

# **The California Building Stone Industry circa 1913**

## **“California”**

By G. F. Loughlin

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## CALIFORNIA.<sup>1</sup>

By G. F. LOUGHLIN.

The Coast Range and the Sierra Nevada contain a vast quantity of various kinds of stone suitable for building, but large areas of these ranges are too remote from transportation lines to be of economic importance. A comparison of the quarry map (Pl. VI) with a geologic map of California will show that, although the different kinds of stone are widely distributed, most of the quarries are located in the vicinity of railroads within reasonable distances from the largest cities.

The stone-producing formations of California comprise rocks of Paleozoic (?), Jurassic, Cretaceous, and Tertiary ages, and include both intrusive and effusive igneous rocks of different kinds, sandstones, limestones, marbles, and slates.

*Granite.*—The granites and related rocks of California form the greater part of the central and southern parts of the Sierra Nevada and of the Coast Range southeast of Los Angeles. Smaller, though considerable areas are found in the Coast Range near San Luis Obispo, east and west of the lower part of Salinas River, near Santa Cruz, and at several places in the Klamath Mountains in the northwestern part of the State. The granites of California are nearly all of light to dark gray color, some with a pale pinkish tint. There are no pink and red granites similar to those of the Northeastern States and of certain Central States. Some, of dark-bluish to black color, are not granites in the geologic sense, but monzonites, diorites, and gabbros. They are known commercially, however, as "blue granite" and "black granite." Many of the light-colored granites are granodiorites and quartz monzonites, strictly speaking, but their differences from true granite are usually microscopic. All gradations in color and composition may be found from light-gray true granite to gabbro or "black granite," but the darker varieties are quarried only to a limited extent. In texture the granites vary from very fine to coarse grained, the medium to rather coarse grained varieties greatly predominating. A favorable feature common to most of the granites is their remarkably good rift and grain, which allows large blocks to be split evenly with a minimum amount of labor. Another feature which seems especially characteristic of California granites is the quantity of stone quarried from large residual boulders, not only for

<sup>1</sup> Folios Nos. 3, 5, 11, 15, 17, 18, 31, 37, 39, 41, 43, 51, 66, and 138 of the Geologic Atlas of the United States describe the geologic distribution of the different formations in the eastern half of California from Redding southward to Mariposa. Folio No. 101 describes the geology around San Luis Obispo, and Folio No. 163 the geology from Santa Cruz northward to Redwood. Much of the information on the building stones of California has been taken from Bulletin No. 38 of the California State Mining Bureau (The structural and industrial materials of California), by L. E. Aubury.



local but for more extensive use. These boulders represent the remnants left from prolonged disintegration of large granite masses, but after removal of a thin weathered coating, they yield sound stone.

The most important quarry districts are in Madera, Placer, Riverside, and San Diego counties.

At Raymond, in Madera County, are two large quarries of biotite muscovite granite which have furnished stone for the post office, the Fairmont Hotel, the Mercantile Trust Co., and other buildings, and for the Dewey and McKinley monuments in San Francisco. The principal granites used in San Francisco are those from Raymond, Rocklin, and Penryn. Granite from the latter two localities, which are in Placer County, may be seen in the State Capitol at Sacramento, and in the Hibernia Bank and the Crocker Building in San Francisco. Most of the 24 quarries at Rocklin are small, though the largest in 1904 had a depth of 100 feet. They all are said to lie within an area not more than a mile square. The stone is of light-gray color and of medium to rather coarse grain. Quartz is abundant, more so than in most of the California granites, in colorless rounded grains. Soda-lime feldspar as a rule is dominant over the potash variety, and is of opaque, white color, giving contrast to the quartz. Black mica, the only other conspicuous mineral, occurs for the most part in fine unaltered scales. Where weathered it has yielded small quantities of iron oxide, which may appear as yellowish brown specks or may have filtered into the cleavage cracks of the translucent potash feldspar grains, giving them a pale flesh-colored tint. This color, however, is too slight to affect noticeably the general gray color of the stone. The stone is said to work well and to take a good polish. Its crushing strength, an average of three tests, is reported to be 21,104 pounds to the square inch.

The Penryn quarries also have been in operation since the early sixties. Boulders as well as ledges have been quarried, and the stone has been used extensively in San Francisco. The granite is of gray (mottled white and black) color, and of coarse-grained appearance, with a slightly developed gneissoid structure. The light-colored minerals, which make up two-thirds of the rock, include both kinds of feldspar and a little quartz. The feldspars are translucent, colorless to pale flesh-colored, and free from alteration. The black minerals, which comprise the remaining third of the rock, are chiefly hornblende and biotite, intimately intergrown, and of brilliant black color. The apparent coarse grain of the rock is due to the tendency of the black minerals to segregate into small, nearly pure groups, which gives the rock an appearance very distinct from that of the majority of California granites.

Besides the granite just described there is, 1 mile east of Penryn, a "black granite," near gabbro in mineral composition, which has been quarried for monumental stone.

At Loomis, 3 miles south of Penryn, a biotite granite, intermediate in color and texture between the stones at Rocklin and Penryn, is quarried. It was used in the extension of the Hibernia Bank Building, San Francisco.

In Riverside County granite has been quarried on a large scale at Casa Blanca for rubble, used in the San Pedro breakwater, and for building and ornamental use at Corona, Riverside, and Temecula. At Corona both boulders and ledges of a biotite muscovite granite



are quarried, the former especially for paving blocks, a large number of which are made. In addition to building stone, a considerable quantity has given general satisfaction as monumental stone in Los Angeles, Riverside, and elsewhere in southern California.

At Temecula the granite is largely quarried from boulders, since these are more easily worked than the ledges, which are for the most part covered with boulders and residual soil. Paving blocks and dimension stone are produced. The rock is a biotite granite of light-gray color with a pale-reddish tint.

The quarries at Riverside and West Riverside have yielded a large quantity of granite for buildings in Los Angeles and vicinity. Two varieties have been noted by the writer: One a light-gray, medium-grained biotite muscovite granite, somewhat resembling the well-known Concord, N. H., stone; the other a medium-gray, medium-grained rather gneissoid biotite granite, in which the biotite tends to segregate into spots or bunches a quarter of an inch in diameter. In both varieties, the minerals are free from conspicuous alteration.

At the Casa Blanca quarries, the granite quarried for rubble contains a large number of dark blotches, but stone of uniform color is said to be available for building. Other quarries in Riverside County have yielded large quantities of stone for paving, road ballast, and concrete.

In San Diego County, Foster and Santee are the principal quarry centers, though granite for local use is quarried at a number of places. The granite from Foster has been used in the Government buildings at Fort Rosecrans on Point Loma, west of San Diego. Two varieties of granite are quarried at Foster. One is a medium gray fine-grained biotite granite, resembling rather closely the well-known gray granite from Westerly, R. I. The soda-lime feldspar is the most conspicuous of the light-colored minerals, owing to its white color, whereas the quartz and potash-feldspar are colorless. The soda-lime feldspar is somewhat altered, and some of its crystals have a greenish tint due to the presence of secondary epidote. A few of its crystals have been softened by weathering, but such crystals are too small to have any noticeable effect on the appearance and durability of the stone. The other variety is a light-gray medium to rather coarse grained gneissoid biotite granite of the same composition as the fine-grained variety; all its minerals are free from megascopic alteration. Associated with the gneissoid granite is a nearly white variety (aplite) containing only a very small quantity of biotite. It is not known whether this variety can be obtained in commercial quantities.

The granite from Santee is used largely for monumental work, also for building stone, and large quantities of it have been shipped to Los Angeles and other points in southern California. In monuments it resembles the widely used granite from Barre, Vt. The rock is of medium to rather dark gray color, distinctly darker than the average California granite, and of medium, even grain. It is composed essentially of bluish gray translucent feldspars and black intergrowths of hornblende, augite, biotite, and magnetite. All the minerals appear to be quite free from alteration. The rock takes a good polish, which, with its dark color, especially adapts it for monumental work.

At Dehesa, in San Diego County, there is an orbicular "black granite" or gabbro, that is well adapted for ornamental work, and would probably be unique among building and ornamental stones.



The rock is characterized by abundant rounded segregations of varying textures uniformly scattered through a medium to rather coarse-grained matrix, and several varieties, based on variations in texture, are said to be available. The orbicular rock has been found only as residual boulders. Other orbicular "black granites" have been found at Rattlesnake Bar, Eldorado County, and in Sierra and Plumas counties, but none has been quarried.

In Butte County a large amount of granite is available, but lack of transportation facilities has prevented development. In Fresno County at Academy, a dark, medium-grained granite is quarried from boulders. In Los Angeles County granite has been quarried largely for crushed stone and in recent years for the Los Angeles aqueduct. In Nevada County granite somewhat marred by streaks and black "knots" for local use has been quarried from boulders at Grass Valley, Nevada City, and Rough and Ready. Some fine-grained "black granite" suitable for monumental work has been reported from Rough and Ready. In Sacramento County a large granite quarry is operated by the State prison at Folsom, chiefly for construction work by the State. In San Bernardino County granite occurs over large areas and is quarried near Crucero, Declez, Halleck, Oro Grande, and Victorville. The chief products are paving blocks and rubble, but some building and monumental stone also is quarried. The county jail in San Bernardino was built of stone from a Victorville quarry. In Shasta, Siskiyou, and Trinity counties there are large quantities of granite, but it is said to be jointed, shattered, or streaked to such an extent that a great deal of it is not suited for quarrying. Gray granite has been quarried in Siskiyou County for monumental work 4 miles southwest of Etna and a nearly black rock (uralitic gabbro) 16 miles north of that place. In Sierra County there are extensive areas of granitic rocks that have not been prospected. In Tulare County granite boulders have been quarried near Portersville, and a gray syenitic rock at Rocky Point. In Tuolumne County a fine-grained gray biotite granite has been quarried at the head of Phoenix Lake.

*Dark volcanic rock ("trap rock").*—Published information on "trap rock," in distinction to other rocks of California, for use as crushed stone is very meager. Trap rock, or macadam, quarries represented on the accompanying map include not only diabase and basalt, the true trap rocks, but some other lavas, tuffs, granite, diorite, and possibly some sandstone, chert or jasper, limestone, shale, and gravel. In Solano and Sonoma counties the principal rock used is basalt; in Napa County, volcanic tuff. In Alameda, Marin, and San Francisco counties "blue rock" or metamorphic sandstone and chert or jasper are commercially termed trap rock, but in the present report certain of these quarries have been classed as sandstone. There is an abundance of basalt and diabase, as well as other suitable volcanic rocks in the State, though they are for the most part too far removed from the larger cities to be of value as crushed rock. In the vicinity of Santa Cruz basaltic rock is available, but it is said to be less suitable for road material than the chert layers which occur in the limestone formations.<sup>1</sup> The chert in this region is scarce. Red

<sup>1</sup> Branner, J. C., Newsom, J. F., and Arnold, Ralph, U. S. Geol. Survey Geol. Atlas, Santa Cruz folio (No. 163), 1909.



chert or jasper ("red rock") well suited for road material occurs in good quantity in the vicinity of San Luis Obispo.<sup>1</sup>

*Light-colored volcanic rocks.*—Volcanic rocks, both effusive and intrusive, and mostly light colored, cover practically the entire area of the northeastern part of the State, and considerable bodies of them are distributed in the Sierra Nevada range and along the eastern border of the State as far south as the Mohave Desert. They are also found extensively in counties just north of San Francisco Bay, and smaller bodies are found in the region around San Luis Obispo. The rocks quarried are largely tuffs of different kinds, but in places include considerable amounts of lavas. The tuffs as a rule are soft and easily worked when quarried, but harden on exposure. They are also refractory, and have been extensively used, especially in the northern counties, for chimneys, fireplaces, and for fire bricks in stoves. The lavas, as a rule, lack the pronounced rift so characteristic of the granites, and break with curved fractures, but they are easily dressed, though not in large blocks, such as may be obtained in the granite quarries. The most important quarries of volcanic rocks are in Napa, San Luis Obispo, Siskiyou, and Sonoma counties.

In Napa County, at Calistoga, a yellowish trachyte and trachyte tuff are quarried, mostly from bowlders. The tuff was used in the St. Helena post office. Near St. Helena reddish and yellowish trachyte tuffs have been quarried and used in several buildings, including the public school, in St. Helena. Other quarries of gray and red trachyte tuffs have furnished stone largely for bridge and foundation work. The red tuff is suitable for trimmings in structures built mainly of the lighter-colored stone. In Sonoma County, which adjoins Napa County on the west and is covered by the same volcanic formations, the principal quarries are near Agua Caliente, Santa Rosa, Sonoma, and Stony Point. The stone quarried is mostly light colored, but a dark-red rhyolite tuff is quarried near Sonoma that has a considerable local use for trimming. Some of the tuffs are locally called sandstone, which they closely resemble in color and texture. In Santa Rosa the Carnegie Library and the California Northwestern Railway station are built of stone quarried east of the town; in Petaluma, the Phoenix Building, Carnegie Library, and other buildings are constructed of trachytic tuff from Stony Point. The prevailing products, however, of these stones are paving blocks, curbing, flagging, and railroad ballast.

In San Luis Obispo County there is a series of dacite and andesite buttes extending northwestward from near San Luis Obispo to Morro Rock, on the coast. The stone has been quarried largely for rubble used in breakwater construction, but has also been used in building construction. The Presbyterian Church and the Free Library in San Luis Obispo contain stone from Bishops Peak. The stone at Los Berros has been used for building in San Luis Obispo, Arroyo Grande, and to a small extent even as far away as Los Angeles.

In Siskiyou County a light-yellowish tuff, with narrow bands and patches of brown ("sap" stains) and white, has been quarried east of Montague and used in some of the buildings of Yreka. Quarries of a similar rock and of blue-gray to brick-red tuffs have been quarried near Little Shasta, and also used for building in Yreka.

<sup>1</sup> Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis Obispo folio (No. 101), 1904.



Near Macdoel a pumice has been quarried and shipped to San Francisco as an ingredient for cement. There is some indication at present that pumice and other highly-porous rocks of low specific gravity may be in considerable demand as fillers in concrete mixtures where a minimum of dead weight is required, thus opening a much more extensive market than has heretofore existed for such types of stone.

The other counties in which volcanic rocks find a local use are given in the quarry list on page 1365. One of the most important formations not previously mentioned is that known as the Tuscan tuff, of Pliocene age, which occurs extensively in the region east of Redding, Shasta County. The extent and distribution of this formation are given by J. S. Diller in the Lassen Peak (No. 15) and Redding (No. 138) folios of the Geologic Atlas of the United States Geological Survey. According to Diller, this rock varies in texture from very coarsely fragmental to fine grained. The fine-grained variety is gray and usually distinctly stratified, and is composed of small fragments of andesite, in part pumiceous, with broken crystals of soda-lime feldspar and hornblende embedded in a fine gray matrix composed of minute angular particles of volcanic glass, which constitute the major part of the rock. Regarding its economic value, Diller says:

The Tuscan tuff stands fire well, and being soft is easily hewn into shape. It is commonly used for chimneys and fireplaces, and in the vicinity of Millville a small church and several smokehouses are made of it. The Tuscan tuff is similar to the trass of the Rhine Valley, which is so extensively used in the manufacture of puzzolan cement, and there appears no good reason why it might not be used in the Redding region for the same purpose, especially since the necessary lime for admixture is abundant.<sup>1</sup>

*Slate.*<sup>2</sup>—California is the only one of the Pacific States that has produced slate. The slate quarried has all come from the Mariposa slate. The only important production has been in Eldorado County, but small quarries and prospects have been opened in Amador, Glenn, Mariposa, and Merced counties. Black slate has been the principal product, but a limited deposit of grayish-green slate has also been worked.

The black slate in the principal quarry, at Slatington, has a black or blue-black color, splits very finely and regularly with a smooth glistening surface, and resembles the slates of Bangor and Slatington, Pa. "Ribbons," or thin highly siliceous bands, are of frequent occurrence, and in some places pyrite is an objectionable impurity. Where quarries and prospects have proved unsuccessful, the rock exploited in some cases was weathered surface rock of poor quality, which may have capped slate of good quality; in others the slate was cut by numerous veins; in others the slate, after exposure for a few years, changed color owing to oxidation either of pyrite or some other iron compound, possibly a carbonate.

The green slate, an unusual alteration product of an igneous rock, forms a band (dike) several feet wide crossing the black slate obliquely to its ribbon structure in the principal Slatington quarry. It works satisfactorily as a roofing slate, though its cleavage surfaces are not as smooth as those of the black slate. It has been used for trimming and lettering on black slate roofs.<sup>3</sup>

<sup>1</sup> U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), p. 14, 1906.

<sup>2</sup> More complete accounts of the slates of California, by E. C. Eckel, may be found in U. S. Geol. Survey Bull. 275, Slate deposits and slate industry of the United States, pp. 56-58, 1906; Bull. 586, pp. 65-70, 1914.

<sup>3</sup> A special description of the green slate by E. C. Eckel may be found in the Jour. Geology, vol. 12, pp. 15-29, 1904.



*Marble.*—The marbles of California have mostly been quarried from crystalline dolomite and limestone strata of Paleozoic age, although the limestones of Triassic, Jurassic, and early Tertiary ages afford in places more or less suitable materials. The outlines of certain limestone and marble deposits of the State have been shown in a recent Survey bulletin.<sup>1</sup> Limited quantities of "onyx marble" and "verde antique" or serpentine marble, have also been produced. Marble deposits of greater or less extent have been reported from at least 28 counties, but many of them are too inaccessible to be of any present importance. Others are too thoroughly fractured or of insufficient attractiveness to give promise of successful development. Many of the "onyx marble" deposits are of too limited extent to be profitably worked.

One of the most interesting deposits reported, not only in California but in all the Pacific States, is that exposed along the southwest base of the White Mountain and Inyo Range, between Keeler and Lone Pine, in Inyo County. It has been quarried on a commercial scale only at Inyo. The marble is a dolomite, generally fine grained and rather hard. Several varieties are available: Pure white; white mottled with yellow, gray, and black and penetrated by black dendritic markings of manganese oxide; yellow, similar to the Siena marble of Italy, but more distinctly granular and more closely resembling the Estromoz or so-called Lisbon yellow marble of Portugal; black, suitable for floor tilings. These marbles are distinctly harder than many eastern marbles and the foreign marbles which they resemble.<sup>2</sup>

Another deposit containing a variety of colored marbles is worked at Columbia, Tuolumne County, and produces fine-grained marbles of pale pinkish, yellowish, and very light to medium gray colors, and coarser-grained marbles of medium to dark gray color. The degree of darkness increases with the percentage of graphite, which occurs in thin seams, irregular streaks, and patches.

At Neenach, close to the boundary between Los Angeles and Kern counties, a white marble with reddish-brown and heavy blue veins is quarried. At Colton, in San Bernardino County, a bluish-gray marble has been quarried for ornamental building and monumental purposes. Both of these marbles are represented in several buildings of San Francisco and Los Angeles. A nearly black variegated marble, rather distinct from most American marbles, is reported near Cadiz, and a brecciated marble of mottled green, black, and white appearance but rather excessively fractured is being worked near Barstow.<sup>3</sup> A deposit of fine-grained hard marble, mostly of gray or black and white colors but with strata of pink, yellowish, and reddish shades, has been prospected on the east edge of the Coyote Mountains in San Diego County. In the western part of Siskiyou County there is an extensive belt of white and gray marble. A pure-white coarse-grained variety is said to be especially abundant, though finer-grained marble is also present. A great variety of colored marbles have been reported from this belt but no further information on them is available. Informa-

<sup>1</sup> Eckel, E. C., Portland cement materials and industry in the United States, with contributions by E. F. Burchard and others: U. S. Geol. Survey Bull. 522, pl. 4, 1913.

<sup>2</sup> This paragraph is abstracted from G. P. Merrill's *Stones for building and decoration*, pp. 206-207, 1903. A brief account of the geology of the deposit is given by R. T. Hill in the *Min. and Sci. Press*, p. 86, July 20, 1912.

<sup>3</sup> Pack, R. W., Ornamental marble near Barstow, Cal.: U. S. Geol. Survey Bull. 540, pp. 363-368, 1913.



tion is also scarce on other dolomite and calcite marbles from various counties not mentioned above. Some idea of their general locations and extents may be gained from the accompanying map.<sup>1</sup>

The most important deposit of "onyx marble" is at Musick in San Luis Obispo County. The deposit is composed of aragonite (the orthorhombic form of calcium carbonate) and forms layers 1 to 10 and in one place 30 inches in thickness. It is a translucent stone partly banded and variegated, partly white and massive, and takes a brilliant polish. Blocks from 3 to 6 feet square have been quarried, and larger ones are said to be obtainable.<sup>2</sup> At Cement, near Suisin City, in Solano County, a resinous travertine, through which are scattered veinlike and pocket-like deposits of a dark brown banded material, has been worked intermittently and used for decorative purposes in San Francisco. According to Merrill,<sup>3</sup> some beautiful material was obtained here, but slabs of any considerable size could not be found free from porous layers or much unattractive coloring. A small deposit of attractive deep brown "onyx marble" has been worked on Sulphur Creek, Colusa County. It formed a vein consisting of two seams, each about 5 inches thick. Small deposits of light brown veined "onyx" are found and occasionally worked in the marble quarries at Colton, San Bernardino County. Many other deposits have been found in the State, but most, if not all, are too small to be of any commercial importance.

Serpentine is widely distributed in California but most of it lacks the necessary qualities in structure and appearance to find favor as a marble. Only one quarry of any consequence has been worked—the "verde antique" marble quarry situated about 16 or 17 miles east of Victorville, in San Bernardino County. The stone is an irregular mixture of yellowish to dark-green serpentine and rather coarse-grained calcite. In places practically pure serpentine is said to be 5 to 10 feet thick; in others, white and bluish gray limestone with no serpentine is 10 to 20 feet thick. The handsomest stone is said to be that in which the bright yellowish green serpentine is banded with the dark green and with white limestone.<sup>4</sup> It has been used for interior decorations in San Francisco and Los Angeles.

At Empire Landing, on Santa Catalina Island, a very dark green serpentine is reported as forming bunches in association with soapstone. The one specimen from this locality seen by the writer is dark greenish rock, nearly black on polished surface, spangled with gray to green, more or less altered, tremolite crystals. It appears from megascopic inspection, to consist essentially of talc, chlorite, and serpentine, the latter occurring both in the groundmass and with talc, as partial to complete pseudomorphs after tremolite. Fine, scattered grains of pyrite are also present.

It may be appropriate to mention here a deposit of olive to grass-green vesuvianite (californite) rock, suitable for ornamental work, which has been prospected on the South Fork of Indian Creek, in Siskiyou County. The rock is said to occur as boulder-like masses

<sup>1</sup> More definite data may be found in Bulletin 38 of the California State Mining Bureau, pp. 95-114, 1906, and on Eckel's map cited on page 1360.

<sup>2</sup> For detailed descriptions of this and other onyx marbles here mentioned the reader is referred to California State Mining Bur. Bull. 38, pp. 111-114, and to G. P. Merrill's *Stones for Building and Decoration*, pp. 268-271, ed. 1903.

<sup>3</sup> *Op. cit.*, p. 269.

<sup>4</sup> California State Mining Bur. Bull. 38, pp. 147-148, 1906.



in serpentine, and as loose boulders in the creek bed. A full description of this unique stone has been given by Kunz.<sup>1</sup>

*Soapstone.*—Talc and soapstone are also widely distributed in the State, but are not extensively worked. Soapstone for local uses, largely firebacks, has been quarried in Butte, Los Angeles (Santa Catalina Island), Sierra, Siskiyou, Trinity, and Yuba counties, but no production was reported in 1912 and 1913. The production of talc and soapstone is considered by J. S. Diller in another chapter of the Mineral Resources of the United States.

*Limestone.*—Limestone and dolomite, mostly crystalline, are widely distributed in California and are quarried at different places for use as local building stone, for lime burning, sugar refining, cement manufacture, and other uses. Much stone of suitable composition is too far removed from important lines of transportation to be of more than local importance. The following paragraphs are intended to give the locations and, where possible, the characters of the most extensive deposits.

The most abundant supply in the State according to Diller<sup>2</sup> is in the Redding district, Shasta County. Here a thick belt of limestone of Triassic age, generally pure, is exposed east of Furnaceville, and forms Brock Mountain and may be traced for many miles to the north. A belt of more prominent limestone ridges and peaks, of Carboniferous age, extends northward from Lilienthal along the McCloud for many miles. Where best developed it is over 1,000 feet thick. A third belt of limestone of Devonian age is exposed near Kennett. Though not so extensive as the others, it is more accessible. The first two limestones have been quarried for flux, and the last is extensively quarried and burned for lime at Kennett. Limestone of Paleozoic age also occurs extensively in Siskiyou and Trinity counties, but none is quarried in the latter county.

The limestone lenses in the Calaveras formation (Carboniferous) afford an abundance of limestone, and have been quarried in Amador, Eldorado, Placer, and Sierra counties, as indicated on the quarry map. In Kern County, a broad belt of coarsely crystallized blue and white limestones, generally much shattered, extends along the north border of Tehachapi Valley and supplies material for the important lime industry at Tehachapi. Crystalline limestone, mostly coarse grained and as a rule almost pure calcium carbonate, is also quarried in Monterey, Riverside, San Bernardino, and Santa Cruz counties. In the last-named county large persistent beds of shattered blue and white limestone are extensively quarried northwest of the city of Santa Cruz and at Felton.

In Santa Clara County, on Black Mountain, a thin-bedded, shattered limestone, colored dark gray to nearly black, has been quarried; 2 miles southeast of Los Gatos a fine-grained, thin-bedded cherty limestone has been worked. In Santa Barbara County a soft, fossiliferous Triassic limestone, chalky in places, and much shattered, has been worked 6 miles southwest of Lompoc for use in sugar refining.

<sup>1</sup> Kunz, G. F., Californite (vesuvianite), a new ornamental stone: *Am. Jour. Sci.*, 4th ser., vol. 16, pp. 397-398, 1903.

<sup>2</sup> Diller, J. S., Limestone of the Redding district, California, U. S. Geol. Survey Bull. 213, p. 365, 1903. See also U. S. Geol. Survey Bull. 225, pp. 176-177, 1904; and U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), 1906.



In San Joaquin and Contra Costa counties travertine or aragonite has been quarried for lime. The deposit in the former county was worked three-quarters of a mile south of Carnegie, and comprises a series of veins varying from 3 inches to 3 feet in thickness.

In addition to the quarries indicated on the map the following deposits are known to be available:<sup>1</sup> In Kern County, 18 miles east of Cantil, and 15 miles west and south of Mohave; in Monterey County, 26 miles south of Monterey; in Riverside County, half a mile to a mile south of Whitewater (suitable for beet-sugar refining and cement manufacture), 14 miles southwest of Mecca, and 5 miles northwest of San Jacinto; in San Benito County, in the mountains south and east of San Juan and 9 miles south of Hollister (suitable for lime and cement manufacture); in San Bernardino County, near Hinkley and 9 miles southeast of Kelso (both suitable for lime and cement manufacture); and in Tulare County, 9 miles east and a little south of Portersville station (suitable for lime and cement manufacture).

*Sandstone.*—Sandstones suitable for building are mostly limited to the Cretaceous and Tertiary formations, which cover extensive areas in the Coast Range and border the northern and central parts of the Sierra Nevada. The prevailing colors are yellow to buff, bluish or greenish gray, and brown. Many of the sandstones, like the volcanic tuffs, are soft when quarried but harden on exposure.

The sandstones which have attracted most attention are quarried in Colusa, Los Angeles, San Luis Obispo, Santa Clara, and Ventura counties. That from Colusa County is quarried near Sites. It occurs in massive beds of bluish or greenish gray to buff color, and is composed chiefly of quartz and feldspar grains in a greenish argillaceous and somewhat calcareous matrix. Tests of the Colusa Sandstone Co.'s stone gave the following results: Specific gravity, 2.56; water absorbed in 24 hours, 3.03 per cent; crushing strength, 8,440 to 8,940 pounds per square inch. Its behavior when subjected to fire and to other sudden temperature changes was generally satisfactory.

In Los Angeles County the principal sandstone quarries are at Chatsworth Park, near Chatsworth station. The stone is fine grained and rather heavily bedded, tawny yellow near the surface, but bluish gray at greater depth where it is unaffected by oxidation. It consists of grains chiefly of quartz and feldspar with some of black and white micas in an argillaceous matrix. It has been used in San Bernardino, Santa Ana, and Los Angeles.

Sandstone in Santa Clara County has been quarried at Graystone and elsewhere. The Graystone quarries furnish a yellowish to buff, medium to fine-grained stone, composed of quartz, feldspar, and a few mica grains in an argillaceous and calcareous cement. Tests have yielded the following results: Weight per cubic foot, 165 pounds; absorption of water, 5.13 per cent; crushing strength (of a single specimen), 2,400 pounds per square inch. Its resistance to fire and to other severe temperature changes was generally good. The buildings of Leland Stanford Junior University, at Palo Alto, are built of this stone. The Carnegie Library of Santa Cruz is constructed of sandstone quarried near Los Gatos, Santa Clara County.

In Ventura County brown sandstone has been quarried, mostly from large boulders, in Sespe Canyon, 5 or 6 miles from Brownstone

<sup>1</sup> Information furnished by J. A. Taff, geologist Southern Pacific Co., San Francisco, Cal.



station. The stone is rather fine grained, and consists chiefly of white quartz and feldspar grains in a brown matrix, which contains considerable calcium carbonate. Tests have resulted as follows: Specific gravity, 2.65; weight per cubic foot, 165.6 pounds; absorption of water, 1.53 per cent; crushing strength, 4,122 pounds per square inch (load applied normal to bedding) and 3,892 pounds per square inch (load applied parallel to bedding). The stone has been found of considerable use in San Francisco, Los Angeles, and Pasadena.

In San Luis Obispo County Cretaceous and Tertiary sandstones have both been quarried, but no explicit information concerning them has been obtained. Other sandstones of interest are the very fine-grained red and pure white argillaceous sandstones near Ione, Amador County; light blue and buff fine-grained sandstone in Contra Costa County; green, blue, red, dark yellowish, and drab sandstones quarried 6 miles south of Tehachapi and used in Los Angeles and Pasadena; bluish or greenish gray, fine-grained, argillaceous sandstone quarried on Angel Island, Marin County, and used in San Francisco; light buff, rather coarse-grained sandstone of Miocene age, quarried in the Santa Ynez Mountains near Santa Barbara and used in Santa Barbara and Los Angeles; tawny colored sandstone of the Chico formation (Upper Cretaceous), quarried near Redding, Shasta County, and used considerably in northern California; and the tawny and gray sandstones, the latter closely resembling the sandstone quarried near Henley and Yreka, in Siskiyou County.

*Production.*—The total production of stone in California in 1913 was valued at the quarries at \$4,118,935, compared with \$3,902,313 in 1912.

*Directory.*—The quarries of all kinds of rock quarried in California are listed below by class of rock, county, and town (or post office):

*Directory of stone quarries in California.*

GRANITE.

- |  |   |
|--|---|
| Amador County: 1. Jackson.                               | Riverside County: 20. Corona (6).                         |
| Calaveras County: 2. Milton (Gopher Ridge) (porphyrite). | 21. Elsinore (4).   |
| Fresno County: 3. Academy (Clovis) (2).                  | 22. Perris (2).   |
| Humboldt County:   | 23. Riverside (8) and West Riverside.                     |
| 4. Arcata (3).   | 24. Temecula Station (5).                                 |
| 5. Eureka.   | Sacramento County: 25. Represa (Folsom).                  |
| Lassen County: 5a. Susanville.                           | San Benito County: 26. Logan.                             |
| Los Angeles County: 6. Azusa.                            | San Bernardino County:                                    |
| 7. Hollywood (Independent station, Los Angeles).         | 27. Crucero.  |
| 8. Monrovia  | 28. Declez (3).   |
| 9. Pacoima or San Fernando (2).                          | 29. Halleck (2).  |
| Madera County: 10. Raymond (3).                          | 30. Hesperia.   |
| Mariposa County: 11. Jasper Point.                       | 31. Victorville (4).                                      |
| Napa County: 12. Napa (2).                               | San Diego County:   |
| Nevada County:   | 32. Campo.  |
| 13. Grass Valley.  | 33. Dehesa.   |
| 14. Nevada City.   | 34. Escondido.  |
| 15. Rough and Ready.                                     | 35. Foster (2).   |
| Placer County:   | 36. San Diego and Helix (3).                              |
| 16. Lincoln.   | 37. Santee.   |
| 17. Penryn (2) and Loomis.                               | San Luis Obispo County: 38. Port San Luis (Port Hartford) |
| 18. Rocklin (24).  | Santa Clara County: 39. San Jose.                         |
| Plumas County: 19. Chilcoot and Cuba (3).                | Sonoma County: 40. Santa Rosa (3).                        |
|  | Tulare County: 41. Portersville (3).                      |



## DARK VOLCANIC ROCK (BASALT, ETC.)

- |  |   |
|--|---|
| <p>Alameda County: 1. Berkeley.<br/>         Butte County: 5. Oroville.<br/>         Contra Costa County: 6. Richmond (4)<br/>         (includes 1 at Point Richmond).<br/>         Fresno County: 7. Reedley.<br/>         Humboldt County: 8. Eureka.<br/>         Kern County: 9. Caliente.<br/>         Los Angeles County:<br/>           10. Acton (2).<br/>           11. Redondo Beach.<br/>           12. South Pasadena.<br/>           13. Spadra.<br/>         Marin County: 14. San Rafael (2).<br/>         Napa County: 16. Napa (3).<br/>         Sacramento County:<br/>           17. Dredge (mail Mills).<br/>           18. Folsom City (State Prison<br/>             Quarry).<br/>           19. Natoma.</p> | <p>San Luis Obispo County: 21. Santa Margarita.<br/>         San Mateo County:<br/>           22. Belmont.<br/>           23. San Mateo (2).<br/>         Siskiyou County: 25. Dietz.<br/>         Solano County:<br/>           26. Benicia.<br/>           27. Cordelia.<br/>           28. Vacaville.<br/>         Sonoma County:<br/>           29. Anadel and Kenwood (2).<br/>           30. Melitta (3).<br/>           31. Petaluma (4) and Pengrove.<br/>           32. Santa Rosa (2).<br/>           33. Sonoma (5).</p> |
|--|---|

## LIGHT-COLORED VOLCANIC ROCKS.

- |   |   |
|---|---|
| <p>Alameda County: 1a. San Leandro.<br/>         Butte County: 1. Pentz (Curtis ranch).<br/>         Calaveras County:<br/>           2. Jackson (Mokelumne Hill).<br/>           3. Vallicita.<br/>           4. Valley Springs.<br/>         Eldorado County: 5. Smith Flat (near Placerville).<br/>         Inyo County: 6. Laws (6 miles west of).<br/>         Los Angeles County: 7. Avalon (between Avalon and Empire Landing).<br/>         Merced County: 7a. Merced Falls.<br/>         Napa County:<br/>           8. Calistoga (5).<br/>           9. Napa (4).<br/>         10. St. Helena (4).<br/>         San Luis Obispo County:<br/>           11. Arroyo Grande.<br/>           12. Bishops Peak (Cerro Obispo) (2).</p> | <p>San Luis Obispo County—Continued.<br/>           13. Los Berros.<br/>           14. Morro Rock.<br/>         Siskiyou County:<br/>           15. Little Shasta (2).<br/>           16. Macdoel.<br/>           17. Montague (8 miles east of).<br/>         Solano County: 18. Winters (southwest of).<br/>         Sonoma County:<br/>           19. Agua Caliente.<br/>           20. Santa Rosa (2).<br/>           21. Sonoma (3).<br/>           22. Stony Point (2).<br/>         Sutter County: 23. Sutter City (Marysville Buttes).<br/>         Tehama County:<br/>           24. Paskenta (north of).<br/>           25. Red Bluff (20 miles west of).</p> |
|---|---|

## SLATE.

- |  |   |
|--|---|
| <p>Eldorado County:<br/>           1. Placerville (2).<br/>           2. Slatington.</p> | <p>Mariposa County: 3. Hornitos.<br/>         Merced County: 4. Planada (11 miles east of).</p> |
|--|---|

## MARBLE.

- |   |  |
|---|--|
| <p>Amador County:<br/>           1. Plymouth (2).<br/>           2. Sutter Creek.<br/>         Butte County:<br/>           3. Pentz.<br/>           4. Oroville.<br/>           5. Pulga.<br/>         Calaveras County:<br/>           6. San Andreas (3).<br/>           7. Vallicita.<br/>         Inyo County:<br/>           8. Inyo.<br/>           9. Swansea.<br/>         Los Angeles County:<br/>           10. Avalon.<br/>           11. Neenack (includes adjacent deposit in Kern County).</p> | <p>Mono County: 12. Topaz.<br/>         Riverside County:<br/>           12a. Eolom station (6 miles south of).<br/>           12b. Eolom station (7 miles southwest of).<br/>         San Bernardino County:<br/>           13. Baker.<br/>           14. Barstow.<br/>           15. Mentone.<br/>           16. Victorville (2).<br/>         San Luis Obispo County: 17. Musick (Arroyo Grande).<br/>         Siskiyou County: 18. Indian Creek.<br/>         Tuolumne County:<br/>           19. Columbia (2).<br/>           20. Sonora.</p> |
|---|--|



## LIMESTONE.

## Calaveras County:

1. Campo Seco (3).
2. Fosteria (4).
3. Murphy.

## Modoc County: 4. Cedarville.

Monterey County: 4a. Salinas (6 miles southeast of).

## Nevada County: 5. Grass Valley.

## Riverside County:

6. Corona (Orange).
7. Riverside.

## Riverside County—Continued.

8. San Jacinto.

## San Bernardino County:

9. Cajon.
10. Colton.

## San Mateo County: 11. Rockaway.

## Santa Clara County: 12. Mountain View.

## Shasta County: 13. Ingot.

## Tulare County: 13a. Lemon Cove (2 miles northeast of).

## LIMESTONE AND LIMEKILNS.

## Alameda County:

1. Berkeley.
2. Pleasanton.

## Amador County: 3. Ione.

## Contra Costa County:

4. Concord.
5. Cowell (mail Clayton).

## Eldorado County:

6. Cool and Auburn.
- 6a. Cothrin (2 miles north of).

## Kern County: 7. Tehachapi (5).

## Los Angeles County: 8. Los Angeles (2).

## Mono County: 9. Mono Lake.

## Monterey County: 10. Monterey.

## Orange County: 10a. Capistrano.

## Placer County:

11. Colfax.
12. Newcastle.

## San Benito County:

13. Hollister (3).
14. San Juan.

## San Bernardino County:

15. Oro Grande (Halleck post office) (3).
16. Victorville.

## San Luis Obispo County: 17. Adelaide.

## Santa Barbara County: 18. Lompoc (2).

## Santa Clara County: 19. Los Gatos.

## Santa Cruz County:

20. Davenport.
21. Felton and Rincon (2).
22. Santa Cruz (4).

## Shasta County:

23. Kennett (5).
24. Redding (2).

## Siskiyou County:

25. Callahan.
26. Fort Jones.
27. Gazelle (2).
28. Greenview.

## Solano County: 29. Cement.

## Sonoma County: 30. Geyserville.

## Tuolumne County:

31. Jacksonville.
32. Sonora (2).

## Ventura County:

33. Oxnard.
34. Ventura.

## SANDSTONE.

## Alameda County:

- 1a. Oakland (8).
- 1b. Piedmont.

## Amador County:

1. Ione.
2. Lancha Plana.

## Calaveras County: 3. Valley Springs.

## Colusa County: 4. Sites (2).

## Contra Costa County:

5. Clayton.
6. Martinez (2).
7. Stege (2).

## Del Norte County: 8. Crescent City.

## Kern County: 9. Tehachapi (6 miles south of).

## Los Angeles County: 10. Chatsworth (3).

## Napa County:

11. Napa (2).
12. St. Helena.

## Orange County:

13. El Modeno.
14. Santa Ana (2).

## San Francisco County: 14a. San Francisco (5).

## San Luis Obispo County:

15. Berros.
16. Edna (near).
17. Santa Margarita (near).

## San Mateo County:

18. Colma.
- 18a. San Pedro Point.

## Santa Barbara County:

19. Montecito.
20. Santa Barbara (14).

## Santa Clara County:

21. Graystone.
22. Los Gatos (10 miles from).

## Shasta County:

23. Redding (northeast of) (2).
24. Texas Spring.

## Siskiyou County:

25. Henley (2).
26. Yreka (2).

## Sonoma County:

27. Coast Bluffs.
28. Freestone (2).
29. Petaluma (2).

## Stanislaus County: 30. Knights Ferry (Wright ranch).

## Ventura County:

31. Camarillo.
32. Santa Susana.
33. Sespe.

## Yolo County: 34. Winters (2).