f; wet, 17⁗d; cones 010 to 02, 9″d; cone 1, 13″f; cones 3 to 11, 17″f; cone 13, 17″d. Finger-nail hardness appears below cone 010, and steel hardness develops at cone 3. The fired condition is sound, stony, and smooth-textured. The total linear shrinkage, plastic basis, at cone 15 is 17.5%. The softening point is cone 30.

No. 110 (p. 176). Riverside County. Alberhill. P. C. P. Co. "Douglas." This is a plastic fireclay, similar to No. 104 (class 5) but not quite so refractory. It is also related to No. 27 (class 6) and No. 273 (class 3), but differs from these in several important respects, as will be noted by a close study of the data. It contains 3.4% of +200-mesh sand. The plasticity is very good, the dry strength is medium, and the dried condition is medium-hard, fine-grained, and close-textured. The colors are: dry, 13⁗b; wet, 13⁗; cones 010 to 02, 7″d; cones 1 and 3, 7″f; cone 5, 17″f; cones 7 to 11, 21‴f; cone 13 slightly darker than cone 11. Steel hardness develops at cone 06. Absorptions below 10% develop at cone 3 and above. All fired test pieces are badly shattered, and broken into two or more pieces. The texture is smooth, and peppery with finely divided specks of iron. The total linear shrinkage, plastic basis, at cone 13, is 22.5%. Slight bloating was noted at cone 15. The softening point is cone 32–33. The clay is used for stoneware and pressed brick.

No. 133 (p. 63). Amador County. Ione (Carbondale). Yos. P. C. Co. "Harvey Clay." This is a buff-burning fireclay with good plasticity, medium-low dry strength, and a medium-hard, fine-grained, close-textured dried condition. It contains 6.8% of +200-mesh sand. The colors are: dry, 9⁗f; wet, 5⁗d; cones 010 to 06, 13″f; cones 04 to 1, 17‴f; cones 3 to 7, 19″f; cone 9, 21‴f; cones 11 and 13, 17⁗f. Steel hardness develops at cone 1, and less than 10% absorption at cone 3. The fired structure is stony and sound, except at cones 11 and 13, at which small tension cracks appear. Blistering is noticeable at cone 13. The maximum total linear shrinkage, plastic basis, is 24.5% at cone 11. The softening point is cone 33. The best firing range is from cone 1 to cone 11. The clay may be used in fire brick, terra cotta, face brick, etc.

No. 149 (p. 156). Placer County. Lincoln. Lincoln Clay Products

Co. "No. 9." This clay is similar to No. 146 in class 8, but does not vitrify so completely at cones 9 to 13, nor can blistering be detected at cone 13, but bloating is apparent at cone 15. The total linear shrinkage, plastic basis, at cone 13, is 19.9%. The softening point is cone 31–32.

No. 153 (p. 147). Placer County. Lincoln. Clay Corporation of California. See No. 152 and 280 in class 8. This sample has lower refractoriness, slightly more sand, and more coloring matter than No. 152. It contains 25.0% of +200-mesh sand. The plasticity is excellent, the dry strength is medium-high, and in the dried condition it is medium-hard, medium-grained, and open-textured. The colors are: dry, 21‴f; wet, 19″d; cones 010 to 1, 11′d; cones 3 and 5, 15″d; cones 7 to 13, 17″d. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 7. The fired structure is sound, stony, and the fired surface texture is slightly rough. The maximum total linear shrinkage, plastic basis, is 21.0% at cone 11. The softening point is cone 30. The best firing range is from cone 1 to cone 11.

No. 156 (p. 151). Placer County. Lincoln. Gladding, McBean & Co. "Fire-proofing Clay." This is a plastic, low-grade buff-burning fireclay that is used in various bodies to increase the refractoriness of the mixture. It contains 8.4% of +200-mesh sand. The plasticity is good, the dry strength is medium-high, and in the dried condition, it possesses finger-nail hardness, is fine-grained, and close-textured. The colors are: dry, 17″d; wet, 17″b; cones 010 to 5, 11′d; cones 7 and 9, 17‴d; cones 11 and 13, 17‴b. Steel hardness is developed at cone 02. Less than 10% absorption appears at cone 1. The fired structure is sound and stony. Slight blistering appears when fired under neutral or reducing conditions to cone 11 and 13. The fired surface texture is slightly rough. The maximum total linear shrinkage, plastic basis, is 18.9%, at cone 9. The softening point is cone 28–29. The best firing range is from cone 02 to cone 9.

No. 204 (p. 151). Calaveras County. Valley Springs. California Pottery Co. "Blue Plastic." The properties of this clay are closely similar to those of No. 203, in class 14, but it contains less iron, which results in lighter fired tones, and in greater refractoriness. It contains 1.0% of +200-mesh material. The colors are: dry, 17″d; wet, 17″b; cones 010 to 04, 9″d; cones 02 to 7, 13″d; cone 9, 15″d. The total linear shrinkage, plastic basis, is 18.4%, at cones 11 and 13. The softening point is cone 27. This is an excellent clay for buff-burned face brick and roofing tile.

No. 213 (p. 59). Amador County. Ione. Eckland pit. This is a buff-burning clay with smooth and strong plasticity, and medium-low dry strength. In the dried condition it is medium-hard, fine-grained, and close-textured. The residue on 200-mesh is 12.6%. The colors are: dry, 13″d; wet, 15″; cones 010 to 02, 11′d; cones 1 to 7, 13″f; cones 9 to 13, 17″d; strongly mottled with iron specks. Steel hardness is developed at cone 3, and less than 10% absorption at cone 13. The fired structure is sound and stony, except at cones 11 and 13, when a few large cracks appear in the fired test pieces. The surface texture is smooth until cone 9 is reached, when the reduction of the non-plastic ferro-magnesian minerals causes a pitted surface. The total linear shrinkage, plastic basis, at cone 13, is 22.1%. The softening point is cone 31. The best firing range is from cone 3 to cone 8. The clay is suitable for face brick and faience tile mixes, and could be used in some fire brick mixes.

No. 229 (p. 174). Riverside County. Alberhill. L. A. B. Co. "No. 7 Pit." This is a buff-burning plastic fireclay that is suitable for face brick or fire brick manufacture. There is slight effervescence in hydrochloric acid. It contains 0.8% of +200-mesh sand. The plasticity is smooth and strong, the dry strength is medium-low, and in the dried condition it is medium-hard, fine-grained and close-textured. The colors are: dry, 9″d; wet, 7″b; cones 010 to 06, 5′f; cones 04 to 3, 5″f; cones 5 to 9, 17″f; cones 11 and 13, 17″d. Steel hardness is developed at cone 1, and less than 10% absorption at cone 9. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 20.4%. Slight bloating appears at cone 15. The softening point is cone 32.

No. 230 (p. 174). Riverside County. Alberhill. G., McB. & Co. East Pit. "No. 9 Clay." This is a buff-burning refractory clay with smooth and strong plasticity, and medium-high dry strength. It contains 2.0% of +200-mesh sand. In the dried condition it is medium-hard, fine-grained, and close-textured. The colors are: dry, 13″″d; wet, 17″″d; cones 010 to 04, pinkish white; cones 02 to 7, yellowish white; cones 9 and 11, 19″f; cone 13, 17‴d. Steel hardness is developed at cone 02, and less than 10% absorption appears below cone 5. The fired structure is stony, and all test pieces are broken into two or more pieces by fracturing. The total linear shrinkage, plastic basis, at cone 13, 17.5 %. The softening point is cone 32–33. The clay can not be used alone, but when mixed with non-plastic material, it is an excellent clay for face brick, fire brick, and terra cotta.

No. 245 (p. 52). Amador County. Ione. Core drill hole No. 55–1. Arroyo Seco Grant. This is a buff-burning clay with good, but sticky, plasticity and medium dry strength. In the dried condition it is soft, friable, fine-grained, and close-textured. The colors are: dry, buff-white; wet, 17″″f; cone 1, 19″f; cones 5 and 9, 17″d; cone 13, 15″i. Steel hardness develops below cone 1, and less than 10% absorption between cone 1 and cone 5. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 19.0%. The softening point is cone 30–31. It could be used in face brick, terra cotta, tile, and fire brick.

No. 246 (p. 52). Amador County. Ione. Core drill hole No. 55–3, Arroyo Seco Grant. The plasticity is good, but sticky; the dry strength is medium, and in the dried condition it is soft, friable, fine-grained, and close-textured. The colors are: dry, grayish white; wet, 15″‴f; cones 1 and 5, 19″f; cone 9, 17″″f; cone 13, 17″″d. Steel hardness is developed below cone 1, and less than 10% absorption is produced between cone 1 and cone 5. The fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 16.7%. The softening point is cone 29.

No. 247 (p. 52). Amador County. Ione. Core drill hole No. 55–2, Arroyo Seco Grant. This is similar to No. 246, but has greater shrinkage, a higher softening point, and effervesces slightly in hydrochloric acid. The total linear shrinkage, plastic basis, at cone 13, is 19.5%. The softening point is cone 32.

No. 248 (p. 52). Amador County. Ione. Core drill hole No. 56–1, Arroyo Seco Grant. The plasticity is good, the dry strength is medium high, and in the dried condition it is medium-hard, fine-grained, and close-textured. A part of the sample consists of soft grains of partly kaolinized matter that is not rendered plastic by the usual methods of preparation. This results in a heterogeneous structure. The colors are: dry, 17‴f; wet, 17‴d; cones 1 and 5, 17″d; cones 9 and 13, 17⁗b. Steel hardness is developed below cone 1, and less than 10% absorption appears between cone 1 and cone 5. Blistering is noticeable at cone 13. The maximum total linear shrinkage, plastic basis, is 21.1%, at cone 9. The softening point is cone 30–31. It is suitable for the manufacture of terra cotta and tile, but is not suitable for making a good fire brick.

No. 249 (p. 52). Amador County. Ione. Core drill hole No. 56–2, Arroyo Seco Grant. This is very similar to No. 245, and does not require a separate description. The total linear shrinkage, plastic basis, is 18.2% at cone 13. The softening point is cone 30–31.

No. 253 (p. 52). Amador County. Ione. Core drill hole No. 57–3, Arroyo Seco Grant. This is similar to No. 136 (class 8) and 240 (class 4), with the differences as noted. There is slight effervescence in hydrochloric acid. The colors are: dry, pinkish white; wet, yellowish white; cone 1, nearly white; cones 5 and 9, 19″f; cone 13, 17‴b. Steel hardness and less than 10% absorption are developed between cones 1 and 5. No firing cracks were noted. The total linear shrinkage, plastic basis, is 21.5%, at cone 13. The softening point is cone 31–32.

No. 254 (p. 52). Amador County. Ione. Core drill hole No. 57–4, Arroyo Seco Grant. This sample contains more coloring matter and more non-plastic ferro-magnesian minerals than No. 253. There is slight effervescence in hydrochloric acid. The plasticity is good, the dry strength is medium, and in the dried condition it is soft, fine-grained, and open-textured. The colors are: dry, 17″f; wet, 17‴f; cone 1, 15″f; cone 5, 17‴d; cone 9, 17⁗d; cone 13, 17‴b. Steel hardness appears below cone 1, and less than 10% absorption is developed between cone 1 and cone 5. The fired structure is sound and stony, except that at cone 13, one large crack developed in the test piece. Blistering is noted at cone 13. The maximum total linear shrinkage, plastic basis, is 21.6%, at cone 9. The softening point is cone 31. This is a suitable clay for face brick, terra cotta and tile.

No. 271 (p. 163). Riverside County. Alberhill. Alberhill Coal & Clay Co. "Lower Tunnel, Hill Blue." See also No. 9 and 272 in class 6, and No. 274 in this class. The plasticity of No. 271 is smooth and strong, the dry strength is medium-high, and in the dried condition it is hard, fine-grained, and close-textured. It contains 2.0% of +200-mesh sand. There is slight effervescence in hydrochloric acid. The colors are: dry, 13⁗ f; wet, 5⁗f; cones 010 to 9, 17″f; cones 11 and 13, 21⁗d. Steel hardness is developed at cone 1, and less than 10% absorption at cone 5. One or two of the test pieces show small cracks, otherwise the fired structure is sound and stony, and the surface texture is smooth. The total linear shrinkage, plastic basis, is 17.8%, at cone 13. The softening point is cone 31–32. For uses, see No. 9, in class 6.

No. 274 (p. 163). Riverside County. Alberhill. A. C. & C. Co. "Upper Tunnel Hill Blue." See also No. 9 and 272 in class 6, and No. 271 above. No. 274 is intermediate between No. 271 and 272 in its content of sand and its ceramic properties. The dry strength is medium. There is no effervescence in hydrochloric acid. The sample contains 11.4% of +200-mesh sand. The colors are: dry, 1''''f; wet, 15'''''b; cones 010 to 06, 15''f; cones 04 to 9, 17''f; cones 11 and 13, 17''d. Steel hardness is developed at cone 5, and less than 10% absorption at cone 9. The fired structure is sound, slightly heterogeneous, and the surface is slightly rough. The total linear shrinkage, plastic basis, at cone 13, is 19.8%. The softening point is cone 30. This is a suitable clay for fire brick, face brick and terra cotta.

c. Dense-Burning, Less Than 6 Per Cent Apparent Porosity Between Cones 5 and 10.

8. Medium to High Strength.

No. 121 (p. 53). Amador County. Ione. Arroyo Seco Grant. Jones Butte. Leased by Stockton Fire Brick Co. "Unctuous Clay." The available quantity of this clay is insufficient for commercial production, but a sample was tested as a matter of general interest. It has a smooth and strong plasticity, medium dry strength, and in the dried condition it is medium-hard, fine-grained and close-textured. The colors are: dry, nearly white; wet, 21'''f; cones 010 to 06, pinkish white; cones 04 to 9, yellowish white; cones 11 and 13, 1''''f. Steel hardness is developed at cone 04. Less than 10.0% absorption appears at cone 5. The fired test pieces are stony below cone 11, and glassy at cone 11 or above. They are sound, but seriously warped. The total linear shrinkage, plastic basis, at cone 13, is 25.6%. The softening point is cone 33. The clay is closely similar to some of the varieties that are mined at Lincoln, Placer County, especially No. 146, *post*.

No. 124 (p. 56). Amador County. Ione (Carbondale). Leased by G. A. Starkweather. "Yaru No. 1." This is a pink-and-cream burning clay with smooth, moderately-strong plasticity and medium dry strength. It contains 1.0% of +200-mesh sand. The dried condition is soft, "soapy," fine-grained and open-textured. A strong tendency to warp and to laminate was noted. The colors are: dry, 21'''f; wet, 21'''d; cones 010 to 04, 9'f; cone 02, 17''f; cones 1 to 7, 17''d; cones 9 to 13, 19''f. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 3. The fired structure is generally sound, but a few pieces split in firing. The total linear shrinkage, plastic basis, at cone 13, is 20.8%. The softening point is cone 32. The best firing range is above cone 1. The clay is suitable for fire brick, terra cotta, stoneware, etc.

No. 136 (p. 58). Amador County. Ione (Clarksona). N. Clark and Sons. "Dosch." This clay has been well known for many years in the pottery, stoneware, and terra cotta industries. It contains but 1.2% of +200-mesh sand. It is smooth and has strong plasticity, medium dry strength, and in the dried condition it is medium-hard, fine-grained, and close-textured. The colors are: dry, yellowish white; wet, 17‴f; cone 010, 17″f, becoming nearer to white with increasing firing temperature, approximating 19″f at cone 3; cones 11 and 13 (flashed) 17‴. Steel hardness appears at cone 1, and less than 10% absorption at cone 3. The fired structure is sound, stony and smooth-textured. The maximum total linear shrinkage, plastic basis is 21.0% at cone 13. Slight bloating was noted at cone 15. The softening point is cone 31. The best firing range is from cone 1 to cone 13. The clay can be cast and jiggered.

No. 146 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "No. 1–6." This is the best known variety of Lincoln clay at the present time. It is shipped to all parts of the Pacific Coast for use in stoneware, pottery, faience tile, terra cotta, fire brick, and other purposes. It is an excellent clay for casting and jiggering. The plasticity is smooth and strong, and it contains but 0.6% of +200-mesh sand. The dry strength is medium, and in the dried condition it is soft, fine-grained and close-textured, with a talcy feel. The colors are: dry, buff-white; wet, 17″d; cones 010 to 04, 11″f; cone 02, 13″f; cones 1 and 3, 17″f; cone 5, 17′f; cones 7 and 9, 21‴f; cone 11, 17⁗f; cone 13, 13⁗f. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 3, and vitrification is complete at cone 9. Slight blistering is noticeable on test pieces fired under reducing or neutral conditions at cones 11 to 15. The fired structure is sound and stony. The maximum total linear shrinkage, plastic basis, is 21.5%, at cone 11. The softening point is cone 31–32. The best firing range is from cone 1 to cone 11. The long vitrification range, the excellent plasticity, and the ability to withstand abuse in drying and firing, are the important advantages that this clay possesses to a greater degree than any other clay in the state that is available in commercial quantities to the entire industry. The same is true of No. 280, see *post*.

No. 147 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "No. 7." This clay is very similar to No. 146, but fires to slightly darker tones. It is used in faience tile, face brick, and sewer-pipe mixes, but is not quite as suitable for casting and jiggering as No. 146. The colors are: dry, 9″d; wet, 13‴b; cones 010 to 04, 5′f; cones 02 and 1, 11″f; cone 3, 15″f; cone 5, 17″f; cones 7 and 9, 17‴f; cone 11, 17⁗f; cone 13, 13⁗d. Steel hardness is developed at cone 1, and less than 10% absorption is developed at cone 3. Vitrification is complete at cone 9—, and blistering is well developed at cone 13. The maximum total linear shrinkage, plastic basis, is 21.4%, at cone 11. The softening point is cone 31.

No. 151 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "Washed China Clay." This sample was supplied by Mr. Dillman from a warehouse stock of some material that was prepared some years ago by washing the No. 1–6 (sample No. 146) clay, in an attempt to produce a china clay for the local market. The color was improved slightly by this treatment, but not sufficiently to permit the use of the clay as a substitute for English china clay, and the shrinkage was increased greatly beyond the already high shrinkage of the crude clay. Slight blistering appears at cone 11. The maximum total linear shrinkage, plastic basis, is 25.6%, at cone 9. The softening point is cone 30.

There is slight effervescence in hydrochloric acid. Scumming was not noticed, as in the majority of the crude Lincoln and Ione clays, but no special tests were made to determine if washing had completely removed the vanadium salts which have been stated to be the cause of scumming of these clays.[1]

No. 152 (p. 147). Placer County. Lincoln. Clay Corporation of California. This sample of plastic fire clay, together with No. 153 (class 7), was taken from the pit approach during the preliminary development of this property. The test results should be compared with those of No. 280, which sample was supplied by the company from the warehouse after full-scale production had been reached. No. 152 has excellent plasticity, medium-high dry strength, and in the dried condition it is soft, fine-grained, and open-textured. It contains 23.6% of +200-mesh sand. The colors are: dry, nearly white, wet, 17‴f; cones 010 to 02, pinkish white; cones 1 to 7, 17′f; cones 9 to 13, 17‴f. Steel hardness appears at cone 1. Less than 10% absorption is developed at cone 1. Slight blistering is apparent at cone 13. The fired structure is stony, and most of the fired test pieces contain one or more large cracks, some of which cause rupture of the test piece into two or more fragments. The maximum total linear shrinkage, plastic basis, is 26.4%, at cone 11. The softening point is cone 33. It was stated by the company that as a rule the softening point of this clay is below cone 29, so that the sample obtained for testing may not be representative.

No. 157 (p. 151). Placer County. Lincoln. Gladding, McBean & Co. "Terra Cotta Clay." This corresponds to No. 146, and is used as the basis for terra cotta and faience tile body mixes. It contains 2.2% of +200-mesh sand. The plasticity is excellent, the dry strength is medium, and in the dried condition it is medium-hard, fine-grained, and close-textured. The colors are: dry, 17″f; wet, 17″d; cones 010 to 1, 11″f; cones 3 to 9, 17″d; cones 11 and 13, 17‴d (flashed). Steel hardness is developed at cone 04, and less than 10% absorption appears at cone 3. The fired structure is sound and stony, except that a few small cracks appeared in some test pieces during firing. The fired surface texture is smooth. Slight blistering is noticeable at cone 13. The maximum total linear shrinkage, plastic basis, is 23.6%, at cone 13. The softening point is cone 32–33.

No. 175 (p. 65). Butte County. Oroville. Table Mountain Clay Products Co. This is a plastic, buff-burning clay from the Ione formation. The plasticity is smooth and strong, the dry strength is medium, and in the dried condition it is soft, "talcy," fine-grained, and close-textured. It contains 2.4% of +200-mesh sand. The colors are: dry, 17″f; wet, 15″d; cones 010 to 04, 7′f; cone 02, 11′f; cones 1 to 5, 15′d; cones 7 and 9, 15″d; cones 11 and 13, 17‴b. Steel hardness is developed at cone 02, and less than 10% absorption at cone 1. The fired structure is stony, and the surface texture is exceptionally smooth. Up to cone 7, all test pieces are sound, and at cone 7 and above, each test piece is fractured into two or more fragments. The total linear shrinkage, plastic basis, at cone 13, is 18.9%. Bloating is pronounced at cone 15. The softening point is cone 30–31. The best firing range is from

[1] See Curry, E. R., Notes on Green Scumming: Jour. Am. Cer. Soc., Vol 9, p. 392, 1926.

cone 02 to cone 13. Since the sample was taken near the surface during the preliminary development of the property, it may not be representative. The clay is suitable for the manufacture of fire brick, roofing tile, terra cotta, and for any pottery or decorative tile in which the buff color is not objectionable.

No. 201 (p. 69). Calaveras County. Helisma. This is a plastic, buff-burning clay from the Ione formation. The plasticity is smooth and strong, the dry strength is high, and in the dried condition it has finger-nail hardness, is fine-grained, and close-textured. The sample contains 11.4% of +200-mesh sand. The colors are: dry, 17‴f; wet, 17‴f; cones 010 to 04, 17″f; cones 02 and 1, 17″d; cones 3 to 6, 17″b; cones 9 to 13, 17‴. Steel hardness and 10% absorption are developed at cone 04. The fired structure is tough, stony and sound, except at cones 11 and 13, where large cracks appear. Vitrification is complete at cone 9, above which temperature bloating begins, but the softening point is cone 28. The maximum total linear shrinkage, plastic basis, is 21.5% at cone 9. The clay is suitable for the manufacture of face brick.

No. 252 (p. 52). Amador County. Ione. Core drill hole No. 57–2, Arroyo Seco Grant. This sample is similar to No. 245 and 249, in class 7, with the important differences as noted below. The colors are: dry, 17″f; wet, 17‴f; cone 1, 13″f; cone 5, 17‴f; cone 9, 17‴d; cone 13, 17⁗d. Slight blistering is noted at cone 13. The maximum total linear shrinkage, plastic basis, is 22.4%, at cone 9. The softening point is cone 32–33.

No. 280 (p. 147). Placer County. Lincoln. Clay Corporation of California. See also No. 153 and 146. The plasticity is excellent, the dry strength is medium-high, and in the dried condition it is medium-hard, close-grained, and fine-textured The bonding strength, with 50% Ottawa sand from —20 to +30-mesh, is 211 lb. per sq. in. It contains 11.2% of +200-mesh sand. There is slight effervescence in hydrochloric acid. The colors are: dry, nearly white; wet, 17‴f; cones 010 to 04, 7′f; cones 2 to 5, 7″f; cones 7 to 13, 21⁗d. Steel hardness is developed at cone 02, and less than 10% absorption at cone 1. The fired structure is stony, and is sound up to cone 9. At cones 11 and 13, a few cracks are noted, and there is slight blistering. The surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 20.3%, at cone 9. The softening point is cone 30–31. The clay is used by the Stockton Fire Brick Co. in the manufacture of fire brick and refractory cement, and is marketed to tile manufacturers and others.

TABLE No. 20.

II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

b. Dense-burning, less than 6% apparent porosity between cones 10 and 15.

7. Mainly medium to high strength, but also including some clays of low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
13	12.4	15.9	28.3	255	22.4	7.0	29–30
39	14.7	18.1	32.8	257	25.5	7.8	29
56	13.1	10.9	24.0	628	26.4	8.1	27
80	17.0	24.8	41.8	Erratic	27.1	8.2	33
83	12.8	17.5	30.3	230*	22.8	7.2	29
85	16.3	17.7	34.0	245	28.6	8.6	31–32
101	16.5	17.1	33.6	355	30.0	9.1	30
110	20.3	20.6	40.9	200–400	34.2	10.3	32–33
133	22.4	21.5	47.9	140	34.6	10.4	33
149	18.6	18.8	37.4	260	32.5	9.8	31–32
153	20.7	21.8	42.5	616	33.7	10.2	30
156	20.3	17.1	37.4	670	36.1	10.8	28–29
204	17.1	17.7	34.8	280	29.9	9.1	27
213	15.5	23.8	39.3	105	24.7	7.6	31
229	17.0	18.4	35.4	181	29.7	9.1	32
230	15.4	18.4	33.8	±419	27.4	8.3	32–33
245	19.6	17.2	36.8	335	34.5	10.4	30–31
246	15.2	17.2	32.4	328	26.8	8.2	29
247	18.1	20.7	38.8	309	30.4	9.2	32
248	27.3	16.4	43.7	±680	48.4	14.1	30–31
249	18.7	16.8	35.5	±395	33.8	10.2	30–31
253	20.2	20.5	40.7	204	33.3	10.1	31–32
254	19.6	21.8	41.4	±251	32.2	9.7	31
271	17.0	17.5	34.5	531	30.4	9.2	31–32
274	19.1	15.4	34.5	444	35.1	13.4	30

* Bonding strength with 50% Ottawa sand (— 20–, + 30-mesh) is 56 lb. per sq. in.

c. Dense-burning, less than 6% apparent porosity between cones 5 and 10.

8. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
121	27.4	20.7	48.1	340	45.3	13.2	33
124	17.4	19.6	37.0	219	29.4	8.9	32
136	20.9	20.1	41.0	270	35.4	10.6	31
146	19.7	19.1	38.8	239	34.0	10.3	31–32
147	20.5	18.7	39.2	284	35.6	10.7	31
151	29.5	28.4	37.9	301	43.4	12.8	30
152	26.8	22.6	49.4	710	43.0	12.8	33
157	20.2	22.1	42.3	379	33.2	10.1	32–33
175	15.4	17.1	32.5	369	27.5	8.3	30–31
201	23.2	18.2	41.4	894	40.2	11.9	28
252	17.6	21.1	38.7	296	29.2	8.9	32–33
280	19.5	20.7	40.2	466*	33.1	10.0	30–31

* Bonding strength with 50% Ottawa sand (— 20–, + 30-mesh) is 211 lb. per sq. in.

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P = Per cent water of plasticity.
D.T.S = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 21. II. Buff-Burning Clays.

A. Refractory clays, softening point cone 27+.

b. Dense-burning, less than 6% apparent porosity between cones 10 and 15.

7. Mainly medium to high strength, but also including some clays of low strength.

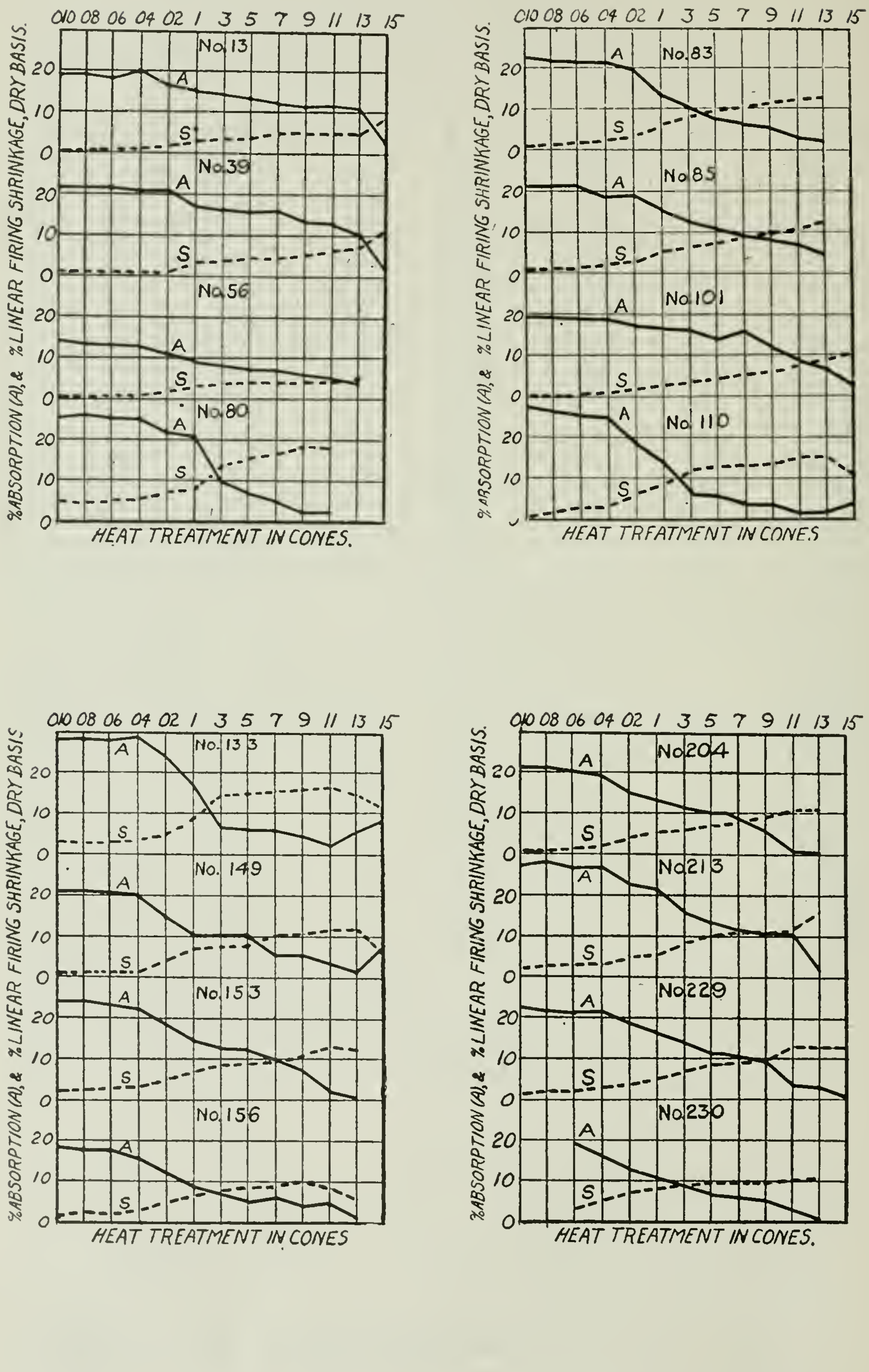
c. Dense-burning, less than 6% apparent porosity between cones 5 and 10.

8. Medium to high strength.

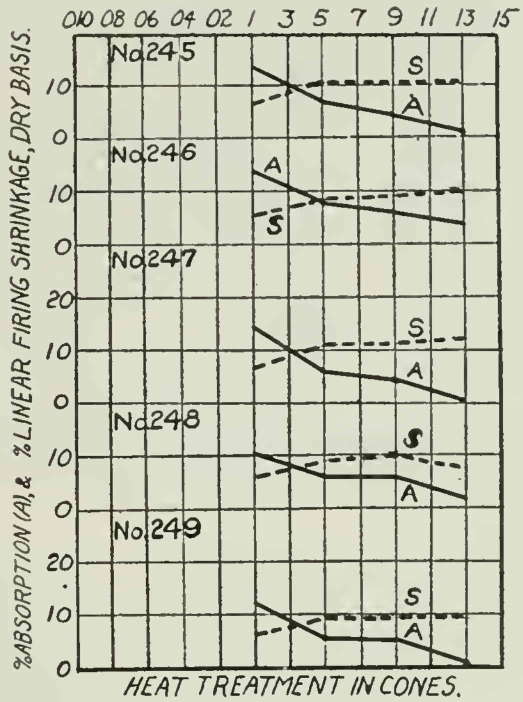
Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
7	13	+1.0	32.1	1.2	32.8	1.9	31.0	2.8	31.1	5.3	30.0	8.1	27.2	9.8	26.6	10.5	24.2	13.6	23.3	13.8	22.3	13.7	22.1	14.3	21.0	23.4	5.3
	39	3.1	35.0	3.1	35.3	3.0	35.0	3.3	31.7	3.5	34.9	10.3	30.2	11.9	29.0	13.2	28.2	13.7	30.8	16.4	25.0	17.6	24.2	20.5	21.2	30.6	4.4
	56	1.5	26.4	1.4	26.0	2.1	26.0	2.1	25.7	6.0	22.2	9.3	19.5	10.9	17.0	*11.1	*14.8	†11.5	†15.6	11.5	12.8	12.2	11.2	13.7	8.2		
	80	14.2	41.2	14.4	42.0	14.8	41.3	15.5	41.5	20.6	38.4	22.0	37.0	36.3	20.6	40.8	16.6	42.7	11.3	46.5	5.8	45.4	5.7				
	83	1.7	37.7	2.3	36.3	4.7	37.3	4.8	37.0	7.4	35.7	17.2	26.8	22.2	21.0	24.8	17.2	28.2	13.2	x28.8	x12.2	32.2	5.9	32.8	5.2		
	85	2.2	34.4	3.2	34.8	3.3	34.6	6.0	33.2	7.0	33.0	14.4	26.4	17.7	23.4	20.3	29.9	22.8	18.9	24.3	16.5	26.8	13.5	30.2	8.4		
	101	+0.1	33.2	1.5	32.5	2.5	32.5	2.9	32.6	5.7	31.0	7.3	29.2	9.6	28.6	12.5	25.5	14.4	28.7	14.7	22.1	19.6	16.0	22.0	11.9	27.0	3.9
	110	+2.4	41.8	5.3	40.8	9.0	40.5	10.0	39.8	18.6	32.2	23.9	26.6	32.9	13.0	34.1	13.0	34.9	9.0	31.9	9.0	38.0	3.9	37.4	4.3	28.1	5.8
	133	8.4	42.1	7.9	42.2	8.2	41.8	9.3	43.0	13.5	37.6	25.1	30.1	37.4	13.3	38.1	12.8	39.1	12.4	40.4	10.0	42.0	4.6	37.4	11.4	30.2	15.7
	149	3.1	34.2	3.1	34.2	4.2	34.1	4.5	33.2	13.3	27.0	19.6	21.0	20.6	20.7	22.5	20.9	27.8	13.0	28.3	12.2	31.0	7.9	32.2	2.2	18.3	12.7
	153	6.2	37.1	6.9	37.6	7.7	37.0	8.5	35.9	11.2	31.9	19.4	27.0	22.2	23.8	24.0	23.5	26.1	19.6	29.8	14.3	34.1	4.0	32.5	0.5		
	156	5.0	31.1	6.7	31.4	5.8	30.4	8.4	27.0	14.6	22.6	19.0	17.2	22.1	14.2	24.2	10.7	21.9	13.5	27.3	9.2	23.5	10.0	16.5	2.0		
	204	2.3	34.4	2.9	34.5	3.9	33.8	6.0	32.8	12.1	27.3	15.6	24.3	17.8	21.9	‡19.3	‡20.0	#19.6	#19.8	23.8	13.3	29.4	1.3	29.6	0.4		
	213	6.5	42.3	7.3	42.8	7.7	41.6	8.2	42.6	14.3	38.0	15.0	36.3	24.0	29.6	27.4	26.5	29.8	23.6	30.0	21.6	31.1	21.8	41.2	3.4		
	229	3.7	35.7	5.5	36.0	6.5	36.0	8.9	35.1	10.7	33.0	14.9	30.0	19.0	26.4	‡22.5	‡22.6	#23.2	#22.7	24.9	19.4	33.6	7.1	34.4	6.2	33.3	1.4
	230					8.3	34.4			19.6	24.4					26.6	14.9			26.6	11.7			28.9	1.4		
	245											17.3	26.0			28.9	14.2			28.3	9.3			28.3	2.3		
	246											14.6	25.7			22.4	16.1			24.6	13.0			26.9	7.5		
	247											18.6	26.7			30.0	13.4			30.3	10.2			32.4	0.5		
	248											17.3	20.1			25.2	13.0			27.2	13.6			20.0	3.6		
	249											16.9	21.0			26.2	12.3			26.1	10.7			26.6	2.0		
	253											15.6	32.2			31.4	11.3			32.2	12.0			35.6	1.6		
	254											20.6	29.3			35.8	7.6			36.2	7.9			34.0	2.6		
	271	6.1	34.8	6.1	34.6	7.4	32.9	8.0	33.2	13.0	29.5	14.0	28.6	20.4	22.7	22.0	20.5	23.3	18.3	23.4	17.1	26.2	12.6	27.9	5.2		
	274	2.0	29.2	4.0	29.6	4.3	29.1	7.5	27.1	9.5	28.0	12.9	25.2	13.5	21.4	14.6	23.0	16.1	21.4	17.5	18.2	24.4	9.9	24.8	2.2		
8	121	7.6	40.3	11.1	40.3	12.4	38.5	12.3	37.4	15.2	36.5	21.0	30.8	26.8	24.4	35.5	13.7	37.6	10.7	38.0	8.1	40.0	1.8	40.3	2.3		
	124	5.8	38.3	5.5	39.7	6.9	36.2	7.1	38.0	17.0	30.9	25.0	21.7	30.1	17.3	31.6	13.8	33.8	10.4	33.5	10.5	35.2	3.0	36.0	3.6		
	136	6.7	35.8	5.9	36.8	6.5	35.9	8.3	35.4	9.4	33.6	15.4	27.9	25.9	17.6	26.6	17.5	29.0	13.3	29.8	10.3	33.0	2.5	33.2	0.0	27.1	9.2
	146	1.4	36.6	4.7	35.7	5.7	35.7	7.3	35.4	18.3	25.2	22.9	20.8	25.4	18.6	30.6	12.9	34.2	2.9	34.4	0.0	35.1	0.0	32.0	0.0	22.5	3.1
	147	1.0	35.3	3.4	35.7	4.0	35.0	5.3	34.6	16.5	25.6	22.0	20.0	25.4	17.0	(32.6)	4.0	31.8	8.2	33.8	0.0	34.0	0.0	21.1	13.6	15.1	6.6
	151	5.2	39.5	6.2	40.1	8.9	38.7	12.5	37.0	23.2	27.4	28.9	22.5	32.2	20.4	35.4	14.6	40.2	0.0	40.9	0.0	39.6	0.0	32.8	11.2		
	152	8.6	41.2	8.0	40.3	11.4	40.2	12.2	39.7	14.0	37.5	31.2	19.4	37.9	6.9	39.2	4.0	39.8	2.4	41.7	2.3	42.6	1.9	41.0	2.9		
	157	9.0	40.2	9.6	39.1	9.7	39.3	11.3	38.2	18.3	32.2	28.8	22.5	36.5	7.9	36.4	7.9	38.6	2.0	39.9	1.1	39.9	1.1	40.6	2.6	29.0	7.1
	175	5.0	36.7	6.0	36.8	8.6	34.2	8.8	34.8	20.4	23.0	28.1	18.3	28.6	13.5	29.9	10.7	30.6	2.3	31.9	1.8	31.4	1.3	32.4	1.0	11.8	14.8
	201	5.8	34.7	6.4	32.9	8.8	31.0	20.2	19.7	24.1	15.2	28.3	9.5	30.8	5.7	‡32.0	‡2.0	#32.0	#2.2	32.4	1.8	19.2	14.5	19.7	14.0		
	252											28.0	23.6			39.8	1.5			39.4	2.7			38.8	4.1		
	280	5.0	37.0	5.2	36.9	9.5	34.4	12.1	33.3	21.8	24.4	25.0	19.7	29.0	13.5	30.8	12.1	31.1	3.3	32.7	1.9	30.1	5.1	23.2	13.7	20.1	8.3

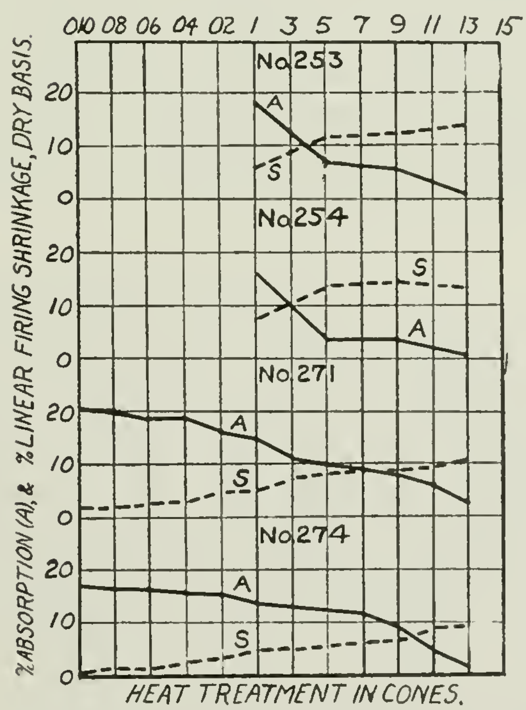
% V. S.=Firing shrinkage, per cent dry volume. % A. P.=Per cent apparent porosity. *Cone 5+. †Cone 7—. xCone 9—. ‡Cone 6—. #Cone 6+.

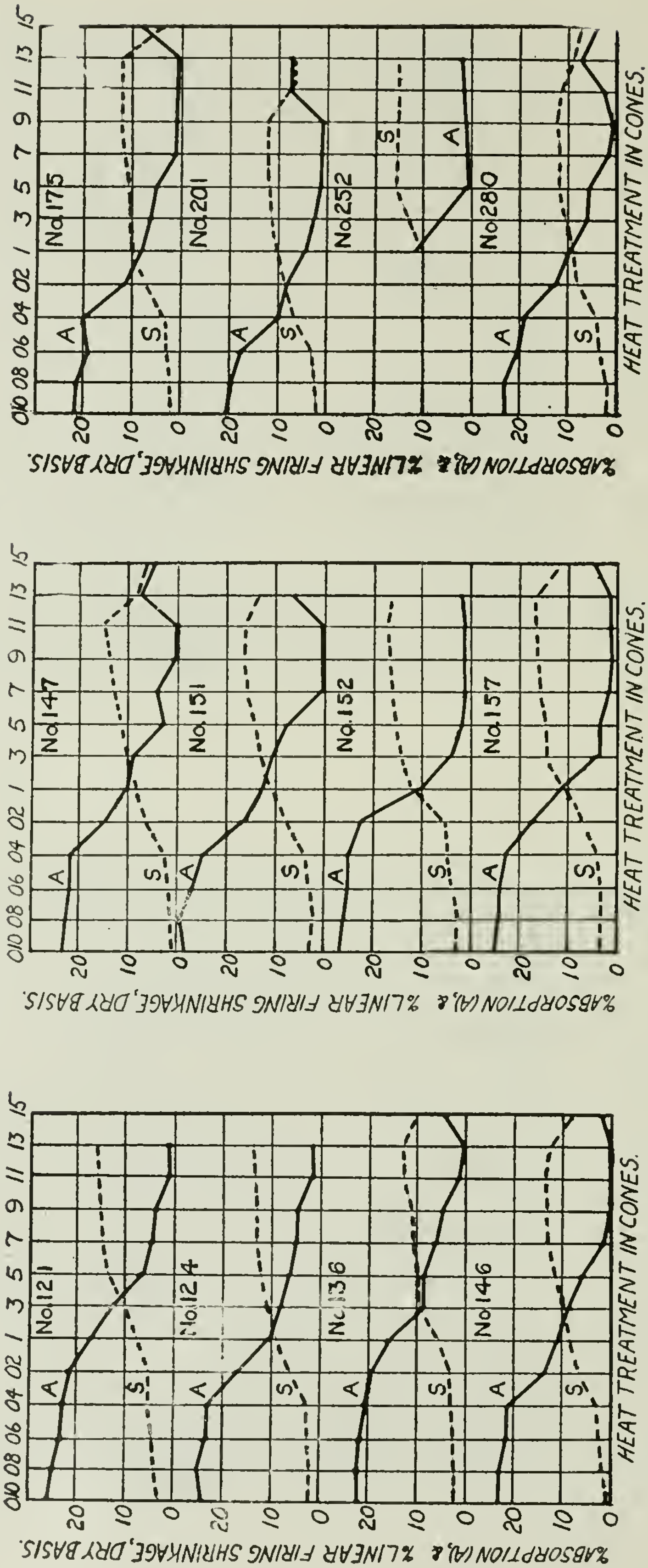
Absorption and linear shrinkage curves for clays of class 7.



Absorption and linear shrinkage curves for clays of class 7.







Absorption and linear shrinkage curves for clays of class 8.

II–B. Non-refractory Clays, Softening Point Cone 27—.

a. Open-Burning, Not Below 6% Apparent Porosity Below Cone 10.

9. Medium to High Strength.

No. 19 (p. 163). Riverside County. Alberhill C. & C. Co. "Yellow Stripping." This is a yellowish, sandy clay that occurs as overburden on parts of the property. It contains 28.2% of +200-mesh sand, and has sufficient plasticity and strength to permit its use in a superior grade of common brick, which is marketed under the name of "Diamond Brand." The dry strength is medium-high, and the dried clay is hard, with a medium grain and open texture. The colors are: dry, 15″d; wet, 15″; cones 010 to cone 3, 7′d; cone 5, 9′f; cones 7 to 9, 11′f; cone 11, 15′f; and cone 13, 15′b. Finger-nail hardness develops below cone 010, and steel hardness at cone 11. A few small cracks developed in the test piece that was fired to cone 13, but all other test pieces were sound. The total linear shrinkage, plastic basis, is 8.4%, at cone 13. The softening point is cone 23. The best firing range is from cone 010 to cone 11. The clay seems entirely suited for making buff and pink face brick. It does not vitrify at sufficiently low temperatures to be suitable as the sole ingredient of bodies with low porosity.

No. 25 (p. 163). Riverside County. Alberhill C. & C. Co. "West Tunnel Blue." See No. 94 and 95. This is a pink and buff-burning sewer-pipe clay having a fair plasticity and medium dry strength. It contains 18.8% of +200-mesh sand. In the dry state it has a medium grain and open texture. The colors are: dry, 23″″f; wet, 23″″d; cones 010 to 04, 17″f; cones 02 to 5, 15″d; cones 7 to 11, 15″b; cone 13, 5″″. It is practically red-burning at cone 13, but is best classed as a buff-burning clay. Finger-nail hardness is developed at cone 010, and steel hardness at cone 1. Vitrification is well advanced at cone 9. The total linear shrinkage, plastic basis, at cone 13, is 19.3%. The softening point is cone 16. The best firing range is from cone 1 to cone 13. The principal value of this clay lies in its vitrification range and temperature, coupled with good fired strength.

No. 36 (p. 20). San Diego County. Cardiff. California Clay Products Co. This is a Pleistocene (?) fireclay, similar to samples No. 33 and 34 in class 6, but with less iron and a higher percentage of fluxes, probably feldspars. It contains 44.4% of +200-mesh sand. The plasticity, and the dry and fired properties are closer to sample No. 33 than to No. 34, but the colors are uniformly of lighter tones and the fired porosities are greater, though the shrinkage is practically the same. The total linear shrinkage, plastic basis, at cone 13, is 8.2%. The softening point is cone 26. The best firing range is from cone 1 to over cone 13.

No. 94 and 95 (p. 171). Riverside County. Alberhill. G., McB. & Co. No. 94 is the "West Blue" and No. 95 is the "Select West Blue" clay. These two samples should be compared with No. 25, the "West Tunnel Blue" of the Alberhill C. & C. Co., and not with their "West Blue" (No. 23, class 5) and "Select West Blue" (No. 16, class 10) varieties. No important differences between No. 94 and 95 were disclosed by the testing, but they both have a higher proportion of sand and a lower percentage of iron than No. 25, which results in a large difference in the ceramic properties and uses of No. 94 and 95, compared with No. 25. No. 94 contains 24.2%, and No. 95 contains 27.6% of +200-mesh sand, compared to 18.8% for No. 25. The plasticity of No. 94 and 95 is good, the dry strength is medium, and in the dried state they are soft, medium-grained and open-textured. The colors are: dry, 17''''f; wet, neutral gray; cones 010 to 02, 13'''d; cones 1 to 13, 13''''d. Abundant particles of ferro-magnesian minerals give a pleasing granitic texture to the test pieces fired above cone 1. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions under 10% are obtained at cone 3. Bloating is pronounced at cone 11, especially when a reducing flame is used. No. 95 has lower shrinkage and lower absorption at cone 9 than No. 94. The maximum total linear shrinkage, plastic basis, is at cone 9, and is 11.7% for No. 94, and 10.5% for No. 95. The softening points are cones 17 and 18, respectively. The best firing range is from cone 1 to cone 9. No. 94 is used in tile bodies, and No. 95 in terra cotta bodies.

No. 99 (p. 171). Riverside County. G., McB. & Co. "Tile Clay." This is a red and tan-burning plastic clay that is used for the manufacture of roofing tile, face brick, and similar products. There is slight effervescence in hydrochloric acid. It contains 30.8% of +200-mesh quartz-mica sand. The plasticity is excellent, the dry strength is medium high, and in the dried condition it is medium hard, medium-grained, and open-textured. The colors are: dry, 13''''d; wet, 17''''; cones 010 to 02, 7''b; cone 1, 11''b; cones 3 to 11, 13''b; cone 13, 15''. Mottling from the presence of ferro-magnesian minerals is pronounced above cone 5, giving pleasing textural effects. Finger-nail hardness is developed below cone 010, and steel hardness develops at cone 5. Absorptions below 10% are not obtained until cone 11 is reached. The fired structure is sound and stony and the texture is rough. The total linear shrinkage, plastic basis, at cone 13, is 11.9%. The softening point is cone 26–27. The best firing range is from cone 02 to cone 9.

No. 114 (p. 90). San Bernardino County. Near Rosamond. Titus deposit. This is a buff-burning clay with fair plasticity, medium dry strength, and a medium hard, medium-grained, dried condition. It has not been produced steadily, but tests have been made by various clay manufacturers. The colors are: dry, grayish white; wet, 23'''''f; cones 010 to 3, 17''f; cones 5 to 9, 17'''f; cones 11 and 13, grayish white. Finger-nail hardness is developed below cone 010, and steel hardness appears at cone 1. The fired structure is sound, homogeneous, stony, and without warp. The surface texture is slightly rough. Above cone 11, scattered iron specks become noticeable. Absorptions below 10% are obtained at cone 9. The total linear shrinkage, plastic basis, is 6.9%, at cone 13. The softening point is cone 17–18. The clay might be useful in stoneware, vitrified floor tile, and similar mixtures, although for the highest purposes, washing would be necessary to remove the non-plastic coloring impurities.

No. 135 (p. 58). Amador County. Ione (Clarksona). N. Clark and Sons. "Dosch Stripping." This is a sandy yellow-burning clay with good plasticity and medium-high dry strength. It contains 18.0% of

+200-mesh sand. In the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 15″d; wet, 15″b; cones 010 to 5, 9″d; cone 7, 19″b. Steel hardness develops at cone 02, and less than 10% absorption at cone 3. The fired structure is sound, granular and rough-textured. A vesicular structure develops above cone 7. The maximum total linear shrinkage, plastic basis, is 15.1% at cone 7. This material is used in sewer-pipe mixes.

No. 168 (p. 136). Nevada County. Chicago Park. Beaser Ranch. This is a pink-burning clay from near the surface of an undeveloped deposit. The plasticity is smooth, but weak, the dry strength is medium, and in the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴d; cones 010 to 06, 15′f; cones 04 and 02, 15′d; cone 1, 13′b. The fired colors are ochraceous salmons and buffs, which are unusual. No scumming or efflorescence was noted. Steel hardness is developed at cone 02. The fired structure is sound, and stony, and the surface texture is exceptionally smooth. The total linear shrinkage, plastic basis, is 8.6% at cone 1. The clay could be used locally for common brick, and might be used to make an attractive, though unusual, face brick.

No. 169 (p. 138). Nevada County. Pearldale. Sonntag Ranch. This is a buff-burning clay from a surface exposure of an undeveloped deposit. The plasticity is fairly smooth and strong, the dry strength is medium, and in the dried condition it is soft, medium grained, and open-textured. The colors are: dry, 17″f; wet, 17″d; cones 010 and 08, 11′f; cone 06, 13′f; cones 04 and 02, 15′f; cones 1 to 5, 17′f; cone 7, 17″d; cones 9 to 13, 17‴b, but with a distinctly mottled appearance. Some interesting color effects for floor tile and face brick can be produced with this clay. Steel hardness is developed at cone 1. Less than 10% absorption appears at cone 7. Slight bloating is apparent from the shrinkage and porosity data at cones 11 and 13, but no loss of shape was noted. The fired structure is sound and stony, and the surface texture is slightly rough. The maximum total linear shrinkage, plastic basis, is 11.1%, at cone 9. The softening point is cone 19–20. The best firing range is from cone 1 to cone 9.

No. 173 (p. 235). Yuba County. Smartsville. J. F. Dempsey Ranch. Kaolinitic material from a copper prospect in volcanic rocks. It was not possible to secure a sample entirely free from limonite. The plasticity is fair, the dry strength is medium, and in the dried condition, it has finger-nail hardness, is medium grained, and open-textured. A high percentage of non-plastic matter is present. The colors are: dry, yellowish white; wet, 17‴f; cone 010, 7″b; fading progressively with increasing firing temperatures to 13‴d at cone 5. Green scumming is pronounced. Steel hardness is developed at cone 04. The fired structure is sound, and fine-granular, except at cone 6, where light superficial hair-cracks appear. The surface texture is slightly rough. The total linear shrinkage, plastic basis, at cone 9, is 19.1%.

No. 255 (p. 52). Amador County. Ione. Core drill hole No. 57–5, Arroyo Seco Grant. This is similar to No. 254 in class 7, but fires to darker colors. The plasticity is good, the dry strength is medium, and in the dried condition it is medium hard, fine-grained and open-textured. There is slight effervescence in hydrochloric acid. The colors are: dry, 9″d; wet, 9″b; cone 1, 9″d; cone 5, 15″d; cone 9, 17″b; cone 13, 15″i. Steel hardness is developed below cone 1, and less than 10% absorption between cone 1 and cone 5. The fired structure is sound and stony, and the surface texture is smooth. No blistering was noted at cone 13. The total linear shrinkage, plastic basis, at cone 13, is 21.6%. The softening point is cone 26. This is a good clay for face brick, roofing tile, and similar products.

No. 283–A and B (p. 232). Tulare County. Ducor. W. A. Sears deposit. See also No 284, class 10, and 285, class 5 These are samples of impure kaolin, and have fair plasticity and medium dry strength. The dry condition is medium-hard, fine-grained, and open-textured. The colors of No. 283–A are: dry, nearly white; wet, 15′f; cones 010 to 3, 17″d; cones 5 and 7, 17′d; cone 9, 15′d; cones 11 and 13, 13′d. The colors of No. 283–B are: dry, grayish white; wet, 21″″f; cones 010 to 02, 17″″f; cones 010 to 5, 21‴f; cones 7 to 13, 17″d. The colors are rather disagreeable yellowish buffs, and are irregular. Yellow scumming is very pronounced. Steel hardness is not developed up to cone 13, the upper temperature limit studied. The fired structure is sound, and there is no evidence of vitrification up to cone 13. The total linear shrinkage, plastic basis, at cone 13, is 10.7% for No. 283–A, and 9.7% for No. 283–B. The softening point of No. 283–A is cone 26–27. Further studies are needed before the possible uses of these clays can be predicted.

10. Low Strength.

No. 16 (p. 163). Riverside County. Alberhill C. & C. Co. "Select West Blue." See also No. 23 in class 5. This is a plastic, buff-burning clay that has a wide vitrification range above cone 7, and is used for face brick and pottery. It contains 22.6% of +200-mesh sand, high in ferro-magnesian minerals, which results in a pleasing granitic texture when fired above cone 7. The plasticity is fair, the dry strength is low, and the clay is soft and friable in the dry state. The colors are: dry, 15″‴f; wet, 15″‴b; cones 010 to 02, 17″f; cones 1 to 5, 17‴f; cones 7 to 13, 17″″f, with a granitic texture. Finger-nail hardness is developed at cone 06, steel hardness at cone 02, and bloating begins at cone 13. The total maximum linear shrinkage, plastic basis, is 14.0%, at cone 11. The softening point is cone 18. The best firing range is from cone 02 to cone 11.

No. 55 (p. 195). San Bernardino County.. 4.2 m. N.E. of Bryman. Gladding, McBean and Co. This is a vitrifying clay of value in face-brick manufacture. It has poor plasticity, low dry strength, and a soft, open, dry condition. A large proportion of non-plastic matter is present which is high in iron, and results in a pleasing granitic texture when fired. The percentage remaining on 200-mesh is 48.6. The colors are: dry, 7″f; wet, 7″d; cones 010 to 04, 7″f, cones 02 to 5, 9‴d; cones 7 to 11, 17″″d; cone 13, 15″‴d. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 1. Absorptions below 10% are obtained at cone 3 or above, and bloating begins above cone 11. The maximum total linear shrinkage, plastic basis, is 9.5%, at cone 11. The softening point is cone 18. The best firing range is from cone 02 to cone 11.

No. 82 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Clay Shale." This is a sandy, buff-burning clay shale, with weak plasticity and medium low strength. It effervesces slightly in hydrochloric acid. In the dried condition it is soft, medium-grained and open-textured. The colors are: dry, 17″d; wet, 17″; cones 010 to 3, 5′f; cones 5 to 11, 9′f; cone 13, 17′f. Iron specks are numerous. Finger-nail hardness develops below cone 010, but steel hardness is barely attained at cone 13, at which point bloating begins. The fired structure is sound, granular, and open. The maximum total linear firing shrinkage, plastic basis, is 3.5%, at cone 11, nearly all of which takes place during drying. The softening point is cone 23–26. The best firing range is from cone 010 to cone 11. The clay may be used with more plastic clays as an ingredient of face brick mixtures, if the mottled texture is not objectionable.

No. 88. (Deposit not described.) Riverside County. Hudson Ranch, near Elsinore. This is an impure silica sand, mixed with enough clay to impart weak plasticity to the mass. The dry strength is medium low, and in the dried condition it is coarse, open, and friable. The colors are: dry, 21″″f; wet, 17″″f; fired, from cone 010 to cone 11, grayish-white, with black specks above cone 7. Steel hardness is developed at cone 11. The fired structure is coarse-grained, and weak. Enough fluxes are present to cause fusion to begin at cone 9. The total linear shrinkage, plastic basis, at cone 9, is 8.3%. The material has little ceramic value.

No. 111 (p. 178). Riverside County. Alberhill. P. C. P. Co. "Lower Douglas." This is a pink-burning clay containing 28.6% of +200-mesh sand, but nevertheless possessing good plasticity, and a medium low dry strength. The dried condition is soft, medium-grained, and open-textured. The colors are: dry, 17″f; wet, 15″d; cones 010 to 1, 9″f; cone 3, 15″ f; cones 5 to 9, 13‴f; cones 11 and 13, 17‴f. Above cone 5, the clay is strongly mottled with iron specks, resulting in a pleasing fine-granitic texture. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. The fired structure is sound and fine-granular. Slight bloating begins at cone 11. Absorptions below 10% are obtained at cone 5 or above. The maximum total linear shrinkage, plastic basis, is 12.4%, at cone 9. The softening point is cone 19–20. The clay is useful in terra cotta, face brick, and faience tile bodies.

No. 167 (p. 138). Nevada County. Wolf. Coe property. Pine Hill Mine. See also No. 159 and 160 in class 1, and 166 in class 11. This is similar to No. 160, but contains more iron. The plasticity is weak, the dry strength is low, and in the dried condition it is soft, fragile, fine-grained, and open-textured. The colors are: dry, 7″b; wet, 9′b; cones 010 to 3, 7″b; cones 5 to 9, 7″d; cones 11 and 13, 17‴d. Finger-nail hardness is developed at cone 010, and steel hardness at cone 11. Less than 10% absorption is obtained at cone 13. The fired structure is sound, and below cone 11, is fine-granular. Above cone 11, it is stony. The total linear shrinkage, plastic basis, at cone 13, is 13.6%. The softening point is cone 23.

No. 170 (p. 136). Nevada County. Banner Mountain road. This is an impure, sandy, pink-burning clay with weak plasticity, and medium-low dry strength. In the dried condition it is medium-hard, coarse-grained, and open-textured. The colors are: dry, 17″d; wet, 17″ b; cones 010 to 06, 13″b; cones 04 to 1, 13″d. Steel hardness is developed at cone 02. The fired structure is sound, granular, open-textured, and the surface texture is smooth. The total linear shrinkage, plastic basis, is 4.8%, at cone 3. It could be used for common brick, but the plasticity is barely sufficient.

No. 238 (p. 70). Calaveras County. Campo Seco. This is an impure sericite schist that is said to have been used as a refractory clay in the former smelter of the Penn Mining Co. The plasticity is weak, the dry strength is low, and in the dried condition it is very soft and friable. The colors are: dry and wet, grayish white; cone 010, 17″f; cones 06 to 1, 17″d; cones 5 and 9, 21″″f. Steel hardness is developed at cone 02, and less than 10% absorption at cone 5. A vesicular structure developed at cone 9. The maximum total linear shrinkage, plastic basis, is 9.3%, at cone 5. The material is of doubtful value in ceramics.

No. 269. Inyo County. American Silica Co. "Death Valley Superfine." This is a very fine-grained, sandy material, with sufficient clay to give a short and spongy plasticity to the mass. There is considerable effervescence in hydrochloric acid. The dry strength is medium low, and in the dried condition it is hard, and has a fine sandy texture. The colors are: dry, 17‴d; wet, 17‴b; cones 010 to 06, 15″f; cones 04 to 1, whiter than 17″; cone 3, 17″d. Steel hardness is developed at cone 3. The fired structure is sound and fine-granular. The total linear shrinkage, plastic basis, is 26.6%, at cone 3. The softening point was not determined.

No. 284 (p. 232). Tulare County. Ducor. W. A. Sears deposit. See also No. 285, class 5, and 283–A and B, class 9. This is an impure kaolin, having weak plasticity, low dry strength, and a medium-hard, coarse-grained, open texture in the dry condition. It was only fired to four cone numbers. The colors are: dry, 15″d; wet, 17″; cones 1, 5, 9 and 13, 15″. The fired colors are rather unsatisfactory yellows for most ceramic products. The fired structure is weak and coarse-granular. The total linear shrinkage, plastic basis, is 6.4%. The softening point was not determined. This is the least satisfactory of the samples tested from this deposit. Yellow scumming is pronounced.

b. Dense-Burning, Less Than 6% Apparent Porosity Below Cone 10.

11. Low Strength.

No. 166 (p. 138). Nevada County. Wolf. Coe property. Pine Hill Mine. See also No. 159 and 160 in class 1 and 167 in class 10. This is similar to No. 159, but contains a higher proportion of fluxes and coloring matter. The residue on 200-mesh is 4.6%. The plasticity is smooth, and moderately strong, the dry strength is medium-low, and in the dried condition it is medium-hard, fine-grained and close-textured. The colors are: dry, 13″f; wet, 9″d; cones 010 to 06, 7″f; cones 04 to 3, 5″f; cones 5 and 7, 5″″f; cone 9, 13″″f. Plasticity is not destroyed until cone 06 is reached, but steel hardness is developed at cone 02. Less than 10% absorption appears at cone 02, and a vesicular structure is developed above cone 3. The fired structure, from cone 02 to cone 3, is sound, and stony, with a smooth surface texture. The maximum total linear shrinkage, plastic basis, is 15.8%, at cone 3. The softening point is cone 13. The clay might find some use as a vitrifying agent in buff, cream, or pink bodies burned between the limits of cone 02 and cone 3.

TABLE No. 22.

II. Buff-Burning Clays.

B. Non-refractory clays, softening point cone 27—.

a. Open-burning, not below 6% apparent porosity below cone 10.

9. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
19	11.0	12.2	23.2	463	21.9	6.8	23
25	19.3	18.9	38.2	388	34.0	10.3	16
36	11.8	19.2	31.0	566	19.9	6.3	26
94	9.1	13.3	22.4	207	17.7	5.6	17
95	7.3	12.3	19.6	241	14.7	4.7	18
99	12.5	14.2	26.7	538	23.7	7.4	26–27
114	8.3	13.9	22.2	231	15.6	5.0	17–18
135	15.7	14.3	30.0	437	29.1	8.8	
168	9.0	16.7	25.7	315	16.1	5.1	
169	8.3	15.1	23.4	246	15.5	5.0	19–20
173	20.0	21.3	41.3	391	33.0	10.0	
255	20.6	21.0	41.6	238	35.2	10.6	26
283 A	9.3	34.2	43.5	347	11.7	3.7	26–27
283 B	11.2	15.7	26.9	369	19.9	6.3	

10. Low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
16	9.3	17.9	27.2	88	16.7	5.3	18
55	3.9	15.7	19.6	97	7.3	2.4	18
82	6.3	20.6	26.9	129	10.5	3.3	23–26
88	2.8	16.9	19.7	175	4.6	1.5	
111	9.9	16.3	26.2	165	18.4	5.8	19–20
167	8.8	21.5	30.3	62	14.5	4.7	23
170	5.3	19.5	24.8	105	9.1	2.9	
238	4.3	16.8	21.1	38	7.8	2.5	
269	31.5	36.8	68.3	166	39.8	11.9	
284	5.0	18.7	23.7	80	8.6	2.8	

b. Dense-burning, less than 6% apparent porosity below cone 10.

11. Low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
166	11.5	24.1	35.6	117	18.8	5.9	13

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 23.

II. Buff-Burning Clays.

B. Non-refractory clays, softening point cone 27—.

a. Open-burning, not below 6% apparent porosity below cone 10.

9. Medium to high strength.

10. Low strength.

b. Dense-burning, less than 6% apparent porosity below cone 10.

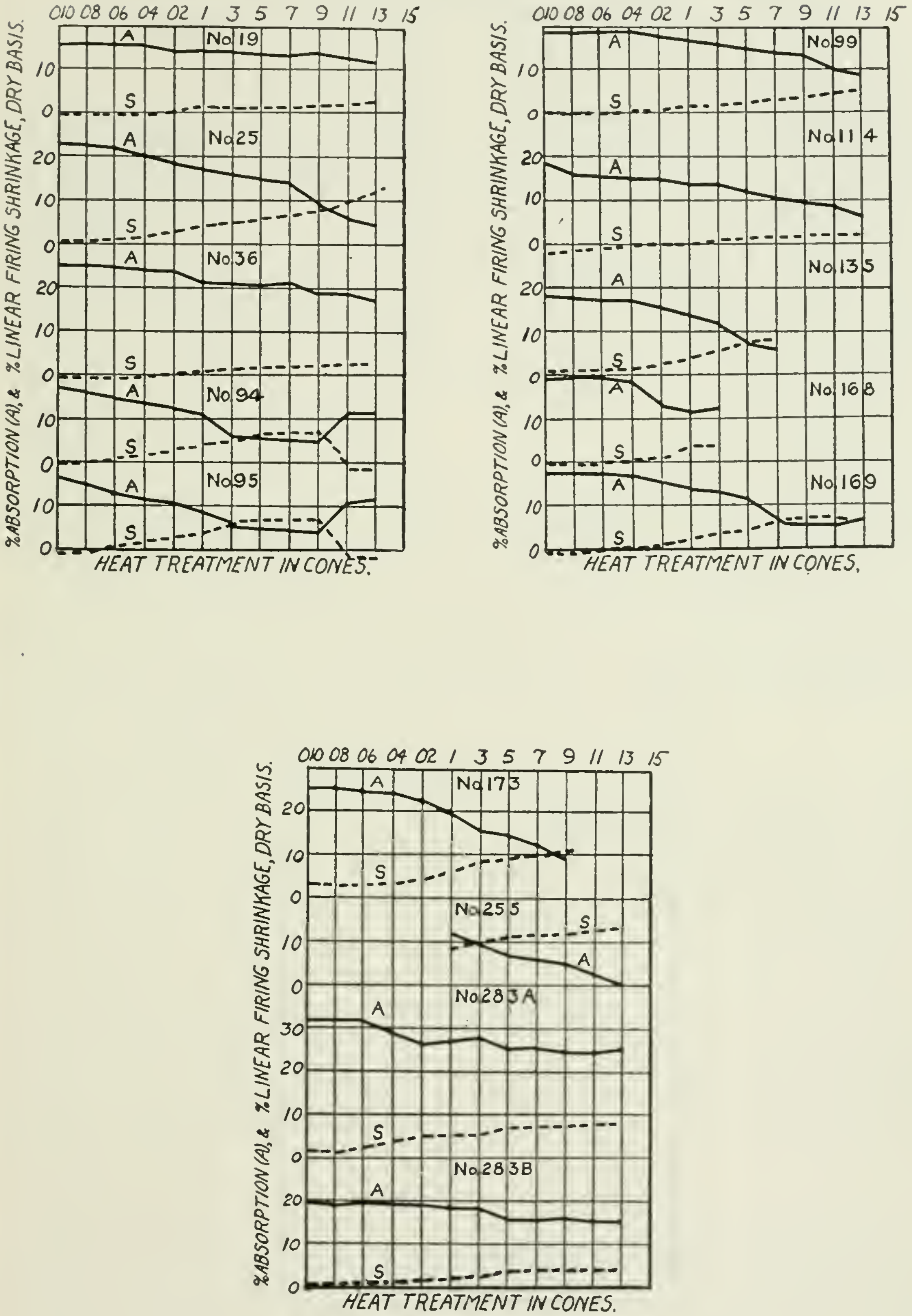
11. Low strength.

Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
9	19	—1.2	29.1	—0 6	30.4	—0.5	30.3	—0.3	29.9	+2.4	28.3	2.7	28.0
	25	+1.4	37.1	1.6	37.2	3.7	36.5	6.2	35.2	8 8	33.8	12.9	32.0
	36	—1.8	39.1	—2.0	39.1	—1.3	39.8	—1.0	39.0	0.0	38.3	3.2	35.5
	94	—1.8	30.1	—1.1	30.2	+2.8	27.8	+4.1	26.4	+6.8	24.8	9.3	22.1
	95	—2.6	29 2	—1 2	28.2	2 7	25.3	+4.5	21.8	7.0	22.1	9.5	19 5
	99	—0.1	33.5	+0.7	34.0	1.0	34.5	1.2	34.4	4 2	33.1	5.5	31.5
	114	—5.7	33.3	—3.3	29 1	—2.3	28.3	—1.9	28.5	+1.5	26.8	2.8	25.6
	135	3.4	32 0	3 1	32.4	3.4	31.9	3.6	30 8	6.8	29.1	12.3	25.0
	168	—1.1	33.0	—1.3	33.2	+0.1	32.9	+0 7	32.5	2.1	22.4	11.3	20.6
	169	—1.7	31.3	—1.6	31.5	—0.4	31.2	—0.3	31.2	+3.4	28 5	6.2	25.6
	173	7.4	40.7	7 2	41.0	7.8	40.3	8.5	39.9	11.6	43.8	16.4	34.9
	255	------	------	------	------	------	------	------	------	------	------	23.6	24 2
	283-A	4.1	38.8	3.6	39.2	6.5	39.0	11.0	37.6	15.1	36.6	14.7	37.6
	283-B	1.8	33.3	1.5	32 5	2.0	33.3	2.8	33.0	3.9	32.8	5.2	32.1
10	16	—2.8	34.6	—2.4	34.7	—1.3	35.0	+1.3	33.9	5.5	31.3	10.0	27.4
	55	0.4	32.5	—2 2	32.2	—1.4	31.9	—0.5	32.4	+0.5	28.9	9.3	24.8
	82	—0.5	40.0	—0 5	39.7	—0.7	40 4	—0 6	40.2	—0.7	40.5	—1.7	38.9
	88	—2.8	34.4	—2 7	34.6	—3.2	35.2	—2.8	34.8	—3.4	34.9	—2 4	33.4
	111	—2.9	32.6	—2.3	31.8	—0.1	30.9	0.0	31 3	+4.4	27.8	6.8	26.0
	167	—0.7	41.2	—0.8	42 7	+2 1	44.0	—0.7	42 3	+0.4	42.7	2.5	42.3
	170	—0.5	37.5	—1.0	38.1	0.0	38.6	+0.3	38 6	3 7	36.3	5.4	34.4
	238	—2.3	35.0	------	------	+2.7	32.0	------	------	7.8	27.6	9.1	26.1
	269	8.3	57.5	10.1	57.2	10.4	57.3	18.4	53.6	21.2	52.3	33.8	42.0
	284	------	------	------	------	------	------	------	------	------	------	5.7	34.6
11	166	------	------	—2.7	39.2	+8.6	30.1	11.9	28.4	24.0	16.5	24 1	12.9

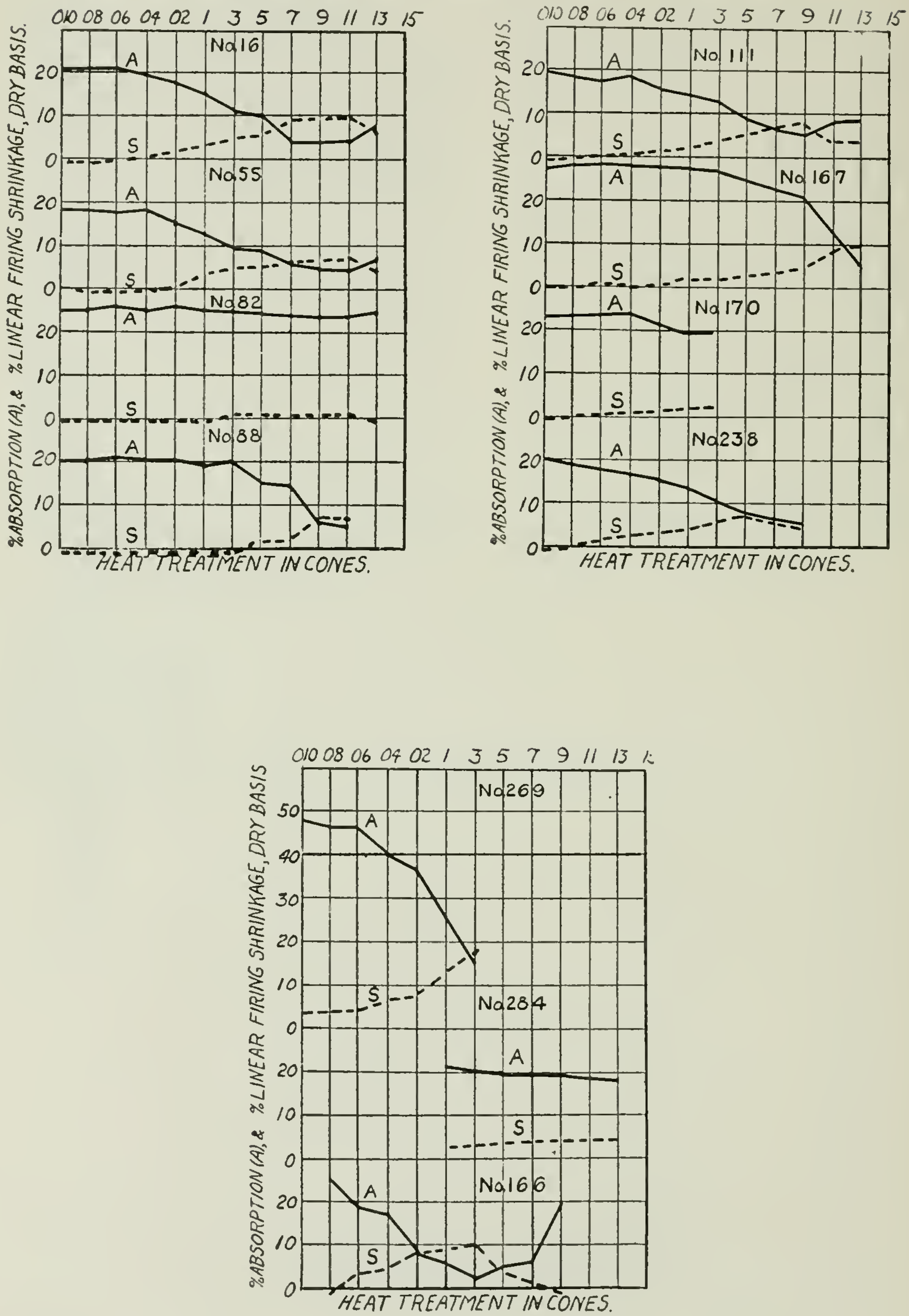
Class No.	Clay No.	Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
9	19	2.8	28.4	3.5	27.2	3.5	26.7	4 2	26.7	4.8	26.0	6.4	23.6	------	------
	25	14.3	29.6	16.3	26.6	16.6	26.8	23.6	18.8	25 7	13.4	29.6	9.8	------	------
	36	+3.5	35.5	3.8	34.9	4.4	35.2	6.1	32.7	6.1	32.2	6.9	29.6	------	------
	94	16.3	13.0	17.0	12.3	18.1	11.4	19.0	10.0	—3.5	20.3	—4.1	20.1	------	------
	95	16.0	11.5	16.6	9.8	17.6	8.4	17.7	6.6	—5.8	18.5	—7.3	19.5	------	------
	99	5.9	31.0	7.8	29.4	9.4	28.2	11.6	26.2	14.1	19.9	15.4	17.8	------	------
	114	3.1	25.0	5.1	23 2	6.6	20.6	6.7	19.2	7.3	17.9	6.6	12.4	------	------
	135	13.4	23.5	19.7	14.7	21 0	12.2	------	------	------	------	------	------	------	------
	168	10.0	22.5	------	------	------	------	------	------	------	------	------	------	------	------
	169	8.3	23.2	10.0	20.8	16.7	12.3	18.7	10.5	16.8	10.7	14 0	12.9	------	------
	173	23.6	29.4	21.9	28.4	26.8	23.6	29.6	18.3	------	------	------	------	------	------
	255	------	------	29.4	15 6	------	------	32.3	11.4	------	------	34.8	0.5	------	------
	283-A	15.2	38.2	19.0	36.1	19.7	37.0	20.2	36.0	20.2	36.0	20 6	37.0	------	------
	283-B	6.2	31.9	10.5	29.0	10.6	28.6	10 7	29 0	11.2	27.7	11.5	28.0	------	------
10	16	14.8	22.0	15 6	20.2	25.4	8.4	25.5	8 5	25 8	9.3	17.2	15.6	------	------
	55	14.1	19.8	14 3	19.2	18.8?	13.2?	19 6	9 7	20.4	9.3	11 0	12.2	------	------
	82	+1 1	39.2	1.4	38.8	+0.9	37.3	0.6	37.1	0.8	37.6	—1 5	37.6	------	------
	88	—1.8	34.1	+4.6	28.2	+5.4	27.2	19.4	12.3	18.2	11.2	------	------	------	------
	111	10.7	23.1	16.1	16.7	18.3	12 9	20.4	11.0	9.8	16.3	9.4	15.9	------	------
	167	3.0	41.8	7.3	39.1	9.2	37.8	11.7	35.0	22.3	24.0	25.9	7.4	------	------
	170	5.9	33.3	------	------	------	------	------	------	------	------	------	------	------	------
	238	------	------	19.7	14.9	------	------	12.0	7 8	------	------	------	------	------	------
	269	44.7	29.7	------	------	------	------	------	------	------	------	------	------	------	------
	284	------	------	10.2	32.4	------	------	9.4	32.6	------	------	11 1	31.1	------	------
11	166	29.1	3.9	11.7	8.8	3.3	10.3	—2 5	31.5	------	------	------	------	------	------

% V. S.=Firing shrinkage, per cent dry volume. % A. P.=Per cent apparent porosity.

Absorption and linear shrinkage curves for clays of class 9.



Absorption and linear shrinkage curves for clays of classes 10 and 11.



III. RED-BURNING CLAYS.

A. Open-Burning, Do Not Attain Less Than 6% Apparent Porosity at Any Temperature Short of Actual Fusion.

12. Medium to High Strength.

No. 8 (p. 163). Riverside County. Alberhill C. & C. Co. "Red Clay No. 2." This is used principally as a red-coloring clay in the manufacture of face brick and other high-grade red-burned products. It is similar in its properties to No. 7 (class 13), but is not quite as uniformly fine-grained, has greater shrinkage and strength, and vitrifies more thoroughly at cone 13. The colors are as follows: dry, 11″b; wet, 11″; cones 010 to 3, 9′b; cone 5, 9″b; cone 7, 7″b; cones 9 and 11, 5″; and cone 13, 5‴b (flashed). Finger-nail hardness is found at cone 08, and steel hardness at cone 9. The total linear shrinkage, plastic basis, at cone 13, is 15.8%. The softening point is cone 19–20. The best firing range is from cone 08 to cone 11, and especially good results are obtained from cone 1 to cone 7.

No. 18 (p. 163). Riverside County. Alberhill C. & C. Co. "Clark Tunnel Mottled." This is a plastic red-burning clay, used in sewer-pipe mixes to increase the vitrification range of the mix. It contains 15.6% of +200-mesh sand, has excellent plasticity, medium dry strength, and in the dried state is medium hard and has a medium grain. The colors are: dry, 11″b; wet, 9″; cones 010 to 06, 9′b; cones 04 to 02, 11′; cones 1 to 7, 9′i; cones 9 to 11, 5″. Finger-nail hardness is developed at cone 010, and steel hardness at cone 3. The total linear shrinkage, plastic basis, is 17.8% at cone 11. The softening point is cone 19. The best firing range is from cone 1 to cone 11.

No. 24 (p. 163). Riverside County. Alberhill C. & C. Co. "West Tunnel Mottled." This is a red-burning clay used in sagger mixes and face brick. It contains 13.8% of +200-mesh sand and has smooth and strong plasticity, medium dry strength. In the dry condition it is medium-hard, fine-grained, close-textured, with a tendency to laminate. The colors are: dry, 11″d; wet, 9″; cones 010 to 04, 9′b; cones 02 to 3, 7″b; cone 5, 9″; cone 7, 5″k; cone 9, 5″i; cones 11 and 13, 1‴. Finger-nail hardness develops below cone 010, and steel hardness at cone 7. The specimens appear to be well vitrified at cones 11 and 13, but the absorptions are greater than 10% at these temperatures. Some of the test pieces are slightly cracked. The maximum total linear shrinkage, plastic basis, is 14.2% at cone 11. The softening point is cone 18–19. The best firing range is from cone 5 to cone 11. Slight bloating is noted at cone 13.

No. 26 (p. 163). Riverside County. Alberhill C. & C. Co. "West Yellow Stripping." This is used for face brick and sewer-pipe. It contains 21.8% of +200-mesh sand and has a smooth and strong plasticity, exceptionally high dry strength, high drying shrinkage, and medium firing-shrinkage. It laminates easily, warps badly in drying, and in the dry state is hard, with a fine grain and close texture. The colors are: dry, 19″; wet, 19″i; cone 010, 11″b, cones 08 and 06, 9″; cone 04, 11″; cones 02 to 3, 7″; cones 5 and 7, 5″; cone 9, 7″; cone 11, 5‴; cone 13, 5‴i. The fired colors are excellent for the darker shades of face brick. Finger-nail hardness is present in the dry condition, and steel hardness appears at cone 1. Absorptions below 10% appear at cone 02. Bloating begins at cone 9. The total maximum linear shrinkage, plastic basis, is 18.5%, at cone 7, and bloating appears at higher temperatures. The best firing range is from cone 02 to cone 7. The clay is especially valuable for its high dry and fired strength, and its wide vitrification range at commercial temperatures.

No. 32 (p. 205). San Diego County. Linda Vista. Vitrified Products Co. A yellow clay-shale of Tertiary age. It is used for structural ware. It has good plasticity, medium high dry strength, and good dry condition. Some lime is present, which does no harm if the larger lime boulders are avoided in mining, and if the mix is well prepared in the plant. The colors are: dry, 17″d; wet, 17″; cone 010, 11′b; cone 08, 11′; cones 06 to 02, 9′; cones 1 and 3, 5‴k. Finger-nail hardness is present in the dry state, and steel hardness appears at cone 04. In the sample tested, the maximum total shrinkage, plastic basis, is 11.2%, at cone 1. The absorption at this point is 8.7%, and at higher temperatures bloating begins, accompanied by the development of yellow-green colors typical of the presence of lime. It is possible that the sample contains more lime than is usually present in the material delivered to the plant. The best firing range is from cone 010 to cone 1.

No. 35 (p. 202). San Diego County. Cardiff. Gladding, McBean and Co. This is a red-burning face-brick clay with excellent plasticity, high dry strength, and safe drying properties. It contains 16.4% of +200-mesh sand. In the dry state it is hard, and has a medium grain and open texture. The colors are: dry, 17″f; wet, 15″d; cones 010 and 08, 11″b; cones 06 and 04, 11′b; cone 01, 9′b; cone 1, 9′; cones 3 to 7, 7″; cones 9 and 11, 5″i; cone 13, 13″i. The fired colors are excellent intermediate shades for face brick. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Vitrification is well advanced, but not complete, at cone 13. The total linear shrinkage, plastic basis, at cone 13, is 14.6%. The softening point is cone 17–18. The best firing range is from cone 1 to above cone 13. The long firing range and high dry strength of this clay are its specially desirable features.

No. 40 (p. 203). San Diego County. Near Carlsbad. Pacific Clay Products Co. "Kelly Ranch Yellow." This is a red-burning, plastic clay with a long vitrification range, from a bed underlying that from which sample No. 39 was taken. It is suitable for the manufacture of face brick, sewer-pipe, roofing tile, and similar products. The sample contains 4.8% of +200-mesh sand. It has a smooth, strong plasticity, high dry strength, and the dry structure is hard, fine-grained, and dense. The colors are: dry, 17‴b; wet, 17″i; cones 010 to 04, 9′b; cone 02, 9′; cones 1 to 5, 9′i; cones 7 and 9, 5″. The fired colors cover a good range of brilliant reds for face brick and roofing tile. Finger-nail hardness is approached in the dry state, and steel hardness appears at cone 08. Porosity under 10% is found at cone 1, and bloating begins above cone 5. The total maximum linear shrinkage, plastic basis, is 18.9% at cone 9. The softening point is cone 18–19. The best firing range is from cone 02 to cone 13.

No. 65 (p. 141). Orange County. Brea. Brea Brick Co. This is a red-burning surface clay suitable for the manufacture of common brick. It effervesces slightly in hydrochloric acid. The plasticity is good, with a tendency to become sticky with excess water, the dry strength is medium high, and the dry condition is hard, dense, and granular. It contains 45.2% of +200-mesh sand. The colors are: dry, 17‴b; wet, 15″k; cones 010 and 08, 9′b; cone 06, 9′; cone 04, 9′i; cone 02, 9′k; cones 3 and 5, 5′k; cone 7, 5″m. The fired colors are excellent for common brick. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 3. Vitrification is complete at cone 7, and bloating begins below cone 9. The fired condition is sound, open, and strong. The maximum total linear shrinkage, plastic basis, is 11.9%, at cone 7. The best firing range is from cone 010 to cone 7, and good structures are obtained from cone 3 to cone 7.

No. 69 (p. 169). Riverside County. 10 m. south of Corona. Emsco Clay Co. "Red Horse." This is a red-burning clay with smooth, strong plasticity. It is suitable as an ingredient of red earthenware, roofing tile, face brick, and sewer-pipe mixes. The sample contains 13.8% of +200-mesh sand. The dry strength is medium, and the dry condition is medium hard, fine-grained and close-textured. The colors are: dry, 9′b; wet, 9′i; cones 010 to 04, 7′b; cones 02 to 3, 9′; cone 5, 7″; cone 7 to 11, 5″i. The fired colors cover an interesting range of deep reds. Finger-nail hardness is developed below cone 010, and steel hardness at cone 04. Vitrification is practically complete at cone 7, but the apparent porosity is still above 8 per cent. All test pieces above cone 08 are slightly cracked. The fired condition is strong, tough and fine-grained. The total linear shrinkage, plastic basis, at cone 7, is 14.4%. The softening point is cone 18–19. The best firing range is from cone 04 to cone 7. [The shrinkage and apparent porosity data at cones 11 and 13 were lost. See absorption curve for general trend.]

No. 73 (p. 169). Riverside County. Emsco Clay Co. "Bone." Although this is locally classed as a bone clay on account of its pisolitic structure in the raw state, it is lateritic, and contains so much iron as to give a low fusion point. It contains 46.8% of +200-mesh material. The plasticity is spongy, but fairly strong, the dry strength is medium, and the dry condition is granular, and open-textured. The colors are: dry, 9′d; wet, 11′i; cones 010 to 04, 11′f; cones 02 to 5, 7″b; cone 7 to 11, 9‴b; cone 13, 5‴k. The fired colors are suitable for red face brick and roofing tile. Finger-nail hardness is developed below cone 010, and steel hardness at cone 1. All fired test pieces are sound, granular, and strong. Vitrification is complete at (approx.) cone 7, beyond which temperature, bloating gradually develops. The maximum total linear shrinkage, plastic basis, is 9.2%, at cone 7. Absorptions below 10% are obtained at cone 02 or higher. The softening point is cone 15. The best firing range is from cone 02 to cone 7. The clay can be used as a coloring agent, and to prolong the vitrification range of red-burned structural ware.

No. 100 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Yellow Stripping." This is an impure, sandy clay that is used in face-brick and sewer-pipe mixtures. It effervesces slightly in hydrochloric acid. The plasticity is good, the dry strength is exceptionally high, and in the dried condition the clay has finger-nail hardness, and is dense and fine-grained. It contains 20.8% of +200-mesh sand. The colors are: dry, 15″d; wet, 17″; cones 010 to 02, 9′b; cone 1, 9′i; cones 3 to 11, 5′i. Steel hardness is developed at cone 06. Absorptions below 10% are obtained from cone 02 to cone 9, inclusive. All fired test pieces are sound, and have a stony structure. Vitrification is complete at cone 5, and bloating begins above cone 9. The maximum total linear shrinkage, plastic basis, is 17.3%, at cone 5. The softening point is cone 14–15.

No. 105 (p. 171). Riverside County. Alberhill. G., McB. & Co. "Sloan Red." This is a red-burning clay with good plasticity, medium dry strength, and in the dried condition it is soft, medium-grained, and open-textured. It contains 17.0% of +200-mesh sand. It is used for face brick, roofing tile, and similar products. The colors are: dry, 11′d; wet, 9′k; cones 010 to 5, 9′b; cone 7, 7″b; cones 9 to 13, 5″i. Finger-nail hardness is developed at cone 06, and steel hardness at cone 1. The fired structures are all sound and stony, with a slightly roughened surface texture. Absorptions below 10% are obtained at cone 7 or above. The total linear shrinkage, plastic basis, at cone 13, is 15.0%. The softening point is cone 18–19.

No. 112 (p. 178). Riverside County. Alberhill. P. C. P. Co. "Hoist Pit Blue." This is a plastic, pink-burning clay that is used in sewer-pipe mixes. The plasticity is excellent, the dry strength is medium, and in the dried condition the clay is soft, medium-grained, and open-textured. It contains 25.0% of +200-mesh sand. The colors are: dry, 17‴b; wet, 19″k; cones 010 to 02, 7′d; cones 1 to 7, 7″d; cone 9, 9″d; cones 11 and 13, 13‴i. Finger-nail hardness appears below cone 010, and steel hardness at cone 1. Absorptions below 10% are obtained at cone 7. The fired structure is sound and heterogeneous, and the fired surface texture is smooth. The total linear shrinkage, plastic basis, at cone 13, is 16.1%. The softening point is cone 19.

No. 113 (p. 176). Riverside County. Alberhill. P. C. P. Co. "Hoist Pit Red." This is a red-burning sandy clay of use in sewer-pipe mixes, roofing tile, red earthenware, etc. It contains 18.6% of +200-mesh sand. The plasticity is excellent, the dry strength is medium high, and in the dried condition the clay is hard, brittle, fine-grained and close-textured. The colors are: dry, 9′b; wet, 7′i; cones 010 to 7, 9′; cones 9 to 13, 9‴. Finger-nail hardness (nearly) is present in the dried state, and steel hardness appears at cone 3. The fired condition is sound and fine-grained, and the fired surface texture is slightly rough. The total linear shrinkage, plastic basis, at cone 13, is 11.3%. The softening point is cone 23–26.

No. 117 (p. 131). Santa Cruz County. Castroville. Joe Arca. This is an excessively plastic surface clay, that can almost be classed as an adobe. It is used for making hand-made roofing tile on a small scale. It has an exceptionally high dry strength, but must be dried carefully to prevent warping and cracking. In the dried condition it is dense, fine grained, and has finger-nail hardness. The colors are: dry, 17‴b; wet, 17‴i; cones 010 to 06, 9′b; cone 04, 9′; cone 02, 9″i. Steel hardness develops at cone 02. Bloating is well advanced at cone 1. All test pieces cracked on firing. The maximum total linear shrinkage, plastic basis, is 18.0%, at cone 02. Most of the shrinkage takes place during drying. The best firing range is from cone 010 to cone 02. The short vitrification range and the poor drying qualities of this clay preclude its general use for structural-clay products.

No. 119 (p. 74). Contra Costa County. Point Richmond. Richmond Pressed Brick Co. This is one of the typical red-burning Tertiary clays of the San Francisco Bay region that are widely used for the manufacture of common brick and building tile. As ground, the sample contains 43.2% of +200-mesh sand. The plasticity is good, the dry strength is medium, and the dried condition is hard, medium-grained, and open-textured. The colors are: dry, 17''''; wet, 17''''i; cone 010, 13''b; cone 08, 11''b; cones 06 and 04, 9''; cone 01, 7''i; cone 1, 5'k. Steel hardness is developed at cone 04+. Vitrification is complete at cone 1, and bloating begins at slightly higher temperatures. The fired structure is sound and fine-granular, and slightly roughened surface textures are obtained. The maximum total linear shrinkage, plastic basis, is 12.1%, at cone 1.

No. 155 (p. 151). Placer County. Lincoln. Gladding, McBean & Co. "Pit Sand." This is a red-burning sand-clay mixture that is used in the manufacture of roofing tile, sewer pipe, and other red-body ware. The residue on 200-mesh is 31.8%. The plasticity is fair, the dry strength is medium high, and in the dried condition it is hard, medium-grained, and open-textured. The colors are: dry, 17'''d; wet, 17''''; cones 010 to 06, 13''; cones 04 and 02, 1''; cones 1 to 5, 11''i; cone 7, 5''m. Finger-nail hardness is present in the dried condition, and steel hardness is developed at cone 1. The fired structure is sound, except for light hair-cracks on the surface. The fired surface texture is rough. Bloating begins at cone 7, before the body is vitrified to a low absorption. The maximum total linear shrinkage, plastic basis, is 15.0%, at cone 5.

No. 176 (p. 66). Butte County. Oroville. Quincy road. This sample is representative of a residual deposit of decomposed granite. The plasticity is fair, the dry strength is medium high, and in the dried condition it is medium hard, coarse-grained, and open-textured. The colors are: dry, 15''d; wet, 15''; cone 010, 15''; cone 08, 13''; cones 06 and 04, 11'; cone 02, 9'; cone 1, 7'i. These are good colors for common brick. Steel hardness is not developed up to cone 1, the upper temperature limit studied. The fired structure is sound and granular, and the surface texture is moderately rough. The total linear shrinkage, plastic basis, is 8.2%, at cone 1. The material is suited for the manufacture of common brick.

No. 178 (p. 66). Butte County. Palermo. Lund Brick Yard. This is a clay-gravel mixture from a Tertiary river channel and is being used for the manufacture of common brick. Three separate samples were taken, No. 178–1, 2, and 3, each representing different phases of the material. Only one of these, No. 178–2, was tested completely. The others were fired to but three different temperatures each. The differences between the three varieties are the result of differing proportions of sand, silt, and gravel. No. 178–1 contains 51.6% of +200-mesh sand, No. 178–2 contains 23.6%, and No. 178–3 contains 15.2%. This description covers No. 178–2, and the reader is referred to the tabulated data for the results on the other samples. The plasticity is strong, but with a tendency to stickiness when excess water is used. The dry strength is high, and in the dried condition it has finger-nail hardness, is medium-grained, and open-textured. The tendency to laminate is pronounced. The colors are: dry, 11′b; wet, 11′i; cones 010 to 3, 9′i; cone 6, 5′k. Steel hardness is developed at cone 02, and less than 10% absorption at cone 6. The fired structure is strong and stony, with a slight tendency to crack. The surface texture is moderately rough. The total linear shrinkage, plastic basis, is 15.8%, at cone 6. The best firing range is from cone 02 to cone 6, for hard-burned ware, and from cones 06 to 02 for soft-burned ware. The material makes a strong brick with good colors, but the irregularity of the deposit is an uncertain factor that makes the close control of shrinkage difficult.

No. 180 (p. 77). Del Norte County. Crescent City. Elk Valley. This is a common-brick clay. The plasticity is good, the dry strength is medium, and in the dried condition it is hard, fine-grained, and close-textured. It contains 19.2% of +200-mesh sand. The colors are: dry, 17″b; wet, 17″i; cones 010 to 06, 9′; cones 04 to 3, 9′i; cone 6, 5′k. Steel hardness is developed at cone 1, and less than 10% absorption at cone 3. All test pieces are sound. The total linear shrinkage, plastic basis, is 17.5%. The best firing range is from cone 010 to cone 3. The clay is entirely suitable for the manufacture of red brick either by the soft-mud or stiff-mud process.

No. 182 (p. 81). Humboldt County. Eureka. Thompson Brick Co. This is a common-brick clay with good plasticity, high dry strength, and in the dried condition it has finger-nail hardness, is fine-grained and close-textured. It contains 16.8% of +200-mesh sand. The colors are: dry, 17″d; wet, 17″k; cones 010 to 06, 11′; cone 04, 9′; cone 02, 7′i; cone 1, 7′m; cones 3 and 5, 7″m. Steel hardness is developed at cone 010, and less than 10% absorption at cone 02. The fired structure is generally sound, but with a tendency to crack. Bloating begins above cone 3. The maximum total linear shrinkage, plastic basis, is 16.6%, at cone 3. The clay is mixed at the plant with a sandier variety to insure safer drying and firing.

No. 183 (p. 81). Humboldt County. Eureka. Second Slough. This is a common clay that has not been used. It has sticky plasticity, high dry strength, and in the dried condition it is hard, medium-grained, and close-textured. The colors are: dry, 17″d; wet, 17″k; cones 010 to 08, 9′d; cones 06 and 04, 9′b; cone 02, 7″; cone 1, 5″k; cones 3 and 5, 5″m. Steel hardness and less than 10% absorption are developed at cone 02. The fired structure is sound, up to cone 1, beyond which bloating begins. The maximum total linear shrinkage, plastic basis, is 18.9%, at cone 1. The clay would be satisfactory for common-brick manufacture, if mixed with less plastic material.

No. 199 (p. 74). Contra Costa County. Port Costa. Port Costa Brick Co. This is a plastic, red-burning Tertiary shale that is used for the manufacture of common brick and hollow tile. There is strong effervescence in hydrochloric acid. The plasticity is good, with a tendency to stickiness, and dry strength is medium, and in the dried condition it is medium-hard, medium-grained, and close-textured. The sample, as ground, contains 40.2% of +200-mesh sand. The colors are:

dry, 21''''f; wet, 21''''; cones 010 to 04, 11'b; cone 02, 9'; cone 1, 7''; cone 3, 7''k. Steel hardness is developed at cone 04, and less than 10% absorption at cone 02. The fired structure is sound, up to cone 1, above which bloating begins. The surface texture is slightly rough. The total linear shrinkage, plastic basis, is 14.8%, at cone 1. The best firing range is from cone 04 to cone 1.

No. 206 (p. 232). Tulare County. Porterville. Black slate. This is a black slate that develops good plasticity, medium dry strength, and fires to a red color. In the dried condition it has finger-nail hardness, is coarse-grained, and open-textured. It should be finely ground to avoid excessive lamination. The colors are: dry, 15''''; wet, nearly black; cones 010 and 08, 17''b; cone 06, 13''b; cone 04, 11''; cone 02, 7''. Steel hardness is developed at cone 04. The fired structure is sound and strong and the surface texture is rough. The total linear shrinkage, plastic basis, is 7.9%, at cone 3. This should be a good clay for common brick and hollow tile.

No. 214 (p. 131). Monterey County. Near Monterey on Salinas road. Monterey Mission Tile Co. This is an adobe clay that is used for the manufacture of hand-made roofing and step tile. The plasticity is strong and sticky, the dry strength is high, and in the dried condition it has finger-nail hardness, is fine-grained, and close-textured. Serious warping and cracking results in drying when the clay is used alone. The colors are: dry, 15''''; wet, 15''''k; cones 010 to 06, 15'' b; cone 04, 11''. Steel hardness and less than 10% absorption are present at cone 010. All test pieces cracked in firing, and serious bloating takes place at cone 04. The maximum total linear shrinkage, plastic basis, is 15.4%, at cone 06. This clay can not be used alone, but when grogged with crushed tile made from the same clay, very attractive hand-made tile can be made.

No. 216 and 217 (p. 213). San Luis Obispo County. State highway 2 m. south of Santa Margarita. These two samples are representative of a large deposit of red-burning shale. The shale develops good plasticity without the necessity of fine grinding. The dry strength is medium, and in the dried condition it is hard and close-textured. The colors are: dry, 17''i to 15''; wet, 15''k; cones 010 and 08, 11'; cones 06 and 04, 9'i; cone 02, 7'k; and cone 1, 7'm. Steel hardness and less than 10% absorption are developed at cone 02. The fired structure is strong, but the test pieces that were fired at or above cone 02 are slightly checked. The total linear shrinkage, plastic basis, at cone 1, is 12.4% for No. 216, and 13.3% for No. 217. The best firing range is from cone 04 to cone 1. The material seems entirely suitable for the manufacture of hard or soft-fired heavy clay products, and is a possible material for paving brick.

No. 251 (p. 52). Amador County. Ione. Core drill hole No. 57–1, Arroyo Seco Grant. This is a red-burning clay with smooth and strong plasticity, and medium dry strength. In the dried condition it is medium hard, fine-grained, and close-textured. It effervesces slightly in hydrochloric acid. Some fine sand is present. The colors are: dry, 15'd; wet, 15'b; cones 1 and 5, 9''b; cones 9 and 13, 11''i. Steel hardness and less than 10% absorption are developed below cone 1. Blistering is noted at cone 13, otherwise the fired structure is sound and stony. The surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 18.8%, at cone 9. The softening point is cone 23. This clay is suitable for face brick.

No. 261 (p. 159). Placer County. East of Lincoln. Valley View Mine. This is an iron-stained kaolin, with fair plasticity and medium dry strength. In the dried condition it is hard, fine-grained, open-textured and heterogeneous. The colors are: dry, 11″d; wet, 15″b; cones 010 to 1, 7″b; cone 3, 7″d; cones 5 and 7, 13″; cones 9 and 13, 15″. Steel hardness is not developed at cone 3. The fired structure is sound, except for a few superficial hair cracks. The surface texture is moderately rough. The total linear shrinkage, plastic basis, is 17.7% at cone 13. The softening point is cone 28, yet it is distinctly a red-burning clay. The material might be used in face brick and terra cotta.

13. Low Strength.

No. 7 (p. 163). Riverside County. Alberhill C. & C. Co. "Pink Mottled." This is one of the important face-brick, roof-tile, and floor-tile clays from the Alberhill district. It is a fine-grained, pink-yellow mottled clay of medium hardness, develops a smooth and strong plasticity, and has medium low dry strength. It contains 14.2% of +200-mesh sand. The colors are as follows: dry, 11″d; wet, 11″; cones 010 to 3, 9′b; cone 5, 7′d; cone 7, 7′b; cones 9 and 11, 7″; cone 13, 7″i. These are good pinks and light reds for face brick, floor tile, etc. At cone 13, fine black specks appear, giving a not unpleasing mottled effect, which could be reproduced at lower temperatures by flashing. The fired surfaces have a smooth texture, capable of taking a polish. Finger-nail hardness is not developed until cone 06 is reached. The hardness at cone 13 is slightly less than steel, although vitrification is not complete at that temperature. The total linear shrinkage, plastic basis, is 10.5% at cone 13. The softening point is cone 17. The best firing range is from cone 06 to cone 11.

No. 72 (p. 169). Riverside County. Emsco Clay Co. "Red." This is similar to No. 8 (class 12) "Red Clay No. 2" from the Alberhill Coal and Clay Co. pits, but has lower drying and firing shrinkage, and lower strength. It is used mainly as a coloring clay in face brick, and other high-grade red-burning products. The residue on 200-mesh is 12.6%. It has a smooth and moderately strong plasticity, medium low dry strength, and a soft, fine-grained, close-textured dry condition. The colors are: dry, 7′; wet, 7′i; cones 010 to 13, 9′, with a slight darkening toward the higher cone numbers. Finger-nail hardness is developed below cone 010 and steel hardness at cone 3. The fired structure is tough and stony. The total linear firing shrinkage, plastic basis, is 12.5%, at cone 13. The softening point is cone 20. The best firing range is from cone 02 to cone 13. Vitrification is practically complete at cone 11.

No. 122 (p. 53). Amador County. Ione. Arroyo Seco Grant, Jones Butte. Leased by Stockton Fire Brick Co. Laterite. This is a true laterite for which no ceramic uses have yet been found, but which occurs in sufficient abundance to be of possible interest. The sample contains a large proportion of non-plastic grains, and the plasticity is weak and short. The dry strength is medium low, and the dried condition is medium hard, medium grained, and open-textured. The colors are: dry, 5″; wet, 5′i; cones 010 to 3, 5″; cones 5 and 7, 9‴; cone 9, 9″i; cone 11, 11″k. Steel hardness appears at cone 1. Less than 10% absorption is present at cone 3. The fired structure is granular and hair-cracked. The total linear shrinkage, plastic basis, at cone 11, is 17.5%. The softening point is cone 17–18.

No. 131 (p. 62). Amador County. Ione. "Newman Red Mottled." This is a red-burning clay with good plasticity, low dry strength, and in the dried condition it is very soft, fine-grained, and close-textured. It contains 3.2% of +200-mesh sand. The colors are: dry, 9″b; wet, 9″; cones 010 to 02, 9′b; cones 1 to 7, 9′; cones 9 to 13, 7′. Steel hardness appears at cone 1, and less than 10% absorption at cone 11. The fired structure is stony, and at cones 11 and 13 several tension cracks appeared during firing. The total linear shrinkage, plastic basis, at cone 13, is 20.0%. The softening point is cone 23–26. The best firing range is from cone 1 to cone 9. The clay can be used as a coloring clay for face brick, roofing tile, and similar ware.

No. 171 (p. 136). Nevada County. North Bloomfield road. This is a red-burning clay that could be used for common-brick manufacture. The plasticity is fair, the dry strength is medium low, and in the dried condition it is hard, fine-grained, and close textured. A tendency to develop drying cracks was noted. The colors are: dry, 17′f; wet, 21‴; cones 010 to 06, 15″b; cone 04, 15″d; cone 02, 11′; cone 1, 9′. The fired colors are suitable for common brick, roofing tile, etc. Steel hardness appears at cone 02, and less than 10% absorption at cone 1. The fired structure is stony, and is sound except for a few small cracks, which may have been formed during drying. The surface texture is smooth. The total linear shrinkage, plastic basis, is 16.1%, at cone 1. Non-plastics should be added.

No. 198 (p. 125). Marin County. San Rafael. McNear Brick Co. This is a red-burning, sandy, clay-shale that develops sufficient plasticity for brick and hollow-tile making. The dry strength is medium-low, and in the dried condition it is medium-hard, coarse-grained, and open-textured. The sample as ground contains 55.8% of +200-mesh material. The colors are: dry, 15″b; wet, 15″i; cones 010 and 08, 7′b; cones 06 and 04, 9′b; cones 02 to 6, 9″b. Steel hardness is developed at cone 1. The fired structure is coarse-granular and open, and hair-cracks are prominent, especially when fired above cone 1. The total linear shrinkage, plastic basis, is 11.8%, at cone 6. The best firing range is from cone 04 to cone 6. The sample contains more non-plastic matter than the normal run-of-pit material.

No. 218 (p. 181). Riverside County. 8 m. south of Corona. This is a pink-mottled clay with excellent plasticity and medium-low dry strength. It is similar to No. 72 (Emsco Red). In the dried condition it is medium-hard, brittle, fine-grained and close-textured. The colors are: dry, 11′b; wet, 9′i; cones 010 to 3, 11′; cone 5, 7′b. Steel hardness is developed at cone 3. The fired structure is sound and stony and the surface texture is smooth. The total linear shrinkage, plastic basis, is 19.5%, at cone 11. The softening point is cone 23. The clay is suitable for the manufacture of face brick, roofing tile, and similar products.

No. 256 (p. 52). Amador County. Ione. Core drill hole No. 60, Arroyo Seco Grant. This is a red-burning clay with good, but sticky, plasticity and medium-low dry strength. In the dried condition it is medium-hard, fine-grained, and open-textured. The colors are: dry, 11″d; wet, 11″; cone 1, 9″; cone 5, 7″i; cone 9, 9‴; cone 13, 9‴i. Steel hardness is developed at cone 5, and less than 10% absorption at cone 13. The fired structure is weak and hair-cracked. The total linear shrinkage, plastic basis, at cone 13, is 20.3%. The softening point is cone 19–20. This is not a good clay, but could be used as part of a face-brick mixture.

TABLE No. 24.

III. Red-Burning Clays.

A. Open-burning, do not attain less than 6% apparent porosity at any temperature short of actual fusion.

12. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
8	11.7	17.6	29.3	221	21.1	6.3	19–20
18	20.7	21.6	42.3	305	34.7	10.4	19
24	13.2	19.7	32.9	252	23.1	7.0	
26	28.7	11.6	40.3	1569	56.8	16.1	
32	16.0	20.1	36.1	794	27.6	8.4	
35	19.1	12.8	31.9	1094	37.3	11.1	17–18
40	22.7	12.8	35.5	1412	44.3	13.0	18–19
65	11.2	12.9	24.2	569	22.1	6.9	
69	12.1	15.4	27.5	265	23.4	7.3	18–19
73	8.5	13.5	22.0	334	16.8	5.2	15
100	36.6	12.8	49.4	1821	71.4	11.9	14–15
105	11.4	17.4	28.8	235	21.0	6.4	18–19
112	11.9	19.7	31.6	291	20.8	6.5	19
113	13.4	13.5	26.9	509	26.2	8.0	23–25
117	30.4	10.5	40.9	±990	63.0	17.8	
119	9.5	13.5	23.0	374	18.5	5.8	
155	23.3	16.6	39.9	580	42.3	12.2	
176	9.9	19.2	29.1	615	16.7	5.3	
178–1	22.6	14.1	36.7	905	44.1	12.9	
178–2	18.0	12.8	30.8	1224	35.8	10.7	
178–3	10.3	14.7	25.0	498	19.5	6.1	
180	18.6	18.8	37.4	300	32.5	9.9	
182	22.1	10.0	32.1	1181	44.7	13.2	
183	24.3	14.4	38.7	±983	46.4	13.5	
199	12.0	14.3	26.3	352	23.3	7.3	
206	5.1	15.3	20.4	340	9.6	3.1	
214	28.5	12.1	40.6	±1000	54.4	15.5	
216	8.0	15.8	23.8	305	15.3	4.9	
217	10.5	15.5	25.9	306	19.9	6.3	
*221	21.2	14.7	35.9	453	39.0	11.6	26
251	17.6	17.9	35.5	381	31.4	9.5	23
261	17.1	25.6	42.7	289	26.8	8.2	28

13. Low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
7	9.9	18.0	27.9	149	17.6	5.3	17
72	7.3	16.4	23.7	133	13.6	4.4	20
122	7.9	22.2	30.1	110	13.9	4.5	17–18
131	17.4	22.8	40.2	94	28.4	8.6	23–26
171	13.5	24.6	38.1	±164	20.9	6.5	
198	6.7	18.9	25.6	166	10.0	3.2	
218	12.9	15.3	28.2	186	24.3	7.5	23
256	16.8	23.5	40.3	156	27.7	8.4	19–20

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

* Impure flint clay from Goat Ranch, Gladding, McBean & Co., Orange County. Description of ceramic properties omitted. See p. 141 for description of deposit.

TABLE No. 25. III. Red-Burning Clays.

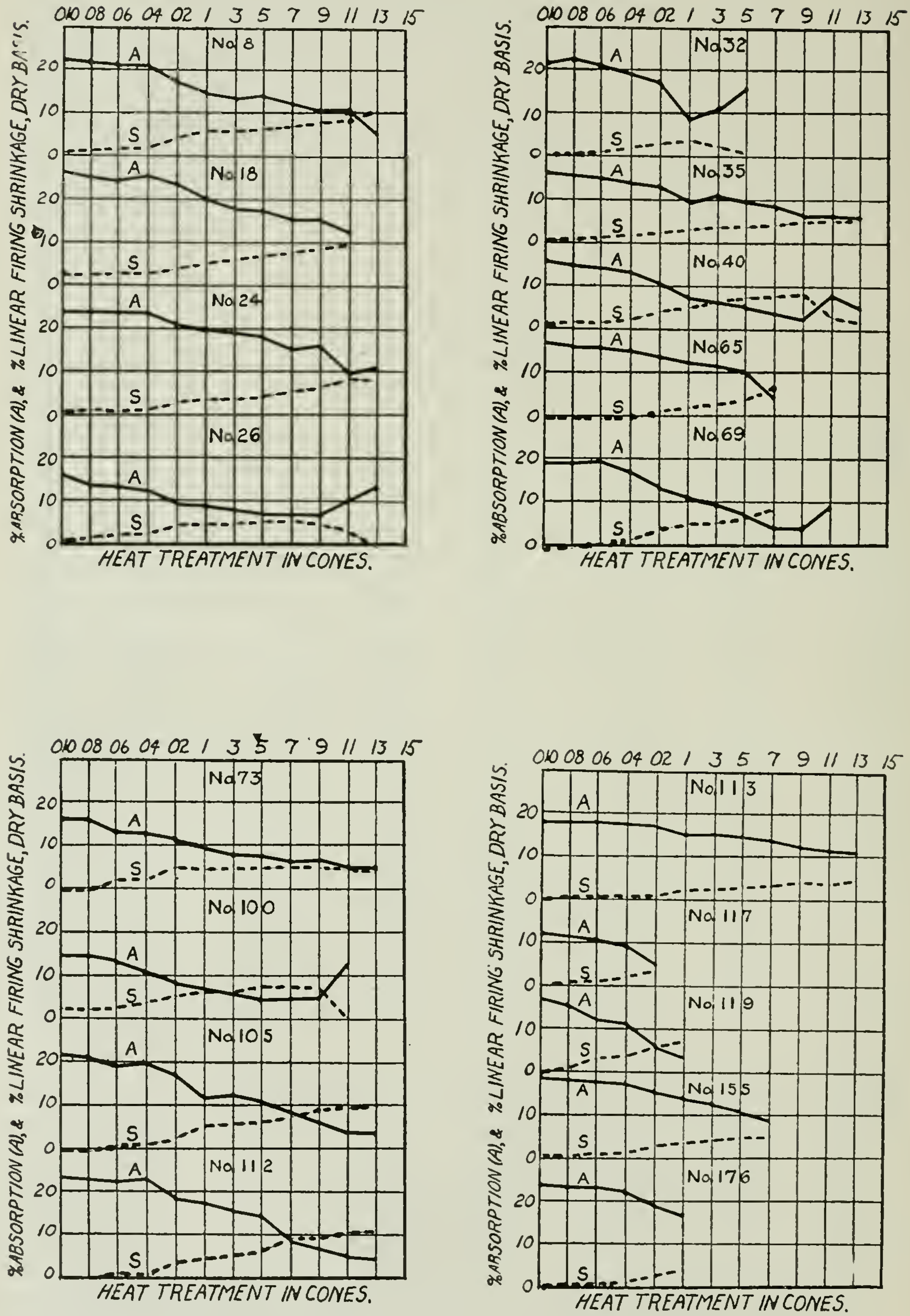
A. Open-burning, do not attain less than 6% apparent porosity at any temperature short of actual fusion.

12. Medium to high strength. 13. Low strength.

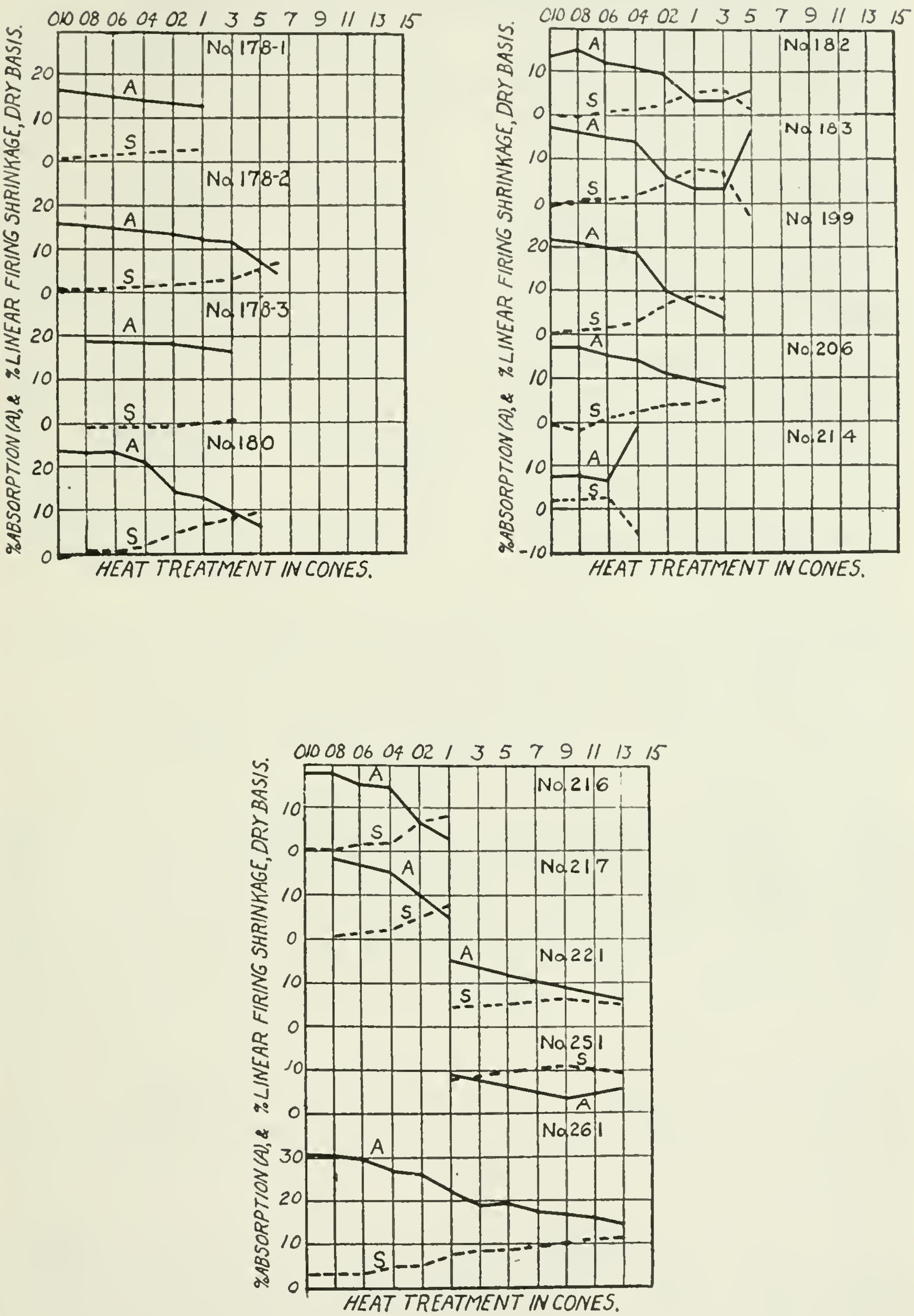
Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
12	8	1.9	37.7	3.2	37.1	3.9	37.0	4.3	36.2	11.6	31.9	16.2	29.2	16.4	27.7	17.3	27.2	19.4	25.0	21.6	22.4	22.0	21.8	28.4	11.5	-----	-----
	18	+5.2	41.5	6.0	40.1	7.2	39.4	7.3	40.5	11.1	38.8	15.4	35.5	17.4	32.0	19.4	32.3	22.3	29.6	23.6	29.2	25.3	21.3	-		-----	-----
	24	1.0	38.8	2.6	39.2	2.0	39.0	3.7	38.6	7.7	36.0	9.5	31.8	10.9	34.5	11.8	33.0	15.4	30.1	18.3	31.6	22.6	19.9	21.6	21.9	-----	-----
	26	1.8	29.0	4.1	25.3	5.3	24.6	6.4	23.8	11.9	18.9	12.5	18.3	12.8	17.2	14.8	15.5	15.5	14.9	14.8	13.5	8.2	19.8	−1.1	23.7	-----	-----
	32	0.0	35.5	+0.5	37.0	2.6	35.2	5.0	33.6	8.1	30.6	10.9	16.3	5.8	18.8	1.4	26.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	35	1.1	29.9	2.2	29.5	3.3	28.6	4.7	26.6	6.2	21.5	9.4	17.9	10.4	22.0	10.5	19.8	11.7	18.0	14.0	13.2	14.2	13.1	14.4	10.7	-----	-----
	40	2.5	28.9	3.2	27.5	3.7	26.7	6.5	25.4	14.3	21.0	14.9	15.2	16.8	13.4	19.2	12.2	21.3	8.1	23.1	5.4	7.5	15.2	4.9	9.2	-----	-----
	65	−1.0	30.1	−1.3	29.5	−0.8	29.3	−0.8	28.5	+3.3	25.9	4.7	23.3	7.4	22.6	9.2	20.6	16.3	7.6	-----	-----	-----	-----	-----	-----	-----	-----
	69	1.5	33.1	−0.5	33.3	+0.2	33.6	2.6	31.7	9.7	25.7	12.7	22.1	14.3	20.0	17.6	11.9	22.4	8.8	-----	-----	-----	-----	-----	-----	-----	-----
	73	−0.3	29.4	0.4	29.5	4.8	25.7	5.4	21.7	8.8	21.0	11.1	19.5	12.6	16.6	12.7	15.3	13.0	12.8	12.5	12.7	11.2	10.7	10.1	8.5	-----	-----
	100	5.8	27.6	5.7	27.0	6.6	21.9	10.3	21.7	14.9	17.1	17.2	14.6	17.9	11.9	20.5	9.6	20.0	9.6	19.3	9.5	0.6	22.9	-----	-----	-----	-----
	105	−0.2	37.0	−0.7	35.5	+2.1	33.9	2.4	34.6	6.3	31.7	14.7	24.1	16.1	22.7	16.2	22.6	19.7	18.3	21.2	12.7	25.2	8.3	26.2	6.8	-----	-----
	112	+0.4	37.9	−0.1	37.4	+2.5	37.1	1.2	37.9	9.4	32.9	11.2	31.1	14.1	28.6	16.6	26.5	24.3	17.0	25.6	14.6	28.4	10.2	28.6	9.7	-----	-----
	113	−0.6	31.5	+0.5	32.2	1.2	32.5	4.1	32.4	2.0	31.4	6.5	28.9	7.2	28.7	7.4	28.0	8.5	26.4	10.9	24.0	11.5	23.3	12.2	22.3	-----	-----
	117	0.0	23.5	2.0	22.8	2.3	21.7	5.4	19.8	10.0	10.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	119	−0.4	31.6	+2.2	29.7	9.3	23.8	10.1	23.0	17.0	13.6	19.6	7.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	155	1.3	32.2	0.9	32.2	2.4	34.5	3.6	30.6	7.3	28.0	10.0	25.6	11.2	24.0	13.3	21.8	12.3	16.4	-----	-----	-----	-----	-----	-----	-----	-----
	176	0.0	38.6	+0.7	38.0	1.6	38.3	2.1	37.1	6.6	33.2	9.6	30.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	178–1	1.2	30.4	-----	-----	-----	-----	5.7	26.8	-----	-----	7.8	25.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	178–2	0.5	29.5	0.5	29.2	1.7	28.6	3.0	27.8	4.7	26.3	6.4	21.8	7.5	23.8	19.0	9.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	178–3	-----	-----	−1.7	33.6	-----	-----	-----	-----	−1.2	32.6	-----	-----	+0.7	29.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	180	−0.8	38.3	+0.2	37.8	0.7	38.3	5.2	36.1	12.7	27.3	17.6	25.4	21.8	19.7	25.4	13.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	182	0.0	24.9	−0.4	24.8	1.9	22.8	3.4	21.1	7.2	18.9	14.9	6.9	16.0	6.8	2.5	10.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	183	−0.8	29.8	+0.7	29.7	2.9	28.2	4.8	26.3	18.9	13.2	22.0	7.6	19.2	7.0	−10.4	27.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	199	1.9	37.2	3.2	37.1	4.2	35.8	6.7	34.3	19.0	21.2	23.6	11.5	22.3	8.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	206	−1.3	31.3	−3.9	30.2	+3.1	28.6	6.1	26.8	10.0	22.7	12.5	20.2	14.6	16.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	214	5.3	14.7	6.0	14.4	6.8	12.6	−18.1	28.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	216	0.8	33.1	0.6	33.2	4.1	29.4	5.1	28.6	17.6	15.5	22.5	6.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	217	-----	-----	1.4	33.3	-----	-----	6.1	28.6	-----	-----	21.6	10.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	221	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	12.6	28.8	-----	-----	16.0	23.2	-----	-----	18.0	18.0	-----	-----	14.3	11.7	-----	-----
	251	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	23.0	19.3	-----	-----	26.6	13.8	-----	-----	29.8	7.8	-----	-----	26.3	12.0	-----	-----
	261	7.8	46.3	8.6	46.0	8.7	45.6	13.3	42.9	11.0	42.4	20.1	38.4	24.0	34.4	24.0	35.2	26.5	32.6	27.4	34.4	28.6	30.6	29.5	28.2	-----	-----
13	7	−0.4	36.5	0.9	36.8	+0.4	38.5	1.0	37.4	3.7	36.0	5.6	34.9	5.9	35.0	7.7	33.5	10.4	31.7	11.4	31.3	11.0	29.9	6.5	24.4	-----	-----
	72	+0.6	35.0	0.7	34.3	1.7	35.7	1.9	35.8	4.3	33.0	7.8	30.9	10.6	28.4	11.8	27.8	12.0	26.8	14.2	25.6	20.5	18.7	23.8	9.6	-----	-----
	122	10.2	14.2	10.4	43.9	12.2	49.3?	12.8	43.9	15.8	41.8	20.2	38.0	33.8	22.0	33.9	22.8	33.9	22.2	34.0	22.0	36.0	21.2	-----	-----	-----	-----
	131	0.8	10.8	2.5	41.0	3.5	41.0	3.6	40.0	6.4	39.6	16.4	32.6	17.8	31.6	19.7	29.5	20.8	28.8	25.4	23.4	28.8	18.5	31.6	10.2	-----	-----
	171	+1.0	40.5	6.5	39.2	9.4	37.2	12.4	35.5	22.8	25.4	28.8	18.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	198	10.8	38.0	11.3	37.9	11.4	38.3	14.7	38.0	14.4	37.8	17.8	33.1	19.8	32.1	24.7	27.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	218	0.9	33.9	0.3	34.2	1.5	33.1	1.9	33.8	7.3	30.0	7.0	31.0	9.9	28.8	10.9	28.2	27.7	25.1	30.0	22.2	34.9	13.2	-----	-----	-----	-----
	256	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	13.0	43.1	-----	-----	18.0	39.8	-----	-----	20.8	37.1	-----	-----	35.6	20.3	-----	-----

% V. S.—Firing shrinkage, per cent dry volume. % A. P.—Per cent apparent porosity.

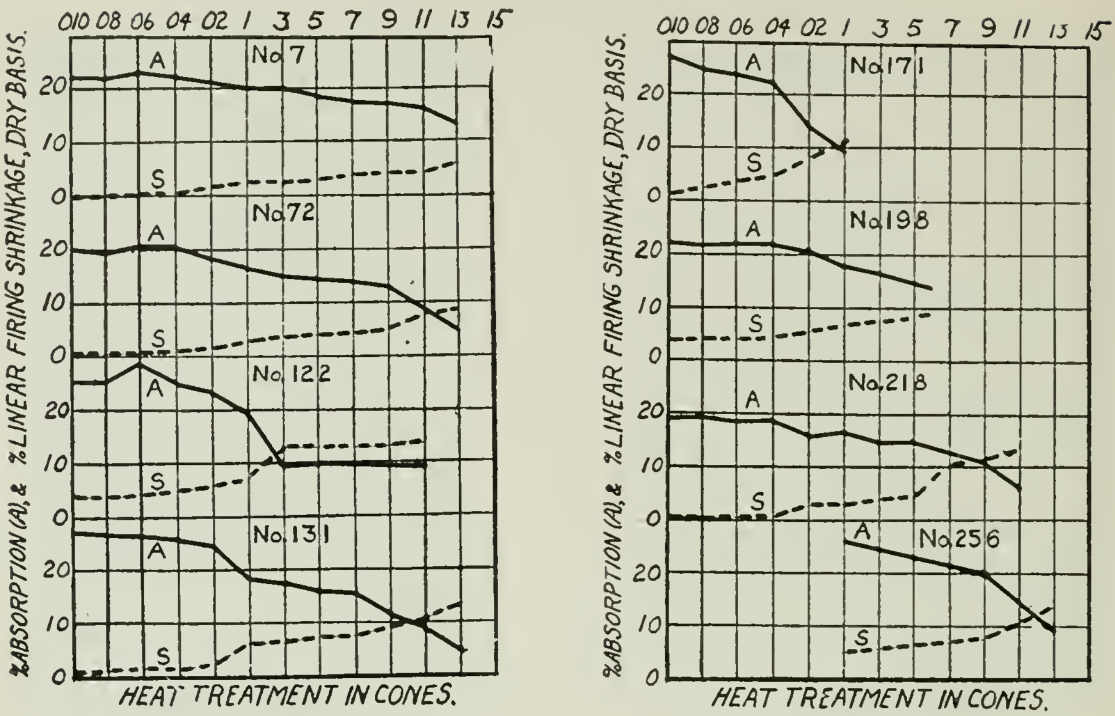
Absorption and linear shrinkage curves for clays of class 12.



Absorption and linear shrinkage curves for clays of class 12.



Absorption and linear shrinkage curves for clays of class ...



III–B. Dense-Burning. Less Than 6% Apparent Porosity at Vitrification.

a. WITH LONG VITRIFICATION RANGE, 4 CONES OR MORE.

14. Mainly Medium to High Strength, But Also Including Some Clays of Low Strength.

No. 10 (p. 163). Riverside County. Alberhill C. & C. Co. "Hill Blue Green." This is a fine-grained, excessively-plastic clay that serves mainly as a strengthening clay in sewer-pipe and similar mixes. The dry strength is very high, but the excessive drying shrinkage causes serious warping and cracking when used alone. The dry clay is very hard and dense. The colors are: dry, 23''''''b; wet, 21''''; cones 010 to 06, 9'b; cones 04 to 1, 9''; cones 3 to 5, 9'''; cone 7, 1'''; cone 9, 1''''b; cone 11, 13''''d (flashed). All test pieces cracked on firing, except those at cones 010 and 08. Finger-nail hardness is found in the dry state, steel hardness is developed at cone 04, vitrification is complete at cone 1, and bloating begins above cone 5. The total maximum linear shrinkage is 22.3%, at cones 3 to 5. The softening point is cone 14–15. The long vitrification range and excellent dry strength of this clay are its principal merits.

No. 21 (p. 163). Riverside County. Alberhill C. & C. Co. "Sagger Clay." This is a pink-burning, plastic clay that finds use as a vitrifying agent in sagger bodies. It has a smooth, strong plasticity, and a medium low dry strength. There is slight effervescence in hydrochloric acid. In the dry state it is soft, with a medium-fine grain, and has a tendency to laminate. The colors are: dry, 7''b; wet, 7''; cones 010 to 04, 5'd; cone 02, 7'd; cones 1 to 5, 7''d; cone 7, 13'''d; cones 9 to 13, 17'''d. Iron specks are prominent at cone 7 or above. Finger-nail hardness is developed below cone 010, and steel hardness at cone 1. A few small cracks appeared in the test firing, probably caused by too rapid firing during the water-smoking stage. The total linear shrinkage, plastic basis, at cone 13, is 21.3%. The softening point is cone 23. The best firing range is from cone 02 to cone 13. The wide vitrification range of this clay within the limits of commercial firing is its principal merit. With the addition of non-plastic material, it is suitable for pink- and buff-burned face brick, roofing tile, and similar products, as well as for saggers.

No. 22 (p. 163). Riverside County. Alberhill C. & C. Co. "Yellow Owl Cut." This is a yellowish clay containing 12.6% of +200-mesh sand, and has good plasticity, high drying shrinkage, medium-high dry strength, and good dry condition, though with a tendency to laminate. It is used in sewer-pipe mixes. The colors are: dry, 15″d; wet, 15″; cones 010 to 08, 5′d; cones 06 to 04, 7′d; cones 02 and 1, 9′b; cones 3 to 7, 7″b; cones 9 to 13, 9‴d. Finger-nail hardness is developed at cone 010, and steel hardness at cone 1. The total linear shrinkage, plastic basis, is 18.6%, at cone 11, and slight bloating appears at cone 13. The softening point is cone 17. The best firing range is from cone 02 to cone 11. The most desirable features of this clay are its dry strength and wide vitrification range.

No. 75 (p. 174). Riverside County. Alberhill. L. A. B. Co. "Red No. 2." This is a vitrifying clay with its light-red firing colors that is valuable in roofing-tile and face-brick mixtures. In the natural state it is hard and brittle and the color is mottled pink and cream. It contains 16.4% of +200-mesh sand. The plasticity is excellent, the dry strength is medium, and the dried condition is medium-hard, and medium close-grained. The colors are: dry, 7″b; wet, 7″; cones 010 to 1, 9′b; cones 3 to 9, 9″b; cones 11 and 13, 1⁗i (flashed). Finger-nail hardness appears below cone 010, and steel hardness at cone 3. Absorptions below 10% are obtained at cone 5, and vitrification is complete at cone 11. Slight bloating appears at cone 13, under reducing conditions. The fired test pieces are moderately hair-cracked, and at cones 11 and 13 a few large open cracks appear. The maximum total linear firing shrinkage, plastic basis, is 24.0%, at cone 11. The softening point is cone 20–23. The best firing range is from cone 3 to cone 11. The clay should be mixed with non-plastics to obtain safe firing properties.

No. 123 (p. 56). Amador County. Ione (Carbondale). Leased by G. A. Starkweather. "Yaru No. 2." This is a red-burning clay with smooth and weak plasticity, and medium dry strength. It contains 5.4% of +200-mesh quartz-mica sand. In the dried condition it is soft, fine-grained and close-textured. The colors are: dry, 17″d; wet, 17″b; cones 010 to 7, 9′; cone 9, 9⁗; cones 11 and 13, 7⁗. Steel hardness is developed at cone 02. Less than 10% absorption appears at cone 1. The fired structure is sound, and the texture is smooth. Vitrification is complete at cone 11, and blistering appears at cone 13. The maximum total shrinkage, plastic basis, is 22.1%, at cone 11. The softening point is cone 27–28. The best firing range is from cone 1 to cone 11. The clay may be used for face brick, roofing tile, red-burned pottery, etc.

No. 127 (p. 57). Amador County. Ione. M. J. Bacon. "Bacon Red." This is a red-burning clay with excellent smooth plasticity, and medium low dry strength. In the dried condition it is soft, and fine-grained. The colors are: dry, 7″b; wet, 7″; cones 010 to 5, 9′b; cone 7, 7′b; cones 9 to 13, 7″b. Steel hardness appears at cone 1. Less than 10% absorption is obtained at cone 7. The fired structure is sound, and the fired surface is smooth. The total linear shrinkage, plastic basis, at cone 13, is 20.0%. The softening point is cone 27. The best firing range is above cone 1. The clay may be used for face brick and roofing tile, and for pink colored pottery or tile bodies.

No. 148 (p. 156). Placer County. Lincoln. Lincoln Clay Products Co. "No. 8." This is a red burning variety that possesses nearly the same plastic, drying and firing properties as No. 146, in class 8, but with a lower softening point. It contains 12.4% of +200-mesh sand. It is used for face brick, sewer pipe, roofing tile, etc. The colors are: dry, 15′b; wet, 15′b; cones 010 to 04, 5′d; cones 02 to 3, 7″b; cone 5, 7″; cone 7, 7″; cone 9, 1‴i; cones 11 and 13, 1⁗. Steel hardness develops at cone 1. Less than 10% absorption is developed at cone 3. The fired structure is sound and stony. Blistering is noticeable at cone 11. The maximum total linear shrinkage, plastic basis, is 20.2%, at cone 9. The softening point is cone 20. The best firing range is from cone 1 to cone 9.

No. 177 (p. 66). Butte County. Oroville. Quincy road. This sample contains a high proportion of partly-decomposed volcanic ash. Since it is the only sample of its type on which test data could be secured, the results are given as a matter of general interest. The plasticity is weak and spongy, the dry strength is medium-high, and in the dried condition it is hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17″i; cones 010 and 08, 15″d; cone 06, 13′b; cone 04, 13′d; cones 02 and 1, 17″i. Steel hardness is developed at cone 04. The sharp change from 16.8% porosity at cone 04 to 0.1% porosity at cone 02 should be especially noted, together with the corresponding sharp decrease in volume. The fired structure at cone 02 is glassy, and large cracks are present. Bloating and fusion follow when fired above cone 1. The total linear shrinkage, plastic basis, is 26.6%, at cone 1.

No. 181 (p. 80). Humboldt County. Angel Ranch. This clay has been used by Mr. R. H. Jenkins at the Humboldt State Teachers College, as a casting clay for pottery. It has good plasticity, with a tendency to stickiness. The residue on 200-mesh is 8.8%. The dry strength is medium high, and in the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴b; cone 010, 11′f; cone 08, 11′d; cones 06 and 04, 9′d; cone 02, 11′d; cone 1, 9″i; cone 3, 11″i; cone 5, 15″. Steel hardness appears at cone 08, and less than 10% absorption at cone 04. Vitrification is complete at cone 1, and a vesicular structure is developed beyond cone 1. The fired structure is sound and stony, and the surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 14.0%, at cone 1. The best firing range is from cone 08 to cone 1.

No. 188 (p. 92). Lake County. Kelseyville. This is a red-burning thin-bedded clay shale. The clay slakes readily in water, and works into a smooth and moderately strong plasticity. It effervesces slightly in hydrochloric acid. The dry strength is medium, and in the dried condition it is medium hard, fine-grained, and close-textured. The colors are: dry, 17‴f; wet, 17‴i; cone 010, 11″; cone 08, 13″; cones 06 to 02, 9′; cones 1 and 3, 7″k. Steel hardness is developed at cone 04, and less than 10% absorption at cone 1. The fired strength is medium and a few small cracks are present in all fired test pieces. The total linear shrinkage, plastic basis, is 25.4% at cone 3. On account of excessive shrinkage, short vitrification range, and medium strength, this material is only useful for manufacturing a poor quality of common brick, even if mixed with non-plastic material.

No. 202 (p. 68). Calaveras County. Valley Springs. California Pottery Co. "Pink Mottled." This is a fine-grained, red-burning clay, with smooth and strong plasticity, and medium dry strength. It contains 4.4% of +200-mesh sand. In the dried condition it is soft, fine-grained, and close-textured. A strong tendency to laminate was noted. The colors are: dry, 11′; wet, 7′i; cones 010 to 04, 9″b; cones 02 to 5, 11″; cones 7 and 9, 9″. Steel hardness is developed at cone 02, and less than 10% absorption at cone 1. The fired structure is sound, tough, and stony. The surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 20.6%, at cone 11, and bloating is apparent at cone 13. The softening point is cone 20. This is an excellent face brick and roofing tile clay.

No. 203 (p. 68). Calaveras County. Valley Springs. California Pottery Co. "Yellow Plastic." This is similar in its ceramic properties to No. 202, but is not so fine-grained, and contains more non-plastic matter. The residue on 200-mesh is 10.2%. The colors are: dry, 15″b; wet, 15″b; cones 010 to 04, 11′b; cone 02, 9′; cones 1 to 5, 11″; cone 7, 7″; cone 9, 5″. Steel hardness is developed at cone 1, and less than 10% absorption at cone 5. The surface texture is rougher than that of No. 202. The total linear shrinkage, plastic basis, is 18.0%, at cone 13. The softening point is cone 19–20.

No. 210 and 212 (p. 186). Sacramento County. Natoma. No. 210 is a sample of "Natoma No. 1," and No. 212 is a sample of "Natoma No. 3." They differ only in the proportion of non-plastic matter, which is greater in No. 212 than in No. 210. The clay is extremely fine-grained, and contains a high proportion of mica. The plasticity is strong, and in the dried condition the samples have finger-nail hardness, are fine-grained, and close-textured. The clay must be dried carefully to avoid cracking. The dry strength of No. 210 is high, and of No. 212 is medium high. The colors of No. 210 are: dry, 13″b; wet, 13″i; cones 010 to 04, 9′; cone 02, 9′i; cones 1 and 3, 9k; cone 5, 9′m. The colors of No. 212 are: dry, 13″; wet, 11″; cones 010 to 06, 13″; cone 04, 7″; cones 02 to 3, 7″i; cone 6, 5″m. Steel hardness and less than 10% absorption are developed at cone 04, and vitrification is complete at cone 5. A vesicular structure appears at cones 7 to 9. The fired structure is sound and strong and the surface texture is smooth. The total linear shrinkage, plastic basis, of No. 210 is 19.1%, at cone 5, and of No. 212 is 16.9%, at cone 6.

Mr. L. W. Austin, of the company, kindly gave the following data on No. 210:

Sizing Test of Natoma Clay No. 1.

Size in mm.	Equivalent mesh	Accumulative on	Per cent through
0.02	1,000	0.40	99.60
0.01	2,000	2.08	97.97
0.006	3,000	7.06	92.94
0.004	4,000	13.36	86.64
0.003	5,000	20.19	79.81
0.002	10,000	29.89	70.11
0.001	20,000	52.07	47.93
0.0006	30,000	59.22	40.78

Mr. Austin reports the results of commercial firing tests on Natoma No. 1 (our number 210) as follows: Drying shrinkage, 7.5 to 9.0%; total linear firing shrinkage at cone 5, approximately 15%; absorption at cones 5 to 7, 0.35 to 0.1%; bloating usually begins at cone 9. Another firing test gave a total linear shrinkage, plastic basis, of 20.5%, after heating to cone 5 in 36 hours and holding the finishing temperature for 4 hours.

A number of clay products manufacturers have tested this clay, and some have introduced it into their mixes. It is particularly valuable for the purpose of producing a hard, strong vitrified body, with rich-red colors, and a smooth texture. In some plants the successful use of this clay will require a modification of the drying procedure. The clay can be cast, or pressed, and takes die impressions very perfectly. In an auger machine, the finely divided mica is an aid to lubrication, yet the flakes are not so large as to cause excessive lamination.

b. With Short Vitrification Range, Less Than 4 Cones.

15. Medium to High Strength.

No. 1 (p. 218). Santa Barbara County. R. Muengenberg and E. H. Whitiker, West Montecito Street, Santa Barbara. This is a mixture of a yellowish sandy clay and a plastic black adobe, mined locally and used for structural wares. It effervesces slightly in hydrochloric acid. It develops a sticky plasticity and has high dry strength and good dry structure. The percentage of +200-mesh sand is 33.2. The dry color is 17'''', the wet color is 17''''i, and the fired color to cone 3 is 9'i, a good color for common brick. Steel hardness is developed at cone 1, and bloating appears at cone 5. The maximum total linear shrinkage, plastic basis, is 12.8% at cone 3. The best firing range is from cone 02 to cone 3.

No. 2 (p. 218). Santa Barbara County. Toro Canyon, near Montecito. An adobe clay, used in the Toro Canyon brickyard operated by Muengenberg and Whitiker for the manufacture of red structural wares. The percentage of +200-mesh sand is 33.4. It develops a sticky plasticity and high dry strength with good dry structure. The dry color is 13''' and the wet color is 13'''i. The fired color is 9'i from cones 010 to 02, and 7''i from cones 1 to 3, both of which are good common brick colors. Steel hardness is developed at cone 1, and bloating appears at cone 5. The maximum total linear shrinkage, plastic basis, is 12.5% at cone 3. The best firing range is between cones 02 and 3.

No. 4 (p 234). Ventura County. A yellow plastic clay from the Fernando (Pliocene) formation, north of Ventura, and used by the People's

Lumber Co. for the manufacture of red structural ware. It is fine-grained, and develops sticky plasticity and high dry strength, but has a high drying shrinkage and a tendency to warp when used alone. It contains but 1.4% of +200-mesh sand. The dry color is 17‴b, the wet color is 17‴, and the fired colors are 9′b from cones 010 to 06, 9′ at cone 04, and 9′i from cones 02 to 1, giving an excellent range for common brick, building tile, and roofing tile. Steel hardness is developed at cone 02, and bloating begins above cone 1. The maximum total linear shrinkage, plastic basis, is 21.4%, at cone 1. The best firing range is from cone 04 to cone 1. The high shrinkage should be reduced with non-plastic material for best results in making structural ware.

No. 5 (p. 234). Ventura County. A grayish blue plastic clay overlying No. 4. Used principally for oil-well mudding, and with clay No. 4 in the manufacture of structural ware. The ceramic properties are similar to those of sample No. 4. The dry color is 21⁗b, the wet color is 21⁗, and the fired colors are 7″b from cone 010 to cone 04, 5′d at cone 02, 7″ at cone 1, and 13‴i (flashed) at cone 3. Knife hardness is developed at cone 02, maximum shrinkage at cone 1, and bloating begins near cone 3. The maximum total linear shrinkage, plastic basis, is 20.0%, at cone 1. The best firing range is from cone 04 to cone 1. For best results, the clay should be mixed with non-plastic material for manufacturing structural ware.

No. 6 (p. 234). Ventura County, 2.7 miles north of Santa Paula. A yellowish plastic clay used for making dry-pressed common brick in the yard of Anderson and Hardison. It contains 17.8% of +200-mesh sand and develops good, but sticky, plasticity, and high dry strength. There is slight effervescence in hydrochloric acid. The dry color is 17‴b, the wet color is 17‴i, and the fired colors are 7′b from cone 010 to cone 02, 7″ at cone 1, and 7″i (flashed) at cone 3. These are good red brick colors. Knife hardness is developed at cone 02, and slight bloating is apparent at cone 3. The maximum total shrinkage, plastic basis, is 17.5%, at cone 1. The best firing range is from cone 04 to cone 1+. The wide vitrification range, from cone 02 to cone 3—, coupled with other desirable qualities, make this a good clay for hard burned structural ware.

No. 30 (p. 203). San Diego County. Rose Canyon. San Diego Tile and Brick Co. This is a yellow and gray Tertiary clay shale, used for making common brick and hollow building tile. It effervesces slightly in hydrochloric acid. It contains 13.0% of +200-mesh sand, has good plasticity for either the auger or the brick-press, medium high dry strength, and a good dry structure. It can be dried rapidly without danger of cracking. The colors are: dry, 21⁗; wet, 17⁗; cones 010 to 04, 9′d; cones 02 and 1, 9″; cone 3, 9‴; cone 5, 9‴i. The fired colors cover a good range of desirable common brick reds. Finger-nail hardness is present in the dry state, and knife hardness appears at cone 1. Vitrification is complete at cone 3, and bloating begins at cone 5. The fired brick are hard, dense and sound. The maximum total linear shrinkage, plastic basis, is 16.4%, at cone 3. The best firing range is from cone 010 to cone 3, and excellent hard-burned brick are obtained from cone 1 to cone 3.

No. 31 (p. 204). San Diego County. Rose Canyon. Union Brick Co. An unconsolidated yellowish sandy-clay of Tertiary age. The formation contains pebbles and boulders, the larger part of which are removed by screening. The sample contains 32.6% of +200-mesh sand. It is used for common brick, but is suitable also for making hollow building tile. The plastic and drying properties are such that it can be used alone. It has a high dry strength, and in the dry state it is hard, with a medium grain and open texture. The colors are: dry, 17‴b; wet, 13‴i; cones 010 to 02, 9′i; cones 1 and 3, 7″; cone 5, 9″i. These are nearly the same as in sample No. 30, and cover a good range of common brick colors. Finger-nail hardness is present in the dry state, and steel hardness appears at cone 1. Vitrification is complete at cone 3, and bloating appears at cone 5. The maximum total linear shrinkage is 10.4% at cone 3. The best firing range is from cone 010 to cone 3, and well vitrified products are obtained from cone 1 to cone 3.

No. 42 (p. 181). San Bernardino County. Vidal. "Blue." See also No. 43. This is a bluish, extremely fine-grained clay-shale of the bentonitic type. In water, it slakes readily to a smooth slip. It effervesces strongly in hydrochloric acid. When mixed with 57.7% water, it develops a smooth, workable plasticity, without excessive stickiness. The drying shrinkage is high, and ordinary air-drying methods caused large drying cracks and excessive warping to develop. In the dried state, it is hard, fine-grained, brittle and close-textured. The dry strength could not be determined accurately. With the firing schedule employed, the clay was badly shattered, but data were obtained for cone 010 and cone 08. The colors are: dry, 17‴f; wet, 21‴d; cones 010 and 08, 15″b. Finger-nail hardness appears in the dry state, and steel hardness at cone 010. In view of the isolation of the deposit, it has no commercial value. The fineness of grain, plastic strength, and apparently high dry strength are interesting features. No tabulated data or charts of firing shrinkage and absorption are presented.

No. 43 (p. 181). San Bernardino County. Vidal. "Pink." This clay is similar to No. 42, except that it contains more iron and more non-plastic matter, resulting in deeper fired colors, and lower drying and firing shrinkage. It effervesces strongly in hydrochloric acid. The dry strength is high. The colors are: dry, 11′f; wet, 17‴d; cones 010 to 1, 11″; cone 3, 13″k. Efflorescence is especially pronounced. Finger-nail hardness is present in the dried state, and steel hardness is developed at cone 08. At cone 3, kiln-marking and bloating begins. The maximum total linear shrinkage, plastic basis, is 20.0%, at cone 1. The fired structure is tough and strong. The best firing range is from cone 08 to cone 1.

No. 60 (p. 100). Los Angeles County. Los Angeles, Davidson Brick Co. This is a red-burning clay suitable for the manufacture of common structural ware. The ratio of clay to sand is such that the plasticity, drying and firing properties are entirely satisfactory without admixture with other materials. It contains 5.4% of +200-mesh sand. There is slight effervescence in hydrochloric acid. The dry strength is medium-high, and the dry structure is hard, fine-grained, and open-textured, with a tendency to laminate. The colors are: dry, 17″d; wet, 17‴i; cone 010, 9′d; cone 08, 11′b; cone 06, 9′b; cone 04, 9″b; cone 02, 7″; cone 1, 9‴; cone 3, 5‴i; and cone 5 (bloated) 9‴k. This affords an excellent range for red brick. Finger-nail hardness is obtained below cone 010, and steel hardness develops at cone 1. Vitrification is complete at cone 3, and bloating begins just below cone 5. All fired test pieces were sound and strong. The maximum total linear shrinkage, plastic basis, is 16.9%, at cone 3. The best firing range is from cone 010 to cone 3, or if vitrified products are desired, from cone 1 to cone 3.

No. 61 (p. 102). Los Angeles County. Santa Monica. Gladding, McBean and Co. This is representative of the clay used by several other plants in the same locality, and in some of the sewer-pipe and conduit plants in the Los Angeles district. It is a red-burning clay, with suitable plastic, drying, and firing properties to permit its use as the sole ingredient of common brick, hollow building tile, roofing tile, etc., and as a vitrifying and bonding clay in sewer-pipe and electrical conduit mixes. It contains 18.0% of +200-mesh sand. The dry strength is medium high, and the dry condition is hard, fine-grained, and close-textured. The colors are: dry, 17‴; wet 13‴k; cone 010, 11′b; cone 08, 11′; cones 06 and 04, 9′; cone 02, 9′i; and cones 1 and 3, 9″k. These colors give a suitable range for the uses indicated above. Finger-nail hardness is obtained below cone 010, and steel hardness at cone 02. Vitrification is complete at cone 1, and bloating begins at cone 3. The fired structure is sound and strong. The maximum total linear shrinkage, plastic basis, is 13.1%, at cone 1. The best firing range is from cone 010 to cone 1, or if vitrified products are desired, from cone 02 to cone 3.

No. 89. Riverside County. Elsinore. Hudson Ranch clay. This is a red-burning sandy clay from an undeveloped deposit. It effervesces slightly in hydrochloric acid. It has good plasticity, medium-high dry strength, and the dried condition is hard, medium fine-grained, and close-textured. The colors are: dry, 17⁗b; wet, 17⁗; cones 010 to 06, 15″b; cones 04 to 1, 13″b; cones 3 and 5, 7″; cones 7 to 13, 7″k. Finger-nail hardness is present in the dried state, and steel hardness is developed at cone 7. Absorptions under 10% are obtained at cone 11, and bloating is well developed at cone 13. All fired test pieces are sound. The maximum total linear shrinkage, plastic basis, is 20.2% at cone 11. The clay might have local use as a coloring and bonding clay, but its high shrinkage and short vitrification range are undesirable features.

No. 118 (p. 192). San Benito County. Paicines. This is a yellowish, plastic surface clay, with a smooth, strong plasticity and exceptionally high dry strength. There is slight effervescence in hydrochloric acid. In the dried condition it is hard, fine grained, and close textured. It contains 4.0% of +200-mesh sand. The colors are: dry, 21⁗d; wet, 21⁗; cone 010, 9′d; cones 08 and 06, 9′b; cone 04, 9′; cones 02 and 1, 9′k; cone 3, 7″k. Finger-nail hardness is developed below cone 010, and steel hardness at cone 04. Less than 10% absorption is developed at cone 04, and vitrification is complete at cone 02, above which temperature bloating begins. The fired structure, up to cone 02, is sound and stony. The maximum total linear shrinkage, plastic basis, is 18.8%, at cone 02. This clay is not in use, but would be entirely suitable for red-burned structural ware, and is worthy of investigation as a casting clay.

No. 172 (p. 136). Nevada County. Manzanita Mine, near Nevada City. This is the so-called "pipe clay" of the hydraulic mines. It develops fair plasticity, medium-high dry strength, and a medium-hard, fine-grained and open-textured dried condition. The colors are: dry, grayish white; wet, 23''''d; cones 010 to 04, 15''b; cones 02 to 3, 11''b; cone 5, 5''i; cone 7, 5''k. Steel hardness is developed at cone 04, and less than 10% absorption at cone 02. The fired structure is sound and stony, and the surface texture is slightly rough. The maximum total linear shrinkage, plastic basis, is 24.8% at cone 5. Bloating is apparent at cone 7. The clay could be mixed with non-plastics and used locally for the manufacture of common brick.

No. 184 (p. 80). Humboldt County. Eureka. Freshwater Slough. This is a common clay with good plasticity, and medium high dry strength. In the dried condition it has finger-nail hardness, is fine-grained, and close textured. The colors are: dry, 17''''b; wet, 17''''i; cones 010 to 06, 13'b; cones 04 and 02, 11'b; cone 1, 13'k. Steel hardness is developed at cone 04, and less than 10% absorption at cone 02. Vitrification is complete at cone 1. The fired structure is sound, and the surface texture is smooth. The maximum total linear shrinkage, plastic basis, is 22.8%, at cone 1. The clay is entirely suitable for the manufacture of common brick, hollow tile, and roofing tile, but should be mixed with non-plastic material to decrease the shrinkage.

No. 185 (p. 80). Humboldt County. Eureka. Loofbourrow Ranch. This is a common clay with sticky plasticity, and medium-high dry strength. It is extremely fine-grained and contains carbonaceous matter. In the dried condition it has finger-nail hardness. The colors are: dry, 15''''b; wet, 15''''i; cones 010 to 04, 11''b; cone 02, 5''; cone 1, 7''m. Steel hardness and less than 10% absorption are developed at cone 02, and vitrification is complete at cone 1. The fired structure is sound. The total linear shrinkage, plastic basis, is 19.3%, at cone 1.

No. 200 (p. 73). Contra Costa County. Walnut Creek (Oxley siding). N. Clark & Sons. This is a red-burning, calcareous shale that is used as a non-plastic ingredient in sewer-pipe mixtures. The plasticity is weak, the dry strength is medium, and in the dried condition it is medium hard, fine-grained, and open-textured. The colors are: dry, 17'''f; wet, 17'''b; cones 010 and 08, 15''b; cone 06, 11'; cones 04 and 02, 9'; cone 1, 9'k; cones 3 and 5, 11'm. Steel hardness and less than 10% absorption are developed at cone 1. The fired structure is fine-granular, and the surface texture is slightly rough. Above cone 1, the test pieces are disrupted by one or more large cracks, and the greenish-brown coloration due to the presence of lime is apparent. The maximum total linear shrinkage, plastic basis, is 19.7%, at cone 3.

No. 211 (p. 81). Humboldt County. Near Strong's Station, Van Duzen River. This is a common-brick clay that has good plasticity, medium-high dry strength, and in the dried condition has finger-nail hardness, is fine-grained, and close-textured. The colors are: dry, 21‴d; wet, 21‴b; cones 010 and 08, 13″b; cones 06 to 02, 11″; cones 1 and 3, 5‴. Steel hardness and less than 10% absorption appear at cone 1. The fired structure is sound and strong, and the surface texture is slightly rough. The total linear shrinkage, plastic basis, is 15.1%, at cone 3. The material could be successfully used for the manufacture of common brick and hollow tile, although the fired colors are not especially attractive.

No. 223 (p. 141). Orange County. Goat Ranch. G., McB. & Co. Red-burning shale. This material develops good plasticity if properly ground and pugged. The dry strength is medium-high, and in the dried condition it has finger-nail hardness, and is close-textured. There is slight effervescence in hydrochloric acid. The colors are: dry, 15″d; wet, 17″k; cones 010 to 06, 13″b; cones 04 and 02, 11″; cone 1, 5″i; cone 3, 5″k; and cone 7, 5″m. Steel hardness and less than 10% absorption are developed at cone 1, and bloating appears at cone 5. The fired structure is sound and strong. The maximum total linear shrinkage, plastic basis, is 14.5%, at cone 3. This is an excellent material for the manufacture of vitrified heavy clay products, such as sewer pipe, electrical conduit, paving brick, and similar ware.

No. 264 (p. 42). Alameda County. Decoto. M & S Tile Co. This is a common alluvial clay that is used for making hand-made roofing tile. The plasticity is good, the dry strength is high, and in the dried condition it has finger-nail hardness, is fine-grained, and close-textured. The colors are: dry, 17″i; wet, 15″k; cones 010 and 08, 11′; cones 06 and 04, 9′i; cone 02, 7′k. Steel hardness and less than 10% absorption are developed at cone 02. Bloating begins above cone 1. The fired structure is sound, and the surface texture is smooth. The total linear shrinkage, plastic basis, is 14.2%, at cone 02. This clay belongs to the same geologic formation as No. 265, and its ceramic properties are closely similar.

No. 265 (p. 40). Alameda County. Niles. W. S. Dickey Clay Manufacturing Company, Plant No. 18. This is a common alluvial clay that is used for manufacturing hollow tile and paving brick. The plasticity is fair, but it is usually necessary to add from 15 to 20% of a plastic clay from Lincoln or Ione to secure suitable working properties for an auger machine. The dry strength is medium high, and in the dried condition it is hard, fine-grained, and close-textured. The colors are: dry, 15″i; wet, 13″k; cones 010 and 08, 11′; cones 06 and 04, 9′i; cones 02 and 1, 9′m. Steel hardness and less than 10% absorption are developed at cone 02, and vitrification is complete at cone 1. The fired structure is sound and strong. The total linear shrinkage, plastic basis, is 14.0%, at cone 1.

TABLE No. 26.

III. Red-Burning Clays.

B. Dense-burning. Less than 6% apparent porosity at vitrification.

a. With long vitrification range, 4 cones or more.

14. Mainly medium to high strength, but also including some clays of low strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
10	36.0	10.5	46.5	1530±	73.4	20.0	14–15
21	13.5	21.7	35.2	187	23.3	7.2	23
22	23.5	14.8	38.3	525	45.0	13.0	17
75	16.6	21.7	38.3	292	28.7	8.7	20–23
123	19.2	23.2	42.4	228	31.0	9.4	27–28
127	16.9	20.7	37.6	121	28.8	8.7	27
148	15.9	19.3	35.2	255	28.1	8.6	20
177	22.1	39.7	61.8	582	26.4	8.1	
181	14.2	12.3	26.5	794	28.6	8.6	
188	25.1	31.7	56.8	364	36.2	10.8	
202	17.5	21.5	39.0	230	29.4	8.9	20
203	15.3	18.6	33.9	232	27.1	8.2	19–20
210	21.5	15.5	37.0	1009	40.3	12.0	
212	18.9	16.3	35.2	625	35.0	10.5	

b. With short vitrification range, less than 4 cones.

15. Medium to high strength.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
1	14.0	13.1	27.1	848	27.8	8.5	
2	12.0	11.9	23.9	845	24.4	7.6	
4	29.4	17.8	47.2	1212	54.0	15.5	
5	22.1	18.3	40.4	1034	39.7	11.8	
6	22.2	13.7	35.9	1258	43.5	12.8	
30	15.3	19.5	34.8	595	27.3	8.0	
31	6.4	13.5	19.9	903	12.5	4.0	
43	30.4	16.7	42.7	1158	59.4	16.8	
60	14.2	18.7	32.9	720	25.1	7.8	
61	11.4	14.2	25.6	639	22.0	6.9	
89	27.5	13.9	41.4	597	52.4	15.0	
118	26.4	13.1	39.5	1363	53.2	15.3	
172	16.6	41.0	57.6	352	20.0	6.3	
184	26.4	20.9	47.3	703	43.8	12.9	
185	18.7	21.4	40.1	502	31.2	9.4	
200	14.7	28.3	43.0	363	21.8	6.9	
211	14.2	16.5	30.7	619	26.1	8.0	
223	10.2	16.8	27.0	412	18.5	5.8	
264	15.6	10.8	26.4	1020	31.8	9.6	
265	12.5	12.4	24.9	791	25.2	7.8	

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 27.

III. Red-Burning Clays.

B. Dense-burning. Less than 6% apparent porosity at vitrification.

a. With long vitrification range, 4 cones or more.

14. Mainly medium to high strength, but also including some clays of low strength.

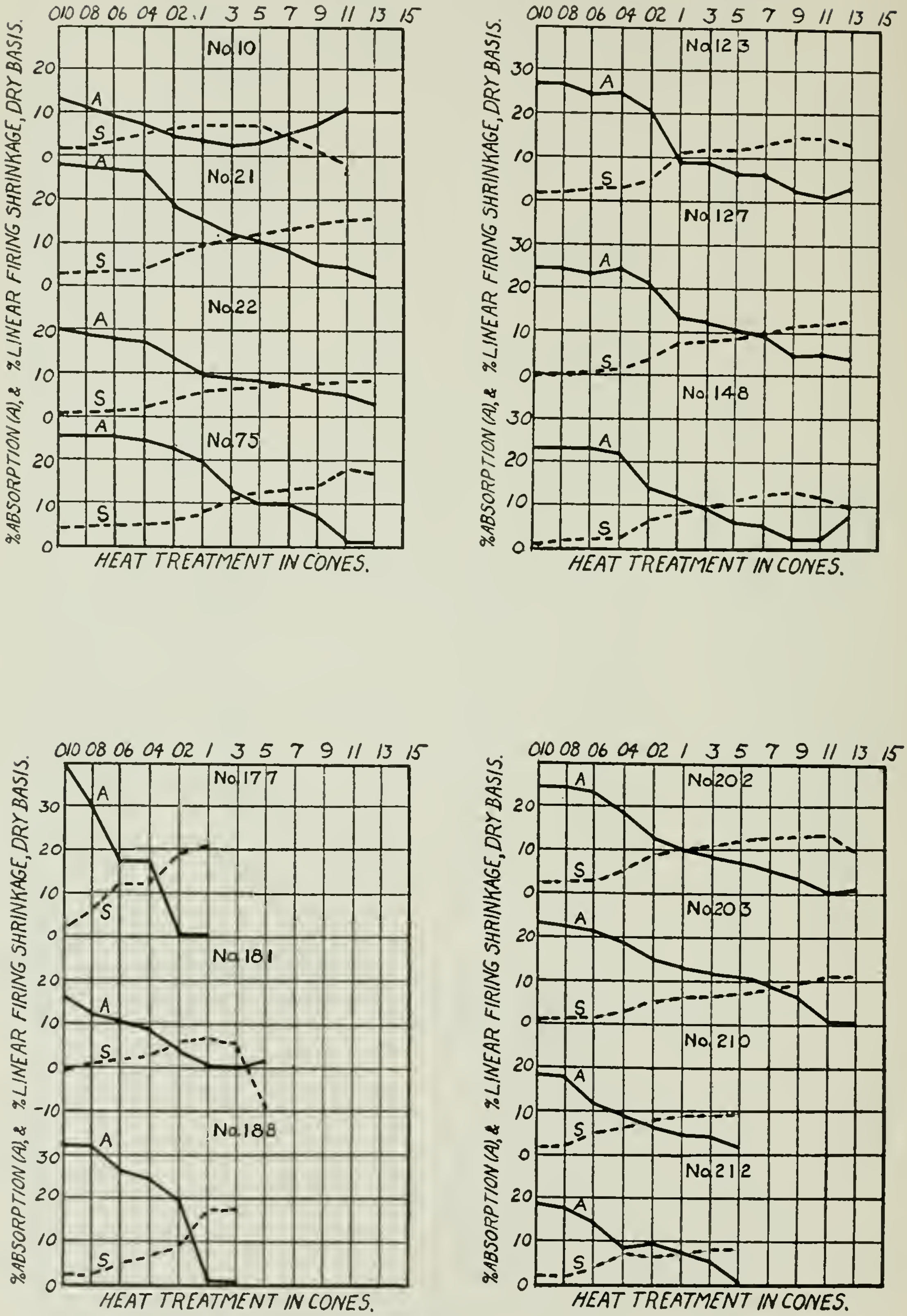
b. With short vitrification range, less than 4 cones.

15. Medium to high strength.

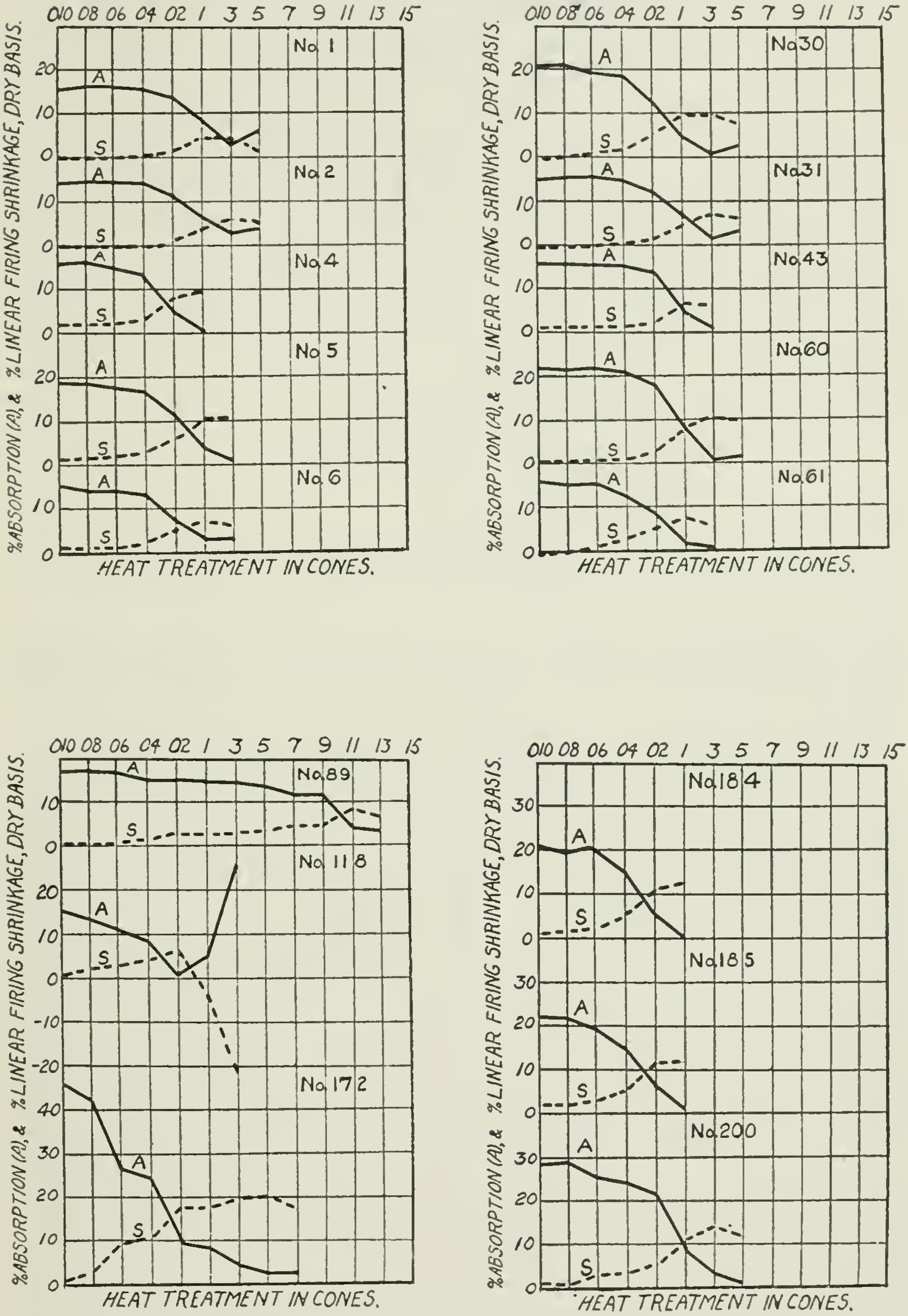
Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
14	10	3.3	21.0	1.3	21.4	7.0	18.7	11.8	13.6	16.8	8.1	18.2	5.4	18.8	2.6	18.8	3.6	11.4	9.0	1.8	12.1	—6.3	20.3				
	21	5.9	43.6	7.8	43.5	9.6	43.2	9.9	42.5	19.1	34.5	25.8	30.5	29.8	24.1	30.6	21.8	33.5	17.0	38.0	10.9	39.0	10.0	40.0	2.5		
	22	0.0	34.8	1.3	31.1	3.9	32.5	6.1	30.8	11.3	25.9	16.7	20.6	16.8	18.5	17.8	16.7	18.5	14.9	20.8	12.3	22.0	10.0	20.4	3.3		
	75	10.3	43.1	11.3	42.6	11.2	42.9	12.1	12.7	15.2	39.9	19.4	36.2	29.2	26.8	33.1	22.0	33.4	21.6	35.8	17.3	43.7	2.7	41.3	2.8		
	123	4.8	10.2	4.8	39.8	7.8	38.3	7.8	38.5	13.4	34.6	30.4	18.7	31.6	18.2	31.7	12.4	31.0	13.3	38.0	5.2	38.2	1.5	34.1	5.6		
	127	0.0	38.1	1.7	39.0	3.0	37.6	3.8	39.0	8.4	35.3	20.0	26.0	21.8	24.6	24.0	21.8	26.0	18.7	31.2	10.2	32.2	11.5	34.2	9.1		
	148	2.2	36.8	1.2	37.6	4.9	37.4	6.0	36.4	17.6	27.3	22.6	23.2	25.7	19.2	30.2	13.8	32.4	12.0	34.8	4.3	32.1	4.7	26.0	16.9		
	177	5.9	47.6	16.9	40.4	31.6	27.6	32.2	27.6	47.2	0.3	50.0	0.3														
	181	—1.2	26.2	+2.6	22.6	4.3	20.1	6.7	17.4	16.5	8.9	18.5	0.0	11.9	0.0	—23.9	2.1										
	188	6.0	45.4	6.0	45.4	13.7	40.6	18.6	39.2	21.9	33.6	13.4	0.9	43.4	0.6												
	202	5.9	39.1	6.5	39.1	18.3	38.0	15.1	33.4	21.4	24.2	27.1	20.5	29.7	17.7	‡32.3	‡13.4	#33.1	#12.3	34.5	6.7	35.0	0.0	25.2	1.6		
	203	1.9	37.3	2.5	37.0	3.7	35.7	7.7	33.4	15.2	28.0	16.9	25.0	18.2	23.4	‡21.0	‡21.0	#21.5	#20.8	25.6	13.3						
	210	4.6	32.8	5.0	32.0	14.5	23.4	17.1	19.0	21.6	13.8	24.4	10.4	24.4	9.3	25.6	3.3										
	212	3.8	32.8	4.4	31.8	10.8	27.4	19.7	18.5	17.8	20.2	20.1	16.0	22.5	11.5	22.7	1.6										
15	1	—0.8	28.4	—0.8	29.1	—0.2	29.2	+0.3	28.6	+3.2	26.0	11.6	17.3	15.2	4.9	5.3	12.1										
	2	—1.5	26.9	—1.5	27.3	—1.3	27.4	—0.4	26.9	+3.1	23.6	11.1	13.5	16.8	5.8	15.1	7.6										
	4	4.5	27.8	4.4	28.8	5.1	26.5	8.5	23.7	21.9	12.2	25.1	1.2														
	5	4.2	31.7	1.6	31.7	5.4	30.2	7.9	28.8	16.4	21.6	28.5	7.4	27.9	1.2												
	6	2.6	27.5	3.1	26.6	3.3	26.2	5.6	24.4	14.5	15.2	19.3	5.8	17.6	5.5												
	30	—0.6	31.3	0.0	34.7	+2.0	33.2	4.2	32.2	11.3	23.8	26.0	9.7	26.5	0.7	20.6	4.4										
	31	—0.3	27.9	—0.6	28.8	—0.3	28.6	+0.2	28.0	+1.0	24.3	13.5	15.3	19.0	2.7	16.8	6.8										
	43	2.8	28.9	2.3	28.4	3.1	28.5	3.7	28.4	5.9	25.8	18.6	9.8	16.7	1.1												
	69	0.3	36.5	0.5	36.2	1.0	36.8	2.0	35.9	6.7	32.3	22.3	17.5	28.1	0.4	25.9	2.8										
	61	—0.8	28.8	+0.1	28.4	2.1	27.8	6.4	21.2	13.9	16.5	19.2?	2.8?	14.5	0.7												
	89	1.1	30.5	0.9	31.1	1.8	30.1	4.2	28.2	7.1	28.5	7.1	28.0	7.7	27.8	8.5	26.6	12.9	23.1	13.1	23.0	22.8	8.3	17.8	1.6		
	118	1.5	27.8	4.9	25.1	7.3	21.4	11.5	17.7	17.9	1.9	—12.3	8.1	—52.8	30.8												
	172	3.0	51.0	8.1	51.7	25.0	40.0	28.4	38.1	43.2	18.9	43.8	16.8	47.9	8.5	49.0	4.5	12.6	4.3								
	184	3.1	32.8	4.7	32.2	5.6	31.2	14.0	27.2	30.3	12.5	31.1	0.0														
	185	4.5	35.1	4.8	34.4	7.4	32.8	15.3	27.6	30.7	13.6	31.3	0.5														
	200	3.1	41.7	2.4	42.1	7.8	39.0	9.5	38.2	14.1	34.8	31.0	17.0	36.6	6.3	31.6	1.3										
	211	0.0	33.4	0.0	33.0	1.6	33.0	3.5	32.9	7.8	28.6	18.9	1.5	22.8	8.1												
	223	0.8	34.4	1.1	33.6	2.9	33.3	7.2	29.8	10.3	25.6	20.7	14.5	26.0	3.5			#—7.5	#29.9								
	264	—0.3	26.4	+0.3	25.7	2.9	23.8	4.0	23.6	16.9	3.8																
	265	—0.6	27.2	—0.6	27.0	+3.0	21.4	1.9	25.3	13.9	13.4	20.3	4.7														

% V. S.—Firing shrinkage, per cent dry volume. % A. P.—Per cent apparent porosity. ‡Cone 6—. #Cone 6+.

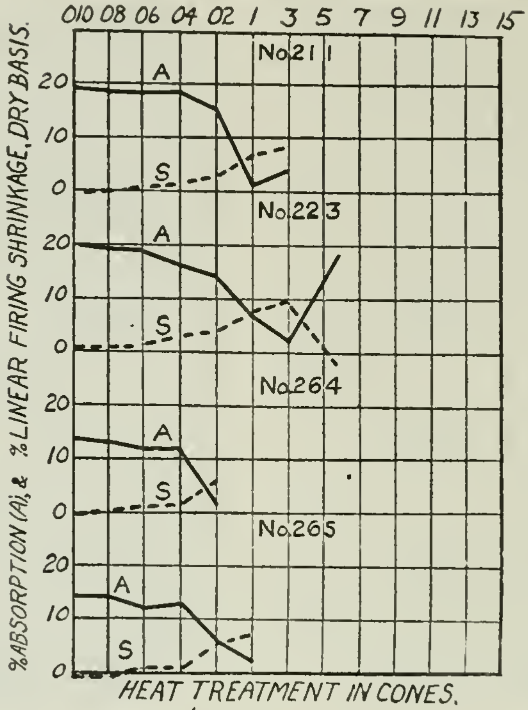
Absorption and linear shrinkage curves for clays of class 14.



Absorption and linear shrinkage curves for clays of class 15.



Absorption and linear shrinkage curves for clays of class 15.



IV. CLAYS BURNING DIRTY WHITE, CREAM WHITE, OR YELLOWISH WHITE.

17. Generally Contain Calcium or Magnesium Carbonate or Both, and Seldom Reach Low Porosity. Very Short Firing Range.

No. 3 (p. 218). Santa Barbara County. One mile south of Carpinteria. Formerly used for making light-colored common brick and building tile, in the Carpinteria plant of the Santa Barbara Builders' Supply Co. A light-yellowish sandy-shale, which develops a weak and sticky plasticity, but with medium-high dry strength. The deposit contains lime concretions which were sorted out as much as possible, but the sample contains too much lime for satisfactory testing, as all test pieces fired below cone 04 slaked in air after firing. The dry color is 17‴d, the wet color is 17‴b, and the fired colors range from 9′f to 19′f, from cone 010 toward cone 02, giving a fair range of pinks and buffs. Fusion begins slightly above cone 02, without preliminary vitrification or the development of steel hardness. The fired porosity is too high to permit the manufacture of structural ware of good quality. The total maximum linear shrinkage, plastic basis, is 10.8%, at cone 02. The best firing range is between cones 04 and 02. No charts of linear firing shrinkage or absorption are given.

No. 41 (p. 202). San Diego County. Escondido. H. T. Morris. This is a poor quality of common-brick clay, containing too much lime for satisfactory use. It effervesces strongly in hydrochloric acid. The plasticity is sufficient for brick-pressing, the dry strength is medium, the drying characteristics are satisfactory, and in the dry state the clay is hard and coarse-grained. The colors are: dry, 19″f; wet, 21‴f; cones 010 to 06, 15″; cones 04 and 02, 13″; and cone 1+, 9″i, with yellow-green blotches indicating the presence of lime. The fired colors are too dull for good exterior effects. Finger-nail hardness is present in the dried state, but steel hardness is not developed below the fusion point. Fusion commences at cone 1+, without previous vitrification. The maximum total linear shrinkage is 6.9%, at cone 1+. The best firing range is from cone 010 to cone 02.

No. 46 (p. 195). San Bernardino County. Government Holes, 12 m. E. of Cima. R. H. Holliman. This is a residual kaolin, too high in coloring compounds, fluxes and non-plastics to be of value. There is strong effervescence in hydrochloric acid. As the deposit has been reported on numerous occasions, the test data are presented for those who may be interested. The material has fair, though short, plasticity, medium dry strength, and is hard and close-textured in the dried state. The colors are: dry, yellowish gray; wet, 17‴f; cone 010, 13″f; cones 08 and 06, 13″d; cones 04 and 02, 13″b; cone 1, 13″″; cones 3 and 5, 17″″. Finger-nail hardness is developed below cone 010, and steel hardness at cone 3. Bloating begins at cone 5, and complete loss of shape occurs at cone 13 (with the laboratory firing schedule used). The maximum total linear shrinkage, plastic basis, is 7.3%, at cone 5.

No. 115 and 116 (p. 90). San Bernardino County. Near Rosamond. Merry Widow Mine. These are samples of fault gouge and altered volcanic rock from an abandoned gold mine. Many clays of this type are called to the attention of the State Mining Bureau. They are usually worthless from the ceramic standpoint, on account of weak plasticity, excessive shrinkage, poor fired colors, low fusion point, short vitrification range, and low fired strength. Test data are presented for two varieties for the purpose of pointing out the defects of such material. No. 115 is a fault gouge. It has sticky and weak plasticity, high dry strength, and in the dried condition, is hard, medium-grained and medium-textured. The high ratio of pore water to shrinkage water should be especially noted. The colors are: dry, nearly white; wet, grayish white; cone 010, 13″d; cones 08 to 04, 15″b; cones 02 to 3, 15″i; cone 5, 15″. Finger-nail hardness is present in the dried state, and steel hardness appears at cone 04. The fired structure is weak, and when fired below cone 02, is granular. At cone 02 and above, the structure is glassy. Most of the fired test pieces have one or more large cracks. Vitrification is complete at cone 1, but kiln-marking begins at this point, and bloating begins at cone 3. The total linear shrinkage, plastic basis, is 24.5% at cone 1.

No. 116 is a sample of decomposed trachyte (?). The properties are similar to those of No. 115, but the shrinkage is less, and the fired structure is stronger.

No. 205 (p. 229). Stanislaus County. Near Patterson. Cummings Ranch. This is a shale with poor plasticity and medium dry strength. In the dried condition it is medium hard, coarse-grained, and open-textured. The colors are: dry, yellowish white; wet, 17″d; cones 010 to 06, 17″d; cones 04 to 3, 17″b; cone 7, 17″d. Steel hardness is not developed up to the firing limit studied, cone 9. The fired structure is moderately strong, sound, granular, and open. The surface texture is slightly rough. The grains composing the mass are heterogeneous in color. The total linear shrinkage, plastic basis, at cone 9, is 13.1%.

The clay would need to be mixed with more plastic material in order to permit its successful use in common brick or face brick manufacture.

No. 262 (p. 159). Placer County. East of Lincoln. Valley View Mine. This is an altered igneous rock of undetermined origin and composition. It develops good plasticity, although a large proportion of the material is non-plastic. The dry strength is medium, and in the dried condition, it is medium hard, open-textured, and heterogeneous. The colors are: dry, 17‴f; wet, 17‴b; cones 010 to 3, 15″d; cone 7, 17‴i. The fired colors are too dull for pleasing brick colors. Steel hardness is developed at cone 7. The fired structure is sound, and medium strong, except for superficial cracks at cone 7. Fusion without vitrification begins above cone 7. The total linear shrinkage, plastic basis, at cone 7, is 10.7%. The material has doubtful ceramic value.

TABLE No. 28.

IV. Clays Burning Dirty White, Cream White, or Yellowish White.

17. Generally contain calcium or magnesium carbonate or both, and seldom reach low porosity. Very short firing range.

Clay No.	% S.W.	% P.W.	% W.P.	D.T.S.	% D.V.S.	% D.L.S.	Softening pt. in cones
3	13.6	26.3	39.9	463	20.8	6.1	
41	11.2	18.5	29.7	322	19.6	6.2	
46	7.6	10.2	17.8	579	15.7	5.1	
115	16.5	37.6	54.1	432	20.4	6.4	
116	24.9	29.1	54.0	550	34.4	10.4	
163	43.0	24.1	67.1	±350	66.8	18.4	
205	9.4	39.8	49.2	269	11.4	3.6	
262	10.1	18.2	28,3	334	18.0	5.7	

% S.W. = Per cent shrinkage water.
% P.W. = Per cent pore water.
% W.P. = Per cent water of plasticity.
D.T.S. = Dry transverse strength, pounds per square inch, without sand.
% D.V.S. = Drying shrinkage, per cent dry volume.
% D.L.S. = Calculated linear drying shrinkage, per cent dry length.

TABLE No. 29.

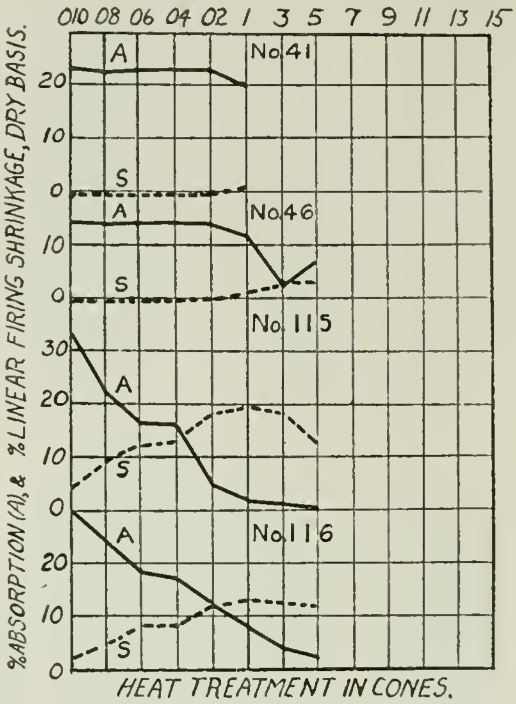
IV. Clays Burning Dirty White, Cream White, or Yellowish White.

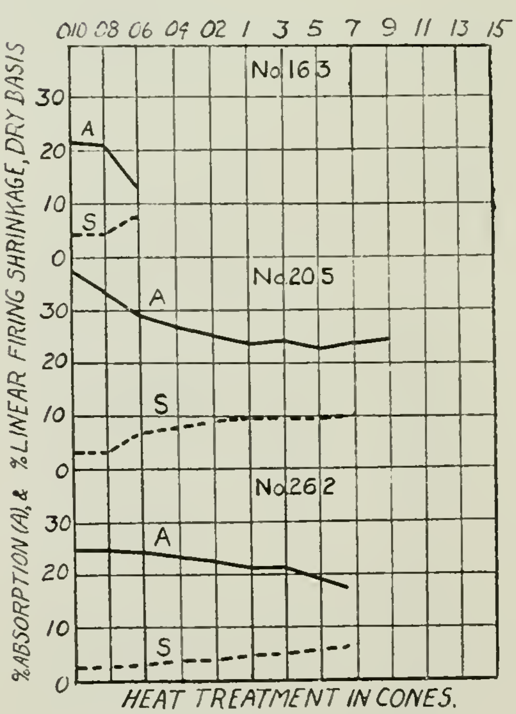
17. Generally contain calcium or magnesium carbonate or both, and seldom reach low porosity. Very short firing range.

Class No.	Clay No.	Cone 010		Cone 08		Cone 06		Cone 04		Cone 02		Cone 1		Cone 3		Cone 5		Cone 7		Cone 9		Cone 11		Cone 13		Cone 15	
		% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.	% V. S.	% A. P.
17	3	....	....	....	....	....	....	7.0	51.9	14.9	45.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	41	—2.0	35.7	—1.6	36.7	—1.8	37.0	—1.0	37.4	—0.8	37.2	†+3.2?	†33.6?	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	46	—2.8	26.0	—2.3	26.2	—2.1	26.7	—1.8	26.7	—0.4	26.1	+2.7	22.7	+6.9	3.5	....	....	7.7	14.9	....	....	....	....	....	....	....	....
	115	11.1	45.1	21.9	34.7	32.6	27.9	33.9	28.2	45.7	9.6	48.2	3.2	46.2	2.1	32.0	0.4	....	....	....	....	....	....	....	....	....	....
	116	5.1	42.0	13.0	36.8	21.9	30.6	22.4	29.5	31.5	22.0	34.0	16.1	35.1	7.6	30.6	2.4	....	....	....	....	....	....	....	....	....	....
	163	12.1	34.5	12.1	32.4	21.7	22.3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	205	8.8	45.7	10.9	43.2	18.0	39.9	21.3	38.2	24.6	37.1	26.5	35.8	26.5	36.2	26.4	34.8	26.9	35.6	27.0	36.7	....	....	....	....	....	....
	262	6.9	42.4	6.6	42.7	7.8	41.9	10.8	40.5	10.9	39.8	13.1	38.6	13.4	38.3	15.9	32.8	....	....	....	....	....	....	....	....	....	....

% V. S.—Firing shrinkage, per cent dry volume. % A. P.—Per cent apparent porosity. †Cone 1+.

Absorption and linear shrinkage curves for clays of class 17.





CHEMICAL ANALYSES.

Table No. 30 gives chemical analyses of certain clays from deposits that were sampled and tested. About one-half of the analyses were made on a portion of the same samples that were tested for ceramic properties and therefore can be directly correlated with the results of the tests. The other half of the analyses were compiled from the literature and from data presented by certain of the clay manufacturers. The sample numbers to which these analyses correspond are given in parentheses, but owing to variations in the character of the clay being mined at different times, the analyses of the samples actually tested may be considerably different from those given in the table.

Table No. 31 presents a group of chemical analyses of deposits that were not sampled. Very few of these clays have possible uses in ceramic manufacture, except for common brick. The analyses are given as being of possible interest in the future and to serve as a guide to the character of material to be found in the localities noted.

TABLE No. 30. CHEMICAL ANALYSES OF CLAYS FROM SAMPLED DEPOSITS.

Clay Class No.	Clay Sample No.[1]	Location of Deposit	Analysis, moisture free basis SiO₂ %	Al₂O₃ %	Fe₂O₃ %	CaO %	MgO %	K₂O %	Na₂O %	TiO₂ %	MnO %	Ign Loss %	Total %	Analyst or authority
1	11	Alberhill: A. C. & C. Co. E-101	63.19	26.99	1.98	0.16	0.04	[2]1.19				6.45	100.00	G. W. Briggs, Stanford University
	(12)	Alberhill: A. C. & C. Co. E-102?	48.18	35.99	1.74	0.48	0.55	[2]2.03				11.22	100.19	Smith, Emery & Co., S. M. R. XIX, p. 207
	37	El Cajon Mtn., San Diego Co.	49.14	31.28	1.44	0.89	0.20	Tr.	0.51			16.52	99.98	Smith, Emery & Co., S. M. R. XIX, p. 207
	62	O'Neill Ranch, Orange Co.	59.21	31.13	0.41	0.46	Tr.	[2]0.31				8.48	100.00	C. W. Briggs, Stanford University
	63	Hunter Ranch Clay, Orange Co.	73.85	18.32	1.38	0.11	0.16	0.11	0.94			6.10	100.97	V. J. Minner, Stanford University
	(128)	Ione sand (type)	71.22	19.27	1.23	0.21	0.34					7.73	100.00	Gladding, McBean & Co.
	160	Pine Hill Kaolin, Nevada Co.	60.18	26.28	2.68	0.64	Tr.	[2]0.89				9.33	100.00	C. W. Briggs, Stanford University
	190	Clark & Narsh, picked kaolin	60.15	27.80	1.12	0.39	Tr.	[2]0.75				9.79	100.00	C. W. Briggs, Stanford University
	(194)	Weiss, Glen Ellen, No. 2 (med.)	56.29	31.13	0.59	0.05	0.05			0.31		11.67	100.09	Smith, Emery & Co., S. M. R. XXII, p. 332
	(195)	Weiss, Glen Ellen, No. 3 (soft)	58.10	26.79	1.17	0.32	0.05			0.56	Tr.	12.66	99.65	Smith, Emery & Co., S. M. R. XXII, p. 332
	236	Nigger Hill, Calaveras Co.	64.67	25.34	1.39	0.61	0.06	[2]1.13				6.81	100.00	C. W. Briggs, Stanford University
	259	Ryan Ranch, Tesla	48.93	36.13	1.15	0.36	0.21	[2]0.87				12.35	100.00	C. W. Briggs, Stanford University
	268	Amer. Ref. Co., El Toro crude	54.42	32.54	1.90	0.20	0.00	[2]0.42				10.52	100.00	C. W. Briggs, Stanford University
2	(15)	Alberhill: A. C. & C. Co. Sel. M. T.	59.44	26.28	2.24	0.26	0.20	[2]0.15				11.64	100.21	Smith, Emery & Co., S. M. R. XIX, p. 201
	(28)	Alberhill: A. C. & C. Co. S. H.-3	63.63	24.07	1.29	0.77	none	[2]0.57		0.90	none	8.77	100.00	Smith, Emery & Co., S. M. R. XIX, p. 199
	(29)	Alberhill: A. C. & C. Co. M. T.	75.46	16.22	2.24	0.03	Tr.	[2]0.20				6.24	100.39	Smith, Emery & Co., S. M. R. XIX, p. 201
	44	Hart Mt. Stand. San. Mfg. Co.	71.76	17.88	1.00	1.52	0.73	0.14	0.75			6.48	100.26	V. J. Minner, Stanford University
	57	Hart Mt. Coors	63.52	25.85	0.58	1.06	0.44	1.74	1.65			6.10	100.94	V. J. Minner, Stanford University
	(57)	Hart Mt. Coors	64.00	25.26	Tr.	0.80	0.14	[2]1.79				8.01	100.00	H. F. Coors, Los Angeles
	(90)	[3]Alberhill (G. McB. Co.) M. T.	73.70	22.88	2.36	0.42	Tr.	[2]0.64					100.00	Burchfiel, J. A. C. S. 6, 1169
3	(70)	Alberhill: Emsco white	60.78	26.00	0.32	0.50	0.04	0.22	0.85	0.80	0.01	10.98	100.50	Smith, Emery & Co.
	(98)	Alberhill: G. McB. & Co. W-105 bone	54.85	43.43	0.72	Tr.	Tr.	[2]0.86				0.26	100.12	Burchfiel, J. A. C. S. 6, 1169
	120	Ione: Jones Butte fireclay	42.17	42.48	1.26	0.16	Tr.	[2]0.96				12.97	100.00	C. W. Briggs, Stanford University
	(273)	Alberhill: A. C. & C. Co. SH-4	48.81	34.58	0.99	0.68	Tr.	[2]0.13		1.43	Tr	13.36	99.98	Smith, Emery & Co., S. M. R. XIX, p. 198
	(273)	Alberhill: A. C. & C. Co. SH-4	37.72	42.21	0.51	0.72	0.05	[2]0.09				18.96	100.26	Burchfiel, J. A. C. S., 6, 1173
4	125	Ione: Gage	61.25	27.00	1.58	0.24	0.58	2.84	1.83			6.34	101.66	V. J. Minner, Stanford University
5	(17)	Alberhill: A. C. & C. Co., Bone	44.30	39.59	2.08	0.39	Tr.	Tr.		1.50		12.13	[4]100.01	Smith, Emery & Co., S. M. R. XIX, p. 203
	(67)	Corona: McKnight fireclay	57.38	27.62	2.06	1.90	0.11	[2]0.13				10.62	99.82	Pac. Clay Prod. Co.
	86	Alberhill: L. A. B. Co. No. 26 bone	45.08	37.31	3.74	0.10	Tr.	0.44	0.72			13.15	100.54	V. J. Minner, Stanford University
	(104)	Alberhill: G. McB. Co. Sloan No. 5	41.48	41.50	0.80	Tr.	Tr.	[2]0.35				15.72	99.85	Burchfiel, J. A. C. S. 6, 1174
	141	Ione: Fancher blue	48.51	36.88	1.91	0.21	0.26	0.09	0.25			12.80	100.92	V. J. Minner, Stanford University
	231	Alberhill: L. A. B. Co. High Alumina bone	30.35	46.52	3.33	0.36	0.10	0.16	1.03			18.34	100.19	C. W. Briggs, Stanford University
	282	[3]Goat Ranch flint fireclay Orange Co.	53.82	41.83	2.13	0.92	0.08	[2]1.22					100.00	C. W. Briggs, Stanford University
6	(9)	Alberhill, A. C. & C. Co. (Hill blue)	60.80	24.75	2.70	0.94	0.51	0.54	0.57		[5]0.03	9.11	99.95	Smith, Emery & Co., S. M. R. XIX, p. 205
	(9)	Alberhill, A. C. & C. Co. (Hill blue)	55.59	26.36	3.95	1.33	0.61	0.41	0.57		[5]0.29	10.90	100.01	Smith, Emery & Co., S. M. R. XIX, p. 205
	33	Cardiff, Wiro Purple	68.59	20.33	2.88	0.09	0.50	0.17	0.48			7.62	100.68	V. J. Minner, Stanford University
	(33)	Cardiff, Wiro Purple	64.48	22.22	2.72	0.68	Tr.	[2]0.57				9.25	100.92	Gladding, McBean & Co.
	(92)	Alberhill: G. McB. & Co. Yellow M.T.	58.06	27.48	2.52	0.52	0.31	[2]1.12				10.08	100.09	Burchfiel, J. A. C. S. 6, 1168

	145	Lincoln: L. C. P. Co. No. 0 (1925 sample)	55 65	28.89	2 61	1.28	0 89	0 20	0 72			9 83	100 07	W. F. Dietrich, Stanford University
	(145)	Lincoln: L. C. P. Co. No. 0 (1928 sample)	55 36	29 23	4 53	0 95	0.12	[2]1 02				8 79	100 00	C. W. Briggs, Stanford University
	150	Lincoln: L. C. P. Co. No. 10 (1925 sample)	52 72	32.39	2 45	0.90	0 39	0.12	0 20			10 70	98 87	W. F. Dietrich, Stanford University
	(150)	Lincoln: L. C. P. Co. No. 10 (1928 sample)	57 28	31 10	2 11	0.51	0 08	0.16	0.38			8 63	100 31	C. W. Briggs, Stanford University
	263	Valley View Mine, Placer Co.	54 18	32 28	1 76	0.08	Tr.	[2]0 65				11 05	100 00	C. W. Briggs, Stanford University
7	(101)	Alberhill, G. McB. & Co. Sloan	55 56	28 79	1 77	0 90	0 20	[2]1.40				10 90	99 52	Burchfiel, J. A. C. S. *6*, 1171
	(110)	Alberhill, P. C. P. Co. Douglas	51 76	29 83	2 10	0.44	0 30	[2]0 79				13.96	99.18	Pac. Clay Prod. Co.
	(133)	[3]Ione: Harvey clay (average)	59.97	35.91	2 89	0 68	0 45	[2]0 10					100 00	K. W. Baum
	149	Lincoln: L. C. P. Co. No. 9 (1925 sample)	55 30	30 29	2 41	1.01	0 52	0 16	0.30			9 51	99.56	W. F. Dietrich, Stanford University
	(149)	Lincoln: L. C. P. Co. (1928 sample)	58 36	28.92	2 06	0 66	0.12	0.48	0.45			9 06	100 06	C. W. Briggs, Stanford University
	201	Valley Springs: blue plastic	61 00	22 38	4 02	0 56	1 14	[2]0 78				10 12	100 00	K. W. Baum
8	146	Lincoln: L. C. P. Co. No. 1-6	52.49	33 45	2 53	0 80	0.63	0 18	0 56			10 30	100 94	W. F. Dietrich, Stanford University
	147	Lincoln: L. C. P. Co. No. 7	52 85	33.50	2 46	0.55	0.33	0 20	0.49			10 03	100 11	W. F. Dietrich, Stanford University
	(157)	Lincoln: G. McB. & Co. terra cotta clay	50 38	32.11	2 99	1 15	1 07			0 38	0 56	11 29	99 93	Gladding, McBean & Co.
	201	Helisma, Calaveras Co.	55 72	24 56	4 02	0 45	1.15	[2]1 18				12 92	100 00	K. W. Baum
9	(25)	Alberhill: A. C. & C. Co. W. T. blue	58.22	16.39	10.36	1.48	2.54	[2]1.10		1.10	Tr.	8.55	[4]100.02	Smith, Emery & Co., S. M. R. XIX, p. 209
	(94)	Alberhill: G. McB. & Co. West blue	68 57	22 99	1 82	0 16	0 04	[2]1 22				5.20	100 00	C. W. Briggs, Stanford University
10	(111)	Alberhill: P. C. P. Co. Lower Douglas	70 20	18 48	4 26	0 42	0 38	[2]1 11				5 46	100 31	Pac. Clay Prod. Co.
12	35	Cardiff: G. McB. & Co.	66 84	17 79	7 54	1 12	0 34	0 20	0 46			6 43	100 72	V. J. Minner, Stanford University
	(40)	Kelly Ranch Yellow	56 58	21 81	8 27	0 10	0 16	[2]0 59				9 98	100 49	Pac. Clay Prod. Co.
	(100)	Alberhill: G. McB. & Co. yellow top clay	62 12	19 22	5 01	2 00	0.68	[2]1 22				10 06	100 34	Burchfiel, J. A. C. S. *6*, 1168
	(112) (113)	Alberhill: P. C. P. Co. hoist pit	63 10	21 08	5 86	0 90	0 05	[2]0 13				8 44	99 86	Pac. Clay Prod. Co
13	(7)	Alberhill: A. C. & C. Co. pink mottled	68 57	15 19	7 75	none	Tr.	[2]2 70		0 97	Tr.	4 69	[6]100 00	Smith, Emery & Co., S. M. R. XIX, p. 208
	122	Ione: Jones Butte Laterite	40.61	37 43	7 27	0 11	Tr.	0 26	0.89			13 10	99 97	V. J. Minner, Stanford University
14	148	Lincoln: L. C. P. Co. No. 8	46 80	26 02	13 72	0 91	0 49	0 25	0 33			11 17	99 99	W. F. Dietrich, Stanford University
	202	Valley Springs: Pink mottled	51 64	23 81	9 78	0 67	1 21	[2]0 91				11 92	100 00	K. W. Baum
	203	Valley Springs: Yellow plastic	57 56	18 97	9 31	0 45	1 16	[2]1 25				11 30	100 00	K. W. Baum
	210	Natoma, Sacramento Co.	46 35	22.62	11 38	2 09	2 21	[2]0 24				15 11	100 00	L. W. Austin

[1] Where the sample number is given in parenthesis ( ), the analysis was not made on the laboratory sample, but on another sample from the same deposit. In all other cases, the analysis was made on the same sample that was used for the determination of the ceramic properties.

[2] Total alkalis by difference.

[3] Ignited basis.

[4] Cl 0.02.

[5] SO_3.

[6] P_2O_5 0.21%; Cl 0.07%.

[7] Cl 0.13%.

TABLE No. 31. CHEMICAL ANALYSES OF MISCELLANEOUS CALIFORNIA CLAYS, NOT SAMPLED.

County	Description	Chemical analysis, moisture free basis							
		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alk.	Ign.	Authority
Alameda	Midway (R.R. cut)	55.06	16.38	7.56	2.85	2.02	und.	und.	K. W. Baum
Calaveras	Near Milton	57.24	18.63	3.21	.82	.61	und.	und.	K. W. Baum
Calaveras	Near Milton	60.12	16.92	und.	und.	und.	und.	und.	K. W. Baum
Calaveras	Near Milton	55.12	20.98	5.68	2.27	1.51	und.	und.	K. W. Baum
Imperial	[1]Full Moon	28.15	42.66	1.93	0.53		[3]0.71	12.53	A. J. Forget, St. Min. Rept. XXII, p. 269
Mariposa	Bryceburg-Merced River Canyon	71.70	12.91	4.57	1.11	2.06	und.	3.82	K. W. Baum
Mariposa	Bryceburg-Merced River Canyon	49.37	17.93	11.90	3.53	2.91	und.	13.35	K. W. Baum
Mariposa	[2]Kittredge, Merced River Canyon	58.06	15.98	10.16	3.39	10.79	und.		K. W. Baum
Mariposa	[2]Kittredge, Merced River Canyon	56.98	16.27	11.67	8.41	5.97	und.		K. W. Baum
Mariposa	[2]Kittredge, Merced River Canyon	60.57	18.18	8.07	8.12	3.56	und.		K. W. Baum
Mariposa	[2]Detwiler, Merced River Canyon	53.91	24.14	13.20	4.56	3.44	und.		K. W. Baum
Mariposa	[2]Detwiler, Merced River Canyon	54.99	14.17	8.73	12.96	7.98	und.		K. W. Baum
Mariposa	Merced (8 mi. north)	63.46	17.18	3.94	2.70	1.70	und.	4.74	K. W. Baum
Merced	[2]Merced Falls, Merced River Canyon	69.47	18.36	7.93	1.24	2.71	und.		K. W. Baum
Merced	Ryer	62.58	17.04	4.28	2.71	1.90	und.	4.68	K. W. Baum
Merced	Merced Falls (2 mi. north)	68.16	17.60	4.50	trace	.30	und.	7.60	K. W. Baum
Merced	Merced Falls (2 mi. north)	70.16	16.82	4.23	und.	und.	und.	7.34	K. W. Baum
Merced	Merced Falls (2 mi. south)	59.10	17.42	5.11	und.	und.	und.	14.30	K. W. Baum
Merced	Snelling (on ditch line)	55.18	16.26	4.10	2.26	2.54	und.	16.96	K. W. Baum
Merced	Snelling (on ditch line)	70.98	und.	und.	und.	und.	und.	12.82	K. W. Baum
Merced	Dalton (1 mi. N. of R.R.)	60.00	15.85	5.95	2.14	1.65	und.	12.54	K. W. Baum
Merced	Merced (8 mi. south)	56.98	14.32	6.08	und.	und.	und.	11.40	K. W. Baum
Merced	Merced Falls (1½ mi. S. on River)	58.90	17.60	5.04	0.56	1.35	und.	15.42	K. W. Baum
Riverside	Laterite (G. McB. and Co.)	38.96	35.76	8.30	0.62	0.16	1.02	15.32	Burchfiel, J. A. C. S. 6 pg. 1173
Riverside	Luscardi lease (Pac. C. P. Co.)	67.40	21.99	2.16	0.02	0.19	2.58	4.72	Pac. Clay Prod. Co.
Riverside	Serrano (Pac. C. P. Co.)	65.94	22.65	1.41	0.10	0.26	0.21	8.42	Pac. Clay Prod. Co.
Riverside	Wildomar (Pac. C. P. Co.)	70.14	14.97	1.61	1.58	0.09	3.94	7.78	Pac. Clay Prod. Co.
San Joaquin	Near Carbona	55.86	15.80	6.20	2.13	1.71	und.	und.	K. W. Baum
San Joaquin	Patterson Pass (nr. W. P. R. R.)	31.76	7.68	2.96	28.29	1.51	und.	und.	K. W. Baum
Solano	Vallejo (2 mi. N. W.)	57.83	19.52	7.46	1.24	2.06	3.86	8.03	St. Min. Rept. XXIII, p. 204
Stanislaus	[2]Oakdale (12 mi. so.)	62.31	19.53	9.68	3.40	2.46	und.		K. W. Baum
Stanislaus	[2]Oakdale	67.31	18.70	6.83	3.73	1.91	und.		K. W. Baum
Stanislaus	[2]Oakdale	62.70	20.31	7.61	3.98	2.69	und.		K. W. Baum
Stanislaus	[2]Oakdale	69.17	16.85	6.39	2.64	1.67	und.		K. W. Baum
Stanislaus	Modesto (2 mi. E. of town)	60.66	18.74	4.10	und.	und.	und.	4.76	K. W. Baum
Stanislaus	Modesto (nr. S. Fe. R. R.)	61.22	18.20	4.41	und.	und.	und.	5.04	K. W. Baum
Stanislaus	Empire (1 mi. E. of town)	61.46	18.01	4.89	und.	und.	und.	5.12	K. W. Baum
Stanislaus	San Joaquin River bank	60.10	15.60	7.70	4.09	2.51	und.	und.	K. W. Baum
Stanislaus	San Joaquin (Lane bridge)	65.90	16.40	3.06	2.41	1.00	und.	und.	K. W. Baum
Stanislaus	San Joaquin (So. of Lane bridge)	63.10	17.46	3.84	und.	und.	und.	und.	K. W. Baum
Stanislaus	Patterson (Hammond Ranch)	57.58	18.33	4.99	.51	.86	und.	und.	K. W. Baum
Stanislaus	Patterson (T 6 S, R 7 E)	60.26	21.00	5.08	.57	.80	und.	und.	K. W. Baum
Tuolumne	Near Jamestown	58.06	27.16	2.84	20	.24	und.	und.	K. W. Baum

[1] SO_3=13.49%. [2] Ignited basis. [3] Na_2O.

INDEX OF CLAY SAMPLE NUMBERS

Sample No.	Property description, page	Test data, page	Sample No.	Property description, page	Test data, page	Sample No.	Property description, page	Test data, page	Sample No.	Property description, page	Test data, page	Sample No.	Property description, page	Test data, page
1	218	338	59	----	265	111	176	315	162	159	----	223	141	343
2	218	338	60	100	340	112	178	324	163	159	350	229	175	300
3	218	348	61	102	341	113	178	324	164	159	------	230	175	300
4	234	338	62	145	259	114	90	312	165	159	------	231	175	281
5	234	339	63	140	260	115	90	349	166	138	316	232	175	281
6	234	339	64	140	260	116	90	349	167	138	315	233	70	------
7	169	328	65	141	322	117	131	324	168	136	313	234	70	------
8	169	324	66	179	277	118	192	341	169	138	313	235	70	263
9	169	287	67	179	277	119	74	325	170	136	315	236	68	263
10	169	334	69	169	323	120	53	272	171	136	329	237	68	263
11	169	257	70	169	272	121	53	302	172	136	312	238	70	316
12	169	257	71	169	278	122	53	328	173	235	313	239	52	281
13	169	296	72	169	328	123	56	335	175	65	304	240	52	274
14	169	287	73	169	323	124	56	302	176	66	325	243	52	------
15	169	264	74	175	278	125	53	273	177	66	336	244	52	281
16	169	314	75	175	335	126	52	279	178	65	325	245	52	300
17	169	277	76	175	288	127	57	335	180	77	326	246	52	300
18	169	321	77	175	278	128	54	261	181	80	336	247	52	300
19	169	311	78	175	288	129	62	261	182	81	326	248	52	301
21	169	334	79	175	278	130	62	290	183	81	326	249	52	301
22	169	335	80	175	297	131	62	329	184	80	342	250	52	282
23	169	277	81	175	289	133	63	298	185	80	342	251	52	327
24	169	321	82	175	315	134	58	261	188	92	336	252	52	305
25	169	311	83	175	297	135	58	312	190	133	261	253	52	301
26	169	321	84	175	289	136	58	302	191	133	280	254	52	301
27	169	287	85	175	298	137	57	266	192	133	281	255	52	313
28	169	264	86	175	279	138	57	280	194	227	262	256	52	330
29	169	264	87	175	279	139	57	290	195	227	262	257	52	291
30	203	339	88	-----	315	140	56	280	197	227	291	258	52	292
31	204	340	89	------	341	141	58	280	198	125	329	259	45	263
32	205	322	90	173	265	142	58	280	199	74	326	261	159	328
33	205	287	91	173	260	143	185	274	200	73	342	262	159	350
34	205	288	92	173	289	144	185	273	201	69	305	263	159	292
35	202	322	93	173	265	145	156	291	202	68	337	264	42	343
36	201	311	94	173	311	146	156	303	203	68	337	265	40	343
37	201	259	95	173	311	147	156	303	204	68	299	266	140	292
38	201	259	96	173	272	148	156	336	205	229	349	268	140	260
39	203	296	97	173	290	149	156	298	206	232	327	269	------	316
40	203	322	98	173	272	150	156	291	208	57	262	270	140	282
41	202	348	99	173	312	151	156	303	209	59	263	271	169	301
42	181	340	100	173	323	152	147	304	210	186	337	272	169	292
43	181	340	101	173	298	153	147	299	211	81	342	273	169	273
44	196	264	102	173	290	155	151	325	212	186	337	274	169	302
45	196	264	103	173	260	156	151	299	213	59	299	280	147	305
46	195	349	104	173	279	157	151	304	214	131	327	282	141	282
53	195	288	105	173	324	158	138	------	216	213	327	283A	232	314
55	195	314	108	176	290	159	137	261	217	213	327	283B	232	314
56	------	297	109	176	266	160	137	261	218	181	329	284	232	316
57	194	264	110	176	298	161	159	------	221	141	330	285	232	282

INDEX TO CLAY SAMPLES, BY COUNTIES

County	Name of property	Designation of clay	Sample No.	Class No.	Description of property, page	Test data, page
Alameda	W. S. Dickey C. M. Co.	Niles	265	15	40	343
	M. & S. Tile Co.	Niles	264	15	42	313
	Ryan Ranch	Tesla	259	1	45	263
Amador	Arroyo Seco Grant	Baker	126	5	52	279
		Gage	125	4	53	273
		Jones Butte fireclay	120	3	53	272
		Jones Butte laterite	122	13	53	328
		Jones Butte 'unctuous'	121	8	53	302
		Lot 237, E. side	240	4	52	274
		Hole 55-1	245	7	52	300
		55-2	247	7	52	300
		55-3	246	7	52	300
		56-1	248	7	52	301
		56-2	249	7	52	301
		56-3	250	5	52	282
		57-1	251	12	52	327
		57-2	252	8	52	305
		57-3	253	7	52	301
		57-4	254	7	52	301
		57-5	255	9	52	313
		Lot 254, N. E. cor.	239	5	52	281
		Lot 255, Hole 60	256	13	52	330
		61	258	6	52	291
		62	257	6	52	292
		Lot 324, Hole 54	244	5	52	281
		Lot 336, Hole 47	243	------	52	------
		Shepard sand	128	1	54	261
		Yaru No. 1	124	8	56	302
		Yaru No. 2	123	14	56	335
	Bacon and Bacon	Bacon blue	139	6	57	290
		Bacon bottom	138	5	57	280
		Bacon red	127	14	57	335
		Chocolate	137	2	57	266
	Carlile	Carlile sand	208	1	57	262
	N. Clark & Sons	Clark sand	134	1	58	261
		Dosch	136	8	58	302
		Dosch stripping	135	9	58	312
	Eckland	Mottled	213	7	59	299
		Sand	209	1	59	263
	Fancher (W. S. Dickey C. M. Co.)	Fancher yellow	141	5	58	280
		Fancher blue	142	5	58	280
	Ione Fire Brick Co.	Sand	140	5	60	280
	Newman Estate	Carbonaceous sand	130	6	61	290
		Pink mottled	131	13	61	329
	Yosemite Portland Cement Co.	Sand	129	62	61	261
		Harvey	133	7	63	298
Butte	Lund Ranch	Common	178-1	12	65	325
			-2	12	65	325
			-3	12	65	325
	Oroville-Quincy Road	Common	177	14	66	336
		Decomp. igneous	176	12	66	325
	Table Mt. C. P. Co.	Yellow plastic	175	8	66	304
Calaveras	California Pottery Co.	Nigger Hill 'kaolin'	236	1	68	263
		Nigger Hill 'kaolin'	237	1	68	263
		Valley Spgs. blue	204	7	68	299
		Valley Spgs. pink-mottled	202	14	68	337
		Valley Spgs. yellow	203	14	68	337
	Helisma	Helisma	201	8	69	305
	Penn. Min. Co.	Kaolinized schist	238	10	70	316
	Texas Min. Co.	Kaolinized schist	233	------	70	------
		Kaolinized schist	234	------	70	------
		Kaolinized schist	235	1	70	263
Contra Costa	N. Clark & Sons	Walnut Cr. shale	200	15	73	342
	Port Costa Brick Co.	Shale	199	12	73	326
	Richmond P. B. Co.	Shale	119	12	74	325
Del Norte	Musick	Common	180	12	77	326
Humboldt	Angel Ranch	Pottery (red)	181	14	80	336
	Loofbourrow	Common	185	15	80	342
	Strong's Station	Common	211	15	81	342
	Sunny Avenue	Common	183	12	81	326
	Thompson Brick Co.	Common	182	12	81	326

INDEX TO CLAY SAMPLES, BY COUNTIES—Continued

County	Name of property	Designation of clay	Sample No.	Class No.	Description of property, page	Test data, page
Inyo	Amer. Silica Co.	Death Valley superfine	269	10		316
Kern	Merry Widow Mine	Impure kaolin	115	17	90	349
		Impure kaolin	116	17	90	349
	Titus	Titus	114	9	89	312
Lake	Kelseyville	Common	188	14	92	336
Los Angeles	Davidson Brick Co.	Common	60	15	100	340
	Gladding, McBean & Co.	Santa Monica common	61	15	102	341
Marin	McNear Brick Co.	Shale	198	13	124	329
Monterey	Arca	Common	117	12	130	324
	Monterey Mission Tile Co.	Adobe	214	12	131	327
Napa	Clark and Marsh	Kaolin, average	190	1	133	261
		Kaolin, selected	191	5	133	280
		Kaolin, lower tunnel	192	5	133	281
Nevada	Banner Mt. Road		170	10	136	315
	Beaser Ranch		168	9	136	313
	Manzanita Mine	Pipe clay	172	15	136	342
	North Bloomfield Rd.		171	13	136	329
	Pine Hill Mine	Kaolin	159	1	137	261
		Kaolin	160	1	137	261
		Kaolin	166	11	138	316
		Kaolin	167	10	138	315
	Sonntag Ranch		169	9	138	313
	Sweet Ranch (Pine Hill)	Kaolin	158		138	
Orange	American Silica Co.	Amreco fireclay	266	6	140	292
		Arc fireclay	270	5	140	282
		El Toro crude	268	1	140	260
		Hunter Ranch—lower	64	1	140	260
		Hunter Ranch—upper	63	1	140	260
	Brea C. P. Co.	Common	65	12	140	322
	Gladding, McBean & Co.	Goat Ranch flint	221	12	141	330
		Goat Ranch flint	282	5	141	282
		Goat Ranch shale M M 3	223	15	142	343
	Vitrefrax Co.	O'Neill Ranch fireclay	62	1	145	259
Placer	Clay Corporation of Cal.	Lincoln fireclay	280	8	147	305
		Lincoln top clay	152	8	147	304
		Lincoln top clay	153	7	147	299
	Gladding, McBean & Co.	Lincoln fire-proofing	156	7	152	299
		Lincoln pit sand	155	12	152	325
		Lincoln terra cotta	157	8	152	304
	Lincoln C. P. Co.	No. 0	145	6	156	291
		No. 1-6	146	8	156	303
		No. 7	147	8	156	303
		No. 8	148	14	156	336
		No. 9	149	7	156	298
		No. 10	150	6	156	291
		Washed china clay	151	8	156	303
	Miscellaneous	Alta	165		159	
		Baxter	162		159	
		Baxter	163	17	159	350
		Baxter	164		159	
		Gorge	161		159	
	Valley View Mine	Kaolin (impure)	261	12	159	328
		Kaolin (impure)	262	17	159	350
		Kaolin (impure)	263	6	159	292
Riverside	Alberhill C. & C. Co.	A-clay	14	6	169	287
		Bone, W-105	17	5	169	277
		Clark tunnel mottled	18	12	169	321
		China, E-101	11	1	169	257
		China, E-102	12	1	169	257
		Diamond	19	9	169	311
		Hill blue	9	6	169	287
		Hill blue, lower tunnel	271	7	169	301
		Hill blue, main tunnel	272	6	169	292
		Hill blue, upper tunnel	274	7	169	302
		Hill blue green	10	14	169	334
		Main tunnel	29	2	169	264
		Main tunnel ex. select	13	7	169	296
		Main tunnel select	15	2	169	264
		No. 10	27	6	169	287

INDEX TO CLAY SAMPLES, BY COUNTIES—Continued

County	Name of property	Designation of clay	Sample No.	Class No.	Description of property, page	Test data, page
		Pink mottled	7	13	169	328
		Red No. 2	8	12	169	321
		Sagger	21	14	169	334
		SH-3	28	2	169	264
		SH-4	273	3	169	273
		West blue	23	5	169	277
		West blue select	16	10	169	314
		West tunnel blue	25	9	169	311
		West tunnel mottled	24	12	169	321
		West yellow	26	12	169	321
		Yellow Owl Cut	22	14	169	335
	Emsco Clay Co. (Harrington pit)	Bone	73	12	171	323
		Pink mottled	71	5	171	278
		Red	72	13	171	328
		Red Horse	69	12	171	323
		White (No. 5)	70	3	171	272
	Gladding, McBean & Co. (Alberhill pits)	Bone (W-105?)	98	3	173	272
		Main tunnel	90	2	173	265
		Main tunnel select	93	2	173	265
		Main tunnel sand	91	1	173	260
		Main tunnel yellow	92	6	173	289
		No. 10	96	3	173	272
		Sloan, bone	103	1	173	260
		Sloan, No. 5	104	5	173	279
		Sloan, red	105	12	173	324
		Sloan, sand	102	6	173	290
		Sloan, white	101	7	173	298
		Smooth bunker	97	6	173	290
		Tile	99	9	173	312
		West blue	94	9	173	311
		West blue select	95	9	173	311
		Yellow stripping	100	12	173	323
	Hudson Ranch	Clay	89	15	------	341
		Sand	88	10	------	315
	Los Angeles Brick Co.	Bone, high-alumina	231	5	175	281
		Bone, smooth	87	5	175	279
		Bone, smooth	232	5	175	281
		Clay shale	82	10	175	315
		No. 7	229	7	175	300
		No. 9	230	7	175	300
		No. 10	78	6	175	288
		No. 20	77	5	175	278
		No. 23	76	6	175	288
		No. 25	81	6	175	289
		No. 26 bone	86	5	175	279
		Pink mottled	85	7	175	298
		P. M. fireclay	84	6	175	289
		Red	83	7	175	297
		Red No. 2	75	14	175	335
		West bone	74	5	175	278
		West pit fireclay	79	5	175	278
		West pit mottled	80	7	175	297
	Pacific C. P. Co. (Alberhill and Corona pits)	Douglas	110	7	176	298
		Douglas lower	111	10	176	315
		Douglas main tunnel	109	2	176	266
		Douglas upper	108	6	176	290
		Hoist pit blue	112	12	178	324
		Hoist pit red	113	12	178	324
		McKnight fireclay	67	5	179	277
		McKnight sewer pipe	66	5	179	277
	Temescal Water Co.	Pink mottled	218	13	181	329
	Wilson, J. W.	Common	42	15	181	340
		Common	43	15	181	340
Sacramento	Michigan Bar	Cutter	143	4	185	274
		Van Vleck	144	3	185	273
	Natoma Clay Co.	No. 1	210	14	186	337
		No. 3	212	14	186	337

INDEX TO CLAY SAMPLES, BY COUNTIES—Continued

County	Name of property	Designation of clay	Sample No.	Class No.	Description of property, page	Test data, page
San Benito	Paicines	Common	118	15	192	341
San Bernardino	Coors	Hart kaolin	57	2	194	264
	Gladding, McBean & Co.	Bryman clay	55	10	195	314
	Holliman & Murphy	Impure kaolin	46	17	195	349
	Millet & Kennedy	Buff-burning	53	6	196	288
	Standard San. Mfg. Co.	Pacific kaolin (Hart)	44	2	196	264
		Pacific kaolin (Hart)	45	2	196	264
San Diego	California C. P. Co.	Cardiff fireclay	36	9	201	311
	El Cajon Mt.	Kaolin, average	38	1	201	259
		Kaolin, selected	37	1	201	259
	Gladding, McBean & Co.	Cardiff	35	12	202	322
	Morris, H. T.	Common	41	17	202	348
	Pacific C. P. Co.	Kelley Ranch white	39	7	203	296
		Kelley Ranch yellow	40	12	203	322
	San Diego T. & B. Co.	Rose Canyon	30	15	203	339
	Union Brick Co.	Rose Canyon	31	15	204	340
	Vitrified Products Co.	Cardiff fireclay	33	6	205	287
		Cardiff fireclay	34	6	205	287
		Linda Vista shale	32	12	205	322
San Luis Obispo	Santa Margarita	Shale	216	12	215	327
		Shale	217	12	215	327
Santa Barbara	Brentner	Carpinteria	3	17	218	348
	Muegenberg & Whitiker	Santa Barbara	1	15	218	338
		Toro Canyon	2	15	218	338
Sonoma	Beltane	Buff-burning	197	6	227	291
	Weiss, J. H.	Average white	194	1	228	262
		Selected white	195	1	228	262
Stanislaus	Cummings Ranch	Shale	205	17	229	349
Tulare	Sears, W. A.	Kaolin (impure)	283-A	9	232	314
		Kaolin (impure)	283-B	9	232	314
		Kaolin (impure)	284	10	232	316
		Kaolin (impure)	285	5	232	282
	Valencia Heights	Shale	206	12	232	327
Ventura	Anderson & Hardison	(Santa Paula)	6	15	234	339
	People's Lumber Co.	Blue	5	15	234	339
		Yellow	4	15	234	338
Yuba	Dempsey Ranch	Kaolin (impure)	173	9	235	313
	Florida	Edgar koalin	59	2	------	265
	Germany	Fireclay	56	7	------	297

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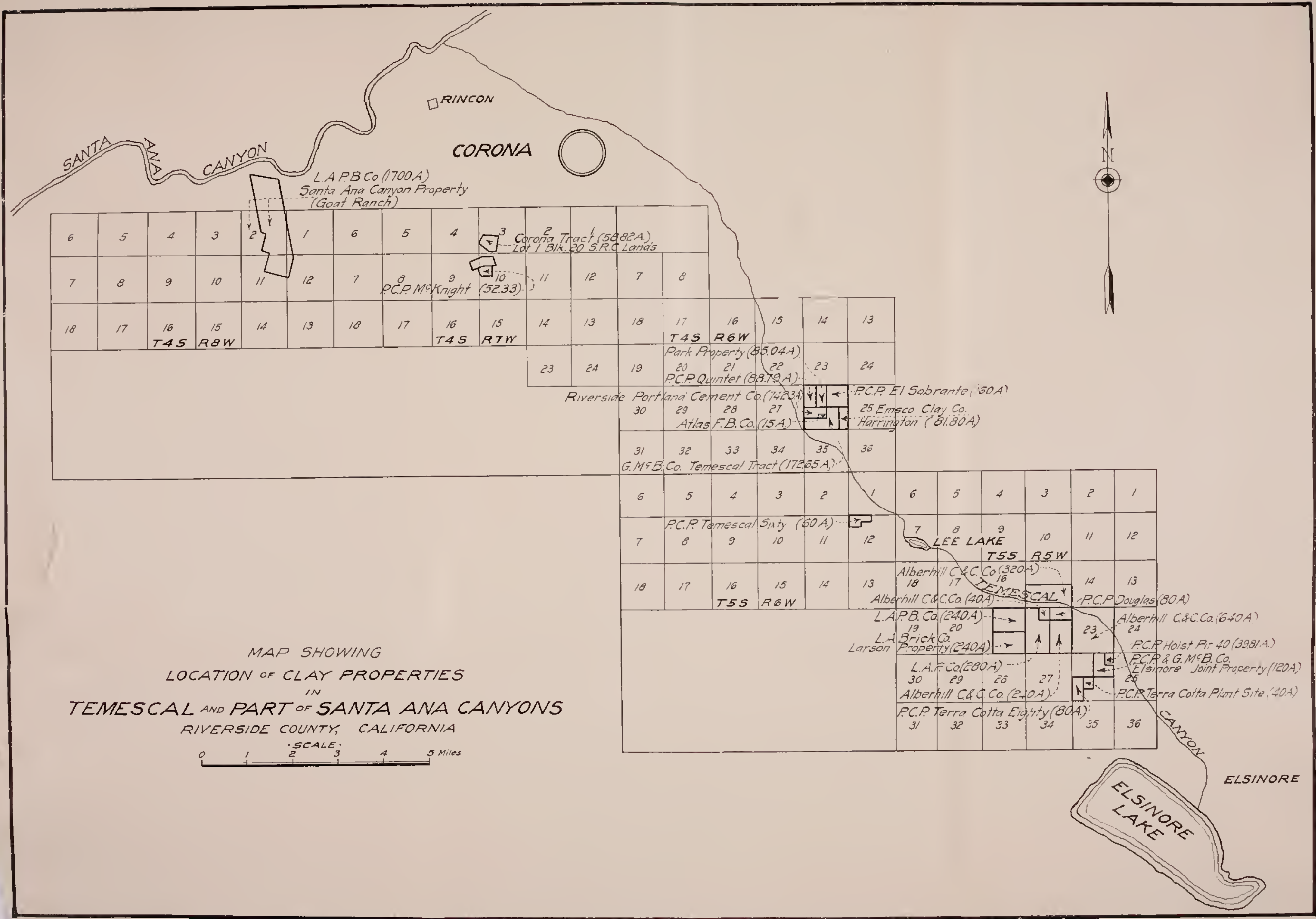

PLATE X. Property map of Alberhill-Corona district, Riverside County. (By courtesy of Robt. Linton.)

The Alberhill and other clay deposits of Temescal Canyon, Riverside County, California

By S. N. Daviess and M. N. Bramlette
Sept., 1942

Abstract

Clay is mined in open pits by several companies in the Alberhill district, and the refractory clays of relatively high alumina content are used largely for fire brick. The Alberhill Coal and Clay Company is the largest operator and has produced a little over 2,000,000 tons of clay, of which nearly half was the refractory type.

The clay occurs at the contact of the lower Tertiary and the Mesozoic basement complex. The weathered surface of basement rocks includes much clay of high iron and low alumina content, and the better clay occurs in the basal Tertiary sediments. The clay deposits vary rather abruptly in thickness and quality, and only local lenses contain workable deposits. Structural deformation makes dips of 10 to 20 degrees common and the clay strata therefore pitch under excessive overburden in short distances. Extensive deposits of thick alluvial fan deposits cover the clay-bearing strata over most of the area, and add to the overburden problems.

The apparent lack of clay deposits of good quality that would total several million tons of ore, and the geological conditions that would make exploration and mining difficult and expensive make this district unpromising.

Introduction

The examination of the clay deposits of Temescal Canyon forms part of the program to evaluate the clays of California and other States as possible ores for aluminum production.

The clay deposits of this district are located in Temescal Wash between Corona and Elsinore, in the western part of Riverside County, California. The largest deposits, so far as known, are centered around Alberhill, about 5 miles northwest of Elsinore. The paved State Highway 71 passes within less than a mile of most of the clay pits, and through the main pit area at Alberhill. A branch line of the Atchison, Topeka, and Santa Fe railroad follows the same route, and has sidings at the main clay pits.

The first mining was by the Elsinore Coal and Clay Co. for the low grade coal that is associated with the clay beds. Since 1897 these operations have been by the Alberhill Coal and Clay Co. The mining of coal was discontinued and this company has been the largest producer of clay from the district. Their production reached a maximum of about 100,000 tons annually in the early 1920-30 period, and was 54,704 tons in 1941. Their total production has been 2,165,000 tons but about half of this total was of lower grade, non-refractory clays. Only the more refractory clays, used largely for fire brick, are now being sold. Production figures of other operators are not available but their total perhaps exceeds 2,000,000 tons though most of this clay is of the less refractory types.

The mapping was done on aerial photographs by S. N. Daviess, with a preliminary examination and brief later visits by M. N. Bramlette. Detailed examination and sampling of the clay beds is possible only in the operating and abandoned pits, as natural outcrops of the clay strata are virtually lacking in the district. The accompanying map was compiled from the central part of the aerial photographs, but necessarily involved some adjustment of alignments and distortion of scale.

Geology

The formations shown on the map include (1) an undifferentiated basement complex of Mesozoic metamorphic and igneous rocks; (2) early Tertiary (Paleocene?) sandstone and shale that rests on a deeply weathered surface of the basement rocks; (3) Quaternary alluvial fan materials; and (4) Recent stream alluvium. The clay deposits occur at the contact of the Tertiary with the weathered surface of basement rocks.

The basement complex includes slate, phyllite, quartzite, and interbedded meta-volcanic flows, and probably correlates with the Santa Ana formation of questionable Triassic age. These rocks are intruded by several types of plutonic rocks of probable Jurassic age, and are overlain locally by thin sandstone lenses and volcanic breccias that may be of Cretaceous age. Where the contact between the basement complex and the basal Tertiary clay and lignite beds is exposed, the basement rocks are deeply weathered. The residual products of weathering vary greatly with the type of basement rock, but exposures of this weathered surface developed on the intrusive rocks were not seen in this area.

The early Tertiary (Paleocene?) strata generally have clay and lignite beds in the basal part, resting directly on the weathered basement complex, and in places it is difficult to distinguish any contact between the residual clay of these basement rocks and the sedimentary clay of the basal Tertiary. Approximately 45 feet of basal Tertiary clay, lignite, and quartz sand with clay matrix are exposed in the main pit of the Alberhill Coal and Clay Co. The grade and chemical composition of this clay varies, but in general the clay of highest alumina content occurs in the basal part of these beds. The shale and sandstone above the basal clay and lignite beds are poorly indurated, micaceous, and generally of greenish gray to brownish gray color. Nearly white sandstone is common in an area to the south of the Hoist Pit (southeast of Alberhill on map). Conglomerates locally present in this formation were not lithologically distinguishable from the Quaternary terrace gravels. Fossils found in this formation were of little value, but collections by previous investigators indicated a probable Paleocene age.

The Quaternary fan deposits are unconsolidated conglomerate and sand, and evidently represent several distinct periods of fan accumulation. These fan deposits cover large areas of Temescal Canyon, especially on the southwest side and thus prevent mapping or exploration of basal Tertiary clay deposits in much of the area. Streams have been entrenched in the large fans along the front of the Santa Ana range and have locally, as at the Twin Springs locality, exposed the clay beds.

Temescal Canyon is a graben lying between the Santa Ana Mountains to the southwest and the Temescal Mountains to the northeast. Thus a block of lower Tertiary sediments is confined to the valley floor and is bounded by a series of faults, with those on the southwest side having much greater total displacement than those on the northeast side. As very little mapping was attempted in the basement complex, these faults are shown on the map only where they cut the Tertiary rocks or limit their outcrop area. In general, the Tertiary rocks form a syncline, with subsidiary folds such as the small syncline north of Lake Elsinore. Presumably the general synclinal structure is related to the faulting that formed the main graben and, in part at least, may represent a large scale type of drag folding. The syncline is seen best on the map in the area between the Los Angeles Brick Co. pits and the Sloan pits of Gladding McBean Co.

Associated with the boundary faults of the graben are very many smaller faults that are well exposed in the clay pits. The faults in the main pit of the Alberhill Coal and Clay Co. have displacements of 4 to 25 feet. Some of the erratic dips, such as that at Twin Springs, probably reflect drag on unexposed faults.

Clay deposits

The refractory clay in this district occurs at the base of the Tertiary strata, with clays of higher iron content in the underlying weathered basement rocks. Sorting of the sediments now comprising the basal Tertiary produced only local deposits of relatively thick and pure kaolinitic types of clay, however, and these grade laterally into very sandy clay and sandstone. The refractory clay is white burning and is used largely for fire brick. The following analyses of clays from the Alberhill Coal and Clay Co. pits are quoted from the published report of Dietrich.1/

1/ Dietrich, W. D., The clay resources and the ceramic industry of California: Calif. State Min. Bureau, Bull. No. 99 (1928), p. 354.

	SH_5 Clay	SH_4 Clay	Select Main tunnel Clay	SH_3 Clay
Al_2O_3	42.21	34.58	26.28	25.85
Fe_2O_3	0.51	0.99	2.24	1.28
SiO_2	37.72	48.81	59.44	65.00
Loss	18.96	13.36	11.64	9.66
Other	0.86	2.24	0.61	2.21

The SH_3 clay is a plastic refractory clay that generally has a higher alumina content than that in the analysis quoted, and grades laterally into the bone clay (SH_4) that may or may not have pisolitic texture. One of the bone type (SH_5) samples shows an exceptionally high alumina content, and this type is commonly pisolitic and resembles bauxite. No gibbsite was recognized in this clay under the microscope, but perhaps some trihydrate of alumina is present in it as is suggested by alumina and water content that are higher than in kaolin. The SH_3 and Select Main Tunnel clays have a higher content of quartz sand that is reflected in the analyses.

The residual clays vary in character, depending on the type of basement rock, but are generally red-burning types that are used only for sewer pipe, tile, and common brick. The Select West Blue clay is an altered volcanic flow and is a higher quality clay than the more common mottled clays that are formed from metasediments. Analyses of these clays are also taken from Dietrich's report (p. 355):

	Pink Mottle clay	West Blue clay
Al_2O_3	15.19	22.99
Fe_2O_3	7.75	1.82
SiO_2	68.57	68.57
Loss	4.69	5.20
Other	3.67	1.42

The bone type of clay, with or without pisolitic texture, is the only clay with a high alumina content that is generally free of much quartz sand. This clay occurs below the lignite beds and sandy clays, and seems to be an uppermost part of the residual clay. It varies in thickness from less than one foot to about ten feet but is generally 3 to 5 feet thick.

Mining in this district is largely from open pits. Power shovels are used only in removing overburden, except at the Emsco Harrington pit, where a lower grade clay is mined by the shovels. The clay is sorted by hand at the Alberhill Coal and Clay Co. and Los Angeles Brick Co. mines. To obtain the refractory clays in the lower strata of the pits of the Alberhill Company, the overlying clay is removed, sorted, and placed in stock piles for possible future sale. At present over 50 feet of overburden must be removed in their Main pit to reach the upper part of the white burning clays. In the 46 feet of these clay and lignite beds about half is not used and the other half is hand sorted. The maximum thickness of clay that might be used for aluminum production would thus be less than 25 feet, with more than 50 feet of overburden. About 2,165,000 tons of clay has been produced by the Alberhill Coal and Clay Co. but approximately half of this has been the low grade, non-refractory clays.

The Los Angeles Brick Co. pits are becoming increasingly difficult to mine due to the steep dip of the clay strata. They are attempting to mine along the strike of the beds, but due also to the topographic relief, the overburden is increasing. Their Highpower pit contains an unusually high alumina clay that resembles bauxite in the pisolitic texture. This bed is locally 10 feet thick at the maximum, and pitches at 20 degrees under overburden that is at present 30 feet or more in thickness.

The Sloan pits of Gladding McBean Co. were abandoned due to the increase in overburden, with a maximum of about 10 feet of bone clay overlain by 20 to 40 feet of overburden. The Harrington pit of Emsco Refractories Co. cannot produce large tonnages without greatly increasing overburden that is already over 30 feet on the clay beds that include less than 15 feet of good refractory clay. The two pits between the railroad and highway, south of the Harrington pit (Map, No. 14 and 17) have only about 4 feet of high alumina clay with overburden of 10 to 30 feet. The Riverside Cement Co. prospect adit follows a bone clay that is 5 to 6 feet thick. This bed crops out just above basement rocks and is overlain by fan deposits that increase rapidly to 100 feet or more thickness. The pit of the Pacific Clay Products Co. in the northern part of the valley (Map, No. 16) is a residual mottled clay that would be of no value for alumina as it is very high in iron and probably low in alumina. In the Hoist pit of this company, southeast of Alberhill, some pisolitic bone clay occurs as small lenses overlying the residual mottled clays, and overburden consists of about 30 feet of Eocene sandstone. The Mortog pit north of Elsinore has been dug in the alluvium of the valley flat. Although no samples were available and the pit is now filled with water, the description by the former operator indicates that only about 18 inches of the clay was of the high alumina type and the overburden is 40 feet or more.

The clays of this district include both residual and transported or sedimentary types. The residual clays are generally mottled with a high iron content, but are variable depending on the bed rock from which they were formed. Only the uppermost few feet, immediately underlying the lignitic and sandy clays of the basal Tertiary, are of a high alumina type and this clay is commonly pisolitic. This seems to represent the high sesquioxide zone of the upper part of the usual lateritic profile of weathering. The clay of the immediately overlying lignitic and sandy strata is largely a high alumina (sedimentary) type that was apparently derived from the surface of the deeply weathered basement rocks, and redeposited in lenticular bodies of varying purity from admixed sand. Lack of fossils beneath the zone of weathering, and the meager fauna in overlying strata preclude a close dating of this period of intense weathering but suggest a Paleocene age.

Reserves

The many widely separated deposits of clay occurring at a single stratigraphic position make it seem probable that clay deposits aggregating many millions of tons are present in this district. The facts that these deposits are lenticular, are included with structurally deformed strata, and are covered with thick accumulations of overlying fan deposits make exploration and mining difficult and expensive. Exposures of the clay beds are virtually lacking except those opened by the pits, but these indicate that variations in thickness and quality are so rapid that projection of known clay beds can be safely assumed for only a few feet or tens of feet at most. The Alberhill Coal and Clay Co. has mined 2,165,000 tons of clay, of which about one half was a refractory clay of fairly high alumina and low iron content, and must of this was high in quartz sand. The total production of clay of probable value as an ore of aluminum is thus only a few hundred thousand tons. Consideration of the mine and prospect pits seems to indicate that less tonnage than the production to date may be included in the reserves. This property seems to be the most favorable one known, considering both the thickness of the clay deposit and the overburden problems. It therefore seems safe to assume the reserves represented in probable extension of deposits now being mined are not very large and may amount to only about a million tons of the refractory clay.

The unfavorable geological conditions for exploration would seem to make the cost excessive for any test drilling for new deposits.


GEOLOGIC MAP OF THE ALBERHILL – TEMESCAL CANYON AREA
EXPLANATION
Qal QUATERNARY ALLUVIUM Unconsolidated deposits in valleys and present stream channels
Qaf QUATERNARY ALLUVIAL FANS Unconsolidated Conglomerate and Sand
Te TERTIARY EOCENE (PALEOCENE?) Coal and clay strata overlain by sandstone, Shale and conglomerate
bc BASEMENT COMPLEX Metamorphic and intrusive and extrusive igneous rocks
PROSPECT
MINE TUNNELS
DRY HOLE
CLAY PIT
DUMP
SLUMP
INDEX TO CLAY PITS
ALBERHILL COAL AND CLAY CO.
1. MAIN PIT
2. PINK MOTTLE NO. 1
3. PINK MOTTLE NO. 2
4. PINK MOTTLE NO. 3
5. HILL BLUE NO. 1
6. HILL BLUE NO. 4
GLADDING-McBEAN CO.
7. OLD SLOAN PIT
8. RED SLOAN PIT
9. NEW SLOAN PIT
LOS ANGELES BRICK CO.
10. PIT NO. 1
11. PIT NO. 23
12. HIGHPOWER PIT
EMSCO REFRACTORIES CO.
13. HARRINGTON PIT
14. UNNAMED
PACIFIC CLAY PRODUCTS CO.
15. DOUGLAS PIT
16. UNNAMED
17. UNNAMED
18. HOIST PIT
19. TWIN SPRINGS
OTHER
20. MORTON PIT
21. RIVERSIDE CEMENT CO.
GEOLOGY BY STEVEN N. DAVIESS JULY 1942
SCALE = APP. 1/24000
BASE FROM A.A.A AERIAL PHOTOGRAPHS
CONFIDENTIAL
U.S. GEOL. SURVEY
FOR USE OF U.S. GOVERNMENT ONLY
Open File
N
Corona 8 miles
Lee Lake
ALBERHILL
AT & SF RR
ELSINORE
LAKE ELSINORE

GEOLOGY AND MINERAL RESOURCES OF THE

CORONA SOUTH QUADRANGLE

CALIFORNIA DIVISION OF MINES

BULLETIN 178

GEOLOGY OF THE CORONA SOUTH QUADRANGLE AND THE SANTA ANA NARROWS AREA

RIVERSIDE, ORANGE, AND SAN BERNARDINO COUNTIES, CALIFORNIA

AND

MINES AND MINERAL DEPOSITS OF THE CORONA SOUTH QUADRANGLE

RIVERSIDE AND ORANGE COUNTIES, CALIFORNIA

By CLIFFTON H. GRAY, JR.
Mining Geologist, California Division of Mines

BULLETIN 178

CALIFORNIA DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO, 1961

STATE OF CALIFORNIA
EDMUND G. BROWN, *Governor*

DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, *Director*

DIVISION OF MINES
IAN CAMPBELL, *Chief*

Bulletin 178

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CONTENTS

PLATES

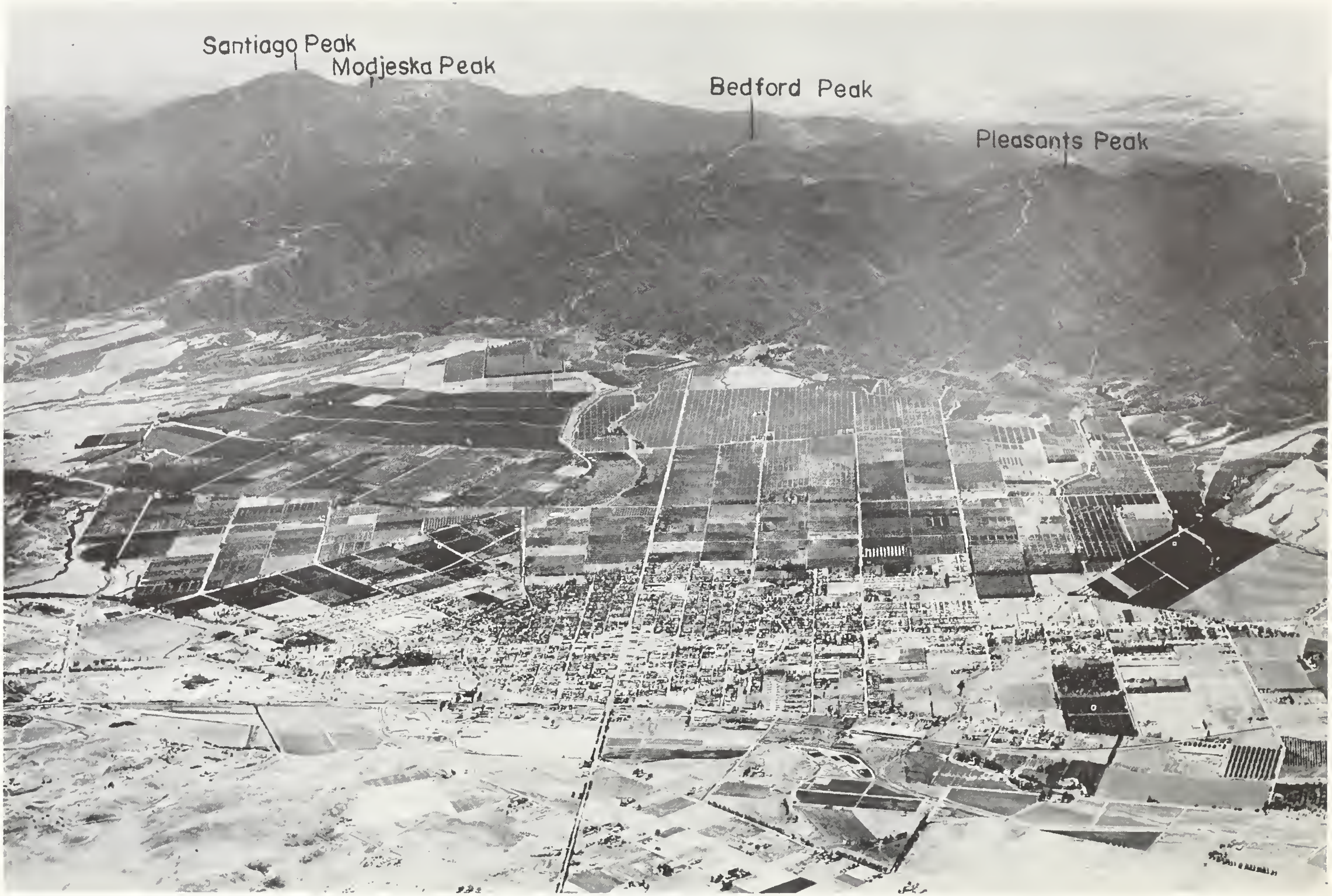

FIGURE 1. (Frontispiece). Oblique air photo of Corona and the Santa Ana Mountains taken April 29, 1957, camera facing south. The city of Corona (originally known as South Riverside in the 1880's and then characterized as the "Queen City," now as the "Circle City") in the foreground. The surrounding citrus groves are developed on a compound alluvial fan surface. Temescal Wash (northwest end of the Corona-Elsinore trough) is to the left. From right to left the trails leading up the ridges to the crest of the mountains are: Skyline Drive (extreme right, middle distance), Hagador fire break (Hagador Canyon to left), Main Street fire break (Main Street Canyon to left), Eagle Truck Trail (Eagle Canyon to right), Bedford Motorway (Bedford Canyon to right). The Main Divide Truck Trail is visible along the crest of the mountains. The low foothills consist of Cretaceous and Paleocene sedimentary rocks to the right of Hagador Canyon and Tertiary sediments to the left. The Elsinore fault bounds the mountain front and separates the Cretaceous and Tertiary sediments from the basement complex of volcanic and metasedimentary rocks which form the main mountain mass. The low San Joaquin Hills are in the background beyond the Santa Ana Mountains. *Photograph by Pictorial Crafts Incorporated, San Bernardino, California.*

ABSTRACT

The Corona South quadrangle and the adjoining Santa Ana narrows area lie in the northern part of the Peninsular Ranges. They contain the northwest end of the Elsinore trough which marks the trace of the Elsinore fault zone and trends northwestward across the center of the mapped area. The Chino fault diverges north-northwestward from its apparent junction with the Elsinore fault near the eastern margin of the Corona South quadrangle.

The oldest rocks, those of the Triassic Bedford Canyon formation, are metasedimentary in character, and occur mainly in the Santa Ana Mountains southwest of the Elsinore fault. Here they have been intruded by late Mesozoic plutonic rocks of the southern California batholith and in a few places are unconformably overlain by Jurassic (?) volcanic rocks. Northeast of the Elsinore fault is a succession of sedimentary rocks, several thousand feet thick, which includes rocks of Upper Cretaceous through Quaternary age. These units are of types found to the west in the Los Angeles Basin.

The dominant structural features are the Elsinore and Chino zones of high-angle reverse dip-separation faults and a synclinal trough which extends from the Puente-Chino Hills southeastward beyond Corona and lies nearly parallel to and to the northeast of the Elsinore fault. The surface distribution of Cretaceous sedimentary rocks indicates a probable minimum vertical displacement of 1,500 feet along the Elsinore fault southwest of Corona, whereas to the southeast a displacement of more than 5,000 feet is suggested by the difference in elevation of the basement complex on opposite sides of the fault. In post-Pliocene time, and perhaps throughout their history, the Elsinore and Chino fault zones have had an apparent high angle reverse sense of movement. Large lateral displacement may have occurred in pre-Pliocene time, but has not been demonstrated in the mapped area. In the Corona area the Elsinore trough is probably a faulted syncline.

Mining operations, especially for clay, crushed and broken stone, and glass sand, have been carried on since the late nineteenth century. Repeated, though unsuccessful, attempts have been made to find petroleum.

GEOLOGY OF THE CORONA SOUTH QUADRANGLE AND THE SANTA ANA NARROWS AREA

RIVERSIDE, ORANGE, AND SAN BERNARDINO COUNTIES, CALIFORNIA *

By CLIFFTON H. GRAY, JR.
Mining Geologist, California Division of Mines

OUTLINE OF REPORT

* Based in part upon a thesis presented to the Claremont Graduate School in partial fulfillment of the requirements for the degree of Master of Arts in Geology.

Illustrations

Illustrations—Continued

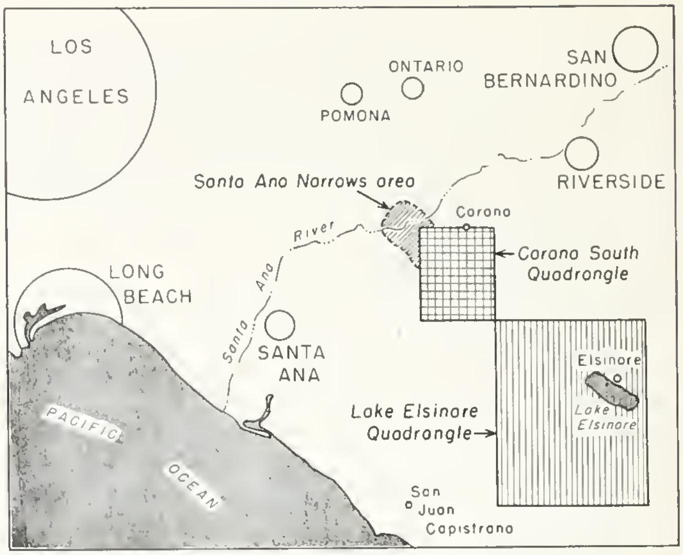

FIGURE 2. Outline map of a portion of southern California and index map of Corona South quadrangle-Santa Ana narrows area.

INTRODUCTION

Location and Accessibility. The area herein described and shown on the accompanying maps lies mostly in western Riverside County, California, but the northwestern part of the map also includes small bits of San Bernardino and Orange Counties and the southwestern part of the Corona South quadrangle lies in Orange County. The approximate geographical center of the area is 4 miles southwest of Corona and 45 airline miles southeast of Los Angeles. The Santa Ana Mountains, one of the Peninsular Ranges, bound the area on the southwest and form the highest and most rugged topography.

In the central part of the area, along the northeastern margin of the Santa Ana Mountains, the Corona compound fan surface slopes gently toward the northeast across the northwest end of the Corona-Elsinore trough, a graben-like valley that extends from Corona to Elsinore. The Corona fan extends as far as Temescal Wash, which marks the northeast side of the Corona-Elsinore trough, beyond which the topography again rises to form the Cajaleo bench (Perris Block, Temescal Mountains, or Gavilan Hills).

The northwest part of the map area is occupied by the southeastern tip of the Puente Hills (Chino Hills). These low hills are separated from the Santa Ana Mountains by the west-southwestward flowing Santa Ana River. The whole area makes a strip approximately fifteen miles long and contains about 75 square miles. Most of the district is reasonably accessible by wheeled vehicles. State Highways 18 and 71 cut across the region and dirt roads give access to the lower parts of the major canyons. Several U. S. Forest Service fire control roads cross the Santa Ana Mountains, but only the Corona Skyline Drive is suitable for standard automobiles. The region southwest of the Elsinore fault is within the Cleveland National Forest which is closed to public use during the summer months because of the high fire hazard.

Physical Features. The area to be discussed lies in the Peninsular Ranges province of southern California. The region in general consists of alluviated valleys separated by rather narrow mountain ranges, which trend northwestward. The flat lands are mostly less than 1,500 feet above sea level and slope gently up to the bases of the mountain ranges. The mountains rise sharply above the alluvial plains to summits that are commonly between 3,000 and 5,000 feet above sea level. Extending northeastward from the Santa Ana Mountains toward Corona is a compound alluvial fan that ranges from 700 feet at Corona to about 1,400 feet elevation at Bedford Canyon.

The drainage system of the Corona area shows a crude gridiron pattern, and surface water flows intermittently. Most of the area is drained by Temescal Creek which flows northwestward through Temescal Canyon. Northwest of the city of Corona it empties into the southwestward-flowing Santa Ana River, the major river, and the only perennial river, in the region. The northeast side of the Santa Ana Mountains, east of Main Street Canyon, drains northeastward to Temescal Creek. West of Main Street Canyon the Santa Ana Mountains drainage is to the north and northwest into or toward the Santa Ana River, but many of the smaller streams flow only a short distance from the mountains before losing their identity on the old alluvial surface of the Corona fan. In general, the main canyons on the east slope of the Santa Ana Mountains are normal to the trend of the mountains, but their tributaries, which enter the larger canyons at right angles, are parallel with the axis of the mountain mass. The principal canyons on the west slope of the Santa Ana Mountains, in the southern part of the area, are nearly parallel to the mountains, and their tributaries are transverse. Their streams eventually join Santa Ana River to the west through Santiago Creek.

The summers are long and warm, the winters are generally moderate, and the air is dry. In summer, showers are infrequent and of short duration. In winter, the precipitation is mainly rain. Snow occasionally falls on the higher peaks and very rarely at lower elevations. The average mean annual temperature is reported to be 62.7° F at Corona, and the annual rainfall there averages 13.3 inches.

The vegetation is sparse in the lower country but is commonly dense and difficult or impossible to traverse above the 1,000-foot contour. It is the sagebrush type characteristic of the California chaparral life zone. Higher in the mountains there is an abundance of thick brush and a few live oak and pine trees. The common plants include black sage, sagebrush, California holly, elderberry, mountain mahogany and prickly pear cactus.

Previous Geologic Work. No previous geologic work has covered in detail the entire area of this report. Several published reports, however, include the general region or parts thereof, but most papers have been of a reconnaissance nature or deal with small areas.

J. D. Whitney, in 1865, gave the first description of the Santa "Anna" and Temescal Ranges in volume I of the Geological Survey of California. He noted the topography, occurrence of sedimentary and crystalline rocks and the complex structure. P. H. Dudley (1935) and R. J. Sampson (1935) described the geology and mineral resources of a portion of the Perris Block, which includes that part of the area northeast of Temescal Canyon. Later Dudley (1936) described the physiographic history of the Perris Block. J. C. Sutherland (1935) described the clays of Riverside and Orange Counties, including those of the old McKnight mine southwest of Corona. In 1945 the California Division of Mines published a brief account of the mining activities of the Riverside County part of the area in the State Mineralogist's Report.

Esper S. Larson, Jr. (1948) described the crystalline rocks in the region southeast of the Santa Ana River. The sedimentary rocks were not differentiated. Later E. H. Pampeyan (1952) mapped in more detail the crystalline rocks of the Cajalco area to the east of, and including, the Temescal Canyon part of the Corona South quadrangle. J. E. Schoellhamer and others (1954) published a detailed geologic map of the northern Santa Ana Mountains, including the Black Star Canyon quadrangle adjacent to the west edge of the Corona South quadrangle. Also in 1954, R. H. Jahns published a generalized geologic map of the Peninsular Ranges province and a geologic guidebook on the northern part of the Peninsular Ranges province.

Purpose and Methods. This paper describes the geology of the northeastern Santa Ana Mountains, the southeastern Puente-Chino Hills, and the northern part of the Elsinore-Corona trough with special emphasis on structure, particularly the relationships of the Elsinore, Whittier, and Chino faults.

Most of the field mapping in the Santa Ana Mountains was done on 1:12,000 Department of Agriculture aerial photos, series AXM. The Temescal Canyon region was mapped on Fairchild aerial photos at the scale of 1:12,000. Northwest of the Santa Ana River the field mapping was done on 1:12,000 U. S. Geological Survey aerial photos, series GS-CP.

The principal base map on which the field data were plotted is the 7½ minute U. S. Geological Survey Corona South quadrangle sheet published in 1954. A planimetric base map was used for the Santa Ana narrows area, and was traced from the 7½ minute Prado Dam and Black Star Canyon quadrangle sheets of the U. S. Geological Survey, published in 1950.

Geologic mapping of the Corona South quadrangle and Santa Ana narrows area was started in September 1950 and continued intermittently until February 1957. Most of the detailed mapping of the sedimentary rocks was done between January and August of 1951. The contacts between the igneous and metasedimentary rocks are generally shown as approximate as, in most places, they are obscured by dense brush.

The crystalline rocks north of State Highway 71 in the Temescal Canyon region were examined only in reconnaissance. The distribution of these units was taken, with minor modifications, from an unpublished report by E. H. Pampeyan (1952).

Acknowledgments. The writer wishes to express his appreciation of aid and information furnished by A. O. Woodford and J. S. Shelton of the Pomona-Claremont

College Geology Department and J. E. Schoellhamer and R. F. Yerkes of the U. S. Geological Survey. J. G. Vedder of the U. S. Geological Survey checked the Paleocene, Miocene and Pliocene megafossils. Patsy B. Smith of the U. S. Geological Survey kindly identified the Pliocene and Miocene microfaunas. Richard H. Jahns of the California Institute of Technology read the structural geology chapter and contributed helpful suggestions.

The willing cooperation of the many property owners in allowing the writer to go upon their properties is gratefully acknowledged. The U. S. Forest Service was most cooperative in allowing the writer access to the Cleveland National Forest.

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The writer owes much to his associates of the Division of Mines and in particular to Oliver E. Bowen, Jr. and Lauren A. Wright, who read the manuscript critically. R. A. Crippen, Jr. assisted materially in preparation of the illustrations.

DESCRIPTIVE GEOLOGY

General Features

The Corona area may well represent the easternmost extension of sedimentary rock types found in the Los Angeles Basin, which is adjacent to the area to the west. The area appears to have been once covered by a rather thick and nearly complete succession of Mesozoic and Tertiary sedimentary rocks (pl. 4). In Plio-Pleistocene time these rocks were folded into a great anticline with the axial trace roughly along the present crest of the Santa Ana Mountains. A syncline was formed to the northeast and is now exposed in the Puente-Chino Hills where it is known as the Arena Blanca syncline. This syncline may extend to the southeast into the northwest end of the Corona-Elsinore trough at least as far as Brown Canyon, which is 7 miles southeast of Corona, at the east edge of the Corona South quadrangle. Later, probably in late Pleistocene and Recent time, the core of the Santa Ana Mountains, which consists of pre-Tertiary crystalline rocks, was raised by a high-angle reverse fault along the northeastern margin of the mountains.

The oldest rock unit exposed is the Bedford Canyon formation of metasedimentary rocks. It is Triassic in age and forms the highest, central portion of the Santa Ana Mountains in the area, and part of the Perris Block, which lies mostly outside the mapped area east of Temescal Wash.

Resting unconformably upon, but locally faulted against, the Bedford Canyon metasedimentary rocks in the Santa Ana Mountains are the Jurassic (?) Santiago Peak volcanics. Intrusive rocks, probably related to the Santiago Peak sequence, cut the Bedford Canyon strata.

East of the Corona-Elsinore trough, in the Temescal Canyon area, are crystalline rocks that have been described (Pampeyan, 1952, p. 14) as representing two closely-spaced and possibly related periods of intrusion. In the first period the Temescal Wash quartz latite porphyry and the Corona hornblende granodiorite porphyry were successively intruded into older marine sedimentary rocks. The second period is represented by the emplacement of batholithic rocks—Cajalco quartz monzonite and the Home Gardens quartz monzonite porphyry—into the sedimentary units and earlier igneous bodies. Pampeyan suggests that the first period of intrusion may be Jurassic and Early Cretaceous in age and that the second period is later Cretaceous. If this is true, the Santiago Peak volcanics and the intrusive bodies related to them in the Santa Ana Mountains are probably related in time to the first period of intrusion in the Temescal Canyon region.

The plutonic rocks of the second period are represented in the mapped area of the Santa Ana Mountains by the San Marcos gabbro and in the Temescal Canyon area by the Cajalco quartz monzonite and the Home Gardens quartz monzonite porphyry. These rock types are also present southeast of the Corona area in the Santa Ana Mountains (Larsen, 1948, map). They also occur beneath the younger rocks of the Corona-Elsinore trough, as samples from three wells east of Bedford Canyon reveal biotite quartz diorite, biotite quartz monzonite, and hornblende granodiorite.

In the Santa Ana Mountains the oldest unmetamorphosed sedimentary rock unit exposed is conglomerate of the Cretaceous Trabuco formation. It is in fault contact with the Santiago Peak volcanic rocks and apparently grades both vertically and laterally into the basal sandstone and conglomerate of the Late Cretaceous Ladd formation. The basal part of the Ladd formation is the Baker Canyon conglomerate member of sandstone and conglomerate. It is conformably and successively overlain by the Holz shale member, and undifferentiated siltstone and shale with interbedded sandstone and conglomerate also of the Ladd formation.

A fault contact separates the Ladd formation from the younger Paleocene Silverado formation, composed of marine and nonmarine beds that are chiefly sandstone, conglomerate and clayey siltstone which intertongue. The Silverado formation in the Santa Ana narrows area grades imperceptibly upward into Eocene Santiago formation siltstone, sandstone, and conglomerate.

Resting unconformably upon the Silverado formation in the eastern part of the Corona South quadrangle are sandstone, conglomerate, and siltstone of the late Eocene to early Miocene Vaqueros-Sespe group, which is mapped as a single unit. In the southeastern Puente-Chino Hills this unit is conformably overlain by sandstone of the middle Miocene Topanga formation.

In El Cerrito Village area of the Corona South quadrangle the Topanga formation apparently rests unconformably on Silverado sandstone and is succeeded conformably by sandstone, conglomerate and shale of the upper Miocene Puente formation, undifferentiated. West of the map area, in the northwestern tip of the Santa Ana Mountains and in the Puente-Chino Hills, Schoellhamer and others (1954, map) have divided the Puente formation into four members. From bottom to top these are: La Vida member, the Soquel member, the Yorba member, and the Sycamore Canyon member.

On Scully Hill in the Santa Ana narrows map area in the southeastern Puente-Chino Hills, the Topanga formation is conformably overlain by La Vida member (shale) which is in fault contact with the overlying Soquel member (sandstone) of the Puente formation.

The Yorba member (shale) conformably overlies the Soquel member and is conformably overlain by the Sycamore Canyon member (sandstone and conglomerate) of the same formation. The Puente strata grade upward into Pliocene (?) sandstone, conglomerate, and shale.

Along the northeastern margin of the Santa Ana Mountain the Vaqueros-Sespe group is overlain in fault contact by the Puente formation, mapped as undifferentiated, which in turn is apparently conformably overlain by Pliocene (?) rocks, which consist of sandstone and minor conglomerate and shale beds.

The central part of the area (in the vicinity of Corona) is a dissected compound alluvial fan. Well-developed terrace deposits rest unconformably on the Mesozoic and Tertiary sedimentary sequence at many places. Alluvial "dirty" appearing sand and gravel fill the stream valleys.

Stratigraphy

Triassic System

Bedford Canyon Formation

The oldest rocks in the mapped area are moderately metamorphosed argillite, slate, graywacke, and quartzite with minor amounts of limestone and local thin-bedded tuffaceous strata. These comprise the Bedford Canyon formation and underlie much of the northern part of the Santa Ana Mountains. Somewhat similar metasedimentary rocks have been mapped (Larsen, 1948, map) for distances of at least 50 miles to the southeast and 30 miles east of the Corona South quadrangle.

Smith (1898, pp. 776-786) applied the term Santa Ana to a limestone in slates in the western part of the Santa Ana Mountains. Merrill (1916, pp. 639-640) used the term Santa Ana metamorphic strata for the slates. Dudley (1935, p. 493) called a series of well-exposed metasedimentary rocks near Elsinore, California, the Elsinore metamorphic series. Larsen (1948, p. 19) proposed the name Bedford Canyon formation for the metamorphic rocks of the region because "the rocks are well exposed and contain fossils in that canyon". This later name seems preferable and is used herein.

The rocks of the Bedford Canyon formation crop out continuously from the eastern margin of the area to Tin Mine Canyon and form the crest of the Santa Ana Mountains. The formation also is well-exposed along the north side of Temescal Canyon where the canyon is entered by Cajalco Road. Because of the complex nature of these metamorphic rocks, their poor exposures, the lack of traceable beds or marker horizons, and the generally impenetrable brush-covered slopes, the formation was not subdivided on the geologic map. The Bedford Canyon formation commonly forms weak, rounded slopes, a much less rugged topography than that developed on the overlying Santiago Peak volcanics. The Bedford Canyon strata are characterized by alternating thin beds, ranging from one inch to several feet in thickness, of impure feldspathic sandstone and somewhat slaty shale.

Probably the most abundant metasedimentary rock types in the Bedford Canyon formation in the Santa Ana Mountains are silty argillite and slate. On fresh surfaces these rocks are black or blue-black with a very fine-grained texture. Slaty cleavage is only weakly developed.

Impure quartzite and graywacke are comparable with argillite in abundance, and are well-exposed in the railroad cut just north of Cajalco Road, along Tin Mine Canyon, and along several fire control roads in the Santa Ana Mountains. The quartzite and graywacke have in general a bluish-gray to yellow-brown or rusty orange color and form steep-sided gorges in the Santa Ana Mountains. Lenses of grayish-black conglomerate, containing angular pebbles and cobbles, are locally present. Bedding is indistinct, whereas fractures and joints are well-developed.

FIGURE 3. Sheared, strongly deformed, and moderately metamorphosed interbedded graywacke (light-colored beds) and slaty shale and argillite (dark-colored beds) of the Bedford Canyon formation. Note minor faults. Typical roadcut exposure along Silverado Motorway, half a mile north of Silverado Canyon. Observer faces east.

The quartzite exposures consist almost wholly of fine- to medium-grained, subrounded to subangular quartz grains, but also contain a minor amount of feldspar and sparse heavy minerals. Microscopic examination shows that some of the quartzite grains consist of quartz in a very fine-grained silicified matrix, rather than interlocking quartz grains. Quartz veinlets are replaced by iron oxides and grains of iron oxides are abundant. Some of the quartzite is poorly sorted with much interstitial clay.

FIGURE 4. Closely folded, thin-bedded, graywacke and argillite of the Bedford Canyon formation. Exposed in cut on Silverado Motorway. Observer faces east.

FIGURE 5. Minor fold in the Bedford Canyon formation showing detail of interbedded graywacke and slaty argillite. Exposed in cut on Silverado Motorway. Observer faces east. Figs. 3, 4, and 5 are typical exposures of the principal lithology of the Bedford Canyon formation and illustrate the similar appearance of most outcrops in large areas underlain by these rocks.

The typical graywacke is poorly sorted and contains subangular, tightly packed to interlocking quartz, feldspar, and dark rock fragments that range in diameter from 0.1 mm to 1.5 mm. Minor interstitial silicified clay is present and much secondary iron oxide occurs on quartz and feldspar grain contacts. Some specimens contain many small grains of epidote and have siliceous cement. Calcite, however, is the principal cement and forms as much as 15 percent of the graywacke. Good exposures in road cuts show that the argillite, slate and graywacke are considerably deformed (figs. 3, 4, 5). The rocks are generally much fractured and jointed and weathered a yellow-brown or tan. Many exposures show thin, alternating beds of argillite and fine-grained, impure quartzite or graywacke.

Dark gray to blue-gray and black limestone with an aphanitic texture crops out in only a few places in the Corona South quadrangle. It occurs as small, irregular lenses within the slate and graywacke. The limestone is crystalline, is poorly bedded, massive, and weathers light gray or brownish-gray. In a few exposures the limestone is somewhat banded, perhaps as a result of flowage, but the banding may represent original bedding. The carbonate bodies appear to be parallel in attitude with the enclosing arenaceous metasedimentary rocks and stand out as resistant ledges. The limestone is fetid, cut by numerous veinlets of medium-grained, macrocrystalline, secondary white calcite and is moderately silicified. In some places, especially on weathered surfaces, the limestone appears to be a breccia.

The largest lens of limestone (see fig. 23, in mineral deposits section) crops out along the west side of the East Fork of Ladd Canyon. This carbonate lens is about 100 to 200 feet in width and several hundred feet in strike (?) length. This limestone body may have formed in quiet shallow water, mostly as an algal reef. The lower few feet of limestone contains many pelecypods with the valves attached and a few small ammonites and upward the limestone contains abundant algallike forms. The upper part, however, appears to be more clastic than the lower fossil-bearing strata. Several smaller limestone lenses occur along the east side of Bedford Canyon, east of Bedford Motorway. Limestone beds, only a few feet wide and several tens of feet, or less, long were observed at several places along the crest of the mountains and on the west slope.

White to greenish-gray strata, probably tuffaceous, crop out along the Main Divide truck trail at the west edge of the Corona South quadrangle and on the ridge between Ladd Canyon and its west fork. These rocks are thin-bedded, much fractured, very fine-grained and highly siliceous. The tuffaceous bodies, which have areal extents of only a few hundred feet, are apparently intercalated with graywacke, slate and argillite near the top of the Bedford Canyon formation.

In most places the Bedford Canyon formation is overlain, apparently unconformably, by the Santiago Peak volcanics. Locally, however, it is faulted against the volcanics. East of Bedford Canyon, along the northeastern side of the mountains, the Bedford Canyon formation is faulted against Tertiary sedimentary rocks.

According to Irving (1935) a thickness of 11,800 ± feet of metasedimentary rocks occurs a few miles southeast of the Corona South quadrangle in the Perris Block along Temescal Canyon. The true thickness of the Bedford Canyon formation in the mapped area is not known as the base was not encountered and the top has been removed by erosion. Larsen (1948, p. 22) reports that the base of the Bedford Canyon formation is nowhere exposed but that probably a thickness of 20,000 feet is exposed in the Santa Ana Mountains. As the metasedimentary rocks of the formation show such a great variation of attitude, are so highly deformed, so poorly exposed, and rarely show well-preserved bedding an attempt to measure sections or thickness would prove fruitless. However, the writer suspects that the 20,000-foot thickness figure is probably excessive for the Bedford Canyon formation in the northwestern part of the Santa Ana Mountains.

Paleontology

Fossils of Triassic age from limestone in upper Bedford Canyon, 6 miles southeast of Corona, and in the East Fork (?) of Ladd Canyon on the south slope of the mountains, have been reported by J. P. Smith (1898, p. 779), Mendenhall (quoted in Willis, 1912, p. 505), Cooper (quoted by Larsen, 1948, p. 18) and Engel (1959, pp. 19, 20, 22-24).

East of Bedford Canyon (from NW cor. sec. 29, T. 4 S., R. 6 W., S.B.M., 2600′ S and 400′ E) a tiny body of dark gray limestone crops out and is about 10 feet in diameter. This limestone (apparently the above mentioned Bedford Canyon locality) contains abundant rhynchonelloid brachiopod debris but the material collected by the writer (March 1956) was too poor to assign names. Engel (1959, p. 24) tentatively identified *Halorella* from this locality.

Fossils from a limestone body in the East Fork of Ladd Canyon have recently been illustrated by Engel (1959, pp. 20, 23) who assigns them to the pelecypod *Daonella sanctacanae* Smith and to the Upper Triassic ammonite genera *Discotropites* and *Juvavites*.[1]

[1] In April 1960, after this manuscript was prepared for publication, the writer, together with N. J. Silberling and J. E. Schoellhamer of the U. S. Geological Survey, collected several small, imperfectly preserved, ammonites and a number of specimens of one pelecypod, many with the valves attached, from the large limestone lens along the west side of the East Fork of Ladd Canyon (from SE cor. sec. 34, T. 4 S., R. 7 W., S.B.M., 900′ N. and 1,000′ W.). This is probably the same locality from which the fossils illustrated by Engel were obtained.

Jurassic (?) System

Intrusive Rocks Related to Santiago Peak Volcanics

Larsen (1948, p. 27) has noted that a number of small bodies of fine-grained granodiorite and related rocks, believed to be about the same age as the Santiago Peak volcanics, crop out in the Corona, Elsinore, and San Luis Rey 30-minute quadrangles. A similar age apparently can be applied to fine- to medium-grained, generally porphyritic basic intrusive rocks that form a group of small, irregular-shaped bodies in the Santa Ana Mountains in the southern part of the Corona South quadrangle. These bodies are mainly along the watershed divide between Bedford Peak and Bald Peak and along the Bedford Motorway; in a stock-like body in Silverado Canyon; and in a number of narrow dikes or sills, chiefly in the southeastern part of the quadrangle. The area underlain by these rocks totals about 2 square miles.

The granodiorite and related rocks are intrusive into Triassic Bedford Canyon formation metasedimentary rocks which are somewhat altered around some of the intrusive bodies. In a few places parts of intrusive bodies are faulted against the Bedford Canyon formation. The intrusive rocks are commonly resistant to weathering and form prominent high peaks and steep slopes along the crest of the Santa Ana Mountains, but there are also deeply weathered bodies. The intrusive rocks are gray or grayish-green in color, form rugged, angular outcrops, and in many places readily break into small fragments. In these respects, and also in their general petrologic features, these rocks resemble the mildly metamorphosed Santiago Peak andesitic volcanic rocks. The intrusive bodies are mostly hornblende andesite, with some quartz latite, hornblende diorite, and minor basaltic rocks. In many places the rock contains inclusions of sand grains and fragments of fine-grained sedimentary rocks, in a very fine-grained, severely altered, igneous groundmass. These masses apparently are shallow intrusions and marginal facies of larger and deeper intrusions. Small surface flows may be included in some intrusive bodies.

Larsen (1948, p. 27) believed these intrusive rocks to be associated with the Santiago Peak volcanic rocks because: (1) they are closely associated in space with the volcanic rocks; (2) have undergone about the same degree of metamorphism as the volcanic rocks; (3) are finer-grained and more porphyritic than the rocks of the batholith and have the texture characteristic of small volcanic plugs; and (4) wherever their relation to the batholithic rocks was determined, they are older. These criteria also apply to the intrusive bodies exposed in the Corona South quadrangle, except that at no place within the quadrangle was the relation between the intrusive rocks and those of the batholith observed.

According to Ralph W. Imlay and Norman J. Silberling, Paleontology and Stratigraphy Branch, U. S. Geological Survey (personal communication, 1960), "the pelecypods in this collection belong to *'Daonella' sanctaeanae* Smith, a *Posidonia*-like form that probably represents a new genus. The ammonites are provisionally identified as follows:

Calliphylloceras sp. juv.
Partschiceras ? cf. P. grantzi Imlay
Lytoceras ? sp.
Hecticoceras ? (Sublunuloceras ?) sp.
Macrocephalites ? sp.

This fauna is Jurassic in age and is probably of early Late Jurassic (Callovian ?) age."

Inasmuch as these fossils occur in only one limestone lens, which has not been assigned a definite stratigraphic position in the Bedford Canyon formation, the age of the entire formation is not established. Perhaps the Bedford Canyon formation includes rocks of both Late Jurassic and Triassic age.

The prominent, roughly circular intrusive body in Silverado Canyon is a dark green, cliff-forming, blocky weathering, hornblende andesite. A narrow, apparently closely associated zone of white, altered rhyolite tuff along its west margin is included with this body on the geologic map. The andesite contains feldspar crystals and hornblende, much replaced by chlorite, in a very fine-grained andesitic groundmass. Several smaller tabular intrusive bodies to the east along Silverado Canyon are of similar composition.

A large irregular stock near Bald Peak is mostly hornblende andesite, but is much contaminated by Bedford Canyon metasedimentary rocks and some basaltic material. This andesite contains large zoned and twinned andesine phenocrysts which are variously oriented in an altered groundmass. Ferromagnesian minerals generally are thoroughly altered, but some specimens contain hornblende and augite. The rock contains abundant chlorite, epidote, and secondary silica. Most samples show quartz veinlets and abundant secondary (?) iron oxides and iron sulfides (pyrite, pyrrhotite ?).

The irregularly shaped body along Bedford Motorway is also hornblende andesite. In some places it is a much altered, calcitized, chloritized andesitic (?) rock without ferromagnesian minerals. Elsewhere, andesine laths comprise the groundmass in which are abundant hornblende phenocrysts commonly altered to penninite. The rock has been epidotized and silicified and considerable opaque minerals (magnetite and pyrite ?) are present.

Southeast of Bedford Peak a small stock on the crest of the ridge forms a prominent topographic feature. It is a quartz latite porphyry and contains biotite and hornblende.

The dikes in the Bedford Canyon formation metasedimentary rocks are mostly andesite porphyries. Specimens from a dike in Brown Canyon show large andesine phenocrysts in a groundmass of feldspar, chlorite, and iron oxide grains. Ferromagnesian minerals are thoroughly altered but the rock contains pyrite cubes. Some dikes are quartz latite porphyries and contain phenocrysts of hornblende, feldspar, and augite in a groundmass of quartz, feldspar, and augite.

The stock at the crest of the mountains at the head of the West Fork of Ladd Canyon, just west of Pleasants Peak, is hornblende diorite. In some places it is a very coarse-grained hornblende diorite with the feldspar much altered. Elsewhere it exhibits diabasic, often a coarse, pronounced, ophitic texture with large phenocrysts of andesine and chloritized hornblende, and contains a considerable number of iron oxide grains. Some of the rock contains several percent of interstitial quartz. The entire stock contains much secondary carbonate, chlorite, and epidote. Along the west margin of this stock on a small knob at the crest of the mountains is a small body of green to blackish-green serpentine only about 150 feet in diameter. It is broken into small fragments, is slickensided, is cut by numerous calcite veinlets, and contains some soft, green, talcose material. In thin section the rock exhibits iron oxide (magnetite ?) grains and calcite "eyes". Rugged, cliff-forming dark reddish brown silica-carbonate rock with veinlets of iron oxide forms a crude aureole on the south and west sides of the serpentine body. The silica carbonate body occurs along a fault zone and is probably hydrothermal in origin and may be de-

Figure 6. A typical exposure of the Santiago Peak volcanics (hornblende andesite). Cut at the foot of Skyline Drive, north side of Tin Mine Canyon. Observer faces west.

rived from alteration of serpentine. The serpentine is probably the alteration product of a ferromagnesian-rich phase of the hornblende diorite intrusive.

Santiago Peak Volcanics

According to Larsen (1948, p. 23) outcrops of the Santiago Peak volcanics lie in a discontinuous belt that extends from south of La Jolla nearly to the Santa Ana River. The exposed length of the belt is about 80 miles but its maximum width is not much over 10 miles. These rocks are exposed on both the northeast and southwest flanks of the Santa Ana Mountains. They were originally called the Black Mountain volcanics in La Jolla quadrangle by Hanna (1926, pp. 199-204).

On the east slope of the Santa Ana Mountains these volcanic rocks, which consist mostly of slightly metamorphosed andesitic flows and breccias, crop out from just west of Bedford Canyon to State Highway 18 at Santa Ana Canyon. South of Tin Mine Canyon and southeast to Bedford Canyon they form the middle elevations of the mountains, whereas to the northwest they extend to the crest. On the west slope the volcanic rocks crop out at the crest of the mountains in the vicinity of Pleasants Peak and extend southward along the West Fork of Ladd Canyon and west beyond the west margin of the Corona South quadrangle. These volcanic rocks are resistant to erosion and form rugged topography, commonly with sheer cliff faces.

In normal sequence the Santiago Peak volcanics apparently overlie the Bedford Canyon formation unconformably with almost 90° difference in dip, but locally the metasedimentary rocks are faulted against the volcanics and may be thrust over them. A small pod of Bedford Canyon quartzite, exposed along the Skyline Drive at the west edge of the Corona South quadrangle, has been engulfed by Santiago Peak andesite, and dikelets of the andesite invade the quartzite.

In general the volcanic rocks are dense and compact and on fresh exposures are dark grayish-green to greenish-black with some lighter colored zones. In many places they show a characteristic hypabyssal texture. The weathered surface of most outcrops is gray or greenish-

Figure 7. Detail of the Santiago Peak volcanics shown in fig. 6. Quarter (in circle) gives scale. The white plagioclase phenocrysts contrast with the dark greenish-gray groundmass.

gray and the overlying soil is dark reddish-brown, buff, or greenish-gray. Andesite and dacite are the commonest rock types; quartz latite and rhyolite are much less common. Most of the volcanic sequence is massive pyroxene or hornblende andesite. Phenocrysts of feldspar are commonly apparent in hand specimens; phenocrysts of mafic minerals are rarer. The groundmass is commonly aphanitic and is so altered to green secondary minerals that the rock might be called a "greenstone".

Evidently a flow breccia, commonly several hundred feet thick, forms a rather widespread basal unit in the volcanic rocks as it was found at several places near the contact with the underlying metasedimentary rocks. This flow breccia consists of angular pebble and cobble clasts of andesitic rock, graywacke, and slate in a fine-grained volcanic matrix. It is well-exposed in Ladd Canyon where it is as much as several hundred feet thick and is also well exposed in a belt 300 to 400 feet wide along the Main Divide truck trail at the west edge of the Corona South quadrangle. Other volcanic breccias and probably some tuffs are also present.

In Tin Mine Canyon is a green volcanic rock with phenocrysts of quartz and feldspar in a fine-grained groundmass. This rock appears to be more resistant to erosion than the andesite and ranges in composition from quartz latite porphyry to rhyolite. Dark minerals are present but altered. Secondary chlorite and epidote may be present.

A small exposure of a fine-grained purple acidic volcanic rock was observed along the Eagle Canyon truck trail. This rock is near the top of the Bedford Canyon formation and appears to have intruded the metasedimentary rocks. It displays flow banding and contains cryptocrystalline red glassy grains and a material which may be bleached green mica. It is probably an intrusive rock related to the Santiago Peak volcanics. Dacitic rocks are also present within the principal mass of andesitic rocks.

The thickness of the volcanic rocks cannot be measured but it probably is very great, and formerly this body of volcanic rock may have been much larger. Within the Corona South quadrangle the Santiago Peak volcanics crop out at elevations ranging from 1,600 to 3,900 feet. Thus a maximum present thickness of about 2,300 feet is suggested as the volcanic rocks at most places appear to be dipping gently. However, in a few places the volcanics appear to be steeply dipping so that the thickness may be much less than that suggested by the outcrop pattern.

Whether any bodies of the volcanic rock are infolded within the metasedimentary rocks is not known, but where relations are clear the volcanics do not appear to be infolded. Probably the lava flows spread over a surface of considerable relief on the old sedimentary sequence so that the volcanics may occupy their present position, in relation to the Bedford Canyon formation, in part as a result of the topography on the old surface, rather than as a result of infolding.

Larsen (1948, p. 24) believes the volcanics to be Jurassic in age as they overlie the Triassic rocks unconformably, have undergone about the same degree of metamorphism, and are intruded by all the batholithic rocks. The writer agrees that the volcanics are clearly post-Bedford Canyon in age and, inasmuch as clasts of the volcanics are found in early Upper or late Lower Cretaceous sedimentary rocks, they are tentatively assigned to the Jurassic period. However, the volcanic rocks might be, at least in part, of Early Cretaceous or mid-Cretaceous age.

Temescal Wash Quartz Latite Porphyry

Dudley (1935, p. 497) named a blue-black to gray porphyritic rock found on the east side of Temescal Wash the Temescal dacite porphyry. Larsen (1948, p. 36) has shown that the composition is more nearly that of quartz latite, and proposed the name Temescal Wash quartz latite porphyry.

The Temescal Wash quartz latite porphyry crops out along the east side of Temescal Canyon and in two small, isolated bodies east of El Cerrito Village in the northeastern part of the Corona South quadrangle. Pampeyan (1952, p. 21) states that the quartz latite intrudes Bedford Canyon metasedimentary rocks. Clasts of the Temescal Wash quartz latite appear in the Upper Cretaceous conglomerates of the Santa Ana Mountains. Therefore the porphyry is clearly older than the Upper Cretaceous sedimentary rocks and younger than Triassic. Larsen (1948, p. 37) believes the porphyry is probably Jurassic.

In describing the porphyry Pampeyan (1952, p. 22) says:

"Outcrops of the quartz latite are a blue-gray color on weathered surfaces and form rugged, steep cliffs and defiles. . . . Hand specimens of this porphyry vary in texture and also in composition. On the west side (along Temescal Canyon) the rock has a blue-black aphanitic groundmass with abundant phenocrysts of quartz and feldspar that average 2 mm in diameter. To the east the groundmass becomes coarser-grained and the phenocrysts reach an average of 5 mm diameter. The composition varies from dacite to quartz latite by slight changes in the feldspar ratio. Inclusions of the Triassic metamorphics, usually about 25 mm long, are found throughout the porphyry".

Under the microscope a sample of the porphyry collected from a small body exposed in the south quarry of the Temescal Canyon rock quarry displays euhedral phenocrysts of orthoclase and subhedral phenocrysts of plagioclase and quartz. Accessory minerals include hornblende, biotite, and magnetite. Chlorite is present as an alteration mineral after hornblende and biotite. The orthoclase phenocrysts contain inclusions as alterations composed of sericite and chlorite, with a few grains of magnetite. The groundmass is a mosaic of quartz, orthoclase, plagioclase, hornblende, chlorite, and magnetite.

Jurassic-Cretaceous (?) Systems

Corona Hornblende Granodiorite Porphyry

According to Pampeyan (1952, p. 25) a dark rock with slight differences in texture and the composition of granodiorite is found southeast of Home Gardens at the northwest end of Temescal Canyon. In 1948, Larsen (p. 39) called this unit "dark granodiorite prophyry east of Corona".

This granodiorite porphyry crops out in two belts, one on each side of Temescal Canyon, in a small body southeast of El Cerrito Village, and in a rectangular body in the northeastern part of the Corona South

FIGURE 8. Typical topography developed on the intrusive and volcanic rocks in the northeast corner of the Corona South quadrangle. View east from Temescal Wash (foreground). Temescal Wash quartz latite porphyry (Jt), Corona hornblende granodiorite porphyry (J-Kc), Home Gardens quartz monzonite porphyry (Khg), alluvium (Qal). Matich and Sundt Company's Temescal Canyon rock quarries in middle distance.

quadrangle. The two belts are separated by the Cajalco quartz monzonite porphyry. Pampeyan suggests the name "Corona hornblende granodiorite porphyry" and describes the rock as follows:

"In hand specimen, this rock is characterized by its dark gray color, zoned plagioclase euhedra, and abundant mafic minerals. Texture varies from a true medium-grained granitic rock, with grain size averaging 1 to 2 mm to a porphyritic rock with fine-grained crystalline groundmass grains 0.5 mm in diameter and phenocrysts averaging 5 mm. A typical specimen has about 45 percent plagioclase, 15 percent quartz, 10 percent orthoclase and 20 percent fine-grained groundmass."

Pampeyan believes that the Cajalco quartz monzonite is younger than the Corona hornblende granodiorite porphyry and that the relations with the quartz monzonite show that the granodiorite is clearly pre-Upper Cretaceous.

San Marcos Gabbro

The San Marcos gabbro occurs throughout the Peninsular Ranges province. It forms about one hundred mappable bodies, many of which are very small, in the San Luis Rey, Elsinore, and Corona quadrangles (Larsen, 1948, p. 42). Miller (1947, p. 1397-1426) proposed the name "San Marcos gabbro" for a group of rocks with a wide range of composition and texture found in the San Luis Rey quadrangle. Earlier, Hurlbut (1935, p. 610) used the name "San Marcos Mountain gabbro" for this rock. Larsen (1948, p. 4) used the San Marcos gabbro designation and mapped a body of this rock about 2 square miles in area, west of Glen Ivy along Coldwater Canyon. The west half of this body is within the Corona South quadrangle and the writer, following Larsen, assigns this varied group of dark colored basic intrusive rocks to the San Marcos gabbro.

The San Marcos gabbro body, noted above, is exposed in the southeast corner of the Corona South quadrangle. It is rectangular in plan and extends from Coldwater Canyon northwest nearly to Brown Canyon on the north. On the northeast the body is bounded by the northwest-trending frontal fault of the Santa Ana Mountains, and is in fault contact with Bedford Canyon metasedimentary rocks on its northwest side, but on the southwest it is intrusive into the Bedford Canyon formation. Xenoliths of slate and hornfels are abundant in this body and several large pods of cherty slate are found in Coldwater and Anderson Canyons and along the intervening ridges.

According to Larsen (1948, p. 43) one of the most noticeable features of the San Marcos gabbro in the field is its wide range in composition. Some large bodies consist almost wholly of one rock type; other bodies consist of smaller masses, of contrasting rock types, a few tens of feet or less across. In the Corona area the San Marcos gabbro consists of small bodies of contrasting basic rock types which show gradational contacts.

Most of the San Marcos gabbro in the Corona South quadrangle appears, in hand specimen, to be a dark, medium-grained granitic rock; but in a few outcrops, the feldspars are lath-shaped and surrounded by ferromagnesian minerals. Under the microscope the rocks commonly exhibit a diabasic texture and some a stoutly ophitic texture.

In the vicinity of Coldwater Canyon, the dark-colored gabbro is very resistant and forms rugged steep-walled canyons. To the northwest, the rock is lighter colored and much less resistant, is deeply weathered, and forms light colored rounded slopes which support a dense brush cover.

The San Marcos gabbro in the Corona area includes three principal rock types which are intermixed. Between Coldwater and Anderson Canyons the rock is mostly a coarse-grained hornblende quartz diorite. A typical specimen has about 65 percent plagioclase (labradorite ?), 20 percent hornblende, 10 percent quartz, and 5 percent minor minerals, which include chlorite, biotite, and ores (magnetite and pyrite). Northwest of Anderson Canyon the rock is mainly hypersthene-biotite gabbro, but is in part norite because of local differences in the augite-hypersthene ratio. This gabbro is holocrystalline, coarse-grained, and has a pronounced ophitic texture. The plagioclase feldspar is zoned labradorite in lath-shaped crystals. Minor minerals include augite, both fresh and altered biotite, penninite and ores (magnetite, pyrite). The third rock type is a dark, aphanitic rock with a cryptocrystalline groundmass which contains abundant small inclusions of slate and graywacke, apparently derived from the Bedford Canyon formation. These inclusions are roughly aligned and on weathered surfaces give the rock a flow-banded appearance. This unit is exposed along the northeast margin of the gabbro west of Anderson Canyon and also along the fault contact between the Bedford Canyon formation and the gabbro at its northwest margin. Along this fault a zone several hundred feet wide has somewhat the appearance of a mylonite cataclastic zone.

Larsen reports (1948, p. 43) that the gabbro cuts Triassic Bedford Canyon metasedimentary rocks and the overlying Santiago Peak volcanic rocks and it is in turn cut by various tonalites and granodiorites which he assigned a Cretaceous age. Larsen (1948, p. 43) believed the San Marcos gabbro to be the oldest rock of the Cretaceous (?) southern California batholith. In the Corona area the gabbro intrudes the Bedford Canyon formation of Upper (?) Triassic age and thus is apparently post Triassic. The gabbro in the Corona area is not cut by other batholithic rocks.

Cajalco Quartz Monzonite

The principal mass of the Cajalco quartz monzonite as mapped by Pampeyan (1952, map) lies east of the Corona South quadrangle. However, he also mapped a large dike-like body of quartz monzonite along Temescal Wash. Dudley (1935, p. 502) named these rocks the Cajalco quartz monzonite. Later, Larsen (1948, p. 76) mapped this unit, together with Dudley's Steele Valley granodiorite, as Woodson Mountain granodiorite.

In the Corona South quadrangle, the Cajalco quartz monzonite crops out in a large dike along the west side of Temescal Canyon, as several smaller bodies southeast of Home Gardens, and over a considerable area northwest of Home Gardens. A small part of this last-noted body lies in the quadrangle. Pampeyan (1952, p. 31) reports that the quartz monzonite clearly intrudes the other units found in the Cajalco area and is cut only by the Home Gardens quartz monzonite porphyry and a few mafic dikes and aplite bodies. He believes it can be safely ascribed to the batholith and says of the rock:

"This pinkish to tan massive granitic rock is mildly resistant forming bouldery slopes . . . Mineral composition remains rather constant but three textural varieties were noted; coarse-grained (5 to 6 mm), medium-grained (1 mm), and porphyritic . . . Hand specimens range from pink to gray-white on weathered surfaces and pink to brown-gray when fresh. Megascopically the following mineral percentages were established: white plagioclase, 35 percent; tan to flesh-red orthoclase, 31 percent; pellucid quartz, 29 percent; biotite, 4 percent; epidote, chalcopyrite, etc., 1 percent."

Home Gardens Quartz Monzonite Porphyry

Pampeyan (1952, p. 35) proposed the name "Home Gardens quartz monzonite porphyry" for the dike-like mass of biotite quartz monzonite porphyry exposed for a north-south distance of approximately 2 miles along Temescal Wash, west and northwest of the Minnesota Mining and Manufacturing Company's plant in Temescal Canyon. In 1948, Larsen (p. 90) identified the rock as granodiorite porphyry. Pampeyan reports that the porphyry has intruded Cajalco quartz monzonite but that relations with the Tesmescal Wash quartz latite porphyry and the Corona hornblende granodiorite porphyry are obscure. Nevertheless he believes the Home Gardens porphyry to be clearly late batholith. He describes the rock as follows:

"From a distance the rock is light gray in color, produces rounded boulders and outcrops, and weathers in place to a yellow-brown soil. Textural variations from porphyritic to porphyro-aphanitic are dependent upon the distance from the quartz monzonite contacts . . . Under the hand lens, orthoclase and plagioclase each amounted to 30 percent, quartz 20 percent, groundmass 15 percent, and the remainder biotite."

Micropegmatite Granite

The west margin of a group of low hills, which lie west of Home Gardens and north of State Highway 18, is formed by a pink, indistinctly granular micropegmatite granite which underlies an area of about one square mile (Larsen, 1948, p. 98). This rock crops out over an area only about a tenth of a mile square in the Corona South quadrangle. In outcrops the rock is reddish-brown

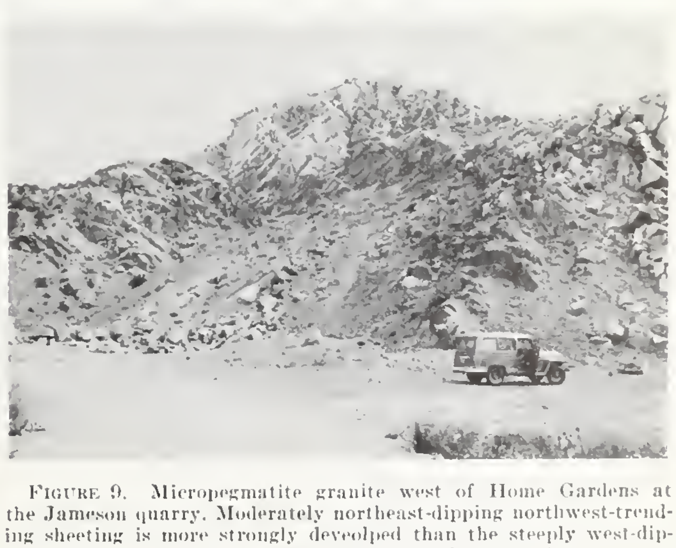

FIGURE 9. Micropegmatite granite west of Home Gardens at the Jameson quarry. Moderately northeast-dipping northwest-trending sheeting is more strongly deveolped than the steeply west-dipping north-trending joint system. Observer faces north.

and forms sheet-like masses (fig. 9). It does not weather to form bouldery slopes. In hand specimen the rock is pink and shows feldspar crystals, as much as 3 mm long, scattered in a very fine-grained crystalline groundmass of feldspar and quartz with very little hornblende. This micropegmatite is younger than the Cajalco quartz monzonite but is not in contact with other rocks of the batholith. To the north, near the railroad, the micropegmatite carries inclusions of the Cajalco quartz monzonite and small dikes intrude the monzonite. The micropegmatite granite is apparently late batholith in age and may be approximately related in time to the Home Gardens quartz monzonite porphyry.

Southern California Batholith

According to Larsen (1948, p. 134) the southern California batholith probably covers an area of more than 50,000 square miles. It extends southward from near Riverside, California, for a distance of about 350 miles and averages about 70 miles in width. It is much larger than the batholith of the Sierra Nevada and is commonly believed to be related to that body.

The plutonic igneous rocks of the Corona area, already described, consist of granodiorite porphyry, gabbro, quartz monzonite, quartz monzonite porphyry, and micropegmatite granite, and are all part of the great southern California batholith. Larsen (1948, p. 136) placed the age of the southern California batholith as Lower Cretaceous, but noted that from relations to fossiliferous rocks in northern Baja California, Woodford and Harris (1938) believed the granitic rocks near San Quentin to be early Late Cretaceous in age. Recent determinations by Larsen and others (1954, p. 1277) of the ages of rocks from the batholith of southern California by the lead-alpha activity ratios on the accessory minerals zircon, monazite, and xenotime indicate an average age of 105 million years. This average is based on 25 age determinations made on rocks ranging from quartz diorite to granite. On the basis of rather close agreement between the geologic evidence and the determinations of lead-alpha activity ratios most workers, including Larsen and others (1954, p. 1277) now believe the batholith of southern California to be early Late Cretaceous in age.

Cretaceous System

Trabuco Formation

Poorly consolidated, massive, commonly red, sandy conglomerate crops out along the northeast margin of the Santa Ana Mountains southwest of Corona. It occurs as a rather uniform narrow belt from 400 to 700 feet in width, extending from Tin Mine Canyon to a point northwest of Mabey Canyon and $2\frac{1}{2}$ miles to the northwest is again exposed over a small area on the south side of Santa Ana Canyon. Similar rocks crop out in a small patch in the southwest corner of the Corona South quadrangle between Ladd and Silverado Canyons.

FIGURE 10. Grayish-green, massive, sandy conglomerate facies of the Trabuco formation composed largely of relatively unweathered cobbles and boulders of grayish-green hornblende andesite from the Santiago Peak volcanics. Exposed in cut along State Highway 18 west of the Elsinore fault. Observer faces south. A second facies, exposed 4 miles southeast, is shown in fig. 11.

FIGURE 11. Reddish brown to maroon conglomerate and sandstone facies of the Trabuco formation exposed in cut on Skyline Drive, north of Tin Mine Canyon. The cobbles and boulders are mostly thoroughly weathered coarse-grained acid plutonic rocks, and fewer clasts are of green hornblende andesite from the Santiago Peak volcanics. Note sandstone lens marked by hammer. Observer faces north.

Packard (1916, p. 140) proposed the term Trabuco formation as a local name for a poorly consolidated, massive, red conglomerate well-exposed in Trabuco Canyon on the west side of the Santa Ana Mountains. He found no fossils, but thought that the stratigraphic relations of the formation indicated an age only slightly older than that of the overlying Chico group (Upper Cretaceous), probably some phase of the pre-Chico Cretaceous. Woodring and Popenoe (1942, p. 170) in discussing the age of the Trabuco say:

"The Trabuco conglomerate is unfossiliferous; and its precise age is unknown. Structurally it is closely related to the overlying marine Upper Cretaceous beds, and probably is thus of early Upper or late Lower Cretaceous age".

The writer follows Woodring and Popenoe in tentatively assigning a Cretaceous age to beds in the Corona area occurring below fossiliferous marine Upper Cretaceous strata and similar in lithology to the Trabuco formation described from the west flank of the Santa Ana Mountains.

The Trabuco formation (fig. 10) is a rather soft, poorly cemented, massive, sandy boulder conglomerate. The loose cementing causes the conglomerate to weather to a somewhat rounded topography which is in striking contrast to the broken, but abrupt, cliffs ordinarily formed by the more resistant sandstone and conglomerate of the overlying Baker Canyon conglomerate member of the Ladd formation and the higher and generally steeper erosion surface of the volcanic basement rock. The Trabuco conglomerate ranges from brick-red and nearly maroon to buff and light brown with zones of grayish-green. The red color is not constant and appears mainly as streaks in brown or buff material.

The massive conglomerate is very poorly sorted and is composed of cobbles and boulders, as much as three feet in diameter, in a loosely cemented matrix of arkosic grit and sand. Most of the clasts are angular to subangular. The constituents include quartzite, graywacke, limestone, and slate; and granitic and volcanic rocks. The volcanic fragments consist mostly of dark green andesite. Reddish or purple acidic volcanics are less common. The most characteristic large boulders and cobbles are coarse-grained acidic plutonic rocks. These are red, pinkish and reddish-brown in color and show large feldspar phenocrysts. They commonly are deeply weathered and decomposed. Irregular, short lenses, as much as a few tens of feet in length, of medium- to coarse-grained buff to red arkosic sands are present (fig. 11).

As bedding features are uncommon, determinations of the attitude and thickness of the formation are generally only approximate. Along Tin Mine Canyon the Trabuco formation may reach 620 feet in thickness, but it thins to the northwest where it is probably only 400 to 500 feet thick. In general the principal mass of the Trabuco formation in the Corona area averages approximately 550 to 600 feet in thickness and forms a belt, somewhat less than two miles long, which extends northwest from Tin Mine Canyon.

Woodring and Popenoe (1942, p. 167) report that, along the western flank of the Santa Ana Mountains, the Trabuco formation lies on the basement with a profound unconformity but has also, in part, been faulted down together with a mass of underlying basement. Along the northeastern flank of the Santa Ana Mountains, in the Corona area, the conglomerate assigned to the Trabuco formation rests in fault contact against the Jurassic (?) Santiago Peak volcanics. In the southwest corner of the Corona South quadrangle a small exposure of Trabuco formation lies unconformably on the Bedford Canyon formation.

The Trabuco formation, in the Corona South quadrangle between Tin Mine and Wardlow Canyons, appears to grade almost imperceptibly upward into a grayish-green, sandy, basal conglomerate which is assigned to the Baker Canyon conglomerate member of the Ladd formation. To the west, along the northeastern flank of the Santa Ana Mountains, the typical red and brown Trabuco conglomerate evidently lenses or wedges out laterally into the basal conglomerate of the Ladd formation. Because of the gradational and lensing character, both vertically and laterally, the writer is in some doubt as to the validity of the Trabuco formation in the Corona area, and recognizes that these rocks might be part of the Ladd formation. However, in the field, the reddish conglomerate does make a fairly good mappable unit.

J. E. Schoellhamer (oral communication, May 1953) reports that, at one place on the western flank of the mountains, the red Trabuco conglomerate can be seen to grade or interfinger with grayish-green Baker Canyon conglomerate.

In their relations with the overlying Ladd formation, the rocks assigned to the Trabuco formation along the northeastern flank of the Santa Ana Mountains are similar to the Trabuco formation as described by Woodring and Popenoe (1942, p. 170) and by Schoellhamer and others (1954) on the southwest flank of the mountains. No fossils were found in the Trabuco formation. This fact, coupled with the generally angular shape of most of the constituents and the rather unusual red color, leads to the suggestion that the Trabuco sandy conglomerate may be nonmarine in origin. Possibly it represents material carried but a short distance from the east and deposited on a coastal plain.

Ladd Formation

Brownish, massive to thick-bedded conglomerate and sandstone with a brownish-gray sandy siltstone or shale at the top of the succession are exposed along the northeastern flank of the Santa Ana Mountains from Tin Mine Canyon to the Santa Ana River valley. In 1916, Packard (p. 141) referred to the Chico group of Upper Cretaceous age, a sequence of conglomerates, fossiliferous sandstones and shales which he found conformably overlying the Trabuco formation in the western Santa Ana Mountains. Later, Popenoe (1937, p. 380) provided the following generalized section of these rocks.

"Upper Cretaceous

Williams formation:

Pleasants member: Light-colored shaly sandstones with many beds of limy fossiliferous sandstone intercalated. Approximate thickness, 320 feet.

Schulz member: Light-colored, coarse, arkosic sandstones with numerous beds of well-rounded boulders. Unfossiliferous. Average thickness, 200 feet.

Unconformity

Ladd formation:

Holz member: Dark bluish- to brownish-gray micaceous sandy shale or siltstone, with interbedded arkosic sandstones and nonpersistent coarse conglomerate lenses. Fossiliferous in the upper half. Thickness 1,500 feet ±.

Baker member: Gray to brownish, massive to thick-bedded boulder conglomerate below, grading up to shaly arkosic soft brown sandstone above. Sandstone at top highly fossiliferous. Thickness 200 feet ±".

In 1941, Popenoe (p. 742) described the lower member of the Ladd formation as the "Baker conglomerate". Later, Woodring and Popenoe (1942, p. 170) gave the type locality of the Ladd formation as ". . . the region immediately west of the mouth of Ladd Canyon" and reported a measured section of the formation as approximately 1,700 feet thick. At this time the name "Baker Canyon conglomerate member" was adopted for the lower member of the Ladd formation.

Baker Canyon Conglomerate Member

In the Corona area the Baker Canyon conglomerate member is represented by a thickness of about 1,400± feet of brown sandstone and conglomerate which contain a few shaly lenses spaced at irregular intervals. These rocks are exposed in a nearly continuous belt from Tin Mine Canyon northwest to Santa Ana Canyon. The width of outcrop ranges from about 500 feet along the north side of Tin Mine Canyon to nearly 1,600 feet midway between there and Mabey Canyon, shrinking again to about 500 feet on the south side of Santa Ana Canyon. The basal part of the Baker Canyon member is a grayish-green cobble and boulder conglomerate that is somewhat similar to the Trabuco conglomerate. The Baker Canyon conglomerate, however, is better cemented and bedded and shows better sorting. Fewer large boulders are present and they are less weathered. The major rock types are andesites and Bedford Canyon metasedimen-

FIGURE 12. Interbedded sandstone and conglomerate of the Baker Canyon conglomerate member of the Ladd formation. Exposed in cut on State Highway 18 west of the Elsinore fault. Observer faces south.

FIGURE 13. Sandstone of the Baker Canyon conglomerate member of the Ladd formation (B) overlain in fault contact (F) by sandstone and siltstone of the Silverado formation (S). Exposure along north side of Tin Mine Canyon.

tary rocks, but with a few red and gray granitic rocks. These occur in a hard matrix of grayish-green, buff or brown arkosic sand or grit. The Baker Canyon conglomerate grades upward into a sequence of thick-bedded and interbedded buff to gray and brown sandstone and cobble conglomerate (figs. 12, 13) with minor finer-grained silty lenses. The sandstone bodies are mostly arkosic, rather coarse-grained, hard, resistant and massive. They commonly provide a rugged topography of bold and steep cliff faces.

From Tin Mine Canyon to just west of Wardlow Canyon the Baker Canyon member apparently rests with conformable gradational contact on the Trabuco conglomerate. West of the Elsinore fault, along Santa Ana Canyon, Baker Canyon conglomerate and sandstone rest in fault contact on Trabuco conglomerate but a short distance to the southeast Baker Canyon strata rest unconformably on Santiago Peak volcanics. The Baker Canyon conglomerate member is overlain gradationally by the Holz shale member for a short distance east and west of Mabey Canyon, west of Fresno Canyon, and east of Santa Ana Canyon.

Paleontology. Near the top of the Baker Canyon conglomerate member a highly fossiliferous and generally extremely hard sandstone crops out discontinuously from Tin Mine Canyon to the northwest side of Mabey Canyon. Many large specimens of such characteristic Upper Cretaceous forms as *Actaeonella oviformis* Gabb and *Trigonarca californica* Packard were collected. Material from locality 3 was examined by W. P. Popenoe who reported (oral communication, May 1953) it to be the same age as the Baker Canyon sandstone, *Glycymeris pacificus* fauna. The Baker Canyon member is marine and the basal conglomerate may represent the deposits of a transgressing sea.

Holz Shale Member

Dark blue-gray to black and buff marine shale, siltstone and sandy claystone, which crop out in three rather widely separated localities, are assigned to the Holz shale member of the Ladd formation. Between Mabey and Wardlow Canyons a buff to gray sandy claystone crops out, crosses Mabey Canyon and extends about half a mile to the east, along the south side of the canyon. This claystone forms a narrow strip averaging 300 feet or less in width and is characterized by the presence of many large, irregular, very hard limy concretions as much as 3 or 4 feet in diameter. This unit lies immediately above a good fossil locality in the Baker Canyon member and evidently overlies the Baker Canyon sandstone gradationally. At this place the Holz shale is about 200 feet thick and is in fault contact with the overlying Ladd formation, undifferentiated. Extending west from Fresno Canyon for a distance somewhat less than a mile is an outcrop, about 200 feet wide, of Holz shale. It is a gray to buff and light brown sandy shale and siltstone. It apparently overlies the Baker Canyon conglomerate member gradationally and is probably conformably overlain by sandy silt mapped as the Ladd formation, undifferentiated. In this area the contacts above and below the Holz shale are obscured by the lack of marker beds and by impenetrable brush and were mapped as approximate. A small outcrop of blue-gray to black Holz shale is found in Santa Ana Canyon just east of the Elsinore fault. Immediately to the east it is covered by

Genus and species	Fossil localities (shown on plates 1, 3)							
	3[1]*	4*	11*	12*	13*	6*	31[1]**	16[2]**
Megafauna								
Acteonella oviformis Gabb			x		x			
Amauropsis pseudoalveata Packard		x	x		x	x		
Aporrhais cf. A. vetus Packard			x					
Astarte cf. A. lapidis Packard				x				
Baculites cf. B. chicoensis Trask					x			
Calva regina Popenoe					x			
Coralliochama cf. C. orcutti White					x			
Glycymeris pacificus Popenoe		x		x		x		
Lima appressa (?) Gabb				x				
Lima beta Popenoe	x							
Meretrix (?) sp.					x			
Ostrea sp.					x			
Pachydiscus (?) sp.							x	
Panope cf. P. californica Packard					x			
Siphonalia cf. S. dubius Packard			x					
Trigonarca californica Packard	x	x				x		
Trigonarca cf. T. excavata Packard		x				x		
Trigonocallista bowersiana Cooper		x		x	x			
Turritella chicoensis Gabb					x			
Microfauna								
Gaudryina aff. Verneulina munsteri (Reuss)								x
Marsonella oxycona (Reuss)								x

[1] Identified by W. P. Popenoe
[2] Identified by M. O. Israelsky

* Plate 1
** Plate 3

Figure 14. Upper Cretaceous faunal list.

a landslide of volcanic material, but does crop out along the highway about a quarter of a mile east of the fault. These Holz beds form a narrow band, with a maximum width of nearly 500 feet and an average width of about 200 feet, that extends eastward for perhaps three-quarters of a mile. Here it is a dark blue to black and gray gypsiferous shale and siltstone, apparently overlying Baker Canyon strata in depositional sequence and in fault contact with Paleocene beds.

Paleontology. The Upper Cretaceous age of the shale assigned to the Holz member is established by the ammonite *Pachydiscus* ? sp. found by D. M. Kinney (oral communication, 1953) west of Fresno Canyon (locality 31). Crushed foraminifera were found along bedding planes of the Holz shale, but little identifiable material was recovered. Fortunately locality 16 (fig. 14) provided two forms which M. C. Israelsky (oral communication, May 1953) identified as in Goudkoff's Cretaceous zone G-1. Goudkoff (1945, p. 960, 991, 992) shows his G-1 zone to be of Upper Cretaceous age, and apparently in the lower part of the Upper Cretaceous.

Ladd Formation, Undifferentiated

A belt of conglomerate, sandstone, siltstone, and shale in the northwest part of the Corona South quadrangle is assigned to the Ladd formation, undifferentiated. These rocks apparently have the same stratigraphic position in space as the Williams formation which in its type area in the northwestern Santa Ana Mountains unconformably overlies the Ladd formation (Popenoe, 1937, p. 380). These rocks are, however, lithologically dissimilar to the Williams formation as defined in the northwestern Santa Ana Mountains by Popenoe (1937, p. 380) and later mapped by Schoellhamer and others (1954) and they seem best placed with the Ladd formation. Rocks designated as "Ladd formation, undifferentiated" crop out in a northwest-trending strip extending from southeast of Mabey Canyon to Fresno Canyon in the Black Star Canyon quadrangle and beyond to a point within half a mile of Santa Ana Canyon. The width of outcrop ranges from about 1,500 feet southeast of Mabey Canyon to nearly 5,000 feet between Wardlow and Fresno Canyons, shrinking again to about 1,200 feet west of Fresno Canyon. This unit probably has a maximum outcrop thickness of about 3,500 feet, although there is some evidence of folding which might substantially reduce the actual thickness.

The Ladd formation, undifferentiated, is composed of buff to gray colored sandstone, cobble and small boulder conglomerate, siltstone and shale. Siltstone forms the major unit but contains beds and lenses of sandstone and conglomerate. The sandstone is white to buff, rather coarse-grained and commonly weakly cemented arkose, although locally it is hard and cliff-forming. The conglomerate is also weakly cemented and consists of clasts of hard volcanic rocks, quartzite, and weathered slate and other metasedimentary rocks, all in a matrix of buff or gray arkose. The metasedimentary clasts are apparently derived from the Bedford Canyon formation. The conglomerate also carries numerous cobbles and boulders of much weathered red and gray, coarse-grained, granitic rocks.

West of Fresno Canyon the rocks mapped as Ladd formation, undifferentiated, rest conformably on the Holz shale member of the Ladd formation, and in this area might be a sandy conglomeratic zone in the upper part of the Holz shale. East of Fresno Canyon, in the Corona South quadrangle, the Ladd formation, undifferentiated, rests with fault contact on Baker Canyon sandstone and conglomerate. Here too, the Ladd formation, undifferentiated, might be part of the Holz shale, although no rocks known to be Holz are exactly similar. The Ladd formation, undifferentiated, is in fault contact with the overlying Paleocene Silverado formation.

Paleontology. No fossils from the Ladd formation, undifferentiated, were collected by the writer. However, during 1956, Donald Lamar (oral communication, Oct. 20, 1956) found fragments at two localities of both straight and coiled cephalopods which indicate a Cretaceous age, although the material is poorly preserved. This material came from the vicinity of the McKnight mine (north line of NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M.) and from a zone about 2,000 feet southwest of the Thomas clay mine (SE¼ sec. 32, T. 3 S., R. 7 W., S.B.M.). Better preserved material, also collected by Lamar, from the Sky Ranch Clay Company mine (East pit) on the north side of Wardlow Canyon (NW¼ sec. 4, T. 4 S., R. 7 W., S.B.M.) yielded the ammonite *Scaphites* sp.

Ladd-Silverado Hiatus

No strata that could be assigned to the Upper Cretaceous Williams formation as described on the western side of the Santa Ana Mountains by Popenoe (1937, p. 380) were found on the eastern flank of the mountains. If the Williams formation was ever present along the northeastern margin of the Santa Ana Mountains it seemingly was early removed by erosion as Paleocene Silverado beds rest on Holz shale, Baker Canyon beds or strata of the Ladd formation, undifferentiated. However, an unconformity was not demonstrated in the field and at every place observed the Silverado formation is faulted against the Ladd formation. Nonetheless the lack of any outcrops of the marine Williams formation and a change to a nonmarine depositional environment for the lower part of the Silverado strata, later described, suggest an unconformity between the Ladd and the Silverado formations. Several miles west of the mapped area, at the crest of the mountains, the Silverado formation lies unconformably on Upper Cretaceous sedimentary rocks (Schoellhamer and others, 1954, p. 69).

Tertiary System

Paleocene Rocks

Silverado Formation

Brown to reddish-brown or white to greenish-gray and gray sandstone which is locally clay-bearing and contains quartz-rich facies, conglomerate, siltstone and silty claystone (figs. 15-20) crop out in a broad, but irregular band, extending across the area from just east of Bedford Canyon to Santa Ana Canyon. These strata have been assigned a Paleocene age on faunal and lithologic evidence. The Paleocene strata in the Corona region include sediments similar to those of the Eocene Ione formation of the western Sierra Nevada foothills. The distinctive sedimentary rocks of both formations include clays and quartz-rich standstone of economic importance and anauxite-bearing sandstone.

FIGURE 15. Exposure of Silverado formation sandstone and clay at the Bedford Canyon clay mine of Gladding, McBean and Company. Hornblende diorite (6), a phase of the Corona hornblende diorite porphyry, is overlain by residual red mottled clay (5), arkosic sandstone (4), sedimentary red mottled clay (3), coarse arkosic sandstone (2), and sandy older alluvium (1). Observer faces southwest. *Photograph by George B. Cleveland.*

FIGURE 16. Another exposure of sandstone and clay of the Silverado formation at the Bedford Canyon clay mine. Sedimentary red mottled clay (C) is overlain by white to buff arkosic sandstone (S). Brown older alluvium (Q) covers the Silverado strata. Observer faces east. *Photograph by George B. Cleveland.*

Dickerson (1914, p. 263) assigned a succession of fossiliferous sedimentary rocks in the Santa Ana Mountains to the Martinez formation, then called lower Eocene. He reported these rocks to be unconformably overlying the Chico group (Upper Cretaceous). Later, English (1926, p. 19) mapped more completely the occurrences of these strata in the northern part of the Santa Ana Mountains. In 1935, Sutherland (p. 76) assigned to the Martinez formation clay-bearing sandstone, shale, and conglomerate southwest of Corona. Woodring and Popenoe (1945) proposed the name Silverado formation for these Paleocene strata because ". . . it is undesirable and generally impracticable to attempt to combine lithologic and age concepts in stratigraphic nomenclatures . . .". The type region was designated as the area northeast of Irvine Park on the west side of the mountains. The writer follows Woodring and Popenoe in assigning Paleocene strata in the Corona area to the Silverado formation.

Along the northeastern flank of the Santa Ana Mountains the Silverado formation rests in fault contact with the Ladd formation or the Santiago Peak volcanics but in Temescal Wash it rests depositionally on intrusive rocks or on residual clay derived from the intrusive rocks. From Santa Ana Canyon to a locality a short distance east of Fresno Canyon the Silverado formation is overlain conformably by the Santiago formation. West of Wardlow Canyon, it is overlain in fault contact by the Vaqueros and Sespe formations, undifferentiated.

Sedimentary rocks in the mapped area assigned to the Silverado formation form a strip parallel to the mountains and ranging in width from less than 500 feet east of Bedford Canyon to a maximum of 2,500 feet between Main Street and Tin Mine Canyons and narrowing to 1,750 feet at Santa Ana Canyon. The maximum true thickness may approach 2,000 feet west of Wardlow Wash. In lower Bedford Wash, in the eastern part of the Corona South quadrangle, the Silverado formation has a maximum thickness of about 200 feet as indicated by drill hole data. Generally poor bedding and the lack of good marker beds, however, make the determination of attitudes and thickness difficult and unreliable. Complex faulting also greatly complicates the thickness

FIGURE 17. Residual red mottled clay (mapped with Silverado formation) exposed along northwest side of Bedford Canyon clay mine. Red mottled residual clay (C) is overlain by buff, medium- to coarse-grained arkosic sandstone (S) with a thin, discontinuous, pebble conglomerate at base (marked by hammer head); contact is very irregular. Dark lens-shaped bodies (L) are red mottled clay clasts in the sandstone. Observer faces northwest.

problem. Moreover, the section may be repeated by folding. Undoubtedly both marine and nonmarine beds are present, apparently interfingering in a complex pattern which has been further complicated by faulting. The presence of local clay beds with lignite seams in poorly sorted, cross-bedded, coarse-grained arkose and a few fresh- and brackish-water fossils indicate a nonmarine depositional environment for the lower part of the formation. Marine fossils in hard lenses and in calcareous concretions in moderately well sorted sandstone and siltstone indicate marine deposition for the upper part of the formation.

The lithologic and faunal evidence suggest that probably the Silverado formation was deposited under lagoonal and near-shore conditions along a coast of very moderate relief. For purposes of discussion, the formation is divided into two members: a lower nonmarine fresh or brackish water unit and an upper marine unit. This is done primarily on lithologic grounds, but also in part is based on stratigraphic position. These members, however, are not delineated on the geologic map as no adequate marker beds or other criteria were found in the field to facilitate mapping the two members. Thicknesses of the two members could not be measured, but the marine member may represent most of the Paleocene strata.

Nonmarine (Lower) Member

The basal part of the Silverado formation in general seems to be nonmarine or lagoonal. It contains large quantities of alumina-rich clay and small amounts of bauxitic clay and high-silica "bauxite". Mining operations have developed several of the clay deposits and a quartz sand deposit which has been for many years the principal source of sand used by the glass making industry of southern California. This unit shows a rather uniform composition from just east of Bedford Canyon to Mabey Canyon, and generally has a thickness of 200 feet or less. Locally it is as much as 500 feet thick.

The lower member is characterized by reddish-brown to greenish-buff clayey sandstone, siltstone, or claystone which commonly contain abundant plates of green to greenish-black and grayish-green mica (biotite and chlorite) and pearly gray anauxite (clay mineral formed by the alteration of biotite). In places in the sandstone and siltstone these platy minerals are so numerous and well aligned as to give the rocks a schistose or foliated appearance like that of a decomposed mica schist. The siltstone and claystone are generally thinly laminated and fissile. Similar micaceous and fissile siltstone crops out for a short distance east of Santa Ana Canyon. Scattered lensing seams of lignite occur in the alumina-rich clay zones, near the base of the Silverado strata.

Locally the basal part of the lower member of the Silverado formation is a thin red cobble conglomerate. On the east side of Hagador Canyon and near Santa Ana Canyon this conglomerate is probably about twenty feet thick. It consists of small to medium cobbles set in a matrix of reddish-buff to gray arkosic grit and is rather well indurated. The cobbles are mostly sub-rounded; many are hard metamorphic and volcanic rocks; granitic clasts are rarer and generally decomposed.

The lower member contains the 1- to 10-foot thick (perhaps as much as 30 feet thick in places) economic sedimentary clay beds of the Silverado formation. These beds consist of relatively high-grade, reddish-brown pisolitic sandy clay, red mottled clay, and white to brownish-gray conchoidally-fracturing kaolinite. In general, however, the clay does not have the yellowish to gray or brownish-gray to olive brown color and similarly colored abundant pisolities of the true Claymont clay bed described by Sutherland (1935, pp. 79-81) and Woodring and Popenoe (1945) in the western and northwestern Santa Ana Mountains. Woodring and Popenoe (1945) named the Claymont clay bed with the type locality on the Claymont property of Gladding, McBean and Company near the crest of the divide at the head of Coal Canyon, about two miles south of the west end of the Santa Ana narrows map area. In the Corona South quadrangle pisolitic clay, somewhat similar to the Claymont clay bed, crops out in a few places between Wardlow and Hagador Canyons, in isolated outcrops between Hagador and Main Street Canyons, in one small exposure on the east side of Bedford Canyon, and in a clay pit in lower Bedford Wash opened by Gladding, McBean and Company in 1955. Drilling indicates this pisolitic clay zone underlies a large part of lower Bedford Wash. The pisolitic clay evidently occurs only as pockets or lenses within buff or gray sandy claystones and red mottled clay which form the bulk of the clay deposits. All of the occurrences of pisolitic clay appear to be near or at the base of the Silverado formation but poor exposures make measuring sections impractical. According to Woodring and Popenoe (1945) the Claymont clay bed is 65 to 140 feet above the base of the Silverado formation in measured sections a few miles west and southwest of the Corona area. Gray to black, finely disseminated carbon in various proportions is associated with the clays and in some places is concentrated in lenses or

FIGURE 18. Gently dipping gray micaceous sandstone (S) and dark red mottled sandy clay (C) of the Silverado formation overlain by older alluvium (A), contact marked by hammer. Exposed 7 miles southeast of Corona in cut on State Highway 71. Observer faces west.

FIGURE 19. Typical Silverado formation conglomeratic sandstone. Exposure along east side of Hagador Canyon. Quarter (in circle) gives scale. Observer faces east.

pockets of soft coal. The clay beds in general have little continuity and are not necessarily connected to one another. Whether or not the clay beds are repeated by folding and faulting, or are original pockets that appear intermittently both horizontally and vertically in the basal part of the sequence is not known. Whatever the original disposition of the clays, they are now so disturbed by faulting and probably by folding in most places that mining operations are indeed difficult. These clays, more fully described under economic geology, are believed to be derived from transported material which originally formed in place as a residual weathered deposit. The clay beds are ordinarily overlain by gray to buff shale which at many places is stained red or pink by iron oxide. In addition to the higher-grade clays, brick-red to reddish-brown or orange-brown and gray sandy clays are abundantly exposed.

Red mottled clay ranging in thickness from 5 to 20 feet, with a discontinuous, but as much as 4-foot-thick pisolitic zone at the top, is exposed in the Gladding, McBean and Company pit in Lower Bedford Wash. This lower zone of red mottled clay is residual in origin and grades downward into the unaltered Corona hornblende granodiorite porphyry. The top of the residual clay is an undulating erosion surface which is overlain by a thin zone, 5 to 15 feet thick, of tawny to buff colored, coarse, weakly indurated arkose which contains much mica and abundant pearly gray anauxite. Red mottled sedimentary clay ranging from 10 to 15 feet in thickness overlies the arkose. The top of the sedimentary clay is a gray to buff or tawny colored pisolitic zone from 1 to 5 feet thick which in places is bleached to nearly white. The sedimentary clay sequence is overlain by 10 to 100 feet of buff to gray and white coarse arkose which contains abundant grayish-green mica and pearly gray anauxite. (See figs. 15, 16, 17.)

East of Bedford Wash and along both sides of State Highway 71 gently dipping, coarse, poorly consolidated and rather pure, white quartz sandstone apparently represents the lowest part of the Silverado formation in that area. This sandstone is distinctive as, in general, it contains numerous green to greenish-black and grayish-green mica plates and pearly gray anauxite plates and in a few places has somewhat of a schistose appearance. Where this sandstone is well-exposed in the Owens-Illinois Glass Company quarry west of the highway, however, it ranges widely in composition and contains lenses of grayish-green sandy clay and micaceous fissile silty claystone as well as mica-free pockets. The sandstone is coarse-grained, thin-bedded and locally cross-bedded. Some of it is poorly sorted and contains scattered smooth and rounded walnut-sized pebbles. A water well (No. 1, fig. 45, Mineral Deposits Section) is reported to have penetrated about 100 feet of these sedimentary rocks and bottomed in hard bedrock. Apparently the bedrock is a very feldspathic biotite diorite with a marked planar structure as is shown by a dimensional alignment of the feldspar laths and apparently also by the mica. A second water well (No. 2, fig. 45, Mineral Deposits Section) is reported to have gone 325 feet in loose sands and to have bottomed in biotite quartz monzonite (oral communication, A. O. Woodford, May 1953). This silica-rich sandstone is believed to represent the basal part of the Silverado formation in the Temescal Canyon part of the area because it rests on igneous basement rocks or on a thin red mottled residual clay zone. However, it is not necessarily equivalent to the basal clay-bearing member which crops out to the northwest along the margin of the Santa Ana Mountains and probably is equivalent in age to the strata that lie just above the lowermost sandy clay and sedimentary red mottled clay zones.

Marine (?) (Upper) Member

Above the basal unit the Silverado formation is generally a coarse, weakly indurated, white to gray and yellow-brown to buff and tawny unit composed of siltstone, sandstone, conglomeratic sand, and conglomerate. This unit crops out from Bedford Canyon to Santa Ana Canyon, and reaches a maximum outcrop width west of Wardlow Wash where it probably has a thickness of 1,500 to 2,000 feet.

The conglomerate is composed mostly of subrounded cobbles of volcanic rocks but includes rarer metamorphic and granitic cobbles and a few sedimentary rocks in an arkosic matrix. It locally contains boulders as much as 3 feet in diameter. The conglomerate in general appears to form lenses in the sand or sandstone. A pebble count made at a locality just east of the south edge of Santa Ana Canyon from a 2- by 3-foot surface of a well-indurated large pebble and small-cobble conglomerate yielded the following:

Rock type	Number	Percent
Granite or quartz monzonite	6	6
Granite or quartz monzonite aplite	10	11
Total plutonic	16	17
Rhyolite or quartz latite	25	27
Andesite	33	35
Total volcanic	58	62
Quartzite	2	2
Indeterminate metamorphic	1	1
Granite or quartz monzonite gneiss	12	13
Total metamorphic	15	16
Sandstone	5	5
Total sedimentary	5	5
Grand total	94	100

This pebble count is typical of much of the Paleocene conglomerate along the northeastern flank of the Santa Ana Mountains. The high percentage of red and purple volcanic clasts in this conglomerate is suggestive of the upper Eocene to lower Miocene Sespe formation described elsewhere in this report. However, the stratigraphic relations of these beds strongly suggest a Paleocene age.

The lowermost sand and sandstone unit of the upper member of the Silverado formation is characterized by numerous angular clasts of siltstone which contain much grayish-green mica. Evidently the siltstone clasts represent a reworking of micaceous siltstone from the lower member, probably when the change from nonmarine to marine deposition occurred. Although no line can be drawn in the field to mark this change, the beds assigned to the upper member are believed in general to represent marine sedimentation, as these rocks are moderately well sorted and bedded and in a few places contain marine fossils in hard, somewhat limy lenses and in calcareous concretions.

FIGURE 20. Vertical siltstone and claystone of the Silverado formation. Exposure at the Thomas clay deposit, east pit, west of Wardlow Wash. Observer faces east.

Buff to brown and gray silty claystone irregularly intercalated with clayey siltstone comprise the upper part of the upper member. These beds are somewhat fissile and commonly contain abundant mica plates, but do not have the "schistose" appearance that is typical of the lower member, previously described. The claystone and siltstone appear to occur in lenticular bodies although they may have thicknesses of from 500 to 1,000 feet. Their exact stratigraphic position is not known, but along the east side of Fresno Canyon they seem to

Genus and species	Fossil localities (shown on plates 1, 3)					
	2[1]**	7*	8*	9[2]*	10[2]*	29[3]*
Brachysphingus ? sp.	x					
Crassatella branneri ? Waring	x					
Crassatellites ? sp.				x		
Glycymeris veatchii major Stanton	x					
Ostrea sp.			x			
Pholadomya sp.		x				
Priscoficus robustus ? (Weaver)	x					
Surcula merriami ? Dickerson	x					
Tellina ? sp.				x		
Turritella infragranulata ? Gabb	x			x		
Turritella pachecoensis Stanton	x			x		
Turritella cf. T. pachecoensis Stanton						x
Venericardia ? sp.					x	

[1] Identified by W. P. Popenoe
[2] Checked by J. G. Vedder
[3] Identified by Ralph B. Stewart

* Plate 1
** Plate 3

FIGURE 21. Paleocene faunal list.

be in the uppermost part of the sequence. The stratigraphic sequence from bottom to top of the upper member of the Silverado formation is not exposed. Scattered bits of circumstantial evidence, however, suggest a lower sandstone, a middle conglomeratic sandstone and an upper sandstone and siltstone.

Numerous exposures of brick-red or reddish brown sandy clay are found in the upper member, apparently at several stratigraphic positions. In general these clays are confined to narrow zones and do not appear to be lithologically the same as those of the lower member. Most of these clay exposures are along minor faults and are interpreted as fault gouge.

Paleontology. Fossils were collected from the Silverado formation at several localities (fig. 21) and, of the species identified, *Turritella pachecoensis* Stanton is the principal guide fossil. W. P. Popenoe examined a collection made by J. E. Schoellhamer at locality 2 south of Santa Ana Canyon in the west part of the Santa Ana narrows map area (pl. 3) and reported the age as Paleocene. Several well preserved Turritellas were collected by the writer and R. F. Yerkes from a large limy concretion intercalated with fissile claystone in the Thomas clay deposit west pit (locality 29). These specimens were identified as *Turritella* cf. *pachecoensis* Stanton by Ralph B. Stewart, Paleontology and Stratigraphy Branch, U. S. Geological Survey, (oral communication, J. E. Schoellhamer, March 1955). Although the specimens are incomplete, Stewart found them better preserved than the type specimen from Pacheco, and placed the modifying cf. in the identification.

Eocene Rocks

Santiago Formation

Eocene rocks do not crop out in the Corona South quadrangle but are present in the adjoining Santa Ana narrows map area two-fifths of a mile to the west. Woodring and Popenoe (1945) named sedimentary rocks of Eocene age a few miles to the west in the northwestern Santa Ana Mountains the Santiago formation. These Eocene deposits were earlier called the Tejon formation by Dickerson (1914, pp. 257-274) and also by English (1926, pp. 19-22).

FIGURE 22. Interbedded sandstone and siltstone of the Santiago formation. Exposed in cut on State Highway 18, a third of a mile east of Green River Camp. Observer faces south.

A band of Eocene (?) sandstone, siltstone, and cobble conglomerate, ranging from 200 to 800 feet in width, extends for about 1¾ miles southeast from Santa Ana Canyon across Fresno Canyon, along the northeast margin of the Black Star Canyon quadrangle. Fossil evidence at two localities, collected by other workers, indicates the Eocene age of these beds. Also, these rocks are lithologically similar to those of the Santiago formation mapped by Schoellhamer and others (1954) to the west in the Santa Ana Mountains. These beds, however, are separated only tentatively from the Paleocene rocks on the Santa Ana narrows area geologic map. The Eocene age is based on conflicting and somewhat indefinite faunal evidence, discussed below, and no continuous marker beds suitable for separating the Paleocene and Eocene rocks were found, but on the east side of Fresno Canyon and east of State Highway 18 a well-cemented cobble conglomerate may mark the base of the Eocene beds.

The Santiago formation apparently rests with conformable, gradational contact on strata of the Silverado formation and is conformably overlain by the Vaqueros and Sespe formations, undifferentiated (fig. 24).

Paleontology. At the east margin of Santa Ana Canyon, just east of State Highway 18, fossil locality 1 is in a hard, limy bed within a weakly cemented siltstone which also contains locality 15. About 20 poorly preserved impressions of mollusks were collected at locality 1, and possibly belong to the fauna of the Santiago formation. M. C. Israelsky examined a microfauna from locality 15 and reported: "Zone A-1 or A-2 of Goudkoff. We may assume it is above the *Siphogenerinoides* zone. On a negative basis it may be A-2". Goudkoff (1945, p. 956-983) indicates that he considers the A-1 and A-2 zones to be pre-Martinez Paleocene, and that the A-2 zone is immediately above the Upper Cretaceous. The *Siphogenerinoides* zone does not extend above the Upper Cretaceous.

W. P. Popenoe examined material collected by G. S. Hilton (1950, map, locality 95) at a locality approximately half a mile east of locality 1. Unfortunately the writer was unable to recover this locality. However, Popenoe (oral communication, 1953) reports two mollusks, *Ampullina* ? sp. indeterminate and *Plagiocardium breweri* ? (Gabb), and says:

"Probably middle Eocene—exact horizon not determinable. I should consider it as neither Cretaceous or Paleocene, but probably somewhere in the middle Eocene. There is nothing like the pelecypod listed above from the Cretaceous, but these are common in the Eocene".

A second locality also not visited by the writer, but reported to be about half a mile east of Fresno Canyon, yielded specimens which, according to J. E. Schoellhamer (oral communication, 1957) are tentatively identified as *Turritella buwaldana.* In the Los Angeles Basin this Turritella is listed by Natland and Rothwell (1954, p. 40) as an Eocene guide fossil.

Upper Eocene to Lower Miocene Rocks

Vaqueros and Sespe Formations, Undifferentiated

Maroon, red, buff, gray and grayish-green, coarse sandstone and conglomerate, fossiliferous in a few places, and containing a minor amount of siltstone, crop out in discontinuous patches from the southeastern extremity of the area to Scully Hill, north of Santa Ana Canyon. On lithologic and faunal evidence these rocks are assigned to the nonfossiliferous Sespe formation and the fossiliferous marine Vaqueros formation. They are mapped as the Vaqueros and Sespe formations, undifferentiated, as the Sespe strata grade both upward and laterally into the Vaqueros strata. These two formations are commonly mapped as a single undifferentiated unit elsewhere in the northwestern Santa Ana Mountains (English, 1926; Woodring and Popenoe, 1945; Schoellhamer and others, 1954).

W. L. Watts in 1897 designated as the Sespe brownstone formation rocks of continental origin that occur in the region of Sespe Creek, Ventura County. In 1924, W. S. W. Kew changed the term to Sespe formation. The Sespe formation was recognized in the northwestern Santa Ana Mountains by English (1926) and later also was described by Woodring and Popenoe (1945). The Sespe beds in the Santa Ana Mountains have yielded no fossils, but probably range in age from late Eocene to earliest Miocene (Woodford and others, 1954, p. 69).

In 1904, H. Hamlin applied the name Vaquero sandstone to fossiliferous marine sandstone in an area in Monterey County, California. Dickerson (1914) listed a Vaqueros fauna from the Santa Ana Mountains. Later, Loel and Corey (1932, pp. 51-60) described the Vaqueros fauna of the Santa Ana Mountains more completely. H. G. Schenck in 1935 redefined the formation and suggested the term Vaqueros group. In the Santa Ana Mountains the Vaqueros formation of early Miocene age overlies the Sespe formation and also intertongues with it (Woodford and others, 1954, p. 69).

In the Corona area the Sespe and Vaqueros formations of nonmarine and marine strata so intricately interfinger that the writer was unable to map them as separate units. The nonfossiliferous and apparently nonmarine Sespe formation is recognized on a lithologic basis, whereas the presence of probable Vaqueros beds is indicated by lithology and by fossil locality 5 which yielded a large assemblage of poorly preserved marine megafossils. These fossils, which include many fragments of thick-shelled oysters, are contained in a weakly cemented, buff, fine-grained sandstone bed which averages 2 feet in thickness and is exposed for about 200 feet. Precise identifications have not been made but the collection as a whole indicates an early Miocene or lower middle Miocene age (oral communication J. G. Vedder, Jan. 1957).

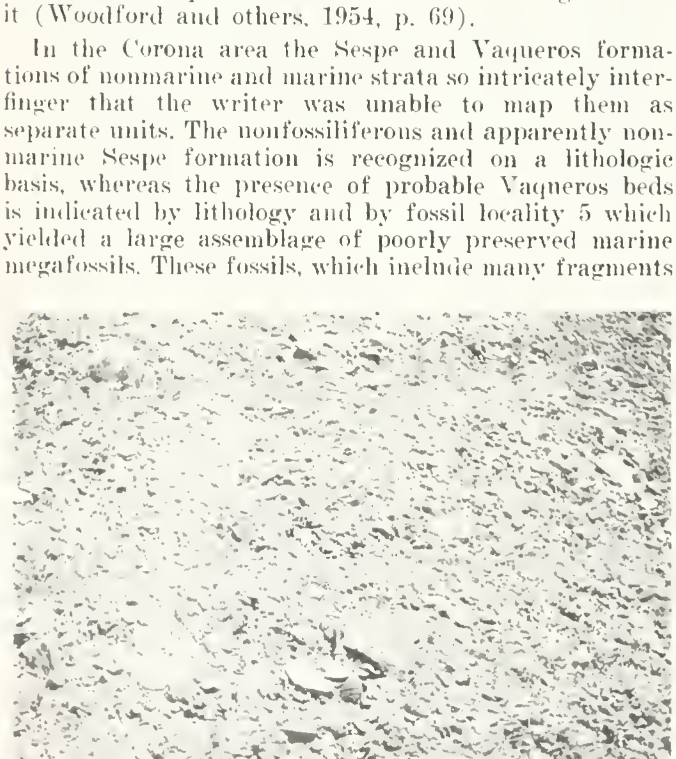

FIGURE 23. Red conglomerate of the Vaqueros and Sespe formations, undifferentiated. Exposed in cut on State Highway 18, five-eighths of a mile east of Green River Camp. Observer faces northwest.

FIGURE 24. Depositional contact (marked by hammer) between conglomerate of the Vaqueros and Sespe formations, undifferentiated and Santiago formation siltstone. Beds dip steeply to the left. Roadcut on State Highway 18 half a mile east of Green River Camp. Observer faces southeast.

Most of the area between Brown Canyon and Bedford Canyon is underlain by Vaqueros-Sespe red to maroon, white or grayish-green conglomeratic sandstone and minor beds of buff siltstone. On the south these rocks rest in fault contact against metasedimentary rocks of the Bedford Canyon formation. They apparently conformably overlie Paleocene sandstone on the northeast. The driller's log from well No. 4 (fig. 45, Mineral Deposits Section) indicates that nearly 1,000 feet of flat-lying Vaqueros-Sespe strata were penetrated before entering probable Paleocene strata.

In the Santa Ana narows area (fig. 24) Vaqueros-Sespe strata apparently rest unconformably on the Santiago formation and are in fault contact against the Silverado formation west of Wardlow Wash. East of Fresno Canyon Vaqueros-Sespe beds are overlain in fault contact by platy shale, sandstone and conglomerate of the upper Miocene Puente formation. Vaqueros-Sespe beds are also exposed along the southern margin of Scully Hill. At one place there they lie conformably below middle Miocene Topanga sandstone and there is a small sliver resting in fault contact with Topanga beds.

Weakly indurated massive, gray to grayish-green, maroon and reddish sandstone, siltstone, conglomerate, and conglomeratic sandstone crop out continuously from Wardlow Wash west to Fresno Canyon and continue west of Fresno Canyon for nearly half a mile and thence extend beneath terrace deposits. These strata show a maximum exposed thickness of 2,300 feet at a locality east of Fresno Canyon. Generally indistinct bedding and discordant attitudes make the calculation of thickness difficult. Vaqueros-Sespe beds also are exposed in the road cut along State Highway 18 southwest of Prado Dam. Here this unit consists of a massive, red to red-brown cobble and boulder conglomerate (fig. 23) but to the north and also to the west on Scully Hill across the Santa Ana River it is mostly a very weakly indurated red arkosic sandstone with conglomeratic lenses. The red sandstone here, and eastward to Wardlow Wash, and the red to grayish-green sandstone east of Bedford Canyon resemble Sespe strata a few miles to the west and southwest where the Sespe formation is well exposed and has been mapped by Schoellhamer and others (1954). The conglomerate is characterized by rounded to subrounded cobbles and boulders of red and dark purple volcanic rocks set in a poorly indurated matrix of red and grayish-green arkosic sand. The volcanic clasts form as much as 70 percent of the conglomerate.

The Vaqueros-Sespe sandstone and conglomeratic sandstone are poorly consolidated and erode easily. They typically have a puffy or hackly appearance. They weather characteristically to form deep, fluted, irregular and ragged gullies. The weathered surface is colored a distinctive and peculiar reddish-gray, and locally is greenish.

The Vaqueros-Sespe strata appear to represent a period of transition from nonmarine to marine depositional environment. Possibly these beds accumulated along the margin of a subsiding or fluctuating basin.

Miocene Rocks

Topanga Formation

Buff and brown sandstone and conglomerate, which crop out along the southern margin of Scully Hill, are here assigned to the marine middle Miocene Topanga formation on the basis of lithologic similarity to fossiliferous Topanga strata a few miles to the west in the southern Puente-Chino Hills. Similar strata also are exposed over an area of about half a square mile in El Cerrito Hills, southeast of Corona.

In 1923, W. S. W. Kew named the Topanga formation from exposures in Topanga Canyon in the Santa Monica Mountains. English (1926, map) assigned the middle Miocene sedimentary rocks of the Santa Ana Mountains and the southern Puente-Chino Hills to the Topanga formation and mapped this formation on Scully Hill in the Santa Ana narrows area and on the western flank of the Santa Ana Mountains.

The Topanga formation on Scully Hill is mostly a buff and tawny to white, medium-grained, arkosic sandstone. It is well indurated and well bedded, and is interbedded with cobble conglomerate. This buff sandstone is blocky and cliff-forming, and at Scully Hill has a maximum thickness of about 800 feet. The Topanga formation conformably overlies Vaqueros-Sespe beds and is apparently unconformably overlain by La Vida (Lower Puente formation) siltstone. No fossils were found.

In El Cerrito Hills, which lie southeast of Corona west of Temescal Canyon and north of Bedford Wash, buff and brown siltstone and shale, diatomaceous in a few places, with subordinate sandstone and conglomerate crop out (fig. 25). These outcrops, which form a rectangular patch about 1 mile long and half a mile wide, are assigned to the Topanga formation on the basis of lithologic and faunal evidence. Indistinct bedding and poor exposures hinder the accurate measurement of thickness, but the actual thickness probably lies within

FIGURE 25. Interbedded sandy cobble conglomerate and conglomeratic sandstone of the Topanga formation. Exposed in stream bank at the east edge of El Cerrito Hills.

the range of 750 to 1,000 feet. Incomplete records from a wildcat well, drilled years ago southwest of State Highway 71, suggest that from 800 to 980 feet of Topanga beds were penetrated. The lower part of this thickness, however, may have been Vaqueros-Sespe strata. In El Cerrito Hills the Topanga formation apparently rests unconformably on Silverado sandstone. Here the Vaqueros and Sespe formations, undifferentiated, may be either overlapped by the Topanga formation or were removed by pre-Topanga erosion.

Paleontology. Fragmentary and poorly preserved megafossils were collected from a number of places southwest of State Highway 71 along the Metropolitan Water District pipe line, but could be dated only as Miocene. These are apparently shallow-water forms.

Microfossils were collected from localities 23, 27 and 30 (fig. 30). An excellent fauna was provided by locality 30, collected from a siltstone well exposed in a Metropolitan Water District pipeline construction ditch 20 feet deep. This fauna consists of 7 genera represented by 12 species. The collection was kindly identified by Patsy B. Smith who reports the most abundant elements represent the Luisian (middle Miocene) stage of Kleinpell (1938, p. 121-131). Two rare forms are referred by her to the lower part of Kleinpell's Mohnian (upper Miocene) stage. She accordingly called the fauna uppermost Luisian (written communication, Patsy B. Smith, October 1956). Therefore these sediments are referred to the upper middle Miocene and assigned to the Topanga formation.

Puente Formation

Marine sedimentary rocks here assigned to the Puente formation of late Miocene age crop out in the Corona South quadrangle in scattered patches along the northeastern flank of the Santa Ana Mountains southeast of Corona, and in a single band west of Wardlow Wash in the northwest corner of the quadrangle. In the Santa Ana narrows area similar strata have been assigned to the Puente formation. These strata are exposed in a narrow band south of State Highway 18 near Prado Dam and extend eastward to Wardlow Wash, and as two bands, one along the southern and the other along the northern margin of the easternmost Puente-Chino Hills. The assignment to the Puente formation of the above mentioned disconnected upper Miocene sedimentary rock outcrops along the northeastern flank of the Santa Ana Mountains in the Corona South quadrangle and in the Santa Ana narrows map area south of State Highway 18, is well supported by faunal evidence (fig. 30) discussed later in this report.

G. H. Eldridge and R. Arnold named the Puente formation in 1907 from exposures in the Puente Hills a few miles northwest of the Santa Ana narrows area. They included in this formation the lower Puente shale member, the Puente sandstone member, and the upper Puente shale member. The Puente formation commonly has been divided into three main members: lower member of shale and sandstone, middle member of sandstone, and upper member of shale, conglomerate and sandstone. English (1926, p. 33-38) used this designation as did Woodford and others (1944), who assigned the Puente to the upper Miocene. Recently Schoellhamer and others (1954) have divided the Puente formation into four members in the southeastern Puente-Chino Hills and in the Santa Ana Mountains. From bottom to top these are: (1) La Vida member, consisting mainly of laminated siltstone with thin interbedded sandstone; (2) the Soquel member, consisting of sandstone with interbedded siltstone and local conglomerate beds; (3) the Yorba member, consisting of thin-bedded siltstone and local beds of sandstone and conglomerate; and (4) the Sycamore Canyon member, consisting of interbedded conglomerate, sandstone and siltstone. The writer uses the names proposed by Schoellhamer and others (1954) because they correspond more closely to the actual stratigraphic units of the Puente formation in this area than do the older and more general names.

La Vida Member

La Vida member is exposed as a narrow belt across Scully Hill. This belt, consisting mainly of siltstone, is about 1,000 feet wide at the eastern margin of the hill and narrows to 200 feet or less to the west where it extends under terrace deposits. The maximum true thickness is about 800 feet. The siltstone weathers to form characteristic rounded, soft slopes and a grayish-brown clayey soil.

La Vida member is mostly a fine-grained laminated siltsone but contains intercalated fine-grained shale beds and minor interbedded buff, medium-grained sandstone. The lower Puente formation in nearby areas commonly includes much platy, siliceous, fine-grained shale but this lithology was not seen on Scully Hill. On fresh exposures La Vida siltstone is gray to pale brown, but most outcrops have weathered to a darker brown or pinkish color. La Vida member unconformably overlies the Topanga sandstone as indicated by a small discordance of dips. On Scully Hill, La Vida member is in fault contact with the overlying Soquel member; but elsewhere in the Puente Hills the contact between La Vida and Soquel members is gradational and at one place a local unconformity exists between the two members (Schoellhamer and others, 1954). La Vida member is seemingly marine, but no identifiable fossils were found.

Soquel Member

Tawny, buff to white and gray sandstone crops out along the north side of the Santa Ana River from east of Yorba Canyon to the western margin of Scully Hill. The outcrop ranges in width from about 700 feet on the east to nearly 1,500 feet on the west. The calculation of thickness is made difficult by irregular attitudes and by slumping but the maximum is probably about 700 feet. This sandstone is here assigned to the Soquel member of the Puente formation because of its stratigraphic position and lithologic similarity to the Soquel member described by Schoellhamer and others (1954). The Soquel member is in fault contact with the underlying La Vida member. The upper contact between the Soquel and Yorba members is gradational.

The sandstone contains intercalated stringers or lenses of cobble conglomerate. It is rather poorly bedded, is generally soft, and medium-grained. It is composed mostly of poorly sorted subangular quartz and feldspar grains. The member locally contains beds of buff and gray siltstone. The Soquel member forms a more rugged and broken topography than either the underlying or overlying siltstones.

Yorba Member

Siltstone similar lithologically to La Vida member, but with the stratigraphic position to assign it to the Yorba member, crops out just east of Yorba Canyon and extends westward across Scully Hill. The outcrop width is about 400 feet east of Yorba Canyon and some 1,500 feet in the western part of the mapped area; evidently the Yorba member continues to thicken to the west. The maximum true thickness within the mapped area is probably 1,200 feet.

This siltstone in general forms a rounded, gentle topography. It is pinkish to gray on a fresh surface and weathers to a brownish-gray soft soil. The Yorba member ranges from a massive to fissile, thin-bedded, buff or gray siltstone and contains interbedded massive, fine-grained, buff sandstone.

The Yorba member overlies the Soquel member somewhat gradationally but the contact is located rather closely by lithologic and topographic evidence. This is demonstrated by a marked contrast between the rough topography developed on the Soquel sandstone and the smooth rounded slopes developed on the Yorba siltstone. Schoellhamer and others (1954) report that the contact between the Yorba member and the underlying Soquel member is gradational throughout the Puente Hills.

Sycamore Canyon Member

Sandstone, conglomerate and siltstone crop out along the north side of Santa Ana Canyon west of Prado Dam, extend westward to Yorba Canyon and continue west of the mapped area. These rocks are assigned to the Sycamore Canyon member on the basis of lithology and stratigraphic position. The width of outcrop ranges from about 700 feet near Prado Dam to 4,500 feet at the western end of the mapped area and continues to widen to the west. Similar strata crop out on the southwest side of the Chino fault. The true thickness of the Sycamore Canyon member is not easily calculated but probably is about 2,700 feet maximum near Yorba Canyon and much greater to the west.

FIGURE 26. Interbedded, tawny, coarse-grained sandstone and cobble conglomerate, Sycamore Canyon member of the Puente formation. Exposed in stream cut, northeast side of Yorba Canyon, southeastern Puente-Chino Hills. Observer faces northeast.

The Sycamore Canyon member in this area is composed chiefly of buff or tawny to gray and white medium- to coarse-grained, massive to well-bedded sandstone, abundantly interbedded with cobble conglomerate that contains granitic and volcanic clasts (fig. 26). Buff or tawny siltstone is also included. The sandstone is poorly sorted and is mostly composed of subangular grains of quartz and feldspar. In general the sandstone is similar to that of the Soquel member, except for more extensive conglomerate. In many places the sandstone stands out to form bold cliff faces and a rugged topography. Buff or tawny siltstone (figs. 27, 28) is locally

FIGURE 27. Siltsone, shale and limy siltstone (light area, center), Sycamore Canyon member of the Puente formation. Beds dip about 40° away from observer. Exposed along north side of Santa Ana River at southeastern tip of Puente-Chino Hills, half a mile southwest of Prado Dam. Observer faces north.

FIGURE 28. Detail of interbedded buff siltstone and gray limy siltstone (marked by hammer), Sycamore Canyon member of the Puente formation. Beds dip about 40° away from observer. Exposed along north side of Santa Ana River at southeastern tip of Puente-Chino Hills. Observer faces north.

interbedded with the sandstone and conglomerate and is minor near Prado Dam but thickens greatly to the west along Yorba Canyon. In places it contains limy siltstone beds.

The Sycamore Canyon member conformably overlies the Yorba member in a gradational contact. Although this contact is not sharp in the southeastern tip of the Puente-Chino Hills it is drawn along the base of the first massive coarse-grained sandstone and conglomerate bed above Yorba siltstone. Sandstone, siltstone, and conglomerate of probable Pliocene age gradationally overlie the Sycamore Canyon member.

Puente Formation, Undifferentiated

Sandstone, conglomerate, thin-bedded siltstone, and laminated diatomaceous siltstone crop out along the south bank of the Santa Ana River south of Prado Dam in the Santa Ana narrows map area. These rocks form a band, as much as 1,000 feet in width, extending east from Santa Ana River to Wardlow Wash in the northwest corner of the Corona South quadrangle. Patches of these strata also crop out at several localities southeast of Corona from where they extend as far east as Brown Canyon at the east central margin of the Corona South quadrangle. These rocks, shown as undifferentiated Puente formation, probably have a maximum thickness of 1,000 feet south of Prado Dam although true thickness is difficult to establish because of irregular attitudes and slumping. Southeast of Corona the Puente formation may be much thinner.

Upper Miocene strata along the northeastern margin of the Santa Ana Mountains are designated as Puente formation, undifferentiated, because the stratigraphic relations of the scattered outcrops, to one another, are not clear. Possibly the same sequence of Puente formation units that was mapped in the southeastern Puente-Chino Hills extends across the Santa Ana River narrows and is present in the Corona region. The various members of the Puente formation in the Puente-Chino Hills appear to thin to the east and thus strata of each member could exist east of the Santa Ana River and be represented in the narrow band of Puente beds which is exposed south, southeast of Prado Dam. South of Prado Dam the Puente formation includes a lower unit of shaly siltstone, a middle unit of sandstone and conglomerate and an upper unit of shaly siltstone. These units may be equivalent to the members mapped west of the Santa Ana River, but in the absence of positive evidence these rocks probably are best designated as Puente formation, undifferentiated.

Along the south side of the Santa Ana River buff to brown medium-grained sandstone and siltstone of the Puente formation, undifferentiated, crop out as far east as Wardlow Wash. These are interbedded with conglomerate and upward the formation is a buff and pinkish to gray shale and thin-bedded siltstone with diatomaceous siltstone lenses. Thin, hard limy beds, locally carrying an abundant microfauna, are intercalated with the shale and siltstone (fig. 29). These Puente strata are exposed in a narrow band which averages about 500 feet in width, but is as much as 800 feet wide, and is about $1\frac{1}{2}$ miles long. The maximum true thickness is about 750 feet.

FIGURE 29. Siltstone and shale of the Puente formation, undifferentiated with intercalated limy bed (above hammer). Exposure in cut on State Highway 18 east of Fresno Canyon. Note similarity to Sycamore Canyon member of the Puente formation shown in fig. 28. Observer faces south.

Here these Puente beds rest, apparently with fault contact, on Vaqueros-Sespe beds. The Topanga formation apparently is cut out. Along part of the contact, midway between Wardlow Wash and Santa Ana River, the lowermost exposed unit of the Puente formation is a cobble conglomerate and is overlain by rather blocky, massive, buff and gray sandstone which grades upward into platy siltstone and shale. Evidently this is the typical sequence of the Puente formation in this area. Here the lower siltstone unit, which occurs below the sandstone and conglomerate unit at a locality near the east side of the Santa Ana River, apparently has been cut out by faulting. Pliocene (?) strata apparently conformably overlie the Puente formation.

East of Corona along State Highway 71, near the northwest end of the Elsinore trough, patches of Puente strata crop out above the alluvium-filled valley. The rocks are white to greenish-gray thin-bedded diatomaceous siltstone, buff to gray siltstone and shale, and brown or buff, medium-grained sandstone with local, rounded cobble, conglomerate lenses. Here the Puente formation is probably thin. The maximum provable thickness measured from outcrops is about 300 feet, but projections in cross sections indicate a possible thickness of about 1000 feet. It is at least locally conformable upon the Topanga formation along the west margin of El Cerrito Hills, whereas to the north, near Compton Siding, it rests directly on basement rocks. To the south, along the west side of Bedford Canyon, diatomaceous siltstone and shale of the Puente formation are in fault contact with Paleocene Silverado strata below and Pliocene (?) rocks above. In some places the Pliocene (?) rocks appear to overlie Puente beds conformably. East of Bedford Canyon Puente siltstone and shale rest with fault contact on Vaqueros-Sespe beds. Several fault slivers of Puente siltstone and shale crop out along Brown Canyon.

Paleontology. The Miocene age of the beds that are referred to the undifferentiated Puente formation is well established by the microfauna (fig. 30). Patsy B. Smith has examined the collections and reports that localities 17, 24, and 25 can be referred to the upper Mohnian stage of Kleinpell (1938, p. 121-131); localities 18, 21 and 32 are probably upper Mohnian stage and localities 19 and 26 apparently represent Kleinpell's Luisian stage (oral communication, Patsy B. Smith, 1953). Mohnian is considered to mean upper Miocene, and Luisian indicates middle Miocene. However, Luisian foraminifera are no barrier in assigning these sedimentary rocks to the Puente formation and the Luisian stage localities furnished too few forms to be conclusive.

Genus and species	Fossil localities (shown on pl. 1)											
Foraminifera	17	18	19	21	22	23	24	25	26	30	32**	27
Bolivina cf. B. decurtata Cushman											x	
Bolivina floridana Cushman										c		
Bolivina hughesi Cushman	x						x	x				
Bolivina tumida Cushman										a		
Bolivina cf. B. vaughani Natland											x	
Bolivina woodringi Kleinpell	x	x										
Bolivina cf. B. woodringi Kleinpell											x	
Bolivina sp.			x	x								
Bulimina montereyana Kleinpell	x	x			x	x		x		a		
Bulimina ovula d'Orbigny			x									
Bulimina cf. B. uvigerinaformis Cushman & Kleinpell										r		
Buliminella curta Cushman	x	x							x			
Buliminella subfusiformis Cushman		x										
Epistominella relizensis (Kleinpell)										a		
Epistominella gyroidinaformis (Cushman & Goudkoff)										c		
Gyroidina soldanii var. rotundimargo R. E. & K. C. Stewart		x									x	
Hemicristellaria beali (Cushman)			x									
Nonion costiferum (Cushman)										a		
Nonion pizarrensis W. Berry										c		
Uvigerina carmelosensis Cushman & Kleinpell										r		
Uvigerina subperegrina Cushman & Kleinpell											x	
Valvulineria araucana d'Orbigny		x					x					
Valvulineria californica Cushman			x						x			
Valvulineria californica var. obesa Cushman										f		
Valvulineria cf. V. grandis Cushman & Galliher										c		
Valvulineria sp.				x								
Virgulina californiensis Cushman		x				x		x		a		
Diatoms												
Coscinodiscus sp.												x

* Identified by Patsy B. Smith
** Locality 32 identified by Richard L. Pierce

a—abundant f—few
c—common r—rare

FIGURE 30. Miocene faunal list*.

The Corona area apparently marks the eastern margin of a shallow, fluctuating basin of Tertiary deposition. In this region middle and late Miocene microfaunas may have overlapped and as a result of local depositional environments in segregated areas, beds containing these microfaunas may appear to interfinger so that it is not always possible to separate these strata into middle and upper Miocene units on the basis of scattered occurrences of microfauna. Under these conditions the Miocene microfaunal stages of Kleinpell may not strictly apply.

Pliocene (?) Rocks

Pliocene, Undifferentiated

White sandstone with interbedded conglomerate and buff or gray siltstone, crop out in the southeastern tip of the Puente-Chino Hills and evidently extend eastward across the Santa Ana River to Wardlow Wash. Southeast of Corona in the vicinity of Bedford and Joseph Canyons, similar strata crop out. These rocks, at each locality, are assigned a probable Pliocene age on the basis of lithologic, stratigraphic, and faunal evidence. Most, if not all, of the probable Pliocene rocks in the Puente-Chino Hills may belong to the Sycamore Canyon member of the Puente formation. However, in the field the white sandstone with interbedded siltstone and conglomerate comprise a mappable unit and accordingly are delineated on the geologic map.

English (1926, p. 38) recognized that part of the strata mapped in the Puente Hills as upper Puente formation might possibly be Pliocene. Later workers provisionally established the Pliocene age on a faunal basis and Woodford and others (1944) show Pliocene strata in the southeastern Puente-Chino Hills. The faunal evidence is not conclusive, however.

North of the Santa Ana River, in the vicinity of Prado Dam, Pliocene (?) strata occupy the center of the Arena Blanca syncline and crop out over an area about 7,500± feet wide. They have a maximum stratigraphic thickness of 3,000± feet. The Pliocene (?) beds are composed of coarse, white, arkosic sandstone with interbedded conglomerate and alternate with beds of black or grayish-brown to buff fine-grained sandstone, siltstone and shale (figs. 31-34). The conglomerate clasts are mostly well-rounded pebbles and cobbles of granitic rocks, but with some quartzites and minor amounts of volcanic rock, set in a generally weakly cemented arkosic sandstone matrix. The white Pliocene (?) sandstone weathers easily and forms an irregular topography with steep, jagged, and fluted ridges (fig. 31).

The Pliocene (?) strata in the southeastern tip of the Puente-Chino Hills gradationally overlie the Sycamore Canyon member of the Puente formation along both limbs of the syncline. This gradational contact is inferred as no continuous marker horizon was found. Moreover, although Pliocene foraminifera have been reported by Roscoe and Katherine Stewart (1930) and also by Woodford and others (1944), these scattered fossil localities do not closely determine the contact.

North of the Chino fault, are exposures of a unit composed of buff to gray and pinkish shale and siltstone with minor amounts of interbedded sandstone and conglomerate. Pliocene foraminifera are reported by Price (1953) to have been found in this unit farther northwest.

White sandstone with interbedded conglomerate and buff to gray siltstone and shale, of probable Pliocene age, are exposed southeast of the Santa Ana River around the Prado Dam spillway and continue eastward to Wardlow Wash. Lithologically they appear to be identical with the Pliocene (?) strata west of Prado Dam except for a reddish brown, micaceous, "dirty" arkosic, platy sandstone and siltstone exposed in the railroad cut north of Wardlow Wash. These Pliocene (?) rocks apparently grade downward into Puente siltstone and shale. An extensive development of terrace deposits, resting in sharp angular unconformity, covers much of the Pliocene (?) rocks east of the Santa Ana River so that they are only exposed in road cuts and ravines.

A Pliocene age is indicated by microfossils from locality 20, just west of Wardlow Wash. Patsy B. Smith examined material from this locality and reported the presence of *Rotalia* cf. *beccarii* (Linné) and *Bolivina seminuda* Cushman (oral communication, May 1953). These two forms indicate a probable upper Repetto age (lower Pliocene) but are not sufficiently diagnostic to rule out a possible upper Pliocene age, and Natland and Rothwell (1954, pp. 34, 40) include *Rotalia beccarii* with Pleistocene guide fossils in the Los Angeles Basin. They are shallow water or lagoonal forms indicating probable deposition along the margins of a basin, perhaps in a lacustrine environment. This depositional environment is evidenced by the beds at locality 20 as well as by the fossils, as the collection was made from a small outcrop of white to gray, somewhat thin-bedded, claystone which has the characteristic appearance of lake bed material. A second collection, made several years later from the same beds in the vicinity of locality 20, was examined by Richard L. Pierce who reports an abundance of *Eponides* sp. which is not diagnostic.

Southeast of Corona, in the vicinity of Bedford and Joseph Canyons, patchy outcrops of white, coarse, arkosic sandstone with conglomerate lenses and a few thin, gray siltstone layers (fig. 35) are here assigned to the Pliocene. The components of the sandstone are mostly medium- to coarse-grained, subangular feldspar and quartz fragments. The sandstone is poorly sorted and contains pebbles and small cobbles of granitic, metamorphic and volcanic rock. It locally contains cobble-sized clasts of grayish-green siltstone which may be reworked from the Puente strata. The sandstone is poorly bedded and only weakly indurated. It overlies Puente siltstone and shale, in a few places apparently conformably, but in most exposures is faulted against the Puente beds.

A meager megafauna from locality 14, on the northwest side of Bedford Canyon, indicates a Pliocene age. J. G. Vedder has examined these fossils and reports: ". . . the material is too poor to give names but appears to be Pliocene. One fragment is *Cantharus* sp. and indicates Pliocene" (oral communication, 1953). The beds at locality 14 are composed of reddish-brown, micaceous, "dirty" arkosic, platy sandstone and siltstone. They appear to be lithologically similar to beds, already described, exposed in a railroad cut west of Corona and north of Wardlow Wash. Locality 28, on the northwest side of Bedford Canyon, yielded only ostracods.

FIGURE 31. Moderately south-dipping white sandstone and conglomerate of Pliocene (?) age in the north limb of the Arena Blanca syncline, just beyond axis. Note steep and ragged weathered surfaces. Exposure in cut on State Highway 71, northwest of Prado Dam. Observer faces northwest.

FIGURE 32. Close-up view of fig. 31 showing detail of white sandstone and conglomerate of Pliocene (?) age. Observer faces northwest.

FIGURE 33. Steeply north-dipping interbedded white sandstone and dark gray siltstone of Pliocene (?) age. South limb of Arena Blanca syncline exposed in cut on State Highway 71, southwest of Prado Dam. Observer faces west.

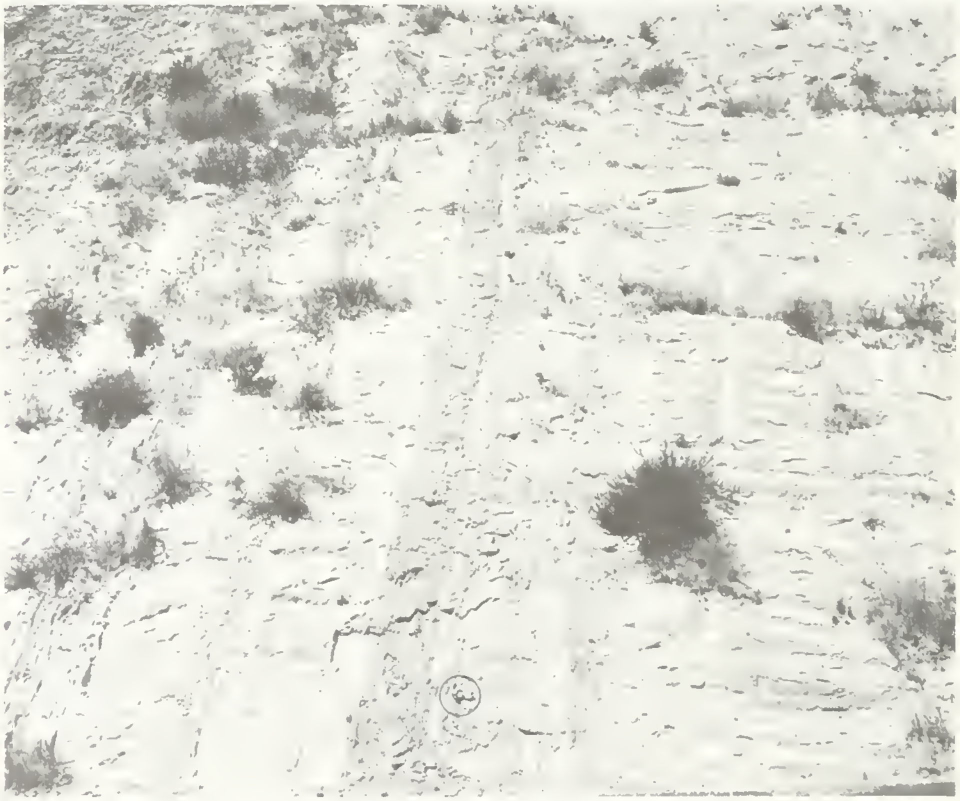

FIGURE 34. Detail of the interbedded white sandstone and dark gray siltstone of Pliocene (?) age shown in fig. 33. Light meter (circle) gives scale. Observer faces west.

FIGURE 35. Poorly consolidated, massive, white arkosic sandstone of Pliocene (?) age exposed at the Jones sand deposit, east of Joseph Canyon. Note thin, gray siltstone layer (marked by hammer). Observer faces west.

Quaternary System

Pleistocene (?)—Recent Rocks

Terrace Deposits

Extensive terrace deposits occur along the northeastern flank of the Santa Ana Mountains from the eastern boundary of the mapped area to the Santa Ana River (fig. 36) and along the southern margin of Scully Hill west of the river. The terrace deposits are unconsolidated gravels made up of angular to subrounded fragments of volcanic, granitic, metamorphic and sedimentary rocks set in a reddish to yellow-brown or buff weakly indurated "dirty" sandy matrix (fig. 37). The typical color is reddish-brown. Most of the clasts are of cobble size but some are boulders. On the flat terrace surfaces large residual boulders as much as three feet in diameter are occasionally encountered. In general the components correspond closely to the sedimentary and basement-complex types found nearby in the Santa Ana Mountains, indicating local derivation. The lower terrace deposits mapped between Bedford and Brown Canyons, however, appear to have been carried down Temescal Creek, rather than from the Santa Ana Mountains.

Some of the terrace deposits are much dissected, but in general they have nearly flat surfaces. In thickness they range from less than 1 foot to 50 feet or more and in places may approach 150 feet. The terrace deposits truncate the older sedimentary rocks with sharp angular unconformities.

No clear evidence for dating the terrace deposits was observed. They have been faulted, truncate Pliocene (?) sedimentary rocks, and are apparently overridden by probable late Pleistocene or Recent landslide material along the southern margin of Scully Hill. From this evidence the terrace deposits are believed to be, at least in part, of Pleistocene age. Some are probably Recent.

Older Alluvium

The town of Corona and the citrus acreage to the south are developed on a surface of older alluvium. This area is termed the Corona compound alluvial fan.

The older alluvium is composed of material similar to that of the terrace deposits (fig. 38). However, the clasts are in general smaller in the older alluvium, the color is characteristically buff to dark brown, rather than the typical reddish-brown of the terrace deposits, and a thicker soil has developed on the older alluvium.

The observed thickness of the older alluvium ranges from only a few feet to a probable maximum of 100 feet, the thickest occurrence being exposed along Bedford Canyon. Eighty feet of older alluvium were penetrated in a drill hole south of the Liston Brick Company plant on the east margin of lower Bedford Wash. No conclusive evidence for dating the older alluvium was found. The deposits are, however, probably mostly of Recent age, as they commonly are but little dissected and generally are undeformed, although some may be as old as late Pleistocene.

At a few places the terrace deposits and older alluvium are difficult to distinguish. This is particularly true south of Corona where flat-topped ridges, covered with fanglomerate deposits, slope gradually northward into

FIGURE 36. View south across Santa Ana River toward Fresno Canyon (center) showing gently north-sloping terrace deposits (Qt) along both sides of the canyon. Tertiary and Cretaceous sedimentary rocks (middle distance) rise sharply behind terraces. Central mass of the Santa Ana Mountains (background) consists of Santiago Peak volcanics.

the Santa Ana River valley. The areas at lower elevations appear to be more closely related to the Corona compound fan, and are mapped as older alluvium. Those at higher elevations, closer to the mountains, and in most places distinctly separated from the Corona compound fan, are mapped as terrace deposits.

Recent Rocks

Alluvium

The lower reaches of the creek beds are filled with a mixture of unconsolidated sand, rounded pebbles and cobbles and a few boulders. Upstream many large angular to sub-angular boulders are encountered. The components of all of the alluvium, except that in Temescal Creek, are locally derived volcanic, granitic, sedimentary and metamorphic rocks. The tributaries of Temescal Creek drain a large area in the Santa Ana Mountains and Perris Block underlain by a host of different volcanic, granitic, and metamorphic rock types and thus the creek bed has much material foreign to the Corona area, and of distant origin.

The Recent alluvium ranges from only a thin veneer in the minor creeks to a cover with a probable maximum thickness of about 100 feet in the Santa Ana River; ninety-four feet are reported at Prado Dam (W. L. Burnham, oral communication, 1953). An exploratory drill hole in lower Bedford Wash is believed to have penetrated over 100 feet of alluvium before entering Paleocene sedimentary rocks.

The major canyons and creek beds of the Corona area have along their borders a considerable deposit of alluvial material which apparently is not being currently transported by water. This alluvial material may, however, be subject to transportation at widely spaced irregular intervals as a result of flood conditions. These gravels have been included with the alluvium on the geologic map as they clearly are not part of the Corona compound fan.

STRUCTURAL GEOLOGY

General Features

The Corona area (figs. 39-41) lies just within the eastern margin of the Los Angeles Basin which, beginning in middle Tertiary time, has received great thicknesses of sedimentary rocks. During much of middle and late Tertiary time an embayment extended southeastward from the Los Angeles Basin into the area now occupied by the Corona-Elsinore trough. The middle and late Tertiary strata that are now exposed in the Corona area are, in general, the near-shore facies of formations that are widely recognized elsewhere in the basin. These sedimentary rocks, as well as the formations of earlier Tertiary

FIGURE 37. Terrace deposits exposed in road-cut near the railroad one mile west of Fresno Canyon. Observer faces east.

and Mesozoic age, have been both complexly folded and faulted in late Cenozoic time.

The dominant fold in the Corona area (fig. 48) is the Santa Ana Mountains anticline, the apparent crest of which approximately coincides with the crest of the mountains. In the central part of the mapped area, this anticline is paralleled on the northeast by the small and shallow Arena Blanca syncline, which is well-exposed in the southeastern Puente-Chino Hills. Along the north-eastern flank of the Santa Ana Mountains a group of high-angle reverse faults and vertical faults, offset in places by cross faults, lie generally parallel to the northwesterly trend of the Santa Ana Mountains and disturb the southwest limb of the Arena Blanca syncline. Overturned strata are common.

FIGURE 38. Typical exposure of older alluvium along northwest side of Bedford Canyon. Observer faces northwest.

Three major structural blocks can be distinguished in the Corona-Santa Ana narrows region (fig. 48): (1) the Santa Ana Mountains block bounded on the northeast by the Elsinore and Whittier faults; (2) the Puente-Chino Hills block bounded on the northeast by the Chino fault and on the southwest by the Elsinore and Whittier faults; and (3) the Corona-Chino valley block on the northeast side of the Chino fault.

Faults

Major Faults

Elsinore Fault

The Santa Ana Mountains have long been recognized as uplifted along a fault zone which lies along their northeastern margin and which many workers have called the "Elsinore fault zone". W. M. Davis (1927, p. 57) well described the trace of this structural feature when he wrote: " . . . the Elsinore rift, which borders the northeastern flank of the Santa Ana Mountains . . . is peculiar in being curvilinear and in exhibiting along its western side a succession of concave bights, each a few miles in length, separated by blunt salients or cusps." The fault zone, which has been traced south-southeastward from the mapped area for a distance of at least 110 miles (Larsen, 1948, pp. 119-127, pl. 1; Jahns, 1954, pp. 29-52, pl. 3) characteristically occupies a trough-like depression and contains several parallel to subparallel faults. At most places, the fault with the most prominent topographic expression has been designated as the "Elsinore fault". In the Corona South quadrangle the Elsinore fault zone occupies the Corona-Elsinore trough whereas the term "Elsinore fault" is herein applied to the most southwesterly of the major faults in the zone and the one along which the Santa Ana Mountains have risen.

In the mapped area the Elsinore fault, which is steep and sinuous and separates dissimilar rock types, can be traced northwestward across the entire mapped area from Temescal Valley to the southeast side of Santa Ana Canyon. The longest continuous segment of the Elsinore fault within the mapped area extends from the northwest corner of Temescal Valley near Brown Canyon to a point just west of Fresno Canyon. Here the fault ordinarily strikes N. 60° to 70° W. The trace of this segment, which is about 10 miles long, generally bends several hundred feet upstream in the canyons and curves out around the noses of the ridges. West of Fresno Canyon the segment terminates against a cross fault and thence an apparent northeasterly offset segment of the Elsinore fault extends nearly due westward to a point just southeast of Santa Ana Canyon where it evidently again assumes a northwesterly strike.

In the southwestern corner of the Corona South quadrangle, between Brown and Anderson Canyons along the southwest margin of Temescal Valley, the frontal fault of the Santa Ana Mountains is subparallel to and has the same sense of movement as the major segment of the Elsinore fault in the mapped area northwest of

Figure 39. Oblique aerial view of the east end of Santa Ana Canyon at Prado Dam. The axis of the Arena Blanca syncline is at left just beyond Prado Dam. The center of the syncline is formed by Pliocene (?) sediments (Tp), and the Sycamore Canyon member of the Puente formation (Tpsc) forms the margins. The Santa Ana River course (center) is filled with Quaternary alluvium (Qal) and the river marks the geographical division between the Puente-Chino Hills (left) and the foothills of the Santa Ana Mountains (right). Older Quaternary alluvium (Qalo) in right middle distance forms the Corona compound alluvial fan. South of State Highway 18 flat-topped terrace deposits (Qt) overlie the Puente formation undifferentiated (Tpu) and Pliocene (?) rocks (Tp) east of Fresno Canyon. The projected trace of the Chino fault trends diagonally across the photo parallel to and beyond the spillway through the clump of trees in right middle distance. Observer faces northeast. *Photograph by Pictorial Crafts, Incorporated, San Bernardino, California, 1953.*

FIGURE 40. Oblique air photo of the Elsinore fault zone showing generalized geology at the northwest end of the Corona-Elsinore trough (left middle distance) and the northeast flank of the Santa Ana Mountains (right) taken in 1957, camera facing southeast. Qal = Quaternary alluvium, Qalo = older alluvium, Qt = terrace deposits, Tp = Pliocene (?) sediments, Tpu = Puente formation, undifferentiated, Tvs = Vaqueros and Sespe formations, undifferentiated, Tes = Santiago formation, Ts = Silverado formation, T = Tertiary sediments including the Silverado, Vaqueros and Sespe, and Puente formations, and Pliocene (?) strata; and terrace deposits and older alluvium, K = Upper Cretaceous sediments including the Ladd and Trabuco formations, B = basement complex including intrusive, volcanic and metasedimentary rocks. *Photograph by U. S. Geological Survey.*

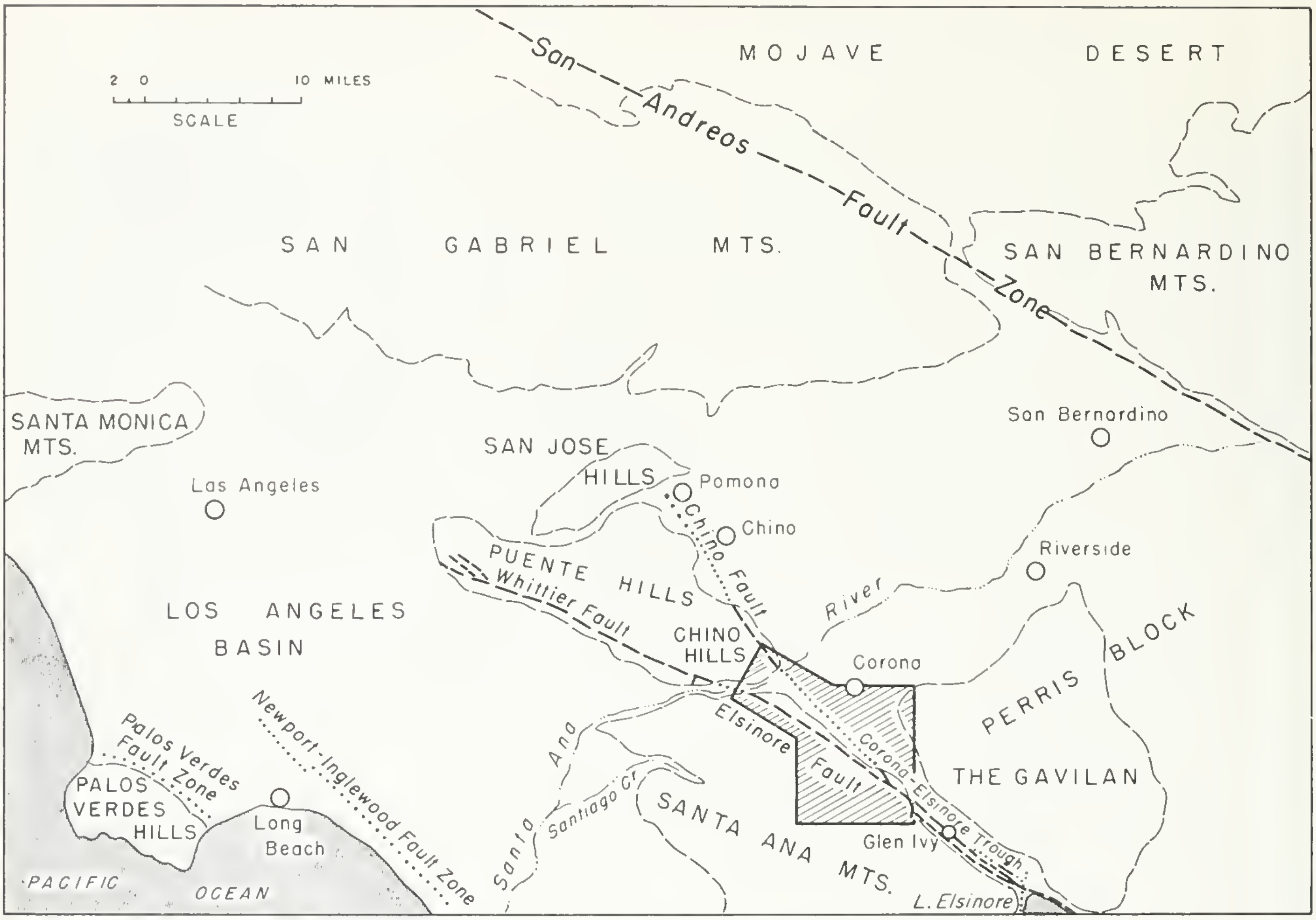

FIGURE 41. Index map of the Corona region, showing major structural features and major faults in a portion of southern California.

FIGURE 42. View northwest across Bedford Canyon (middleground) along the Elsinore fault (F). The fault separates Santiago Peak volcanics (V) and Bedford Canyon metasedimentary rocks (M) on the southwest from Tertiary sedimentary rocks (Ts, Silverado formation; Tp, Puente formation, undifferentiated; T, Pliocene, undifferentiated; Q, Terrace deposits) on the northeast. Note landslide mass (L) of Santiago Peak volcanics. Older alluvium (A) in foreground.

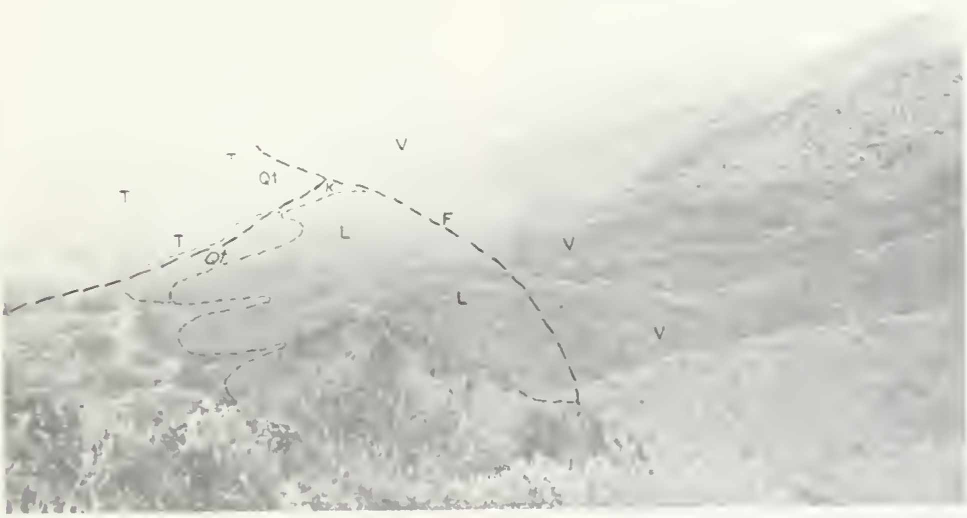

FIGURE 43. View southeast from Skyline Drive along the Elsinore fault (F). The fault separates Santiago Peak volcanic rock (V) from Tertiary (T) and Cretaceous (K) sedimentary rocks. Note large landslide area (L) of volcanic rock on northeast side of fault and sharply truncated terrace deposit (Qt) in middle distance. Tin Mine Canyon at left. At the east side of Hagador Canyon (middle distance) a fault that separates Cretaceous and Tertiary sedimentary rocks joins the Elsinore fault.

FIGURE 44. View southwest across the Santa Ana River course toward the Elsinore fault (F) in the Santa Ana narrows area. The fault separates Santiago Peak volcanic rock (V) on the southwest from Cretaceous and Tertiary sedimentary rocks (S) on the northeast. Note large landslide area (L) of volcanic rock.

Temescal Valley. It may be an offset segment of the Elsinore fault or may form the west side of a graben which is bounded on the east by an alluvium-covered portion of the Elsinore fault. This frontal fault, which extends southeastward at least 7 miles beyond the mapped area to a point south of Alberhill, is terminated on the west (in Brown Canyon) by a cross fault which apparently has stepped back this frontal fault as a southwesterly offset segment of the Elsinore fault half a mile to the northwest. Fault features in Temescal Valley are aligned with the northwest segment of the frontal Elsinore fault. Minor movement, more recent than the movement on the frontal fault, apparently has produced the fault features in Temescal Valley. This fault segment apparently joins the stepped-back frontal segment of the Elsinore fault at a point south of Alberhill, about 6½ miles beyond the mapped area.

In the mapped area, northwest of Brown Canyon, the Elsinore fault separates Santiago Peak volcanics and Bedford Canyon metamorphic rocks on the southwest from Cretaceous and Tertiary sedimentary rocks on the northeast. Southeast of Brown Canyon the fault trace is entirely in the Quaternary alluvium and terrace deposits of the Temescal Valley. Along the southwest margin of Temescal Valley an offset segment of the fault separates San Marcos gabbro from the alluviated valley. Many large landslide masses of the basement rock occur along the fault and obscure its trace. In most exposures the trace of the fault is marked by a zone of thoroughly crushed and pulverized basement rock several hundred feet thick, rather than by a single plane. However, along the Corona Skyline Drive, north of Tin Mine Canyon, an exposure of volcanic rock shows a smooth surface that may be the fault plane. Here the fault appears to be either vertical, or steeply-dipping southwestward into the mountains. No slickensides or other features that would indicate the direction of movement were observed. The only other possible exposure of the fault plane was found east of Bedford Canyon in a clay pit. Here too the fault appears to be vertical or to dip steeply to the southwest.

Although the Elsinore fault is not well exposed, its approximate location is shown in the linear alignment of numerous springs and vegetational differences, the wide shear zone of fractured basement rocks, and the local occurence of minor fault scarps in the basement rocks and in Quaternary rocks.

The nature of the movement along the Elsinore fault zone has long been in controversy. Eckis (1934, p. 76) believed that the Santa Ana Mountains had been uplifted on a series of normal faults along the northeast edge of the mountains. According to Engel (quoted in Eckis, 1934, p. 76), ". . . the faults of the Elsinore zone are almost exclusively normal." However, Sutherland (1935, p. 75) thought that the "Whittier-Elsinore fracture zone" was primarily a system of reverse faults. R. H. Jahns has suggested (oral communication, September 1958) that the earliest movement—probably in the Upper Cretaceous to lower Tertiary time interval—was predominantly in a lateral sense. Lateral movement, Jahns believes, is suggested by the straightness of the trace of the Elsinore fault zone, its parallelism with the San Andreas fault zone along which lateral movement has been demonstrated (Hill and Dibblee, 1953, p. 443-458) and the juxtaposition along the Elsinore fault zone, southeast of the Corona area, of dissimilar plutons of the southern California batholith.

The distribution of Cretaceous and Paleocene strata suggests lateral movement. Southeast of Santa Ana Canyon Cretaceous and Paleocene strata, in fault contact, are exposed on the northeast side of the Elsinore fault. Approximately 1½ miles to the northwest, on the southwest side of the projected trace of the Elsinore and Whittier faults, Schoellhamer and others (1954, pl. 1) show Cretaceous and Paleocene strata in depositional contact.

The evidence within the area mapped by the writer has permitted no conclusions regarding the antiquity or earliest sense of movement of the Elsinore fault zone, but it does strongly suggest that, since lower Tertiary time, the Elsinore fault has been a plane of reverse dip separation.* A steep southwest dip is suggested by the trace of the fault in irregular topography.

In the vicinity of Fresno Canyon, and southeastward across the Corona South quadrangle, lateral movement in post lower Tertiary time becomes improbable as it would seemingly have produced a much straighter trace than the fault apparently shows. Indeed, at a locality just west of Fresno Canyon the trace of the Elsinore fault is offset by a later fault. Earlier lateral movement and later deformation of the fault plane could produce the irregularities. Moreover, the preservation of the Arena Blanca syncline as a continuous feature adjacent to the Elsinore fault would be difficult to envision if large lateral movement had occurred on the fault since Plio-Pleistocene time.

Much less conclusive evidence against lateral movement is the juxtaposition along Bedford Canyon of masses of Bedford Canyon formation overlain by prebatholith volcanic rocks and the similarity of the clasts in the sedimentary rocks, especially those in the Cretaceous strata, with the basement rock types that lie immediately across the fault. This may not be significant, however, because of the widespread occurrence in southern California of lithologically similar Bedford Canyon strata and the clasts in the Cretaceous sediments are of common and widespread rock types. The evidence against strike separation is not conclusive enough to preclude post lower Tertiary horizontal shifts of one or two miles.

An accurate calculation of the amount of vertical displacement on the Elsinore fault does not seem possible on the basis of evidence within the mapped area. As Cretaceous sedimentary rocks of the Ladd formation cap the crest of the mountains at the head of Tin Mine Canyon at an elevation of 2,750 feet and the same Cretaceous units are found low along the northeast side of the mountains at elevations as low as 1,250 feet, a vertical separation of 1,500 feet is suggested.

Larsen (1948, map) shows granodiorite and volcanic rock of the basement complex at elevations above 5,000 feet near Santiago Peak southeast of the mapped area. Well records from the eastern part of the mapped area indicate that diorite and quartz monzonite were penetrated at elevations near sea level. These few well records suggest that in the Bedford Canyon-Brown Canyon area the basement rocks have a relatively flat surface that dips gently southwestward. The widespread occurrence of post-Cretaceous residual clay also suggests a low, nearly flat surface. If an essentially planar, pre-Paleocene surface was developed on the basement rocks in the area now traversed by the Elsinore fault, a vertical displacement of greater than 5,000 feet is suggested for this southern portion of the fault.

* In this paper the fault classification terms follow those recently proposed by M. L. Hill (1958, p. 1688) in order to eliminate confusion between separation (apparent relative movement) and slip (actual relative movement).

Chino Fault

The Chino fault cuts across the northeastern slope of the Puente-Chino Hills. Within the mapped part of the Puente-Chino Hills it strikes N. 35° to 45° W. and dips about 55° SW. It is apparently a reverse fault and places Miocene sedimentary rocks over Pliocene (?) strata. Southeast of the Puente-Chino Hills the fault is largely or wholly hidden beneath alluvium, but its projected course appears to gradually converge upon and to perhaps eventually join the Elsinore fault. Sharp differences in groundwater levels in water wells on La Sierra Stock Ranch near State Highway 18, as well as topographic features (chiefly anomalous, narrow trenches) indicate that the fault may cross the Santa Ana River and extend southeast of Highway 18 along the first major wash cut in the older alluvium east of Wardlow Wash. Farther southeast, along the margin of the Santa Ana Mountains, the chief evidence for the Chino fault is topographic. A well-defined scarp at the contact between terrace deposits and older alluvium may be the surface expression of the Chino fault. Its trace also may coincide with anomalous scarplets and benches, especially between Mabey and Main Street Canyons, and with offset drainage lines in the streams between Main Street and Joseph Canyons. The southeastward projection of the trace of the Chino fault from its easternmost exposure in the Puente-Chino Hills suggests that the Chino fault joins one of the faults parallel to the Elsinore fault west of Bedford Canyon and thence joins the Elsinore fault between Bedford and Brown Canyons.

In the Corona region the displacement along the Chino fault may be much greater than that along the Elsinore fault. Indeed, west of McBribe Canyon, the latter may be a horse-tailing extension of the Whittier fault, which, according to Woodford and others (1954, p. 75), is exposed to the northwest in the southern Puente Hills and trends about N. 70° W. for about 25 miles from the Santa Ana River to Whittier. Nearly 8 miles of strike separation, in a right lateral sense, along the Chino fault is suggested by the disposition of two lithologically similar occurrences of the Vaqueros and Sespe formations—one in the northwest corner and the other in the east central portion of the Corona South quadrangle.

These localities are on opposite sides of the projected course of the Chino fault, but are separated by an area almost 7 miles wide which is underlain by younger sedimentary beds. Somewhat similar relations exist for Pliocene (?) and Paleocene strata. Thus such lateral movement, if actual, may date from Paleocene time as the Silverado formation of this age is affected, but most of the movement probably would have occurred since Pliocene time as the seeming offset of Pliocene (?) beds is almost as much as that of the earlier rocks.

However, several features point against lateral movement along the Chino fault. (1) The Arena Blanca syncline extends across the projected fault trace with no apparent lateral offset. (2) Perhaps the most compelling evidence against lateral movement was found at a locality several miles northwest of the highway cut noted

FIGURE 45. Chino fault exposed in cut, west side of State Highway 71 about 1¼ miles north of Prado Dam. The fault (center, left of danger sign) separates siltstone and shale of the Sycamore Canyon member of the Puente formation (left) from Pliocene (?) siltstone and sandstone (right). Observer faces northwest.

below. Here fossiliferous middle Puente sandstone strata, which rest on both sides of the fault and have been encountered in wells, are apparently not offset laterally (oral communication, R. F. Yerkes, 1957). Several additional, but less significant features, tend to support this evidence. (1) The general distribution of the Bedford Canyon formation, already noted in the description of the Elsinore fault, requires no lateral movement. (2) Minor drag folds, which are well exposed on both sides of the Chino fault in the road cut on State Highway 71,

FIGURE 46. Vertical to steeply west-dipping shear zone exposed underground in water tunnel north of Bixby Canyon. The fault (left of hammer) separates brecciated intrusive rock at left (phase of the San Marcos Gabbro) from Bedford Canyon formation graywacke (right). Observer faces south.

FIGURE 47. Closeup of vertical shear zone in Bedford Canyon formation graywacke. Hammer point marks gouge zone. Exposure underground in water tunnel north of Bixby Canyon. Observer faces south.

have amplitudes of about 8 inches and horizontal axes, which favors dip-separation movement. Thus lateral movement along the Chino fault, at least since middle Puente time (upper Miocene), seems improbable.

Minor Faults

A number of minor faults have been mapped. Most are apparently vertical or high-angle reverse and are remarkably parallel to the Elsinore fault. Some are cross faults, most of which are apparently vertical and have only a few hundred feet of displacement. A few cross faults have an equally small apparent lateral offset.

Cross faults at large angles with the Elsinore and Chino fault systems complicate the structural pattern of the area. Northwest of Tin Mine Canyon a group of cross faults, each with an apparent lateral movement of only a few hundred feet, have greatly disturbed clay beds in the Silverado formation. West of Fresno Canyon a cross fault with apparent horizontal movement has offset the basement rocks about 1,000 feet and has also apparently offset the Elsinore fault. In Brown Canyon the Elsinore fault is apparently offset nearly 2,600 feet by a north-northeast-trending vertical or high-angle reverse cross fault (figs. 46, 47).

The cross faults probably are tear faults. They may be caused by the same compressional forces that apparently produced the major northwestward-trending reverse faults of the area. The cross faults also may be an effect of jostling at a time (possibly lower Tertiary) when movement on the Elsinore fault may have changed from lateral to high-angle reverse. The horizontal offsets on the Elsinore fault, especially the offset at Brown Canyon, may be only apparent. The apparent offset block may have dropped between the continuation of the original Elsinore fault and a more southwesterly vertical fault and be a product of vertical movement along the fault zone.

On Scully Hill a normal fault of little apparent displacement separates La Vida and Soquel members of the Puente formation. This fault, herein designated the Scully Hill fault, may cross the Santa Ana River and assume an easterly and southeasterly course, subparallel to the Elsinore fault, as far as Wardlow Wash to the southeast of which it appears to extend beneath Quaternary deposits and has a course nearly parallel to that of the Chino fault. West of Wardlow Wash this fault has been interpreted as marking the contact between Vaqueros-Sespe and Puente strata. The Topanga formation and probably part of the Puente formation are, therefore, missing. These relationships are possibly attributable to an unconformity, but the linear trace of the contact, its alignment with faulting to the west, and a high degree of deformation in the bordering rocks strongly suggest a fault contact. If this is true, then this fault must have a vertical separation of about 1,000 feet, which is the minimum thickness of the missing strata.

A set of vertical or high-angle reverse faults lies parallel to and northeast of the Elsinore fault on its apparent downthrown side. These faults probably are sympathetic to the main fault and belong to the Elsinore fault zone. Two such faults extend eastward from Santa Ana Canyon. A third fault branches from the Elsinore fault from a point on the east side of Hagador Canyon and thence extends northwestward nearly parallel to the Elsinore fault. It is better defined to the northwest, chiefly by topographic features including small fault sags and aligned saddles, but also by differences in rock types encountered in the drilling of two water wells closely spaced on either side of the fault, in the vicinity of Mabey Canyon. Northwestward this fault extends beneath terrace deposits at a locality on the east side of Fresno Canyon. In the eastern part of the mapped area, in the vicinity of Bedford and Brown Canyons, several vertical north to north-northwest-trending faults of unknown displacement have greatly disturbed the Tertiary sedimentary rocks.

Age of Faulting

The most compelling evidence in the mapped area suggests that the initiation of predominantly vertical movement along the Elsinore and Chino faults commenced prior to late Pleistocene time. That it probably occurred mostly in late Pliocene and early Pleistocene time is strongly suggested by the marked unconformity between Quarternary terrace deposits and highly deformed Pliocene (?) strata. However, geomorphic and topographic features, including aligned scarplets and trenches, as well as anomalous drainage lines, scarps, and benches, indicate the movement has continued into Recent time. That the movement has been discontinuous is shown by the extensive occurrence of terrace surfaces at different elevations. At least some of the faults that parallel the Elsinore fault are believed to have been active more recently than it. West of Fresno Canyon, for example, a cross fault offsets the Elsinore fault but is in turn cut by a fault that, west of Fresno Canyon, parallels the Elsinore fault, thus showing both of these faults to have moved more recently than the Elsinore fault. The last-mentioned fault apparently cuts off still another fault parallel to the Elsinore fault east of Fresno Canyon.

Evidence for pre-Pliocene movement exists but is not conclusive. Cretaceous strata apparently are not present in the Corona-Chino valley or Puente-Chino Hills blocks. This gap in the sedimentary record suggests the possibility of a period of strong deformation from post Upper Cretaceous time through pre-Pliocene time or even pre-Upper Cretaceous deformation. If Cretaceous sedimentary rocks did exist in these blocks, as is strongly suggested by the abrupt termination south of Santa Ana River and west of Wardlow Wash of extensive Cretaceous strata, then a post-Upper Cretaceous pre-Miocene uplift may well have occurred along the Elsinore and Chino fault systems. Such movement would have been reverse to that which appears to have characterized late Pliocene or Pleistocene time and Recent time and may have caused the Cretaceous beds to be stripped from the Corona-Chino valley and Puente-Chino Hills blocks. During Cretaceous time, however, these blocks may have been structural highs which received no sediments and were perhaps elevated or moved laterally by Cretaceous or pre-Cretaceous faulting.

Relationship Between the Elsinore, Whittier, and Chino Faults

The question of whether or not the Elsinore fault extends northwestward to join the Whittier fault across the Santa Ana River has aroused much interest. The

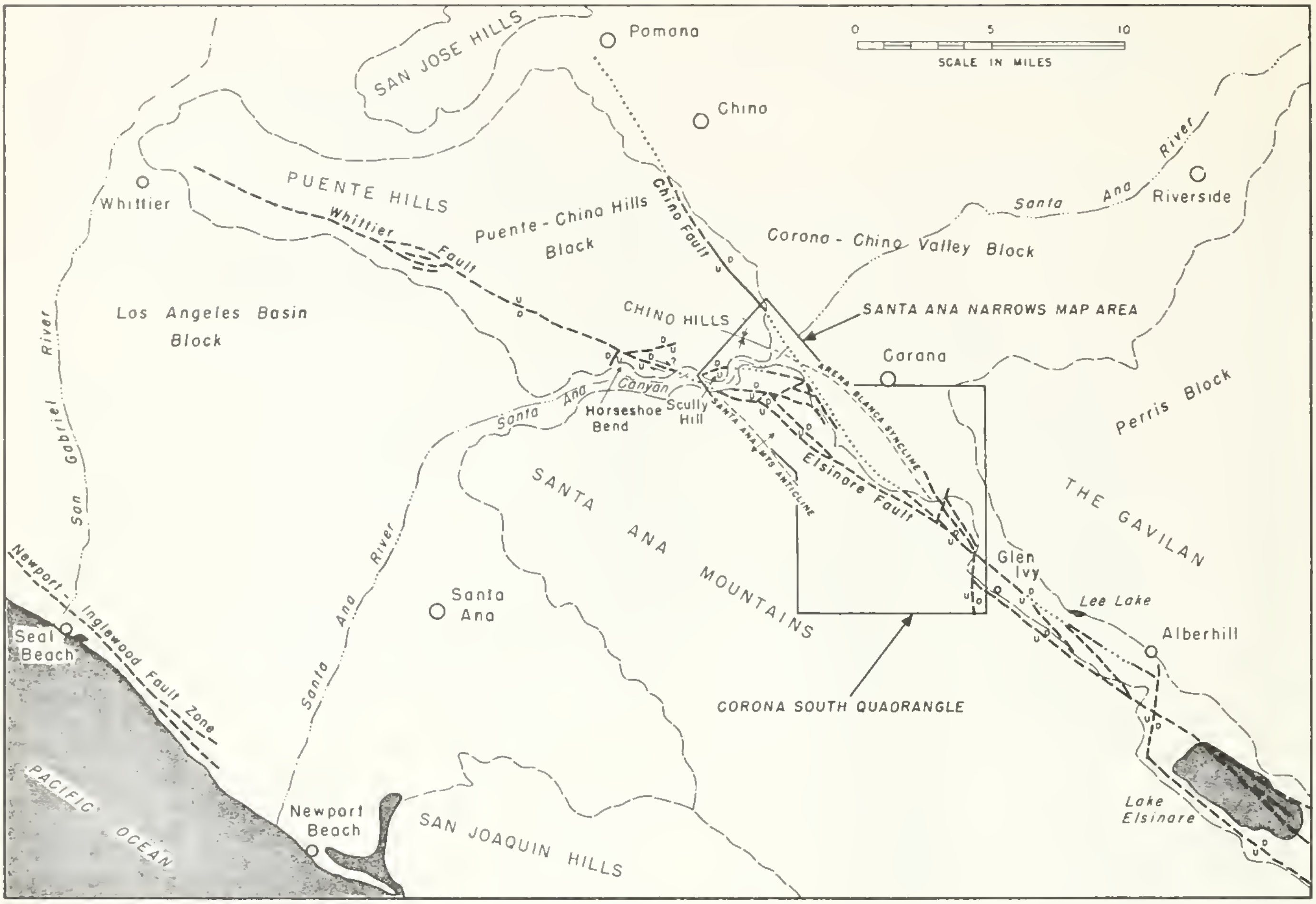

FIGURE 48. Sketch map showing major structural features of the Corona area and their probable relation to adjacent portions of southern California.

Whittier fault is generally considered to have at least a small component of lateral movement, whereas, in the mapped area, the Elsinore fault, at least since lower Tertiary time, apparently has none. According to Woodford and others (1954, p. 75) the major segment of the Whittier fault appears to be upthrown on the northeast side. This relationship persists northwestward from a cross fault at the west edge of Horseshoe Bend which is on the Santa Ana River and about 3 miles west of the mapped area (fig. 48). In the Corona area the Elsinore fault is apparently downthrown on the northeast. Woodford and others (1954, p. 75) suggest that from the Horseshoe Bend cross fault southeast about 3 miles to a point on the Santa Ana River where the projected trace of the Whittier fault and the river intersect, the Whittier fault is characterized by movement with a lateral component as well as a component of dip separation with the apparent displacement downward on the northeast side.

Nearly 3 miles of strike separation, in a right lateral sense, is suggested by two similar occurrences of Puente and Topanga strata—one on the northeast side of the Whittier fault at Scully Hill (pl. 3; fig. 48) and the other on the southwest side of the fault at Horseshoe Bend (see Schoellhamer and others, 1954, pl. 1). If this suggested lateral offset is actual, then, as pointed out by Woodford and others (1954, p. 75), the Scully Hill fault and the northeast-trending Horseshoe Bend cross fault may be offset segments of the same fault. Moreover, the Whittier fault in this area apparently has at least a small component of dip-separation which dies out southeastward toward the Santa Ana River. The amount of displacement is not known, but, inasmuch as the Whittier fault appears to cut out the Soquel and La Vida members of the Puente formation southeast of Horseshoe Bend (Schoellhamer and others, 1954, pl. 1) the dip-separation component may be of the order of 5,000 feet in the eastern Puente-Chino Hills.

The relationships described above suggest that in Plio-Pleistocene time the Puente-Chino Hills block may have been pushed southeastward along the Whittier fault and was also elevated relative to the Los Angeles Basin. At the same time the Santa Ana Mountains block was rising and also perhaps moving slightly northwestward. Apparently the three structural blocks—the sinking Los Angeles Basin and the two, wholly independent, rising blocks (fig. 48)—meet at the Santa Ana narrows to produce a rotational movement along the Whittier and Elsinore fault zone. From evidence in the mapped area lateral movement, at least since lower Tertiary time, does not appear to have extended southeast of the Santa Ana River. As already stated, much greater dip-separation movement on the Elsinore fault is suggested in the eastern part of the Corona region than in the vicinity of Santa Ana Canyon so that vertical displacement may be relatively small in the Santa Ana narrows.

The southeastern part of the Puente-Chino Hills block, bounded by the steeply dipping to vertical Whittier-Elsinore fault zone on the southwest and by the moderately southwest-dipping Chino fault on the northeast, appears to be a giant wedge that tapers southeastward and downward. The evidence for right-lateral movement as well as evidence for dip separation at the eastern end of the Whittier fault and for reverse movement along the Chino fault suggest that the wedge moved prow-like eastward and concurrently upward on its northeast side. This suggested movement also may have caused the southeastern margin of the wedge to be rotated downward with respect to the Santa Ana Mountains block. If the wedge did move in this manner, the writer would ordinarily expect the strata along its margins and especially at its apex to be highly contorted. The lack of extreme disorder in these strata may be attributable to the relief of compression by the upward movement along the Chino fault.

An extension of the Whittier fault eastward along the trend mapped by Woodford and others (1944, map) and Schoellhamer and others (1954, pl. 1) would join the Elsinore fault, or one of the faults parallel to it, at a locality southeast of the Santa Ana River where Cretaceous and Paleocene sedimentary rocks are greatly contorted by faulting. However, the Horseshoe Bend cross fault, where there is apparently an abrupt reversal of the displacement on the Whittier fault, was previously thought likely to terminate the Whittier fault (Woodford and others, 1954, p. 75). Recent mapping indicates this is not the termination and that the Whittier fault continues southeast past Horseshoe Bend to the Santa Ana River (oral communication, R. F. Yerkes, 1957), and that along this part of its trace the Whittier fault has caused the block on its southwest side to move upward (Woodford and others, 1954, pl. 1). Thus, in the area of the Santa Ana River, the relative movement on the Elsinore and Whittier faults is the same. If the trace of each fault is projected across the river, they coincide. If the Elsinore and Whittier faults do not join to form a single, continuous break across the Santa Ana River, the Whittier fault probably splits and frays out into the Elsinore fault zone.

The Chino fault probably is continuous with a fault that intersects the Elsinore fault near McBribe Canyon, midway between Bedford and Brown Canyons, but this has not been fully demonstrated. If the Chino fault is not continuous with this or one of the other northwest-trending faults in the Bedford Canyon-Brown Canyon area, it must die out beneath the older alluvium south of Corona, as no other fault zone that could join the Chino fault was found in the northeastern quarter of the Corona South quadrangle. However, topographic features, chiefly scarplets; and anomalous drainage lines, scarps, and benches, strongly suggest that a fault borders the lower margin of the Santa Ana Mountains south of Corona. If so, this fault appears to intersect the Elsinore fault between Bedford and Brown Canyons, and may well be the southeastward extension of the Chino fault. If this is the Chino fault, then it and the Elsinore fault bound the southeastern part of the wedge-shaped fault block—the Puente-Chino Hills block—that extends northwestward from Bedford Canyon into the Puente-Chino Hills.

Folds

The rocks along the northeastern flank of the Santa Ana Mountains strike, in general, N. 50° to 70° W. to form folds approximately parallel to the Elsinore fault and to the trend of the mountains. Dips range mostly from 30° to vertical, and have an estimated average of about 60°. In a few places Tertiary beds are horizontal or very gently dipping. Most of the observed dips are to the northeast, although local and marked differences in dip suggest repetition of the beds in a series of minor folds. Overturned beds and vertical beds are common, particularly near the Elsinore fault. Indeed, all of the Silverado strata between Main Street and Hagador Canyons may be overturned. These commonly show dips of 45° to 65° SW. and at a few localities they are vertical.

Along the southeastern tip of the Puente-Chino Hills Tertiary sedimentary rocks strike from N. 70° W. to N. 80° E. and at many places strike nearly west. South and west of Prado Dam the strata dip consistently to the north or northeast, whereas a short distance north of Prado Dam, across the axis of the Arena Blanca syncline, the dips are to the south or southwest. The axial trace of the syncline trends approximately N. 70° W. This syncline is asymmetrical, in that the north limb dips about 35° and the south limb averages about 60°. The syncline appears to plunge to the northwest.

Southeast of Corona, along the west side of Bedford Canyon, scattered patches of Miocene and Pliocene (?) sedimentary rocks form part of a syncline which has been broken by faulting. This syncline also is asymmetrical. Vertical to steeply northeast-dipping beds are exposed on the south limb and strata on the north limb dip about 35° SW. It apparently plunges northwestward and is probably the faulted and eroded remnant of the Arena Blanca syncline of the Puente-Chino Hills. Farther east, along Brown Canyon, Paleocene Silverado beds, upper Eocene to lower Miocene (?) Vaqueros-Sespe beds, and upper Miocene Puente beds form a shallow and narrow synclinal remnant. The sedimentary record suggests that the eastern margin of a narrow basin of Tertiary deposition—probably an arm of the Los Angeles Basin—was near Brown Canyon.

Cretaceous and Tertiary sedimentary rocks constitute the southwestern flank of the Santa Ana Mountains and, in general, dip southwestward to westward off of the basement rocks that form the crest of the mountains (Schoellhamer and others, 1954). On the northeast and north flank of the Santa Ana Mountains the Cretaceous and Paleocene strata dip generally northeastward to northward. These strata, therefore, have the form of a great northwestward-trending anticline. The crest of the anticline approximates the crest of the mountains, and has been broken, slightly east of its axis, by movement on the Elsinore fault. Remnants of the northeast limb of this anticline, although highly faulted, occur along the northeastern flank of the Santa Ana Mountains in the Corona region and remain as the southwest limb of the Arena Blanca syncline.

Elsinore Trough or Graben

Temescal Canyon (locally termed Temescal Valley) is an irregular valley from 1½ to 3 miles in width and about 20 miles in length, extending from Corona to Elsinore. It is often referred to as the Elsinore trough or graben. This trough is the northwest part of a valley-like region about 40 miles long which extends southeastward from Corona to a point beyond Temecula. The entire feature is commonly termed the Elsinore-Temecula trough. In the Corona region the trough superficially resembles a graben, but northwest of Brown Canyon no fault was found that could mark the northeast side of the graben, and Temescal Canyon appears to be an erosional trough bounded by a young fault zone on its southwest side. To the southeast of the Corona South quadrangle, however, the trough may well be a graben. Recent mapping by Fish (1953, map) and Rogers (1959, pl. 5) as well as a brief field investigation by the writer indicates that the Elsinore fault extends southeastward past Glen Ivy Hot Springs (a third of a mile east of the Corona South quadrangle at the mouth of the Coldwater Canyon), at least to a point about one mile southeast of Lee Lake (3 miles east-southeast of Glen Ivy), and marks the southwestern side of a graben (fig. 48). Rogers shows another fault, nearly parallel to the Elsinore fault, about a quarter of a mile southwest of Lee Lake and with the necessary separation to form a graben. This fault may join with faults of the same separation between Brown Canyon and Bedford Canyon in the eastern part of the Corona South quadrangle. If this is true a graben about half a mile wide may exist east of Bedford Canyon and extend southeastward past Glen Ivy and perhaps beyond Lee Lake.

Conclusions

1. A single break, apparently offset in two places, and with a high-angle reverse dip-separation sense of movement, can be designated as the Elsinore fault.

2. Strike separation along the Elsinore fault has not been proved, within the mapped area, but horizontal shifts in a right lateral sense may have amounted to 1 or 2 miles. Pre-middle Tertiary lateral movement, suggested by the juxtaposition of dissimilar rock types of the Southern California batholith southeast of the mapped area, may have been much greater.

3. The Elsinore and Whittier faults apparently join across the Santa Ana River narrows, where rotation along the fault zone may have occurred.

4. The Chino fault probably is a reverse fault. The southeasterly projection of its trace suggests it joins the Elsinore fault southeast of Corona, east of Bedford Canyon.

5. The major movement along the Elsinore and Chino faults, as indicated by the Tertiary rocks in the mapped area, probably commenced prior to late Pleistocene time and may date from late Pliocene time. The movement has continued into Recent time.

6. The top of the Santa Ana Mountains marks the crest of a great northwest-trending anticline. It is paralleled on the northeast by the Arena Blanca syncline.

7. In the Corona area the Corona-Elsinore trough apparently is a broad valley eroded in poorly consolidated sediments and bounded by a young fault zone on its southwest side.

FIGURE 49. View west along the Santa Ana Canyon toward Santa Ana narrows (center). At left are the Santa Ana Mountains. Elsinore fault trace is just behind trees in middle distance at left edge of photo. Flat areas (1) in center beyond the trees and south of the railroad and (2) half way up the mountains at the left are landslides of Santiago Peak volcanic rock. Note landslide cirques at the left in the Santa Ana Mountains. The Puente-Chino Hills are on the right. North of the railroad, Scully Hill is the typical topographic expression of the Miocene sedimentary rocks. From left to right they are: Topanga formation (irregular surface), La Vida (shale) member of the Puente formation (rounded slopes), Soquel (sandstone) member of the Puente formation (irregular surface), Yorba (shale) member of the Puente formation (rounded topography), and the Sycamore Canyon (sandstone and conglomerate) member of the Puente formation (irregular surface above right edge of citrus grove). Sandstone and conglomerate of the Vaqueros and Sespe formations, undifferentiated, exposed at far right, east side of Santa Ana River.

GEOMORPHOLOGY

General Features

The land forms in the Corona area are predominantly block mountains which have been dissected marginally by streams (fig. 40, 49). They are now in a late-youth stage of development.

The most prominent topographic features are expressions of movement along the Elsinore fault. The highest altitude in the mapped area, 4,007 feet, is Pleasants Peak, a point on the crest of the Santa Ana Mountains. This is 3,300 feet above the surface of the compound alluvial fan at Corona and 3,532 feet above the Santa Ana River at Prado Dam. The Santa Ana Mountains block is asymmetrical in profile with the northeast slope steeper and more abrupt than the southwest slope.

The Puente-Chino Hills block, uplifted between the Whittier fault on the south and the Chino fault on the north, has a maximum elevation of 1,781 feet at San Juan Hill, 3 miles west of the mapped area. The Puente-Chino Hills have a relatively gentle topography and the block is more symmetrical than the Santa Ana Mountains block.

Drainage

General Features. The overall drainage pattern is integrated inasmuch as all of the major streams eventually reach the Santa Ana River, to whose level all of the streams are grading. In the Puente-Chino Hills the drainage pattern is dendritic. The tributaries in the Santa Ana Mountains generally enter the major streams at nearly right angles and thus form a trellis or gridiron pattern. Alternate periods of rejuvenation and of aggradation are indicated by the incised stream courses on the Corona alluvial fan. Evidently the one drainage outlet for the area, the Santa Ana River, is aggrading as its bed is filled with nearly one hundred feet of alluvium at Prado Dam. This aggradation has been attributed to a eustatic rise of sea level at the end of Pleistocene time (Poland, 1947).

Stream Types. The smaller streams and tributaries are consequent, but the two major streams, the Santa Ana River and Temescal Creek, are each of a special type.

The Santa Ana River is apparently an antecedent stream that flowed along its present course before uplift of the Puente-Chino Hills and Santa Ana Mountains blocks and was able to maintain its former course across a slowly rising mountain mass. The stream cut into the rising mass throughout the period of deformation, resulting in the Santa Ana narrows. This is suggested by topographic evidence, particularly by small, flat-topped benches or mesas at different elevations along the Santa Ana Mountains side of the river and slightly deformed terraces at different levels. Superposition is not likely because of the distribution and structure of the Tertiary sedimentary rocks. Apparently no uplift is in progress today across the Santa Ana River, as the channel is being alluviated all the way to the ocean (Poland, 1947, p 4, pl. 7).

Temescal Creek is a fine example of a superimposed stream. This stream has cut a steep cliff face in basement rocks along the northeast side of Temescal Canyon. One might at first suspect that the debouching of fanglomerate material from the Santa Ana Mountains had forced Temescal Creek against the hard rocks and permitted the cutting of Temescal Canyon. However, reference to the geologic map shows that, southeast of Corona, Temescal Creek has cut a gorge wholly in resistant basement rocks. Farther southeast, recent work by Fish (1953, map) and Rogers (1959, pl. 5) shows that Temescal Creek is entirely in basement rocks at Lee Lake and again north of Glen Ivy. This is also true just east of the mapped area. All of these canyons are apparently cut through unfaulted basement rocks. Fish also found deep alluvial fill from elevation 1,000 to 1,574 feet and Rogers assigned part of these outcrops in the Perris Block northwest of Dawson Canyon to the Paleocene Silverado formation. The patchy outcrops of Tertiary sediments and old terrace deposits southeast and east of Corona in the Elsinore trough and on the Perris Block

FIGURE 50. Two levels of terrace deposits (Qt) overlying Silverado formation sandstone and conglomerate (TS) along the east side of lower Hagador Canyon. These two terrace levels have formed by differential erosion. Observer faces east.

indicate that this region was once buried by sedimentary rocks. Apparently in Plio-Pleistocene time Temescal Creek followed a meandering course on these sedimentary rocks and later became superimposed on the resistant basement rocks.

In Plio-Pleistocene time Tertiary sedimentary rocks filled the site of the present Elsinore trough southeast of Corona and, as already indicated, apparently lapped up on the southwestern edge of the Perris Block. These sediments may later have been slightly tilted to the southwest by movement on the Elsinore fault. This tilting may have provided the initial course of Temescal Creek and the creek quickly eroded most of the soft sediments.

Terrace Deposits, Terraces and the Corona Alluvial Fan

Many of the terrace deposits, so well developed along the northeastern flank of the Santa Ana Mountains, have nearly flat surfaces (fig. 52); others have been greatly dissected. Most of the surfaces are nearly horizontal and slope northward or northeastward at 5° or less, but a few slope as much as 15°. The beds of the terrace deposits are generally horizontal or dip less than 5° north or northeast, but some southeast of Bedford Canyon were observed to dip as much as 15°, thus indicating deformation. A number of terraces in the region south of Prado Dam lie at slightly different elevations. Many of these terraces are flattopped ridges with the geomorphic form of an old terrace, but have little or no terrace material deposited on them. Evidently these are denuded benches that never were covered with terrace deposits. They probably were cut by the Santa Ana River and the different levels represent periods of more rapid rise of the mountain block transverse to the Santa Ana River.

Differential erosion and faulting apparently have both been factors in determining the present day elevations of the terrace deposits. Two terrace levels, developed on a once apparently continuous terrace deposit along the east side of Hagador Canyon where no faulting is likely, afford a good example of features formed mostly by differential erosion, which is probably the dominant process (figs. 50, 51). The topographic break between terrace deposits and the older alluvium is probably a scarp along the Chino and several parallel faults. This is most evident south of Corona between Hagador and Main Street Canyons. The material shown as older alluvium may well be merely a thin veneer on the down-dropped portion of a large, pre-existing alluvial fan, and that the terrace deposits are remnants of the upthrown block.

The Corona compound alluvial fan has a typical fan-like drainage pattern. It has been much dissected (fig. 53), and differential erosion has produced many broad and nearly flat surfaces at different elevations. Typical fan head trenches are present and are especially well developed in the Main Street Canyon-Eagle Canyon region. The fan has a general northeast slope which averages about 4° and ranges from 3° south of Corona to 5° along the northwest side of Bedford Canyon.

Landslides

Landslides or slumps occur at many places along the Elsinore fault. They are irregular masses of fractured basement rock that generally rest upon the main rock mass. However, two slides of basement rock are isolated from the mass. The first of these, northwest of Bedford

FIGURE 51. View northeast across the northwest end of the Corona-Elsinore trough from Skyline Drive. Temescal or Gavilan Hills (part of Perris Block) in background. Citrus groves in left middle distance are on the Corona compound alluvial fan. Ridge line in center (with trees) is same two terrace levels shown in fig. 50. Brush covered area in foreground is underlain by Ladd formation sandstone and conglomerate and Silverado formation sandstone.

FIGURE 52. Flat-topped terraces southeast of Prado Dam along State Highway 18. Terrace deposits (Qt) overlie white Pliocene (?) sandstone (Tp). White outcrop at right is fossil locality 20. Lower Wardlow Wash in foreground. Observer faces southwest.

FIGURE 53. Surfaces of Corona compound alluvial fan. View southeast toward Tin Mine Canyon (center background) and Santa Ana Mountains (background).

Canyon, is a large block of pulverized volcanic rock resting on Paleocene and Miocene sedimentary rocks and surrounded by them (fig. 42). This slide has apparently moved about 1,800 feet horizontally. The other isolated block, composed of volcanic slide material, is in Santa Ana Canyon at the southern margin of Scully Hill. The toe of the slide apparently overrides terrace deposits and sedimentary rocks of the Vaqueros and Sespe formations on the north. The Santa Ana River has cut off the southern part of the slide which once may have formed a weak dam across the river. This slide must have moved a minimum horizontal distance of about 1,500 feet. That it may have moved almost 3,000 feet is suggested by a large landslide cirque high in the Santa Ana Mountains to the south (fig. 49).

The landsliding is probably contemporaneous with the faulting or slightly later. As landslides override terrace deposits and in several places seem to be mixed with terrace material, they are probably late Pleistocene to Recent in age.

GEOLOGIC HISTORY

The geologic history recorded in the rocks of the Corona area began in Triassic time when most of the area apparently was submerged under the sea. The region then received thick deposits of silt, mudstone or clay, and sandstone and minor amounts of fossiliferous limestone of Late Triassic age. As these strata are much more deformed than the unconformably overlying volcanic rocks of Jurassic (?) age they may well have been folded and mildly metamorphosed and possibly eroded during or at the end of Triassic time.

A great volume of volcanic rock was poured upon a surface of the folded Triassic sedimentary rocks, possibly in Jurassic time. The emplacement of the hypabyssal and plutonic igneous intrusive bodies of the differentiating magma of the great batholith of southern California may have begun in Jurassic time and probably persisted into early Late Cretaceous time. Isotopic dating, however, (Larsen and others, 1958, pp. 35-62) of rocks from the great batholith of southern California indicates that it was emplaced largely or wholly in early Late Cretaceous time. The Triassic rocks and the later volcanic rocks were tightly folded and mildly metamorphosed apparently partly before and probably also during the emplacement of the batholith. Probably during early Late Cretaceous time the area was eroded to a terrain of rather low relief and the batholithic rocks were exposed. Lateral movement along the Elsinore fault zone may have occurred during the Late Cretaceous-early Tertiary time interval.

The area apparently remained a positive land mass during early Late Cretaceous time and received nonmarine sediments. Upper Cretaceous seas then transgressed the area and left a thick deposit of fossiliferous marine strata. Toward the close of the Cretaceous period the area may have again become at least in part a positive land mass and the marine sedimentary rocks were partly eroded away.

The Upper Cretaceous seas may have been the last to cross the region of the present Santa Ana Mountains. The Paleocene, Eocene, and Miocene seas probably did not submerge the central part of the present mountains, but bordered the site of their northern peripheries. Pliocene seas apparently were even more restricted and marginal.

In Paleocene time strata of both marine and nonmarine origin were laid down over a surface of moderate relief. These beds probably represent continuous deposition along the margins of a fluctuating sea under lagoonal and nearshore conditions. Deposition of marine strata marked the Eocene epoch toward or at the close of which the area again became a positive land mass and received continental deposits without apparent interruption from late Eocene to early Miocene time. Probably the area was of moderate relief and near the shoreline of a shallow sea. Subsidence recurred early in the Miocene epoch.

Marine sedimentation was renewed in early Miocene time and must have continued well into Pliocene time. Toward or at the close of the Pliocene epoch the sea retreated as the great orogeny, which initiated the processes that formed the present land features, began. The Tertiary and Cretaceous strata were folded into a great anticlinal arch, at the site of the present Santa Ana Mountains, and a syncline to the northeast. After folding, the relief may have been moderate. A period of major block faulting began in either late Pliocene time or at the end of the Pliocene epoch and has continued, in moderate degree, until the present. Erosion has continuously carved the uplifted mountain blocks into their present complicated forms. Terrace deposits, terraces and broad erosion surfaces, at different elevations, record an irregular rate of uplift.

Summary of major events and salient geologic features.

1. Corona area receiving marine sediments during Triassic time.
2. Folding and mild metamorphism at the close of the Triassic period.
3. Volcanism in Jurassic (?) time.
4. Folding and metamorphism of the volcanic rocks and earlier sedimentary rocks.
5. Jurassic (?) and Cretaceous igneous activity associated with the intrusion of the great batholith of southern California.
6. Erosion to a mature surface, Upper Cretaceous nonmarine sedimentation; subsidence and marine sedimentation in Late Cretaceous time.
7. Possible lateral movement along Elsinore fault zone during Late Cretaceous-early Tertiary time interval.
8. Sites of present Elsinore trough and northern peripheries of Santa Ana Mountains filled with Tertiary sediments. Both marine and nonmarine strata were deposited during different times. Sediments probably overlapped the southwestern Perris Block region.
9. Major folding and block faulting, beginning probably either in late Pliocene or end-Pliocene time, continuing to the present.
10. Tertiary sedimentary rocks rapidly eroded from the Elsinore trough.
11. Development of the present topography and deposition of surficial deposits.

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MINES AND MINERAL DEPOSITS OF THE CORONA SOUTH QUADRANGLE
RIVERSIDE AND ORANGE COUNTIES, CALIFORNIA

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OUTLINE OF REPORT

Illustrations

INTRODUCTION

Mining Districts. Mining districts, at least parts of which are within the Corona South quadrangle, include the Silverado, Santa Rosa, Yorba, and Corona. The designation "Silverado mining district" was early applied to an area generally south of the Corona South quadrangle, but apparently including the part of the quadrangle that lies south of the drainage divide and thus is in Orange County. The settlement of Silverado, in Silverado Canyon, was a mining boom town founded in 1878. It was a center of extensive mining activity until 1881. Most of this activity was south of the area of the present study but that prospectors from Silverado ranged over the area is shown by a number of unidentified prospect pits and adits. The name "Santa Rosa mining district" has been applied to an area in Orange County that also lies mainly south of the Corona South quadrangle, but which also embraces prospects in the southwest part of the quadrangle.

A mining district on the northeast side of the drainage divide has been referred to both as the Yorba and Corona. Yorba, the older term, is the name of the owner of the Spanish land grant which included the present town of Corona and much of the northeastern flank of the Santa Ana Mountains. In recent years, the term Corona mining district has been generally applied to the northeast flank of the Santa Ana Mountains in the southwestern tip of Riverside County.

Acknowledgments. The author wishes to express his appreciation to the property owners and mine operators for their cooperation and helpfulness. Joe Deleo, Jr., Corona, mining contractor and clay supplier, furnished much useful information on the clay deposits. Arthur G. Moore and N. M. Nichols, Gladding, McBean and Company, supplied data concerning recent clay exploration and mining activities, as did Gerritt Poelstra, Tillotson Refractories Company. Data on recent prospecting for glass sand were kindly furnished by Meredith C. Brown. Results of laboratory tests of rock samples from the Sidebotham and Temescal Canyon rock quarries were made available by Mason K. Read, U. S. Army Corps of Engineers. Mrs. Irene J. Ware, who has resided in the area since 1907, provided interesting historical background.

The helpful suggestions of Lauren A. Wright, George B. Cleveland, and Thomas E. Gay, Jr., staff members of the Division of Mines, are gratefully acknowledged.

Mineral Resources. The nonmetallic materials—clay, sand and gravel, glass sand, and broken rock—provide the only commercial minerals currently (1958) produced in the Corona district.

Prospecting for tin, gold, silver, and other metallic minerals was very actively pursued many years ago and has continued on a much smaller scale to the present. Probably the early efforts date from about 1853 when tin was discovered near Cajalco, about 5 miles southeast of Corona (Hanks, 1884, pp. 120-122) and east of the Corona South quadrangle. Tin Mine Canyon, 4 miles southwest of Corona and within the quadrangle, has been prospected for tin, antimony, and other metallic minerals, apparently with little success. The mineralized zones, to which the prospectors were attracted, are in metamorphosed sedimentary rocks of the Triassic Bedford Canyon formation, in Jurassic (?) Santiago Peak volcanic rocks, and in small intrusive bodies associated with the Santiago Peak volcanic rocks.

After the early interest in prospecting for metallic minerals subsided, about 1860, there followed a period of nearly 30 years in which little mining or prospecting was done. Renewed interest in prospecting and mining probably began about 1885 with the discovery of coal, as several prospects were then active about 4 miles southwest of Corona (Goodyear, 1888, p. 505). Since that time the principal interest has been in nonmetallic minerals. By 1910 the emphasis had shifted to clay, which was found to be associated with the coal seams. Gypsum deposits have been explored during the past 50 years, but with relatively little success. Silica sand and broken rock products have become increasingly important since the mid-1940's, and together with clay today form the principal commercial mineral commodities of the area.

Recent prospecting has been aimed mostly at the development of known clay bodies and the discovery of additional clay bodies. Since about 1950 clay shale deposits, of both Paleocene and Upper Cretaceous age, have been extensively developed in the area southwest of Corona, and the mined products are being utilized in the manufacture of common clay products. These clay shales were first mined about 1910. The discovery, in 1954, of a large deposit of Paleocene clay in the lower Bedford Canyon area, by Gladding, McBean and Company, marked the most important mining development that had occurred in the Corona area for many years. Indeed, this was one of the principal discoveries in the history of the clay industry in California.

In May 1957, a new quarry for riprap and facing rock was opened along the northeast margin of Temescal Wash. This may prove to be a significant source of material for the construction industry.

Exploration for petroleum along the northeastern margin of the Santa Ana Mountains is of continuing local interest but has led to very little production. One dry hole was drilled during 1956 and several operators were holding active oil and gas leases in 1958.

Uranium prospecting, which was especially intensive in the mid-1950's, extended into the Santa Ana Mountains. A number of claims were staked in the Corona South quadrangle by some of the many "week-end" prospectors that tried their luck. In 1958 most claims remained undeveloped and none had been productive.

The Corona area has furnished a significant part of the mineral production of Riverside County. In the future the nonmetallic deposits of the Corona area promise to be even more important, both to the development of southwestern Riverside County, in particular, and to the building and industrial mineral industries of southern California in general.

The principal mining properties in the Corona South quadrangle are described below in alphabetical order. The first section is devoted to metallic minerals and the second to nonmetallic minerals. A third section deals briefly with ground water, and a fourth with petroleum exploration activities. Where locations are given in miles from Corona, the distance is measured from the center of town (6th and Main Streets). A tabulation of all known mining properties is included at the end of the report.

METALS

Gold

Gold-bearing quartz veins are reported (Tucker, 1925) to have been discovered in the Corona South quadrangle along Ladd Canyon in 1896. Early day prospectors searched for the precious metal, but so far as known, no noteworthy lode or placer discoveries were made. Gold production from this area must have been small, if any, and none is recorded.

Williams (Ophir ?) Mine. Location: secs. 4 and 9 (?), T. 5 S., R. 7 W., S.B.M. about one airline mile north of Silverado Post Office in Ladd Canyon, in the vicinity of the junction with the West Fork of Ladd Canyon. Ownership: Undetermined.

The Williams mine area is said to have been first located in 1896. By 1925 the property comprised the Williams group of four lode claims owned by J. Goodby, Los Angeles. This area was apparently also covered by the Ophir group of six lode claims which were held by Frank Requa and L. O. Hall in the 1930's. The early prospecting was for gold and later owners prospected also for silver, lead, and zinc. There is no known production.

Tucker (1925, pp. 59-60) described the Williams vein as a gold-bearing quartz vein, 1 to 2 feet in width, on the contact of slate and porphyry. The vein was reported to contain free milling gold and a small percentage of pyrite, to be exposed on the surface for 1,500 feet, to strike due north, and to dip 60° east. The geologic setting, as described by Tucker, closely resembles the geology of the southwest corner of sec. 4, T. 5 S., R. 7 W., S.B.M. where Triassic Bedford Canyon formation metasedimentary rocks are in contact with slightly metamorphosed porphyritic andesites of the Jurassic (?) Santiago Peak volcanics. However, the quartz vein was not found during the present study.

The property was reported by Tucker (1925, pp. 59-60) to be developed by a crosscut adit driven 150 feet west. At the time of Mr. Tucker's visit in 1925, the property was idle and the workings caved. In June 1956, no identifiable trace of this mine remained and the area had a dense brush covering. An old cabin remains in the vicinity. Several debris piles and one short, caved adit on the south side of Ladd Canyon in the northwest corner of sec. 9 may mark former mine workings.

Lead-Silver-Zinc

Prospecting for lead, silver, and zinc along Silverado Canyon on the west flank of the Santa Ana Mountains reached a peak about 1880 when several adits and prospect pits were opened. Apparently none in the Corona South quadrangle was ever developed into a mine. Later prospecting on the east flank of the mountains resulted in the discovery of the Corona lead-zinc mine in Manning Canyon. Some of the mineralized zones that were prospected are in intrusive dikes and plugs related to the Jurassic (?) Santiago Peak volcanics. Others are in altered metasedimentary rocks of the Triassic Bedford Canyon formation. Records of production, if any, were not found. All lead-silver-zinc prospects have long been idle.

Corona Lead-Zinc Mine. Location: SE¼ sec. 14, T. 4 S., R. 7 W., S.B.M., 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, California, formerly held five lode claims by location: Wild Oak Nos. 1-5. Part of the area covered by these claims is probably included in Eagle Group No. 3 placer located in 1953 by T. A. Fraser, 718 Howard Street, Corona, California.

The Corona lead-zinc mine was located by Joe Smith, Temecula, California, and Fred Spiess, Corona, California, probably in the early 1940's. In 1943-45 it was under lease and option to Victor Mishelle, Corona Lead-Zinc Company, Malibu Beach, California, but was idle when visited by Tucker and Sampson in 1945 (Tucker and Sampson, 1945, p. 147). The claims were abandoned and relocated by Robert A. Mattey, Sr., about 1947. He later deeded the claims to R. A. Mattey, Jr., who subsequently relocated the group about 1948 and did some development work for several years. This included building and improving roads, developing the water supply, removing a small tonnage of rock from the crosscut adit, and repairs to the mill, which, however, was never operated by Mr. Mattey. In 1953 the writer found the principal adit locked, the open cuts slumped, and the entire area covered with dense brush. The most recent known activity was in 1953 when ten tons of clay shale was mined from a small open cut on the east end of the property.

According to Tucker and Sampson (1945, p. 147) the Corona lead-zinc 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 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 the writer visited the property in 1953 little vein material was encountered and no ore minerals were observed.

Development has been by open cuts and adits. Tucker and Sampson (1945, p. 147) described the development thus: main working was 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.

A mill with capacity of 1½ tons per hour was erected in Manning Canyon in the early 1940's. Milling equipment consisted of jaw crusher, roller mill, screens, and two concentration tables; middling product from tables went to a Lamley jig, tailings to waste. Ore mined from the principal open cut 300 feet above the mill was moved to the mill by gravity by means of a wooden chute. This ore was said to be antimonial lead ore and reported to assay 10 percent lead, 14 percent antimony, and 40 ounces of silver per ton (Tucker and Sampson, 1945, p. 147). The mill is said to have been in operation about 1943, but no record of production was found. In 1956 the mill building, minus much of the equipment, remained on the property which was idle. Only annual assessment work appears to have been done for several years.

The eastern part of these claims apparently included clays and clay shales of the Paleocene Silverado formation. Several small open cuts along the west side of Manning Canyon explore the shales.

Tungsten

Small amounts of scheelite (?) are reported (Hilton, 1950, p. 80) to have been found in a few fractures and veins in the Temescal Wash quartz latite porphyry at the Temescal quarry of the Minnesota Mining and Manufacturing Company. This occurrence was not verified by the writer.

Uranium

In recent years radioactive minerals have been sought in the northern Santa Ana Mountains by many "weekend" prospectors. Numerous claims were located within the Corona South quadrangle, particularly along Tin Mine and Silverado Canyons where volcanic and metamorphic rocks are exposed. None has been developed other than by shallow prospect pits.

The writer made a reconnaissance of this area by following truck trails with a Jeep carrying an Engineers Model SC-10 combination scintillation and geiger counter. Nothing above a low background count was observed.

NONMETALLIC MINERALS

Clay and Clay Products Manufacturing Plants

History of Development

The Corona South quadrangle contains part of the oldest and most productive clay district of southern California. The first operation, which was opened as early as 1890, was the McKnight mine. This property, together with a number of smaller deposits extending along the northeast flank of the Santa Ana Mountains between Wardlow Wash and Joseph Canyon, was active until about the middle 1930's and furnished a considerable tonnage of red-burning clay and flint-fire clay.

During the early period of operation several tile manufacturing plants west of Corona were supplied from deposits in the Corona South quadrangle. The Corona Pressed Brick and Terra Cotta Company, which between 1905 and 1910 operated a plant near the railroad half a mile west of Corona, produced high-grade pressed building brick (Aubury, 1906, p. 223). Later the plant was operated by the Pacific Sewer Pipe Company, but was dismantled before 1916 (Merrill, 1919, p. 570). About the same period the Pacific Clay Manufacturing Company operated a plant (fig. 1) near the railroad one mile west of Corona. This company was succeeded by the

FIGURE 1. Pacific Clay Manufacturing Company plant, Corona, about 1902. This plant, destroyed by fire about 1920, occupied the site of the present Jordan Tile Manufacturing Company. Photograph from a brochure, *Corona, California, The Queen Colony, Illustrated*, published by the Corona Publishing Company, 1902. *Courtesy of Mr. and Mrs. Howard S. Ware, Corona, California.*

Pacific Sewer Pipe Company, which later became the present Pacific Clay Products organization. The plant was active as early as 1902 and was still active in 1919 (Boalich and others, 1920, p. 90) but was destroyed by fire several years later. For several years beginning in 1905 refractory clay from the McKnight mine was used in these plants to make fire brick (Aubury 1906, p. 224). In the early 1900's, clay from the McVicar pit (now part of Sky Ranch Clay Company property) was shipped to Los Angeles and used by the California Clay Manufacturing Company (Aubury 1906, p. 223), which later became the Los Angeles Brick Company and is now the Los Angeles Brick and Clay Products Company.

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. This plant which was operated at different times by the Prado Tile Company, La Olla Tile Company, and the Casa Blanco Tile Company, was closed about 1940 when the Prado flood control project acquired the former site of Prado.

Clay shales from the Corona South quadrangle were first mined and used in the manufacture of common clay products by the Corona Pressed Brick and Terra Cotta Company at their Corona plant during 1905-10. This material also was mined and used at the Colton cement plant during this same period (personal communication, Mrs. Mary Mattey). Each year since about 1950 a few thousand tons of Paleocene and Upper Cretaceous clay stones and fissile shales, principally from the Mabey Canyon and Wardlow Wash area along the west edge of the quadrangle, have been quarried and used as a source of red-burning clay for the manufacture of common clay products. Two plants in the Corona area are currently (1958) operating: Tillotson Refractories Company, 1150 West 6th Street, Corona, and Jordan Tile Company, 909 Railroad Street, Corona. These clay shales also have been used since about 1951 by Mission Clay Products Corporation, Olive, the Atlas Sewer Pipe Company, Whittier, and are supplied to a number of small pottery and brick manufacturing plants in southern California.

Since 1948 the Liston Brick Company in lower Bedford Wash has been using small amounts of Miocene diatomaceous shale and Quaternary alluvium in the manufacture of red brick.

Mining of Paleocene clay in the Corona area was carried on intermittently and on a small scale from the closing of the McKnight mine in the late 1930's until 1954, when large reserves of Paleocene clay were discovered and developed in lower Bedford Canyon, near its intersection with Temescal Wash. A quarry was opened there in 1955 and is mined periodically. In July 1956 Gladding, McBean and Company began construction of a large clay products manufacturing plant at that site; the plant was placed in operation in early 1958.

Geology of Clay Deposits

The Alberhill-Corona clay district, which includes the above-mentioned deposits in the Corona South quadrangle, is the principal clay-producing area in southern California. Although production from the Corona region has been small in recent years, it will be of major importance when the newly discovered deposits in Bedford Canyon are put into full production.

The clay deposits, which are included in the Paleocene Silverado formation (geologic text, pp. 23-29), crop out discontinuously in an irregular, rather narrow, horseshoe-shaped belt, the ends of which point southeast. The deposits extend northwest from Elsinore to Corona, around the northwest tip of the Santa Ana Mountains and thence southeastward on the west flank of the mountains across Trabuco Canyon to the Tierra Colorado clay district in southeastern Orange County (figure 2). The clays in the district show two types of origin—residual and sedimentary. However, most of the clay of both origins probably was originally derived from weathered surfaces of Jurassic (?) or Cretaceous hypabyssal intrusive rocks. Less abundant are clays that have weathered from Triassic argillites and slates. Elsewhere in the Santa Ana Mountains Cretaceous shales may have been a source of clay.

In the Corona South quadrangle small lenses of sedimentary clay crop out in a discontinuous belt of Paleocene sandstone, shale and conglomerate averaging about half a mile in width and extending from Brown Canyon northwest across most of the quadrangle. Probably large areas, masked by younger sedimentary rocks, are underlain by this formation.

Residual Clays. Residual clays have developed in place by subaerial chemical weathering of aluminum-rich rocks which, in the Alberhill region, include: (1) quartz latite porphyry, (2) quartz latite volcanic breccia, (3) Santiago Peak volcanics, latite to andesite, (4) mixed gabbro-diorite, and (5) Bedford Canyon formation slates. In the Corona area the source materials are quartz diorite and argillite or slate. The textures of the igneous rocks are well preserved in the lower parts of the residual sequences, which grade down into unaltered rock. Outlines of feldspar phenocrysts and hexagonal quartz grains and slaty cleavage are remnant structures that indicate the residual clay was derived from hypabyssal igneous rocks and slate, respectively. In all exposures the igneous source rocks are those rich in plagioclase feldspar.

Residual clays have been noted in only two places in the Corona South quadrangle and in each occurrence the clay is derived from a distinct rock type—metasedimentary rock at one and intrusive rock at the other. In a small exposure south of Cajalco Road and along the east side of the railroad (No. 2, plate 1) a layer of bright brick-red clays about 30 feet thick grades successively downward into gray and greenish-buff clay and unaltered argillites of the Triassic Bedford Canyon formation. These clays are overlain unconformably by a 5-foot thickness of sedimentary white sands of the Paleocene Silverado formation. This deposit has been idle for many years and appears to be of very limited extent. The second and more extensive residual deposit was exposed by excavations made in lower Bedford Canyon in 1955. Here brick-red and red and gray mottled residual clay ranging in thickness from 5 to 20 feet with a thin, but as much as 4 feet thick, discontinuous pisolitic zone at the top is developed on a weathered surface of hornblende quartz diorite. Fracture and shear zones in the basement rocks extend into the residual clay zone but do not appear

FIGURE 2. Sketch map showing location of Corona South quadrangle and principal Paleocene clay mines and clay districts in the northern Santa Ana Mountains, Riverside and Orange Counties.

to have cut the overlying sedimentary sequence. The irregular erosion surface at the top of the residual clay at the Bedford Canyon locality is overlain, in order, by: buff sand; red mottled transported clay with a pisolitic zone at the top; buff to white coarse arkose; stream channel material; and older alluvium.

The residual clay was derived during a period of intense weathering before deposition of the Paleocene Silverado formation. Recent drilling (1956-57) has shown that a sequence similar to that in the Bedford Canyon locality underlies a large area in lower Bedford and Joseph Canyons. Drill holes in other areas, southeast toward Elsinore, are said to have penetrated similar sequences.

Sedimentary Clays. The sedimentary clays in the Corona area differ from place to place but are of four general types: (1) buff to red and yellow iron-stained clay shale; (2) white to red and red mottled red-burning clay with good plasticity (locally called "red plastic" or "potters" clay); (3) brownish-red to yellowish-green pisolitic clay (locally called "bone-clay" or "bauxite"); and (4) dark gray to black, fine-grained, dense kaolinite with a conchoidal fracture and a wide range in sand content (locally called "flint fire clay", or "fire clay"). These types, especially the gray kaolinite, are commonly associated with lignite and are found near the base of the Silverado formation. The lignite contains local lenses of pisolitic clay.

In the Corona area, the sedimentary clay-bearing formation has been so deformed by folding and faulting that although individual beds occur similar to those found to the southeast at Alberhill, no complete sections were observed in this area. Exposed at Alberhill is the following typical section, about 46 feet thick, of sedimentary clay, which overlies residual clay.

(top)

Red and white mottled claystone
Yellow and gray mottled claystone
Pisolitic clay, brownish red or yellowish green in color, and composed of round, concentric pisolites ("bone clay")
Red and gray mottled claystone
Banded claystone, gray and yellow-buff colored
Clayey sandstone, sand grains mostly quartz
Gray claystone, kaolinite ("fire clay")
Carbonaceous claystone, commonly associated with lignite

(bottom)

The foregoing units are all found in the Corona area and apparently in the same order of deposition, but only in isolated patches. Probably the most complete section similar to that found at Alberhill is at the McKnight mine, but the workings that exposed the clay are now inaccessible.

The clay beds which crop out in the vicinity of the McKnight mine and in isolated patches for about 6 miles to the southeast are intercalated with shales, buff to white arkosic sandstones, and conglomerates of the Paleocene Silverado formation (see geologic text, pp. 23-29). The clays grade gradually downward into the sandstones and conglomerates which are faulted against the underlying basement rocks. The sandstones are generally green or buff but near the top grade into dark colored shales of gray and reddish-brown. In places the underlying sandstone is reddish-green, very fine-grained and platy and carries such abundant black to greenish-black mica (biotite and muscovite) and pearly gray anauxite that it has a schistose appearance. The clay beds generally are overlain by clay shales which are almost everywhere stained red, pink or yellow by iron oxide. At the Bedford Canyon locality and at a few places along the northeast margin of the Santa Ana Mountains, the clays are overlain by buff and white sandstone. Two principal typical varieties of clay are found at the McKnight mine, although minor amounts of all eight of the varieties listed from Alberhill are also found. An upper bed of red mottled clay is as much as 60 feet thick and contains lenses of pisolitic clay. A lower bed consists of gray or blackish-gray fire clay reported to reach 30 feet in thickness. Some of these lower clays are reported to be highly refractory but to have a low fired strength (Dietrich, 1928, p. 277). However, none are now exposed. These clays by today's standards probably would be classed as low refractory clays.

The sedimentary clays are best exposed at present in new excavations in lower Bedford Canyon. However, the section is not complete as no fire clay or lignite is present. Residual clays are overlain by 5 to 15 feet of buff sand followed by 10 to 15 feet of red mottled sedimentary clay with a thin 1- to 5-foot-thick zone of bleached pisolitic clay at the top. The upper surface of the clay-bearing zone is irregular and overlain by coarse, white, anauxite-bearing arkose. A spectrographic semi-quantitative analysis of the pisolitic zone indicated major constituents of aluminum, silicon and iron with trace elements including titanium, magnesium, manganese, boron, gallium, vanadium, barium, chromium, and silver. X-ray diffraction analysis of this material indicated both the red clay matrix and the oolitic inclusions (pisolites) to be kaolinite (from unpublished data collected by the Division of Mines).

Paleocene Silverado formation and Upper Cretaceous Ladd formation clay shales have been utilized in recent years as a constituent for the manufacture of common clay products. Large reserves of these clay shales are indicated as they crop out over much of an area of about one square mile in the northwest corner of the quadrangle north of Mabey Canyon and west of Wardlow Wash.

Origin of the Sedimentary Clays. The Paleocene clays, as already stated, apparently were produced during a period of deep weathering during the emergence that followed Cretaceous time. The weathered surface was then partly eroded and the clay-bearing Silverado formation was deposited unconformably on rocks ranging in age from Triassic to Cretaceous, or on the weathered materials derived from them. The Paleocene beds probably were laid down as a continuous deposit over the area of the present northern Santa Ana Mountains. These beds were later much deformed by folding and faulting.

The Paleocene sediments are related not only to the source rocks in the nearby land areas but to the topography of the old surface. It is postulated that coarse sands and cobble-to-boulder conglomerates were deposited where the adjacent land was high; sands and clays were deposited where it was low. The high-grade clays were deposited only where favorable conditions of sedimentation existed as in quiet bodies of water adjacent to low lands. The high-grade fire clays were probably deposited in small lagoons or bogs, with concurrent deposition of coarser material at their margins and with occasional coarse beds intercalated with the clays. The sedimentary red mottled clays commonly are similar to nearby or underlying residual clay. These sedimentary clays probably moved only a short distance from nearby highs during Paleocene submergence. The red mottled clays are more widespread than the gray fire clays as they did not require the special conditions of deposition outlined above.

The sedimentary clays represent the lowermost part of the Paleocene sedimentary sequence and are nonmarine or lagoonal. The alumina-rich clay is associated with lignite beds and other carbonaceous material. In many places a fossil oyster reef occurs a short distance above the clays and a significant Paleocene marine fauna is found above the oyster reef. Therefore the conditions of depositions during early Paleocene time in the Corona area were: nonmarine or lagoonal deposition of clays; brackish water conditions following clay deposition during a transition period; and finally marine deposition of the sedimentary sequence overlying the clays.

Alumina-Rich Clays. The Silverado formation of the Corona district contains considerable quantities of alumina-rich clays, and small amounts of bauxitic clay and high-silica bauxite. These clays are the fire clay and pisolitic zones of both the previously described residual and sedimentary units.

During World War II these clays attracted much interest as a possible source of aluminum as new sources of supply were believed to be imperative. The U. S. Geological Survey made several geologic investigations of the Alberhill-Corona-Tierra Colorado clay region; sev-

FIGURE 3. Oblique aerial view of lower Bedford Wash (center) and Temescal Wash (extreme left) in the Corona-Elsinore trough showing principal mineral producing operations in the east central portion of the Corona South quadrangle, June 1957, (1) Sand quarry and processing plant of Owens-Illinois Glass Co. (Corona silica sand deposit), (2) Coronita Ranch sand deposit (undeveloped), (3) Liston Brick Co., (4) Corona (Bedford Canyon) vitrified clay pipe manufacturing plant (under construction, 1957), Gladding, McBean and Co., (5) clay stockpiles, Gladding, McBean and Co., (6) Bedford Canyon clay mine, Gladding, McBean and Co. Glass sand and clay are produced from the Paleocene Silverado formation. Alluvium and terrace deposits cover much of the geology and there are only a few exposures outside of quarry areas. Observer faces southeast. *Photograph by Pictorial Crafts, Incorporated, San Bernardino, California, courtesy of Gladding, McBean and Company, Los Angeles, California.*

FIGURE 4. Mineral deposits and mineral processing plants in Corona-Elsinore trough near Bedford Wash, (1) Coronita Ranch sand deposit, (2) Corona silica sand deposit (Owens-Illinois Glass Co.), (3) Blarneystone rock quarry (metavolcanic rock used for riprap, quarry just east of Corona South quadrangle), (4) Cajalco clay pit, (5) Liston Brick Company, (6) Corona plant, Gladding, McBean and Company, quarry at left behind trees. Observer faces southeast.

FIGURE 5. Gladding, McBean and Company's Corona vitrified clay pipe manufacturing plant in lower Bedford Wash. The clay (Paleocene Silverado formation) is mined from an open pit behind trees at left and stored in stockpiles at left. The structures from left to right are—tower and vertical press building and conveyor shed, auger press building, drying buildings (low structures to the left of center) and periodic "beehive" kilns. Observer faces northwest. *Photograph by David P. Shelhamer, Los Angeles, California, December 1957, courtesy of Gladding, McBean and Company, Los Angeles, California.*

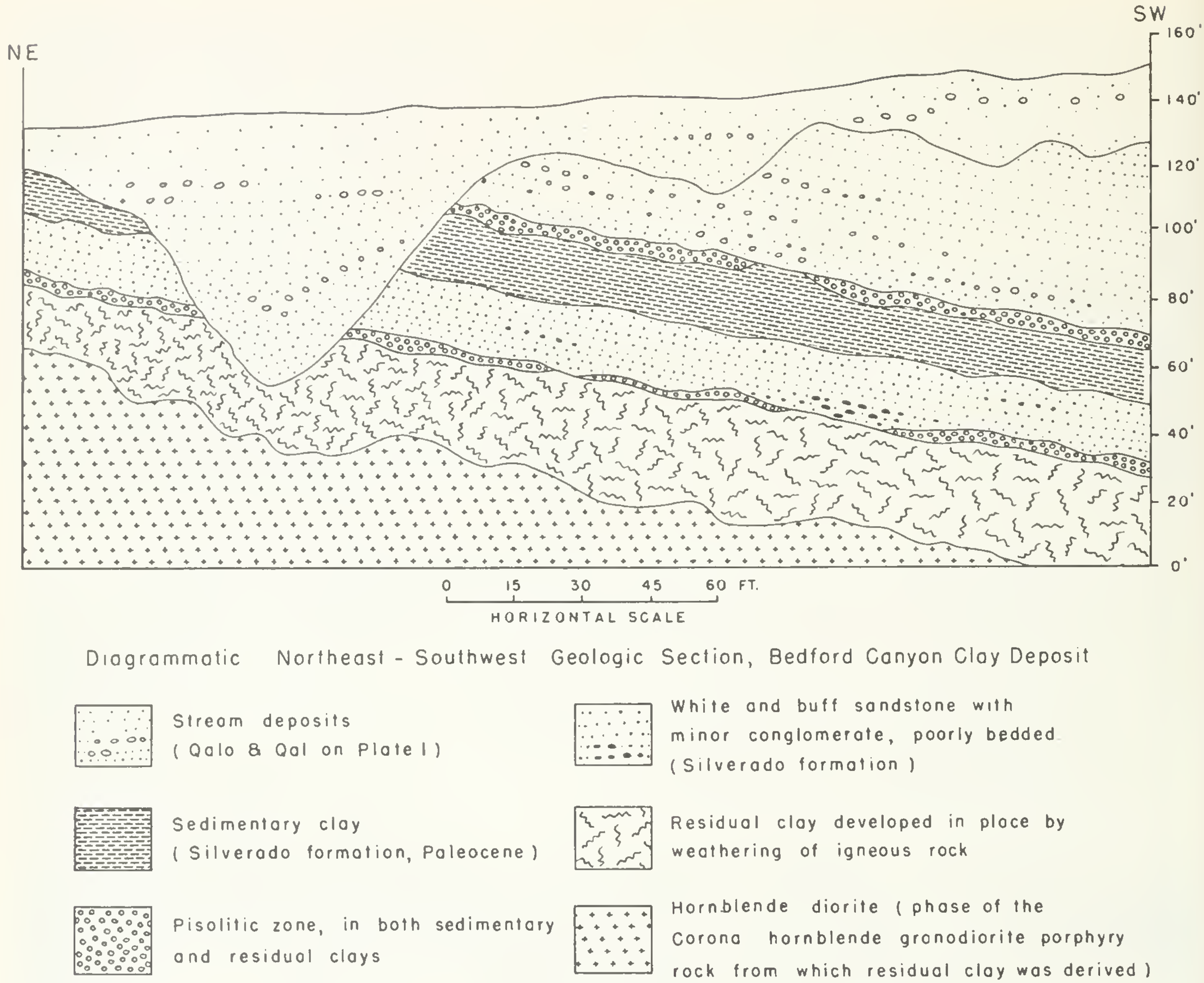

FIGURE 6

eral reports were placed on open file and a general study by Stauffer (1946) was published. The Aluminum Company of America briefly investigated the Alberhill deposits and the Kaiser Steel Corporation examined one area (Middlesworth Clay deposit) as a possible source of alumina for steel manufacture (Draper, 1944). These studies failed to indicate sufficient reserves of alumina-rich clay that could be mined as aluminum ore.

Prospecting for Clays

Prospecting for new clay bodies would be greatly hindered by the deep cover of alluvial fan material and terrace gravels and by the lack of knowledge concerning the degree and nature of the deformation of the hidden clay-bearing zones. A knowledge of the pre-Silverado surface would be of great benefit to prospecting, but, unfortunately, indications of the old topography are not clearly evident.

The easily located clay beds were discovered years ago and those that proved valuable were mined. Any remaining undiscovered deposits are probably too deeply buried for effective prospecting by surface methods and therefore future prospecting should be carried on by detailed geologic studies and core drilling of favorable areas. This method recently resulted in the above-mentioned discovery in lower Bedford Canyon.

In general, the more promising areas for prospecting are those away from the Santa Ana Mountains and on the northeast side of the Elsinore-Chino fault zone. Less promising are the areas closer to the mountains and within the fault zone. The clay-bearing beds probably do occur in these latter areas, but the overburden there is probably too thick for open-pit mining. Paleocene sedimentary beds exposed at the surface between the Elsinore and Chino faults furnished the limited clay mining operations carried on in the Corona district years ago. However, based on field observations, it appears there is only a remote possibility of finding additional reserves, in this area, suitable for large-scale mining.

As previously stated, the known deposits of residual clay are developed on plagioclase-rich igneous rocks, slates, and argillites; thus the alluvium-covered margins of such basement rock bodies appear to be the best places for prospecting. The residual clays in lower Bedford Canyon are developed on hornblende quartz diorite, a phase of the Corona hornblende granodiorite porphyry. This porphyry, whose margins are in part covered with alluvium, crops out in several irregular bodies over an area of about 2 square miles in the northeastern part of the Corona South quadrangle. These areas could well merit further attention by the prospector.

Prospecting and exploration of Paleocene and Cretaceous clay shales have been and should continue to be effectively carried out by surface trenching with bulldozers. Supplemental core drilling of promising areas will prove valuable for depth determination as these shale bodies are ordinarily lensing, are commonly cut by faults, and may pinch out at depth.

Bedford Canyon (Corona) Clay Deposit. Location: N½ sec. 16, T. 4 S., R. 6 W., S.B.M., on the west side of Temescal Wash, on State Highway 71 about 5 road miles southeast of Corona. Ownership: Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 39 (P.O. Box 578, Corona), own approximately 160 acres in an irregular shape in the N½ sec. 16. This property was formerly private ranch land. Arthur G. Moore, Corona, is assistant superintendent and resident engineer of the Corona plant and N. M. Nichols is division geologist.

The Bedford Canyon clay deposit, as previously stated, was discovered in August 1954 by geologists of Gladding, McBean and Company who were engaged in an intensive exploration program. The clay was not exposed as the entire area was covered with alluvium. However, Stauffer (1946, map station 32) mentioned an old test pit, at the east edge of El Cerrito Hills along the northwest margin of Bedford Canyon, which at a depth of about 20 feet penetrated residual, red, mottled clays on the weathered surface below the Silverado formation. In 1950 the writer found little trace of this pit. The Bedford Canyon area was considered likely to contain a large clay body as it was assumed to be underlain by the Silverado formation. Indeed, Paleocene clay deposits were known to crop out nearby and to have been mined, on a small scale. The property was taken under an option and initial exploration was entirely by core drilling. The first core hole is reported to have penetrated 40 feet of overburden and then 100 feet of red clay. Construction of a plant (figs. 3, 4, 5) for the manufacture of red-burning clay products began in July 1956, and it was placed in operation on January 1, 1958.

It is noteworthy that this discovery was made with modern methods of prospecting which included regional geological studies and the core drilling of areas indicated to be favorable. This discovery may be the most important clay find made in California since the early 1900's.

FIGURE 7. Bedford Canyon clay mine of Gladding, McBean and Company, during initial development in early 1955. Hornblende diorite (D) is overlain by residual red mottled clay (C, mapped with the Paleocene Silverado formation), Silverado formation arkosic sandstone (S), and older alluvium (A). Observer faces southeast. *Photograph by David P. Shelhamer, Los Angeles, California, courtesy of Gladding, McBean and Company, Los Angeles, California.*

FIGURE 8. Bedford Canyon clay mine of Gladding, McBean and Company, November 1956. Hornblende diorite (6) is overlain by residual red mottled clay (5, mapped with Paleocene Silverado formation), arkosic sandstone (4), sedimentary red mottled clay (3), and coarse arkosic sandstone (2) of the Silverado formation, and sandy older alluvium (1). Observer faces northwest. *Photograph by George B. Cleveland.*

Because of the alluvial cover the deposit was missed by earlier prospectors using only surface methods of exploration such as shallow bulldozer cuts or hand trenches.

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 (figs. 6, 7, 8). 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 (phase of the Corona hornblende granodiorite porphyry) 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, and abundant pearly gray anauxite. 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 and pearly gray anauxite.

Brown to dark gray, sandy older alluvium, which contains angular cobble clasts, covers the Silverado formation and ranges from 20 to 50 feet in thickness. In places, the Silverado arkose has been channeled and filled with the older alluvium which contains zones of stream gravel and zones of gray, fine-grained, cross-bedded stream sand and silt. Recent alluvium fills the bottom of Bedford and Joseph Canyons. At the west edge of the pit, fossiliferous middle Miocene (Topanga) sandstone apparently overlies, but may be faulted against, the Silverado formation. At the time of the writer's visit (July 1956), the actual contact was not observed but was covered with material from the excavation.

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.

One sample collected by the writer from the pisolitic zone of the sedimentary clay was analyzed by G. A. Uman, Sanitary Engineering Laboratory, Los Angeles Department of Water and Power as shown below:

I X-ray diffraction analysis
- A. Red matrix material
  1. Kaolinite
  2. Hematite or hydrohematite
- B. Pisolitic inclusions
  1. Kaolinite

II Spectrographic semi-quantitative analysis

Element	Concentration
Aluminum	Major constituent
Silicon	Do.
Iron	Do.
Trace elements (in decreasing order of concentration)	
Titanium	Between 0.2% and 0.001%
Magnesium	Do.
Manganese	Do.
Boron	Do.
Gallium	Do.
Vanadium	Do.
Barium	Do.
Chromium	Do.
Silver	Do.

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. This pisolitic material resembles the alumina-rich clay found at the Middlesworth deposit (described herein). The operator recognizes and expects to blend five or six different pit clays. The distinctions most easily made in the field are as follows:

1. Sedimentary clay
   1. Uppermost part: tan to white, bleached, altered pisolitic zone. Locally termed "upper bone clay".
   2. Upper part: red-brown and gray pisolitic zone. Locally termed "upper bone clay".

3. Lower part: red, white, and gray mottled clay. Locally termed "red mottled clay".

II. Residual clay

1. Top of residual clay: red pisolitic zone, iron-rich pisolites abundant, locally termed "bone clay"; grades downward to red mottled clay containing sparse iron-rich pisolites, locally termed "semi bone clay".
2. Upper part: red and tannish-gray mottled clay; altered hornblende diorite, igneous texture destroyed.
3. Lower part: maroon, red, and purplish mottled clay with a few pods of light green mottled clay; altered hornblende diorite, igneous texture recognizable.

Drill-hole data indicate that the Silverado formation has a maximum thickness of about 200 feet in this area. The commercial clay zones are from 40 to 150 feet in total thickness and average 100 feet. The overburden ranges from about 20 to 50 feet in thickness, and averages 30 feet throughout the property. However, to the west and southwest toward the Santa Ana Mountains, the overburden reaches 200 feet in thickness or more and therefore these areas could not be economically mined under present conditions. The operators state that the proved reserves of high-grade red-burning clay are sufficient to supply the plant for 50 years, and that the property has estimated reserves of over 10 million tons of all types of red-burning clay, or enough to keep the plant in operation for 100 years (Ceramic News, November 1956, p. 22).

During the initial development, early in 1955, a number of closely spaced core holes were sunk in the northwest part of sec. 16, T. 4 S., R. 6 W., in the lower reaches of Bedford and Joseph Canyons. Stripping operations, carried on with bulldozers, rippers, scrapers, and tournapull-type equipment, began in 1955. About 100,000 cubic yards of overburden were removed in developing the exploratory pit which is southwest of Highway 71 between the east edge of El Cerrito Hills and lower Joseph Canyon. The overburden was used as fill for leveling the plant site and storage yard in lower Bedford Canyon. When the pit was opened, about 3,000 tons of clay including five or six different "types" were mined and stockpiled. Various amounts of these several clay "types" were blended to form a sample which was used to make sewer pipe in a test run at the Glendale plant of Gladding, McBean and Company. It is reported that extensive test runs of vitrified clay sewer pipe yielded satisfactory results. A total of 15,000 tons of clay have been mined for testing purposes (Ceramic News, November 1956, p. 22). The property was mostly inactive during early 1956 but in July large scale stripping operations were resumed and some clay was stockpiled. The pit (fig. 8) has been inactive since July 1956 and probably mining will be periodic, with sufficient clay being stockpiled to supply the plant for many months. By early 1957 the pit was approximately 700 feet long in a north-south direction, 200 to 300 feet wide and 125 feet deep.

Construction of the plant, at an estimated cost of $5,000,000 and designed for the manufacture of vitrified clay pipe for sewer lines and storm drains and multiple duct vitrified clay conduit for telephone and power lines, was begun in July 1956. The Bedford clay, blended with clay from the company's Sloan pit at Alberhill and several local filler clays will be utilized. The filler clays include Silverado formation clay shales from the Thomas clay deposit (described herein) and 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.). The plant will house a 420-foot tunnel kiln and 8 periodic or "beehive" kilns. Buildings will 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. About 90 persons will be employed (Ceramic News, August 1956, p. 17).

The initial rated capacity will be 6,000 tons per month. This will be expanded gradually to 12,000 tons per month in about 3 years.

Corona Placer (Lord). Location: NW¼ sec. 14, T. 4 S., R. 7 W., S.B.M., about 3½ miles southwest of Corona on the ridges northwest of Main Street Canyon. Ownership: A. E. Ganahl, 1011 Victoria, Corona, owns one patented placer claim (Corona Placer) and six unpatented placer claims (Corona Placer Nos. 2, 3, 4; Scorpio Nos. 1, 2, 3) totaling over 100 acres.

The Corona placer may include at least part of the clay and mineral paint deposits worked by George W. Lord and others about 1900 (Aubury, 1906, pp. 223, 339). The claim was originally located by Mr. Lord, but the patent was issued to H. E. Ganahl in 1914. The Corona Placer claims Nos. 2, 3, 4 were located in 1916 by Fidel Ganahl and the Scorpio claims were located by Weldon Draper in 1943. In 1957 all of these claims were held by A. E. Ganahl.

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). However, in 1957 slumping of the old workings and dense brush made detailed mapping of the Corona placer impracticable. 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. 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 to the northwest. However, fire clay is not now exposed and clay reserves appear to be small.

By 1914 the property had been developed by two open cuts and two adits, each about 100 (?) feet long. These workings are now inaccessible. The property has long been idle, except for annual assessment work which has included stripping by bulldozer and road building. Amount of production is not known, but probably was not large.

Grapevine Clay Mine. Location: Lot 9, sec. 4, T. 4 S., R. 7 W., S.B.M., about 3 miles southwest of Corona on the south side of Mabey Canyon. Ownership: Mrs. Mary A. Mattey, 11359 Biona Avenue, Los Angeles 66, California, owns one unpatented claim (Grapevine placer) of about 12 acres. Application for patent was filed with the U. S. Bureau of Land Management in Los Angeles in January 1956.

FIGURE 9. Quarry at the Grapevine clay shale deposit, south side of Mabey Canyon. The quarry face is about 25 feet high and exposes claystone of the Holz shale member of the Upper Cretaceous Ladd formation. Material is loosened by bulldozer and pushed to a loading chute bunker (fig. 10) hidden by trees at lower left below quarry. Observer faces southwest.

The Grapevine clay deposit was located by Joseph Erenreich many years ago, apparently as a lode claim, and, after lapsing, was relocated by him in 1945. Shortly thereafter the property was acquired by Robert A. Mattey and passed to Mrs. Mattey in 1952. The earliest period of activity was from about 1900 to 1910. In 1906 the California Portland Cement Company removed some "cement rock" by team and wagon and about 30,000 tons are said to have been shipped to their Colton plant (personal communication, Mrs. R. A. Mattey, Nov. 1956). 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, Corona, mined some clay shale. Starting in 1953 the Sky Ranch Clay Company began mining this clay shale, on a royalty basis, for use by the Tillotson Refractories Company in Corona. During 1955 production was about 350 tons per month. The property was idle in November 1956.

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° northeast or is vertical. The Grapevine claim covers only about 1000 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). This material is used as a constituent in the manufacture of common red-burning clay products.

Development consists of several short exploratory adits and open cuts (fig. 9). Three adits were driven

FIGURE 10. Loading chute-bunker at Grapevine clay shale deposit. Loosened clay shale is pushed into bunker from quarry above (figure 9) by bulldozer. This illustrates the typical method used for many years to load trucks at most of the clay deposits in the Corona area. Skiploaders (fig. 18) have replaced this method in most operations. Observer faces southwest.

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 (fig. 10) for loading into small trucks.

Jones (Hoffman, Hoag Ranch) Clay Deposit. Location: NW¼ sec. 19, T. 4 S., R. 6 W., S.B.M., near the head of a small canyon midway between Joseph and Bedford Canyons. Ownership: Mrs. D. C. Hammond, 2955 E. California, Pasadena, California, owns about 400 acres of ranch land (purchased by Coronita Ranch, c/o D. C. McMillan, 8704 Colima Road, Whittier, California, in late 1957).

The Jones clay 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. Hammond. Local residents report the period of greatest activity as about 1900 when clay and coal were mined.

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, pp. 500-501) describe the clay in the workings as a gray, plastic clay bed approximately 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.

According to Tucker and Sampson (1929, pp. 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. The production of clay from this property probably was small and the coal is said to have been used only locally. The property was idle in 1925 and apparently has since remained idle. In 1956 all of the workings were badly caved and only several old mine rails and some scattered dump material mark the site.

Jordan Tile Manufacturing Company. Location: 909 Railroad Street, Corona, in the NE¼ sec. 26, T. 3 S., R. 7 W., S.B.M. (projected), in Corona North quadrangle. Ownership: Mosaic Tile Company, Zanesville, Ohio.

At the plant of the Jordan Tile Company, built in 1948, 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. As the company has no mining properties, raw materials are purchased from a number of suppliers. This plant (fig. 11) 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.

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. After pugging, the mixture is put through manually operated presses which make 5 to 20 tiles, depending upon the size. Most of the tile is made in one-half to one inch squares, but various sizes and shapes are made and some tiles are as much as 2 inches square. The pressed raw tiles are hand-trimmed to remove rough edges, stacked on kiln cars, and fired in a tunnel kiln. The finished "vitreous" tiles, which are made in various colors, are hand-assembled into any desired mosaic pattern and have found a wide range of use in the building industry.

FIGURE 11. Jordan Tile Manufacturing Company plant, Corona. Raw material storage is in open building at left background. Large building houses pugging machines, presses, tunnel kilns, storage and shipping facilities and offices. One of the first clay pipe manufacturing plants in the Corona area—the Pacific Clay Manufacturing Co. (fig. 1)—occupied this site from about 1900 to early 1920's. Observer faces northwest.

Red, brown, buff and gray colored "quarry" tile, in several sizes, is manufactured from California raw materials, mostly from nearby quarries in the Silverado formation. These include white, sandy fire clay from the Sloan Number 1 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 Wash; clay shale from the Thomas clay deposit, east pit (see herein); and waste clay from the processing of clayey sand at the Corona silica sand deposit (see herein). Lesser amounts of fire clay from Lincoln and Ione, California also are used. No artificial coloring is added, the earthy colors coming from the clays. After pugging, the clay mixture for "quarry" tile is extruded, cut in various sizes, and fired in a tunnel kiln. The finished tile is then packaged in cardboard boxes for rail or truck shipment.

"Granitex" is a trade name for a tile which is related to both the "vitreous" tile and "quarry" tile. It is pressed, as the "vitreous" tile, but like "quarry" tile, it is made of and colored by, natural clays from the Corona area. The "Granitex", made in various shades of brown and red, has a speckled appearance and the tiles are assembled in sheets similar to the unglazed ceramic mosaics made with the "vitreous" tile.

Kroonen Clay Deposit (Keno Group; Dutch Placer). Location: S½ sec. 4; NE¼ sec. 9; NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., about 3 miles southwest of Corona between Tin Mine and Mabey Canyons. Ownership: Mary L. Kroonen, 708 West Eighth Street, Corona, California, owns eight patented placer claims: Victor, Little Canyon, Dutch Republic, Big 4, White Clay, Kroonen, Black Chief, and Keno totaling about 150 acres. John Tillotson, 807 Park Lane, Corona, owns the Leo Lorenzo placer claim (20 acres) originally included in the Kroonen group.

The Kroonen group is adjacent to the old McKnight mine and probably the early exploration occurred during the same period, about 1890-1900. The property had been sufficiently developed so that patent was applied for in 1914. It was granted in 1917 to Leo Kroonen, Corona. By 1928 the property was idle but had been developed by tunnels and open cuts (Tucker and Sampson, 1929, p. 501). In 1956, the tunnels had been made inaccessible by caving and the cuts were slumped, but clay exposures were observed in several open cuts. The amount and the exact period of production are unknown, but this property probably furnished red-burning and perhaps some fire clay to several nearby clay products manufacturing plants which were active about 1900 to 1920. The property apparently has been idle for many years.

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 much disturbed by faulting and form the narrow part of a wedge-shaped fault sliver of Silverado formation sedimentary rocks. The clay beds are not well exposed but the red mottled clay may be as much as 10 feet thick while the kaolinite and lignite zones range from several inches to one foot in thickness. The lateral extent is not traceable more than several tens of feet. Reserves of clay appear to be small.

Liston Brick Company. Location: SE cor. NW¼ sec. 16, T. 4 S., R. 6 W., S.B.M., 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 4, Corona, California.

The Liston Brick Company manufactures common brick products in both common and commercial sizes. This plant (figs. 12, 13) was established in 1948 by Mr. Liston, who had previously operated the Coast Brick Company in Torrance. 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 a field kiln—the final operation. About 20 workers are employed, including the plant crew and sales personnel.

The company purchases all of the mineral raw materials used from producers in the Corona South quadrangle. These materials are furnished from three sources: (1) diatomaceous shale of Miocene age is supplied from the Chocolate Drop deposit (figure 15; see tabulated list); (2) Owens-Illinois Glass Company provides sandy clay stripping waste material from the quarry at their nearby glass sand plant; and (3) small amounts of local soil are sometimes used.

McKnight Clay Mine. Location: NE¼ sec. 9; SW¼ sec. 3; NW¼ sec. 10, T. 4 S., R. 7 W., S.B.M., along the south side of Kroonen (Richardson) Canyon about 3 miles southwest of Corona, between Tin Mine and Mabey Canyons. Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles, California, owns three patented placer claims (Lucky, Trio, and McKnight), and one unpatented claim (Old Shaft), totaling about 65 acres.

Development of the McKnight deposit began about 1885 with the discovery of coal (Goodyear, 1888, p. 505). Coal mining proved to be unprofitable, but attention was soon turned to the associated clay beds. Crawford (1896, pp. 616-617) reports that 200 tons of clay per month were shipped by J. H. McKnight to plants in South Riverside (Corona) and Los Angeles during 1896. 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 of the property for many years.

The McKnight mine was closed down during the middle or late 1930's and has since remained inactive except for small intermittent production of red-burning clay from open pits. The amount of production is not known, but judging from the extent of the 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. However, by today's standards, it would not have been considered a large mine at any time.

Figure 12. Liston Brick Company plant in lower Bedford Wash. Raw materials (left) are blended by bulldozer. Building left of center houses pugging, extruding, and cutting machines. After curing the bricks are fired in field kilns (right middle distance). Observer faces northeast.

Figure 13. Plant and finished brick storage yard of Liston Brick Company, lower Bedford Wash. Plant (left background), raw clay stockpile (center background), office and shop (right background), finished brick storage in foreground. Observer faces southwest.

FIGURE 14. Field kilns of Liston Brick Company. Bricks in left foreground have been stacked to form a field kiln and the outside kiln wall is being erected. Kiln in left center background has been fired and the outside kiln wall is being removed. Kiln in right center foreground has been fired and almost completely dismantled. Kiln in right background has the outside wall erected, sealed with "mud" and pipes installed, ready for natural gas firing. After firing the walls are removed and the brick is sold directly from the kiln piles. Observer faces southeast.

FIGURE 15. Chocolate Drop clay shale deposit. Topanga formation (middle Miocene) diatomaceous shale is mined by bulldozer and loaded by skip loader on trucks for transport to the nearby Liston Brick Company, where the shale is used in the manufacture of common brick products. Observer faces southeast.

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 crop out in several open pits and cuts on a low, brush-covered hill along the south side of Kroonen Canyon. The clay section is not completely exposed, but fragmentary exposures and previously published descriptions suggest that the McKnight sequence is similar to the sedimentary sequence 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, and used in the manufacture of common clay products; and a lower layer of fire clay, 30 feet thick, used for fire brick. Results of extensive laboratory tests of these two clay types are given by Dietrich (1928, p. 277). The clay deposits are intercalated with sandstone and conglomerate. They are underlain by green, buff, and reddish-brown sandstone and overlain by clay shale which is stained pink or red by iron oxides. This shale was used early as red-burning clay (Sutherland 1935, p. 77). According to Sutherland (1935, p. 77) most of the mined clay was a flint-fire clay, moderately sandy and well-indurated and containing various proportions of very fine-grained, gray to black, disseminated carbon. The carbonaceous material is concentrated in places in lenses and pockets of coal which contain occasional lenses of pisolitic clay. In other places an extremely hard, light-gray fire clay occurs without the more extensive black fire clay. Analyses from Pacific Clay Products are as follows (Sutherland 1935, p. 78):

	Black McKnight clay (fire clay) Percent	*Red McKnight clay (red-burning)* Percent
SiO_2	57.38	63.86
Al_2O_3	27.62	21.52
Fe_2O_3	2.06	4.12
CaO	1.90	.24
MgO	.11	.09
Alkalies	.13	.83
Ignition loss	10.62	8.73

The McKnight clays occur in a fault block of sedimentary rocks of the Silverado formation. The fault block is triangular in plan, and is about 6,000 feet long with a maximum width of 2,500 feet, bordered by Upper Cretaceous sandstone, conglomerate and shale of the Ladd formation, undifferentiated. The structure is further complicated by cross fractures and folding which make the clay beds difficult to mine. The Paleocene clays may rest unconformably on and be infolded with Upper Cretaceous rocks and were later disturbed by complex faulting. However 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.

The McKnight property was mined mostly by underground workings which literally honey-comb the mine area (Sutherland 1935, p. 79). 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 a search for coal (Goodyear 1888, p. 505). At the time of patent (1905), the property had been developed by four adits, with level workings totaling about 500 feet and two small open pits. Large quantities of high-refractory clays were being mined by underground methods for use in the Pacific Clay Manufacturing Company's plant one mile west of Corona (fig. 1). Sewer pipe, water pipe, glazed and unglazed tiles, flue linings, chimney pipes, firebrick, electric conduit, and terra cotta were among the products manufactured at this plant. The fire brick was made from the refractory clay of the McKnight mine while the common clay products were made from Temescal Valley clays obtained southeast of Corona (Aubury 1906, p. 224).

The Pacific Sewer Pipe Company was operating the McKnight mine in 1915 and was using the refractory clay to manufacture fire bricks (Acorn brand) at Corona (Merrill 1919, pp. 569, 570). Boalich (1920, pp. 89-90) reported that flint-fire clay was mined in 1919 from a vertical shaft 130 feet deep and that two men were employed at the mine. Fire brick from the McKnight clay and common clay products from Temescal Valley clays were manufactured at the Corona plant which employed 50 to 60 persons. According to Dietrich (1928, p. 179) Pacific Clay Products was mining fire clay in 1925 from the McKnight property 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. Reserves of fire clay were believed to be small, but a considerable tonnage of red-burning sewer pipe clay remained (Dietrich 1928, p. 179). Mining and loading was by hand methods and output in 1925 was 50 tons per day each of red-burning and fire clay. The clay was trucked to a railsiding for shipment to the plant in Los Angeles, the Corona plant having burned down several years earlier. Production of red-burning clay ceased several years later but fire clay was still being mined in 1931, overhead stoping methods being employed (Sutherland 1935, p. 78). 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. In 1942 a small tonnage of red "ladle" clay was supplied to Pacific Clay Products Lincoln Heights plant in Los Angeles and about 1952 several hundred tons of red-burning clay were mined. By 1945 the main workings were caved and inaccessible. At present (1958) several small adits are open but show little clay; several open pits above the old underground workings partly expose the clay sequence. There are no plans to reopen the property.

Middlesworth Clay Deposit (Brown Star Claims; Lord ?, Freeman ?). Location: NW¼ sec. 14; SW¼ sec. 11; NE¼ sec. 15, T. 4 S., R. 7 W., S.B.M., 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, California, holds three unpatented placer claims (Good Luck, Good Hope, Valley Brief) in the NW¼ sec. 14 totaling about 37 acres. William H. Redding, et al., 1008 South Pacific Avenue, San

Pedro, California, own 105 acres of patented ranch land ($N\frac{1}{2}NE\frac{1}{4}$ sec. 15; $SW\frac{1}{4}$ sec. 11) and one unpatented placer claim (Red Bull No. 1, $S\frac{1}{2}SE\frac{1}{4}$ sec. 10) of about 80 acres. Patented ranch land totaling 12.5 acres in the $N\frac{1}{2}NW\frac{1}{4}NW\frac{1}{4}$ sec. 14 was owned in 1944 by Mrs. Mabel M. Freeman, Riverside, California.

This property apparently now embraces part of several clay and mineral paint deposits operated as early as 1905 by George W. Lord (Aubury 1906, p. 203) 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. C. Middlesworth, Corona, held four 20-acre placer claims, known as the Brown Star claims; the patented areas were owned by the Freeman interests. Early development was by open cuts, shallow shafts and two adits, 150 feet in length. In 1943, the Kaiser Steel Corporation took a short term option on the property and did considerable exploratory work. The production is not known but probably was not large, and there has been none for many years.

The clays crop out 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-plactic 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 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 latest and most extensive development work on the property was done in late 1943 by the Kaiser Steel Corporation in an effort to develop a source of alumina-rich clays (25 percent alumina, or greater) for use in steel manufacture. Detailed investigations were made of the $NW\frac{1}{4}NW\frac{1}{4}$ sec. 14, which had been idle for many years and was covered with dense brush. 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. The average of 107 samples taken from surfaces thus exposed and from shallow auger holes was 18.9 percent alumina, 57.11 percent silica, and 5.11 percent iron oxide. The bauxitic clays varied from a high of 31 percent Al_2O_3 to a low of 15 percent Al_2O_3. Approximately 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).

The property was not opened as the clay did not prove to be sufficiently rich in alumina to meet the requirements, tonnage estimates were low, and there is considerable overburden which would require much stripping for full recovery. Little exploratory work has been done since 1943 and the property was idle in 1956.

Sky Ranch Clay Company Deposits. Location: $W\frac{1}{2}$ and $SE\frac{1}{4}$ sec. 4; $E\frac{1}{2}$ sec. 5, T. 4 S., R. 7 W., S.B.M., about $3\frac{1}{2}$ miles southwest of Corona along Mabey and Wardlow Canyons and intervening ridges. Ownership: Clifford and Maude M. Tillotson, P. O. Box 237, Corona, California, own four patented placer claims (Fire Clay No. 1, Fire Clay No. 2, M & M placer, and Susie); and three unpatented placer claims (Insight No. 1, Insight No. 2, and Frenchy placer) totaling about 170 acres. They also own clay-bearing patented ranch land in the $S\frac{1}{2}NE\frac{1}{4}$ sec. 5 (Sky Ranch clay mine, west pit) and in the $NW\frac{1}{4}SE\frac{1}{4}$ sec. 4 (McClintock pit), totaling about 85 acres. 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. These properties are operated collectively by the Sky Ranch Clay Company, P. O. Box 398, Corona, California.*

The clay-bearing area lies along Mabey and Wardlow Canyons and the intervening east-trending ridges, where Paleocene clay and Upper Cretaceous clay shale are exposed in cuts and pits made in the steep, brush-covered hills. The McClintock pit, the easternmost deposit, is along the north side of Mabey Canyon. To the west the Susie pit occupies a saddle midway between Wardlow and Mabey Canyons and the Fire Clay group adjoins the west edge of the Susie pit. The Frenchy placer (Sky Ranch clay mine, east pit) is astride Wardlow Canyon and adjoins the north boundaries of the Susie pit and Fire Clay group. The Sky Ranch clay mine, west pit, lies along the north side of Wardlow Canyon west of the Frenchy placer.

Operations in the vicinity of the patented properties began about 1900 when a small tonnage of clay was shipped from the Susie claim (McVicar pit) to the California Clay Manufacturing Company in Los Angeles (Aubury 1906, p. 223). The Fire Clay Nos. 1 & 2 and the M & M placer, then known as the Fire Clay group, were patented to J. H. Moore and George T. Mabey, Corona, and the Susie placer to William G. McVicar in 1913. There followed a long period of inactivity, although the Susie claim, later acquired by Earl M. McClintock, may have had small intermittent production. Additional claims were held at different times by various locators, but none is known to have been productive.

A renewal of activity began about 1945 when Earl McClintock located the Insight Nos. 1 & 2 claims. In 1946, these claims were leased to Clifford Tillotson, operator of the Sky Ranch Clay Company, who, in 1945, began developing sources of red-burning clays for use at the Tillotson Refractories Company in Corona. The

* Pacific Clay Products, 1255 West Fourth Street, Los Angeles, California, on September 1, 1957 acquired the Susie placer claim and the patented ranch land in the $S\frac{1}{2}NE\frac{1}{4}$ sec. 5 and $NW\frac{1}{4}SE\frac{1}{4}$ sec. 4, T. 4 S., R. 7 W., S.B.M., totaling about 105 acres. Mining operations continued as Pacific Clay Products, Corona shale mine.

FIGURE 16. Sky Ranch Clay Company mine, west pit. Clay shale of the Ladd formation, undifferentiated (Upper Cretaceous) is loosened and stockpiled by ripper-bulldozer at left. The loosened material is loaded by skiploader (right) on trucks for transport to Tillotson Refractories Company in Corona. This is the typical method employed in mining clay shale deposits in the Corona area. Observer faces northeast.

FIGURE 17. Clay shale stockpile, Sky Ranch Clay Company mine, west pit. Ripper-bulldozer (upper left) loosens the clay shale and pushes the loosened material to the stockpile from which a skiploader (lower right) loads trucks. Observer faces north.

Frenchy placer was located by J. A. Carmile in 1948. In the early 1950's the Susie claim was operated by Earl M. McClintock who furnished some clay to the Mission Clay Products Corporation at Olive, for use in the manufacture of sewer pipe. By 1955, all claims had been deeded to Mr. Tillotson, who since about 1945 had continuously produced each year several tens of thousands of tons of red-burning clay and clay shale. This has been used as a constituent in the manufacture of common clay products at the Tillotson Refractories Company, Corona (see herein). The clay shale is locally termed "Wardlow shale".

The Sky Ranch Clay Company deposits, except the Susie claim and the McClintock pit, 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 currently (1957) being 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 1500 feet.

The area is traversed by several northwest- to west-trending faults which, on the Susie claim, have caused a wedge-shaped block of typical sedimentary clays and lignite of the Paleocene Silverado formation to be down-dropped between two topographically higher blocks which contain sandstone and conglomerate of the Upper Cretaceous Ladd formation, undifferentiated. This structure might also be interpreted as a faulted syncline with Paleocene rocks, draped in part unconformably over Upper Cretaceous rocks. The Paleocene clays exposed in the Susie pit in 1957 included red and yellow mottled pisolitic beds 1 to 2 feet thick but exposed only for a length of several tens of feet in the central part of the pit, and a sandy white, red, greenish, and blue-gray clay zone 5 to 10 feet thick traceable for about 150 feet along a shear zone on the south side of the Susie pit. The same structure extends eastward about 2,000 feet to the McClintock pit where traces of clays similar to those in the Susie pit are exposed.

Development has been by open cuts and short adits. By 1910 the Susie claim had been explored by three cuts and four short adits. Later mining on this claim was by open cuts which were active during the early 1950's, and by 1957 the pit area was 250 feet wide and 350 feet long. The Susie pit continues to be intermittently active. Development on the Fire Clay group included four short adits and seven open cuts in 1910. Later mining was from a small quarry, active about 1950. The McClintock pit has been explored by several shallow pits and cuts. The foregoing areas were all idle in early 1957.

Mining currently (July 1957) is in the west end of the Frenchy placer along the north side of upper Wardlow Canyon and adjoining patented ranch land to the west in the S½NE¼ sec. 5 (Sky Ranch clay mine, west pit). Development of the present Sky Ranch clay mine began in 1951 when Upper Cretaceous clay shales were stripped by bulldozers. A quarry was opened on the Frenchy placer claim (Sky Ranch clay mine, east pit) about 2,000 feet east of the currently (1957) active west

FIGURE 18. Loading clay shale, Sky Ranch Clay Company mine, west pit. Typical method of loading clay shale in the Corona area. Observer faces northeast.

FIGURE 19. Sky Ranch Clay Company mine, east pit, north side of Wardlow Canyon. Quarry exposes clay shale of the Ladd formation, undifferentiated (Upper Cretaceous). Typical brush covered terrain of the Sky Ranch Clay Company mine area. Observer faces northeast.

pit and along the north side of Wardlow Canyon. The east pit furnished from 10 to 20 thousand tons of clay shale each year for several years, but has been inactive since about 1956. The west pit (figure 16) which is developed in an Upper Cretaceous clay shale zone along the north side of Wardlow Canyon, is about 500 feet wide, the loading face is about 20 feet high, and the shale has been mined to depths ranging from 5 to 10 feet over a strike length of about 1,500 feet. This pit was opened early in 1956, and in 1957 was the principal source of clay shale used by the Tillotson Refractories Company, Corona, discussed elsewhere in this report.

Paleocene clays appear to have little areal extent beyond the present limits of the Susie and McClintock quarries and reserves appear to be small. Large areas of 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.

Before 1956, the shale was mined with a combination Caterpillar-bulldozer-ripper which pushed the material into small wooden or steel chute-bunkers (figure 10) for loading into small trucks for transport to the Tillotson Refractories Company in Corona. Since early 1956, mining has been with a Caterpillar D-4 combination bulldozer-ripper (figure 17) which has loosened and moved the shale to a stockpile. From here a caterpillar No. 933 Traxcavator skip loader has loaded the shale on a 4-yard dump truck (figure 18). Two men do the mining, one operates the bulldozer-ripper and the other loads the dump truck and hauls the shale to Tillotson Refractories Company. Hard limy concretions which are locally intercalated in the shale, are removed by hand sorting at the mine.

Thomas Clay Deposit, East Pit. Location: NW¼ sec. 33, T. 3 S., R. 7 W., S.B.M. (projected), 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, California, owns this property as part of the 500-acre La Sierra Stock Ranch; approximately 23 acres are leased to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 39, California, who have sublet mining rights to the east pit area to Joe Deleo, Jr., clay supplier and mining contractor, 1233 Garretson, Corona, as operator.

In 1951 Joe Deleo, Jr., began prospecting activities which led to the discovery of the clay deposit on the Thomas property. The clay-bearing area subsequently was leased to Gladding, McBean and Company and Mr. Deleo began mining clay as a sublessee during 1953. A small production of only a few thousand tons each year has been maintained with some increase in production during 1956. Mr. Deleo supplies red-burning clay shale to several manufacturers of common clay products in the Metropolitan Los Angeles area. These manufacturers include the Atlas Sewer Pipe Company, Whittier, and the Jordan Tile Manufacturing Company, Corona.

The red-burning clay shale is obtained from a 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, 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 consists of bulldozer cuts and benches, that have formed a sloping quarry face about 200 feet high and as much as 300 feet wide. 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 a vertical face 50 feet high is being cut (figure 20) where the clay is loaded by a 1½ cubic yard Lorain 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.

FIGURE 20. Thomas clay deposit, east pit (operated by Joe Deleo, Jr.). Fissile claystone of the Silverado formation (Paleocene) is mined by a ripper-bulldozer which piles loosened material from hill above at foot of sloping quarry face. Loosened material is loaded by the 1½ cubic yard power shovel into dump trucks for transport to several manufacturers of common clay products. Observer faces southeast.

Thomas Clay Deposit, West Pit. Location: NW¼ sec. 33, T. 3 S., R. 7 W., S.B.M. (projected), 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, California, owns this property as part of the 500-acre La Sierra Stock Ranch; approximately 23 acres are leased to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 39, California. Mining rights to part of the property are sublet to Joe Deleo, Jr., Corona, who operates the adjoining east pit, across the canyon.

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 drilling is reported to have indicated several million tons of reserves. This material would probably be suitable as a constituent for red-burning common clay products. The production consists of a few hundred tons utilized for plant tests, and in October 1956 several thousand tons of clay shale remained stockpiled in the canyon between the west and east pits.

The deposit is on strike with the east pit across the canyon and is an extension of the same deposit. Excellent Paleocene marine fossils have been found (locality 29, pl. 1) in the west pit. Here 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.

The property is developed by open cuts and benches on several levels. Mining has been done with bulldozer and ripper. Intermittent development work is continuing.

*Tillotson Refractories Company**. Location: 1150 West 6th Street (State Highway 71), Corona, SW ¼ sec. 26, T. 3 S., R. 7 W., S.B.M. (projected), in Corona North quadrangle. Ownership: Tillotson Refractories Company, 1150 West 6th Street, Corona. Clifford Tillotson owns and manages the operation and Gerritt Poelstra is superintendent.

Tillotson Refractories Company began operations in 1941 with the manufacture of insulating fire brick from clay purchased from the Alberhill Coal and Clay Company. In 1945, Mr. Tillotson began utilizing clay shales, from his Sky Ranch clay mine, in the manufacture of vitrified clay sewer pipe. Since then this has been the only product manufactured.

Raw materials used include (1) Upper Cretaceous clay shale (locally designated "Wardlow shale") from the Sky Ranch Clay Company (already described in this report); (2) red mottled clay of the Paleocene Silverado formation and mined at the Harrington clay pit 9 miles distant to the southeast on the east side of Temescal Wash and north of Dawson Canyon, and (3) "ball clay" (a plastic, refractory, sedimentary clay which is principally kaolinite and other aluminum silicates) of the Paleocene Silverado formation supplied by the Elsinore Clay Company from pits 2 miles north of Elsinore on State Highway 74.

In this modern plant (figure 21) the raw mix is made from a mixture of about 65 percent clay shale, 20 percent red mottled clay, and 15 percent "ball clay". Sewer pipe is formed by a combination pug mill, deairing and extruding machine. The pipe is then glazed and placed in drying rooms where it is dried by gas heat. From the drying rooms the pipe goes to "bee hive" periodic kilns for setting and burning, the final step in the process. The plant has been in continuous operation since 1941 and has grown steadily. There are now (1957) about 100 employees.

Vitrified sewer pipe is made in 4-, 6-, and 8-inch sizes and is mostly sold locally, but also reaches market areas as far distant as San Diego and Arizona.

Coal

Small quantities of lignitic coal are reported to have been mined near the mouths of Eagle and Main Street (Gypsum) Canyons, from a small canyon east of Joseph Canyon, and from the vicinity of the McKnight clay mine between Hagador and Mabey Canyons. Considerable carbonaceous material is scattered irregularly through nonmarine sandstones and soft clay shales, gyp-

* Acquired by Pacific Clay Products, 1255 West Fourth Street, Los Angeles, California, on September 1, 1957. Operation continued without immediate major changes as Pacific Clay Products Corona Plant.

FIGURE 21. Clay pipe manufacturing plant of Tillotson Refractories Company, Corona. Raw material is ground, pugged and extruded to form clay pipe in building in background. Also in this building the pipe is glazed and dried by gas heat. The pipe then goes to periodic "beehive" kilns (center) for firing. Finished pipe is stored in yard (right foreground) to await truck shipment to users. Observer faces southwest.

siferous in places, of the Paleocene Silverado formation. Where mined, the coal is in small lenses or pockets closely associated with the economic clay zones of the Silverado formation.

Goodyear (1888, p. 505) described an active coal prospect about 4 miles southwest of Corona which may have been on or near the area of the McKnight clay mine where coal seams are still exposed in the old workings. He reported that a bed of soft coal, ranging from 3 inches to 4 feet in thickness and very irregular in quality, was exposed by an adit 60 feet in length from which a winze had been sunk about 170 feet deep.

Later, Tucker (1921, p. 325) reported the existence of a coal seam 4 feet wide on the Hoag Ranch in the vicinity of Joseph Canyon. Minor amounts of coal, not being utilized, are presently exposed in the active open pit workings of the Sky Ranch Clay Company mine (Susie claim) just north of Mabey Canyon. Recent (1956) drilling in lower Bedford Canyon near Highway 71 is reported to have encountered a lignitic coal zone 12 feet in thickness.

Production of coal in the Corona district has evidently been minor and was probably only for local use. All properties are idle at present and have been so for many years.

Dumortierite

Dumortierite is of value because of its excellent refractory qualities. According to Pampeyan (1952, pp. 53, 56, 57, 70) there are several occurrences of muscovite-dumortierite-tourmaline-quartz veins in coarse-grained phases of the Cajalco quartz monzonite near Temescal Wash. These occurrences were first described by Murphy (1930, pp. 79-80) and later mentioned by Larsen (1948, p. 106). The best-defined vein lies in the NE¼ sec. 5, T. 4 S., R. 6 W., S.B.M., near the railroad trestle. Another vein occurs in the NW¼ sec. 33, T. 3 S., R. 6 W., S.B.M., south of Home Gardens. In a third area, on the west side of Temescal Wash in the NW¼ sec. 9, T. 4 S., R. 6 W., S.B.M. (projected), dumortierite is disseminated through the quartz of the country rock. Pampeyan (1952, p. 53) estimated that none of these occurrences contained more than 2 percent of dumortierite. However, he described two richer occurrences east of the Temescal Wash area, one about one mile northwest of Cajalco Hill, the other about 1½ miles northeast of Cajalco Hill just northwest of the Cajalco spillway near the N¼ cor. sec. 1, T. 4 S., R. 6 W., S.B.M. These localities are on the Lake Mathews quadrangle. The locality northwest of Cajalco Hill is about 3 by 75 feet in plan and contains an average of about 20 percent dumortierite by volume.

Gypsum (Gypsite)

Gypsite, an earthy mixture of very small gypsum ($CaSO_4 \cdot 2H_2O$) 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 and is about 4 miles south and southwest of the center of Corona. There a narrow, irregular belt, averaging about 500 feet in width but as much as 3000 feet wide containing rather low-grade gypsite, extends for about 3½ miles in a northwesterly direction between Joseph and Tin Mine Canyons. Although the gypsum content is only between 20 and 30 percent, the material carries enough iron and lime to make it of value as a soil conditioner (Ver Planck, 1952, p. 58).

During the first third of the twentieth century a considerable tonnage of this material was mined and mostly used locally as an agricultural mineral by orchardists of the district, several of whom had their own deposits. Mining has been carried on in Hagador Canyon, Main Street (Gypsum) Canyon and Eagle Canyon and here and there from the intervening ridges. Gypsum was mined, ground, and shipped from the Corona area as early as 1900, but most of the mining took place from 1909 to 1919 and from 1924 to 1934; there have been no shipments since that time although small amounts of material may have been sporadically mined for local use. During the period 1943-53 there was a minor renewal of activity. Several claims were taken by location and both the Eagle Canyon (Frazer) and Hagador Canyon deposits were taken under lease by several operators. Apparently little material was mined and in 1956 all of the properties were idle.

According to Ver Planck (1952, p. 58) those who have reported production of gypsite include the Soil Tone Company and E. R. E. Nonhof from Hagador Canyon; G. W. Lord from Gypsum (Main Street) Canyon; and the Amestoy Mineral Fertilizer Company, Natural Fertilizer Company, and Mineral Fertilizer Company from Eagle Canyon. These operations are indicated to have had production of less than 10,000 tons each. Early producers from unrecorded localities include El Cerrito Ranch, W. H. Jameson Company, and W. C. Barth (Merrill, 1919, p. 579). The latest production was in 1944 when Dr. Leon N. Katz, San Fernando, mined about 1,000 tons from the Frazer deposit in Eagle Canyon. The material was not sold, but used only for testing and experimental purposes (personal communication, Dr. Leon N. Katz, Dec. 16, 1956).

The host rock in the commercial gypsite belt, which is adjacent to the Elsinore fault zone, is a mass of dark greenish-gray hornblende andesite and dacite porphyries of the Jurassic (?) Santiago Peak volcanics, which have been mildly metamorphosed. In places the volcanic rocks are hard and have been cut by shear planes that strike northeast to northwest and dip steeply northwest or northeast, or are vertical, giving a blocky appearance. Elsewhere the volcanic rocks are soft and much weathered, but with relic shear planes. Along the shear planes are zones of hydrothermal alteration where the porphyries have been kaolinized and stained with limonite. Some fractures are filled with calcite and the volcanic rocks are pyrite-bearing. Closely spaced veinlets of fibrous gypsum cut the hydrothermally altered rock in all directions. Probably both the gypsum-bearing altered rock (gypsite) and the gypsum veinlets were mined.

Gypsite beds also occur locally in Upper Cretaceous and Paleocene clay shales which contain thin veinlets of gypsum along fractures and bedding planes. Calcium sulfate-bearing ground water being drawn upward by capillary action has deposited these small gypsum crystals. The gypsite beds in Cretaceous and Paleocene sedimentary rocks have not been mined and are believed to be too small for commercial development.

The commercial production of gypsite in the Corona area is hindered by several factors. For agricultural use, the only possible current economic outlet for this material, gypsite must generally contain more than 50 percent gypsum although grades as low as 30 percent are sometimes used under special conditions. Even so, the Corona deposits would require beneficiation. The commercial producer also must comply with the State Department of Agriculture regulations which require among other things that each lot or bag of gypsum must bear a tag stating the percentage of gypsum which cannot be more than 5 percent lower than the guarantee. In the Corona deposits, it would seemingly be difficult to maintain the purity of the product within the 5 percent limit, unless the producer used a very low figure. Finally, the grade and size of the Corona deposits do not appear to warrant the required investment in mining and milling equipment.

Small-scale development of some of the Corona gypsite deposits for local agricultural use might be possible. This would be particularly true if mine run material would be of special benefit to local citrus groves. However, even though the deposits are close to the citrus area, the cost of mining and handling might rule out such development in favor of commercial products which are both fertilizers and soil conditioners.

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., along both sides of the mouth of Eagle Canyon, about 4 miles south of Corona. Ownership: T. A. and F. M. Frazer, 718 Howard Street, Corona, California own three unpatented placer claims: Eagle Group, Eagle Group No. 2 and Eagle Group No. 3, totaling about 150 acres.

In 1913 the Eagle Canyon deposit was mined for agricultural gypsum by the Amestoy Mineral Fertilizer Company which became the Natural Fertilizer Company in 1914 and continued the operation during 1914-15. After 1915, the company became the Mineral Fertilizer Company and operated in 1916 and 1917. The property apparently was then idle for several years. T. A. Frazer located some of the present claims in 1924 and others in 1939, but evidently did only discovery and assessment work. Dr. Leon N. Katz, 9837 Foothill Boulevard, San Fernando, California, held the property under lease in 1943-44 and T. A. Frazer located still another claim in 1953. The recorded production of gypsite from this deposit is small. Only during the years 1913-17 was the mined material marketed. During 1943-44 Dr. Katz mined a total of about 1,000 tons of gypsite from both sides of Eagle Canyon. This material was not sold, but was used only for testing and experimental purposes. There has been no production since 1944.

The 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. An efflorescent deposit of yellowish-white aluminum sulphate occurs with the gypsum exposed in an open cut on the west side of Eagle Canyon. Minor amounts of gypsum are also present in clay shales of the Paleocene Silverado formation which rest in fault contact on the volcanic rocks. The mining apparently has been confined to the altered volcanic rocks, although the Silverado sedimentary rocks have been prospected. The gypsite-bearing 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, and is associated with iron and lime. However, most of the material has a gypsum content of only about 15 percent (personal communication, Dr. Leon Katz, Dec. 1956). Analysis of a composite sample taken by Dr. Katz, made by Ed Eisenhauer, Jr., Los Angeles, 1944 (see page 84).

Development consists of 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

Analysis of gypsite from Eagle Canyon

	Percent
Calcium oxide (CaO)	6.42
Magnesium oxide (MgO)	.09
Ferric oxide (Fe_2O_3)	3.69
Aluminum oxide (Al_2O_3)	6.41
Sodium oxide (Na_2O)	2.20
Potassium oxide (K_2O)	.16
Sulphuric anhydride (SO_3)	8.40
Phosphoric anhydride (P_2O_5)	.21
Silica (SiO_2)	61.62
Water (free) at 105°C	1.04
Combined water	9.36
Equivalent to calcium sulphate ($CaSO_4 \cdot H_2O$) (calculated)	16.22

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. At this time the lessee also installed a small crushing plant on the east side of Eagle Canyon. The plant consisted of a Williams hammer mill, with bucket elevator to a 10-ton storage bin. Gypsite mined from the open cut was delivered by truck to the crusher. Operations were suspended in 1945 because of high moisture content. Experiments with a dryer proved unsatisfactory and the lease was terminated. The mill was removed in the early 1950's.

Hagador Canyon Gypsum Deposit. Location: NW¼ sec. 15; S½SW¼ sec. 10; NE¼ sec. 16, T. 4 S., R. 7 W., S.B.M., along Hagador Canyon and the ridges on both sides of the canyon, about 4 miles southwest of Corona. Ownership: W. R. and Virginia Adams, 301 Fruit Street, Santa Ana, California, own two unpatented placer claims located in 1952: Farmer's Friend Nos. 1 and 2. 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).

The earliest recorded operation in the vicinity of Hagador Canyon was in 1910 when 275 tons of gypsite are reported to have been mined and shipped to citrus groves near Corona for use as a soil conditioner (Tucker and Sampson 1945, p. 169). According to Merrill (1919, p. 579) and Ver Planck (1952, p. 144) the first major operation was in 1915-16 when the Soil Tone Company, Corona, shipped a considerable tonnage from this area. Later the property was owned by the Amestoy Estate who leased to E. R. E. Nonhof, Corona, from 1924 to 1933, and the property was operated by Nonhof and G. R. Freeman in 1934. During the 1930's Nonhof and Freeman located eight placer claims known as the White Gypsum group in secs. 9, 10, and 16, T. 4 S., R. 7 W., S.B.M. The claims along Hagador Canyon were finally abandoned and in 1943 J. C. Middlesworth and C. E. McCorkill, Corona, relocated the deposit as Big Chief Nos. 1 and 2, Amador, and Morning Star Nos. 1 and 2 placer claims. In 1945 C. E. McCorkill located the Valley View placer. Victor Mishelle, Malibu Beach, held the property under lease in 1945 and later acquired part of the claims by quit claim deed. Some of these claims

FIGURE 22. White Gypsum group deposit, south side of Tin Mine Canyon. Small amounts of gypsite were mined about 1923 from open cuts (light colored area in ravine, middle distance). Area is underlain by hydrothermally altered volcanic rock (Jurassic ? Santiago Peak volcanics) that contains veinlets of satin spar and gypsite. Dense brush cover is typical of the Corona gypsum-bearing area. Observer faces south.

apparently have been abandoned, in part, and were partly relocated by the present owners between 1952 and 1956. This property probably has been the principal source of agricultural gypsite in the Corona area. The output was sold as a soil conditioner to citrus growers in southwestern Riverside County.

The deposit was mined in 1915, 1916, 1924, and 1926-34; no production has been reported since 1934. Since 1934 only discovery work, sampling, experimenting with the material as a soil conditioner, and annual assessment work has been done.

The gypsum occurs in hydrothermally altered metavolcanic rocks of the Jurassic (?) Santiago Peak volcanics, and is similar to the Eagle Canyon deposit which is described elsewhere in this report. 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 the gypsite beds are about 200 to 300 feet in width and about 750 feet in length on the Big Chief claims which lie astride Hagador Canyon in secs. 10 and 16, but the principal exposure is on Big Chief No. 2, on the west side of the canyon. On the Morning Star Nos. 1 and 2 which join the Big Chief claims on the southeast and lie 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. On the Amador claim, which is southwest of the Big Chief claims and lies along the west branch of Hagador Canyon in the NE¼ sec. 16, is exposed a gypsite body several hundred feet thick.

Following is an analysis of samples by Smith-Emery Company (Tucker and Sampson 1945, p. 169):

		Percent
Big Chief No. 1	calcium sulphate ($CaSO_4 \cdot 2H_2O$)	14.7
	phosphoric anhydride (P_2O_5)	0.05
Big Chief No. 2	calcium sulphate ($CaSO_4 \cdot 2H_2O$)	18.5
	phosphoric anhydride (P_2O_5)	0.06

Samples taken by Tucker and Sampson (1945, p. 169) from Big Chief Nos. 1 and 2 and analyzed by Ed Eisenhauer, Jr., Los Angeles were as follows:

	Percent
Calcium oxide (CaO)	8.80
Magnesium oxide (MgO)	0.62
Ferric oxide (Fe_2O_3)	4.19
Aluminum oxide (Al_2O_3)	3.66
Sodium oxide (Na_2O)	2.89
Potassium oxide (K_2O)	0.30
Sulphuric anhydride (SO_3)	12.06
Loss in ignition	13.05
Gypsum ($CaSO_4 \cdot 2H_2O$) (calculated)	23.05

Development, reported by Tucker and Sampson (1945, p. 169) was as follows: shallow open cuts and an adit 20 feet in length on Big Chief No. 1; open cut 75 feet in width and 15 feet high on Morning Star Nos. 1 and 2 (the area from which the first shipment was made in 1910); and several large adits and open cuts and trenches on the Amador claim.

The largest tonnage came from the area of the Amador claim which was worked by E. R. E. Nonhof from 1927-34. Material from the open cut on the west side of Hagador Canyon was delivered by a jig back tram, 1,800 feet in length, to a crushing and screening plant in the canyon. This plant had a reported capacity of 40 tons per day. Collapsed remains of the tram line and plant remained on the property in 1956.

The open cuts and trenches are now caved and the principal adits are made inaccessible by standing water and caving. All of the claims are overgrown with brush so that the gypsite-bearing zones are very poorly exposed.

Main Street (Gypsum) Canyon Gypsum Deposit. Location: S½NE¼ sec. 15; N½S½ sec. 14, T. 4 S., R. 7 W., S.B.M., about 4 miles south of Corona along Main Street (Gypsum) Canyon and adjoining ridges. Ownership: Mrs. Josephine Middlesworth, 847 W. 9th Street, Corona, California, owns one unpatented placer claim (Morning Star) in the S½NE¼ sec. 15. Floyd N. Champion, et al., 3316 E. Anaheim Street, Long Beach 4, California, own 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.

The Main Street Canyon gypsum deposit probably was first worked by the Standard Fertilizing Company who mined 250 tons of gypsum in 1901 and about 150 tons before that date (Aubury, 1906, p. 286). George W. Lord controlled the property in 1906 and operated it intermittently and on a small scale from 1906 to 1917. G. R. Freeman became a partner in 1915 and continued to operate the deposit until 1937. J. C. Middlesworth located the Morning Star claim about 1944 and leased it to Dr. Leon Katz, San Fernando, California, for a short period. In 1945 the deposit was leased to Victor Mishelle, Malibu Beach, California, and since that time has been idle. The Capitol Dome group of claims, still held by location, were located prior to 1939 and include the eastern margin of the Main Street (Gypsum) Canyon deposit. This deposit had intermittent production of gypsite for agricultural use by citrus growers in the vicinity of Corona during a period before 1901 until 1935 (Ver Planck 1952, p. 126).

FIGURE 23. Ladd Canyon (Kroonen) limestone deposit. Dark gray crystalline limestone lens occurs in metagraywacke and argillite of the Triassic Bedford Canyon formation. This carbonate mass, the largest in the Corona South quadrangle, crops out on the west side of the East Fork of Ladd Canyon. Observer faces northwest.

The gypsum occurrence is similar to that of the Eagle Canyon deposit described elsewhere in this report. 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 (Gypsum) Canyon.

Analysis of samples (Tucker and Sampson 1945, p. 168) made by Ed Eisenhauer, Jr., of Los Angeles is as follows:

	Percent
Calcium oxide (CaO)	11.05
Magnesium oxide (MgO)	0.81
Ferric oxide (Fe_2O_3)	5.32
Aluminum oxide (Al_2O_3)	4.43
Sodium oxide (Na_2O)	1.13
Potassium oxide (K_2O)	0.17
Sulphuric anhydride (SO_3)	16.31
Loss in ignition	13.35
Gypsum ($CaSO_4 \cdot 2H_2O$)	31.24

The deposit has been developed by adits, trenches, open cuts, and prospect pits. Dr. Katz did some sampling in 1944. Since 1945 only annual assessment work has been done; on the Capitol Dome group this has included cleaning out adits, clearing brush and some new open cuts.

Limestone

Dark-gray to black, fine-grained crystalline limestone lenses within the Bedford Canyon formation crop out at a number of places in the Corona South quadrangle. All but two of these occurrences are only a few feet wide and no more than several tens of feet long. In addition some of the fine-grained metasiltstones appear to contain about 15 percent calcite.

Two limestone bodies, one along the East Fork of Ladd Canyon and the other east of Bedford Motorway are of possible commercial interest. Chemical analyses indicate that these limestone bodies might be suitable for portland cement manufacture, but their small size apparently precludes this use. These occurrences are described elsewhere in this report.

Limestone was reported from this area as early as 1886, and a number of claims have been located. No record of production was found but small amounts of lime may have been burned before 1900 for local use as early day residents report the remains of a small lime kiln were found in Hagador Canyon in 1907. All claims were idle or abandoned for many years until 1958.

Ladd Canyon (Kroonen) Deposit. Location: SE¼ sec. 34, T. 4 S., R. 7 W., S.B.M. and NE¼ sec. 3, T. 5 S., R. 7 W., S.B.M. (projected), about 2½ miles northeast of Silverado post office along the west side of the East Fork of Ladd Canyon, Orange County. This is apparently the same limestone deposit that was reported to be in secs. 3 and 4, T. 5 S., R. 7 W., and sec. 33, T. 4 S., R. 7 W., S.B.M. in previous accounts (Tucker 1925, p. 68; Logan 1947, p. 261) but which could not be located here by the writer. Ownership: Great West Minerals and Materials Development Company, 8541 Calmada Avenue, Whittier, California, holds a total of 200 acres in 10 unpatented placer claims: Black Bird, Black Eagle, Black Hawk, Double D., Eureka, Mammoth, Mary, Santa Ana, Sunset, and Ultimo.

This deposit is said to have been discovered in 1886, but the first mining claims appear to have been located in 1915 when Leo Kroonen, Corona, California, located 10 claims. Mr. Kroonen did exploratory work through the 1930's but after that the property apparently was idle until relocated by the present owners in early 1958. This limestone was briefly described by Fairbanks (1893, pp. 115-116) and is probably the same body of limestone later mentioned by Smith (1898, p. 779).

In the 1930's these claims were accessible by several miles of dirt road leading northeast from Silverado Canyon along Ladd Canyon and then along the East Fork of Ladd Canyon. Much of this road is now completely washed out, and in some places is nearly impassable on foot. These claims are now best reached by taking the Ladd Canyon spring truck trail from the Main Divide truck trail and then proceeding down the creek about half a mile along the old Ladd Canyon foot trail, some traces of which still remain.

Dark gray, bluish-black, to black, very fine-grained crystalline limestone, which weathers light gray, occurs in bodies which crop out on the west slope of the East Fork of Ladd Canyon from the creek bed to the ridge top, 1,000 feet to the west. The limestone is fetid, cut by numerous veinlets of white, secondary calcite, and is moderately silicified. The limestone bodies appear to strike about N. 30°-35° W. and dip 45° to 60° to the northeast, but at one place in the southern part of the largest body the dip appears to be to the southwest, suggesting a possible anticlinal structure. The limestone bodies are narrow, discontinuous pods and stand out as resistant ledges or bold cliff faces (figure 23) in a series of Bedford Canyon formation metagraywackes, siltstones, shales, and argillites which are in part slaty. Some of the fine-grained, brown metasilts appear to contain about 15 percent calcite. The argillites and graywackes also have calcite cement.

The areas in the Ladd Canyon region shown as limestone on the geologic map (pl. 1) are mostly of carbonate rock but also contain intermixed metagraywackes, argillites, and shales. The largest continuous carbonate mass is about 100 to 200 feet in width and several hundred feet in strike (?) length. This mass is in a zone in which carbonate rocks are exposed over most of an area that averages about 500 feet wide and 1,000 feet long. In places, especially observable on weathered surfaces, this body appears to be a limestone breccia. Previous workers have collected ammonites and pelecypods from the Ladd Canyon area which indicate an Upper Triassic age for the limestone which is mapped (pl. 1) with the Bedford Canyon formation (p. 12, geologic text). In the largest carbonate lens, described above, the writer also found a few small ammonites and a number of pelecypods. This ammonite fauna is Jurassic in age (see footnote, geologic text, pp. 12-13).

Two samples, believed to be typical of the carbonate bodies, were collected by the writer from the SE¼SE¼ sec. 34, T. 4 S., R. 7 W., S.B.M. Sample No. 1 is from the largest carbonate body and No. 2 is from an elongate pod immediately south. Analyses of these samples, made by Abbot A. Hanks, Inc., San Francisco, in June 1956 were as follows:

Sample No.	Silica	Ferric oxide	Aluminum oxide	Calcium oxide	Magnesium oxide	Phosphorus pentoxide
1	8.28%	0.48%	1.87%	46.71%	2.32%	0.04%
2	3.27	0.26	0.39	50.81	2.12	0.01

The following analysis of a limestone from the same general area was made in the 1920's by F. W. Huber, University of California:

SiO_2	1.34%
CaO	51.45
Fe_2O_3 & Al_2O_3	1.95
MgO	1.86
Ignition loss	43.08
Undetermined	0.32

These few data indicate these carbonate rocks might be suitable for the manufacture of portland cement, although the magnesium oxide content is somewhat higher than is preferred by most users. This limestone probably would not be accepted as chemical grade or in the glass industry nor for other specialty uses which require a high chemical purity or extreme whiteness of processed material. No adequate estimate of reserves is possible because of a dense covering of brush in this area. However, the reserves probably are small and surely not sufficient to support a modern cement plant, unless the calcite-rich argillites could be utilized.

The carbonate bodies have been explored by a number of open cuts and several short adits, now mostly caved and heavily overgrown with brush. Trails leading to the larger outcrops were barely discernible when the property was visited in July 1956 and no recent work was observed. In May 1958 the owners repaired the Ladd Canyon spring truck trail and bulldozed a jeep trail from the spring to the deposit. So far as known, no commercial shipments of limestone have been made from this deposit.

Mineral Paint (Ocher)

Small amounts of mineral paint were produced from the Corona area during the period 1897-1910, but no production has been recorded since then (Tucker and Sampson 1945, p. 122, pl. 23). The deposits lie along the northeast margin of the Santa Ana Mountains in a northwest-trending belt extending from Main Street (Gypsum) Canyon to Hagador Canyon. They were developed as early as 1888 (Goodyear 1888, p. 505) and were mined in several operations. The principal activity was in the vicinity of Main Street Canyon.

This mineral paint was used as color pigments and was stated to be of very choice quality. About 20 colors were manufactured by the National Paint and Color Company of Corona (Aubury 1906, p. 339).

The mined material was ocher or ochery earth and apparently was obtained from the soft, fine-grained, reddish shales and yellow, red, and brown to purplish and blackish clays of the Silverado formation. The various colors of these rocks are determined largely by the amount and kind of iron present. According to Santmyers (1929, pp. 2-5) good grades of ocher should contain 20 or more percent iron oxide.

In 1944 the Kaiser Steel Corporation collected 107 samples from the Middlesworth clay deposit, northwest of Main Street Canyon and described elsewhere in this report. These samples yielded an average iron oxide content of 5.11 percent, and the highest iron oxide content was 16.43 percent (Draper, 1944). The results of that sampling indicate the ochery earths in the Corona area are too low in iron oxide to be of present commercial interest as a source of mineral paint.

Rock Products

In the Corona area, the quarrying of rock products is the principal mineral industry both in value and quantity. These products consist of the following categories, some of which are no longer produced: (1) broken and crushed stone used years ago for road base and riprap and currently for riprap; (2) decomposed "granite" used to surface roads; (3) dimension stone, including paving stone, building stone and monument stone; (4) roofing granules, produced by crushing hard intrusive rock; (5) sand and gravel for concrete aggregate; and (6) specialty sands, including sand used in foundries, sandblasting, and glass making. A listing of all rock producing operations in the Corona South quadrangle may be found in the tabulated list.

Broken and Crushed Stone

Broken and crushed stone, in blocks weighing as much as 10 tons, were produced prior to 1927 from the Temescal rock quarry which has also yielded thousands of tons of small (2- to 4-inch) crushed rock for macadamizing streets, and $\frac{1}{32}$- to 3-inch rock used in concrete aggregate. Three quarries, including the Temescal quarry, were opened near the mouth of Temescal Wash between 1888 and 1940; two have been nearly idle for many years, but since 1948 the Temescal quarry has been the source of large tonnages of roofing granules. So far as is known, no crushed coarse road base material has been produced from the Corona South quadrangle since the early 1930's.

In June 1957 production of broken stone was resumed when the new Temescal Canyon rock quarry was opened to supply 200,000 tons of riprap material for a levee along the Santa Ana River west of Riverside. This new quarry may continue as a source of broken rock of various sizes to the construction industry.

Jameson Quarry. Location: SW$\frac{1}{4}$ sec. 29, T. 3 S., R. 6 W., S.B.M., about one mile west of Home Gardens in low hills on the north side of State Highway 18. Ownership: Mrs. Mary C. Jameson, 316 East Olive Street, Corona, California, owns about 55 acres of patented ranch land.

The Jameson quarry was opened some years before 1924, as a small pit was then present. The quarry was idle from 1924 until about 1939 and was operated extensively during 1939-40 by J. B. Stringfellow, Riverside, California. This operation furnished a large tonnage of rubble, riprap, derrick stone, and toe rock, used to face Prado Dam and its abutments, which was constructed across the Santa Ana River narrows 4$\frac{1}{2}$ miles northwest of Corona under direction of the Corps of Engineers, U. S. Army. The property remained idle until about 1950 when Mr. Stringfellow quarried a small tonnage of rubble stone used to face the upstream abutments of the bridge on State Highway 18 across Temescal Creek, east of Corona. Since 1950 the quarry has

FIGURE 24. Jameson quarry, west of Home Gardens. Cretaceous micropegmatite granite has been obtained here intermittently since before the early 1920's, for use as small riprap and rubble. The most extensive operation was during 1939-40 when J. B. Stringfellow Construction Company quarried a large tonnage of riprap used to face Prado Dam. Observer faces east.

been inactive, except for the occasional gathering of small amounts of remaining loose material to be used locally as ornamental stone.

The quarry is in a pink, fine-grained, granular micropegmatite granite which may be approximately related in time to the Home Gardens quartz monzonite porphyry. The micropegmatite 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 and lies mostly in the Corona North quadrangle. In hand specimen, the rock shows a few feldspar crystals in a very fine-grained crystalline mass of feldspar, quartz and minor hornblende. Larsen (1948, pp. 98-99) gives a detailed petrographic description together with a chemical analysis.

The rock occurs as reddish-brown, sheet-like masses and is well jointed so as to break into crude rectangular blocks. This sheet-like character is not shown by the other granitic rocks of the Corona area. The suitability of the rock for facing material is evidenced by the apparent lack of deterioration in the Prado Dam facing during 17 years. Probably little, if any, large riprap material could be developed from this quarry, but it contains a substantial reserve of material for small or medium sized rubble stone.

Rock was quarried on one level from a north-south bench (figure 24) about 200 feet long with the face 10 to 50 feet high, but potential backs are about 80 feet. No equipment remains on the property.

Sidebotham (Phillips) Quarry. Location: W½NW¼; NW¼SW¼ sec. 5, T. 4 S., R. 6 W., S.B.M., about 2 miles southeast of Corona, south of Temescal Wash and east of Compton siding. Ownership: William N. Guth, Chicago, Illinois, owns about 100 acres of patented land in section 5.

The Sidebotham quarry was 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. Local residents report that the quarry was owned by a Mr. Phillips and that the quarrying was done by the Sidebotham Rock Company. The major part of the output probably was used by the Santa Fe Railway Company to repair damage to their track beds caused by overflow of the Colorado River. Some material is said to have been used about 1938 to protect State Highway 18 from the Santa Ana River west of Green River Camp. The property was later acquired by the Staso Milling Company, 332 South Michigan Avenue, Chicago, Illinois, and, although inactive, was retained by them until 1957 when it was acquired by the present owner.

The rock exposed in the quarry area is an equi-granular to somewhat porphyritic, medium-grained granodiorite, a phase of the Corona hornblende granodiorite porphyry which typically contains about 45 percent plagioclase, 15 percent quartz, 10 percent orthoclase and 20 percent fine-grained groundmass with abundant mafic minerals. The rock is dark gray to blue-gray on weathered surfaces and dark greenish-gray on fresh surfaces. The granodiorite is hard, irregularly jointed, and breaks into large, blocky, generally unweathered masses. In thin sections of fresh specimens few microfractures are seen and the only observed alteration was a partial sericitization of the orthoclase. Tests on two samples from the Sidebotham quarry made about 1939 by the District

FIGURE 25. Sidebotham (Phillips) quarry, north pit. Jurassic or Cretaceous granodiorite (Corona hornblende granodiorite porphyry) was quarried here about 1935-39 for use as riprap and track ballast by the Santa Fe Railway Company. Crusher installation foundation remains in right foreground. Observer faces southwest.

Laboratory, Corps of Engineers, U. S. Army, showed the following:

Specific gravity	Absorption	L.A. Rattler, % loss at 500 rpm: Average	Maximum	Minimum
2.70	0.2	12.2	13.2	11.1

The L. A. Rattler test results, as well as the observed physical properties, indicate the granodiorite probably is sufficiently sound for use as riprap on levee slopes. However, the little-fractured nature of the rock may make the cost of quarrying prohibitively high. Substantial reserves are present as the granodiorite crops out over nearly the entire area of the property.

The 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 (figure 25) is about half a mile to the north (NW¼NW¼ sec. 5) and was opened on one level about 350 feet long in a southeast-northwest direction. The face is from 25 to 50 feet high with potential backs of about 120 feet.

No equipment remains, but concrete foundations mark the location of loading facilities. These quarries have been idle since 1939. Future plans of the present owner are unknown, but the proximity of residential areas makes future large-scale operation unlikely.

Temescal Canyon Rock Quarry. Location: SW¼ sec. 33, T. 3 S., R. 6 W.; NW¼ sec. 4, T. 4 S., R. 6 W., S.B.M., 1 mile south of Home Gardens along the east side of Temescal Wash near its northwest end. Ownership: Frank S. Spires, Corona, California, and Wesley Collins, Costa Mesa, California, each own a large acreage. In June 1957 the Temescal Rock Products Company, P. O. Box 364, Corona, California, held about 250 acres in secs. 4 and 33 under lease. Matich Brothers and Sundt Company Contractors, Colton, California, was the operator in September 1957.

The Temescal Canyon Rock quarry was first opened in May 1957 by the Temescal Rock Products Company to supply approximately 267,000 tons of stone for a levee being constructed along the Santa Ana River west of Riverside. The quarried product consists of facing stone, toe stone, and derrick stone in several sizes ranging from 1 pound to 4,500 pounds. This project, the Riverside Levees Flood Control Project, is under construction (September 1957) by the U.S. Army Corps of Engineers, Los Angeles District. After a small initial production, the quarry operation was taken over by the Matich and Sundt Company, in August 1957, who continued to supply stone to the levee project. In the future the Matich and Sundt Company expects to furnish rock, according to specification, to the construction industry. However, in April 1958 the Riverside County Board of Supervisors denied the Matich and Sundt Company's request for a permit to operate the rock quarry. Strong opposition to quarrying operations in the vicinity was registered by residents of the Home Gardens-Corona area.

The operation consists of two quarries, about 1,250 feet apart on the east side of Temescal Wash, in an equigranular to somewhat porphyritic phase of the Corona hornblende granodiorite porphyry, 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. Texture varies from medium-grained granular at the quarries to porphyritic with fine-grained crystalline groundmass elsewhere. The composition is that of a granodiorite and typical specimens contain about 45 percent plagioclase, 15 percent quartz, 10 percent orthoclase, and 20 percent fine-grained groundmass with abundant mafic minerals. Alteration minerals include sericite and chlorite.

In the north quarry is exposed only granodiorite porphyry, but in the south quarry is exposed a small mass, about 300 feet long and 25 to 50 feet wide, of Temescal Wash quartz latite porphyry which is surrounded by granodiorite. Several dikes of decomposed granitic material cut the granodiorite. The dikes are as much as 10 to 15 feet thick, where exposed in the quarry face, and probably are related to the Cretaceous Cajalco quartz monzonite. The quartz latite porphyry is blue-gray on weathered surfaces and dark blue-black on frésh fractures. In hand specimen the porphyry shows abundant phenocrysts of euhedral orthoclase and subhedral plagioclase and quartz, ranging from 1 to 6 millimeters in longest dimension, and smaller phenocrysts of hornblende, biotite, and magnetite. The nature of the groundmass cannot be determined in hand specimen, but microscopic examination shows it to be a mosaic of quartz, orthoclase, plagioclase, hornblende, and magnetite. The hornblende and biotite have partly altered to chlorite, whereas secondary sericite and chlorite occur as inclusions in the orthoclase phenocrysts.

In hand specimen both the granodiorite and quartz latite are hard and dense. Although microfractures are present they are largely confined to the feldspar phenocrysts. Alteration is confined to some sericitization of the orthoclase. In June 1957 the U. S. Army Engineer Division Laboratory, Corps of Engineers, Sausalito, California 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

The microscopic characteristics, together with the L.A. Rattler test, indicate this material is probably suitable for levee slope riprap. Although the rock is very hard and dense within individual blocks, its rather well-defined jointing and content of weathered dikes apparently supply good breakage qualities, and quarrying should be relatively easy. However, the weathered zones at times make blast hole drilling difficult. 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. The potential maximum backs are about 250 feet above the floor of Temescal Wash.

Temescal Rock Products Company had two quarries, one about 1,250 feet north of the other, under development in June 1957. These lie in the SW¼ sec. 33. The rising topography along the east side of Temescal Wash provided a natural slope for the initial quarry face (figure 26) and this face was being steepened by blasting to form a face about 60 feet high. Blast holes were drilled by a Joy rotary-air-blast drill (figure 28), with capacity of 100 feet. The holes were 60 feet deep and arranged in

FIGURE 26. Temescal Canyon rock quarry of Matich and Sundt Company, eastside of Temescal Wash. Granodiorite (Corona hornblende granodiorite porphyry) of Jurassic or Cretaceous age was obtained from north quarry (left foreground) and south quarry (right middle ground) during 1957, for use in facing a levee along the Santa Ana River west of Riverside. Jurassic quartz latite (Temescal Wash quartz latite porphyry) was also obtained from the south quarry. Observer faces southeast.

FIGURE 27. Loading blasted-down rock at north pit of Matich and Sundt Company's Temescal Canyon rock quarry. Vertical blast holes are drilled from above (rock drill and compressor, upper right). Six-wheel dump trucks transport the material to job site or to stockpile area in Temescal Wash where the rock is sized by means of bulldozers and secondary breaking is done with drop balls operated from truck-mounted cranes. Observer faces east.

two rows around the face. The rows were 10 feet apart (10-ft. burden) perpendicular to the quarry face, and the holes were 15 feet distant, parallel to the quarry face. After blasting, some secondary breaking was done with jackhammers (figure 28) and a drop ball operated from a small truck-mounted crane. Two Caterpillar D-8 bulldozers removed waste rock overburden and cleaned up the quarry floor.

Blasted-down rock was loaded into small Autocar cab over end-dump trucks, equipped with 6-yard quarry-type bodies, which transported the material a short distance to an inclined grizzly (figure 29). Material less than 2 inches in smallest dimension dropped through the grizzly and was removed by bulldozer, while the usable rock accumulated in a stockpile at the foot of the grizzly where a No. 109 Northwest power shovel with $2\frac{1}{2}$-cubic-yard dipper bucket loaded the material on trucks for transport to the job site. Rock in the quarry was loaded by another Northwest power shovel, either for direct transport to the job or for the grizzly. A Caterpillar No. 977 Traxcavator skip loader with rock bucket was used to clean up the quarry floor and to load trucks or to stockpile blasted-down rock.

The method of rock handling was somewhat modified when Matich Brothers assumed the quarrying operations. Drilling is done (September 1957) with two rotary air-blast drills. Blasted-down rock is loaded on six-wheel end-dump trucks at the face by Northwest power shovels with $2\frac{1}{2}$ cubic yard dipper buckets (figs. 27, 30). The material is transported by trucks about half a mile to a stockpile area in Temescal Wash. Here the rock is spread out and sized by means of bulldozers and the necessary secondary breaking is done with two truck-mounted cranes with drop balls. Caterpillar No. 977 Traxcavator skip loaders with rock buckets load finished rock on dump trucks for transport to the job site near Riverside.

Decomposed Granite

Two places in the Corona South quadrangle have been mined for "decomposed granite" ("DG"), probably for local use in surfacing unpaved roads. A small quarry was

FIGURE 28. Blast hole drilling with Joy rotary-air-blast drill (top center) and secondary breaking with jackhammer (middle right) at Temescal Canyon rock quarry, north pit. Observer faces northeast.

FIGURE 29. Temescal Canyon rock quarry, south pit. During initial quarry development in June 1957 by the Temescal Rock Products Company blasted-down rock from the quarry (right middle distance) was loaded by power shovels on small dump trucks which transported the rock a short distance to a grizzly (center). Rock under specification size dropped through the grizzly and was removed as waste by bulldozer. Useable rock accumulated in a stockpile (center foreground) at the foot of the grizzly where power shovels loaded the material on trucks for transport to the job site. Observer faces northeast.

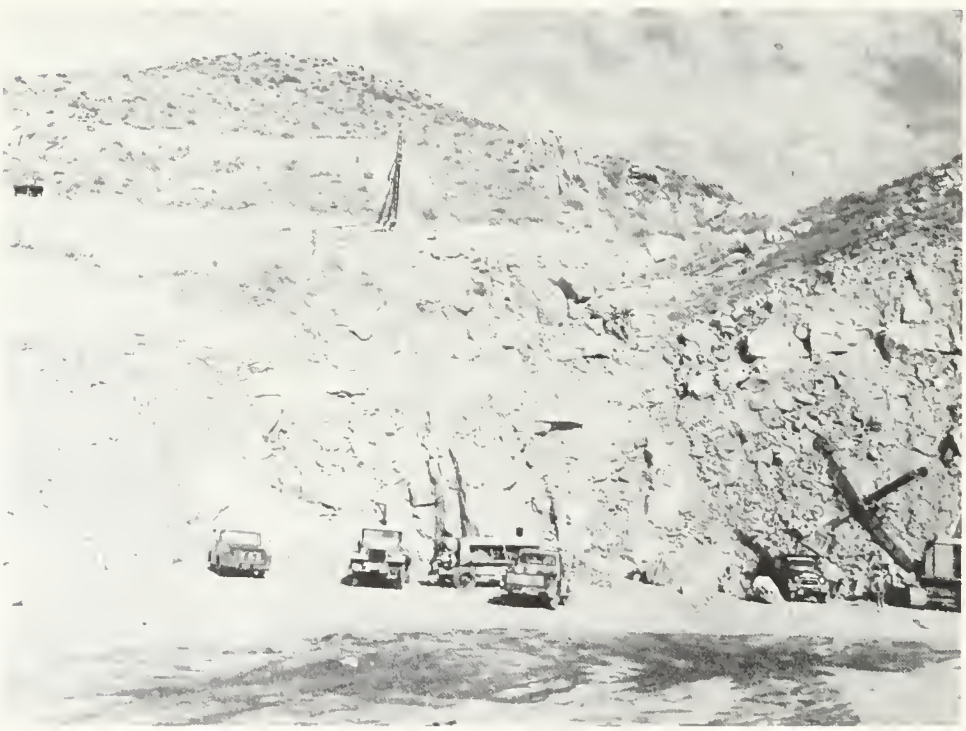

FIGURE 30. Matich and Sundt Company's Temescal Canyon quarry, south pit, September 1957. Most of the rock quarried here is granodiorite but the ravine (right center) contains a small body of quartz latite porphyry. Blast holes are drilled above (center) while blasted-down rock is loaded below (lower right) for transport to sizing area. Observer faces east.

opened years ago in weathered quartz monzonite northeast of El Cerrito Village. During 1956 a few tons of weathered quartz diorite apparently was mined northwest of Anderson Canyon. The total tonnage of decomposed material furnished from the quadrangle has been small.

Dimension Stone

Dimension stone, which includes blocks of natural stone which are generally cut or broken to definite shapes or sizes, was quarried in the Corona region during the first quarter of the twentieth century. Three classes of dimension stone were produced: Belgian paving blocks, monument stone, and building stone. Little or none has been produced since the 1920's.

Most, if not all, of the production came from an area 3 to 4 miles northeast of Corona in secs. 8, 16, and 17, T. 3 S., R. 6 W., S.B.M. (Merrill, 1919, pp. 584-585). This region is several miles north of the Corona South quadrangle and is underlain by a group of plutonic rocks which represent the southern California batholith. A great deal of this material is available, but the fresh unweathered rock is rather inaccessible. However, some of the production, especially the monument stone, may have come from rock quarries in the northeast corner of the Corona South quadrangle.

Several claims for building stone recently have been located in secs. 28 and 33, T. 4 S., R. 7 W., S.B.M. (see tabulated list). These claims are located in platy quartzite, serpentine, and blocky silica-carbonate rock, and apparently remained unworked in 1957.

Roofing Granules

Large tonnages of roofing granules have been produced since 1948 from the Temescal rock quarry. This is by far the largest mining operation in the Corona South quadrangle to date.

Temescal Rock Quarry. Location: S½ sec. 4, T. 4 S., R. 6 W., S.B.M. (projected), on the east side of Temescal Canyon (formerly locally termed Hoag's Canyon), about 4 miles southeast of Corona. Ownership: Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul, Minnesota (P.O. Box 815, Corona, California), owns patented land in secs. 4, 5 and 9, T. 4 S., R. 6 W., S.B.M., totaling about 1,100 acres. R. E. Gundlach is regional manager and G. J. La Venture is plant superintendent.

The Temescal rock quarry was opened about 1888 to furnish rock for macadamizing streets in Los Angeles and nearby towns. According to Goodyear (1888, p. 506) an extensive crushing works with a capacity of about 200 tons of crushed rock per day was being erected in 1888. This site may also be the location of the San Jacinto Tin Mining Corporation's projected "6.5 mile" tunnel which was intended to crosscut the Cajalco tin veins. This tunnel, begun about 1890, was soon abandoned. 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.

By 1914 an inclined tramway had also been installed to load blocks, as much as 10 tons in weight, for riprap and seawall construction. The quarry, whose floor was 180 feet above the bottom of Temescal Canyon, extended along the hillside south of the crushing plant. After blasting, broken rock was loaded with a steam shovel into electric dump cars for rail transport to the nearby primary crusher. Finished products of five size grades were stored in bins, awaiting rail shipment (Merrill, 1919, pp. 586-587).

About 1920 the quarry was purchased by the Blue Diamond Materials Company, Los Angeles, which used the "porphyry" for building aggregate and road metal. Mining was by the tunnel or coyote system and brought down from 600,000 to 1,500,000 tons of rocks in each blast; 45 to 125 tons of powder were used per charge. The production of the crushing plant had been increased to nearly 5,000 tons per day (two shifts) by 1924 and the bench then being quarried was approximately 350 feet high and 1,200 feet long. Crushed rock products in six sizes, ranging from $\frac{1}{32}$-inch to 3-inch, were produced and used mainly for concrete aggregate, particularly in highway and building construction (Allen, 1923, pp. 887-890; Tucker, 1924, p. 45). The Blue Diamond Company continued operation of the quarry until 1927, when the plant was destroyed by fire. Except for small amounts of 3-inch crushed rock, sold occasionally to local aggregate producers for use in special road jobs (personal communication, C. H. Gray, Sr., Dec. 1956), the property remained idle until 1947 when it was reopened by the Minnesota Mining and Manufacturing Company to produce roofing granules. It has been in continuous operation since.

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 and forms rugged, steep cliffs. The rock, which has a fresh appearance, consists of abundant white feldspar and quartz phenocrysts in a gray microcrystalline

FIGURE 31. Minnesota Mining and Manufacturing Company operation in Temescal Canyon. Plant (foreground) includes coloring building and warehouse at left, crushing and screening building (center), and offices at far right. Raw material stockpile behind plant (right middle distance). Primary crusher is at quarry floor level, above stockpile and about 200 feet above plant. After crushing the rock is colored with subvitreous ceramic glazes for use as granules on prepared and built-up roofing. Observer faces southeast. *Photograph courtesy of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.*

Figure 32. Temescal rock quarry of the Minnesota Mining and Manufacturing Company. Jurassic (?) Temescal Wash quartz latite porphyry is blasted down by large-scale coyote-hole blasting methods. At face (right center) Lorain 2½ cubic yard diesel power shovel loading 12-ton Euclid end-dump truck which transports material to primary crusher. Secondary breaking of blasted down rock is done (left center) with crane-mounted drop ball while in left foreground Caterpillar D-8 bulldozer cleans up quarry floor. Observer faces northeast. *Photograph courtesy of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.*

groundmass. The phenocrysts are mainly of plagioclase whereas the groundmass is mainly quartz and orthoclase in about equal amounts. The rock ranges from dacite to quartz latite in composition, an effect of small differences in the feldspar ratio. The rock has good breakage qualities and is very hard. Locally it has often been referred to as "dark porphyry" or hard "trap" rock. Reserves of the "porphyry" are virtually inexhaustible.

The Minnesota Mining and Manufacturing Company became interested in the Temescal quartz latite porphyry

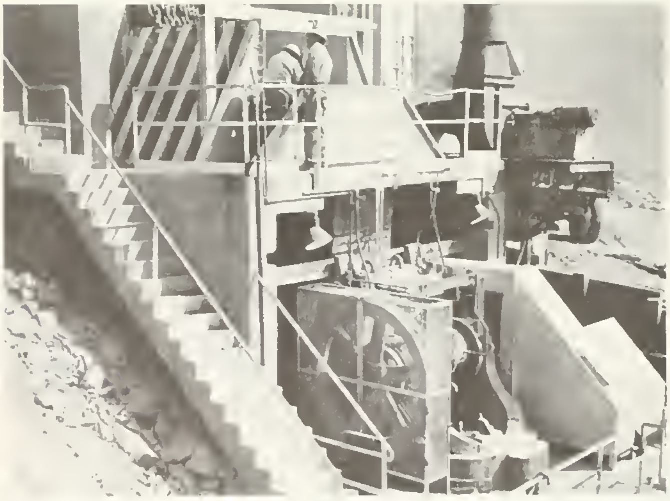

Figure 33. Primary jaw crusher at Temescal rock quarry of Minnesota Mining and Manufacturing Company. The crusher is set at 4 inches and produces rock for the raw material surge pile at a rate of 150 tons per hour. Observer faces southeast toward quarry floor at right. *Photograph courtesy of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.*

as early as 1937. Samples were processed in the company's operating Wausau, Wisconsin, roofing granule manufacturing plant and the resulting granules were subjected to weathering tests under all types of climatic extremes. Five years of such tests proved the rock to be satisfactory and the company then acquired an 800 acre tract along Temescal Canyon. The huge quarry had been idle since 1927, but the previous operator had left 150,000 tons of blasted-down rock at the foot of a steep 400-foot quarry face.

The present operator began a new quarry road in April 1947, and the construction of a steel and concrete plant was completed a year later. The first granules were processed in June 1948. The function of the plant is twofold; first, the material is crushed and screened into sizes suitable for various types of roofing granules and second,

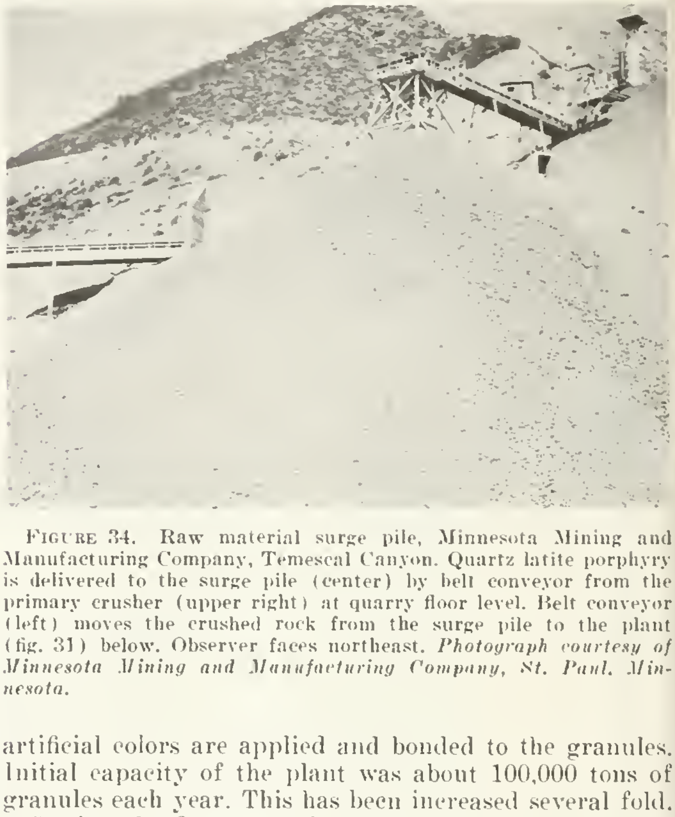

Figure 34. Raw material surge pile, Minnesota Mining and Manufacturing Company, Temescal Canyon. Quartz latite porphyry is delivered to the surge pile (center) by belt conveyor from the primary crusher (upper right) at quarry floor level. Belt conveyor (left) moves the crushed rock from the surge pile to the plant (fig. 31) below. Observer faces northeast. *Photograph courtesy of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.*

artificial colors are applied and bonded to the granules. Initial capacity of the plant was about 100,000 tons of granules each year. This has been increased several fold.

During the first year, the plant operation drew upon the 150,000 tons on the quarry floor. The "coyote-hole" method of blasting has since been used; two shots in 1949 and 1950 brought down 500 and 325 thousand tons respectively in the first step of the process. The existing quarry face is steep and nearly 400 feet high and the company has continued to widen the bench, which is about 1,000 feet long, on that face. In the spring of 1956 the length of the quarry, on the same bench, was extended about 900 feet to the south. This southward quarry extension, however, was only exploratory and the original north part of the quarry continues in 1958 to be the chief source of rock. As quarrying progresses the face probably will be benched or worked on two levels.

After initial blasting, secondary drilling is done with jackhammers to reduce the larger pieces to about 3 feet maximum dimension, or secondary breaking is done by crane-mounted drop ball. A Caterpillar D-8 tractor-bulldozer is used to clean the quarry floor and to aid the operation of a Lorain 2½-cubic-yard diesel shovel and a 2½-cubic-yard Bucyrus Erie electric shovel by means of which four 12-ton Euclid end-dump trucks are loaded (figure 32). The material is trucked a short distance to the primary jaw crusher (figure 33, 34), located at quarry floor level about 200 feet above the processing plant (figure 31). From the primary crusher a belt conveyor takes the material to a surge pile (fig. 34). From there another belt conveyor moves the material to the plant.

Granules are produced in a variety of sizes and a wide range of colors. Pastel shades of red, green, and blue are some of the most popular. The trade term for the colored granules is "ceramic-color stone". 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 in two sizes (¼- to ½-inch; 1½- to 3-inch) and 10 colors are produced for built-up roofing. The granules for built-up roofing are colored at a small plant on East Third Street, Corona, north of the city park (figure 35). Crushed material is delivered by dump truck to the Corona plant from the Temescal Canyon quarry and sizing plant, about 5 miles

FIGURE 35. Roofing granule coloring and sacking operation of Minnesota Mining and Manufacturing Company at Corona. Here crushed and sized rock, delivered by trucks from the Temescal Canyon operation, receives a subvitreous ceramic glaze. From raw material stockpile the rock goes to coloring operation (right) and then to rotary kilns (right center) where the color is bonded to the rock. Finished granules are elevated to storage bins and packaged in paper bags, which are stored on pallets (left) awaiting truck shipment to users. Granules are produced in two sizes and 10 colors for use on built-up roofing. Observer faces northwest.

The rock is crushed in four stages which successively employ the primary jaw crusher; standard cone; short-head cone; and roll crusher. The fines are removed in intermediate stages. The screening system is complex and includes a final rescreening, after glazing, of the finished product to remove tramp oversize and the last traces of fines and dust. The coloring is done in batches; raw granules, plus oxides, chemicals, and other coloring ingredients are proportioned and put through a mixing cycle. After mixing, the particles, now uniformly coated go to a rotary kiln where the pigment is permanently bonded on the granules as a sub-vitreous ceramic-type glaze. The finished granules are stored in steel silos from which they are loaded into box cars. A small proportion of the output is packaged in paper bags.

Careful quality control is maintained by a laboratory inspection of samples taken during various stages. Full provision has been made for elimination and removal of dust. The plant has a daily capacity of more than 500 tons and is the largest of its kind on the Pacific Coast. About 85 persons are employed.

distant. Coloring ingredients are added to the raw granules and the material goes to a rotary kiln where the pigment is bonded on the granules. The finished granules are sacked in paper bags. Two identical kiln circuits are used, one for each of the granule sizes produced.

The products are supplied to roofing manufacturers throughout the west coast region and are shipped to points as far distant as Vancouver, British Columbia. Fine-sized material is also marketed as an impact abrasive.

Reject material from the crushing operations recently has been put to a new by-product use. During 1956, Pacific Clay Products began using small amounts of this reject (—28 mesh) in sewer pipe manufacture at their Los Nietos plant. Gladding, McBean and Company also use this material in the manufacture of sewer pipe at their nearby Corona plant, which was placed in operation in January 1958. This material is reported to improve the shrinkage and drying qualities of the pipe. About 80,000 tons of the reject are produced each year.

FIGURE 36. Corona sand and gravel plant of the Transit Mixed Concrete Company in lower Temescal Wash, east of Corona. This medium-sized plant processes stream bed material from lower Temescal Wash. Observer faces northwest.

Sand and Gravel

Sand and gravel, so far as known, have been produced commercially only in small amounts from the Corona South quadrangle. However, two areas immediately north of the quadrangle have been significant sources.

Sand and gravel was mined during 1939-40 from the lower part of Wardlow Wash in sec. 28, T. 3 S., R. 7 W., S.B.M. (projected), in the southwest corner of the Corona North quadrangle, just south of State Highway 18. This material was used to make hot asphalt and concrete for the construction of the nearby highway in 1939, and also for concrete aggregate used in Prado Dam in 1940. The property has been idle many years. In August 1957 the Torrance Sand and Gravel Products Company, Torrance, California, announced their intention of opening the deposit and constructing a processing plant which was expected to be in operation in 1958. In October 1958, however, the deposit remained inactive.

The Transit Mixed Concrete Company (see tabulated list) operates a medium-sized sand and gravel quarry and plant (figure 36) one mile east of Corona in secs. 29 and 30, T. 3 S., R. 6 W., S.B.M. (projected), at the mouth of Temescal Wash. The plant and most of the mine area are in the Corona North quadrangle but a small part of the mined-out portion of the pit extends across the north edge of the Corona South quadrangle. Their operations include the production of rock, sand, and gravel and the manufacture of regular and lightweight building blocks, pipe, and other concrete products. This property has been in operation for many years and was formerly operated by Kuster and Waterbury.

Two small shallow gravel pits east of the Corona City dump, in sec. 32, T. 3 S., R. 6 W., S.B.M. (projected), were operated on a small scale during 1937-39 by the Corona Rock Company (see tabulated list). These pits are 10 to 15 feet deep and expose a dirty, silty sand with very little rock.

Specialty Sands

Glass Sand

Glass sand was produced from the Corona area as early as 1905 (Aubury, 1906, p. 375). The exact location of the deposit, which was operated by the Corona Pressed Brick Company, is not known, but it probably was either the Nonhof molding sand deposit or one of several "feldspar" deposits along Wardlow Wash.

Silica sand, now entirely used in glass manufacture, has been continuously produced from the Corona sand deposit since the 1920's. The sand is quarried from nearly flat-lying beds of the lower part of the Paleocene Silverado formation which are exposed in only a few places east of Bedford Canyon about 6 miles southeast of Corona.

Logs from several oil wells drilled between Bedford and McBribe Canyons indicate that this sand unit ranges from about 100 to possibly more than 300 feet in thickness, and may underlie at least 2 square miles in that area. It is covered, however, by younger sedimentary units that range in thickness from about 200 to nearly 1,000 feet. The overburden thickens southward. The Silverado sands are probably down-dropped by several vertical faults several thousand feet north of McBribe Canyon, and in some places between these faults and the Elsinore fault the Silverado formation may be completely cut out by faulting.

Considerable bulldozer trenching and some drilling by the Ottawa Silica Company, Box 437, Ottawa, Illinois, in search of new silica sand deposits was done in 1956. This work was confined to an area along the Elsinore fault zone and included both sides of McBribe Canyon which lies between Bedford and Brown Canyons. The drill holes were put down in a narrow fault sliver of Paleocene Silverado formation sandstone northwest of McBribe Canyon and are reported to have encountered useable glass sand (personal communication, R. G. Crosley). Most of the area examined, however, is underlain by grayish-green sands, clayey sands and conglomerates, that probably are upper Eocene to lower Miocene in age and were mapped as the Vaqueros and Sespe formations, undifferentiated. These sands are not the same as those currently being mined for glass sand at the Corona sand deposit and if correctly assigned to the Vaqueros-Sespe, are younger. The exploration work apparently did not encounter a satisfactory reserve of useable glass sand.

In April 1957, the landowners of the Coronita Ranch sand deposit (described elsewhere in this report) which is along the northeast margin of Bedford Wash, put down 10 exploratory drill holes. Several of the holes, at shallow depths, penetrated Silverado formation sandstone similar to that exposed in the Owens-Illinois Glass Company pit which adjoins the property on the east. Other holes bottomed in older alluvium at 90 feet, indicating that the sand deposit is not of uniform thickness and has been channeled and filled with stream debris. During 1958 the Del Monte Properties Company, P. O. Box 150, Pacific Grove, California, did extensive drilling and sampling on the Coronita Ranch. This exploration was not completed at the time of writing (Oct. 1958) but preliminary results indicate a probable commercial glass sand deposit.

Foundry and Sandblasting Sand

Foundry ("molding") sand has been obtained in small quantities from several localities in the Corona South quadrangle. These deposits apparently are in secs. 10 and 11, T. 4 S., R. 7 W., S.B.M., about 4 miles southwest of Corona. The sands are lenses in the Paleocene Silverado formation and were worked intermittently from 1917 to 1924. The material was used in Los Angeles for iron casting, apparently as molding sand. Foundry sand and material for sandblasting formerly were produced, by the Weisel Industrial Sand Company, from the Corona sand deposit now operated for glass sand by the Owens-Illinois Glass Company.

Corona Silica Sand Deposit (Owens-Illinois Glass Company, P. J. Weisel Industrial Sand Company). Location: NE¼ sec. 21; SE¼ sec. 16, T. 4 S., R. 6 W., S.B.M., 6 road miles southeast of Corona on State Highway 71. Ownership: Louis A. Weisel, et al., La Habra, California, 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, California (P.O. Box 298, Corona, California), holds under lease about 140 acres in secs. 16 and 21. P. J. Oertel is plant manager.

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, which lies athwart State Highway 71 in Temescal Valley, was opened and developed in the early 1920's by the P. J. Weisel Industrial Sand Company. The plant was operated by this company until 1945 when it and the deposit were taken over by 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.

The sand is obtained from a quartz-rich facies of the Paleocene Silverado formation. The deposit consists of gently dipping, thinly bedded and locally cross-bedded white sandstone. Where exposed in the active pit (1957) west of the highway and in the old quarry face east of the highway, the usable sandstone is about 120 feet thick; but well data (figure 45) indicate it may be nearly 300 feet thick a short distance west of the present pit. 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 weakly cemented by clay and contains lenses of gray or grayish-green silt and sandy clay. Along the northwest margin of the pit west of the highway, the intercalated sandy clay beds strike N. 40° to 50° W. and dip 8° to 10° to the southwest.

The sandstone is coarse-grained to pebbly. The sand size particles are almost wholly angular to subangular quartz grains, and the pebbles, which are rounded, are of quartz and feldspar. The sandstone contains abundant pearly gray flakes of anauxite and black to greenish black or grayish-green mica (biotite and muscovite) which commonly give the sand a distinctive schistose appearance. Minerals present in minor proportions include, in order of decreasing abundance: feldspar, magnetite-ilmenite, epidote, zircon, tourmaline, and hornblende. 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 ½-inch).

A marked increase in the clay-sand ratio occurs below the usable sandstone at a depth of about 120 feet in the pit west of the highway; this apparently marks the lower limit of glass sand. Stripping of the upper part of the deposit in the north extension of the pit has shown the presence of lenses and pods of micaceous silt and sandy clay in a greater ratio than in the south part, thus requiring the selective removal of considerable waste material. Drilling in the pit area west of the highway has penetrated clay beneath the anauxite-bearing glass sand (Stauffer, 1946, map), and water wells on the property bottomed in feldspathic biotite diorite at 100 feet (well no. 1, plate 1) and biotite quartz monzonite at 325 feet (well no. 2, plate 1).

The Corona silica sand deposit is an unusual quartz-rich facies in the lower part of the Paleocene Silverado formation and is apparently nonmarine. Deposits of silica sand and clay occur elsewhere in the Silverado formation 10 to 15 miles to the south, southwest along the southwestern flank of the Santa Ana Mountains, mainly near Trabuco Canyon, Orange County, but are not altogether comparable in composition with the Corona deposit. None of the Silverado sandstone exposed elsewhere in the Corona area appears to correlate precisely in composition with the Corona deposit, but the arkosic sandstone which overlies the sedimentary clay zone in many of the clay pits probably correlates stratigraphically with the Corona deposit.

The property was first developed in the early 1920's by means of a quarry in sec. 16, T. 4 S., R. 6 W., S.B.M., on the east side of Highway 71. By 1928 a washing and screening plant, on the east side of the highway and of 50 tons daily capacity, was in operation. Material mined from quarries and open pits east of the highway was delivered to the plant by dragline scrapers. The products included glass sand, foundry sand and sandblasting sand. Ten men were employed (Tucker and Sampson, 1929, p. 504). By 1944, the principal quarry was 600

FIGURE 37. Glass sand processing plant of Owens-Illinois Glass Company at Corona. Raw material is obtained from gently dipping sandstone of the Paleocene Silverado formation (exposed in pit, center). Sand from surge pile is moved by conveyor belt (left) across State Highway 71 to the plant (left center) where it is processed for use as glass sand. Processed sand is conveyed to storage bins (right center) from which the sand is loaded into railroad cars or trucks for transport to glass manufacturing plants. Offices and laboratories are housed in quonset type building (center). Observer faces northeast. *Photograph by Thomas E. Gay, Jr.*

FIGURE 38. Gently dipping sandstone (Paleocene Silverado formation) exposed in pits at the Corona silica sand mine of Owens-Illinois Glass Company. Carryall scrapers transport raw sand to crusher at base of inclined conveyor (right middle distance) which supplies raw surge pile (center middle distance). A second inclined conveyor (left middle distance) conveys the sand across State Highway 71 to processing plant. Inactive pit east of highway is at left of plant, active pit (1958), which has been greatly enlarged since this photo was taken in 1956, occupies the foreground and behind conveyor at right is the largest pit, inactive since 1957. Observer faces southeast, view along the Corona-Elsinore trough. Santa Ana Mountains at right, Gavilan Hills at left. *Photograph by Thomas E. Gay, Jr.*

feet long and 600 feet wide and about 120 feet deep. Sand was blasted from the face and moved by dragline to the plant where it was screened, classified, washed, crushed, dried and passed over a magnetic separator. About 3,000 tons of material per month were produced and shipped via rail to various users for sandblasting, glass sand, and stucco plaster (Tucker and Sampson, 1945, pp. 163-164). Daily output was from 100 to 150 tons of sand which averaged about 93 percent SiO_2, 4+ percent Al_2O_3 and 3 percent alkalies with Fe_2O_3 content about 0.10 percent (Valentine, 1947, p. 1).

In the late 1940's the quarry east of the highway was abandoned and open pit operations were started in sec. 21, just west of the highway and across the road from the plant. In 1956 this quarry 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. During 1956, overburden was stripped from a large area adjoining the north edge of the pit and in early 1957 all mining was in this north extension of the pit (fig. 39).

In 1947, the Owens-Illinois Glass Company erected a modern sand treatment plant (fig. 37), which was placed in operation in January 1948. 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.

In the pit, both stripping of overburden and mining are done with rippers and bulldozers (fig. 38). Carryalls, drawn by Caterpillar tractors, scrape up the loosened raw materials. They haul overburden to waste dumps and crude sand to a dumping hopper over the crusher pit. The crusher disintegrates the material, but does not crush the pebbles. From the crusher a belt conveyor takes the material to a raw storage pile.

From raw storage piles, the material is moved up a long belt conveyor which crosses the highway to surge bins at the mill. From there the feed is divided and directed into twin circuits in the mill where it is scrubbed, ground, and classified by size. After classification loose fines are piped as a slurry to thickeners from which the underflow (reject material) is transferred to waste ponds. About 20 to 25 percent of the raw ore is rejected at this first classification. Classified material is then scrubbed by attrition scrubbers to remove coatings of clay and iron oxide from the quartz grains which are then washed and screened into plus and minus 30-mesh fractions. Minus 30-mesh material is classified to remove fines which go to a thickener. The overflow from the thickener and the rake product from the classifier are transferred to the "amber" sand drain bins. Plus 30-mesh material from the screens is ground and classified to remove fines which go to a thickener. The rake and thickener products are screened into plus and minus 40-mesh fractions. Plus 40-mesh material is reground and classified in closed circuit; minus 40-mesh is dewatered in a Dorr classifier from which the sand goes to "flint" sand drain bins and water is reclaimed for reuse in the mill.

The clay and other fines are removed and sand of the required size and purity is prepared by the above outlined process of grinding and classifying which rejects about 45 percent of the pit run material. The sand is drained for several hours after which the relatively dry top part is pulled from the bins onto a conveyor by a reclaiming digging ladder and the material goes to driers. After drying the sand then passes over Dings magnetic Hi-intensity separators that remove magnetic impurities such as mica (biotite and muscovite), magnetite, ilmenite, epidote, zircon, tourmaline, and hornblende. Magnetic products, which comprise about 3 to 4 percent of the dry processed sand, go to waste piles and the finished sand to storage bins. Hopper bottom railroad cars and trucks are loaded directly from the storage bins and transport the sand to market.

Two grades of sand are produced: "flint" sand which is used to make colorless glass, and "amber" sand which is used in the manufacture of amber- and green-colored glass containers. The composition of the flint sand is as follows:

SiO_2	94.5% to 96.0%
Al_2O_3	2.5% to 3.5%
K_2O, Na_2O, etc.	1.8% to 2.3%
Fe_2O_3	.03% to .035%

FIGURE 39. Owens-Illinois Glass Company's glass sand operation in the Corona-Elsinore trough, southeast of Corona. Inactive original pit east of highway is at left, present (1958) active pit at center and top of plant barely visible beyond. Pits are opened in Paleocene Silverado formation sandstone which is overlain by a thin covering of terrace deposits on the flat-topped ridges at both left and right. Observer faces southeast.

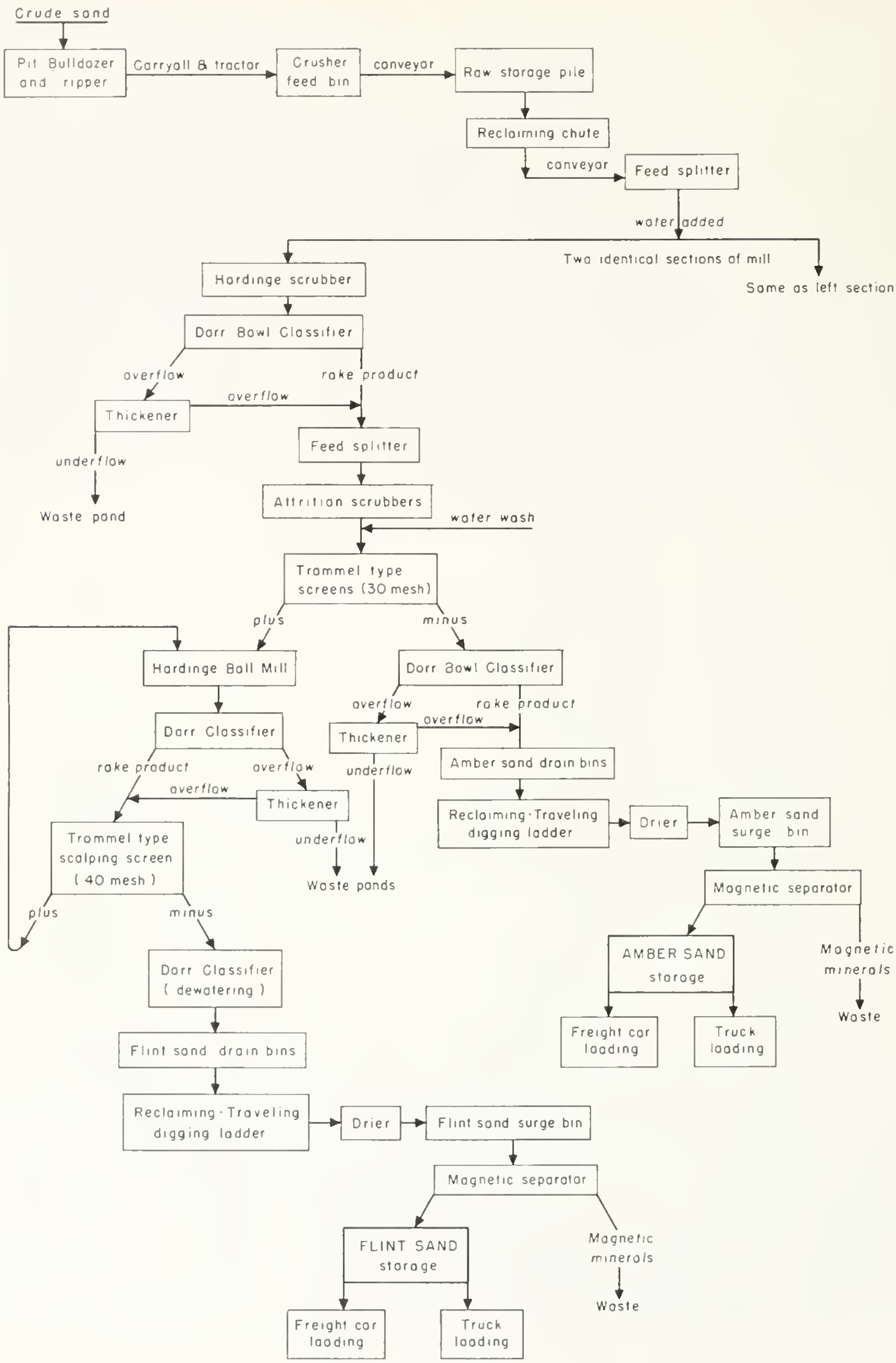

FIGURE 40. Generalized flow sheet of Owens-Illinois Glass Company sand treatment plant, Corona, Riverside County.

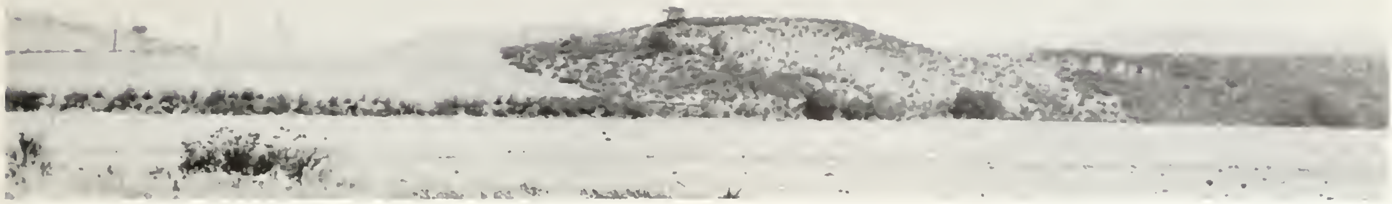

FIGURE 41. Coronita Ranch sand deposit. Flat-topped hills covered with terrace gravels are underlain by sandstone of the Paleocene Silverado formation. Corona silica sand mine is beyond low hill at left. Low areas in left and right middle distance are covered with older alluvium. Lower Bedford Wash (foreground) is covered with alluvium. Observer faces southeast.

The composition of amber sand differs from that of flint sand only in that the iron content is higher and totals from 0.04 to 0.06 percent.

Initial capacity of the plant in 1948 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. Since 1950, more than 100,000 tons of finished sand have been shipped each year to the Los Angeles area.

The waste pond material contains a large proportion of clay of which a portion is used, after settling, as a constituent in the manufacture of common clay products. Since 1956 the Jordan Tile Company of Corona has used some of this material in the manufacture of red-burning quarry tile, and Hancock Brick Company, Highgrove, also uses small amounts. Since about 1948, the Liston Brick Company located half a mile north of the Owens-Illinois operation, has used small amounts of the stripped waste clay materials in the manufacture of common clay products.

The deposit appears to contain easily accessible reserves sufficient for many years of operation at current consumption rates. Vast additional reserves, although unproven, are indicated by geologic evidence to exist northwest, west and south of the present pit. However, overburden in this area may prove too thick for economic mining operations.

Coronita Ranch Sand Deposit. Location: SW$\frac{1}{4}$ sec. 16, E$\frac{1}{2}$SE$\frac{1}{4}$ sec. 17, T. 4 S., R. 6 W., S.B.M. along the east margin of lower Bedford Wash a quarter of a mile west of State Highway 71 and 6$\frac{1}{2}$ road miles southeast of Corona. Ownership: Joel D. Middleton, 9531 Heather Road, Beverly Hills, California, and Donald C. McMillan, 8704 Colima Road, Whittier, California, own 240 acres of patented ranch land.

The Coronita Ranch sand deposit (fig. 41) 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 furnished a steady supply of specialty sand for many years. On this property the Silverado sandstone crops out in one small exposure on the east bluff of Bedford Wash. Here it strikes N. 45° W. and dips 8° to 10° SW. The accompanying geologic map (pl. 1) shows the remainder of the property is covered mostly by older alluvium (Qalo) and alluvium (Qal) but one small hill is capped by terrace deposits (Qt). Low hills, which rise along the south margin of the property east of Bedford Wash, are underlain by the Sespe and Vaqueros formations, undifferentiated (Tvs).

This property was first explored for glass sand in April 1957, when 10 drill holes (fig. 42) were put down in the SW$\frac{1}{4}$ sec. 16 along the southeast margin of and east of Bedford Wash. The investigation was carried out under the direction of Mr. Meredith C. Brown who kindly furnished the drill logs (fig. 43) and results of laboratory work (fig. 44). Samples were tested in the laboratories of Pacific Clay Products by Mr. Jack Kilgore, chemist. Early in 1958 the property was taken under option by the Del Monte Properties Company, P. O. Box 150, Pacific Grove, California. This company 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.

The alluvial overburden ranges from 2 feet along the east edge of Bedford Wash to more than 90 feet in the east part of the property along the old county road. Five drill holes, ranging from 26 to 90 feet in depth, encountered overburden only which is shown as older alluvium on the geologic map (pl. 1). This area of thick overburden trends north-northeast and separates the two areas of thinner overburden, one on the Coronita Ranch property and the other on the adjoining Corona property. Apparently much or all of the Silverado sandstone

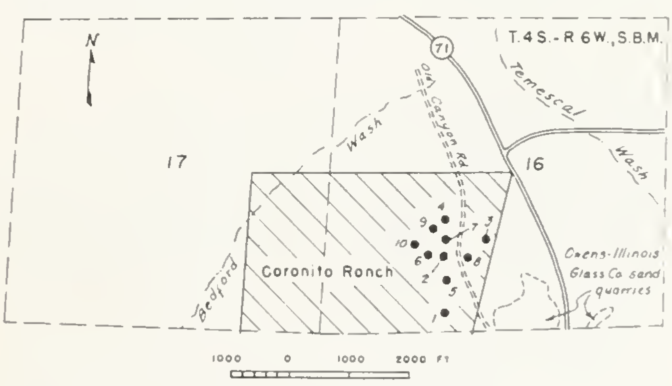

FIGURE 42. Sketch map showing location of drill holes on Coronita Ranch sand deposit.

Drill hole no. (fig. 42)	Spl. interval depth (feet)	Sample description
1	0–33.2	Rock & gravel. Rock to 6" dia.
	33.2–38.0	Sd & gravel with sticky cl bond.
	38.0–70.0	Fine sd, cl & silt with occasional rocks. Interpretation: 0-70, older alluvium.
2	0–28.0	Overburden. Rock & gravel.
	28.0–32.0	Cs ss. Light yellow cl bond.
	32.0–38.8	Med gr ss turning from cream to white.
	38.8–40.8	Cs gr ss white.
	40.8–49.2	Fine gr ss much mica present.
	49.2–53.0	Coarser gr ss with greenish cl streaks.
	53.0–55.8	Fine grading to cs ss.
	55.8–62.0	Cs gr white ss.
	62.0–66.2	Fine gr ss much black mica.
	66.2–75.0	Cs ss much quartz. Less mica.
	75.0–81.0	Med gr ss much mica.
	81.0–88.0	Cs white ss very clean.
	88.0–90.0	As above. Slight increase in mica. Interpretation: 0-28, older alluvium; 28-90, Silverado fm.
3	0–26.0	Overburden. Rock & gravel. Abandoned. Rocks too large. Interpretation: 0-26, older alluvium.
4	0–69.0	Overburden. Sd, gravel, silt, & cl. Abandoned. Interpretation: 0-69, older alluvium.
5	0–43.0	Overburden. Heavy rock & gravel. Abandoned. Interpretation: 0-43, older alluvium.
6	0–24.5	Overburden. Rock & gravel.
	24.5–38.0	Fine gr ss, yellow to green. Some mica.
	38.0–42.5	Micaceous ab.
	42.5–47.3	Med gr ss, atreaks of hard gray cl.
	47.3–57.0	Fine gr ss. Mica decreasing.
	57.0–68.0	Cs gr ss, pink & white.
	68.0–82.0	Fine gr ss, gray & green. Much mica.
	82.0–90.0	Cs gr ss, tan & white. Less mica. Interpretation: 0-24.5, older alluvium; 24.5-90, Silverado fm.
7	0–42.0	Overburden. Rock & gravel.
	42.0–44.0	Cs ss, tan iron stained.
	44.0–69.0	Cs white ss.
	69.0–72.0	Fine yellow sd. Much mica.
	72.0–76.0	Cs white ss.
	76.0–78.0	Cs white ss with streaks of hard gray cl.
	78.0–90.0	Cs white ss. Interpretation: 0-42, older alluvium; 42-90, Silverado fm.
8	0–90.0	Overburden. Abandoned because of overburden depth. Interpretation: 0-90, older alluvium.
9	0– 2.0	Overburden, sd & gravel.
	2.0–28.0	Cs cream & white ss.
	28.0–34.5	Cs gray ss. Alternate beds of mica in streaks.
	34.5–41.8	Cs white ss some mica in streaks.
	41.8–47.0	Cs white ss little mica.
	47.0–52.5	Med gr ss much mica.
	52.5–55.0	Heavy black mica. Looks like lignite.
	55.0–90.0	Cs white & gray ss very little mica. Interpretation: 0-2, alluvium; 2-90, Silverado fm.
10	0– 8.0	Overburden. Sd & rock.
	8.0–15.0	Med gr cream colored ss.
	15.0–80.0	Alternate cs & med gr ss. Interpretation: 0-8, alluvium; 8-80, Silverado fm.

FIGURE 43. Logs of drill holes, Coronita Ranch sand deposit. *Courtesy Meridith C. Brown; interpretation added by C. H. Gray.*

Drill hole no. (fig. 42)	Spl interval depth (feet)	Total recovery (%)	+4 mesh (%)	−4+30 mesh (%)	−30+150 mesh (%)	Natural −4+30 mesh		Natural −30+150 mesh	
						Fe_2O_3 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	Al_2O_3 (%)
2	32.0-40.8	75.6	3.4	52.7	43.9	.031	5.72	.090	4.76
	40.8-49.2	68.5	1.9	27.6	70.5	.031	5.32	.142	8.01
	49.2-90.0	78.4	3.0	51.3	45.7	.024	4.83	.115	5.28
6	45.0-57.0	75.4	1.7	33.4	64.9	.044	5.41	.058	5.84
	57.0-68.0	79.5	4.3	52.9	42.8	.025	4.97	.730	8.97
	68.0-82.0	67.4	0.6	18.7	80.7	.043	7.33	.074	8.86
	82.0-90.0	77.1	1.8	48.8	49.4	.035	4.81	.119	5.93
7	44.0-90.0	79.0	3.7	53.9	42.4	.029	5.32	.032	4.92
9	2.0-52.5	80.9	3.6	57.1	39.3	.025	5.37	.030	4.47
	52.5-90.0	81.9	3.8	58.7	37.5	.026	4.77	.039	3.86
10	8.0-80.0	76.2	2.1	45.3	52.6	.029	4.17	.036	4.91
Average		76.4	2.7	45.5	51.8	.031	5.27	.133	5.98
Outcrop, east edge Bedford Wash		72.7	0.7	41.8	57.5	.039	5.86	.086	12.16

Preparation and analysis of samples: samples were split and blended; +4 mesh was removed. −4 mesh was scrubbed clean in a Fagergren laboratory cell and the clay removed by decantation. This was dried and weighted (indicated in Total Recovery column). Sample was then screened into two fractions (−4 +30 mesh, −30 +150 mesh columns). The −4 +30 mesh was ground to −30 +150 mesh. Mica was removed from this sample and the natural −30 +150 mesh material by electrostatic separation, followed by magnetic separation for removal of the iron-bearing minerals. Standard methods of analysis used by the glass industry were employed. (Data courtesy of Meredith C. Brown).

FIGURE 44. Analyses of drill hole samples, Coronita Ranch sand deposit. *Analyses by Jack Kilgore, Pacific Clay Products, May 1957.*

was removed by erosion from a rather narrow watercourse, which was later filled with alluvial debris. Medium- to coarse-grained Silverado sandstone, siltstone, and sandy clay with abundant greenish-gray mica was encountered in 5 drill holes, all of which bottomed in this formation at 90 feet. Overburden ranged from 2 to 24 feet.

Beneficiation tests and analyses of samples indicate that the Coronita Ranch sand deposit is probably of glass grade (Brown, 1957). The iron oxide content of beneficiated material is low, the deposit is favorably located in regard to transportation and is adjacent to an operating glass sand plant. The sand was not bottomed in any of the drill holes which penetrated sand indicating that substantial reserves are probably present. However, additional drilling and sampling would be necessary to give a meaningful estimate of the potential of this deposit.

Jones (Hoag Ranch) Sand Deposit. Location: SW¼ sec. 17, T. 4 S., R. 6 W., S.B.M. between Bedford and Joseph Canyons about 4 miles southeast of Corona. Ownership: Riverside Cement Company Division of the American Cement Corporation, Post Office Box 832, Riverside, California, owns 80 acres of patented ranch land.

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 has been 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.

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 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. As glass manufacturers usually require sands with the iron content less than 0.04 and rarely permit over 0.06 percent, the Jones sand probably would require beneficiation to reduce the iron content. A more detailed study of the quartz-feldspar ratio and much more sampling together with chemical analyses would be required to evaluate this deposit as a potential source of glass sand.

The property had been idle for many years, and only the remains of a small wooden loading bin and an open cut marked the location in 1956. In September 1958 the Riverside Cement Company, Division of the American Cement Corporation, P. O. Box 832, Riverside, California, held the property under option and did extensive drilling and sampling. At the time of writing (October 1958) the drilling had not been completed but preliminary information indicated substantial reserves of white sand, probably suitable for use in the manufacture of white portland cement. In December 1958 Riverside Cement Company announced their intention of constructing a white cement manufacturing plant adjacent to the existing Crestmore plant in West Riverside.

Temescal Canyon Silica Sand Deposit. Location: NE¼ sec. 29, T. 4 S., R. 6 W., S.B.M., 5 miles southeast of Corona southeast of Bedford Motorway and north of McBribe Canyon. Ownership: Arthur E. Garratt, 3340 Eastern Avenue, Los Angeles 32, California, owns sec. 29, formerly railroad land.

Coarse, weakly indurated, white arkose of probable upper Eocene to lower Miocene age (undifferentiated Vaqueros and Sespe formations on accompanying map) 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. The Vaqueros and Sespe sandstones in the Temescal Canyon deposit area were prospected years ago by means of several shallow pits from which a small production may have been obtained. Sampson and Tucker (1931, p. 444) give the following analysis for material which presumably came from the prospect pit designated as No. 58 on plate 1:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ign. Loss	Moisture
73.74%	12.77%	1.03%	5.25%	3.04%	0.87%	1.22%

Early in 1956 the Ottawa Silica Company, Box 437, Ottawa, Illinois, took the property under option and explored in this area and also in the W½ sec. 28 where sandstone, silt and sandy clay of the undifferentiated Vaqueros and Sespe formations crop out along McBribe Canyon. Eight 18-inch diameter drill holes, made with a cesspool digger, were put down in the Silverado formation in the NE¼ sec. 29 while the remainder of the area was explored by numerous bulldozer cuts and trenches. Samples, taken at 2-foot intervals from the drill holes and selectively from the open cuts, were tested in the company's laboratory. None of the testing data is available, but the Silverado sandstone in sec. 29 is reported to be suitable for use as glass sand, whereas the Vaqueros and Sespe sandstone in sec. 28 is not (personal communication, R. G. Crosley).

WATER RESOURCES (GROUND WATER)

Water is perhaps the most sought-after and important natural resource in the Corona area. The town of Corona and surrounding citrus groves lie in the Temescal ground water basin which has been described in some detail by Eckis (1934, pp. 178-181, plates C & D) from whom the following has been largely abstracted. This basin has a surface area of approximately 16,200 acres and is bounded by the Santa Ana River on the north; the Chino and Elsinore fault zones on the southwest; El Cerrito Hills on the southeast; and the granitic hills of the Perris Block form an irregular northeast margin. Other small alluvial basins lie to the southeast along the Corona-Elsinore trough.

No. on plate 1	Operator	Well	Location S.B.B.&M. T.	R.	Sec.	Date begun	Total depth (feet)	Geology and remarks
1	Owens-Illinois Glass Company	(water well)	4S	6W	16	1947	100	100′ of Silverado fm. ss and clay. Bottomed in feldspathic biotite diorite at 100′.
2	Owens-Illinois Glass Company	(water well)	4S	6W	21	1947	325	325′ of Silverado fm. ss and clay, clay zone beneath ss; bottomed in biotite qtz. monzonite at 325′.
3	Orangethorpe Oil Co.	Orangethorpe 1	4S	6W	28	1-49	625	Spud in Qal. Reported to have encountered oil at depth of 625′ in poorly consolidated, coarse, ss and cbl cg. Pumped 2½ B/D 14.5 gr. oil.
	redrilled by: Johnson, C. H. (Fife Bros.)	redrilled as: Heinlein				5-50	678	Deepened to 678′; 5 B/D 90.0 cut. Pumped off 5/13/50. Abandoned 1951.
4	Frontier Petroleum Company	Barger 1	4S	6W	28	1-50	1,060	Spud in Qal; drillers log indicates probably in Vaqueros and Sespe fms., undifferentiated, ss and cg to 840′; 14′ red clay; 207′ of white, coarse, silica sd (prob. Silverado fm). Bottomed in white silica sd at 1,060′. Abandoned 2/4/50.
5	Frontier Petroleum Company or Max N. Hammerling (?)	(Undetermined)	4S	6W	21	1950	720(?)	Spud in Vaqueros and Sespe fms., undifferentiated; reported by local residents to have penetrated "granite" at 680′ and bottomed in "granite" at 720′.
6	Max N. Hammerling	M.N.H. 1	4S	6W	21	11-51	830	Spud in Vaqueros and Sespe fms. undifferentiated; drilling in sd and sh at 396′; non-commercial gas and oil shows reported; top of "granite" 763′; deepened to 830′ and converted to water well 3/3/52.
7	V.O.D. Oil Co., Inc. (Brownson Drlg. Co.)	Berghofer 1	4S	6W	29	11-50	1,823	Spud in Qt; cbl cg or breccia w/gray sandy matrix at 1,020′; gray sd at 1,064′; reported to have bottomed in sedimentary rocks at 1,640′. Converted to water well 9/15/51. Deepened to 1,823′, 1953. Abandoned 1953.
8	Kenneth E. Reed	Kincheloe 1	4S	6W	17	1-50	609	Spud in Qalo; cored, no showings; suspended 3/3/50. Converted to water well.
9	Mankin, Johnson and Johnson (Frontier Petroleum Co.)	Case 1	4S	6W	34	2-50	2,000±(?)	Spud in Qalo; total depth reported as 865′ 2/25/50, may have reached approx. 2,000′; show of o land gas reported. Abandoned 2/17/50.
10	Elkhorn Petroleum Co.	Heinlein 1	4S	6W	28	4-49	994	Spud in Qal. Abandoned 5/2/49.
11	Palm, Peter	Peter Palm 1	4S	6W	28	6-50	825	Spud in Qal. Reported to have bottomed in ss and sh. Abandoned 1950.
12	H. & W. Associates	Marie Boyd 1	4S	6W	28	12-53	905	Spud. in Qt; oil showing reported at 310′, gas showings from 535′-545′; sd and sh at 885′; sidewall samples taken; hole caved, idle, 4/10/54; suspended 5/18/54.
13	Notterman, Nick L.	Notterman 1	4S	6W	28	5-56	851	Spud in Vaqueros and Sespe formations, undifferentiated. Apparently bottomed in greenish gray clayey sand or silt. Idle 7/21/56.
14	Croft, G. S. G.; Ingram, Alice Terry; Reiter, Ellis D; (Ciroco Oil Co.)	Ciroco-Wright 1	4S	7W	33	11-51	1,525	Spud in Qt; entered reddish sd and cg at shallow depth. Abandoned 12/5/51.
	redrilled by: Fairmont Oil Co.	redrilled as: Wright 1				8-54	1,597	Fairmont began deepening from 1,516′, 8/28/54; taken over by Pethyridge and Erlich at 1,597′.
	Pethyridge, Frank; Erlich, Lou W.					9-54	4,027	Ditch Spl. 2,465′, Mohnian forams; Core 2,587′-2,591′, pbl to cbl cg; core 2,900′±, oil sd, had fair odor and cut; core 2,936′-2,947′, pebbly, poorly sorted white sd, with greenish cast, large green biotite flakes, white clayey matrix, some brown colored sd, gives dark brown cut; core 2,954′-2,960′ cs gr pbl cg, white clayey matrix, no oil staining; core 3,370′-3,375′, dark gray micaceous siltstone w/streaks lt. col. sd, sparse megafauna, forams recovered reported to be Eocene (Laiming B zone). Interpretation: 0-2100′, Pliocene and Puente fm., undifferentiated; 2,100′-2,550′, Puente fm. silt; 2,550′-3,200′, Vaqueros and Sespe fms., undifferentiated; 3,200′-4,027′, Eocene, Laiming B zone; Bottomed in Eocene. Abandoned.
15	(Undetermined)	(Undetermined)	4S	6W	8	1930 (?)	1,550 (?)	Well approx. located. Spud in Topanga fm., reported black, sh at 980′; may have bottomed in hard ss at 1,550′ and be entirely in Miocene rocks. However, last 580′ drilled could be basement; black sh at 980′ might be base of Silverado fm.; Prob. drilled about 1930.

No. on plate 1	Operator	Well	Location S.B.B.&M. T.	R.	Sec.	Date begun	Total depth (feet)	Geology and remarks
	Trabuca Oil Co.	Trabuca Oil Co. 1	4S	6W	28	5-25	4,500 (?)	Exact location not available. Local residents report at least one of these wells was in Brown Canyon near Orangethorpe 1 (No. 3 on plate 1), abondoned 1931. In relation to records for other wells in this area these depths are greatly in excess of the known thickness of Tertiary sedimentary rocks.
	Trabuca Oil Co.	Trabuca Oil Co. 1-A	4S	6W	28(?)	1925 (?)	4,490 (?)	
16	Charles Cather and Kenneth Sperry CA-SP No. 2	Union-Wright No. 1	4S From SE Cor. Sec. 33, 2,100′N, 900′W. Elev. 791′KB	7W	33	12 24 59	3,505	Well record: Spud in Silverado fm.; 0-1,800′ Eocene & or older; 1,800′ top Cretaceous; 2,450′ top fault zone; 2,550′ top lower Mohnian; 2,630′ top middle Miocene; 3,050′ top middle Eocene; 3,325′ top lower Eocene; lower Eocene or Paleocene at T.D. Directional hole, bottom hole location north 212′, east 15′. At bottom ran: E-log, continuous dipmeter, sidewall gun. Dipmeter at 2,750′ S89W, 17°. Interpretation: 0-1,800′, Silverado fm.; 1,800′-2,450′, Ladd fm. undifferentiated; 2,450′-2,630′, Puente fm. undifferentiated & or Pliocene, undifferentiated; 2,630′-3,050′, Vaqueros and Sespe fms., undifferentiated (?); 3,050′-3,505′, Eocene (Santiago fm.?), lower part (3,325′-3,505′) may be Silverado fm. Abandoned 1 14 60.

FIGURE 45. Summary of records of wells drilled in Corona South quadrangle, compiled from Division of Mines Special Report 45 (Jennings and Hart 1956, pp. 63-64), scout reports, unpublished driller's logs and private reports, and observation by the writer.

The Temescal basin is connected by alluvial fill with the Arlington basin to the northeast and the Chino basin to the northwest. The depth of the Temescal basin is not known accurately but the maximum depth of the water-bearing alluvial series in most places may be from 300 to 400 feet. The basin is apparently an alluvium-filled trough sloping to the northwest into the deeper part of Upper Santa Ana Valley.

Probably the major source of groundwater is percolation of run-off from Santa Ana Mountains streams and from Temescal Wash. Rainfall penetration, return irrigation water imported from upper basins, and underflow from Arlington basin all contribute to the supply.

In the foothills of the Santa Ana Mountains, southwest of the margin of the Temescal basin as delineated by the Chino and Elsinore fault zones, wells have been drilled in the upper parts of most of the major canyons. In general these wells have met with little success as the alluvial material that could contain water is very shallow and of limited areal extent. The wells that have been moderately successful have almost surely penetrated faults or fracture zones in the underlying volcanic, metamorphic, or older sedimentary rocks. Numerous natural springs are found along the trace of the Elsinore fault but commonly produce only a small trickle of water during the winter to early summer seasons. However, some have been developed to provide a small supply of water throughout the year. At several places, especially on the west edge of Bedford Canyon and between Brown and Bixby Canyons, large tunnels have been driven into fault zones in search of water. Flows of 10 to 20 gallons per minute are locally obtained where fracture zones are penetrated in tunnels. However, the stored water generally drains out in a short time and, without rainfall penetration recharge, the flows usually drop to small fractions of their initial discharges. The method of tunneling is in general too expensive and uncertain to be practical, the maximum probable obtainable water being too slight to warrant the risk.

PETROLEUM

Exploration for oil in the Corona area has been carried on in a small way for at least 40 years. Records (fig. 45) indicate 15 wildcat oil wells have been drilled within the Corona South quadrangle since 1925, and there probably are others of which there is no record. Twelve of these wells were put down in the period 1949-56. The others were drilled during an earlier exploration period (1920-30?). Several operators now (1958) hold oil and gas leases and more wells probably will be drilled. Records of lease applications on file with the U. S. Bureau of Land Management show that applications for oil and gas leases have been made several times on nearly all the public domain within the Corona South quadrangle, even in those areas underlain by Triassic metasedimentary and Jurassic (?) volcanic rocks.

To date, all efforts to develop petroleum along the northeastern margin of the Santa Ana Mountains have met with little success although large amounts of oil are produced from Miocene and Pliocene beds in the Puente Hills, only a few miles to the northwest. During the period 1949-56, the Orangethorpe Oil Company and several other operators drilled 12 wells between Bedford and Brown Canyons. The Orangethorpe No. 1 (3 on pl. 1) in Brown Canyon is reported to have encountered oil at a depth of 625 feet in a poorly consolidated coarse sandstone and cobble conglomerate (probably Silverado formation). A 14.5-gravity oil was pumped at the rate of 2½ barrels a day for about a month and the well was finally abandoned in 1951. Some of the other holes, including M. N. H. No. 1 and Marie Boyd No. 1 (6, 12 on pl. 1) may have encountered non-commercial gas and oil shows, but no other production has been reported. All of these wells apparently represent attempts to locate structural traps in Tertiary sedimentary rocks of the easternmost part of the much-faulted Arena Blanca syncline. Small fault slivers of upper Miocene Puente formation, undifferentiated sandstone and shale and Pliocene (?) sandstone and shale, as well as larger bodies of

Map no. (fig. 47)	Claim name	Group	Location S.B.B.&M. Section	T.	R.	Patent number	Serial number	Date of patent	Survey number	Size in acres	Original patent owner	Patent owner (1957)	Status (1958)
1	Fire Clay No. 1 Placer	Fire Clay group	NE¼ 5 NW¼ 4	4S	7W	360331	012815	1913	4838	20	J. H. Moore; Geo. T. Mabey, Corona	Clifford & Maude M. Tillotson, P.O. Box 237, Corona	Idle
2	Fire Clay No. 2 Placer	Fire Clay group	SW¼ 4	4S	7W	360331	012815	1913	4838	20	do.	do.	Idle
3	M & M Placer	Fire Clay group	SE¼ 5	4S	7W	360331	012815	1913	4838	20	do.	do.	Idle
4	Susie Placer		SW¼ 4	4S	7W	365178	012814	1913	4837	20	W. G. McVicar, Daisy M. Terpening, Corona	Pac. Clay Prod., 1255 W. 4th St., Los Angeles	Active
5	Leo Lorenzo	Dutch, (Keno, Kroonen) group of placers	SW¼ 4	4S	7W	611465	024140	1917		20	Leo Kroonen, Corona	John Tillotson, 807 Park Lane, Corona	Idle
6	Victor	Dutch, (Keno, Kroonen) group of placers	SW¼ 4	4S	7W	611465	024140	1917		20	do.	Mary L. Kroonen, 708 W. 8th St., Corona	Idle
7	Little Canyon	Dutch, (Keno, Kroonen) group of placers	SE¼ 4	4S	7W	611465	024140	1917		20	do.	do.	Idle
8	Dutch Republic	Dutch, (Keno, Kroonen) group of placers	SE¼ 4	4S	7W	611465	024140	1917		18.15	do.	do.	Idle
9	Big 4	Dutch, (Keno, Kroonen) group of placers	NE¼ 9	4S	7W	611465	024140	1917		20	do.	do.	Idle
10	White Clay	Dutch, (Keno, Kroonen) group of placers	NE¼ 9	4S	7W	611465	024140	1917		8.23	do.	do.	Idle
11	Kroonen	Dutch, (Keno, Kroonen) group of placers	NE¼ 9	4S	7W	611465	024140	1917		18.42	do.	do.	Idle
12	Black Chief	Dutch, (Keno, Kroonen) group of placers	NE¼ 9	4S	7W	611465	024140	1917		20	do.	do.	Idle
13	Keno	Dutch, (Keno, Kroonen) group of placers	NW¼ 10	4S	7W	611465	024140	1917		15	do.	do.	Idle
14	Luckey	McKnight group	SW¼ 3 NW¼ 10 NE¼ 9	4S	7W	210		1905	4045	16.48	Pac. Clay Mfg. Co.	Pac. Clay Prod. 1255 W. 4th St., Los Angeles	Idle
15	Trio	McKnight group	NW¼ 10 NE¼ 9	4S	7W	210		1905	4045	17.34	do.	do.	Idle
16	McKnight	McKnight group	SW¼ 3 NW¼ 10	4S	7W	210		1905	4045	18.51	do.	do.	Idle
17	Findley Feldspar Placer		SE¼ 33	3S	7W	917651	034485	1923		20.30	M. W. Findley, G. R. Freeman, Ada Tillotson, Corona	Ray & Irma B. Overacker, 412 Olive St., Huntington Beach, Calif., less about 5 acres owned by Harold F. Stowe	Idle
18	Findley Feldspar Placer No. 2		SE¼ 33	3S	7W	917651	034485	1923		17.07	do.	do.	Idle
19	Findley Graphite Placer		NW¼ 4	4S	7W	616413	029643	1918		24.78	E. B. Collier, M. W. Findley, Corona	Otto E. Thomas, 338 S. Normandie, Los Angeles	Idle
20	Conduit Clay Placer No. 1		SE¼ 32	3S	7W	578678	027524	1917		132.11	Ira J. Coe	Riverside Cement Co., P.O. Box 832, Riverside	Idle
21	Conduit Clay Placer No. 2		SW¼ 33	3S	7W	600254	027525	1917		62.5	do.	Ray & Irma B. Overacker, 412 Olive St., Huntington Beach own N. 22 acres, Riverside Cement owns S. 40 acres	Idle
22	Corona Placer		NW¼ 14	4S	7W	441190	014126	1914	4839	18.72	H. E. Ganahl, Corona	A. E. Ganahl, 1011 Victoria, Corona	Idle

FIGURE 46. List of patented mining claims, Corona South quadrangle, California. Data are from records of the U. S. Bureau of Land Management and the Riverside County Assessor, September 1956.

Paleocene Silverado formation sandstone, shale and conglomerate and upper Eocene to lower Miocene Vaqueros and Sespe formations, undifferentiated siltstone, sandstone, and conglomerate are exposed in the area. However, the areal extent of the Miocene and Pliocene strata is very small, and, the data furnished by the wildcats suggest that the Tertiary sequence is generally thin. The evidence now available points against the discovery of a noteworthy oil field in the Brown-Bedford Canyon region. The small amounts of oil previously discovered may well have migrated along the Chino fault zone from producing Miocene or Pliocene zones in the Puente-Chino Hills, about 12 miles to the northwest.

The area south of Corona between El Cerrito Hills and Wardlow Wash has been explored only by the Ciroco-Wright No. 1 well (14 on pl. 1)*. This well, started in 1951 and abandoned in 1954, probably penetrated both Miocene and Eocene marine sedimentary rocks including some oil sands but there was no production. This well was drilled southwest of the projected trace of the Chino fault. The entire area between Corona and this well is covered by older alluvium, and the depth and character of the sedimentary sequence which lie beneath the alluvium are unknown to the writer. The hope of finding oil in the Corona area seemingly rests in the possibility that oil-bearing Tertiary rocks occur there. However, most of the Tertiary sequence may have been removed by erosion before deposition of the fanglomerates.

The records of drilling operations in the earlier period of exploration are very indefinite and generally are incompatible with data from the recent drilling. The known data for the earlier ventures, as well as the current, for wells drilled on the Corona South quadrangle are summarized in fig. 45.

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* In December 1959, after this manuscript was prepared for publication, the Union-Wright No. 1 well (no. 16 on pl. 1 and fig. 45) was drilled 700 feet southwest of Ciroco-Wright No. 1.

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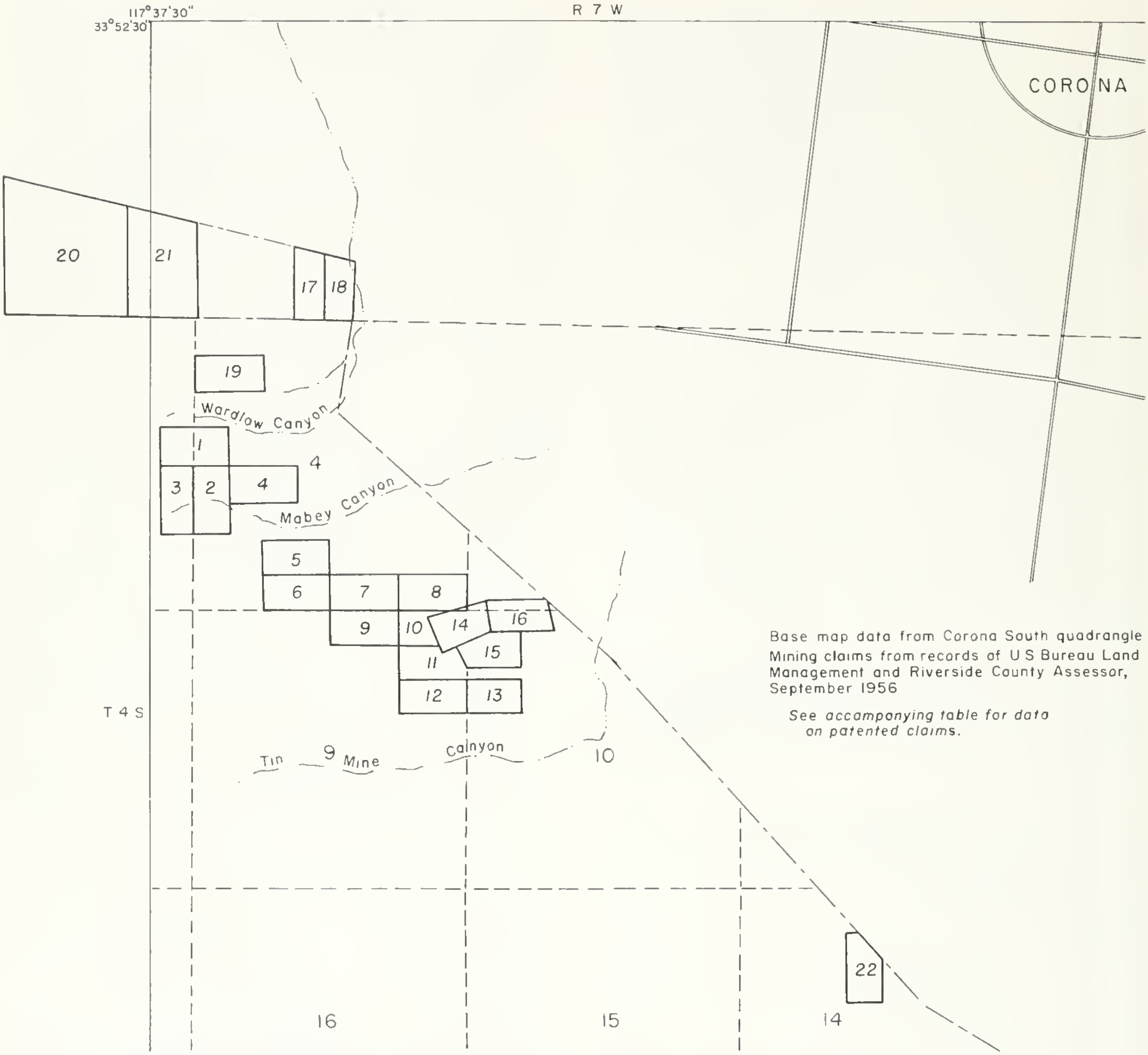

FIGURE 47. Index map showing patented mining claims in and adjacent to the Corona South quadrangle.

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TABULATED LIST OF MINES AND MINERAL DEPOSITS IN CORONA SOUTH QUADRANGLE

The data contained in the following tabulated list were drawn from investigations by the writer as well as from other sources, both published and unpublished, believed by the writer to be authentic. All properties listed were visited during 1956-57.

The list is arranged in alphabetical order by mineral commodity. The number in the first column is the number given the location of the deposit on the map, plate 1, in pocket. Synonyms are given in parentheses after the preferred name and appear as cross references elsewhere in the list.

The date of ownership appears in parentheses following the owner's name and address. Former owners and operators are listed below the present owner. Many of the ownership data were obtained from the offices of the Assessor and Recorder, Riverside County. Ownership data are believed to be accurate as of the time the report was written, but the data commonly were not completely verified. Uncertain section locations are followed by a question mark; the abbreviation "proj." indicates incomplete public land survey lines on the base map. Locations in miles from Corona are from 6th and Main Streets and are approximate airline distances unless otherwise indicated.

References appear in parentheses in the last column and refer to the accompanying bibliography. Only the last names of the authors are given. The first number after each name is the year of publication, and is separated from the page reference by a colon. Succeeding references are preceded by semicolons. The term "herein" refers the reader to a description in the body of the text of this report.

CLAY

No.	Name of claim or mine	Owner (name and address)	Location				Remarks and references
			Sec.	T.	R.	B. & M.	
1	Bedford Canyon deposit (Corona clay deposit)	Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 39 (1957)	N½ 16	4S	6W	SB	Five miles southeast of Corona, west side of Temescal Wash in lower Bedford Canyon. Large deposit of red-burning clay of Paleocene Silverado formation, both residual and sedimentary clays. Discovered in 1954; plant construction began in 1956, placed in operation with intermittent large-scale open-pit mining in January, 1958. (Stauffer 46: map station 32; Ceramic News Aug. 56:17; Nov. 56:22; herein.)
	Brown Star claims						See Middlesworth.
2	Cajalco pit	Louis A. Weisel, et al., La Habra, own patented ranch land in this area (1957); leased by Pacific Clay Products during the 1930's	NE¼ 16	4S	6W	SB	East side of Temescal Wash about 5 miles southeast of Corona, south of Cajalco Rd. along east side of railroad. Residual red mottled clay derived from Triassic Bedford Canyon argillites and/or slates; bright brick-red clays about 30 ft. thick grade laterally into mottled grayish green clays and gray clays, thence into unaltered argillites. Overlain unconformably by coarse, weak, sandstone of Paleocene Silverado formation, 0 to 5 ft. thick which is capped by 10 to 20 ft. of angular cobble and boulder conglomerate of Quaternary age. On the south this sequence is in fault contact with Bedford Canyon quartzite and hornfels. Exploited by irregular quarry about 100 ft. long, 10 to 30 ft. high; old mine rails may mark sites of two small adits, now obliterated. Deposit apparently has very little areal extent beyond the quarry limits. Developed and operated by Pacific Clay Products for a short time in early 1930's. Production undetermined, but apparently small. Idle since 1938.
	Castillo's						See under coal.
3	Chocolate Drop	Francis A. Stearns, Box 262, Corona (1957)	NW¼ NW¼ 17	4S	6W	SB	About 3½ miles southeast of Corona at the south margin of El Cerrito Hills. Pale gray, diatomaceous, clay shale is mined from a low isolated hill (see photograph in text) composed of upper middle Miocene shale (Topanga formation). 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 Co. for use in common red brick. Small tonnage mined each year by Liston Brick Co. since pit opened in 1948. See Liston Brick Co. under clay products manufacturing plants.
4	Conduit clay placer	Riverside Cement Co., 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)	SW¼ 33 SE¼ 32	3S	7W	SB	West edge of Corona South quadrangle, 3½ miles southwest of Corona. Two patented placer claims (Conduit Nos. 1 & 2); east part of Conduit No. 2 is on Corona South quadrangle, remainder and Conduit No. 1 are on adjoining Black Star Canyon quadrangle. Clay shales of Upper Cretaceous Ladd formation were prospected for clay about 1900 and the property was patented in 1917. Riverside Cement Co. acquired their holdings prior to 1950. Late in 1956 the property was explored by extensive bulldozer cuts, mostly on the property in Black Star Canyon quadrangle; numerous samples were taken and chemical analyses were made in an effort to find material suitable for pozzolanic additives for use with portland cement. Only sandy to very sandy clay shales were exposed. These have no apparent economic value at present. Production, if any, must have been small. Long inactive except for the exploratory work done in 1956.
	Corona clay deposit						See Bedford Canyon deposit.
5	Corona placer (Lord?)	A. E. Ganahl, 1011 Victoria, (P.O. Box 643) Corona (1957)	NW¼ 14	4S	7W	SB	West side of Main St. Canyon about 3½ miles southwest of Corona; adjoins east edge of Middlesworth clay, which see herein. Clay was mined from the Paleocene Silverado formation in the early 1900's. Long idle. (Aubury 06:223, 339; Tucker and Sampson 45:161; herein.)
	Corona shale mine, Pacific Clay Products						See Sky Ranch Clay Company deposits.
	Dutch placer						See Kroonen deposit.

CLAY—Continued

No.	Name of claim or mine	Owner (name and address)	Location				Remarks and references
			Sec.	T.	R.	B. & M.	
6	Eagle Canyon (Fraser)	T. A. and F. M. Fraser, 718 Howard St., Corona (1957); leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando (1943-44)	SW¼ 13	4S	7W	SB	Four miles south of Corona; part of Eagle group of unpatented placer claims (see Eagle Canyon gypsum herein). Shallow prospect pits and small open cuts along the west side of Eagle Canyon and in Manning Canyon to the west expose sandy clays and clay shales of the Paleocene Silverado formation. Dr. Katz shipped several truck loads of "fire" clay from the west side of Eagle Canyon in 1941 to several plants in Los Angeles which tested it for flue tile, but found it to be unsuitable. Production small. Idle.
7	Emsco pit	Mrs. Graciosa and Bernard W. De Pipkins, Harvard St., Los Angeles (1956); Emsco Refractories Co., Southgate (operator; 1937-40); patented ranch land.	SE¼ 33	3S	7W	SB proj.	East bank, Wardlow Wash, 3 miles southwest of Corona. Red mottled sandy clay of Paleocene Silverado formation exposed in small quarry. Opened in 1937 by Emsco Refractories Co. when a few hundred tons of gray, sandy, carbonaceous high-refractory clay were shipped to their Southgate plant. Clay zone reported to be about 8 ft. thick, dipping 45° ± east. Mined 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 ft. south of quarry and some clay was mined; ceased operation about 1940. Clay zone not found in quarry at time of visit (1950). Adit was inaccessible, but lignite, carbonaceous clay and impure reddish-brown sandy clay were on dump. Adit and dump were destroyed by Metropolitan Water District pipe line 1956. Production undetermined, but apparently small. Idle since about 1940.
8	Findley feldspar placer	Ray and Irma B. Overacker, 412 Olive St., Huntington Beach (1957)	SE¼ 33	3S	7W	SB	Along west bank of Wardlow Wash, about 3 miles southwest of Corona. Two patented placer claims (Findley feldspar Nos. 1 & 2). Pods and irregular stringers of red, white, and gray mottled and white and purple mottled clays in matrix of weak, coarse, white arkose of Paleocene Silverado formation with some cobble conglomerate; sandstone beds strike N. 70° E., dip 30° NW. Explored by several open cuts; perhaps also by underground workings, now caved. 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 Co., about 1905. The property is said to have produced a considerable tonnage of clay about 1920 used in brick plants in Los Angeles area; no record of production found. Idle since long before 1938 when acquired by present owners.
9	Findley graphite placer mine	Otto E. Thomas, 338 So. Normandie, Los Angeles (1956), reported purchased by Omar Short, Santa Ana (1957)	NW¼ 4	4S	7W	SB	About 3½ miles southwest of Corona, north of Wardlow Canyon. One patented placer claim (Findley graphite placer). Thin discontinuous zones of impure red and green sandy clays occur in shear zones in Upper Cretaceous sandstone and conglomerate of the Ladd formation, undifferentiated. Explored about 1900 by shallow open cuts and one adit said to have showings of "graphite", not found in 1956. Clay zones have been exposed in bulldozer cuts made in late 1940's. Exposed clay not of current economic interest. Little or no production. Idle.
10	Fire clay group	Sky Ranch Clay Co., (Clifford Tillotson, owner) P.O. Box 237, Corona (1957)	4, 5	4S	7W	SB	Both sides of Mabey Canyon, 3½ miles southwest of Corona; 3 patented placer claims; Fire Clay No. 1, Fire Clay No. 2, M. & M. placer. Upper Cretaceous clay shale of the Holz shale member of the Ladd formation was explored by 4 short adits and 7 open cuts before 1910. Production from this period undetermined. Sky Ranch Clay Co. mined a small tonnage from an open cut about 1950. See Sky Ranch Clay Co. deposits herein.
	Fraser						See Eagle Canyon.
	Freeman clay	Undetermined (1957); G. R. Freeman, Corona (operator, 1927)		4S	7W	SB	G. R. Freeman, Corona, reported some clay production in 1920's. Exact location not reported, probably various deposits between Main St. and Hagador Canyons, about 3½ miles southwest of Corona. Long inactive. See Middlesworth clay and Corona clay placer, herein.
11	Grapevine	Mrs. Mary A. Mattey, 11359 Biona Ave., Los Angeles 66 (1957)	SE¼NW¼ SW¼ 4 (lot 9)	4S	7W	SB	Three miles southwest of Corona, south side of Mabey Canyon. Clay shale of the Upper Cretaceous Holz shale member of the Ladd formation; active. (Herein.)
	Hoag Ranch						See Jones.
	Hoffman						See Jones.

CLAY—Continued

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
12	Jones (Hoffman, Hoag Ranch)	Mrs. D. C. Hammond, 2955 E. California, Pasadena (1956); purchased by Coronita Ranch, c/o D. C. McMillan, 8704 Colima Rd., Whittier, in late 1957	NW¼ 19	4S	6W	SB	Clay and coal prospect 4 miles southeast of Corona (Tucker 21:325; Tucker & Sampson 29:500-501; Sampson 35:520; herein.)
	Keno group						See Kroonen deposit.
13	Kroonen deposit (Keno group, Dutch placer)	Mary L. Kroonen, 708 West 8th St., Corona (8 claims 1957) and John Tillotson, 807 Park Lane (P.O. Box 398) Corona (one claim, 1957)	S½ 4 NE¼ 9 NW¼ 10	4S	7W	SB	About 3½ miles southwest of Corona, west of and adjoins McKnight mine, between Tin Mine and Mabey Canyons; 9 patented placer claims. Sedimentary clays of the Paleocene Silverado formation. Small intermittent production during first quarter of the century. Long inactive. (Tucker & Sampson 29:501; herein.)
14	Leo Lorenzo placer	John Tillotson, 807 Park Lane, Corona (1957)	N½ SE¼ SW¼ 4	4S	7W	SB	See Kroonen deposit.
	Lord	Undetermined (1957). George W. Lord, Corona (operator, 1905)		4S	7W	SB	Exact location unknown. Light gray, fine-grained fire clay reported under development in 1905. May be same as Middlesworth clay or part of Corona placer, described herein. Long inactive. (Aubury 06:223.)
15	McClintock pit	Pacific Clay Products, 1255 West Fourth St., Los Angeles (acquired Sept. 1, 1957); Sky Ranch Clay Co., P.O. Box 237, Corona (owner, 1955-1957); Earl M. McClintock, P.O. Box 34, Olive (owner, 1952)	NW¼ SE¼ 4	4S	7W	SB	Three miles southwest of Corona, on north side of Mabey Canyon. Red mottled sandy clay lenses in Paleocene Silverado formation sandstone and conglomerate; furnished a small amount of clay for use in sewer pipe to the Mission Clay Products Corp., Olive, about 1952. Developed by open cuts; exploratory bulldozer work in 1956 failed to expose economic clay. Idle.
16	McKnight clay mine	Pacific Clay Products, 1255 West Fourth St., Los Angeles (1957)	NE¼ 9 SW¼ 3 NW¼ 10	4S	7W	SB	Three miles southwest of Corona between Tin Mine and Mabey Canyons. Large amounts of red-burning clay and fire clay were produced from Paleocene Silverado formation sedimentary clays from about 1885 to the middle 1930's. Idle since then except for small intermittent production of red-burning clay. (Goodyear 88:505; Crawford 96:616; Aubury 06:224; Merrill 19:569-570; Boalich and others 20:89-90; Dietrich 28 179, 277; Tucker & Sampson 29:502; Sampson 35:520; Sutherland 35:75-79; herein.)
	McVicar pit						See Susie placer.
17	Middlesworth (Brown Star claims) (Lord?, Freeman?)	Josephine Middlesworth, 847 W. 9th St., Corona, and William H. Redding, et al., 1008 S. Pacific Ave., San Pedro (1957)	NW¼ 14 NE¼ 15 SW¼ 11	4S 4S 4S	7W 7W 7W	SB SB SB	About 3½ miles southwest of Corona between Main St. and Hagador Canyons. Paleocene red "pottery clay" and pisolitic "bauxite" were mined intermittently during first third of the century. Property examined in 1943 by Kaiser Steel Corp. as source of alumina-rich clay. Amount of production unknown. Idle. (Aubury 06:223; Draper 44:1-11; Tucker & Sampson 45:161; herein.)
18	Peterson's claim	Arthur E. Garratt, 3340 Eastern Ave., Los Angeles 32 (1957); patented land, formerly railroad section. Elsinore Clay Co., Box 421, Riverside (operator, 1930?)	N½ 29	4S	6W	SB	About 5½ miles southeast of Corona, between Bedford Motorway and McBribe Canyon. Red mottled clay and sandy gray to white clay with minor pisolitic zones intercalated in sandstone and conglomerate of the Paleocene Silverado formation; adjacent to Elsinore fault zone. Some development as early as 1892 (indicated on U. S. Bureau Land Management survey map dated 1892). Several open pits, dug about 1930, may have yielded small amounts of clay. Bulldozer cuts were made in NE¼ sec. 29 during 1956 in an unsuccessful effort to discover glass sand. Reserves of clay appear to be very small. Production undetermined, but probably small. Long idle.
	Red Bull claims	William H. and Leona Redding, A. F. and Carolyn Bullard, 1008 S. Pacific Ave., San Pedro (1957)					See Middlesworth.
	Sky Ranch Clay Company deposits	Sky Ranch Clay Co. (Clifford Tillotson, owner) P.O. Box 237, Corona, (1957). Susie placer, McClintock pit and Sky Ranch clay mine, west pit were purchased Sept. 1, 1957 by Pacific Clay Products, 1255 West Fourth St., Los Angeles, who continued mining the Sky Ranch clay mine, west pit, as Corona shale mine	W½ 4 E½ 5	4S	7W	SB	Along Mabey and Wardlow Canyons and intervening ridges, 3½ miles southwest of Corona. Includes Susie placer (McVicar pit); McClintock pit; Fire Clay group; Sky Ranch clay mine, east and west pits; and Leo Lorenzo placer, which see herein. Intermittent production of sedimentary Paleocene Silverado formation clays since about 1900. Steady production of clay shale from Upper Cretaceous Ladd formation and Holz shale member since about 1950. Currently furnishes raw materials to Tillotson Refractories Co., Corona. (Aubury 06:223; herein.)

CLAY—Continued

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
19	Sky Ranch clay mine, east pit	Sky Ranch Clay Co. (Clifford Tillotson, owner) P.O. Box 237, Corona (1957)	NE¼SW¼ NW¼ 4	4S	7W	SB	North side of Wardlow Canyon, 3½ miles southwest of Corona; Frenchy placer claim (unpatented). Quarry opened in 1951 and until 1956, steadily furnished a considerable tonnage of clay shale from Upper Cretaceous Ladd formation to Tillotson Refractories Co., Corona. Idle since 1956. See Sky Ranch Clay Co. deposits herein.
20	Sky Ranch clay mine, west pit	Sky Ranch Clay Co. (Clifford Tillotson, owner) P.O. Box 237, Corona (1957) Patented ranchland (75 acres) in the S½NE¼ sec. 5 purchased Sept. 1, 1957 by Pacific Clay Products, 1255 West Fourth St., Los Angeles. Mining continues in this area to supply the Corona plant of Pacific Clay Products (formerly Tillotson Refractories Co.)	NW¼SW¼ NW¼ 4, S½NE¼ 5	4S	7W	SB	North side of Wardlow Canyon, 3½ miles southwest of Corona; Frenchy placer claim (unpatented, NW¼ SW¼NW¼ sec. 4); patented ranch land S½NE¼ sec. 5 (75 acres). Quarry opened early in 1956 in the S½NE¼ sec. 5, and has since furnished a considerable tonnage of Upper Cretaceous Ladd formation clay shales to the Tillotson Refractories Co., Corona. In 1957 this pit was the company's principal source of clay shale. Quarry developed in a clay shale zone which is about 500 ft. wide east-west and extends about 1,500 ft. northwesterly. See Sky Ranch Clay Co. deposits herein.
21	Susie placer (McVicar pit)	Pacific Clay Products, 1255 West Fourth St., Los Angeles (acquired Sept. 1, 1957); Sky Ranch Clay Co., (Clifford Tillotson, owner) P.O. Box 237, Corona (1954-Sept. 1, 1957)	NW¼ 4	4S	7W	SB	Ridge north of Mabey Canyon, 3½ miles southwest of Corona; patented placer claim. Narrow, wedge-shaped fault sliver of Paleocene Silverado formation sedimentary clay, including red mottled, white, and gray clay and pisolitic clay with minor associated lignite, intercalated with Silverado sandstone and conglomerate. Wm. G. McVicar shipped clay to the California Clay Manufacturing Co., Los Angeles, about 1900. Later acquired by Earl M. McClintock who shipped some clay to Mission Clay Products Olive, during the early 1950's. Acquired by Sky Ranch Clay Co. in 1954. Early development was by short adits and open cuts, recent mining has been from open pits. Deposit apparently has very little areal extent beyond the pit limits. Production not determined, but appears to be small. Intermittently mined by Sky Ranch Clay Co. which see herein. (Aubury 06:223.)
22	Switzer	Elmo Switzer, 808 West 8th St., Corona (1957) owns about 50 acres, patented ranch land	NE¼ 5	4S	7W	SB	Adjoins Findley graphite placer on the east and Sky Ranch Clay Co. on the south, 3½ miles southwest of Corona. Buff Upper Cretaceous clay shales of the Ladd formation, undifferentiated, were explored by bulldozer cuts about 1945. A white sandy clay zone 2 to 5 ft. thick occurs along a shear zone which strikes N. 50° W., dips 40° NE. Small amounts of this white sandy clay "ganister" were mined from an open cut by the Sky Ranch Clay Co. about 1945 for use at Tillotson Refractories Co., Corona. Idle since except for occasional sampling.
23	Thomas clay deposit, east pit	Charles A. Thomas, P.O. Box 518, Corona, leased to Gladding, McBean & Company, 2091 Los Feliz Blvd., Los Angeles; sublet and operated by Joe Delco, Jr., 1233 Garretson, Corona (1957)	NW¼ 33	3S	7W	SB proj.	About 3½ miles southwest of Corona, west of Wardlow Wash. Red-burning clay shale of the Paleocene Silverado formation is mined and furnished to several manufacturers of common clay products. Production each year of a few thousand tons. (Herein.)
24	Thomas clay deposit, west pit	Charles A. Thomas, P.O. Box 518, Corona, leased to Gladding, McBean & Co., 2091 Los Feliz Blvd., Los Angeles (1957)	NW¼ 33	3S	7W	SB proj.	About 3½ miles southwest of Corona, west of Wardlow Wash. Paleocene clay shale of the Silverado formation is being developed as a constituent for common clay products. No production except for testing. Active development carried on in 1956. (Herein.)
25	Unnamed pit	Temescal Water Co., Corona (1957); Liston Brick Co., P.O. Box 4, Corona (operator, 1956)	NE¼ 16	4S	6W	SB proj.	About 4½ miles southeast of Corona on east side of Temescal Canyon. Liston Brick Co. intermittently mines small tonnage of soil developed on Triassic Bedford Canyon formation metasedimentary rocks for use in red brick. Material removed from small, shallow open pits; loaded on small dump trucks by combination bulldozer-loader.
26	Unnamed prospect	P. J. Oertel, E. I. Downs, A. J. Velthoen, W. B. Munn, W. J. Wood, c/o P. J. Oertel, Marilyn Dr., Corona (1957). Patented ranch land	SE¼ 33	3S	7W	SB proj.	West side Wardlow Wash, 3 miles west of Corona. White and pink, mottled, impure, sandy clay of Paleocene Silverado formation. Strike of beds N. 60° W., dip 45° to 60° NE; overlain by pebble arkose. Developed by caved pit or shaft 10 ft. deep in 1957. Apparently no production. Long idle.
27	Unnamed prospect	Mrs. Graciosa V. and Bernard W. de Pipkin, Harvard St., Los Angeles (1956); patented ranch land	NE¼ 4	4S	7W	SB proj.	Flat-topped ridge east of Wardlow Wash, 2½ miles southwest of Corona. Gray and white, brownish-buff, iron-red to limonite-yellow colored mottled clay bed 5-10 ft. thick, intercalated with white arkose and conglomerate of Paleocene Silverado formation. Developed by two shallow open cuts. Apparently no production. Long idle.

CLAY—Continued

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
28	Unnamed prospect	Joy G. and Walter T. Jameson, Corona (1957); S.R.C. Lands (1926)	SW¼ 3	4S	7W	SB proj.	Three miles southwest of Corona. Reddish-brown pisolitic clay bed strikes N. 50° W., dips 55° NE. Clay bed 3 ft. thick is exposed along a strike length of 30 ft.; overlain by clayey reddish sandstone, underlain by 2 ft. of white and gray fire clay which grades downward into red iron stained clayey sandstone and buff arkose. Developed by several small prospect pits. Apparently no production, long idle. (Dietrich 28; map facing p. 162.)

CLAY PRODUCTS MANUFACTURING PLANTS

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
1	Gladding, McBean and Co., Corona Plant	Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 39	NW¼ NW¼ 16	4S	6W	SB	Plant location: 5 road miles southeast of Corona on State Highway 71. Manufactures vitrified clay pipe and conduit. See Bedford Canyon (Corona) clay deposit herein.
	Jordan Tile Manufacturing Co.	Mosaic Tile Co., Zanesville, Ohio	NE¼ 26 Corona	3S North	7W quad.	SB	Plant location: 909 Railroad St., Corona, manufactures quarry tile and vitreous tile. (Herein.)
29	Liston Brick Company	Lionel P. Liston, P.O. Box 4, Corona	SE cor. NW¼ 16	4S	6W	SB	Plant location: 5½ road miles southeast of Corona on State Highway 71, in lower Bedford Wash. Manufactures red brick from raw clay materials purchased from producers in the Corona South quadrangle. (Herein.)
	Pacific Clay Products, Corona Plant	----------	----------	----------	----------	----------	See Tillotson Refractories Company.
	Tillotson Refractories Company	Pacific Clay Products, 1255 West Fourth St., Los Angeles (acquired Sept. 1, 1957); Tillotson Refractories Co., Clifford Tillotson, 1150 West 6th St., Corona (owner, 1945-Sept. 1, 1957)	SW¼ 26 Corona	3S North	7W quad.	SB proj.	Plant location: 1150 West 6th St., Corona, manufactures vitrified clay sewer pipe in several sizes. Supplies small amounts of ground fire clay and pipe layers clay. (Herein.)

COAL

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
30	Castillo's	Arthur E. Garratt, 3340 Eastern Ave., Los Angeles 32 (1957); patented land, former railroad section	NW¼ 29	4S	6W	SB	About 5½ miles southeast of Corona. Coal prospect on east bank of Bedford Canyon shown on U.S. Bureau Land Management survey map dated 1892. Red mottled clay, claystone and minor amounts of pisolitic clay and lignite of the Paleocene Silverado formation are exposed in a small, steep canyon. No development work noted in July 1956. Long idle.
	Hoag Ranch	----------	----------	----------	----------	----------	See Jones.
	Hoffman's prospect	----------	----------	----------	----------	----------	See Jones.
	Jones (Hoffman's prospect, Hoag Ranch)	----------	----------	----------	----------	----------	See Jones under clay.
	McKnight	Pacific Clay Products, 1255 West Fourth St., Los Angeles (1957)	NE¼ 9 SW¼ 3 NW¼ 10	4S	7W	SB	In 1888 a bed of coal was observed to crop out in rocks that probably have since been removed in coal mining operations. The 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 ft. thick; about 50 feet down it widened to 4 ft. of rather clean soft coal. Below this it pinched out to only 3 or 4 inches with an irregular dip. Production not determined, but probably small for local use. See McKnight under clay. (Goodyear 88:505.)
31	Unnamed prospect	Arthur Weirick, Chase & Skyline Dr., Corona (1956); patented ranch land	NW¼ 10	4S	7W	SB	North side of Tin Mine Canyon 3½ miles southwest of Corona. 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), on old McKnight ranch, probably part of McKnight's coal prospect which see herein. No trace of adit or dump was found in 1957.

GOLD

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
	Cliff No. 1						See Red Rock under dimension stone.
	Sam No. 1						See Red Rock under dimension stone.
32	Williams (Ophir ?)	Undetermined (1957)	SW¼ 4 NW¼ 9	5S 5S	7W 7W	SB SB	About one airline mile north of Silverado Post Office in Ladd Canyon, in the vicinity of the junction with the west fork of Ladd Canyon; Orange County. Long idle. (Tucker 25:59-60; herein.)

GYPSUM

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
	Barth (Prizer)	Undetermined (1957); H. A. Prizer, address undetermined (1909); W. C. Barth, address undetermined, acquired in 1914.		4S	7W	SB	Location undetermined. Small production of gypsite for agricultural use reported in 1909, 1914, 1917. Previously published location—sec. 2 (Ver Planck, 1952, p. 124)—not confirmed; sec. 2 is wholly covered by older alluvium (Qalo). This location may have been for a grinding or storage area; the gypsum probably was obtained from the Eagle Canyon-Tin Mine Canyon gypsite belt. (Merrill 19:579, Ver Planck 52:125.)
33	Big Chief (Freeman-Nonhof, White gypsum group, Ware)	P. E. Coleman, 301 Fruit St., Santa Ana (1957). G. R. Freeman and E. R. E. Nonhof, Corona (1923); leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando (1943); Howard S. and Irene J. Ware, 219 E. Olive St., Corona, (owners, 1947)	SE¼ 9 SW¼ 10	4S	7W	SB	South side of Tin Mine Canyon, 3½ miles southwest of Corona. Formerly part of White Gypsum group (see herein) with a small production of gypsite reported in 1923. Developed by several short adits 10 to 30 ft. long and shallow open cuts. Sampled and exposed by bulldozer cuts in 1943. Later abandoned. Relocated in 1954 by P. E. Coleman as Big Chief placer (20 acres), location amended 1956. Trenching and sampling in progress, December 1956.
34	Capitol Dome group	Floyd N. Champion, et al., 3316 E. Anaheim St., Long Beach 4 (1957)					See Main Street (Gypsum) Canyon deposit.
35	Eagle Canyon (Frazer)	T. A. and F. M. Fraser, 718 Howard St., Corona (1957); leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando (1943-44)	Lots 1 & 2 SW¼ 13 N½NW¼ 24	4S	7W	SB	Both sides and west of Eagle Canyon, about 4 miles south of Corona. Small production of gypsite for agricultural use 1913-17, 1944. (Merrill 19:579; Tucker & Sampson 45:168; Ver Planck 52:58, 125, 132, herein.)
	El Cerrito Ranch	Undetermined (1957)					Small tonnage of gypsite reported to have been produced in period 1915-17 for private agricultural use; probably from Eagle Canyon-Tin Mine Canyon gypsite belt. (Merrill 19:579; Ver Planck 52:135.)
	Elki	George S. Jones, 3262 Santa Ana St., South Gate (1957)	SW¼ 10	4S	7W	SB	Three claims Elki 1-3, located in 1956. Developed by open trenches and adit 30 ft. long. See White Gypsum group.
	Frazer						See Eagle Canyon.
	Freeman-Nonhof						See White Gypsum group and Big Chief.
	Gypsum Canyon						See Main Street Canyon.
36	Hagador Canyon	W. R. and Virginia Adams, 301 Fruit St., Santa Ana; Orrin M. Pierce, 1607 N. Flower St., Apt. G, Santa Ana; A. F. Bullard and Wm. H. Redding, 1008 S. Pacific Ave., San Pedro (1957)	NW¼ 15 NE¼(?) 16	4S	7W	SB	Hagador Canyon, 4 miles southwest of Corona. Veinlets of satin spar and gypsite in hydrothermally altered volcanic rock (Santiago Peak volcanics). Idle except for annual assessment work which includes trenching and sampling. (Merrill 19:579; Symons 28:269; 35:279; Tucker & Sampson 45:168-169; Ver Planck 52:57-58, 126, 132, 142, 144; herein.)
	Jameson	Undetermined (1957); W. H. Jameson Co., Corona, (1915)	3 (?)	4S	7W	SB	W. H. Jameson Co. is reported to have produced a small amount of gypsite in 1915 for private use on orchards. 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. Probably the gypsum was mined from the Eagle Canyon-Tin Mine Canyon gypsite belt. (Merrill 19:579; Ver Planck 52:126, 138.)
37	Main Street (Gypsum) Canyon	Josephine Middlesworth, 847 W. 9th St., Corona (1 claim 1957); Floyd N. Champion, et al., 3316 E. Anaheim St., Long Beach 4, (5 claims 1957); Middlesworth property leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando (1944) and to Victor Mishelle, West Los Angeles (1945)	NE¼ 15 SE¼ 14 W½ 14	4S 4S	7W 7W	SB SB	Main Street Canyon, 4 miles south of Corona. Intermittent production of gypsite 1900-1935. Idle except for annual assessment work. (Aubury 06:286; Merrill 19:579; Tucker & Sampson 45:168, Ver Planck 52:57-58, 126, 136, 140; herein.)

GYPSUM—Continued

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
	Omei	Mrs. B. I. Markwell, 1001 N. Lowell St., Santa Ana (1957)	S½ 9	4S	7W	SB	See White Gypsum group.
	Prizer						See Barth.
	Red Bull						See Hagador Canyon.
	Tecumseh group	Orrin M. Pierce, 1607 N. Flower St., Apt. G, Santa Ana (1957)	SW¼ 10 SE¼ 9 NW¼ 15 NE¼ 16	4S	7W	SB	Parts of former White Gypsum and Hagador Canyon deposits (see herein). Five claims, Tecumseh, Minot, Why Not, Alpha, Omega. Idle.
	Ware						See White Gypsum group and Big Chief.
38	White Gypsum group (Freeman-Nonhof, Big Chief, Ware)	P. E. Coleman, 301 Fruit St., Santa Ana (1957); G. R. Freeman and E. R. E. Nonhof, Corona, (1923); W. E. Hill and E. R. E. Nonhof, 1116 Ramona St., Corona (1935); leased to Dr. Leon N. Katz, 9837 Foothill Blvd., San Fernando (1943); Howard S. and Irene J. Ware, 219 E. Olive St., Corona, (owners, 1947)	SE¼ 9 SW¼ 10 NE¼ 16	4S	7W	SB	South side of Tin Mine Canyon, 3½ miles southwest of Corona. Formerly a group of 8 unpatented claims (White Gypsum 1-8). Veinlets of satin spar and gypsite in hydrothermally altered volcanic rock (Santiago Peak volcanics). Developed by several small cuts, shallow pits, and short adits. 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. Acquired by H. S. Ware about 1940; area of present Big Chief claim (see herein) sampled and exposed by bulldozer cuts 1943; bulk sampling of White Gypsum group (then known as Ware Gypsum) 1947. Later abandoned and partly relocated in 1954-56 as Big Chief, Omei, Tecumseh, and Elki (see herein). (Ver Planck 52:127, 142, 146.)

LEAD-SILVER-ZINC

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
39	Corona lead-zinc mine	Robert A. Mattey, Jr., 11359 Biona Dr., Los Angeles 66 (1953)	SE¼ 14	4S	7W	SB	Manning Canyon 4 miles south of Corona. Mineralized fracture zone in Bedford Canyon formation. No record of production. Idle. (Tucker & Sampson 45:147-148; Goodwin 57:601-602; herein.)
	Ophir						See Williams under gold.
	Williams						See under gold.
40	Unnamed prospect	Undetermined (1957)	SE¼ 33	4S	7W	SB	About 2 airline miles north of Silverado Post Office on east side of West Fork of Ladd Canyon. Short adit, now caved; driven east-west across contact of Santiago Peak volcanic rocks and Bedford Canyon formation slate. Apparently an early day prospect. May have been part of the Williams (Ophir ?) mine, which see under gold.
41	Unnamed prospect	Undetermined (1957)	SE cor. NE¼ 11 SW cor. NW¼ 12	5S	7W	SB	About 3 road miles northeast of Silverado Post Office, Orange County. One adit north of Maple Springs truck trail driven N. 60° E., 100± ft. long; one short adit driven south, and one shallow pit south of truck trail. Adits driven in altered zones in hornblende andesite porphyry and rhyolite tuff (?), intrusive and volcanic rocks related to Santiago Peak volcanics Prospecting probably dates from about 1880. Production, if any, not determined; idle many years.

LIMESTONE

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
	Kroonen						See Ladd Canyon.
42	Ladd Canyon (Kroonen)	Great West Minerals and Materials Development Co., 8541 Calmada Ave., Whittier (1958); Leo Kroonen, Jr., Corona (1931)	SE¼ 34 NE¼ 3	4S 5S	7W 7W	SB SB proj.	2½ airline miles northeast of Silverado Post Office, along west side of East Fork of Ladd Canyon. Orange County. Several small limestone pendants within graywacke and slate of Triassic Bedford Canyon formation. Long idle. (Fairbanks 93:115-116; Smith 98:779; Tucker 25:68; Logan 47:261; herein.)
	Nonhof	Undetermined (1957); E. R. E. Nonhof, 1116 Ramona Ave., Corona (1924)	16 (?)	4S	7W	SB	Hagador Canyon; one claim located in 1915 on which the owner reported a bold outcrop of lime, 1,500 ft. long, about 70 ft. wide, and 50 ft. thick; developed by a short adit. The writer was unable to locate such an outcrop in 1953, although several small exposures of pyrite and limonite-bearing medium-grained crystalline limestone were found, and limy metashales occur in the Triassic Bedford Canyon formation in the area. Several short adits have been

LIMESTONE—Continued

No.	Name of claim or mine	Owner (name and address)	Location: Sec.	T.	R.	B. & M.	Remarks and references
	Nonhof Continued						driven. These may have been the source of "limestone" for a small kiln in upper Hagador Canyon. Ruins of a kiln are said to have been found in 1907, but were not identifiable in 1953.
43	Unnamed prospect	Undetermined (1957)	NW¼ SW¼ 32	4S	6W	SB	7¾ miles southeast of Corona, just east of Bedford Motorway. Discontinuous pendant, 20 to 30 ft. wide and about 1,000 ft. long, of dark gray fine-grained limestone. Weathers light gray. Apparently in part breccia. Strikes N. 65° E., dips 75° NW. Occurs within graywacke and slate of Triassic Bedford Canyon formation. Reserves are apparently small. Undeveloped prospect. Analysis by Abbot A. Hanks, Inc., June 1956, of one random type sample collected by the writer was as follows: SiO_2 9.18%; Fe_2O_3 0.80%; Al_2O_3 9.18%; CaO 43.74%; MgO 0.83%; P_2O_5 0.03%

MINERAL PAINT (OCHER)

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
	Lord	Undetermined (1957); George W. Lord, Corona (operator, 1905)		4S	7W	SB	Exact location undetermined; probably was in the area of NW¼ sec. 14, NE¼ sec. 15, 3½ miles SW of Corona. Aubury (1906, p. 339) reported a bed of fine-grained, light colored, yellow ocher 8 ft. wide in a deposit of fire clay. Numerous prospect pits and open cuts and several caved adits expose Paleocene Silverado formation clays in this area, none active in 1956. This deposit may be part of several claims now held by Josephine Middlesworth, 847 W. 9th St., Corona or on patented ranch land owned by W. H. Redding, 1008 S. Pacific Ave., San Pedro. See Middlesworth clay herein. Long idle. (Aubury 06:339; Merrill 19:579; Symons 30:156.)
	National Paint and Color Company	Undetermined (1957); National Paint and Color Co., Corona (operator, 1905)		4S	7W	SB	Exact location undetermined; probably was in NW¼ sec. 14, 3½ miles SW of Corona. This firm produced about 20 colors of natural pigments (ocher, red oxide, vermillion red, grays, etc.) in Corona in 1905. Reported 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. Long idle. (Aubury 06:339; Symons 30:156.)
	Paint mine	Undetermined (1957); George W. Lord, Corona (owner, before 1905); Corona Pressed Brick and Terra Cotta Co., Corona (owner, 1905)		4S	7W	SB	Exact location undetermined; probably was in the area of NW¼ sec. 14, NE¼ sec. 15, 3½ miles SW of Corona. Property developed by G. W. Lord. Reported to be about 500 yds. NW of the Lord deposit, described herein. Long idle. (Aubury 06:339; Symons 30:156.)

ROCK PRODUCTS
Broken and Crushed Stone

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
	Blue Diamond Materials Co.						See Temescal rock quarry under roofing granules.
44	Jameson quarry	Mary C. Jameson, 316 E. Olive St., Corona (1957); J. B. Stringfellow, P.O. Box 6, Riverside (operator, 1940, 1950)	SW¼ 29	3S	6W	SB proj.	One mile west of Home Gardens, north of State Highway 18. Pinkish-gray micropegmatite granite was quarried intermittently from 1940-50. Idle since. (Herein.)
	Matich Brothers quarry						See Temescal Canyon rock quarry.
	Phillips						See Sidebotham.
45	Sidebotham (Phillips) quarry	William N. Guth, Chicago, Illinois (1957); A.T. & S.F. R.R. Co. (operator, 1935-39)	W½ NW¼; NW¼ SW¼ 5	4S	6W	SB proj.	About 2½ miles southeast of Corona on the south margin of Temescal Wash. Granodioriate was quarried intermittently from 1935 to 1939 and used for railroad track ballast and riprap. Idle since about 1939. (Herein.)
46	Temescal Canyon rock quarry	Frank Spires, Corona and Wesley Collins, Costa Mesa (1957); leased to Temescal Rock Products Co., P.O. Box 364, Corona (operator, May-July 1957); Matich Brothers Contractors, Colton (operator, Sept. 1957)	SW¼ 33 NW¼ 4	3S 4S	6W 6W	SB proj. SB proj.	East side of Temescal Wash, 1¼ airline miles south of Home Gardens. Quarry opened in May 1957, in granodioriate for use as riprap on Santa Ana River levee west of Riverside. (Herein.)

ROCK PRODUCTS—Continued
Broken and Crushed Stone

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
	Temescal Rock Company						See Temescal rock quarry under roofing granules.
	Temescal Rock Products Co.						See Temescal Canyon rock quarry.

Decomposed Granite

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
47	Unnamed pit	Alfred H. and Sue M. Beazley, 601 Fern Drive, Fullerton (1957); patented ranch land	SW¼ NE¼ 4	5S	6W	SB	Ridge midway between Bixby and Anderson Canyons about 8 miles southeast of Corona. Brownish-gray, soft, much weathered biotite quartz diorite (phase of San Marcos gabbro); largely altered to clay minerals, breaks into very fine-grained material. Small amount scraped from ridge by bulldozer during 1956, probably used locally by ranchers to surface unpaved roads. Idle since Dec. 1956.
48	Unnamed pit	Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn. and P.O. Box 276, Corona (1957)	NE¼ NW¼ 9	4S	6W	SB proj.	Northwest of El Cerrito Village and about 3½ miles southeast of Corona. Light brownish-gray, soft, weathered, quartz monzonite (Home Gardens quartz monzonite porphyry) with minor hard, light-gray blocks. Developed by two small, nearly connected quarries totaling about 100 ft. in length with face from 10 to 25 ft. high; mined by power shovel without blasting. Small intermittent production, probably used locally to surface unpaved roads. Idle.

Dimension Stone

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
49	Red rock prospect	Cecil J. and Helen L. Clark, 1908 S. Parton, Santa Ana, (1952)	NE¼ 28	4S	7W	SB	Two placer claims: Red Rock & Mari-Etta were located for building stone in 1952, ¼ mile west of Pleasants Peak along the Main Divide Truck Trail, Orange County. This is probably the same area earlier located as Cliff No. 1 and Sam No. 1 lode claims and held by Cliff Overacker and Sam Clapp during the 1930's. These were gold-silver prospects. The building stone claims include a small outcrop of serpentine which is bordered on one side by a massive ledge of reddish-brown silica-carbonate rock, but most of the area is occupied by weathered diorite and andesite. This material probably will not find special favor in the building industry, but some might be useful in ornamental stonework. Development consists of several shallow pits and cuts and one short adit. The property was inactive in July 1956, and little recent work has been done.
50	Unnamed prospect	Cecil J. Clark, 1908 So. Parton, Santa Ana (1952?)	NE¼ 33	4S	7W	SB	Placer claim (20 acres) for "building stone" located on the ridge between Ladd Canyon and the West Fork of Ladd Canyon about 2½ miles north of Silverado Post Office, Orange County. Area underlain by platy, fine-grained white to buff quartzite of the Bedford Canyon formation; thin bedded altered tuffs (?) and porphyritic andesite of the Santiago Peak volcanics. Reached by one mile of foot trail from Pleasants Peak. Developed by several shallow pits. In June 1956 no recent activity was evident.

Roofing Granules

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
51	Temescal rock quarry	Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn., and P.O. Box 276, Corona (1957); Temescal Rock Co. (1914); Blue Diamond Materials Co., Los Angeles (1927)	4, 5, 9	4S	6W	SB proj.	Quarry and processing plant for fine granules used in processed roofing on east side of Temescal Canyon, 4 miles southeast of Corona. Processing plant for coloring coarse granules (used in built-up roofing) north of Corona City park on East 3rd St. Quartz latite porphyry quarried for road metal and riprap, 1888-1927; used for roofing granules since 1948. (Goodyear 88:506; Merrill 19:586-587; Tucker 21:331-332; 24:45; Allen 23:887-890; Bradley 23:95; Tucker & Sampson 29:508, 524; 45:166-167; Ingram 49: 457; Utley 49:5pp; Megaphone 51.6-7; Jahns 54:21; herein.)

ROCK PRODUCTS—Continued
Sand and Gravel

No.	Name of claim or mine	Owner (name and address)	Location Sec.	T.	R.	B. & M.	Remarks and references
52	Corona Rock Co.	Riverside County Flood Control District (1957); Corona Rock Co., (Bill Flynn, operator 1937-1939?)	W½ 32	3S	6W	SB proj.	Two miles southeast of Corona, along the east side of the city dump. Several small, shallow pits 10-15 ft. deep expose dirty, silty sand with sparse gravel. A small sand and gravel plant was erected about 1937, but was dismantled after several years. Production undetermined, but small. Long idle.
	Kuster & Waterbury						See Transit Mixed Concrete Co.
53	Transit Mixed Concrete Co., Corona plant	Transit Mixed Concrete Co., 3464 E. Foothill Blvd., Pasadena (1957)	29, 30	3S	6W	SB proj.	One mile east of Corona at northwest end of Temescal Wash, north of State Highway 18. Only the south edge of the mined out pit area is within the Corona South quad; plant and active pit are ½ mile northwest in Corona North quad. Plant operated for many years by Kuster and Waterbury before 1942; since then worked by present operator. Large production (see sand and gravel herein).
54	Unnamed prospect	Mrs. R. Boyd and W. Heinlein, 3264 Floresto Ave., Los Angeles (1957); 50 acres leased to Temescal Rock Products Co., P.O. Box 364, Corona (1957); patented ranch land	SE¼ 28	4S	6W	SB	Lower Brown Canyon, 7 miles southeast of Corona. Deposit of stream gravels, said to be 80% rock with average depth of 40 ft. Undeveloped 1957.

Specialty Sands (Glass Sand)

No.	Name of claim or mine	Owner (name and address)	Sec.	T.	R.	B. & M.	Remarks and references
55	Corona silica sand deposit (Owens-Illinois Glass Co., Corona sand plant No. 96; P. J. Weisel Industrial Sand Co.)	Louis A. Weisel, et al., La Habra (1957); leased to Owens Illinois Glass Co., 350 Sansome St., San Francisco (operator, 1957)	SE¼ 16 NE¼ 21	4S	6W	SB	Athwart State Highway 71 on west side of Temescal Wash 5½ miles southeast of Corona. Quartz-rich Paleocene sands are processed to furnish large tonnage of clean, high-silica sand used to make glass. Operated by P. J. Weisel Industrial Sand Co. from about 1920 to 1945; by Owens-Illinois Glass Co. since then. New plant built in 1947 has been in continuous operation since January 1948. (Tucker & Sampson 29:504; 45:163-164; herein.)
56	Coronita Ranch sand deposit	Donald C. McMillan, 8704 Colima Rd., Whittier, and Joel D. Middleton, 9531 Heather Road, Beverly Hills (1957)	SW¼ 16 E½ SE¼ 17	4S	6W	SB	Lower Bedford Wash 4½ miles southeast of Corona, adjoins northwest part of Corona sand deposit. Exploratory drilling in April 1957 penetrated quartz-rich Paleocene sand. Deposit has not been developed. (Brown 57:8 pp.; herein.)
	Findley feldspar placer						See under clay.
	Hoag Ranch						See Jones sand deposit.
57	Jones (Hoag Ranch) sand deposit	Riverside Cement Company, Division of the American Cement Corporation, P.O. Box 832, Riverside (1958)	SW¼ 17	4S	6W	SB	Ridge between Bedford and Joseph Canyons, 4 miles southeast of Corona. Pliocene unconsolidated sand. Long idle except for extensive drilling and sampling done in September, 1958. (Tucker & Sampson 29:505; 45:163; Sampson and Tucker 31:443; herein.)
	Nonhof						See under foundry sand.
	Owens-Illinois Glass Co., Corona sand plant No. 96						See Corona silica sand deposit.
58	Temescal Canyon silica sand deposit	Arthur E. Garratt, 3340 Eastern Ave., Los Angeles 32 (1957); patented land former railroad section; L. M. Freeman, Los Angeles (1931)	NE¼ 29	4S	6W	SB	Five miles southeast of Corona, southeast of Bedford Motorway. Coarse, weakly indurated white arkose of the Vaqueros and Sespe formations, undifferentiated; and Silverado formation sandstone. Production undetermined but apparently small, if any, and before 1930. (Sampson and Tucker 31:444, herein.)
	P. J. Weisel Industrial Sand Company						See Corona sand deposit.

ROCK PRODUCTS—Continued
Specialty Sands (Foundry Sand)

No.	Name of claim or mine	Owner (name and address)	Location				Remarks and references
			Sec.	T.	R.	B. & M.	
59	Jackson & Havens	William H. Redding, et al., 1008 S. Pacific Ave., San Pedro (1957); George W. Lord, Corona (1924); leased to Jackson and Havens, Riverside (operator, 1924)	SW¼ (?) 11	4S	7W	SB	Three miles southwest of Corona midway between Main St. and Hagador Canyons, along the margin of the Santa Ana Mts. A bed of white "molding" sand about 30 ft. thick composed of coarse, white, sub-angular arkose (Paleocene Silverado formation) overlain by about 2 ft. of gravel and soil overburden (Quaternary terrace) 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. The deposit was worked by open cuts, the material being loaded into small mine cars and transported to loading bins. During 1922 sand was shipped to Union Tool Co., Los Angeles. Production undetermined, but apparently small. By 1956 all equipment had been removed.
60	Nonhof	Arthur Weirick, Chase & Skyline Dr., Corona (1956); E. R. E. Nonhof, 1116 Ramona Ave., Corons (1924)	NW¼ 10	4S	7W	SB	Three miles southwest of Corona, west side of lower Hagador Canyon. Bedded deposit of sand, 50 ft. thick, reported in 1924 to occur in unconsolidated sands, gravels and clays (of Paleocene Silverado formation). Sand deposit covered about 2 acres with a 5 ft. overburden of gravel and soil (Quaternary terrace). 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 Co., about 1905. Development in 1924 consisted of open cuts and one adit 50 ft. long; by 1956 the workings were not identifiable and may have been destroyed by work at the adjacent McKnight clay mine. Production undetermined, but apparently small. Long idle. (Aubury 06:375.)

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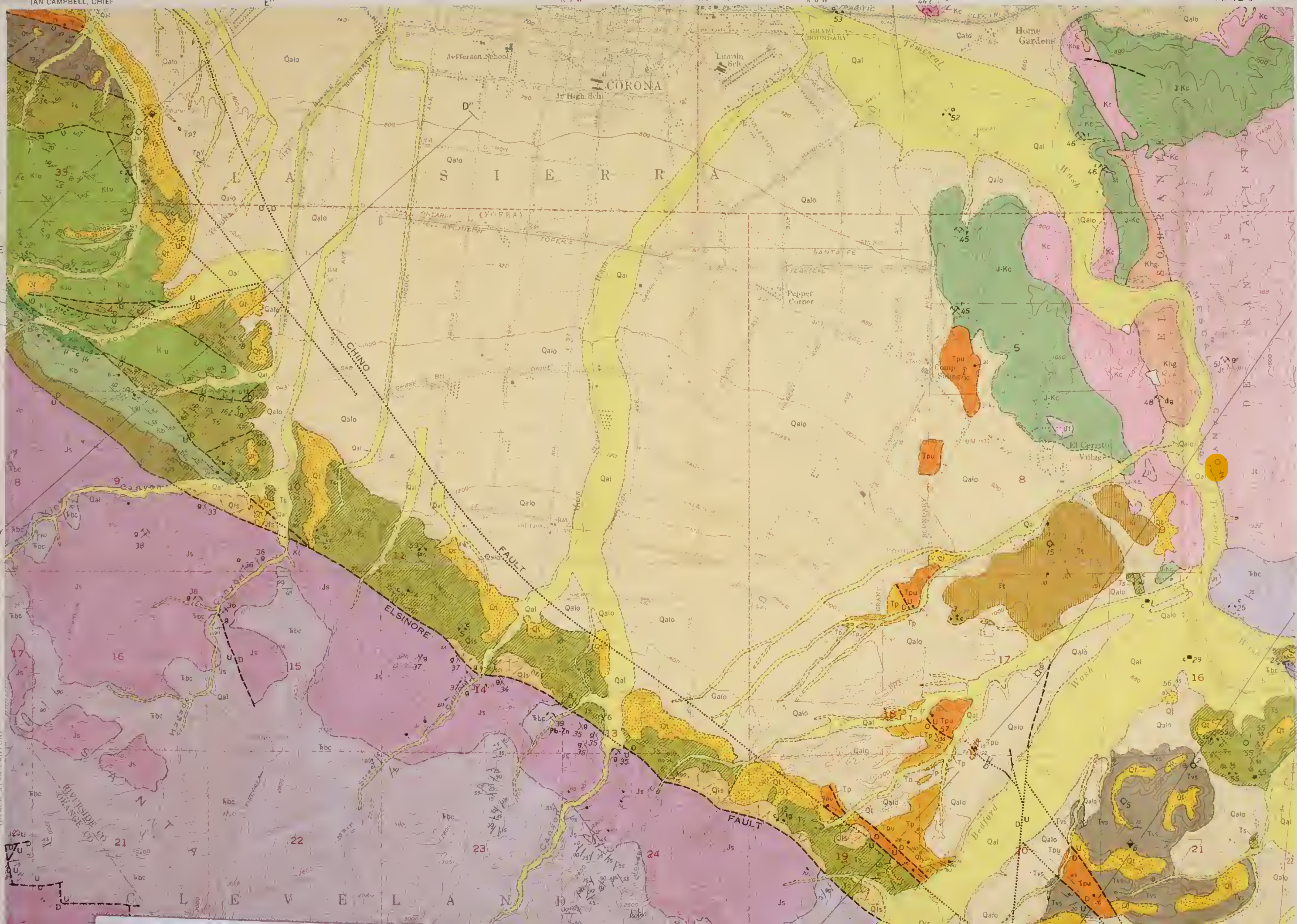


EXPLANATION

SURFICIAL DEPOSITS

QUATERNARY

Recent

Qls — Landslide

Qal — Alluvium
Gravel, sand, silt

Pleistocene (?)

Qalo — Older alluvium
Sand, gravel, and rubble; buff and gray in color

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

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

Miocene — Middle

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

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

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

Klu — Ladd formation, undifferentiated
Greenish gray sandstone and conglomerate, buff siltstone and shale, marine

Ladd formation

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

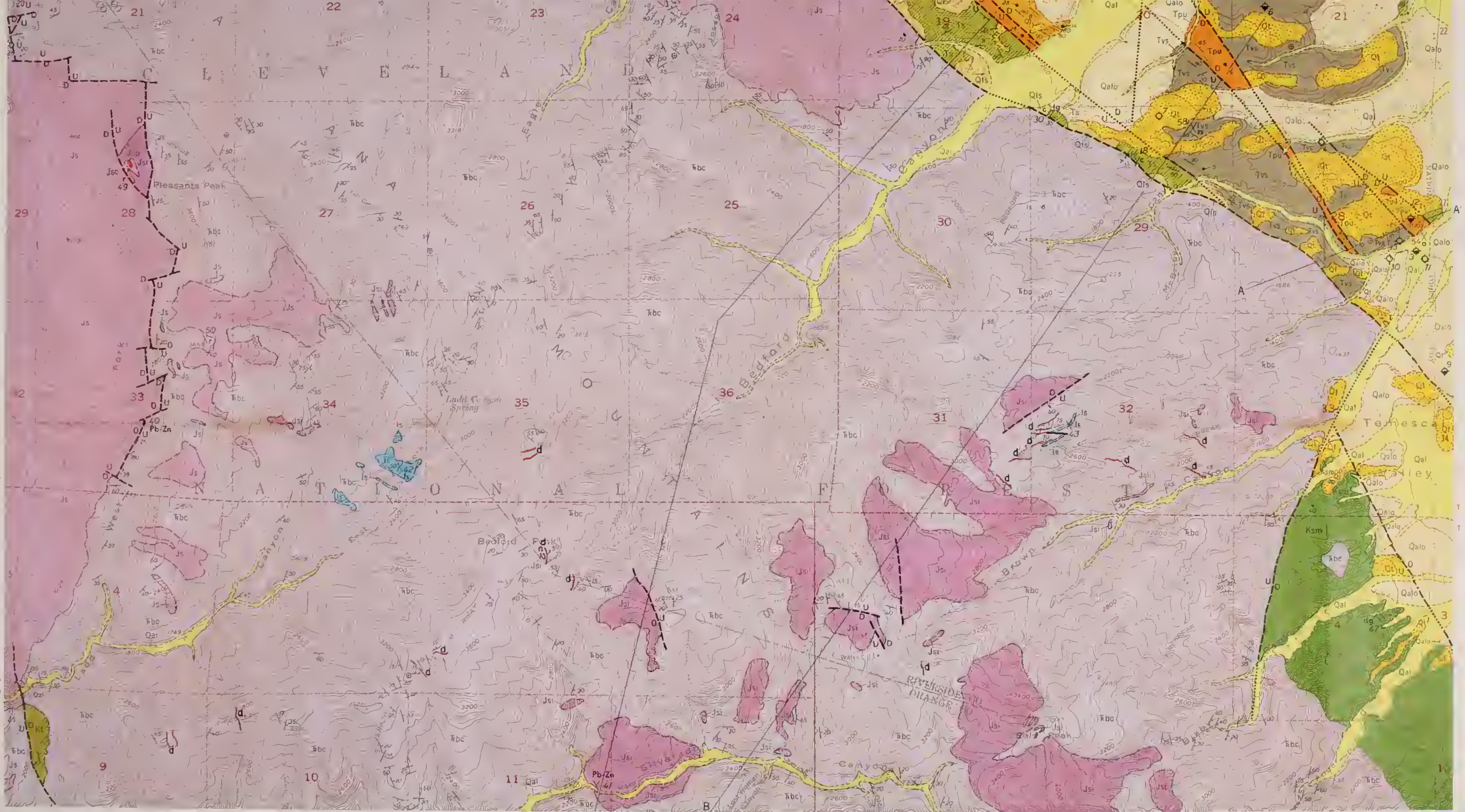
Kt — Trabuco formation
Red, buff and grayish-green massive conglomerate, minor sandstone, probably nonmarine

IGNEOUS & METAMORPHIC ROCKS

…ACEOUS (?)

Kmp — Micropegmatite granite
Pink, fine-grained granular rock

Khg — Home Gardens quartz monzonite porphyry
Light gray biotite quartz monzonite



Topographic base map by U.S. Geological Survey 1954
Topography from aerial photographs by multiplex methods and by plane-table surveys 1933
Aerial photographs taken 1952. Field check 1954
Polyconic projection. 1927 North American datum
10,000-foot grid based on California coordinate system, zone 6
Dashed land lines indicate approximate locations

Geology surveyed 1950-56

GEOLOGIC AND ECONOMIC MAP OF THE CORONA SOUTH QUADRANGLE, CALIFORNIA

By Cliffton H. Gray, Jr.

1960

SCALE 1:24000

CONTOUR INTERVAL 40 FEET
DASHED LINES REPRESENT HALF INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION 1954

Igneous geology after Pampeyan, 1952.

CRETACEOUS (?)

Micropegmatite granite
Pink, fine-grained granular rock

Khg
Home Gardens quartz monzonite porphyry
Light gray biotite quartz monzonite

Kc
Cajalco quartz monzonite
Pinkish to tan massive granitic rock

Ksm
San Marcos gabbro
Dark medium-grained rock, quartz diorite to gabbro

J-Kc
Corona hornblende granodiorite porphyry
Dark gray porphyritic rock, abundant mafic minerals

JURASSIC (?)

Jt
Temescal Wash quartz latite porphyry
Blue-black to gray quartz latite to dacite porphyritic rock

Js
Santiago Peak volcanics
Andesitic and dacitic flows and breccias, slightly metamorphosed

Jsi, Jsc
Intrusive rocks related to Santiago Peak volcanics
Andesitic and dioritic bodies, slightly metamorphosed; Jsp, serpentine; Jsc, silica carbonate rock

TRIASSIC (?)

Ȓbc, ls
Bedford Canyon formation
Dark gray to brown argillite, slate and graywacke, with thin beds of quartzite and limestone; ls, area mostly of limestone

SYMBOLS

Contact, dashed where approximately located

Indefinite contact

Inferred boundaries

Fault, showing dip (dashed where imperfectly exposed, dotted where concealed)
U, upthrown side; D, downthrown side

Strike and dip of beds — Overturned beds

Strike of vertical beds — Horizontal beds

Strike and dip of joints — Strike of vertical joints

Dike (dacites & andesites; 5 to 30 ft. thick; related to Jsi).

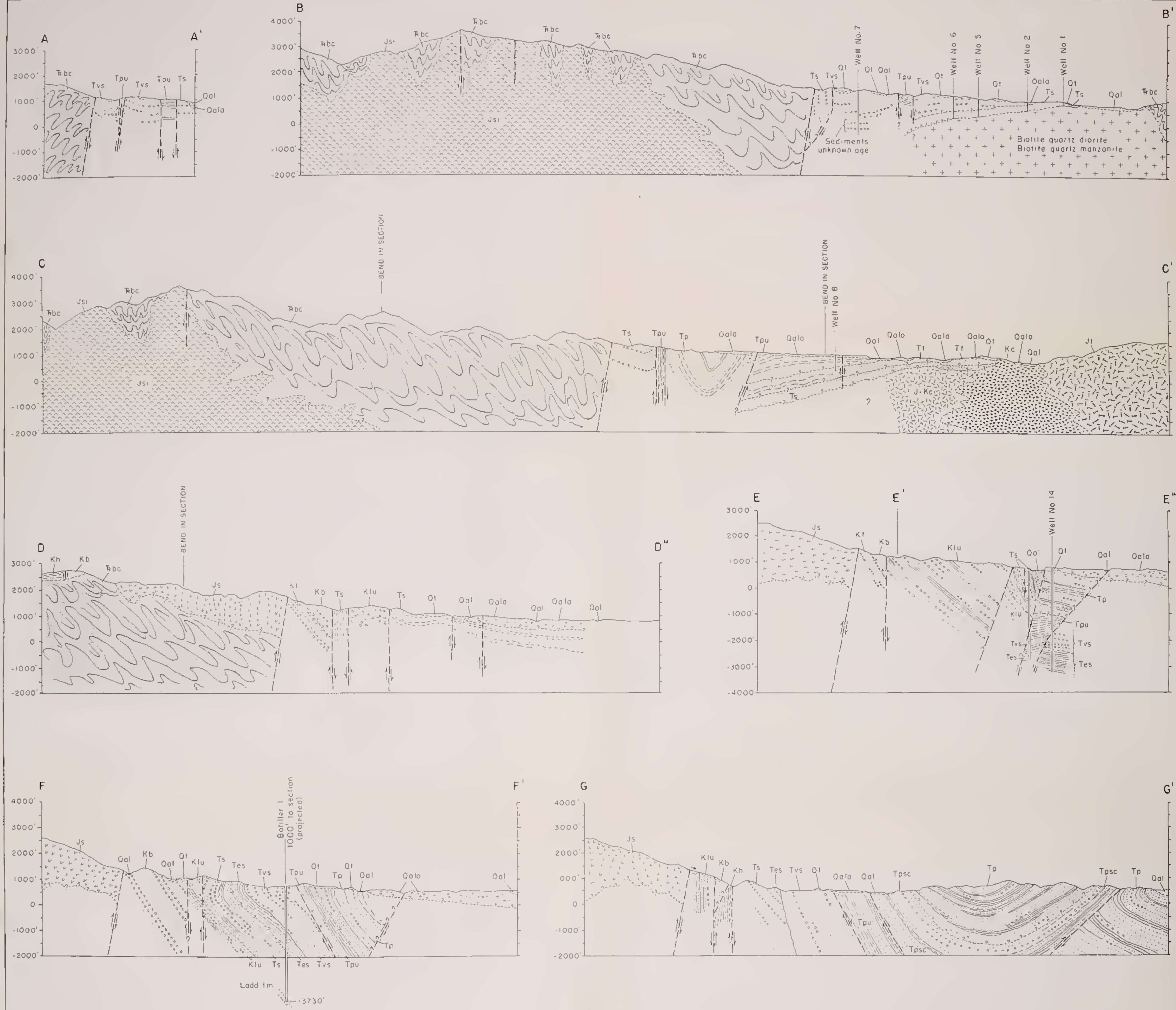
Fossil locality
(See table in text)

Mine or quarry — Prospect

Sand, gravel or clay pit — Mineral products processing or manufacturing plant

Au = gold Pb-Zn lead-zinc a = aggregate c = clay
dg decomposed granite g gypsum gr = roofing granules
lg = lignite ls = limestone r = rock ss = specialty sands

Water well — Oil well, dry hole with show of oil or gas — Oil well, dry hole
(See tabulated list in text)



MAP SYMBOLS

Contact
dashed where approximately located

Inferred boundaries

Landslide

Fault
showing relative movement

EXPLANATION

Qal, alluvium, Qala, older alluvium; Qt, terrace deposits; Tp, Pliocene, undifferentiated, Tpu, Puente formation, undifferentiated; Tpsc, Sycamore Canyon member (Puente formation); Tt, Topanga formation; Tvs, Vaqueros and Sespe formations, undifferentiated, Tes, Santiago formation; Ts, Silverado formation; Klu, Ladd formation, undifferentiated, Kh, Holz shale member (Ladd formation), Kb, Baker Canyon conglomerate member (Ladd formation), Kt, Trabuco formation; Kc, Cajalco quartz monzanite; J-Kc, Corona hornblende granodiorite porphyry, Jt, Temescal Wash quartz latite porphyry; Js, Santiago Peak volcanics; Jsi, intrusive rocks related to Santiago Peak volcanics; TRbc, Bedford Canyon formation

For full description see explanation on Plate 1, for well records see Figure 45

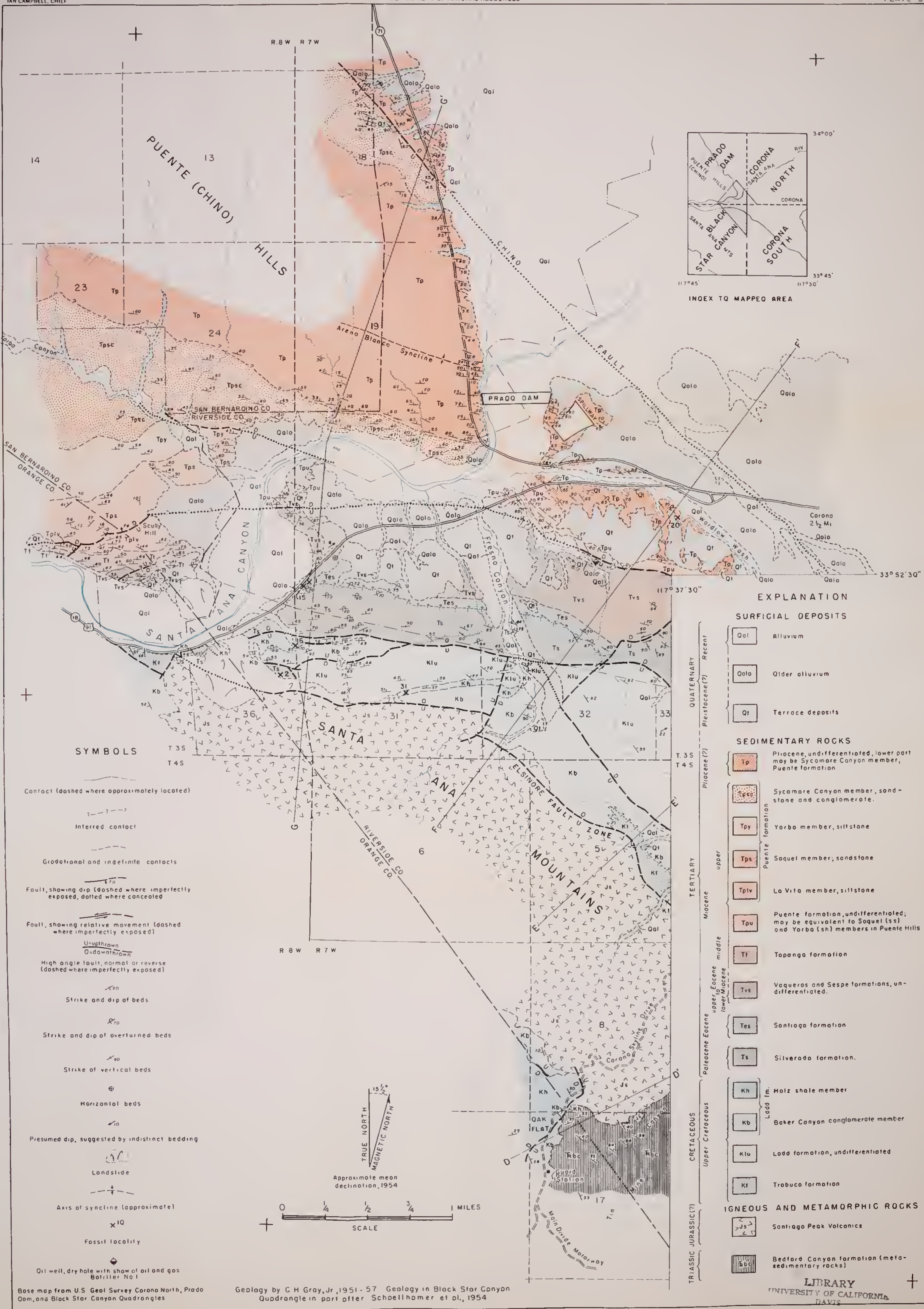
SCALE IN MILES

1 .5 0

by Cliffton H Gray, Jr

GEOLOGIC SECTIONS OF CORONA SOUTH QUADRANGLE AND SANTA ANA NARROWS AREA,

RIVERSIDE, ORANGE, AND SAN BERNARDINO COUNTIES, CALIFORNIA


PUENTE (CHINO) HILLS
SANTA ANA MOUNTAINS
SANTA ANA CANYON
ELSINORE FAULT ZONE
CHINO FAULT
Arena Blanco Syncline
PRADO DAM
SPILLWAY
Fresno Canyon
Wardlow Wash
Scully Hill
OAK FLAT
Corona 2 1/2 Mi
SAN BERNARDINO CO
RIVERSIDE CO.
SAN BERNARDINO CO
ORANGE CO.
RIVERSIDE CO
ORANGE CO
Main Divide Motorway
117° 37' 30"
33° 52' 30"
PRADO DAM
CORONA NORTH
PUENTE (CHINO) HILLS
SANTA ANA
CORONA
RIV
SANTA ANA MTS
BLACK STAR CANYON
CORONA SOUTH
34°00'
33°45'
117°45'
117°30'
INDEX TO MAPPED AREA
EXPLANATION
SURFICIAL DEPOSITS
QUATERNARY
Recent
Pleistocene(?)
Qal Alluvium
Qolo Older alluvium
Qt Terrace deposits
SEDIMENTARY ROCKS
TERTIARY
Pliocene(?)
Miocene
upper
middle
upper Eocene to lower Miocene
Paleocene Eocene
Tp Pliocene, undifferentiated, lower part may be Sycomore Canyon member, Puente formation
Tpsc Sycomore Canyon member, sandstone and conglomerate.
Puente formation
Tpy Yorba member, siltstone
Tps Soquel member; sandstone
Tplv La Vita member, siltstone
Tpu Puente formation, undifferentiated; may be equivalent to Soquel (ss) and Yorba (sh) members in Puente Hills
Tt Topanga formation
Tvs Vaqueros and Sespe formations, undifferentiated.
Tes Santiago formation
Ts Silverado formation.
CRETACEOUS
Upper Cretaceous
Ladd fm.
Kh Holz shale member
Kb Baker Canyon conglomerate member
Klu Ladd formation, undifferentiated
Kt Trabuco formation
IGNEOUS AND METAMORPHIC ROCKS
JURASSIC(?)
TRIASSIC
Js Santiago Peak Volcanics
Bedford Canyon formation (metasedimentary rocks)
SYMBOLS
Contact (dashed where approximately located)
Inferred contact
Gradational and indefinite contacts
Fault, showing dip (dashed where imperfectly exposed, dotted where concealed)
Fault, showing relative movement (dashed where imperfectly exposed)
U=upthrown
D=downthrown
High angle fault, normal or reverse (dashed where imperfectly exposed)
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Horizontal beds
Presumed dip, suggested by indistinct bedding
Landslide
Axis of syncline (approximate)
Fossil locality
Oil well, dry hole with show of oil and gas
Bothiller No 1
TRUE NORTH
MAGNETIC NORTH
13 1/2°
Approximate mean declination, 1954
0 1/4 1/2 3/4 1 MILES
SCALE
R.8W R.7W
T.3S
T.4S
Base map from U.S. Geol Survey Corona North, Prado Dam, and Black Star Canyon Quadrangles
Geology by G H Gray, Jr, 1951-57 Geology in Black Star Canyon Quadrangle in part after Schoellhamer et al., 1954

GENERALIZED COLUMNAR SECTION

Era	Period	Age	Formation	Member	Map Symbol	Maximum Thickness Outcrop	Lithology	Description
CENOZOIC	QUAT	RECENT	Alluvium		Qal	100'		Gravel, sand, silt.
CENOZOIC	QUAT	RECENT (?) & PLEISTOCENE	Older Alluvium		Qalo	100'		Reddish-brown to buff gray dirty sand and gravel, a few boulders.
CENOZOIC	QUAT	RECENT (?) & PLEISTOCENE	Terrace Deposits		Qt	150'		Reddish-brown to buff and gray dirty sand and gravel, angular, some boulders.
								Unconformity
CENOZOIC	TERTIARY	PLIOCENE (?)	Pliocene (undifferentiated)		Tp	3000'		South of Chino Fault: Heavily-bedded white sandstone and conglomerate, with lesser amounts of buff to gray sandy silts and shale. North of Chino Fault: Mostly buff to gray sandy silt and shale. Minor conglomerate and sandstone lenses. Marine.
CENOZOIC	TERTIARY	UPPER AND MIDDLE (?) MIOCENE	Puente	Sycamore Canyon	Tpsc	2700'		Coarse sandstone and conglomerate, with interbedded siltstone. Marine.
CENOZOIC	TERTIARY	UPPER AND MIDDLE (?) MIOCENE	Puente	Yorba Shale	Tpy	1200'		Buff to gray, massive to fissile siltstone, interbedded fine sandstone. Marine.
CENOZOIC	TERTIARY	UPPER AND MIDDLE (?) MIOCENE	Puente	Soquel Sandstone	Tps	700'		Sandstone and conglomerate, minor amount of interbedded buff and gray siltstone. Marine.
CENOZOIC	TERTIARY	UPPER AND MIDDLE (?) MIOCENE	Puente	La Vida Shale	Tplv	800'		Buff to gray siltstone, minor interbedded sandstone. Marine.
CENOZOIC	TERTIARY	UPPER AND MIDDLE (?) MIOCENE	Puente (undifferentiated)		Tpu	1000' ?		Buff to pinkish-gray siltstone and shale, considerable diatomite, numerous hard limy beds up to 1 ft. thick with many Miocene forams, minor amounts of buff to tawny sandstone and cobble conglomerate. Marine.
								Unconformity
CENOZOIC	TERTIARY	MIDDLE MIOCENE	Topanga		Tt	800'		Buff to tawny sandstone, siltstone and shale, minor cobble conglomerate. Marine.
								Unconformity
CENOZOIC	TERTIARY	LOWER MIOCENE TO UPPER EOCENE (?)	Vaqueros (lower Miocene) and Sespe (upper Eocene to lower Miocene) formations, undifferentiated		Tvs	2300'		White to buff, red, and green sandstone and grit with conglomerate up to 70% composed of red and purple volcanic clasts. Minor amount of greenish-gray siltstone. Interfingering marine and non-marine.
								Unconformity
CENOZOIC	TERTIARY	EOCENE	Santiago		Tes	600'		Interbedded sandstone, siltstone and conglomerate with numerous red volcanic clasts. Sparse Eocene fauna, Turritella cf. T. buwaldana. Marine.
CENOZOIC	TERTIARY	PALEOCENE	Silverado		Ts	2000'(?)		Interbedded sandstone, siltstone, grit and conglomerate. Buff to red basal clay horizon with minor amount of pisolitic clay and lignite. Red mottled residual clay at base. Good Paleocene fauna, Turritella pachecoensis. Marine and non-marine, probably interfingering.
								Unconformity
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	Ladd	Holz Shale	Kh	500'		Gray to black silt, large limy concretions. Locally contains silty clay. Marine.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	Ladd	Baker Canyon	Kb	1400'		Buff to tawny heavily-bedded sandstone and conglomerate. Good fauna: Trigonarca californica, Glycymeris pacificus. Marine.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	Ladd (undifferentiated)		Klu	3500'		Buff siltstone and shale; buff to white sandstone and sandy conglomerate. Fragments of Upper Cretaceous ammonites from several localities. Marine.
MESOZOIC	CRETACEOUS	CRETACEOUS	Trabuco		Kt	600'		Red, buff and grayish-green boulder conglomerate, many red granitic clasts. Evidently grades laterally into Baker Canyon. Non-marine (?)
								Unconformity
MESOZOIC	CRETACEOUS	CRETACEOUS ?	Home Gardens quartz monzonite porphyry		Khg			Light gray porphyritic to porphyro-aphanitic biotite quartz monzonite. Includes pink micro pegmatite granite west of Home Gardens.
MESOZOIC	CRETACEOUS	CRETACEOUS ?	Cajalco quartz monzonite		Kc			Pinkish to tan massive granitic rock.
MESOZOIC	CRETACEOUS		San Marcos gabbro		Ksm			Dark, medium grained granitic rock. Extremely variable; from hornblende quartz diorite to hypersthene biotite gabbro, with diabasic or ophitic texture.
MESOZOIC	JURASSIC	JURASSIC ?	Corona hornblende granodiorite porphyry		J - Kc			Dark porphyry rock with slightly variable texture and composition of granodiorite.
MESOZOIC	JURASSIC	JURASSIC ?	Temescal Wash quartz latite porphyry		Jt			Blue-black to gray quartz latite to dacite porphyritic rock.
MESOZOIC	JURASSIC	JURASSIC ?	Santiago Peak volcanics		Js			Slightly metamorphosed andesitic and dacite flows and breccias, volcanic conglomerate at base. Non-marine (?)
MESOZOIC	JURASSIC	JURASSIC ?	Intrusive rocks related to Santiago Peak volcanics		Jsi			Small hypabyssal intrusive masses. Mostly hornblende andesite and diorite. Slightly metamorphosed.
								Unconformity
MESOZOIC	TRIASSIC		Bedford Canyon		Ŧbc	?		Argillites and slate; considerable quartzite; minor amount of limestone. Marine.

BULLETIN 178
PLATE 1

EXPLANATION

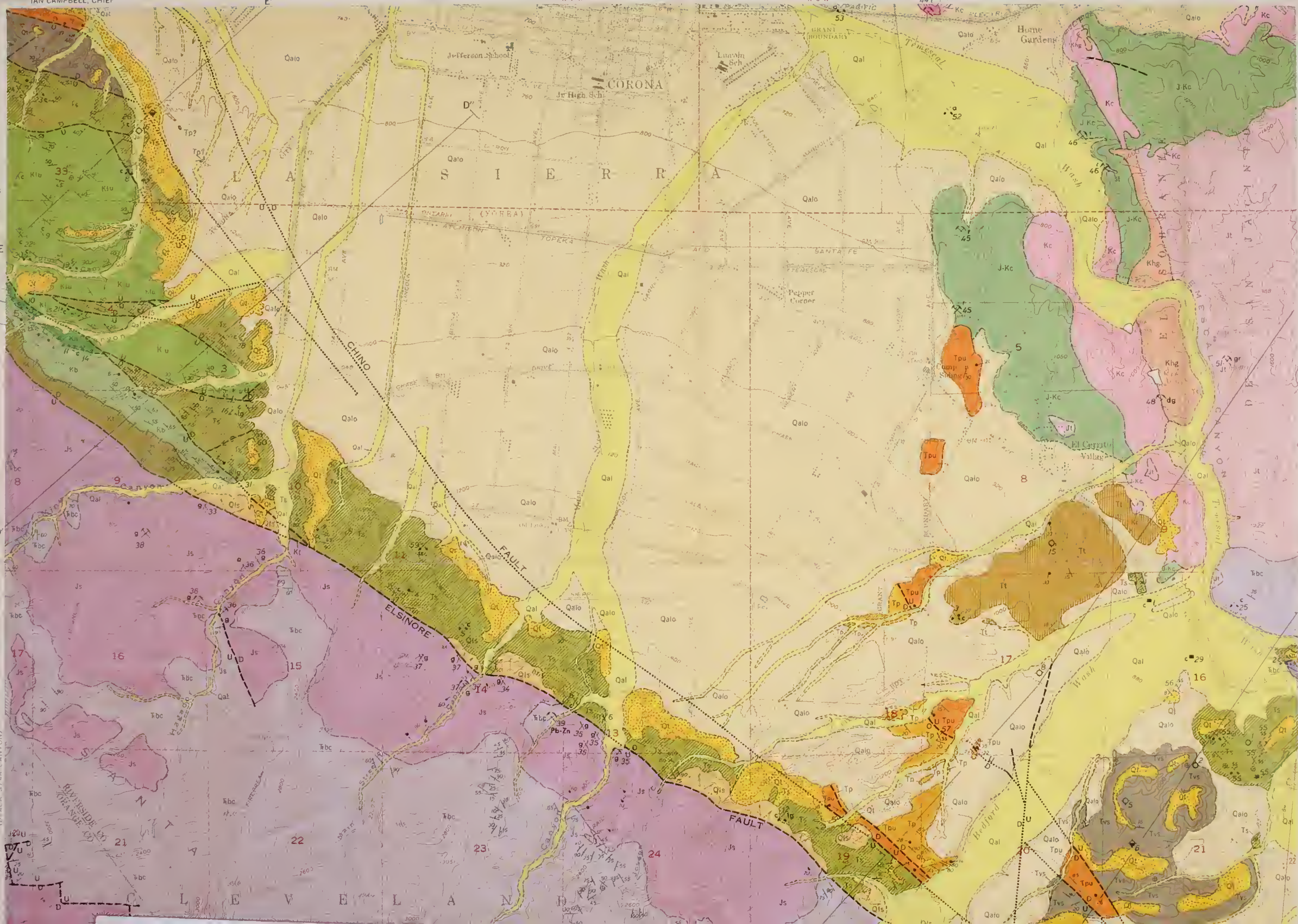
SURFICIAL DEPOSITS

Qls

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

Pleistocene (?)

Qalo
Older alluvium
Sand, gravel, and rubble; buff and gray in color

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

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

Middle

Tt
Topanga formation
Buff sandstone, conglomerate, and sandy siltstone, marine

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

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

Klu
Ladd formation, undifferentiated
Greenish gray sandstone and conglomerate, buff siltstone and shale, marine

Ladd formation

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

ACEOUS (?)

Kmp
Micropegmatite granite
Pink, fine-grained granular rock

Khg
Home Gardens quartz monzonite porphyry
Light gray biotite quartz monzonite

Saul, R. B., Gray, C. H. Jr. and Evans, J. R., 1961, *Mines and Mineral Resources of Riverside County, California,* California Division of Mines and Geology, unpublished, preliminary manuscript.

Saul, R.B., Gray, C.H., and Evans, J.R., 1968, "Mineral Resources, Mines and Prospects of Riverside County" California Division of Mines and Geology (unpublished) preliminary manuscript, 357 p.

PREFACE TO BLM-DPS EDITION

On 11-16-78, we obtained a carbon copy of this report from Clifton Gray, Jr. of the CDMG in Los Angeles. He felt that it was the only copy in the possession of the CDMG at that time. Photocopying of this edition was completed at DPS on 11-21-78

According to Mr. Gray, the CDMG copy (kept in file folders) was dropped several years ago. The report was then paginated in the order it was picked up. While being photocopied at DPS, several errors were made in the paginated sequence. Neither these, nor the CDMG errors have been rectified as of this date. As a result, not all pages are in order. Some pages dealing with one commodity may be found within another section. Misplaced pages are probably near where they belong, so a short search may locate them. Some pages may be missing altogether, although no such omissions have been discovered as of this date.

Some years ago, according to Mr. Gray, all photographs and diagrams for this report were accidentally discarded.

This report was used to provide background information for reports in some G-E-M Resources field areas. When information could be verified or updated by DPS field work, it was added, dated, and initialed. NOT ALL VERIFICATIONS OR UPDATES HAVE BEEN NOTED HEREIN! Numbers written next to claim name are map index numbers.

This report has never been published. It cannot be replaced. PLEASE HANDLE IT CAREFULLY!

DPS G-E-M Resources
M.W. Shumaker
11-24-78

Riverside Co.

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.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
Preliminary Manuscript

SUBJECT TO REVISION

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. Such 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.

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 underlain by basin-range structure. Here, no evidence of recent movement on range-bounding faults was found, but, locally, late Tertiary gravel is faulted and deformed.

Status of Lands

Figure __/, Plate __/, and table __/ 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.__/) 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 claim notices and affidavits of assessment work as proof of abandonment. Such notices are subject to destruction by the elements, insects, rodents, and vandalism.

Abstract

Limestone, for the manufacture of portland cement, is mined from bodies of pre-Cretaceous metamorphic rock in the Crestmore Hills. At present this is the only such operation in Riverside County and 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 stone 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, with European origins, 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.

In 1960 this county ranked 8th in value of annual mineral production in California with a total of $36,692,145. In the period 1893-1960 mineral production in Riverside County had a total reported value of $504,170,144. 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.

Virtually all of the metaliferous lode deposits except iron ore are in or closely associated with old, inactive faults some of which originated during the intrusion of the Mesozoic Southern California Batholith. 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 1891-1961, mineral commodities valued at about $842 million were produced in Riverside County. A major part of this total comprises the combined values of iron ore, limestone for cement, sand and gravel, stone, gypsum, and clay.

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 and the largest known deposit of iron ore in the west. 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 small scale.

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, 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. Iron, rare earths, and deposits of radioactive minerals were described by Evans except for several minor deposits of iron at the east end of the county.

Certain published reports warrant particular acknowledgment. The work of Rene 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 former Division of Mines engineers and geologists, especially those by Reid J. Sampson and W. Burling Tucker. The completeness of the report was enhanced by unpublished data 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).

Bennie W. Troxel, Cliffton H. Gray, and Dr. Lauren A. Wright contributed their experience and constructive criticism to all phases of the work. Many useful suggestions were offered by other members of the Division of Mines and Geology.

Geography

Riverside County is bounded on the south by Imperial and San Diego Counties, the west by Orange County, and the north by San Bernardino County. The Colorado River forms the eastern boundary and Arizona lies further east. Because it includes parts of several geologic and physiographic provinces, Riverside County possesses a diversity of topography and climate.

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 west 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.

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 [illegible]ee 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
Reconnoissance 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	19(14) 41	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, Berkeley
--- 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.)

— MINING DISTRICTS —

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 __/. 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 reports use different, and sometimes conflicting, names for similar areas. The Ironwood district, for example, once included 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 __/.

The offices of the county assessor and recorder, both of which are in the courthouse in Riverside, 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 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. __/). 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, 19__). These markers should be used where available.

G E O L O G Y

General Features

Riverside County lies athwart a mosaic of natural provinces (fig. __/) 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 Croccpia, Chuckwalla, Cocks-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. __/), 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 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 __/, 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 __/) 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 Orocopia Schist, Pinto Gneiss and Chuckwalla Complex.

The Orocopia Schist was 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 underlie 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 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.

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 meta-igneous 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 Cotton-wood, Little San Bernardino Orocopia, Eagle, Chuckwalla, Little Chuckwalla, Mule and Big Maria Mountains, [illegible]

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 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. 1369) 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". 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.

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 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 Coxcomb 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 a small iron deposit 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.

Other early Mesozoic metasedimentary rocks are exposed on the east slope of the Santa Ana Mountains and east and southeastward to Domengioni 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 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, Cockscomb, 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).

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 Cockscomb 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 rough 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 Quartz 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. These dikes are probably late Mesozoic in age. Miller (1944, p. 32) suggested that the replacement iron ore deposits in the Eagle Mountains are of late Mesozoic 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 1400-foot sandstone called the Baker Canyon Member. and an overlying silt- to silty clay called the Holz Shale.

Woodring and Popence (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 conformably 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, and 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, p. 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 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 1000 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: 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 1000 feet of siltstone, shale, diatomite, limy beds and minor sandstone and conglomerate.

The Soquel Sandstone Member is 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 1200 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.

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 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 1800 feet and the overlying sandstone and shale 1500 feet. The Mount Eden Formation is exposed in the area of Potrero Creek and its tributaries. The Pliocene age of the Mount Eden Formation 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).

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 calcarious tuff, estimated (Fraser, 1931, p. 515) to be 1500 to 2000 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 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 Palm Spring Formation (Woodring, 1931) is made up of 3,300 to 4,800 feet of nonmarine(?), 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. A ~~paired valves of a~~ specimen (paired valves) of the marine pelecypod genus <u>Rangia</u> ~~were~~ was found by the author in a clay unit in the upper part of the Palm Spring Formation about 4½ miles east of Thermal.

The Palm Spring Formation grades northeastward into the Canebreak Conglomerate, described by Dibblee as a marginal facies, 0 to 3,000 feet thick (1954, p. 25, fig. 3).

The Palm Spring Formation and Canebrake Conglomerate are overlain unconformably by the Ocotillo Conglomerate. This 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 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, 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.

The 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 Salton Sea, contains a fauna of mullusks, orbitoids and small foranminifera. These marine rocks constitute about 4800 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 non marine, 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 __/). The volcanic rocks exposed in the Orocopia Mountains might be roughly synchronous with the Dos Palmas Rhyolite to the west and 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.

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 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 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 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.

The basin in and around which the marl and travertine deposits formed was probably 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 __/).

Lee described the Chemehuevis Gravel (1908, p. 18), as a valley filling as much as 700 feet thick deposited during an aggrading stage of the Colorado River. 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 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 not yet (1961) developed (Tucker and Sampson, 1945, pl. 35).

R. Saul 10/?/?

LIST OF MINES AND MINERAL DEPOSITS IN
RIVERSIDE COUNTY

(work sheet for map)

All locations within San Bernardino Base line and Meridian

No.	Name	Sec.	T.	R.	Quadrangle
	Antimony				
1.	Mountain Group	8	4S	7W	Black Star Canyon
	Arsenic				
2.	Shining Star	6	6N	4W	Lake Elsinore
	Asbestos				
3.	Charleboix (Percival Asbestos)	29,32	6S	5E	Palm Desert
	Beryllium				
4.	Santa Rosa Mountain	19	7S	5E	Idyllwild
	Clay				
5.	Atlas Pit	26	4S	6W	Lake Mathews
6.	Bedford Canyon (Corona) Clay Deposit	16	4S	6W	Corona South
7.	Brown	23,24	1S	23E	Vidal
8.	Cajalco	16	4S	6W	Corona South
9.	Chocolate Drop	17	4S	6W	Corona South
10.	Conduit Clay	32,33	3S	7W	Corona South
11.	Corona Clay Pit	26	4S	6W	Lake Mathews
12.	Corona Placer (Lord?)	14	4S	7W	Corona South
13.	Douglas Pit	22	5S	5W	Alberhill
14.	Eagle Canyon (Fraser)	13	4S	7W	Corona South
15.	Elsinore Clay Company (Norton) Clay deposit	31	5S	4W	Elsinore
16.	Elsinore Joint Property	26	5S	5W	Elsinore
17.	El Sobrante	26	4S	6W	Lake Mathews

No.	Name	Sec.	T.	R.	Quadrangle
18.	Ensco	33	3S	7W	Corona South
19.	Evans Shafts	31	5S	4W	Elsinore
20.	Findley Feldspar	33	3S	7W	Corona South
21.	Findley Graphite	4	4S	7W	Corona South
22.	Findley Prospect	2	5S	6W	Lake Mathews
23.	Fire Clay	4,5	4S	7W	Corona South
24.	Grapevine	4	4S	7W	Corona South
25.	Harlow Pit	15	4S	6W	Lake Mathews
26.	Harrington (Ensco) Pit	25	4S	6W	Lake Mathews
27.	Hoist Pit	26	5S	5W	Elsinore
28.	International Pipe & Ceramics Corp., Corona Plant	16	4S	6W	Corona South
29.	International Pipe & Ceramics Corp. (Gladding, McBean & Co.)Alberhill Dist.	21,22	5S	5W	Alberhill
30.	Jones (Hoffman, Hoag Ranch)	19	4S	6W	Corona South
31.	Jordan Tile Manufacturing Company	26	3S	7W	Corona North
32.	Kroonen (Keno, Dutch Placer)	4,9,10	4S	7W	Corona South
33.	Liston Brick Company	16	4S	6W	Corona South
34.	Los Angeles Brick & Clay Products Co.	21,22,28	5S	5W	Alberhill
35.	McClintock	4	4S	7W	Corona South
36.	McKnight	3,9,10	4S	7W	Corona South
37.	Middlesworth (Brown Star, Lord? Freeman?)	11,14,15	4S	4W	Corona South
38.	Mount (Mission) Clay Products	34	4S	6W	Lake Mathews
39.	Murphy Pit	35	4S	6W	Lake Mathews
40.	Oak Park Clay Prospect	18	5S	5W	Alberhill
41.	Pacific Clay Products Alberhill Mines	15,22,23,26	5S	5W	Alberhill
42.	Pacific Clay Products, Corona Plant	26	3S	7W	Corona North
43.	Pacific Clay Products, DeGuerre Mines	27	5S	5W	Alberhill
44.	Palen Mountains	24,25	5S	17E	Sidewinder Well
45.	Park	26	4S	6W	Lake Mathews
46.	Peterson's	29	4S	6W	Corona South
47.	Prospect (name undetermined)	14	5S	5W	Elsinore
48.	Prospect (name undetermined)	16	5S	5W	Alberhill
49.	Quintet	26	4S	6W	Lake Mathews
50.	Red Top	20,21	6S	9E	Thermal Canyon

No.	Name	Sec.	T.	R.	Quadrangle
51.	Sievert Clay Prospect	36	6S	5W	Wildomar
52.	Silt deposit (name undetermined)	5	5S	3W	Perris
53.	Sky Ranch Clay Company Deposits=	4,5	4S	7W	Corona South
54	Sky Ranch	4	4S	7W	Corona South
55.	South Pit	35	4S	6W	Lake Mathews
56.	Susie Placer (McVicar Pit)	4	4S	7W	Corona South
57.	Switzer	5	4S	7W	Corona South
58.	Temescal	35	4S	6W	Lake Mathews
59.	Temescal Water Co.	35	4S	6W	Lake Mathews
60.	Terra Cotta Eighty	26	5S	5W	Alberhill
61.	Terra Cotta Plant Site	26=	5S	5W	Alberhill
62.	Thomas Clay Deposit, East Pit	33	3S	7W	Corona South
63.	Thomas Clay Deposit, West Pit	33	3S	7W	Corona South
64.	Tropico (Temescal) Tract	26	4S	6W	Lake Mathews
65.	Twin Springs (Temescal Sixty) Prospect	12	5S	6W	Lake Mathews
66.	Undetermined	16	4S	6W	Corona South
67.	Undetermined	33	3S	7W	Corona South
68.	Undetermined	4	4S	7W	Corona South
69.	Undetermined	3	4S	7W	Corona South
70.	Wardlow (Sky Ranch)	4,5	4S	7W	Corona South
71.	Wildomar Kaolin Deposit	7	7S	3W	Murrieta
	Coal				
72.	Alberhill Coal and Clay Company Coal Deposit (Colliers & Cheney Coal Mine)	22	5S	5W	Alberhill
73.	Dolbeer and Hoff Mine	26	5S	5W	Alberhill
	Copper				
74.	Anderson (Hope)	11,14	2S	12E	Dale Lake
75.	Aztec	30	4S	20E	Midland
76.	Big Basin (Hines) Copper Prospect	3	4S	6W	Lake Mathews
77.	Big Horn	32,33	3S	20E	Midland
78.	Cactus Hill	17	2S	5E	Thousand Palms
79.	Collins Prospect	4	4S	6W	Corona South
80.	Copper Point	10	2S	12E	Dale Lake

No.	Name	Sec.	T.	R.	Quadrangle
81.	Eagle Nest	30	4S	20E	Midland
82.	Green Hornet	32	7S	21E	McCoy Spring
83.	Homestake	7,18	4S	19E	Palen Mountains
84.	Indian Copper	18	2S	5E	Thousand Palms
85.	Little Mountain (Lion's Den)	7	4S	22E	Big Maria Mountains
86.	Nancy	3 ?	4S	13E	Eagle Tank
87.	Orphan Boy	10	3S	18E	Palen Mountains
88.	St. John	32	4S	20E	Midland
	Feldspar and Silica				
89.	Brown	35	4S	11E	Pinkham Well
90.	Bundy-Murrieta	17	6S	3W	Romoland
91.	California Land and Mineral Co.	4,5	7S	3W	Murrieta
92.	Coahuila Brave (Williamson)	17	7S	2E	Hemet
93.	Hemet Silica	26	5S	1W	Hemet
94.	Lang Silica	7	8S	2E	Aguanga
95.	Nettleton	14	6S	4W	Lake Elsinore
96.	Perris Mining Co.	16	6S	3W	Romoland
97.	Southern Pacific	31	4S	2W	Lakeview
98.	Spicer Silica	29	2S	4W	Riverside East
99.	Stone and Alexander	19	2S	5W	Riverside West
100.	Tully	32	4S	2W	Lakeview
101.	White Prince (Yellow Queen)	25	4S	5W	Steel Peak
	Fluorite				
102.	Fluorspar Group	10	3S	18E	Palen Mountains
103.	Orocopia Fluorspar	25	6S	12E	Canyon Spring
104.	Red Bluff	24	3S	20E	Midland
	Gems				
105.	Anita (Magee)	22	6S	1E	Hemet
106.	Belo Horizonte (Columbia Gem, California Gem, April Fool)	1	7S	3E	Idyllwild

No.	Name	Sec.	T.	R.	Quadrangle
107.	Pono (Simmons)	33	6S	2E	Hemet
108.	Juan Diego #1	5	7S	2E	Hemet
109.	Juan Diego #2	32	6S	2E	Hemet
110.	Mule Mountains, Fire Agate	26,27 — 34,35	8S	20E	Palo Verde Mountains
111.	Olinger Deposit	1	7S	2E	Idyllwild
112.	Schindler	29,30,32,33	6S	2E	Hemet
113	Storm-Jade Mountain	4	4S	13E	Eagle Tank
	Gold				
114.	Alice	25	1S	23E	Vidal
115.	Alica	24	6S	3W	Romoland
116.	Anaheim-	6	2S	10E	Valley Mountain
117.	Anna Bell	24	4S	22E	Big Maria Mountains
118.	Arlington Tunnel	13	4S	5W	Steele Peak
119.	Atlanta (Ronnie B)	1	2S	9E	Valley Mountain
120.	Augustine	8,17	8S	17E	Chuckwalla Spring
121.	Aztec and Rainbow	19	7S	17E	Sidewinder Well
122.	Barrel Tanks Placer	15?	2S	13E	Eagle Tank
123.	Beal	19	7S-	16E	Chuckwalla Mountains
124.	Bill Rush	19	2S	10E	Pinkham Well
125.	Black Butte (Gold Tiger)	10	2S	8E	Twentynine Palms
126.	Black Warrior (Gold Master ? Paymaster ?)	20	2S	10E	Pinkham Well
127.	Boss (Goat or Goat Basin)	1	2S	9E	Valley Mountain
128.	Brooklyn (36 1S 12E)	1	2S	12E	Dale Lake
129.	Brown (Hillside, Priest)	7	2S	20E	Rice
130.-	Brown Mine North	1	2S	19E	Rice
131.	Bryan	32	6S-	16E	Chuckwalla Mountains
132.	Cactus	22,27	3S	13E	Eagle Tank
133.	Captain Jinks (Jenks)	1	4S	10E	Pinkham Well
134.	Carlos Jr.	1	2S	9E	Valley Mountain
135.	Cathy Jean	25	1S	23E	Vidal
136.	Chuckwalla Spring	9,10,16	8S	17E	Chuckwalla Spring
137.	C.O.D.	2	7S	15E	Chuckwalla
138.	Combination Quartz	12?	4S	10E	Pinkham Well
139.	Copper Giant (?)	28	4S	9E	Lost Horse Mountain

No.	Name	Sec.	T.	R.	Quadrangle
140.	Corona (Peggy)	32	4S	4W	Steele Peak
141.	Cow Bell	2,10	2S	11E	Valley Mountain
142.	Crescent (Baumonk)	1	7S	14E	Chuckwalla Mountains
143.	Dalton	24?	2S	11E	Pinkham Well
144.	Desert King	14	2S	12E	Eagle Tank
145.	Desert Queen (McHaney)	5,6	2S	9E	Twentynine Palms
146.	Dr. Musick	19	4S	4W	Steele Peak
147.	Dos Palmas	16	7S	12E	Canyon Spring
148.	Dottie Welborn	31?	6S	15E	Chuckwalla Mountains
149.	Double Jack	19	6S	21E	McCoy Spring
150.	Duplex	14?	2S	12E	Eagle Tank
151.	Elton (Lucky Boy)	8	2S	9E	Twentynine Palms
152.	Eureka	6?	7S	15E	Chuckwalla Mountains
153.	Frank Hill (Star)	13?	2S	11E	Pinkham Well
154.	Gavilan	19	4S	4W	Steele Peak
155.	Gold Crown (Bon Ton)	10,15	2S	12E	Dale Lake
156.	Gold Crown (San Diego)	4 or 5	6S	15E	Chuckwalla Mountains
157.	Gold Cup	23?	6S	13E	Canyon Spring
158.	Gold Dollar	36	1S	23E	Vidal
159.	Gold Fields of America	5	3S	10E	Pinkham Well
160.	Gold Galena (Gold Coin)	8,9	3S	9E	Lost Horse Mountain
161.	Gold Park Consolidated(?) No. 1	2	2S	9E	Twentynine Palms
162.	Gold Park Consolidated (?) No. 2	1	2S	9E	Valley Mountain
163.	Gold Park Consolidated (?) No. 3	1	2S	9E	Valley Mountain
164.	Gold Park Consolidated (?) No. 4	6	2S	10E	Valley Mountain
165.	Gold Park Consolidated (?) No. 5	12	2S	9E	Valley Mountain
166.	Gold Point	5	3S	10E	Pinkham Well
167.	Gold Rice	12	2S	33E — 23E	Vidal
168.	Gold Shot	28	6S	4E	Idyllwild
169.	Gold Standard	1	2S	12E	Dale Lake
170.	Gold Standard	9,10	3S	8E	Lost Horse Mountain
171.	Golden Bee	16	3S	10E	Pinkham Well
172.	Golden Bell (Blue Bell)	8?	3S	10E	Pinkham Well

No.	Name	Sec.	T.	R.	Quadrangle
173.	Golden Bird	28	1S	22E	Vidal
174.	Golden Charlotte (Golden Chariot)	31	4S	4W	Steele Peak
175.	Golden Eagle	14?	5S	13E	Canyon Spring
176.	Golden Egg	14	2S	12E	Eagle Tank
177.	Golden Nuggett	34	5S	10E	Cottonwood Spring
178.	Golden Nugget	30	4S	4W	Steele Peak
179.	Golden Rod	1	2S	12E	Dale Lake
180.	Good Hope	15	5S	4W	Elsinore
181.	Granite	4	6S	15E	Chuckwalla Mountains
182.	Grandaddy	5	8S	21E	McCoy Spring
183.	Grubstake	5	8S	21E	McCoy Spring
184.	Hansen (Hensen) (Hensen Well)	26	3S	8E	Lost Horse Mountain
185.	Happy Jack	31	6S	16E	Chuckwalla Mountain
186.	Helicross	3?	2S	12E	Dale Lake
187.	Hemet Belle	29	6S	4E	Idyllwild
188.	Hexahedron (Hexie)	11	3S	9E	Lost Horse Mountain
189.	Hidden (Exasperation, Lost Mine Parallel)	7	3S	8E)	
		12?	3S	7E)	Lost Horse Mountain
190.	Hidden Treasure	13	8S	20E)	
	(American Flag)	18	8S	21E)	Palo Verde Mountains
191.	Hong	24	4S	5W	Steele Peak
192.	Hodges	4	8S	21E	McCoy Spring
193.	Hornet	1	2S	9E	Valley Mountain
194	Ida-Leona	30	4S	4W	Steele Peak
195.	Indian Rose Quartz Queen (Indian Queen)	32	4S	4W	Steele Peak
196.	Iron Chief	35?	3S	13E	Eagle Tank
197.	Jean (Postmaster)	35	1S	23E	Vidal
198.	John's Camp	4	2S-	9E	Twentynine Palms
199.	Jumbo	30,31	4S	4W	Steele Peak
200.	Lane	10	6S	15E	Chuckwalla Mountains
201.	Langdon	10	4S	22E	Big Maria Mountains
202.	Last Chance	26?	6S	15E	Chuckwalla Mountains
203.	Leon	18	6S	2W	Romoland
204.	Lost Angel (Laseter, Sippi?)	35	3S	8E	Lost Horse Mountains
205.	Lost Horse	3	3S	8E	Lost Horse Mountain

No.	Name	Sec.	T.	R.	Quadrangle
206.	Lost Pony	24	6S	14E	Chuckwalla Mountains
207.	Louise	17	2S	12E	Pinkham Well
208.	Lucky Boy (Walker)	9	6S	3W	Romoland
209.	Lucky Dollar	24?=	5S	13E	Canyon Spring
210.	Lucky Strike (Ophir)	21	5S	4W	Lake Elsinore
211.	Lum Gray (Arica, Gray, Long Shot, Priest)	12	2S	19E	Rice
212.	Maggie (Little Maggie)	32	4S	4W	Steele Peak
213.	Mammoth	8	6S	3W	Romoland
214.	Mastodon	13,14	5S	11E	Cottonwood Spring
215.	Meek (Thelma and Desert Gold)	14	2S	12E	Eagle Tank
216.	Menifee	5	6S	3W	Romoland
217.	Mine (Name undetermined)	8?=	3S	10E	Pinkham Well
218.	Mine (Name undetermined)	34	2S	8E	Lost Horse Mountain
219.	Mine (name undetermined)	4	3S	8E	Lost Horse Mountain
220.-	Mine (name undetermined)	10	3S	8E	Lost Horse Mountain
221.	Mine (name undetermined)	33	2S	8E	Lost Horse Mountain
222.	Mission (Huff-Lane)	14,21	2S	12E	Eagle Tank
223.	Mission Sweet	34?	3S	13E	Eagle Tank
224.	Model	2	7S	14E	Chuckwalla Mountains
225.	Moose=	11,12	2S	12E	Dale Lake
226.	Morning Star	32	6S	16E	Chuckwalla Mountains
227.	Morning Star (Jackknife, Morgan)(6 2S 24E)	31	1S	24E	Vidal
228.	Morris Washington	22	4S	4W	Steele Peak
229.	Moser (Gold Flake?, Patches?)	20,21	2S	16E	Coxcomb Mountains
230.-	Mountain Queen	7	2S	20 E	Rice
231.	Mountaineer (Calzona)	31	1S	24E	Parker
232.	Mystery (Dirtry)	15?	2S	13E	Eagle Tank
233.	New El Dorado (El Dorado)	16,17	3S	10E	Pinkham Well
234.	New El Dorado (Pinyon Well) Millsite	24	3S	8E	Lost Horse Mountain
235.	North Star	6	2S	10E	Valley Mountain
236.	North Star (Sunset)	14	2S	12E	Eagle Tank
237.	Nuisance	12	2S	9E	Valley Mountain
238.	Oehl Placer	1	2S	12E	Dale Lake
239.	Outlaw	17	2S	13E	Dale Lake
240.	Pinto	14	2S	12E	Eagle Tank

No.	Name	Sec.	T.	R.	Quadrangle
241.	Pinto (Calidonia)	1	2S	9E	Valley Mountain
242.	Pinto Chief	1	2S	12E	Dale Lake
243.	Pinyon (Tingman-Holland)	26	3S	8E	Lost Horse Mountain
244.	Poulson	29	6S	4E	Idyllwild
245.	Prospect (name undetermined)	16	2S	12E	Eagle Tank
246.	Prospector	18	2S	24E	Poston
247.	Rainbow	7	8S	21E	McCoy Spring
248.	Red Cloud	5?	7S	15E	Chuckwalla Mountains
249.	Red Streak	22?	6S	15E	Chuckwalla Mountains
250.	Red Top	34?	6S	15E	Chuckwalla Mountains
251.	Renrut-Reerg (Alveston)	29	6S	4E	Idyllwild
252.	Rice	31	7S	1E	Sage
253.	Rich Gold (Gold Crown #2)	8?	3S	10E	Pinkham Well
254.	Romoland	23,26	5S	3W	Romoland
255.	Roosevelt (Roosevelt and Rainbow, Santa Fe)	7	8S	21E	McCoy Spring
256.	Rose of Peru	1	2S	12E	Dale Lake
257.	Ruby Lee	10	4S	11E	Pinkham Well
258.	Rusty Gold (Summit or Sunset)	15	2S	12E	Eagle Tank
259.	San Antonio	32	4S	4W	Steele Peak
260.	Santa Fe	31	4S	4W	Steele=Peak
261.	Santa Rosa (Rosario, Northern Belle)	30,31	4S	4W	Steele Peak
262.	Schellenger	18	4S	22E	Big Maria Mountains
263.	Shannon	1	2S	9E	Valley Mountain
264.	Silver Bell	8?	3S	10E	Pinkham Well
265.	Silver Scorpion	1	2S	9E	Valley Mountain
266.	Sinock	17?	2S	12E	Eagle Tank
267.	Smith Brothers No. 1 and No. 4	7,8	2S	10E	Valley Mountains
268.	Smith Brothers No. 8	19	2S	10E	Valley Mountains
269.	Snowcloud	6	5S	10E	Pinkham Well
270.	Standard	13	2S	12E	Eagle Tank
271.	Stanford	9	5S	4W	Steele Peak
272.	Stanford (Small Prospects near)	5	5S	4W	Steele Peak
273.	Steece (Black Canyon)(6 2S 24E)	1	2S	23E	Parker
274.	Stella	10	2S	12E	Dale Lake

No.	Name	Sec.	T.	R.	Quadrangle
275.	Sterling	30?	6S	14E	Canyon Spring
276.	Stone House	4	8S	21E	McCoy Spring
277.	Sunrise	26	2S	12E	Eagle Tank
278.	Top of the World (Victor, La Plomo, Steele)	32	4S	4W	Steele Peak
279.	Triangle (Pilot)	1	7S	15E	Chuckwalla Mountains
280.	Twin Buttes No. 1	18	5S	2W	Winchester
281.	Twin Buttes No. 2	18	5S	2W	Winchester
282.	Undetermined	4	5S	5W	Lake Mathews
283.	Undetermined	4	5S	5W	Lake Mathews
284.	Vidal Lime	19	1S	24E	Vidal
285.	Virginia (Missing Link, Virginia Shay)	32,33	4S	4W	Steele Peak
286.	Washington	24	4S	5W	Steele Peak
287.	Zulu Queen	15	2S	13E	Dale Lake
	<u>Gypsum</u>				
288.	Big Chief (Freeman-Nonhof, White Gypsum, Ware)	9,10	4S	7W	Corona South
289.	Eagle Canyon (Frazer)	13,24	4S	7W	Corona South
290.	Elki	10	4S	7W	Corona South
291.	Hagador Canyon	10,15,16	4S	7W	Corona South
292.	Jameson	3	4S	7W	Corona South
293.	Main Street (Gypsum) Canyon	14,15	4S	7W	Corona South
294.	Maria Mountains	1,2,3,4,	4S	20E	Midland and Big Maria Mountains
		30,31,34, 35	3S	21E	" " " " "
		5,6,7	4S	21E	" " " " "
295.	Morning Star	1	2S	23E	Vidal
		31	1S	24E	"
		6	2S	24E	"
296.	Palen Mountains	1,2,3, 10,11,12, 13,14,15	3S	18E	Palen Mountains
297.	Riverside Mountains	6,7	2S	24E	Parker and Vidal
298.	Tecumseh	9,10	4S	7W	Corona South
		15,16			" "
299.	White Gypsum	9,10 16	4S	7W	" "

No.	Name	Sec.	T.	R.	Quadrangle
	Iron				
300.	Black Giant	34,35	3S	13E	Eagle Tank
301.	Eagle Mountain	34,35 36	3S	14E	Coxcomb Mountains
302.	East Wide Canyon (Iron-Titanium)	17	2S	6E	Thousand Palms
303.	Iron Cap (Maria Mountains Iron)	14,15	4S	22	Big Maria Mountains
304.	Iron Cap and Iron King	19	5S	18E	Sidwinder Well
305.	Iron King and Iron Queen	21,28	5S	18E	Sidwinder Well
306.	Lindy Coop No. 1	36	4S	22E	Big Maria Mountains
307.	Prospect (name undetermined)	1	2S	23E	Vidal
308.	Sulphide Bismuth (Lang)	11	2S	7E	Twentynine Palms
	Lead -- Silver -- Zinc				
309.	Bald Eagle (Neal)	27,34	3S	21E	Midland
310.	Black Eagle	30?	3S	14E	Eagle Tank
311.	Cap Hunter (Poor Boy)	33	7S	16E	Chuckwalla Mountains
312.	Corona Lead-Zinc	14	4S	7W	Corona South
313.	Desert Center	18,19	7S	17E	Chuckwalla Mountains
314.	Groover (Carbonate Lead)	4	2S	11E	Valley Mountain
315.	Jacklin	24	1S	22E	Vidal
316.	Ragsdale	19	7S	17E	Sidewinder Well
	Limestone				
317.	Best Ranch	28	5S	4W	Lake Elsinore
318.	Big Maria Mountains Limestone deposits	20,21,22, 27,28,34,35	4S	22E	Big Maria Mountains
319.	Blind Canyon	18	2S	5E	Palm Springs
320.	Blue Diamond and Eagle	17,18	4S	1E	San Jacinto
321.	Castro Quarry (Magstone Products)	1	3S	5W	Riverside East
322.	Chino Canyon Deposits	5,6	3S	4E	Palm Springs
323.	Eden Hot Springs Limestone Deposit	25	3S	2W	El Casco
324.	Fingal Deposit	17	3S	3E	Palm Springs
325.	Glen Avon (Mathews)	2	2S	6W	San Bernardino

No.	Name	Sec.	T.	R.	Quadrangle
326.	Guiberson (Whitewater) Deposit	23,22	3S	3E	Palm Springs
327.	Hubbard Limestone deposit	24	4S	1W	San Jacinto
328.	Jensen Quarry	5	2S	5W	San Bernardino
329.	Lamb Canyon (Snyder) deposit	32	3S	1W	Lakeview
330.	Maria Mountains Marl	27	5S	23E	Blythe Northeast
331.	Moore Limestone deposit (Bautista Canyon Deposits)	34	5S	1E	Hemet
332.	Mount Edna deposit	28	3S	1E	San Jacinto
333.	New City Quarry	36	2S	5W	Riverside East
334.	Nightingale (Harris)	6,8,9 10,11,12	7S	5E	Idyllwild
335.	Nonhof	16?	4S	7W	Corona South
336.	Novella Limestone deposit	26,27	3S	3E	Palm Springs
337.	Potrero Creek deposit	34	3S	1W	San Jacinto
338.	Prospect (name undetermined)	32	4S	6W	Corona South
339.	Riverside Cement Co. (Crestmore)	2,3	2S	5W	San Bernardino
340.	San Jacinto Rock Products Co.'s Limestone deposit (Bautista Canyon Deposits)	35	5S	1E	Hemet
341.	Sims Limestone deposit	12	4S	1W)	
		7	4S	1E)	San Jacinto
342.	Snow Rock	5	2S	5W	San Bernardino
343.	Southern Pacific deposit	23,25	3S	3E	Palm Springs
344.	Whitestone	8,9,17	2S	5E	Joshua Tree and Thousand Palms
345.	Whitlock limestone deposit	27,28,34	6S	4E	Idyllwild
	Magnesite				
346.	Hemet Magnesite	31	5S	1W	Winchester
	Manganese				
347.	Arlington Black Jack	18,19	4S	20E	Midland
348.	Arlington No. 3	19	4S	20E	Midland
349.	Beal-McClellan (Black Eagle and Newport, Brum and Newport)	23	5S	4W	Lake Elsinore
350.	Big Bullett	31	6S	11E	Mortmar

No.	Name	Sec.	T.	R.	Quadrangle
351.	Black Ace (Doran)	23	3S	18E	Palen Mountains
352.	Black Rock	22	3S	23E	Big Maria Mountains
353.	Black Strike (Grosse)	19	4S	20E	Midland
354.	George (Red Rock)	32,33	4S	20E	Midland
355.	Langdon	17	4S	21E	Midland
356.	Lucky Boy (Paddy Faulkner)	24	3S	20E	Midland
357.	Manganese Canyon	13,24	4S	19E	Midland
358.	Yellow Stone (Giant Chief)	24	3S	20E	Midland
	Mica				
359.	Ida V.	10	7S	2E	Hemet
360.	Johnson	9	3S	6E	Thousand Palms
361.	Pine Knot (Lucky Day, Lucky Fay)	6	2S	7E	Joshua Tree
	Mineral Paint				
362.	Lord	14,15	4S	7W	Corona South
363.	National Paint and Color Co.	14	4S	7W	Corona South
364.	Paint	14,15	4S	7W	Corona South
	Mineral Springs				
365.	City of Elsinore	6	6S	4W	Elsinore
366.	Crestwell Baths	Cor. 5,6,7,8	6S	4W	Elsinore
367.	Desert Hot Springs	30	2S	5E	Thousand Palms
368.	Eden Hot Springs	23	3S	2W	El Casco
369.	Gilman Hot Springs	9	4S	1W	San Jacinto
370.	Glen Ivy Hot Springs	10	5S	6W	Lake Mathews
371.	Highland Springs	25	2S	1W	Beaumont
372.	Lake Elsinore Hotel	Cor. 5,6,7,8	6S	4W	Elsinore
373.	Lakeview Inn Hot Springs	7	6S	4W	Elsinore
374.	Murrieta Hot Springs	13,14	7S	3W	Murrieta
375	Nicholls Warm Springs	36	6S	21E	Ripley
376.	Palm Springs	14	4S	4E	Palm Springs
377.	Soboba Hot Springs	30	4S	1E	San Jacinto

No.	Name	Sec.	T.	R.	Quadrangle
	Molybdenum				
378.	4 L'S	34	4S	2E	Lake Fulmor
	Peat				
379.	Burro Flats	14	2S-	1E	Cabazon
	Perlite				
380.	Great Western Exploration Co.	26,27	8S	18E	Chuckwalla Spring
	Rare-Earths				
381.	Ajax	6	2S	10E	Valley Mountain
382.	Baby Blue	9	2S	10E	Valley Mountain
383.	Desert View	31,32	5S	10E	Cottonwood Spring
384.	Live Oak Tank	16,17	2S	9E	Lost Horse Mountain
385.	Peerless Nuclear	5,8,16?	2S	10E	Valley Mountain
386.	U-Thor	21	2S	10E	Pinkham Well
	Rock Products				
	(Dimension Stone)				
387.	Blue-Gray Granite Quarry	14	4S	4W	Steele Peak
388.	Mt. Hole Quarries	8,16,17	3S	6W	Corona North
389.	Rubidoux Hill Quarry	22	2S	5W	Riverside West
390.	Sierra Grande Quarries	29	3S	6W	Corona North
391.	Temecula Quarries	30	8S	2W)	
		24	8S	3W)	Temecula

No.	Name	Sec.	T.	R.	Quadrangle
	(Broken and Crushed Stone) (Granite)*(Roofing Granules)**				
392.	Bernasconi Quarry	11	4S	3W	Perris
393.	Blarney Stone (Harlow, Corona) Quarry	15	4S	6W	Lake Mathews
394.	Box Springs Quarry	33	2S	4W	Riverside East
395.	Casa Blanca Quarries*	10	3S	5W	Riverside West
396.	Dendrite	14?	2S	12E	Eagle Tank
397.	Haven Granite Co.	9	2S	5W	San Bernardino
398.	Hole Ranch Quarry	22	3S	6W	Corona North
399.	Jameson	29	3S	6W	Corona South
400.	Juaro Canyon Quarry	20	4S	1E	San Jacinto
401.	Old City Quarry	14	2S	5W	Riverside West
402.	Ormand Quarry	9	2S	5W	San Bernardino
403.	Painted Hill	35,36	2S	3E	Whitewater
404.	Palo Verde Dam Quarries	14,18,19	5S	23E	Blythe N.E.
405.	Sidebotham (Phillips) Quarry	5	4S	6W	Corona South
406.	Storm Sulfide (Green Giant-Long Green)	4,5?	4S?	13E	Eagle Tank
407.	Stringfellow (Bly Bros., and McGilliard, Shannon)	1	2S	6W	San Bernardino
408.	Temescal Canyon (Hawley, Pacific Rock and	4	4S	6W)	
	Gravel Co) Rock Quarry	33	3S	6W)	Corona South
409.	Temescal Rock Quarry**	4	4S	6W	Corona South
410.	Undetermined *	2	3S	6W	Riverside West
411.	Undetermined	3	2S	6W	San Bernardino
~~412.~~					
	(Decomposed Granite)				
412.	Arnold Heights Pit	27	3S	4W	Riverside East
413.	Brokar Pit	20	2S	5W	Riverside West
414.	Coplin Pit	29	3S	6W	Corona North
415.	Fontana Paving, Inc.	5	4S	6W	Corona South
416.	Mason Street Pit	3	3S	3W	Sunnymead
417.	Nuevo Road	24	4S	4W	Perris
418.	Riley Material Co.	25	2S	6W	Riverside West
419.	Riverside County Pit	2	4S	4W	Steele Peak

No.	Name	Sec.	T.	R.	Quadrangle
420.	Riverside County Pit	4	3S	6W	Corona North
421.	Riverside County Pit	19	6S	2W	Winchester
422.	Riverside County Pit	26	5S	3W	Romoland
423.	Riverside County Pit	29	5S	3W	Romoland
424.	Riverside County Pit	18	5S	3E	Idyllwild
425.	Riverside County Pit	19	5S	1E	Hemet
426.	Riverside County Pit	9	4S	3W	Perris
427.	Riverside County Pit	25	2S	6W	Riverside West
428.	Riverside County Pit	12	3S	6W	Riverside West
429.	Riverside County Pit	11	6S	4W	Elsinore
430.	Riverside County Pit	23	6S	4W	Elsinore
431.	Riverside County Pit	8	6S	4W	Elsinore
432.	Sugar Loaf Pit	17	2S	4W	Riverside East
433.	(Undetermined)	30	4S	4W	Steele Peak
434.	(Undetermined)	2	2S	6W	San Bernardino
435.	(Undetermined)	17	3S	4W	Riverside East
436.	(Undetermined)	32	2S	4W	Riverside East
437.	(Undetermined)	15	3S	4W	Riverside East
438.	(Undetermined)	10	3S	4W	Riverside East
439.	(Undetermined)	36	3S	6W	Lake Mathews
440.	(Undetermined)	32	2S	5W	Riverside West
441.	(Undetermined)	14	5S	2W	Winchester
442.	(Undetermined)	36	4S	4W	Steele Peak
443.	(Undetermined)	14	2S	6W	Riverside West
444.	(Undetermined)	22	2S	6W	Riverside West
445.	(Undetermined)	29	3S	5W	Riverside West
446.	(Undetermined)	29	3S	5W	Riverside West
447.	(Undetermined)	25	3S	6W	Riverside West
448.	(Undetermined)	25	3S	6W	Riverside West
449.	(Undetermined)	11	4S	4W	Steele Peak
450.	(Undetermined)	5	3S	5W	Riverside West
451.	(Undetermined)	32	4S	4W	Steele Peak

No.	Name	Sec.	T.	R.	Quadrangle
	(Sand and Gravel)				
452.	Dardoo Adit	10	4S	8E	Lost Horse Mountain
453.	Corona Rock Co.	32	3S	6W	Corona South
454.	Desert Hot Springs, Ready Mix, Inc.	13	2S	4E	Desert Hot Springs
455.	Fan Hill Canyon	20	3S	7E	Thousand Palms
456.	Fargo Canyon	10	5S	8E	Indio
457.	Flat Top Mountain	33	3S	5E	Thousand Palms
458.	Hicks-Allred Indio Hills	5	4S	6E	Thousand Palms
459.	Industrial Asphalt, Corona Plant	29, 30	3S	6W	Corona North
460.	Massey Indian Ave.	23	3S	4E	Palm Springs
461.	Massey Indio Hills	3	5S	7E	Lost Horse Mountain
462.	Massey Whitewater	11	3S	3E	Whitewater quad
463.	Mission Creek	16	2S	4E	Palm Springs
464.	Murrieta Borrow Pit	-	-	-	Murrieta
465.	Pomona Ready Mix Concrete	5	4S	6W	Corona South
466.	Riverside County Gravel Pit	29	6S	7E	Palm Desert
467.	Riverside County Gravel Pit	20	7S	3E	Idyllwild
468.	Riverside Sand Company	25	2S	6W	Riverside West
469.	San Gorgonio Rock Products	3	3S	1E	Banning
470.	Service Rock (The Service Gravel) Co.	3, 10	2S	5W	Riverside West
471.	Shepwells Big Maria	27	5S	23E	Blythe North East
472.	Thermal Canyon Wash	18	6S	9E	Thermal Canyon
473.	Triangle Rock Products, Inc. Mira Loma Plant	6	2S	6W	Gausti
474.	(Undetermined)	8	3S	2W	El Casco Quad.
475.	(Undetermined)	8	3S	2W	El Casco
476.	(Undetermined)	14	4S	1W	San Jacinto
477.	(Undetermined)	32	4S	8E	Lost Horse Mountain
478.	(Undetermined)	6	4S	6E	Thousand Palms
479.	(Undetermined)	28	4S	6W	Corona South
480.	Valley Rock and Sand Corp.	22	3S	2W	El Casco
481.	Valley Transit Cement Co.	31	6S	9E	Oasis
482.	Yeager Indio Hills	5	4S	6E	Thousand Palms

No.	Name	Sec.	T.	R.	Quadrangle
	(Specialty Sands)				
483.	Corona Silica Sand Deposit	21, 16	4S	6W	Corona South
484.	Coronita Ranch	16, 17	4S	6W	Corona South
485.	Jackson and Havens	11?	4S	7W	Corona South
486.	Jurupa (Riverside) Moulding Sand	29	2S	5W	Riverside West
487.	Nonhof	10	4S	7W	Corona South
488.	Smith Silica Pit	17	4S	6W	Corona South
489.	Temescal Canyon	29	4S	6W	Corona South
	Talc				
490.	Palen Mountains	18	5S	18E	Sidwinder Well
491.	Tunnel	23	7S	11E	Orocopia Canyon
	Tin				
492.	Black Rock (North Black Rocks)	18,19	4S	5W	Lake Mathews
493.	Chief of the Hills	3, 4	6S	4W	Elsinore
494.	Holmes Ranch	12	4S	6W	Lake Mathews
495.	Moore	23, 24, 13, 14	4S	6W	Lake Mathews
496.	Prospect (name undetermined)	4	6S	4W	Elsinore
497.	Prospect (name undetermined)	22, 27	5S	4W	Elsinore
498.	South Black Rock	19	4S	5W	Lake Mathews
499.	Temescal (Cajalco)	2, 3, 10, 11	4S	6W	Lake Mathews
	Tungsten				
500.	Aztec (Chuckwalla Tungsten)	22?	6S	15E	Chuckwalla Mountains
501.	Crescent	28	4S	23E	Big Maria Mountains
502.	Garnet Queen	20	7S	5E	Palm Desert
503.	Good Fairy	10, 15	8S	17E	Chuckwalla Springs
504.	Lucky Strike	33	8S	3E	Beauty Mountain
505.	Pawnee (Carr, Oak Grove)	31, 6	8S, 9S	3E, 3E	Beauty Mountain
506.	Red Ocher	26	3S	20E	Midland
507.	Tubbs	5?	7S	15E	Chuckwalla Mountains
	Uranium				
508.	Caproni-Woock	13, 14, 23, 24	6S	23E	McCoy Spring
509.	Ram	4	2S	11E	Valley Mountain

Antimony

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 shipment 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 veinlets of stibnite without apparent orientation. Disseminated bits of stibnite and small clots of pyrite also occur. Both calcite and quartz, as well as 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, 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 hill-slope 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 recovered
			H_2O	Sb	As	
942	792 (sorted ore)		1.0%	38.7%	0.34%	307 lbs.
948	2,800	2,746	1.91%	34.2%	0.15%	939 lbs.$
948	1,907	1,890	0.90%	11.1%	0.13%	probably process
otal	5,499					

References: Crawford, 1896, p. 31; Merrill, 1917 [1919] p. 524; Tucker, 1921, p. 324; Tucker and Sampson, 1929, p 468; Tucker and Sampson, 1943, p. 65-66; Tucker and Sampson, 1945, p. 123.

C.H.G. 4/26/58.

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.

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 ~~N~~ 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 quartzite and slate, and 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. Sugary siliceous material occupies the fault ~~zone;~~ and parallel siliceous veins are reported in the adjacent rocks.

Asbestos

ASBESTOES

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 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 ultra-basic 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, earth"y" 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. 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, 1957) 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 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.

Percival Asbestos Mine

See Charleboix Claims.

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., Idyllwild 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 metasedimentary rocks separated by irregular bodies of 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 surfacial material presently exposed the beryl is finely fractured and partially altered. Though the beryl crystals appear to be more abundant here than in pegmatite dikes in the nearby Coahuila area, their relatively small 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

Clay

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 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 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 develcped 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.

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 1962 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 . __/). 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.

Alberhill Coal and Clay Company

See: Pacific Clay Products Alberhill Mines.

Clay

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.

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.

Brown Star Claims

See: Middlesworth Clay deposit.

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 other, 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 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 limits.

Production: Undetermined, but apparently small.

References: Gray, 1961, p. 110.

C.H.G. 9/1/60.

Castillo's deposit

See: Castillo's deposit under coal.

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 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 Deposit

See: Bedford Canyon Clay deposit.

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. Gahahl, 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.

Corona Shale Mine, Pacific Clay Products

See: Sky Ranch Clay Company deposits and Wardlow shale mine.

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. 3-1).

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. G-1, G-2, and table G-1 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.

Dutch Placer

See: Kroonen Clay deposit.

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 G-1/, G-2/, and table G-1/. 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

See: Harrington Pit.

Emsco Pit

Location: $SE\frac{1}{4}$ sec. 33, T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, $7\frac{1}{2}$', 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 $45°\pm$ 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: $NW\frac{1}{4}$ sec. 4, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, $7\frac{1}{2}$', 1954; northeastern flank of the Santa Ana Mountains, about $3\frac{1}{2}$ 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 idle working was a small open-cut hillslope.

Production: Undetermined.

References: Gray, 1961, p. 78-80, 111.

C.H.G. 2/27/61.

Fraser Clay deposit

See: Eagle Canyon clay deposit.

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 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: SE$\frac{1}{4}$NW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 4 (lot 9), T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, 7$\frac{1}{2}$', 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: $E\frac{1}{2}SE\frac{1}{4}$ sec. 26, $NW\frac{1}{4}SW\frac{1}{4}$ sec. 25, T. 4 S., R. 6 W., S.B.M., Lake Mathews quadrangle, $7\frac{1}{2}$', 1953; about $8\frac{1}{2}$ 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 Paleocene 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.

Hoag Ranch deposit

See: Jones clay deposit.

Hoffman deposit

See: Jones clay deposit.

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. G-1).

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. 4-2/ and table 4-1/ 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. __/).

Ownership: International Pipe and Ceramics Corporation, 2901 LosFeliz 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 G-1/, G-2/, and table G-1/ for details of each pit.

Development: Open pits, see figure __/ and table __/ 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) Clay 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.

Keno Group

See: Kroonen clay deposit.

Kroonen (Keno Group, Dutch Placer) Clay Deposit

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 patent was applied for in 1914 and 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 much disturbed by faulting and form the narrow part of a wedge-shaped fault sliver of Silverado Formation sedimentary rocks. The clay beds are not well exposed but the red mottled clay may be as much as 10 feet thick and the kaolinite and lignite zones range from several inches to one foot in thickness. The lateral extent 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 to have been developed by tunnels and open cuts. In 1956 the tunnels had been made 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

Leo Lorenzo Placer

See: Kroonen Clay deposit.

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

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 6-1/ and 6-1/ and Table 1-1/ 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.

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.

The McKnight clays occur in a fault block of sedimentary rocks of the Silverado Formation. The fault block is triangular in plan, and is about 6,000 feet long with a maximum width of 2,500 feet, bordered by Upper Cretaceous sandstone, conglomerate, and shale of the Ladd Formation, undifferentiated. The structure is further complicated by cross fractures and folding which make the clay beds difficult to mine. The Paleocene clays may rest unconformably on and be infolded with Upper Cretaceous rocks and were later disturbed by complex faulting. However, 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.

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. 2/23/61.

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.

Geology: This 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 crop out in several open pits and cuts on a low, brush-covered hill along the south side of Kroonen Canyon. The clay sequence is not completely exposed, but fragmentary exposures and previously published descriptions suggest that the McKnight sequence is similar to the sedimentary sequence 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 extensive laboratory tests of these two clay types are given by Dietrich (1928, p. 277). The clay deposits are intercalated with sandstone and conglomerate. They are 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) this shale was used early as red-burning clay, but most of the mined clay was a flint-fire clay, moderately sandy and well-indurated and containing various proportions of very fine-grained, gray to black, disseminated carbon.

Geology: The clays crop out 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 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

McVicar Pit

See: Susie Placer.

Middlesworth (Brown Star Claims, Lord?, Freeman?)

Clay Deposit

Location: NW¼ sec. 14; SW¼ sec. 11; NE¼ sec. 15, T. 4 S., R. 4 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.

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 sequence.

Morton Clay Deposit

See: Elsinore Clay Company.

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.

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.

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).

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.

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.

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. 6-1). 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.

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 G-1).

Ownership: Pacific Clay Products, 1255 West Fourth Street, Los Angeles holds about 1,500 acres, formerly operated by the Alberhill Coal and Clay Co.

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 G-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 G-2 is a generalized stratigraphic column showing lithologic features of the clay-bearing units in the Alberhill area and table G-1 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. G-1). White to cream burning, 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. G-1, table G-1). 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.

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. G-1/).

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. __/, table __/). 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.

Palen Mountains Clay Deposit

Location: Secs. 24, 25, T. 5 S., R. 17 E., and secs. 19 (proj.), 30 (proj.), T. 5 S., R. 18 E., S.B.M., Sidewinder Well quadrangle, 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 over an area of about one square mile. It underlies the eroded surface of an undetermined thickness of inter-bedded, buff-colored silt and calcareous, bentonitic clay and is overlain by a surficial deposit of angular gravel approximately 2 feet in average thickness. Where examined, in a shallow prospect (fig. __/), 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

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 7-1).

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 Bull Claim

See: Middleworth Clay deposit.

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 __/).

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.

Development: The deposit has been explored through several bulldozer cuts connected by unimproved roads.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 162, pl. 35.

R.B.S. 3/15/62

Red Top Clay Deposit

Location: Secs. 20 and 21, T. 6 S., R. 9 E., S.B.M., Thermal Canyon quadrangle, 7.5', 1956; 4 miles due east of Thermal. The property is reached by unimproved, dirt roads which extend eastward to the Mecca Hills from the end of Avenue 56.

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 underlie a northwest-trending ridge, about a quarter of a mile wide and 1½ miles long (fig. ___/). The thickness of the deposit is obscured by folds, faults and a deeply eroded, slope-wash-covered surface. 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 Cor. of the NW¼ sec. 21.

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 Ranch 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

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, West Pit

See: Wardlow Shale mine.

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.

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.

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.

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.

Temescal Sixty

See: Twin Springs Prospect.

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.

Thomas Clay Deposit, East Pit

Location: $NW\frac{1}{4}$ sec. 33 (proj.), T. 3 S., R. 7 W., S.B.M., Corona South quadrangle, $7\frac{1}{2}$', 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.

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, 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.

Temescal Tract

See: Tropico Tract.

GOLD

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."

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. __/) 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, 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 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 private 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 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.

Alice Group

Location: Sec. 25 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 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 of War Production Board Order L-208.

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 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.

Geology: The rocks in the mine area are 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 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 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.

The only other development noted on the Alice Group is a vertical shaft of unknown depth on the Lucky Boy claim, NE¼NW¼ sec. 25, T. 1 S., R. 23 E., about three quarters of a mile northwest of the workings described above.

Production: In an unpublished schedule of estimated costs and realization for 1938, this company stated that total net operating profit from gold and copper for 12 months was $166,465.80.

According to Tucker and Sampson (1945, p. 127), the estimated tonnage of ore developed in the mine was reported to be 20,000, with an average value of 0.40 ounces in gold per ton and from 1 to 2 percent copper. Shipments of siliceous ore made to American Smelting and Refining Company's Smelter at Hayden, Arizona, were reported to have averaged $50 per ton in gold and copper.

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 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 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.

Anna Bell Mine

Location: Sec. 24 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 1951; on the southwest side of a northwest-trending canyon in the Big Maria Mountains. The mine is about 25 miles, by road, north of Blythe. The last 7 miles is an umimproved 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 gneiss, gneissic granite, and 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° SW. The heaviest concentration of ore and associated gangue minerals occurs in a shoot at the junction of the upper shear zone and a limestone unit. The ore minerals are pyrite and iron oxides. Both shear zones contain small amounts of secondary copper minerals which probably are alteration products of chalcopyrite.

Fig. 1 /. Sketch map showing the workings of the Anaheim mine and their areal distribution (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Anaheim Mine

Location: SW¼ sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), ~~(U. S. Geological Survey)~~ out Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 9 miles S. 30° E. of Four Corners, Twentynine Palms (see pl. 1 /).

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 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. 1 /).

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. 1 /). 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.

American Flag Mine

See Hidden Treasure Claims.

↑
O.K.

Atlanta (Ronnie B) Mine

Location: NE¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 8.3 miles S. 28° E. from Four Corners, Twentynine Palms (see pl. 1_/).

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, Earl 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_/).

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, 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 intruded by thin pegmatite 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.

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 on Gavilan Flat 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 diorite. No well defined vein is exposed at or near the portal.

See p. 287

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.

Arica Mine

See: Lum Gray Mine.

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.

Augustine Mine

Location: S½ sec. 8 (proj.), N½ sec. 17 (proj.), T. 8 S., R. 17 E., S.B.M., Chuckwalla Spring quadrangle, 1953; just west of Augustine Road and 1½ miles northwest of Chuchwalla 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 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 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, an upper vein in the plane of a normal fault which cuts and displaces the gneissic structure. The former is exposed on the southeast slope of the ridge where it strikes N. 15° E. and dips 30° NW. The latter strikes N. 85° E. in an oblique angle across the ridge just northeast of the peak (altitude 2555 feet as shown on the topographic map) and dips 70° north-northwest (fig. __/).

The lower vein consists of discontinuous, lenticular bodies of quartz ranging from 0 to 2 feet in thickness, 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 matter forms lenticular bodies ranging from 0 to 4 inches in thickness.

These southwest veins are of similar mineral content but the upper deposit appears to be the richest. They carry oxides of iron, secondary copper minerals, pyrite, chalcopyrite, and gold.

The lower vein might yield a small quantity of silver from 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.

Chuckwalla M&S.

Aztec and Rainbow Claims

Location: Sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 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~~ as much as 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 Midva~~il~~le, 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. 15?, T. 2 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.

Baumonk

See Crescent (Baumonk).

Beal Mine

Location: Sec. 19 (?), T. 7 S., R. 16 E., S.B.M., U.S. Corps of Army Engineers Chuckwalla Mountains quadrangle, 15', 1945; on the south slope of the Chuckwalla Mountains, one mile west of Black Butte and 2 miles north 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 granite and 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. __/).

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 quadrangle, 15', 1943; 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 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.

Blackbird Mine

See Tubbs Claims (tungsten-gold).

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 (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.

Black Canyon Group

See Steece Group.

Black Jack Claims

See Dos Palmas Mine.

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 Well quadrangle, 15', 1943 (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).

Bonanza Lode

Location: NE¼ sec. 26(?), T.3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 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 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.

History: The Black Warrior 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 were 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 3 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). 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 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	
		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.

Black Warrior (Paymaster) Mine

Location: Sec. 15, 16, 17, 20, 21 (?), T. 2 S., R. 10 E., S.B.M. (proj.), U. S. Army Corps of Engineers, Pinkham Well quadrangle, 15', 1943; Pinto Mountains, about 12 miles southeast of Twentynine Palms. This deposit was not found in the field but the location given above is very close (William F. Keys, oral communication, January 1960). Mr. Keys also indicated that the Black Warrior and Paymaster are two different names for the same mine.

Ownership: Undetermined.

History: In 1921 the mine was owned by Gold Park Consolidated Mines Company (Tucker, 1921, p. 348). From 1929 to at least 1945 the mine was owned by William F. Keys formerly of Banning, and Twentynine Palms; present address is P.O. Box 114, Joshua Tree (Tucker and Sampson, 1929, p. 476, and 1945, p. 128).

Geology: Highly oxidized vein quartz containing iron and manganese oxides and considerable pyrite and some arsenopyrite occurs along a generally north-trending shear zone in gneissoid-granite (Tucker and Sampson, 1929, p. 476).

Development: A shaft 200 feet deep is vertical to the 70-foot level from where it is sunk 65° east; at the 70-foot level there is a drift run 90 feet northwest and on the 150-foot level a crosscut was run 60 feet west (Tucker and Sampson, 1929, p. 476).

Production: Undetermined.

References: Tucker, 1921, p. 348; Tucker and Sampson, 1929, p. 476; Tucker and Sampson 1945, p. 128, 141.

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, 1956; Pinto Mountains, Gold Park, 8.1 miles S. 27° E. of Four Corners, Twentynine Palms (see pl. 1 /).

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 122-foot shaft with about 1,000 feet of crosscuts and drifts at ~~this level~~ 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 quartz monzonite and hornblende granite intrude the Pinto gneiss. Locally, segments of gneiss have been engulfed and occur as xenoliths and perhaps roof pendants. The mine area is much 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 /).

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 1 /. 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).

Blue Bell Mine

See Golden Bell Mine.

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/). 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. 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. 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 quartz monzonite cut by diorite dikes and ~~five~~ 5 parallel quartz veins, about 1000 feet apart. Two gold-bearing quartz veins, one known as the Brooklyn, the other the Los Angeles, have been 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 bunches of galena. The 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: The Brooklyn, Los Angeles and Gold Rose Mines were mined sporadically from 1900 to 1941. About 10,000 tons of ore ~~were~~ was removed, from which nearly 5,000 ounces of gold, 4,500 ounces of silver, 3,000 pounds of copper, and 260 pounds of lead were recovered.

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, 1954; east slope of the Arica Mountains, 6½ miles southwest of Rice.

Ownership: Undeteremined (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 which underlie the 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.

Development of the south vein consists of a vertical shaft of uncertain depth, a 100-foot shaft inclined 60° southwestward on the vein, a 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 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. 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~~ long and appears to be little more than a prospect.

See p. 328

Brown Mine North

Location: $NW\frac{1}{4}NE\frac{1}{4}$ sec. 1, T. 2 S., R. 19 E., S.B.M., Rice quadrangle, 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 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 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.

Production: Statistics were not found for these claims, but the vein material resembles that of the nearby Lum Gran 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 ?

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: Sec. 32, T. 6 S., R. 16 E., (proj.), S.B.M., Chuckwalla Mountains quadrangle, 15', 1945; 7½ miles southeast of Desert Center and 1½ 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, presumably the same man, 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). The property was described in 1945 (Tucker and Sampson, p. 129). In that report two claims, the Bryan and Dottie Wellborne, were included under the name Bryan. The Dottie Wellborne (see herein) is not near the Bryan. It is in the next township to the west, is tied to U.S. Location Monument no. 80 instead of U.S. Mineral Monument no. 146 as is the Bryan, and was part of the Red Cloud Mining Company holdings (Saul, 1962, p. 3,7).

Geology: Several en echelon shear zones and associated quartz veins are exposed for about 1800 feet down a ridge. They strike north to N. 30° E. and dip 50° W. and NW. The veins range from fine stringers a fraction of an inch wide to as much as 3 feet in width.

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 quadrangle, 15', 1943; 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 intruded by 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.

Figure 1 /. 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).

The country rock is porphyritic granite, lenticular bodies of dioritic-to gabbroic composition and fine-grained basic dikes.

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 S. 30° W., 280 feet through sheared and jointed granite. About 130 feet from the portal a short drift extends 35 feet to the right and a 45-foot drift was driven left from the end of the adit. This level appears to have been exploratory; it cuts no veins.

The workings at the upper level were unsafe and were not thoroughly explored. They appear to consist of an inclined shaft about 40 feet deep from which a drift extends southeast 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

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.)~~ Saul, 1962, p. 7

C.H.G. 5/16/61.

Calidonia Mine

See Pinto Mine.

Captain Jinks (Jenks) Mine

Location: Sec. 1 (?), T. 4 S., R. 10 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; 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.

Geology: The mine area is underlain by an 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 is 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.

Captain Jenks Claim

See Ruby Lee Claim and Millsite.

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, 1956; Pinto Mountains, Gold Park, about 8.7 miles S. 29 E. of Four Corners, Twentynine Palms (see pl. 1 /).

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.

Geology: In the SE¼ of sec. 1, about ¼ miles southwest of the Silver Scorpion gold mine, hornblende granite ~~crisscrossed~~ cross-cut ~~with~~ by fine-grained green basic dikes, as much as one foot thick, and tan to brown White Tank quartz monzonite intrude the Pinto gneiss. The same rock types occur in the W½ sec. 6, T. 2 S., R. 10 W., about 1,000 feet northeast of the Silver Scorpion gold mine (figs. 1 / and 2 /). In addition, the Gold Park gabbro-diorite is exposed in a southeast-trending adit (fig. 2 /). This area is much faulted and hematite and gold (?) bearing milky quartz veins are provalent in the fractured zones. Thin pegmatites, 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. 1 /). Northeast of the Silver Scorpion gold mine are 2 shafts, 3 adits, (a ~~few~~ wooden and brick dwellings) and 13 prospects (figs. 1 / and 2 /). ~~In February and April 1959 the mine was idle.~~ The mine was not in operation on the days of the field visits.

Production: Undetermined.

References: None.

J.R.E. 2/11/59 and 4/13/59.

Figure 2 /. 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, 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 are hornfelsic-to gneissic. They are cut by a mineralized fault and a basic dike. 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 driven to the northeast at angles of 70° to 80° in search of gold. The lower of the 2 shafts enters the vein from 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 is the foot wall of the vein and in the upper shaft it is 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.

Gold

Chuckwalla Group

See Bryan mine.

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Chuckwalla and Model Group

See Bryan Mine.

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.

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 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 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. __/). The gold has been 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

Location: Sec. 2 ~~(proj.)~~, T. 7 S., R. 15 E. (proj.), S.B.M., U. S. Army Corps of Engineers Chuckwalla 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 the C.O.D. was operated by Carl De Vaul, Desert Center. The present owner has been cleaning out the old shafts and installing timber and sheathing as assessment work.

Geology: Crushed quartz veins ranging from 0 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.

Production: According to U. S. Bureau of mines records (published with permission of the owner) 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. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; 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. 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.

Copper Giant (?) Mine

Location: SE¼NW¼ sec. 28, T. 4 S., R. 9 E., S.B.M., Lost Horse Mountain quadrangle, 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 (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.

Corona (Peggy) Mine

Location: NW¼SE¼ sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 1953; about 6 miles west of Perris.

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 was found.

Geology: A poorly-exposed quartz vein crops out on the north slope of a diorite ridge for a distance of roughly 500 feet. The vein strikes S. 75° E., dips 25° SW. and is as much as 4 inches thick. It is sparsely stained and pocketed with iron oxides and contains scattered biotite mica crystals.

Development: The vein is explored by one short adit and 2 inclined shafts grouped within 100 feet of each other. The adit (or west working) is about 15 feet long and is boarded up for storage space. The 2 inclined shafts, the middle and east ~~shaft~~ working, 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 portal, no similar body was seen in the shaft. The east shaft was driven S. 35° ~~W~~ 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, 1956; Pinto Mountains, about 7 miles south of Old Dale, on the Twentynine Palms Highway.

Ownership: Undetermined.

History: Undetermined.

Geology: In the mine area 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 1/, 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: 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 200-300 feet. The 50-foot plus shaft at local 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~~ 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

Figure 1/. Geologic sketch map showing the location and distribution of the workings at the Cow Bell Mine.

Crescent (Baumonk) Mine

Location: Sec. 1, T. 7 S., R. 14 E. (proj.), S.B.M., U.S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 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 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 recorded in the literature. According to the owner of the Crescent, who talked with the aging Mr. Baumonk, the Baumonk mine was worked late in the last 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 shallow ravines on opposing sides of a low ridge of 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 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. These veins are as much as 2 feet in width. They strike N. 40° E.; their dip ranges from vertical to 50° NW. Oxides of iron occur as small pockets and veinlets in the quartz as with ~~all~~ 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 is a vertical shaft of undetermined depth about 35 feet west of the adit portal of the Crescent. 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 (June 1959). The tonnage shipped from the Baumonk was not determined. Some of the 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 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/).

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 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.

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 200-300 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 Gold Group

See Meek Mine and Thelma Group.

Desert King Mine

Location: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 3 miles north-northeast of Mission and Sunrise Wells (pl. 3/).

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 in 1938 for a short period of time.

Geology: Massive quartz monzonite 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. 1/.

Development: The main workings consist of a tunnel (adit) driven west about 150 feet. Other work is of minor extent and restricted to shallow shafts and prospects (fig. 1/. The mine is idle.

Production: In 1938 the Desert King mine yielded 18 tons of ore from which 3 ounces of gold and 1 ounce of silver were recovered.

References: Saul, 1962, p. 7. J.R.E.

Figure 1/. 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).

Desert Queen (McHaney) Mine

Location: SW¼ sec. 5, and SE¼ sec. 6, T. 2 S., R. 9 E., S.B.M.; Twentynine Palms quadrangle, 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 a 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.

From 1932 to 1941 the mine was in nearly continuous operation. ~~During the early part of the 20th century~~ (1912-1914) the gold-quartz ore was processed 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 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.

Geology: The mine workings are near the top of a steep northwest-trending ridge cut in the White Tank quartz monzonite, and just south of a sharp contact with the Palms quartz monzonite. A steep N. 70° E.-trending canyon is cut along the contact between the two rock types (fig. 1).

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. _/ and _/). 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. _/). 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.

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. __/). Below and 200 to 300 feet northeast of the main adit are 2 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 2 adits are driven southwest (fig. __/). ~~These workings were not visited.~~ 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)
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

Figure 2. View north toward the Desert Queen mine. Note the contrast in rock types on the north and south sides of the canyon (fig. 1).

Figure 1. Geologic map showing the location and areal distribution of the workings of the Desert Queen mine. (topography and land grid from 15' Twenty-nine Palms quadrangle).

Figure 3. Geologic sketch map of the main adit level, Desert Queen mine.

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 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: Sec. 16 (?), T. 7 S., R. 12 E. (proj.), S.B.M., U. S. Army Corps of Engineers Canyon Spring quadrangle, 15', 1944; 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 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 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 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 5 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. __/). The ~~All 3~~ adits ~~are driven northeast and~~ 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.

Dottie Welborn Claim

Location: Sec. 31 (?), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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. __/).

Ownership: Undetermined.

History: A patent was issued on the Dottie Welborn, in 1904, to the Red Cloud Mining Company. No published reference to this claim was found.

Geology: The country rock is contorted 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

Double Jack Claims

Location: W½ sec. 19, T. 6 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 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 meta-sedimentary 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 faults appear to be essentially parallel to the structure of the country rock. The two systems differ mineralogically. The faults which truncate 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.

Duplex Mine

Location: Sec. 14 (?), T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 3 miles north-northeast of Sunrise and Mission Wells (see pl. 3 /)

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 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.

Edith Claim

See Mammoth Group.

El Dorado Mine

See New El Dorado Mine.

Elton Mine

Location: SW¼ sec. 8, T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 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: Undetermined.

History: Undetermined.

Geology: The mine workings are in gray to brown, medium-grained massive quartz monzonite which is intruded by numerous aplite dikes, as much as 1-foot thick, and a few thin veings 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

Ensperation Mine

See: Hidden mine.

Eureka Group

Location: Sec. 6 ? (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, 2 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 gneissic.

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. It consists of 2 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. (?), S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; Pinto Mountains, about 3¼ miles west of the Gold Crown mine and close to 3 miles northeast of Pinto Mountain (see pl. 3/).

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

Goat Basin Mine

See Boss or Goat Mine.

Goat Mine

See Boss or Goat Basin Mine.

Gold Coin Mine

See: Gold Galena mine.

Gold Crown #2 Mine

See Rich Gold Mine.

Gold Crown (Bon Ton) Mine

Location: Secs. 10 and 15, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountain, about 3 miles south of New Dale (Site) and about 4½ miles south of the Supply mine (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 Berhardino 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 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.

Geology: The Gold Crown quartz vein trends N. 20° W., dips 75° W., and cuts 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 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.

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	6,039	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

Figure 1/. Fifty ton cyanide plant built in 1935 to process ore from the Gold Crown mine, Riverside County. Picture taken about 1936 by W. B. Tucker. View is northeast.

Figure 2. Gold Crown shaft and mining camp, Riverside County. The mill is to the viewers right and just out of the picture. Picture taken by W. B. Tucker about 1936. View is east.

Gold Crown (San Diego) Mine

Location: NW¼ sec. 4 ~~(proj.)~~, or NE¼ sec. 5 ~~(proj.)~~, T. 6 S., R. 15 E. (proj.), S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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). In 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, mine was held with the Gold Crown and ~~was~~ held by the owners of the Granite mine which is immediately north of it. In 1949 the present owner bought the Gold Crown from Henry K. Hennigh.

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~~ short drift 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.

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 (?), T. 6 S., R. 13 E., S.B.M., U. S. Army Corps of Engineers Canyon Spring quadrangle, 15', 1944; 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 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. 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. 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 northwest-trending vein appears to be as much as 10 feet wide. The northeast-trending 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 (Tucker and Sampson, 1945, p.130-131). 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, 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.

#158

DPS 1727

Gold Dollar Mine

Location: SW¼ sec. 36 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 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 is a brief statement in the Fifteenth Report of the State Mineralogist (Merrill and Waring, 1917, p. 84) which gives 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 Bornig and Lynda Development Co.

Geology: The country rock in the Gold Dollar mine area is contorted 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 campsite 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 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.

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/).

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 - 6 ounces in gold per ton (Tucker and Sampson, 1945, p. 132).

Geology: The major workings are in 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. 1_/).

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.

Figure 1. Geologic sketch maps of the Golden Bee Mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

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. 1/). In the mill site area the gneiss is intruded locally by White Tank Quartz Monzonite.

Development: One-quarter of a 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 (Fig. 1/). 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 1/. 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).

Gold Flake Claim

See Moser Claims.

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, 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 (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 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 Master Mine

See Black Warrior Mine.

Gold Park Consolidated (?)

Mine No. 1

Location: SE¼ sec. 2, T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 1955; Pinto Mountains, Joshua Tree National Monument, about 8.5 miles S. 21° E. from Four Corners, Twentynine Palms (see pl. 1/).

Ownership: Undetermined.

History: Undetermined.

Geology: 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. 1/). ~~It~~ is idle.

Production: Undetermined.

References: None.

J.R.E. 2/12/59

Fig. 1/. 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, 1956; Pinto Mountains, Gold Park, 8.3 miles S. 23° E. from Four Corners, Twentynine Palms (see pl. 1 /).

Ownership: Undetermined.

History: Undetermined.

Geology: A nearly vertical fault cuts highly weathered 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, 1956; Pinto Mountains, Gold Park, 8.3 miles S. 25° E. from Four Corners, Twentynine Palms (see pl. 1/).

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 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. 1/). Both rock units are highly weathered and undergoing granular disintegration.

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.

Figure 1 /. Sketch map of the Gold Park Consolidated (?) Mine No. 3 (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

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 /).

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. 1 /).

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. 1 /). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 3/19/59.

Figure 1 /. Geologic sketch map of the Gold Park Consolidated (?) mine No. 4.

Gold Park Consolidated (?)
Mine #5

Location: NE¼ sec. 12, T. 2 S., R. 9 E., S.B.M. (proj.), (U. S. Geological Survey) Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 9.4 miles S. 26° E. of Four Corners, Twentynine Palms (see pl. 1/).

Ownership: Undetermined.

History: Undetermined.

Geology: Hornblende granite and White Tank quartz monzonite intrude the Pinto gneiss along the lower west, and south flanks of a roughly triangular shaped hill. The area is much cut by 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. 1 /). An arrastra has been constructed on a flat cleared off area several tens of feet downslope from this shaft (fig. 2 /). 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.

Fig. 1 /. Geologic sketch map of the Gold Park Consolidated (?) Mine #5 (topography from U.S.G.S. 15' Valley Mountain quadrangle, 1956).

Fig. 2 /. An arrastra, or rude drag-stone mill used for pulverizing gold (?) quartz material. Note the stone "drag" in the extreme right part of the circular rock lined depression.

Gold Point 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; Hexie Mountains, Joshua Tree National Monument, about 4.5 miles southeast of White Tank adjacent to the Pinto Basin Road (see pl. 2/).

Ownership: William F. Keys, P.O. Box 114, Joshua Tree owns at least one unpatented claim (October 1959).

History: In 1935 the mine was owned and operated on a small scale by Leon M. Campbell, Twenty-nine Palms.

Geology: Medium- to coarse-grained Pinto gneiss, cut by a northwest to west-trending and 60° southwest-dipping fault, is intruded by Gold-Park gabbro-diorite. Thin, highly oxidized quartz stringers in the fault plane contain minor amounts of gold probably. Of interest are two dikes of Gold Park gabbro-diorite at locality D, fig. 1/. The exposure is in a minor cliff face at right angles to the strike of the dikes (fig. 2/). A few hundred feet west of these dikes in an excellent exposure in the same cliff face, a number of irregular bodies of gabbro-diorite have intimately intruded the gneiss.

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. 1/). The mine is idle.

Production: In 1935 46 tons of crude ore were processed to recover 23 oz. of gold and 7 oz. of silver (compiled by the U. S. Bureau of Mines ~~records~~ and published with ~~the~~ permission of the ~~mine~~ owner).

References: None.

J.R.E. 10/15/59.

Figure 1/. Sketch map showing the areal distribution (A), and a geologic sketch map (B) of the Gold Point Mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

Figure 2/. View southwest into a minor cliff face where two dikes of Gold Park gabbro-diorite cut the Pinto Gneiss (locality D, fig. 1/). The dikes are exposed at right angles to their strike.

#167

Gold Rice Mine

Location: NW¼ NW¼ sec. 12 (proj.), T. 2 S., R. ~~33~~ 23 E., S.B.M., Vidal quadrangle, 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 is one of contorted and faulted gneissic rocks which contain a few thin lenses of carbonates. 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.

North road impassable, 1979.

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 Rose Mine

See Brooklyn mine.

Gold Shot Mine

Location: NW¼ SW¼ sec. 28, T. 6 S., R. 4 E., S.B.M., Idyllwild quadrangle, 1959; in Penrod Canyon, 2¼ 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" 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.

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. 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 Standard Mine

Location: SE¼(?) sec. 9, SW¼(?) sec. 10, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 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 (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 much 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, 1956; Pinto Mountains, about ½ mile south of the Brooklyn mine and about 3 miles southeast of New Dale (Site). See pl. 3/.

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 quartz monzonite.

Development: A crosscut adit is driven about 600 feet northeast and into the side of the hill. It connects 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.

Gold Tiger Mine

See: Black Butte mine.

Golden Bell (Blue Bell) Mine

Location: Sec. 8 (?), 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 4 miles southeast of White Tank, and about ½ mile southwest of the West Pinto Basin Road (see pl. 2 /).

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 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. 1 /).

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.

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)	Recoverable Metals 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.

Golden Bird Claim

Location: $NW\frac{1}{4}NW\frac{1}{4}$ sec. 28, T. 1 S., R. 22 E., S.B.M., Vidal quadrangle, 1950; 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 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 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

Golden Chariot Mine

See Golden Charlotte.

Golden Charlotte (Golden Chariot) Mine

Location: $NE\frac{1}{4}$ sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, $7\frac{1}{2}$', 1953; about 6 miles west of Perris. The Golden Chariot Mine is south of and adjacent to the Santa Rosa.

Ownership: Undetermined (1959). ROBERT C & MARTHA L HESS (1975)

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 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: Sec. 14 (?), T. 5 S., R. 13 E., S.B.M., U. S. Army Corps of Engineers, 15', 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 was shown on the mines map in the 1945 county report by Tucker and Sampson (pl.35).

Geology: The country rock is granitic. Two en echelon shears are exposed through a distance of about 350 feet from the top of the hill down the 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 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 __/). 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: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), 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 (pl. 3/).

Ownership: Karl Schapel, Box 113, Twentynine Palms, owns 2 unpatented lode claims.

History: Originally owed 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: 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. 1/).

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. 1/).

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. Material will be fed through a primary jaw crusher and ball mill 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

Figure 1/. Geologic sketch map of the Golden Egg mine.

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.

Golden Nuggett Lode Claim

Location: SW¼SE¼ sec. 34, T. 5 S., R. 10 E., S.B.M., Cottonwood Spring quadrangle, 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 (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 Rod Mine

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 4 miles southeast of New Dale (Site) and 2 miles south of the Brooklyn mine (see pl. 3/).

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.

Geology: A north-striking and 80° W.-dipping quartz vein occurs in quartz monzonite and ranges in thickness from 2 to 4 feet (Tucker and Sampson, 1940, p. 49).

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: From 1935 to 1953, sporadic mining of the Golden Rod mine yielded roughly 2,200 tons of ore averaging about 0.5 of an ounce of gold and 0.1 of an ounce of silver per ton.

References: Tucker and Sampson, 1940, pp. 49-50; Tucker and Sampson, 1945, p. 132.

J.R.E. 3/8/60

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).

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).

Bull 146

Ownership: Dr. Berto Olson, 2508 Ocean, Corona Del Mar.

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

About 1923, Mrs. Velna L. Teater 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 Panamint Mining Company leased the property from 1947 to 1953. In 1959 it was reported (Engel, p. 67) that no operative machinery remained, and all workings below about 50 feet were flooded and presumably largely caved. By 1962 Dr. Olson had acquired the property and had leased it to a group of investors who planned to build a mill for the treatment of dump material and ore from new underground work.

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.

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; Sampson, 1935, p. 509-511, Engel and others, 1959, p. 63-67.

R.B.S., from Engel and others.

Grandaddy Mine

Location: NE$\frac{1}{4}$ sec. 5 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 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 gneissic granite. A fault, which strikes N. 40° W. and dips 85° NE. crosses the claim. A 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 minerals observed in~~ fill fissures and vugs in the vein.

Development: The vein has been explored by shallow trenches along the full length of its outcrop. ~~[illegible]~~

Production: Undetermined.

References: None.

R.B.S. 4/8/58.

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 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 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).

Geology: A mineralized fault strikes N. 10° - 20° W. along a low granite ridge 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. 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 country rock is cut by basic dikes as much as 3 feet in thickness. Both the dikes and veins along the faults have been disturbed 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 carrying oxides of iron as stains and smears and as pseudomorphs after pyrite. Fine, free-milling gold occurs in the iron oxides. Manganese oxide dendrites are common in fractures and there are scattered stains of copper minerals. Silver is reported as a product of the mine but its ore mineral was not identified. Some part 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). The quartz veins range from 0 to 3 feet in thickness.

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 ~~up to a~~ much as on foot thick were stoped in a 10 foot-wide shear zone north and south of the junction of the faults.

When visited (March, 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 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.

Gray Mine

See: Lum Gray Mine.

Great Western Claim

See Red Cloud Group.

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.

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 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. 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 veins of quartz 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.

Hodges Mine

Location: W½ sec. 4 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 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 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 as 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.

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 reports (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 (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: Sec. 31 (proj.), T. ~~5~~ 6 S., R. ~~15~~ 16 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; about 1½ miles southwest of Corn Spring and 7 miles southeast of Desert Center.

Ownership: ~~Not~~ Undetermined (1959).

History: These claims were operated in the years 1896 to 1898 by the Happy Jack and Chuckwalla mining companies (Merrill and Waring, ~~1912~~ 1917, 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 granite ridge and for 200 feet on a rise to the north across a narrow ravine. The vein lies along a shear zone which 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 - 2 feet in thickness.

According to Merrill and Waring (191~~9~~7, 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.

Ownership: Undetermined.

History: Undetermined, probably active during the 1930's. Idle.

Geology: Shear zones containing quartz stringers in massive quartz monzonite (fig. __/). 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.

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. __/). 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.

HEMET BELLE MINE

Location: E½ SE ¼ sec. 29, T. 6 S., R. 4 E., S.B.M., Idyllwild quadrangle, 1959; 2 miles east of Kenworthy Guard Station, in the San Jacinto Mountains.

Ownership: D. C. Mayne, 25889 Columbia Street, Hemet (1963).

History: The Hemet Belle 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 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 $15.00 to $20.00 per ton in gold with some pockets of richer ore.

Development: The old 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 completed a new road to the mine in 1963. All the old workings have been opened and made accessible. A new haulage and prospect tunnel 200 feet long has been driven 200 feet below the old adit. (Written communication D. C. Mayne, 1963).

Production: Undetermined.

References: Merrill and Waring, 1917, p. 535; Tucker and Sampson, 1929, p. 481; written communcation, D.C.Mayne, 1963. R.B.S. 6/24/58.

Hensen Mine

See: Hansen mine.

Hensen Well

See: Hansen mine.

Hexahedron (Hexie) Mine

Location: SE¼NE¼ sec. 11, T. 3 S., R. 9 E., S.B.M., Lost Horse Mountain quadrangle, 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.

CALIFORNIA DIVISION OF MINES AND GEOLOGY

Preliminary Manuscript

SUBJECT TO REVISION

Hexie Mine

See: Hexahedron mine.

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, 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, 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.

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. (S.B.M.), 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.

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 was shown by Tucker and Sampson (1945) on their plate 35, but it appears to be mislocated.

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 been carried 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.

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.

Hillside Group

See Brown Mine.

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 Harford Springs.

Ownership: Undetermined (1959).

History: The first report on the Hoag Mine was by R. J. Sampson in 1935 (p. 512). According to Sampson 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 (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 weathered diorite. The vein explored by the mine is poorly exposed. According to Tucker and Sampson, 1945 (p. 135) it strikes northwest and dips 40° SW. 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.

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_/).

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. 1_/). 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 1. Sketch map of the Hornet group (topography from U. S. G. S. 15' Valley Mountain quadrangle, 1956).

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. 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 diorite. The vein strikes N. 70° W., dips about 50° SW., and is 1 to 2 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, 1916, p. 528; Sampson 1935, p. 508; Tucker and Sampson, 1945, p. 135-136; Larsen, 1948, p. 310.

R.B.S. 6/15/59.

Gavilan

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 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 was most active during the thirties. It was closed in 1942 because of the gold closing order L-208 and has since remained idle.

Geology: The country rock is 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~~ 3 inclined shafts were found which were spaced [illegible] 150 feet apart through a horizontal distance of 250 feet. They were caved and their extent was not deteremined. In 1945 the workings were reported (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. 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 run $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

Indian Queen

See Indian Rose Quartz Queen.

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.

Ownership: Frank Koehn, Rt. 2, Box 94, Perris.

History: The old Indian Queen 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, 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.

Geology: The country rock is weathered 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 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. 35?, T. 3 S., R. 13 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; 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, owns 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. Mr. Lane did not complete payments on the property and the original owners took over installing 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.

Jean (Postmaster) Mine #197

Location: N½ sec. 35 (proj.), T. 1 S., R. 23 E., S.B.M., Vidal quadrangle, 1950; on the northwest slope of the Riverside Mountains 5 miles south-southwest of Vidal.

Ownership: Undetermined (1958). JOHN R. SHAVERS. 963 HELMICK ST CARSON, CA 1974, 23 FEB. (MWS-11-7)

History: The Jean mine is so named on the Vidal quadrangle map but this name was not found in the literature. The mine was 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 the property being worked by Bethel Mining and Lasing Company in 1929 (Tucker and Sampson, 1929, p. 473). In 1930 that company recorded 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 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.

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Jackknife Mine

See Morning Star Mine.

? Jean Mine

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 12-18 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 stoping 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.

60 70

Iron Chief

Geology: The mine is in a contact area between 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 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.

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

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 MINE

The collars of the shafts are timbered and a weathered head frame remains at the head of the stope. All other structures and equipment have been destroyed or removed. The mine is open and dry as far as could be determined but apparently has been idle for many years. The road shown on the map is good to within half a mile of the mine, but is badly gullied where it descends into a wash in the northwest corner of Sec. 35 (Dec. 1957). (INACCESSIBLE BY CAR, OCT 1978) MW

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.

513?

Gold

John's Camp

Location: SE¼SW¼ sec. 4 (proj.), T. 2 S., R. 9 E., S.B.M., Twentynine Palms quadrangle, 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 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.

Juanita No. 5

See Mountain Quéen Mine.

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 __/).

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 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.

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 1,332.10 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

Keystone Mine

See Tubbs Claims (tungsten-gold).

Lane Mine

Location: Sec. 10 (proj.), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 times during 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. 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.

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.

Langdon Claim

Location: SW¼, sec. 10 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 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, gneiss cut by quartz-feldspar pegmatite dikes, is faulted. The faults are poorly exposed. One, 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 driven 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.

La Plomo Mine

See Top of the World Mine.

La Rica Mine

See Stone House Mine.

Laseter Mine

See: Lost Angel mine.

Last Chance Mine

Location: Sec. 26 (?), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 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.

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 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.

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 and untimbered as far down as could be observed from the partially caved 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).

References: Crawford, 1894, 223; 1896, p. 312; Merrill and Waring, '17, p. 534 535 Tucker and Sampson, 1929, p. 483.

R.B.S. 10/22/58.

Liberty Group

See: Tubbs Claims (under tungsten).

Little Maggie

See Maggie Mine.

Long Shot #1

See Lum Gray Mine.

Lost Angel (Laseter, Sippi?) Mine

Location: SW¼ sec. 35, T. 3 S., R.8 E., S.B.M., Lost Horse Mountain quadrangle, 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, is said to have been worked by a Mr. McFarland in the 1890's. The Lost Angel 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 (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.

Los Angeles Mine

See Brooklyn mine.

Lost Horse Mine

Location: SW¼NW¼ sec. 3, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 1958; Joshua Tree National Monument, 3 miles southeast of Ryan Campbround 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 by the Lost Horse Mine, was worked as early as 1894 when ore was hauled to the Piñon Mountain mill (apparently located at the present El Dorado patented mill site at Pinyon Well). During this early development, Fife,** Lang, Holland, and Tingman, of Indio were the owners of 2 claims (Crawford, 1896, p. 223). The area was surveyed for patent in 1895 and a patent was issued in 1897 to the Lost Horse Quartz Mine (Survey No. 3333) 13.5 acres 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.

* Sold to Park Service 1968± - Now being made into tourist attraction. (1975).

** John James Fife - original co-locator - see Riverside County Recorder Book #1.

— DLF 1975

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). 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 Mine Parallel

See: Hidden mine.

Lost Pony Mine

Location: Sec. 24, T. 6 S., R. 14 E., S.B.M., U. S. Army Corps of Engineers, 15', Chuckwalla Mtns. quadrangle, 1945; 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 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 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

Lost River Placer Claim

See Chuckwalla Spring Placers.

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', 1943; 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.

Production: In the years 1937 through 1939 the Louise mine yielded 108 tons of ore from which 35 ounces of gold, 51 ounces of silver, 209 pounds of copper and 1,292 pounds of lead were recovered.

References: Tucker and Sampson, 1929, pp. 483-484; Goodwin, 1957, p. 604. J.R.E. 3/30/60

Lucky Boy Mine

See Elton Mine.

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 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).

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 (?), T. 5 S., R. 1 E., S.B.M., U. S. Army Corp of Engineers, ~~15'~~, Canyon Spring quadrangle, 15', 1944; about 3 miles east-northeast 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 carry oxides of iron which ~~[illegible]~~ probably formed from the weathering of sulfides. Gold, where present, is a free-milling residue as ~~with~~ in 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 ~~due to~~ because of the unsafe condition of the back.

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 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

Lucky Lady Claim

Location: SE$\frac{1}{4}$ sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 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: 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 contained in a recently 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 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, 1917, 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.

Development: The shear zone is explored by one vertical shaft, 700-800 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 - 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.

Geology: The country rock consists of contorted and sheared metasedimentary rocks 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~~ discontinuously 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).

Lum Gray (Arica, Gray, Long Shot, Priest) Mine

Location: NE¼ NE¼ sec. 12, T. 2 S., R. 19 E., S.B.M., Rice quadrangle, 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).

Production: During its intermittent development in the years between 1912 and 1950 the Lum 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.

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 could ~~were~~ not be identified in 1959 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 2 ~~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; 1945, p. 136-137, pl. 35; Sampson, 1935, p. 512.

R.B.S. 9/24/59

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.

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: The mine area is underlain by deeply weathered 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.

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. __/). 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.

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 __/. 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 - 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.

B.S. 9/21/59.

Mastodon Mine

Location: SE¼ sec. 14, SW¼ sec. 13, T. 5 S., R. 11 E., S.B.M., Cottonwood Spring quadrangle, 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. 1/). 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. 1/). 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.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 129, (and p. 138.

J.R.E. 12/11/59.

Figure 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).

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 were visited in the field. Both shafts should lie on the Desert Gold Group of claims, because they are sunk on steeply-dipping and generally north-striking faults. The shaft nearest the house (pl. 3/) is at least 100 feet deep and drifts join to it at one or more levels. It is estimated that there is a total of about 400 feet of work. The other shaft, about a tenth of a mile east and higher on the hillslope, is at least 120 feet deep and drifts join to it at one or more levels. Total work here is estimated to be about 700 feet. The mine was not in operation on the day of the property visit.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 488; Tucker and Sampson, 1945, p. 144.

J.R.E. 3/11/60

Mc Haney Mine

See Desert Queen mine.

Meek (Thelma and Desert Gold Group) Mine

Location: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 4 miles south-southeast of New Dale (Site) and 1 mile southeast of the Gold Crown mine (pl. 3/).

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 ½ to 2 feet. According to Tucker and Sampson (1945, p. 144) all veins cut quartz monzonite and locally are heavily mineralized with hematite showing free gold.

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 (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 0, 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) the shafts are 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.

Missing Link Mine

See Virginia Mine.

Mission (Huff-Lane) Mine

Location: Secs. 14 and 21, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 2 miles north-northeast of Mission and Sunrise Wells (pl. 3/).

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, S. Bonnie Brae St., Los Angeles. The Mission Gold Mines Co., Mecca, owned and intermittently operated the mine from 1939 to 1942. The present owner, representing the Mission Mining Co., operated the mine in 1951 and 1955.

Geology: Massive quartz monzonite is cut by a series of semi-parallel quartz veins containing pyrite, chalcopyrite, hematite, gold, and secondary copper and iron minerals. The other principal vein is known as the Water Well ; Verde and Lone Star respectively. 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.

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. 3/). 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

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).

Mission Sweet Mine

Location: Sec. 34?, T. 3 S., R. 13 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Eagle Mountains, about 3 miles southwest of the Black Eagle mine and 9½ miles northeast of the East Pinto Basin-West Pinto Basin-Cottonwood Pass and Black eagle mine roads intersection.

Ownership: Undetermined.

History: Undetermined.

Geology: 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 0.2 of a mile northeast of the principal 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 sunk only 18 feet, with 20-foot drifts driven north and south at the 18-foot level in a fault plane. The mine is at an elevation of about 2200 feet and is idle.

Production: Undetermined.

References: None.

J.R.E. 3/17/60

Model (Chuckwalla and Model) Mine

Location: Sec. 2, T. 7 S., R. 14 E., (proj.), S.B.M., Chuckwalla Mountains quadrangle, 15', 1945. 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.

Recoverable Metals

Year	Crude ore	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, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 4 miles north of Mission and Sunrise Wells and 2 miles east of the Gold Crown mine (pl. 3/).

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 Inc., 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 quartz monzonite, and contains a gold-quartz vein 6 foot 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.

Monarch Mine

See Tubbs Claims (tungsten-gold).

Morning Star Mine

Location: Sec. 32 (proj.), T. 6 S., R. 16 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; about 1½ 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 granite ridge. 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 but no assay data ~~ever~~ 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, 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. __/).

Ownership: Benjamin M. Stansbury, P.O. Box 315, La Canada (1960).

History: According to Jack Stewart, a resident of Parker, Arizona, the Morning Star 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) 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.

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 (fig. ___/). Gold occurs in a gangue composed of iron and manganese oxides, limestone, schist, barite, secondary copper minerals, and quartz. The copper minerals are chrysocolla and malachite. The ore is in pockets, veins, and zones of fault breccia.

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 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-thick breccia zone. As exposed in the workings the lower terminus of the ore 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 of this.

Development consists of an inclined shaft 160 feet long along which stoping was done, and a vertical shaft sunk to and through the inclined workings. The vertical shaft is 160 feet deep, the lowest 30 feet in ore which assayed $14 to $19 per ton in gold and 12 to 14 percent copper. These 2 shafts are in the plane of the northwest-trending fault.

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.

Production: By 1932 an estimated $100,000 in ore averaging $60 per ton in gold and copper had been taken from these claims. At that time a contract was made with the American Smelting and Refining Company whereby their Hayden, Arizona plant was to purchase ore at a maximum smelting rate of $4 per ton with no penalties due to the fact that the ore made a favorable smelting mixture (Mitchell, unpublished report 1932). Records of production since 1932 were not found and whether any ore was delivered to Hayden under the 1932 contract is not known.

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.

Morning Star Mining Company

See Morning Star Mine.

Morgan Claims

See Morning Star Mine.

Morris Washington Deposit

Location: S½ sec. 22, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5' 1953. The deposit is part of an elongate hill of diorite 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 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 fissures a fraction of an inch wide up to shear zones 20 feet in width; mineralizing solutions have filled them with granular calcium carbonate. Where such fissures cross crushed parts of the dike the voids and fractures in the dike are similarly mineralized.

The presence or percentage of gold, or other precious metals in the deposit, was not determined.

Development: The principal workings are a 30-foot shaft inclined 30° W. and a partially caved drift adit about ~~ten~~ 10 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: E½ sec. 20 (proj.), and SW¼ sec. 21, T. 2 S., R. 16 E., S.B.M., Coxcomb Mountains quadrangle, 19[illegible]; on the northeast slope of a northwest-trending ridge about 2½ miles northwest of siphon #86 of the Colorado River Aqueduct.

Ownership: Five contiguous, unpatented, claims, Leo, Maxie, Jenny, Moser and Bamby are held by Carl Moser, 1732 W. Rosecrans, Gardena and Edward Severson, general delivery, Yucca Valley. Mr. Moser holds the Leo, Maxie and Bamby claims and a half interest in the Jenny and Moser. 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 appear to be mislocated on the 1945 map (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 granodiorite and complexly intruded pendants of metamorphic rocks. Quartz veins ranging from several inches to as much as 5 feet in thickness are unevenly exposed for about 7,000 feet. The veins strike N. 40° W. and dip from 65° SW. to about 85° NE. They lie in the planes of a system of faults along which movement has recurred since their deposition. ~~of the veins.~~ The vein quartz is strongly fractured and the contained metal-bearing minerals largely altered by meteoric water the circulation of which was no doubt aided by additional fracture planes in the country rock. The vein contains irregular masses of pyrite, iron oxides, calcite, 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.

Development: When visited in 1962 development was proceeding on the Jenny and Moser Claims and preparations were being made to develop the Leo claim. On the Jenny 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 adit 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 600 feet, well on to the Moser claim. In this southeast drift it is hoped to cross a downward extension of 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 (1962) development.

On the Leo Claim there is an old shaft 20 feet deep at the bottom of which is a 12-foot cross-cut, and an open cut just southeast of the shaft. In addition new work is planned by Carl Moser about 400 feet northwest. An ore chute is exposed in a prospect and an adit now (1962) 40 feet long, is to be driven northwest, from a point about 250 feet down slope from the exposed ore, to explore its downward extent.

Production: No sustained production has yet been reported from these claims. In 1947 and 1948 a total of 18 tons of ore were 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.

Mountaineer (Calzona) Mine

Location: S½ sec. 31, T. 1 S., R. 24 E., S.B.M., Parker Quadrangle, 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. __/). 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.

Development: The mine has been worked from a 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 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 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 ____ shows the principal features of the mine and orientation of the workings on the faults.

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. __/). 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.

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.

Mystery (Mirtry) Mine

Location: Sec. 15?, T. 2 S., R. 13 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', at the base of the north slope of the Eagle Mountains, Joshua Tree National Monument, about 6 miles southeast of Mission Well. 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~~.

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.

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 quadrangle, 15', 1943; Hexie Mountains, Joshua Tree National Monument, about 5 miles southeast of White Tank, and

March 3rd, 1965

NEW EL DORADO MINE

Section 8 & 17, Township 3 south, Range 10 east, S.B.M.

The last owner of this mine was John McEnnis, 15461 Del Grado Dr., Sherman Oaks, California.

He quit-claimed to the State of California. "New El Dorado Mining Claims"---number 14-15 ----sale number 3414 ---Instrument number [illegible]94 ---dated 12/64.

Geology: A major fault striking N. 20° W. and dipping 76° E. cuts the Pinto gneiss which here has been carved into an elongate east-trending ridge (fig. 1 /). Oxidized milky vein quartz, 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 (fig. 1 /). A non-distinct 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.

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 vanadanite, but no formal report of production appears to have been made.

References: Brown, 1923, p. 266; Tucker and Sampson, 1929, p. 485.

J.R.E. 12/9/59

Figure 1 /. Plat of the lode claims and millsite of the New Eldorado Mining Company (Survey No. 5601- A-B; surveyed October 25-30, 1921; patent no. 919797 issued October 10, 1923).

Figure 2 /. Sketch maps showing the location (A); on the 90-foot level (B); and geology of the New El Dorado mine (Topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

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.

Production: During its two principal periods of development, 1911 to 1916, and 1930 to 1938, the New Eldorado Mine yielded a total of some 5,400 tons of ore from which about 2,000 ounces of gold, 600 ounces of silver, and 2,000 pounds of lead were recovered.

The "Eldorado (New Eldorado) mine" has been described (Brown, 1923, p. 266) as a source of vanadium, the ore mineral being vanadanite, but no formal report of production appears to have been made.

References: Brown, 1923, p. 266; Tucker and Sampson, 1929, p. 485; Goodwin, 1957, p. 605.

J.R.E. 12/9/59

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. 1 /). The uppermost shaft is sunk 20 feet vertically in a gouge zone 1-foot thick. About 140 feet south another shaft is sunk 25 feet vertically. A trench, from 0-6 feet deep, extends north about 80 feet from this shaft. Approximately 80 feet further south is a 7-foot deep trench, 55 feet long 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. 1 /). 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 1./. 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).

NEW Hemet Belle Mine

See Hemet Belle Mine.

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 quadrangle, 15', 1943; Pinto Mountains, about 2½ miles north of Mission and Sunrise Wells (pl. 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. 3/8/60.

North Star Mine

Location: NE¼ sec. 6, T. 2 S., R. 10 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, about 8.3 miles S. 30° E. from Four Corners, Twentynine Palms (see pl. 1 /).

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, W. C. Winnie, president, J. E. Schweng, secretary, C. W. Roach, manager; Offices 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 a north-trending, nearly vertical fault zone which cuts the Pinto gneiss. The gneiss is cut by: an irregular body of medium-grained hornblende granite, aplite dikes, fine-grained green basic dikes and dikelets, and tabular veins of milky quartz. 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 yellow pyrite, altering to limonite, and possibly contain [illegible] gold.

Northern Belle Mine

See Santa Rosa.

Nuisance Group

Location: NE¼ sec. 12, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park area, 9.4 miles S. 25° E. of Four Corners, Twentynine Palms (see pl. 1 /).

Ownership: Undetermined.

History: Virginia Downs filed on the property November 1, 1955.

Geology: Pegmatite dikes, fine-grained green basic dikes as much as 2 feet thick and thin veins of gold (?) bearing quartz occur in the Pinto gneiss. They are strongest along, and in the plane of a north-trending, 71° west-dipping fault (fig. 1 /).

Development: An inclined but partly caved shaft has been sunk to an undeterminable 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 (fig. 1 /).

Production: Undetermined.

References: None.

J.R.E. 3/20/59.

Figure 1 /. Geologic sketch map of the Nuisance group.

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/).

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 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

NOT ON COMB MAP

Ohio Claims

Location: NE¼ sec. 1, T. 2 S., R. 22 E., S.B.M., Vidal quadrangle, 1950; at the southeast edge of the West Riverside Mountains near Riverside Pass.

Ownership: R. F. Boyd and A. Geiger, Vidal (1958).

History: Undetermined.

Geology: The rocks on these claims are gneisses cut by pegmatite dikes and quartz veins. gneissic plutonics? MWS - 11-24-78

Development: A single inclined shaft of unascertained but probably shallow depth explores a poorly exposed pegmatite dike, the thickness of which is obscured by shearing. The approximate attitude of the dike is N. 45° E., 70° SE. It is composed of quartz, microcline, chlorite, calcite, and hematite.

No equipment remains at the site. The shaft is open and dry but access is difficult. This appears to have been a small operation.

NEXT TO POST-1958 POWERLINE ROAD. MWS 11-24-1978

Production: Undetermined.

References: None.

R.B.S. 2/18/58.

Old Channel Claim

See Chuckwalla Spring Placers.

Ophir Mine

See Lucky Strike Mine.

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 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 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, 1956; Pinto Mountains, Joshua Tree National Monument, about 9 miles northeast of Sunrise Well, and 2½ miles northeast of the Zulu Queen mine.

Ownership: Undetermined.

History: The Outlaw mine may have been part of the holdings of the Sunrise Mines Inc., San Diego. Several mines in the eastern and northern part of the Pinto Basin were operated by this company in the 1930's (see the Sunrise mine description).

Geology: The mine is on top of a small outlying hill which is on the northeast side of a southeast-trending wash that drains the Pinto Mountains from the north. 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 estimated to be sunk at least 100 feet in the altered zone. For 35 feet the shaft is at an inclination of 70° westward but below this it begins to shallow. Water was obtained at Sunrise Well about 9 miles southwest. The dirt road which connects the well with the mine, and also the Zulu Queen mine, is in part good, but generally in very poor condition; especially that part from the Zulu Queen mine turnoff to the Outlaw mine.

Production: Undetermined.

References: None.

J.R.E. 3/10/60.

Patches Claim

See Moser Claims.

Paymaster Mine

See Black Warrior Mine.

Mountain Queen Mine

Location: NW¼NW¼ sec. 7, T. 2 S., R. 20 E., S.B.M., Rice quadrangle, 1954; on the east slope of the Arica Mountains.

Ownership: Undetermined (1958).

History: This property was located (date unknown) as the Juanita No. 5, 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 2 gold-bearing shear zones in a homoclinal section of schists and carbonates exposed on the east slope of the Arica Mountains. In the mine area, the bedding and schistocity 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 has a dip and strike close to that of 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 in thickness. 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° northwest, 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.

Peggy Mine

See Corona Mine.

Pilot Mine

See Triangle.

Pinto (Calidonia) Mine

Location: NE¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 8.4 miles S. 27° E. of Four Corners, Twentynine Palms (see pl. 1 /).

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 Hugmenia, 1918, p. 1).

Geology: Hornblende granite, locally ~~criss-crossed~~ cross-cut with thin stringers of epidote, intrudes the Pinto gneiss. The area is much faulted and a majority of the workings are in a north-trending and steeply west-dipping fault zone (fig. 1 /). Both the gneiss and the granite are cut by gold (?) bearing milky quartz veins as much as 3 feet wide; strongest along the pre-existing planes of weakness.

Development: Five shafts, one 45 foot deep, have been sunk (fig. 1 /). 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 northernmost shaft in the fault zone; the other southwest 45 feet (figs. 1 / and 2 /). The latter mentioned adit has a total of 55 feet of drifts; the north drift probably intersects the southernmost shaft in the fault zone (fig. 1 /). The mine is idle.

Production: Undetermined.

References: Tucker and Huguenin, 1918, p. 1.

J.R.E. 2/11/59.

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).

Figure 2_/ View est toward the Pinto (Calidonia) mine. The road leading to the mine ends at the portal of an adit driven southwest into the hill. (see fig. 1_/).

Pinto Chief Mine

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, 1 mile south of the Brooklyn mine and 3½ miles southeast of New Dale (Site). See pl. 3/.

Ownership: Undetermined.

History: An old property, dating at least from the 1930's.

Geology: A northeast-trending and nearly vertical fault cuts quartz monzonite. The fault contains quartz veins of undetermined thickness and extent (Karl Schapel, oral communication, 3/8/60).

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, 3/8/60). The mine is idle.

Production: Undetermined.

Reference: None.

J.R.E. 3/8/60

Pinto Mine

Location: Sec. 14, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 3 miles north-northeast of Mission and Sunrise Wells (pl. 3/).

Ownership: Undetermined.

History: Mr. Olsen and Mr. Jenson, Hollywood, owned and operated the mine in 1932.

Geology: Massive 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, 3/8/60).

Development: The main shaft is sunk at least 200 feet in the fault. There are southwest-northeast drifts of undetermined extent on at least two levels (Karl Schapel, oral communication, 3/8/60). 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, 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.

Geology: The mine area is underlain by light gray to buff, deeply weathered, coarse-grained quartz monzonite (White Tank quartz monzonite). 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 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.

Pinyon Well

See: New Eldorado Millsite.

Poor Boy Claim

See Cap Hunter Mine.

Postmaster Mine

See Jean Mine.

Poulson Claim

Location: NW¼ sec. 29, T. 6 S., R. 4 E., S.B.M., Hemet Reservoir quadrangle, 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 site 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 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 __/).

Production: Undetermined. Idle (1959).

References: None.

R.B.S. 10/23/59.

Priest Mine

See: Brown Mine.

Prospector Claims

Location: SE¼ sec. 13, 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 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. 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 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

Rainbow Mine

Location: NW¼ sec. 7 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 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 written up with the Roosevelt Mine in a common group of 8 claims which had once been called the Santa Fe (Tucker and Sampson, 1945, p. 142-143).

Geology: The Rainbow Mine is in an area underlain by sheared granite. A vein, which pinches and swells from 0 to a maximum of 2 feet in thickness, is exposed for about 500 feet up a west-to-northwest-trending ridge. The vein strikes east-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 averaged $12 per ton in gold.

~~Development~~

Development: A drift adit was driven on the vein from a point low on the ridge and follows the vein about 130 feet westward. 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. Some timber is still present in the form of stulls in the stopes but no equipment or buildings remain on the site. The mine is open and dry. Access is good.

Production: Undetermined.

References: Tucker and Sampson, 1945, p. 142-143.

R.B.S. 2/19/58.

Red Cloud Group (Red Head Group)

Location: Sec. 5 (?), T. 7 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 (fig. __/).

Ownership: J. D. Huston, P.O. Box 3667 Terminal Annex, Los Angeles 54.

History: These patented claims, the Red Head, White Wings, Great Western, and Dottie Welborn (see herein), (fig. __/), were located prior to 1886. Possibly the earliest report of the property was published in February 1886 but no details were given (Mining and Sci. Press, 1886, vol. 52, p. 100). The claims were worked by the Red Cloud Mining Co., Salton, from 1899 to 1901. The Red Cloud 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. & W. Mine Development Co., 2250 Crenshaw, Los Angeles (U. S. Bureau of Mines records).

Geology: The Red Cloud Group is in an area of gneissic rocks which have a northwesterly structural trend. A quartz vein as much as 15 feet in thickness 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 continued 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 (figs. __/, __/). The shearing and alteration of the country rock yields an uneven mixture of gangue material but the vein appears to consist primarily of quartz containing pockets and veinlets of iron oxides and pyrite. Fluorite is common in the dump of the Red Head 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 material. 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.

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. __/). The crosscut adit, shown below the White Wings Adit was intended to run northeastward some 600 feet from the Red Head Mill Site (fig. __/) to serve in part as a drainage channel 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)	Gold (ounces)	Silver (ounces)	Copper (lbs.)	Lead (lbs.)
		Recoverable Metals			
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.

Red Head Claim

See Red Cloud Group.

Red Head Group

See Red Cloud Group.

Red Streak Mine

Location: Sec. 22 (?), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 cut in a complex of intruded metamorphic rocks crossed by dikes of aplite, petmatite, 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 in thickness, lies in the shear zone. The vein is fractured and carries iron oxides as bunches 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 a 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 an 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 (proj.), T. 6 S., R. 15 E., S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; 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 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 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., Hemet Reservoir quadrangle, 1940; about 2 miles east of Kenworthy Guard Station.

Ownership: E. K. Turner, Route 1, Box 32, Mountain Center.

History: Division of Mines files indicate that this property was patented in 1896 by Rueben B. Alves as 2 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 and that samples taken from thin veins in the walls of the shear zone, assayed $5 to $8 per ton.

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: $S\frac{1}{2}$ sec. 31, T. 7 S., R. 1 E., S.B.M., Sage quadrangle, 1954; $4\frac{1}{2}$ miles south of Sage. A peak named Roundtop lies on the west boundary of section 31.

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 said that these men made meager wages in gold (personal communication, Harry Bergman, Oct. 20, 1958).

Geology: The workings of this mine are spaced irregularly along a poorly exposed contact between mica schist and 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.

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 from 0 to 2 feet in width. Light timbering was used but it is now (July, 1958) in bad repair. The portal is partially caved. One of the vertical shafts is situated immediately in front of the adit portal. It is blocked by deranged timber and sheathing near its collar. Its depth could not be estimated. 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. Though some timber remains in this shaft, entry is hazardous. The southwest shaft is vertical for an estimated depth of about 100 feet below which point it is flooded. The depth was not determined. It is untimbered. A quartz vein as much as four inches wide follows the plane of the shear where it is exposed at the collar.

The remaining 2 shafts are about 800 feet farther northwest and are about 200 feet apart along a line drawn northeast between them. The northeasternmost 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).

Production: Undetermined.

References: None.

R.B.S. 7/25/58.

Rich Gold (Gold Crown #2) Mine

Location: Sec. 8 (?), 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 4 miles southeast of White Tank, and about ¼ mile south of the West Pinto Basin Road (see pl. 2/).

Ownership: Undetermined.

History: Originally located as the Gold Crown #2. Relocated as the Rich Gold mine July 1, 1931 by S. B. Trujillo and Loyd E. Kinder, 1223 W. 5th St., San Bernerdino.

Geology: Pinto Gneiss is cut by west-trending minor faults and a northwest-trending pegmatite dike (fig. 1/). 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. 1/), 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 (fig. 1/, loc. 1). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 1/25/60.

Figure 1/. 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).

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 on the north side of an unnamed group of hills. Narrow, poorly exposed quartz veins lie ~~on~~ in 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: ~~The fault~~ A shear 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

Ronnie B. Mine

See Atlanta Mine.

Roosevelt (Roosevelt and Rainbow, Sante Fe) Mine

Location: NW¼ sec. 7 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 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 were formerly known as the Santa Fe.

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.

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.

Rosario Mine

See Santa Rosa.

Rose of Peru

Location: Sec. 1, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 3 miles southeast of New Dale (Site) and about 1 mile south of the Brooklyn mine (pl. 3/).

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-south drifts on the 200-foot level (Karl Schapel, oral communication, 3/8/60). 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). 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.)	~~Silver~~
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 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. 15, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 1 mile southwest of the Gold Crown mine and close to 3½ miles south of New Dale (Site). See pl. 3/.

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, Twentynine 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 quartz monzonite.

Development: The main shaft is sunk vertically 35 feet in a fault containing a hematite-gold quartz vein 1-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 in depth sunk on quartz "blow-outs" and veins; all in close proximity to 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: SE¼ sec. 32, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about four miles west of Perris (see fig. __/).

Ownership: Roger Clapp, c/o Lawrence Butterfield, 822 N. June Street, Hollywood.

History: U. S. Bureau of Mines files show that this claim was worked by Ralph Mellor, Perris, in 1935 and by Dick Montijo from 1938 through 1940. No previous record was found.

Geology: The San Antonio claim lies high on the northwest slope of a ridge composed of deeply weathered dioritic rock. 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 1000 feet. The vein quartz contains veinlets and bunches of iron oxides which carry free-milling gold.

Development: The vein has been explored through six inclined shafts five adits and an open cut (fig. __/). The most extensive of these workings, inclined shaft #6, is shown in greater detail in figure __/.

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 granite).

Production: Compiled by the U.S. Bureau of Mines and published with permission of the owners.

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. 6/17/59

San Diego Mine

See Gold Crown Mine.

Santa Fe

See Roosevelt and Rainbow Mines.

Santa Fe Group

Location: NW¼ sec. 31, T. 4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7½', 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 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 Mine is on the north slope of a low ridge composed of deeply weathered diorite. The poorly exposed vein strikes N. 70° W. and dips about 45° SW. The width of the vein could not be determined but is probably less than a foot. The vein material found on the surface consists of two types of material; quartz-tourmaline and quartz containing pockets and fractures filled with oxides of iron. The ore, presumably the latter of the above, was once reported 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.

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: SE¼ sec. 30 and NE¼ sec. 31, T.4 S., R. 4 W., S.B.M., Steele Peak quadrangle, 7.5', 1953; about 6 miles west of Perris.

Ownership: Undetermined (1959).

History: The Santa Rosa was located about 1879 by Mexicans who worked the ore 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 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. This was probably the structure shown in photos in subsequent reports (Crawford, 1896, following p. 310; Merrill and Waring, 1917, p. 530) in which a 20-stamp mill was installed (Crawford, 1894, p. 224-225; Sampson, 1935, p. 514).

At present (1959) the Santa Rosa is idle. All structures and machinery have been removed.

Geology: The vein explored by the Santa Rosa Mine, though reported to be as much as 3 feet wide (Sampson, 1935, p; 514), is poorly exposed on the surface. It strikes N. 10° W. and dips 45° SW. (Crawford, 1896, p. 314). These observations were not confirmed owing to the inaccessible state of the mine. The country rock is 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.

Schellenger Mine

Location: Sec. 18 (proj.), T. 4 S., R. 22 E., S.B.M., Big Maria Mountains quadrangle, 1951; on the west slope of a hill, about 1½ miles north of Black Hill.

Ownership: Undetermined (1958).

History: In 1929 Tucker and Sampson, (p. 487) reported that a total of 6 claims were held by E. E. Schellenger, Blythe, but only assessment work had been done. By 1945 (Tucker and Sampson, p. 143) development had progressed to essentially the present state, and the mine was idle. Ownership had changed to T. A. Ashby, Rice, and M. A. Anderson, Pasadena. When visited in December, 1958, the Schellenger mine appeared long idle.

Geology: The country rock is gneiss cut by granitic pegmatite dikes as much as 6 feet wide which strike northwest. The dip of one, taken where it crosses the mine area, is 40° NE. A fault which trends east and dips 85° N. offsets the pegmatite dikes. 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 are pyrite and oxides of iron, reported to carry $15 per ton in gold (Tucker and Sampson, 1945, p. 143).

Development: Two adits, a lower and an upper, are driven east on the vein. The lower adit is about 70 feet long, open, dry, and untimbered except at the portal. A narrow raise extends a few feet up the vein from the face of the lower adit but is not holed-through to the upper workings. The upper adit is roughly 30 feet higher on the vein and about 50 feet farther east. It is 30 feet long and untimbered.

Production: Undetermined.

References: Tucker and Sampson, 1929, p. 487; 1945, p. 143.

R.B.S. 12/19/58.

Shannon Mine

Location: NW¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park area, 8. 1 miles S. 23° E. from Four Corners, Twentynine Palms (see pl. 1 /).

Ownership: Undetermined.

History: Undetermined.

Geology: Hornblende granite is cut by thin aplite and pegmatite dikes, and contains gold (?) bearing milky quartz veins as much as 1½ feet thick. Minor, nearly vertical faults occur locally. A fissure filling of vein quartz is exposed in the adit nearest the road (fig. 1 /).

Development: The workings consist of 2 adits, one driven northeast 38 feet, the other southwest 25 feet, a 100-foot shallow trench, a prospect pit, and a shaft inclined 60° E. and sunk to a depth of about 30 feet (fig. 1 /). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 2/12/59.

Figure 1 /. Geologic sketch map of the Shannon mine.

Silver Bell Mine

Location: Sec. 8 (?), 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 4 miles southeast of White Tank, and about ½ mile southwest of the West Pinto Basin Road (see pl. 2 /).

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. Later exploration was for copper in the mid 1950's. In 1956 the property was sold to Farrington Mann, 9207 S. Lakewood Blvd., Rivera.

Geology: Pinto Gneiss is cut by two major faults, several minor faults, and is intruded locally by thin, highly altered, basic dikes (see fig. 1 /). A zone of crushed material containing highly oxidized chalcopyrite-pyrite-specularite-gold bearing quartz is well exposed in the open cut along a north-trending and steeply east-dipping fault (see fig. 1 /). The wall rock is highly stained and altered, and contains secondary copper (chrysocolla-azurite-malachite) and iron (limonite-hematite) minerals (fig. 1 /).

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 gold (?) quartz veins contained in minor faults (fig. 1/ ,(1) and (2)). Mining of the copper-bearing crush and altered zone has involved the shaving off of the east slope of a small knob-like hill (fig. 1/, (3)). 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 only 25 feet (fig. 1/, (5)). About 400 feet west of the burrows an adit is driven close to 160 feet in much fractured Pinto gneiss containing altered dikes (fig. 1/, (4)).

Production: Several tons of material were 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 Co., about 2½ miles north of Twentynine Palms on Utah Trail. Concentrates produced were not marketed.

References: None.

J.R.E. 12/11/59.

Figure 1/. Sketch map showing the areal distribution, and geologic sketch maps of the workings at the Golden Bell (Blue Bell) and Silver Bell Mines.

Silver Scorpion Mine

Location: SE¼ sec. 1, T. 2 S., R. 9 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, Gold Park, 8.7 miles S. 28° E. of Four Corners, Twentynine Palms (see pl. 1 /).

Ownership: Undetermined.

History: Carlos J. Bassler, Jr. and Francis E. Bassler located the property October 16, 1953 (see Ownership, Carlos Jr. gold mine).

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 shaft is sunk 20 feet 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 (fig. 1 /). At 20 feet a drift extends southeast for an unknown distance paralleling the fault line exposed on the surface (fig. 1 /). It is idle.

Production: Undeteremined.

References: None.

J.R.E. 3/20/59.

Figure 1 /. Geologic sketch map of the Silver Scorpion mine.

Sinock Mine

Location: Sec. 17 (?), T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 3¼ miles northwest of Mission and Sunrise Wells (see pl. 3/).

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 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 as the workings were not entered, and the dump covered most of the surface outcrops, no statement can be made concerning their thickness and extent.

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 driven in the plane of the fault. Total workings here are estimated to be 400-500 feet. Several tens of yards southwest of the main shaft is another shaft. It is sunk at least 100 feet in the plane of the N. 70° E.-trending fault. Work done here is less than at the main shaft, perhaps 200-300 feet total. The mine access road is narrow and poor.

Production: Undetermined.

References: None.

J.R.E. 3/30/60

Sippi Mine

See: Lost Angel mine.

Smith Brothers Claims

Location: Smith Brothers No. 1 is in the SW¼ sec. 8, Smith Brothers No. 4 is in the NE¼ sec. 7 of T. 2 S., R. 10 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, about 10 miles S. 30° E. of Four Corners, Twentynine Palms (see pl. 1 /). Smith Brothers No. 8 is in the NE¼ sec. 19, T. 2 S., R. 10 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15, 1943; Pinto Mountains, 11.2 miles S. 25° E. of Four Corners, Twentynine Palms (see pl. 1 /).

Ownership: Undetermined.

History: John Uland, Milton B. and Albert H. Smith located the claims in 1955.

Geology: The country rock at prospect No. 1 is Pinto gneiss and at prospect No. 4, 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. 1 /). At No. 8 claim hornblende granite is cut by steeply south-dipping fault carrying 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. 1 /). At No. 8 claim a shaft has been sunk vertically 14 feet on a N. 75° E.-trending fault. Short drifts extend ~~out~~ from the ~~bottom~~ foot of the shaft in nearly east and west directions (fig. 1 /). The claims were not being worked on the day of the property visit.

Production: Undetermined.

References: None.

J.R.E. 3/17/59.

Figure 1 /. Sketch maps of the Smith Brothers claims (pl. 1 /).

Snowcloud Mine

Location: Sec. 1, T. 5 S., R. 9 E., or sec. 6, T. 5 S., R. 10 E., S.B.M. (proj.), U. S. Army Corps of Engineers Pinkham Well quadrangle, 15', 1943; 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: Pinto gneiss underlies the southwest slope of a northwest-trending ridge. The gneiss is cut by a north-trending and 80° E-dipping fault. 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 shaft. The shaft is sunk 40 feet 80° east in the fault plane; from which point it shallows and extends on possibly another 100 feet. The vein has been much overhand stoped at several places to the surface, from the floor of the tunnel along its course to the shaft intersection. The mine is accessible by jeep trails leading north through Pinkham Canyon from Cactus City. It is at an elevation of 3000 feet and 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	35	47	8

References: None.

J.R.E. 1/23/60.

Standard Mine

Location: Sec. 13, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, Joshua Tree National Monument, about 3 miles north-northeast of Mission and Sunrise Wells (pl. 3/).

Ownership: Undetermined.

History: The mine was owned and operated by Willard Allen and Joe Geiger, Twentynine Palms, from 1938 to 1941.

Geology: Massive 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, 3/8/60). The mine is idle.

Production: During the years 1938 to 1941 the Standard mine yielded about 700 tons of ore from which 631 ounces of gold and 46 ounces of silver were recovered.

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~~ Brothers. 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 thickness 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 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 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, an old arrastre pit is still discernible.

Production: Undetermined.

References: Crawford; 1894, p. 225.

R.B.S. 9/25/59.

Star Mine

See Frank Hill mine.

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, 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 reported on described 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 section of limestone and cherty dolomite about 700 feet thick is separated from underlying 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.

Steele Mine

See Top of the World Mine.

Stella Mine

Location: Sec. 10, T. 2 S., R. 12 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, about 3 miles south of New Dale (Site) and approximately 1/10 mile north of the Gold Crown mine (see 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: Sec. 30 (?), T. 6 S., R. 14 E., S.B.M., U. S. Army Corps of Engineers Canyon Spring quadrangle, 15', 1944; on the northeast slope of the Orocopia Mountains, 3½ miles south of U. S. Highways 60 and 70 and 1½ 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 that year the property was being worked and a 10-stamp mill under construction by the Sterling Mining Co., Los Angeles (Crawford, 1896, p. 314). The Sterling was once reported to have been a part of the Red Cloud Group (Merrill and Waring, 1917, 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 run 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, 1917, p. 539.

R.B.S. 2/11/60.

Stone House (La Rica) Mine

Location: NE¼NW¼ sec. 4 (proj.), T. 8 S., R. 21 E., S.B.M., McCoy Spring quadrangle, 1952; on the crest of the Mule Mountains half a mile northeast of the Hodges mine and about 3 miles west of Ripley. The mine is reached by means of a steep, narrow trail up the ridge due north of the stone house on the old Hodges campsite.

Ownership: Joe Hannah Jr., et al., c/o Melvin Wehe, 121 W. 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 search of 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 2 shallow prospect pits explore the fault. The adits are driven northwest just below a saddle at the head of the canyon and the 2 prospects are a few tens of feet above them near the saddle. The lower adit is about 40 feet long. The upper adit, 50 feet higher on the same vein, is 15 feet long. 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.

Sunrise Mine

Location: Sec. 26, T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corps of Engineers Eagle Tank quadrangle, 15', 1943; southeastern tip of the Pinto Mountains, one mile north of Mission Well.

Ownership: Howard M. Fox, 810 N. Whittier Drive, Beverly Hills.

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.

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, Inc., 416 Electric Building, San Diego. In 1933 the Sunrise Group consisted of 15 claims and was operated by Sunrise Mines Inc. along with the Zulu and Moose groups (see herein) and the Cortez group of 3 claims whose location is undetermined. The main camp was just south of the Sunrise shaft and included an office, mess hall, assay office, bunkhouses, and mill which included two Straub 10-stamp mills. 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 who were remodeling the mill to do custom work. Four men were employed (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.

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.

Summit Group

See Rusty Gold (Sunset Group) mine.

Sunset Group

See Rusty Gold (Summit Group) mine.

Sunset Mine

See North Star mine.

Sunrise Mine

See: Zulu Queen Mine.

Tingman-Holland Mine

See: Pinyon mine.

Thelma Group

See Meek Mine and Desert Gold Group.

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.

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 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) only assessment work is being done.

Geology: The workings of the Top of the World Mine lie athwart a low ridge (fig. __/) underlain by 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 metamorphic rocks.

Judging from the arrangement of the workings and some of the older reports it appears that the vein lies at or near the igneous-metamorphic 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 from 0 to 3 feet in thickness and is composed of crystalline quartz carrying unevenly distributed gold and silver-bearing galena. Ore from one chute (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 opening to an adit driven north from the south slope of the ridge to ventilate and drain the mine. An ore chute was stoped between three raises at the southwest end of the 60-foot level.

Plate __/ is a rough sketch of the workings in the plane of the vein, and figure __/ is a photo of the surface. The head frame stands over an inclined shaft in the hanging wall which was sunk by the present owner to avoid the caved upper part of the old main shaft, the caved collar of which lies in the pit to the right of the head frame in the photo.

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. 514; 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.

Triangle (Pilot) Mine

Location: Sec. 1, T. 7 S., R. 15 E. (proj.), S.B.M., U. S. Army Corps of Engineers Chuckwalla Mountains quadrangle, 15', 1945; in the Chuckwalla Mountains at the mouth of a canyon which drains the north slope of Pilot Mountain, about 2½ miles south and east of Aztec Well. An unimproved dirt road extends southward from Aztec Well to the mine.

Ownership: Not determined (1959).

History: The only published description of the Triangle (Tucker and Sampson, 1929, p. 489) reported it to be owned by Wm. B. Krosse, J. M. Halloway and C. A. McGraw who lived at Aztec well.

Geology: A fault 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 which reaches a maximum width of about 2 feet. 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. The country rock is gneissic granite.

Development: The Triangle mine consists of 3 inclined shafts, 2 open-cuts, and an adit. The shafts are about 70 feet apart 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, drifting extends 30 - 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 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 $135 in gold was recovered.

References: Tucker and Sampson, 1929, p. 489; Tucker and Sampson, 1945, pl. 35 (mislocated). R.B.S. 5/1/59.

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~~ 7 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

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.

Unknown Mine

Location: NW cor. sec. 34, T. 2 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 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 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 shrinks to 6 inches at a depth of 20 feet; a second dike is 4 inches thick at the surface, and there are several thin dike stringers. 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.

Unknown Mine

Location: NE¼NE¼ sec. 4, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 1958; 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 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.

Unidentified ?

~~Undetermined~~ Mine

Location: Sec. 8 (?), 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 4½ miles southeast of White Tank, and about ½ mile south of the West Pinto Basin Road (see pl. 2 /).

Ownership: Undetermined.

History: Undetermined.

Geology: Blue-gray quartzite and quartz-muscovite schist (part of the Pinto Gneiss) is cut by a northwest-trending and 65° southwest-dipping fault. The fault is marked by (~~contains~~) a 2 to 5-foot wide breccia-gouge zone which contains thin quartz stringers (fig. 1 /).

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 (fig. 1 /). The mine is idle.

Production: Undetermined.

References: None.

J.R.E. 1/25/60

Figure 1/. Sketch map showing the areal distribution of the workings (A), and a geologic sketch map (B) of the undetermined mine (topography from U.S.A.C.E. 15' Pinkham Well quadrangle, 1943).

Un~~determined~~identified Prospect

Location: Sec. 16 (?), T. 2 S., R. 12 E., S.B.M. (proj.), U. S. Army Corp of Engineers Eagle Tank quadrangle, 15', 1943; Pinto Mountains, about 3 miles northwest of Mission and Sunrise Wells (see pl. 3/).

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 milky quartz veins, as much as 1-foot thick, cut massive quartz monzonite. In the prospect area the veins are semi-parallel and tend 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. The mine access road is narrow and poor.

Production: None.

References: None.

J.R.E. 3/30/60

Unknown Mine

Location: NE¼NE¼ sec. 33, T. 2 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 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.

Unknown Mine

Location: NE¼NW¼ sec. 10, T. 3 S., R. 8 E., S.B.M., Lost Horse Mountain quadrangle, 1958; Joshua Tree National Monument, about 1 mile south of the Lost Horse Mine near the crest of Lost Horse Mountain on its southwest flank.

Ownership: Undetermined (1957).

History: Undetermined, but apparently an old property long inactive.

Geology: The mine workings explore quartz-bearing shear zones in banded quartz-biotite gneiss (Pinto gneiss). There are two principal shear zones, about 100 feet distant. One shear zone strikes north, dips 80° W., and contains thin quartz stringers; the second shear zone strikes N. 25° W., is vertical, and contains reddish-brown iron-stained vein quartz as much as 1 foot thick. This quartz vein is exposed discontinuously at the surface for about 400 feet.

Development: A vertical shaft (100± feet deep) is sunk on the 400-foot quartz vein, and this vein is explored by shallow pits and trenches for about 150 feet. A short adit is driven on the other quartz vein, and shallow pits explore several tiny quartz outcrops in the area.

Production: Undetermined.

References: None.

C.H.G. 6/20/57.

Victor Mine

See Top of the World Mine.

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 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 ~~Limes mine~~ Vidal Lime Claim are platy gneiss. 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 in width.

Development: This deposit is explored by 2 shafts. One is inclined steeply along the fault and the other, a few feet away, is vertical, apparently affording access to the inclined shaft. The depth of these shafts was not determined. 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.

Some new timber has been applied to the shafts, the vertical one being newly covered. No equipment was on the property when visited (December 1957).

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 (U.S. Bureau of Mines [illegible]).

References: None.

R.B.S. and C.H.G. 12/20/57

Virginia Shay Mine

See Virginia Mine.

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.

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 dioritic country rock 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 in a previous report (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. It is reported to be 200 feet deep but this was not verified. According to Mr. Kitchen the shaft which was sunk to explore the north vein reached a depth of 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 exess 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

Walker Claim

See Lucky Boy.

Washington Mine

Location: NE$\frac{1}{4}$ 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 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 3 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.

White Owl Group

See: Morning Star Mine.

White Wings Claim

See Red Cloud Group.

Zulu Queen Mine

Location: Sec. 15, T. 2 S., R. 13 E., S.B.M. (proj.), Dale Lake quadrangle, 1956; Pinto Mountains, Joshua Tree National Monument, about 6 miles northeast of Sunrise Well.

Ownership: Undetermined.

History: The Zulu Queen mine is one of 3 mines owned by the Sunrise Mines Inc., 726 Electric Bldg., 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 quartz monzonite. The shear zone trends north, dips vertically, and contains gold-bearing quartz veins and lenses that range from a few inches to 18 inches in thickness.

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 first level. Water was obtained from Sunrise Well about 6 miles southwest. The dirt road which connects the well with the mine is in part good, but generally in very poor condition. The mine is at an elevation of 1700 feet and low on the northeast slope of a small hill near the mouth of a wash which drains the Pinto Mountains from the north. It is idle.

Production: In the years 1934 to 1938 the Zulu Queen mine yielded some 112 tons of ore from which 38 ounces of gold and 7 ounces of silver were recovered.
References: Tucker, 1933, Unpublished Field Report No. 121; Tucker and Sampson, 1945, pp. 143-144, pl. 35.

J.R.E. 3/10/60.

Gypsum

Gypsum

Gypsum

The principal source of gypsum ($CaSO_4 \cdot 2\ H_2O$) in Riverside county has been the upper Paleozoic (?) Maria formation (Miller, 1944, p. 25), 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 deposits of potential commercial grade have been prospected since early in the present century.

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 remained about the same but the operation has been overshadowed by the exploitation of deposits in other counties (Ver Planck, 1952, p. 13).

Gypsiferous material to be used 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)

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 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 60 percent gypsum.

Small quantities of gypsite are said to 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 is wholly covered with older alluvium. This location may have been for a grinding or storage 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: $SE\frac{1}{4}$ sec. 9, $SW\frac{1}{4}$ sec. 10, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, $7\frac{1}{2}$', 1954; northeastern flank of the Santa Ana Mountains, $3\frac{1}{2}$ 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.

Capitol Dome Group

See: Main Street (Gypsum) Canyon deposit.

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.

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.

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.

Freeman-Nonhof Deposit

See: White Gypsum group and Big Chief deposits

Frazer Deposit

See: Eagle Canyon gypsum deposit.

Garland Deposit

See Maria Mountains Deposits.

Garbutt and Orcutt Deposit

See: Maria Mountains Deposits.

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.

Gypsum Canyon Deposit

See: Main Street Canyon gypsum deposit.

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.

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 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.

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.

Langdon Deposit

See: Maria Mountains Deposits.

Main Street (Gypsum) Canyon Gypsum Deposit

Location: $S\frac{1}{2}NE\frac{1}{4}$ sec. 15; $N\frac{1}{2}S\frac{1}{2}$ sec. 14, T. 4 S., R. 7 W., S.B.M., Corona South quadrangle, $7\frac{1}{2}$', 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 $S\frac{1}{2}NE\frac{1}{4}$ sec. 15 (1957). Floyd N. Champion, et al., 3316 E. Anaheim Street, Long Beach, own five unpatented placer claims (Capitol Dome 1-5) covering about 75 acres in the $NW\frac{1}{4}SE\frac{1}{4}$ 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 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.

Maria Mountains Deposits

Location: Secs. 1, 2, 3, and 4 (proj.) T. 4 S., R. 20 E.; secs. 30, 31, 34, and 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 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).

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.

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 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.

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 11/20/58). The latter worker, a student at Stanford University, probably has the greatest fund of evidence to support his theory but has not yet published (1960). The structure problem might be considered purely academic were it not for the obviously divergent alternatives offered regarding the accessibility of reserves at depth. As with the Palen Mountains deposit (see herein), the disturbed condition of these rocks makes estimation of reserves uncertain at best.

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 careful geologic mapping of this area now being conducted by the U. S. Geological Survey is as yet only partially published (Hamilton, 1960, p. 277-278).

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 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 eliminated by selective procedures in the quarry.

The Utah Construction Company quarry is in sec. 11, T. 4 S., R. 20 E. 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.

Morning Star Deposit

Location: NE¼NE¼ sec. 1, T. ? 23 E. (proj.), SW¼SW¼ sec. 31, T. 1 S., R. 24 E., and NW¼NW¼ sec. 6, T. 2 S., R. 24 E., S.B.M., Vidal quadrangle, 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 ~~deformed.~~ 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 which form bold ridges and cliffs (fig. __/).

Development: None.

Production: None.

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, 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.

Geology: The Palen Mountains Gypsum deposit includes several sequences of gypsiferous beds in a north-dipping, faulted homoclinal section of metamorphosed igneous and sedimentary rocks exposed in an area 3 miles long and 1½ miles wide in Palen Pass. The gypsum occurs as irregular, massive beds of white, finely crystalline rock of reportedly good grade, ranging from 0 to 150 feet in thickness, interbedded with marble or in thinly laminated gypsiferous epidotic schist and quartzite. Anhydrite is not common but its possible increase at depth has not been determined (Hoppin, 1954, p. 5-8). Deformation of these rocks has caused redistribution of gypsum by plastic flow with resulting thickening and thinning of units. Limestone units appear to have been more brittle. Isolated blocks and small fragments of limestone are commonly engulfed by gypsum. 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.

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.

Parkford Deposit

See: Riverside Mountains Deposits.

Prizer Deposit

See: Barth deposit.

Red Bull Deposit

See: Hagador Canyon gypsum deposit.

Riverside Mountains (Parkford) Deposits

Location: Secs. 6 and 7, T. 2 S., R.24 E., S.B.M., Parker quadrangle, 1950 and Vidal quadrangle, 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 (Tucker and Sampson, 1945, p. 167, pl. 35; Ver Planck, 1950, p. 227; 1952, p. 24; 1957, p. 234) 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 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 in sec. 7 (Tucker and Sampson, 1929, p. 511) by Smith, Emery & Company, Los Angeles.

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.

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 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)

Savage Deposit

See: Maria Mountains Deposits.

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.

Ware Deposit

See: White gypsum group and Big Chief deposit.

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.

Lead-Zinc-Silver

Lead, Silver and Zinc

The base metals, lead and zinc, and the noble metal silver, 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 valuable metal such as copper or gold. Ore containing appreciable quantities of zinc has been encountered in only one mine, the Bald Eagle, although it has been reported from the Black Eagle mine and perhaps one or two other localities where it is of minor significance.

From 1891 to 1961 a total of 2,228,562 pounds of lead valued at $341,975 was reported from Riverside County. The total value is based on a price per pound which has fluctuated from as low as three cents in 1932 to a high of 18 cents in 1947. 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 fairly abundant in many mines, especially those in the Chuckwalla Mountains, but generally as small disseminated 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. All of the above minerals are heavy enough to appear as concentrates in most tabling or sluicing techniques and offer a source of revenue which should not be overlooked in a singleminded quest for the gold with which they commonly are found.

A total of $127,248 worth of silver was reported from Riverside County mines between 1891 and 1961. Most of this metal 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. Figueroa) 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, 1952; Big Maria Mountains, about 3 miles northeast of Midland.

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 Figueroa, P.O. Box 453, Blythe. In 1950 and 1951 the mine was active and production was recorded.

Geology:

Geology: The mine area is along the contact between an intrusive body of fine-grained granodiorite (?) and northeast-trending, tan-colored dolomitic limestone (fig. 2/). 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 augen gneiss rests upon the dolomitic limestone, and forms the backbone of the ridge above and northwest of the workings.

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)	Gold (ounces)	Silver (ounces)	Recoverable Metals Copper (pounds)	Lead (pounds)	Zinc (pounds)
1950	56	1	390	108	15,922	------
1951*	181	---	1166	---	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. __/) (personal communication, Danny G. Figueroa).

References: Tucker & Sampson, 1945, p. 148; Tucker, 1929, p. 491.

J.R.E. 12/18/58.

Figure 1. Index and geologic map showing the location and areal distribution of the workings of the Neal Group (topography from U.S.G.S. 15' Midland quadrangle, 1952).

Figure 2/. Looking southwest toward Midland and the Little Maria Mountains. The lower workings of the Neal Group are visible in the right foreground (fig. 1/).

Figure 3. View north toward the upper workings of the Neal Group. Note the gently west dipping beds of dolomitic limestone and the darker colored overlying augen gneiss (fig. 1/).

Black Eagle Mine

Location: Sec. 30?, T. 3 S., R. 14 E., S.B.M. (proj.), U. S. Army Corps of Engineers 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 M. 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 1938.

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).

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 vanadate, 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. 1/). It is of minor importance and nearly all the work has been confined to the Bald Eagle Vein (Tucker and Sampson, 1945, p. 146).

Development: A two-compartment shaft is sunk in the Black Eagle Vein to a depth of 650 feet. There are levels at 60, 100, 150, 200, 300 and 500 feet. On the 60-foot (adit level) there is a drift 600 feet west and 160 feet east from the shaft. On the 150-foot level there is a drift 500 feet west and 180 feet east from the shaft. There is a 200 foot west drift and 180-foot east drift on the 200-foot level. On the 300 foot level there is a 485-foot drift west from whence a crosscut extends south 550 feet to the South Vein. The vein has been drifted 170 feet from the cross-cut. At present (1960) the mine is in large part caved, filled and boarded over, and of course inaccessible.

Production: The total production of the mine is estimated by Tucker and Sampson (1945, p. 147) to be $200,000. They also 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	$172.00	15,303	$616.00	$1,953.00
1936	6,355	525.00	53,983	2,483.00	4,269.00
1938	15,044	1,479.00	241,510	11,109.00	3,387.00
1939	68,683	7,143.00	634,071	29,801.00	11,604.00
940	22,269	2,516.00	536,047	26,823.00	22,510.00

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

Figure 1/. Plan map and longitudinal sections of the Black Eagle Vein in 1924 (adapted from an unpublished report by M. A. Newman.)

Cap Hunter (Poor Boy) Mine

Location: Sec. 33 (?), T. 7 S., R. 16 E., S.B.M., U. S. Army Corps of Engineers, Chuckwalla Mountains quadrangle, 15', 1945; 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, much of which is shown on the Sidewinder Well quadrangle, 1952; (U. S. Geological Survey, 15'); but is not indicated on the Chuckwalla Mountains quadrangle.

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.

Geology: The low ridges in the mine area are underlain by 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.

Development: The workings, now inaccessible, comprise 3 inclined shafts on the fault and an undetermined amount of drifting and stoping. 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)	Silver (ounces)	Copper (pounds)	Lead (pounds)
1952	1		5		316
1953	3	1	25		1,098
1954	40	1	15	54	850

References: None.

R.B.S. 1/22/60.

Carbonate Lead Mine

See Groover Mine.

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.

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 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.

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.

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', 1945; and Sidewinder Well quadrangle, 1952; on the east slope of the Chuckwalla Mountains about 2 miles south of Ship Creek. In March 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.

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 bunches of galena, cerussite, iron oxides, and sparse crusts and 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 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.

Groover (Carbonate Lead)

Location: Sec. 4, T. 2 S., R. 11 E., S.B.M. (proj.), Valley Mountain quadrangle, 1956; Pinto Mountains, 6 miles south-southwest of Old Dale.

Ownership: F. E. Groover, 12691 Trask Ave., Garden Grove, owns 1 unpatented claim (March 1958).

History: Undetermined.

Geology: An intrusion of porphyritic quartz monzonite into white, tan weathering medium-grained dolomitic limestone, has produced a tactite zone as much as 7 feet thick. The intrustion has been along a fault in the area adjacent to the main shaft (Fig. 1/, B). The tactite zone contains galena, azurite, malachite, and minor amounts of gold and silver. A body of massive epidote and gray chert occurs adjacent to the main adit (fig. 1, B). 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 composed principally of varicolored quartzites (fig. 1/, A). Major normal faults, trending northwest and dipping southwest, cut both the quartz monzonite and the metasedimentary rocks.

Development: The 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 (fig. 1/, B). The main adit, 300 feet east of 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 (fig. 1/, B). The mine is idle.

Production: Undetermined.

~~Selected~~ References: None.

J.R.E. 3/29/60

Figure 1/. 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: NE¼ NW¼ sec. 24, T. 1 S., R. 22 E., S.B.M., Vidal quadrangle, 1950; on the northeast slope of the West Riverside Mountains, 7¼ miles southwest of Vidal.

Ownership: Undetermined( ).

History: Undetermined.

Geology: The country rock is slightly gneissic 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.

Development: A 75-foot drift has been driven southwest along a vertical quartz vein which strikes N. 55° E. The vein is tracable for about 60 feet on the surface and is from 4 to 6 inches wide in the adit. The quartz contains small proportions of galena, chrysocolla, and iron oxides. The adit is open and dry but no equipment remains at the site. When the property was visited, the road, shown on the map, was still in good condition (Dec. 1957). CK 11-78

Production: Undetermined. ~~Idle.~~

References: None.

R.B.S. and C.H.G. 12/17/57.

Neal Group

See Bald Eagle Mine.

Ragsdale Claim

Location: NE¼ sec. 19 (proj.), T. 7 S., R. 17 E., S.B.M., Sidewinder Well quadrangle, 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 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.

X

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 south~~west~~east 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; Saul, Evans, and Gray, 195—, p. —.

C.H.G. 7/2/63.

Maria Mountains Marl

(~~Marl and Travertine Deposits North of Blythe~~)

Marl and travertine have formed local caps, flanking sheets and buttressed benches ~~(fig. —)~~ 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, 1961, 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 date (1958) these unusual deposits of calcium carbonate have been exploited in only a small way as a source of dimension stone ~~(fig. —)~~ 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; Saul, [illegible], p. —.

R.B.S. 4/10/58

X

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, Winchester. Probably the rock was crushed and marketed as poultry grit. By 1929 the property was idle and apparently has since remained idle.

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 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. Hanks, Inc., San Francisco showed the material to be dolomitic as follows:

ple No.	Insoluble	Fe_2O_3 and Al_2O_3	CaO	MgO	P_2O_5
C.-N1	11.46%	0.60%	38.92%	8.65%	0.12%
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; Gray, Evans, and Gray, 196—, p. —.

C.H.G. 7/2/63.

Nightingale Limestone

Location: Secs. 6, 8, 9, 10, 11, 12, T. 7 S., R. 5 E., S.B.M., Idyllwild quadrangle, 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.

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.

X

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) 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 __/).

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. 55 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; Saul, Evans, and Gray, 196—, p. —

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; Saul, Evans, and Gray, 19[illegible], p.

C.H.G. 3/3/61

Magstone Products

See: Castro Quarry.

Snyder Deposit

See: Lamb Canyon deposit herein.

Bautista Canyon Deposits

See: Moore limestone deposit and San Jacinto Rock Products Company's limestone deposit herein.

Harris Limestone Deposit

See Nightingale limestone.

~~Unknown~~ Prospect (name undetermined)

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; Sand, Evans, and Gray, 196—, p. —

C.H.G. 3/3/61.

Mira Loma

See: Glen Avon Limestone Deposit.

Old City Quarry (Fairmount Hill Quarry, North Hill Quarry)

See under Rock Products, Broken and Crushed Stone.

North Hill Quarry (Fairmount Hill Quarry, Old City Quarry)

See: Old City Quarry under Rock Products, Broken and Crushed Stone.

X

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 (1956).

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; Sand, Evans, and Gray, 196-, p. --.

C.H.G. 7/30/63.

X

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. 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 modified 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.

X

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 two new finish mills were installed in 1963. Early in 1964 ~~and~~ later phases of the modernization program, which will include ~~first the replace-ment of the finish-end and finally~~ enlargement of raw materials handling capacity and installment of new rotary kilns, were under way. In January 1964 the Company announced plans to double the capacity of the white plant [illegible] the project scheduled for completion by mid-1965.

X

Geology: At Crestmore limestone and siliceous meta-sedimentary rocks occur as a large screen in Cretaceous quartz diorite (Bonsall Tonalite). The metamorphic rocks have been called the Jurupa Series and are regarded as probably of late Paleozoic or early Mesozoic age. The limestone deposit consists of two roughly lenticular bodies which crop out and are separated by about 500 feet of quartz diorite. 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 from 200 to 300 feet in thickness, but to the east the upper body (Sky Blue Limestone) is about 500 feet thick and the lower body (Chino 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 $CaCO_3$. A typical analysis of the limestone is: CaO, 55.85%; MgO, 0.3; SiO_2, nil; Al_2O_3, nil; Fe_2O_3, trace; P_2O_5, trace; Ig. loss, 43.80%. 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.

X

Development: Since June 1956 all mining has been 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 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. Eventually limestone will reach the surface by means of an underground belt conveyor, construction of which started during 1963.

X

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. Two 530-foot long kilns will be installed to replace the 13 kilns now in use and when the rebuilding is completed in the fall of 1964 the plant will have a capacity of about 4,500,000 barrels. Complete automation of the kilns will be by a [illegible] 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 mines in Temescal Canyon (Corona clay pit) and near San Juan Capistrano, [illegible] County ~~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.

[illegible] TRW-330 control [illegible] system. [illegible] kilns, the TRW-330 system will [illegible] out-of-limit performance [illegible], and [illegible] raw mix [illegible] ([illegible] Products Oct. 1962 p. 134, [illegible] 1964, p. 112).

X

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 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; Robotham, 1934, 20 p.; 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; Saul, Evans, and Gray, 196—, p. —.

C.H.G. 2/21/63. 11/9/64

X

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.

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, white to light gray, 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:

le no.	Insoluble	Fe_2O_3 and Al_2O_3	CaO	MgO	P_2O_5
.-S1	1.56%	0.26%	53.17%	1.30%	0.01%
.-S2	0.92	0.26	54.24	0.94	0.01
.-S3	0.86	0.22	54.85	0.46	0.01

X

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; Saul, Evans, and Gray, 196—, p. —.
C.H.G. 7/2/63.

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:

No., location, and description	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	P_2O_5
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%
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
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
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
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	0.14
"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
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

X

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; Sand, Evans, and Gray, 196—, p. —.

C.H.G. 7/2/63.

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.

Production: Plant capacity is 100 tons per day maximum, and about 60 tons if making fines only.

References: Gay, 1957, p. 574; Gaul, Evans, and Gay, 196—, p. —.

C.H.G. 1/23/63.

Whitestone Deposit

Location: SE¼ sec. 8, S½ sec. 9, E½ sec. 17, T. 2 S., R. 5 E., S.B.M., Joshua Tree quadrangle, 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.

Whitlock Limestone Deposit

Location: $NE\frac{1}{4}$ and $E\frac{1}{2}SE\frac{1}{4}$ sec. 28, and secs. 27, 34, T. 6 S., R. 4 E., S.B.M., Idyllwild quadrangle, 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 who 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 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; Sont, Evans, and [illegible], 196—, p. —.

C.H.G. 7/2/63.

Hemet Magnesite Mine

Location: $NW\frac{1}{4}$ sec. 31, T. 5 S., R. 1 W., S.B.M., Winchester quadrangle, 7.5', 1953; $3\frac{1}{2}$ 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 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

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	60%
Matrix (magnesite, limonite, opal serpentine(?))	
Serpentine	tr.

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 through 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. 516-619; 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.

Nichols Magnesite Deposit

See: Hemet Magnesite mine.

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 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 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% to 35% Mn, has required beneficiation.

Mining has been both open pit and underground, both on a small scale. 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 refined at a small "Humphrys Spiral" plant just north of Blythe. Much of the ore milled at Ripley came from Imperial County.

With the closing of the government carlot program, August 5, 1959, manganese mining in Riverside County abruptly ceased.

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.

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 1961 were included with barite, gypsum, iron ore, peat, petroleum, and wollastonite, which had a combined value of $33,769,768.

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 adjacent 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.

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 1938-1945. 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

C

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 mostly 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.

D

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 2¼ 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.

Geology: A discontinuous 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. 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.

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; Saul, Evans, and Gray, 196-, p. —.

C.H.G. 1/7/64.

Blind Canyon Deposit

Location: SE¼SW¼ sec. 18, T. 2 S., R. 5 E., S.B.M., Palm Springs quadrangle, 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 interleaved 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.