of which are more or less silicified. It outcrops irregularly and is irregularly colored. The material is said to carry up to $2 per ton in gold, and also small values in quicksilver. There are also occasional small green-colored patches due to associated epidote. It is mined by open cut.

In the mill there are two gasoline engines (25 h.p. and 4 h.p.); a 10″ x 12″ jaw crusher, and a Beer roller mill. The rock is crushed dry in the roller mill, through an 8-mesh screen in the front segment. The discharge drops in front of a blower. The fines are blown out along a "tube" (a wooden frame covered with cloth, about 3′ square by 20′ long), with cone hoppers set at intervals in the bottom. The coarser portions from the nearer cones are returned to the mill. At the time it was visited no commercial production had been made, as they were still experimenting with the equipment. The plant is intended to handle fifty tons per day. Practical tests made with experimental lots of this paint are stated to have been very satisfactory. In fact, the buildings at the mine which had been painted with it about a year before, still looked as fresh as if newly coated.

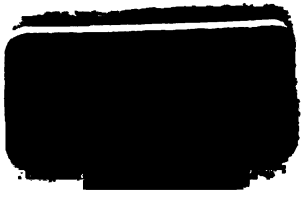
Bibl.: Bull. 50, p. 160; U. S. G. S. Min. Res. 1910, Pt. I, p. 697; 1911, Pt. I, p. 901; 1912, Pt. I, p. 939.

Woods & Harlan Prospect. F. C. Woods, Leesville, and H. H. Harlan, Williams, owners. It is in Sec. 35, T. 18 N., R. 7 W., 4½ miles west from Stonyford, on the south fork of Stony Creek; elevation 1300 feet (bar.). There are masses of both jasper and a highly siliceous yellow ochre outcropping along the creek. There are two principal outcrops of the yellow, showing 10 to 15 feet wide. It is undeveloped.

MINERAL WATER.

The mineral springs of Colusa County are all west of the line of contact between the sedimentary and the metamorphic series, thus bringing them within the area of the latter. Most of them are saline, some of them markedly so, particularly certain springs on Sulphur Creek.

Blank's Sulphur Spring. A. A. Gibson, Sulphur Creek, owner. This spring is now included in the Wide Awake quicksilver mining property. It is on the south side of Sulphur Creek, a short distance west of the post office. When the Wide Awake shaft (down 500 feet), which is a few hundred feet distant, was sunk it cut off this spring. As long as the shaft was kept open the spring was dry. Now that the shaft is filled with water to within 56 feet of the collar, the spring is again flowing,



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

Mines and Mineral Resources

Of the Counties of

Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo

By WALTER W. BRADLEY, Field Assistant

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INTRODUCTION.

The group of counties whose mineral resources are herewith presented is principally of that section of the State often referred to as "north of the Bay," lying adjacent to and immediately north of San Francisco Bay. A portion of the west side of the Sacramento Valley at its southern end is also included, as well as a portion bordering on the Pacific Ocean. This area includes the largest and most important mineral springs district of the State, and was also at one time a large producer of quicksilver, though to a lesser degree of recent years. Its yield of structural materials and building stone is also an important item, and growing.

The following report presents the results of four months of field work in the area described. But little geological detail was attempted, as it was desired to bring the economic data down to date without too much delay. We have listed as far as possible all mineral properties of whatever nature, their location, ownership, character of the deposit, method of working, equipment, and other information of interest.

We wish to acknowledge the uniform courtesy of the various operatives and owners in freely giving information as well as access to the numerous mineral properties visited.

COLUSA COUNTY.

Field Work in October, 1913.

Colusa County, like its neighbors, Glenn on the north and Yolo on the south, is one of the Sacramento Valley counties, with a portion of the Coast Range on its western edge. Its mineral resources are confined principally to the Coast Range section. Butte and Sutter counties bound it on the east, with Lake on the west. It has an area of 1100 square miles, with 65 square miles of the northeast corner lying on the east side of the Sacramento River. The upper branches of Stony Creek drain the northwest part of the county and Bear Creek the southwest, while several smaller streams traverse the eastern two thirds, to the Sacramento. Snow Mountain is at the northwest corner.

The eastern edge of the Coast Range is here composed of a series of sedimentary strata, principally sandstones, dipping at 45° to 75° to the east and under the valley alluvial deposits. Their strike is west of north. West of these are the metamorphic series. During the course of the field work I crossed the contact between the sedimentaries and the metamorphics at four separate points: about ½ of a mile west of Stonyford; 2½ miles west of Lodoga; 1½ miles east of Cooks Springs; and about ½ of a mile east of Wilbur Springs. Plotted on the map, these points are seen to be in a straight line, running about N. 20° W.

The mineral products of Colusa County, in the order of their production to date (see Table, page 4) are: Sandstone, mineral water, quicksilver, gold and silver, stone industry, salt, and brick. The total value is in excess of $2,600,000. In addition to these, occurrences of the following have been noted: Borax, coal, copper, chrome, gypsum, iron, limestone, mineral paint, natural gas, onyx marble, petroleum, and sulphur.

The actual output is in excess of that shown by the table, as the Manzanita mine is known to have been a gold producer as early as 1865. Also, high grade copper ore was shipped from the county in the early sixties. There are no available records of these values, nor for the quicksilver produced between 1877 and 1895.

ARAGONITE (see Onyx Marble).

BORAX.

Borax is an important constituent in some of the hot sulphur springs on Sulphur Creek, but it has never been extracted commercially from the waters.

Bibl.: R. III, p. 16; Bull. 24, pp. 69, 70.

TABLE OF MINERAL PRODUCTION.

Year	Gold and silver	Quicksilver		Sandstone		Mineral water		Stone industry	Miscellaneous and unapportioned
	Value	Flasks	Value	Cubic feet	Value	Gallons	Value	Value	
1875		700	$58,905						
1876		407	17,908						
1877		466	17,382						
1878									
1879									
1880	*$4,908								
1881	3,500								
1882	2,575								
1883	1,000								
1884	1,580								
1885	45,000								
1886	11,617								
1887	7,461								
1888	6,000								
1889	13,626								
1890	2,810								
1891									
1892									
1893	300								
1894				20,000	$7,500				
1895		1	40						40 tons, $400; salt.
1896		58	2,054			50,090	$12,530		
1897		43	1,510			31,500	1,620		8 tons, 160; salt.
1898						21,000	1,050		21 tons, 439; salt.
1899						5,000	1,120		20 tons, 300; salt.
1900		275	12,359			53,500	12,350		20 tons, 80; salt.
1901	1,800	235	10,575	88,981	80,082	92,200	20,220		18 tons, 270; salt. 270 M., 2,160; brick.
1902	850	605	26,100	99,395	87,456	142,305	79,698		18 tons, 396; salt.
1903		510	21,708	146,828	312,500	174,000	85,900		18 tons, 360; salt.
1904		†400	16,526	100,000	290,000	156,170	38,051	$1,250	18 tons, 180; salt. 300 M., 1,800; brick.
1905		826	12,821	118,954	276,908	160,000	80,000		18 tons, 225; salt.
1906				88,921	101,802	197,875	49,344		150 tons, 1,700; salt.
1907	742	17	648	86,964	78,259	254,075	51,233	3,500	16 tons, 240; salt.

1908	584	21	900	73,284	43,971	200,000	88,000	850	10 tons, 125; salt.
1909		11	545	47,070	24,684	150,000	75,000	620	
1910				112,947	56,505	150,000	75,000	16,500	
1911		5	230	101,029	50,027	136,300	68,150	16,702	1,596 unapp.
1912				51,137	15,804	165,330	39,061	15,300	
1913				34,927	15,550	132,720	32,931		
Totals	$104,303	4,080	$199,711	1,170,327	$1,440,998	2,271,565	$811,258	$54,722	$10,431

*1880 to 1890, U. S. Mint Reports.
†Flasks of 75 pounds since 1904; previously 76½ pounds.

Totals.

Gold and silver	$104,303
Quicksilver	199,711
Sandstone	1,440,998
Mineral water	811,258
Stone industry	54,722
Miscellaneous and unapportioned	10,431
Total to end of 1913	$2,621,423

BRICK CLAY.

At one time bricks were made at Colusa, but not of recent years.

Bibl.: R. VIII, p. 159; Bull. 38, p. 242.

CHROME.

Chromite is reported in T. 17 N., R. 6 W., by J. T. Rathbun, of College City.

Bibl.: Bull. 38, p. 362.

COAL.

Some development work was at one time done on several small lignite veins near Sulphur Creek, but nothing of consequence was found.

Bibl.: R. VII, p. 190; VIII, p. 158; X, p. 158; XI, p. 188.

COPPER.

Copper ore has been found at several points in the northwestern part of the county near Stonyford (formerly Smithville), and various claims have been located at different times. None of these are now extant except the two groups noted below, and only assessment work is done on them. About 1861 there was something of a copper excitement in this section and a small tonnage of sorted ore was shipped to the Selby smelter. A smelter was built at the mouth of Hyphels Creek, but it proved a failure.

Bibl.: R. V, p. 98; VIII, p. 159; X, p. 158; Bull. 50, pp. 159, 160.

Lion Mine. Frank Fender, Stonyford, owner. This group of two claims (originally four) is in Sec. 17, T. 17 N., R. 6 W., and was first located about 1861. The ore carries native copper, cuprite and malachite, with some calcite; and the ore body is said to be 4 feet wide, strike northwest, dip 45° SW. The country rocks are serpentine and some basalt. There are two shafts (an incline and a vertical) and one adit. The depth of the old workings is not known. On the failure of their smelter built in the valley below, the original operators shipped hand-picked ore for a time to Selby's smelter. Only assessment work has been done of recent years.

Bibl.: R. IV, p. 125; V, p. 97; VI, Pt. I, p. 104; X, pp. 158, 261; Bull. 50, p. 160.

Ruby King Group (see under Mineral Paint.)

GOLD AND SILVER.

Clyde Mine. Geo. and Thomas Moyer, owners. It is in the SE. ¼ Sec. 12, T. 14 N., R. 6 W., 3 miles northwest of Sulphur Creek post office. For several years between 1880 and 1890, it contributed to the county's gold output; but only assessment work is maintained now. The gold, with small values in silver, occurs in a shale, there being no defined ledge.

Bibl.: R. XI, p. 183; XIII, p. 126.

Keely Claim. This claim, near the Clyde mine, and from which a small production at one time resulted, has been abandoned for several years.

Bibl.: R. XI, p. 184; XIII, p. 126.

Manzanita Mine. (See under Quicksilver.)

Ruby King Paint Mine. (See under Mineral Paint.)

Trout Creek Prospect. Barnett & Drew, locators. It is on the east side of Snow Mountain, northwest of Fouts Springs. A tunnel was driven in 1907, but no work has been done recently.

GYPSUM.

Gypsum has been noted at several points but not developed commercially.

Bibl.: Bull. 38, p. 283.

IODINE (see under Salt).

LIMESTONE.

Lambert Ranch. J. T. Rathbun, College City, in Sec. 20, T. 16 N., R. 5 W., north of Leesville. Lime has been burned from a deposit on this ranch but not recently.

Bibl.: Bull. 38, p. 66.

Manzanita Mine (see also under Quicksilver). Jones & Ryan, Sulphur Creek, owners. There is a belt of crystalline limestone on the western part of this property, which has been utilized locally. Idle.

Bibl.: Bull. 27, p. 45; Bull. 38, p. 66.

Wide Awake Mine (see also under Quicksilver). A. A. Gibson. Sulphur Creek, owner. There is a body of limestone composed entirely of fossil shells, on the Wide Awake quicksilver property. It has been utilized locally.

Bibl.: R. VIII, p. 188; Bull. 3, p. 6; U. S. G. S., Mon. XIII, p. 367.

and Iron" (3 springs) 63°; "Allen" (at club house) 56°. The last named is the one from which water has been bottled for sale.

Bibl.: R. VI, Pt. I, p. 62; VIII, p. 327; XII, p. 334; XIII, p. 511; R. of M., Lake County, p. 5; U. S. G. S. Bull. No. 32, p. 203; Water Sup. 338, p. 198; ANDERSON (op. cit.), pp. 76–78.

Anderson Springs. These springs which are in Sec. 25, T. 11 N., R. 8 W., have been in the possession of the Anderson family since their location in 1873, the present owner being Miss Barbara Anderson. They are picturesquely situated in the timbered section of southwestern Lake County, 6 miles northwest from Middletown and 24 miles north from the railroad at Calistoga, at an elevation of 1525 feet (bar.). There are eight springs in active use, besides several others. The "Cold Sulphur" (white), below the hotel, has a temperature of 63° F. The others are mostly above the hotel, and have the following temperatures: "Iron," 103° F.; "Sour," 65°; "Bellmer," 65°; "Magnesia" or "Father Joseph," 70°; "Hot Sulphur and Iron," 145°; "Iron and Magnesia," 103°; "Steam Bath," 138°. Around the last two named, there is considerable sulphuretted hydrogen gas escaping. The hotel has accommodations for over 100 people.

Besides the detailed analysis shown in the "Table of Analyses," the "magnesia" or "Father Joseph" spring carries Epsom and Glauber's salts, also traces of chromium. At the "steam bath," a series of small rooms has been built against the bank, covering the fissures where the hot vapors escape from the rock. The steam enters through holes in the walls and floor. The temperature in these rooms is 138° F. If the thermometer could have been put into the rock fissure itself, a higher temperature would probably have been recorded. The "hot sulphur and iron" spring is about 15 feet from the steam bath; and there is a deposit of fine flour sulphur around the inside of the barrel enclosing the spring. The rocks and bank around these springs are encrusted with deposits of salts from the vapors, resembling the similar but larger deposits of such materials at The Geysers in Sonoma County which are but 6 miles in an air-line, northwest of Anderson Springs, on the other side of the range.

Bibl.: R. VI, Pt. I, p. 62; VIII, p. 327; XII, p. 335; XIII, p. 511; R. of M., Lake County, p. 5; U. S. G. S. Bull. 32, p. 203; Water Sup. Pap. 338, pp. 89–91; ANDERSON (op. cit.), pp. 82–89.

Bartlett Springs. Bartlett Springs were discovered in 1869 by Green Bartlett, while on a camping trip. As he was suffering from rheumatism at the time, and found himself benefited by use of these waters, he took up the springs and established a resort there. Though the farthest from the railroad, Bartlett Springs is today the largest and best equipped in accommodations of any of the Lake County resorts.

It is in Sec. 2, T. 15 N., R. 8 W., near the head of Bartlett Creek, a branch of Cache Creek, at an elevation of 2375 (bar.) feet above sea-level. The present owner is the Bartlett Springs Company, office 634 Third street, San Francisco, C. E. McMahan, president, with G. A. Otto, manager, at the springs.

There are two main "roads" to Bartlett Springs: (1) by auto stage, 42 miles from Williams, Colusa County, on the east side; or (2) by auto stage from the railroad at Pieta in Mendocino County on the west, to Lakeport; thence by gasoline launch across Clear Lake to Bartlett Landing; finishing by auto stage, up over the mountain ridge (crossing at an elevation of 4040 feet) to the springs. Leaving San Francisco at 7.45 a. m. one reaches Bartlett's at 4.30 p. m. the same day, by either route. The second is by far the more picturesque, particularly on the return trip in the morning as the machine winds in and out around the many turns of the road. At each turn one gets a new view of Clear Lake and its beautiful mountain setting. From the summit to the level of the lake, a horizontal distance of about 3 miles, is a drop of 2700 feet in altitude.

There are three springs, the principal one having a good strong flow and a little excess gas. Its temperature is 56.5° F., and it is a delightful water to drink—clear and sparkling. It is walled in with a cement curbing and surrounded by a pavement of the same. The whole arrangement makes a unique and picturesque setting (see photo. No. 8). For the bathhouse the water is artificially heated. The "Soda-magnesia" spring has a temperature of 59° F.; but the "Aperient" was dry at the time of our visit. It is said to be intermittent and sometimes "roars" with excess gas. Besides these there is a "gas spring," higher up on the hill, which emits a considerable volume of moist carbonic acid gas, but no water.

There are several buildings and a large number of cottages, besides the main hotel, with accommodations for a total of over 500 people. Additions have been made, each of the last two years; yet, the manager reports having had to turn away 200 applicants during the month of July this year (1913). There is a resident physician at Bartlett's during the season, from May 15th to October. The postoffice is in the hotel, and there is a general merchandise store, drugstore, bakery and a butcher shop maintained by the company for the accommodation of cottagers and campers.

The bottling works are below the hotel, the spring being above, giving a good working hydrostatic pressure at the plant. In bottling Bartlett water, it is drawn from the bottom of the spring through a block tin pipe, to prevent the escape of the natural gas that the water contains, and through a Bergfeld filter. The bottles are filled through a tube that extends to the bottom of the bottle, and when filled are at once

hermetically closed with crimped caps. Before packing each bottle is carefully examined and all defective ones emptied. It is adapted for exportation. It is free from organic matter and is charged only with its own natural gas. In addition to the water bottled at the spring, a small amount is shipped in barrels to the San Francisco office, and there bottled, carbonated—being labeled "sparkling."

The bottling works are equipped with a gasoline engine for power, a large mechanical bottle washer, labeling machine, belt conveyor (to carry bottles from labeler to packers), and other mechanical appliances.

Photo No. 8. "Bartlett" Spring, at Bartlett Springs, Lake County, California.

Fifteen men are employed and the plant has a capacity of 10,000 bottles per day of nine hours. The bottles are the usual mineral water size (5 per gallon) and are packed in cases of 50.

An ice plant is also installed there. The first two or three years of bottling, two 4-mule teams were required to haul the product to the railroad at Williams. Now, there are from eight to twelve, 8, 10, and 12-mule teams on the road during the five months from May to October.

No water is bottled during the winter and spring months, as the roads are in bad condition and there are no storage facilities at the springs.

Bibl.: R. VI, Part I, p. 92; VIII, p. 327; X, p. 253; XII, p. 335; XIII, p. 511; R. of M. Lake County, p. 5; U. S. G. S. Bull. No. 32, p. 203; Water Sup. Pap. 338, p. 201; ANDERSON (op. cit.), pp. 91–94.

Behr Soda Spring. It is in Sec. 10, T. 13 N., R. 8 W., on the edge of Clear Lake, 5 miles east of Kelseyville, and is owned by John Behr, of Upper Lake. It is not utilized commercially.

Bibl.: R. of M., Lake County, p. 5.

Blue Lakes. At Blue Lakes (Midlake, P. O.) in Sec. 6, T. 15 N., R. 10 W., 18 miles east of Ukiah, are two springs, a "sulphur" and an "iron," the former of which is said to have a temperature of 60° F. The Blue Lakes Realty Company owns the property, with H. W. Kemp, Midlake, manager of the resort, which is located between the upper and lower lakes.

Bibl.: R. of M., Lake County, p. 5.

Bonanza Springs are in Sec. 30, T. 12 N., R. 7 W., between Seigler and Howard Springs, 5 miles southwest from Lower Lake, and 2 miles east of Adams Springs. They are on a comparatively flat ridge in a section of rolling hills, with abundant pine, "fir," oak, alder and manzanita. The elevation is 2400 feet (bar.). These springs have been in use over twenty-two years, the present owners, C. N. E. Ehret and H. Penning having bought it in 1910. At one time there was a large hotel there, but it was destroyed by fire, and at present the springs are used only as a camping resort. No water is bottled for sale. The temperatures of the principal springs are: "white sulphur" 64° F.; "iron and soda" 59.5°; "magnesia" (a well) 66°; fresh water (well) 55°; "borax" and "iron" were dry at the time of our visit, as the result of a succession of three dry years.

Bibl.: R. VI, Part I, p. 92; VIII, p. 327; XII, p. 335; XIII, p. 511; R. of M., Lake County, p. 5; U. S. G. S. Bull. No. 32, p. 204; Water Sup. Pap. 338, p. 190; ANDERSON (op. cit.), p. 100.

Borax Springs. There are borax springs on the edge of Clear Lake, near both Borax Lake and Little Borax Lake (Hatchinhama) but they are not utilized except locally.

Bibl.: R. VI, Part I, p. 63; VIII, p. 327; X, p. 239; R. of M., Lake County, p. 5; GEOL. SURV. OF CAL. Geol Vol. I, p. 99; U. S. G. S. Mon. XIII, pp. 266–268; ANDERSON (op. cit.), pp. 101, 168, 176.

Bynum Spring is at the head of a small branch of Scott Creek, which is dry in summer. The surrounding hills are bare except for chamiso brush. It is 6 miles southwest from Lakeport, in Sec. 9, T. 13 N., R. 10 W., and is reached by a good wagon road, being 14 miles east of Hopland, its railroad shipping point. The spring is named for its locator, who found it about fifty years ago; but bottling began only about five years ago. There is no resort there. The present owner is Geo. W. Crippen, of Richmond. The elevation is 1800 feet. The spring flows about 10 gallons per hour, the temperature being 60° F. It is an excellent table and bar water. There is a little excess gas. The bottling is done by hand, and a hand-operated crowning machine used.

Bibl.: R. of M., Lake County, p. 5; U. S. G. S. Water Sup. Pap. 338, p. 182.

Carlsbad Springs. These springs in Sec. 1, T. 12 N., R. 9 W., 5 miles south of Kelseyville were utilized at one time, but are now abandoned. Mrs. E. McGovern of Kelseyville is the owner.

Bibl.: R. of M., Lake County, p. 5; U. S. G. S. Water Sup. Pap. 338, p. 187.

Castle Springs (Mills). These springs were formerly known under the name of Mills, also Noble's Springs. They are in Sec. 26, T. 11 N., R. 8 W., 7 miles northwest from Middletown, 1 mile above Anderson Springs, at an elevation of 2450 feet (bar.). They were located about thirty years ago, by W. Mills. The property has been in litigation, but is now owned by Mrs. Campbell-Van Luven, who states that it will be reopened next season (1914). A fine, cement-lined swimming pool 25 by 60 feet has been built recently. The "Big Hot" sulphur spring which is in a small canyon above the hotel flows about 40,000 gallons per twenty-four hours, and has a temperature of 163° F. at the spring. It is piped to the bath house and swimming tank. Other springs on the place are: "Sour" 65° F.; "black sulphur" 67°; "white sulphur" 66°; "Vangas" 66° (much H_2S escapes from bank around this spring); and a small hot spring, uncurbed, issuing from the bank near the large one has a temperature of 153° F. The hotel and cottages will accommodate 75.

Bibl.: R. VIII, p. 328; XII, p. 337; XIII, p. 511; U. S. G. S. Bull. No. 32, p. 206; Water Sup. Pap. 338, pp. 91–93; ANDERSON (op. cit.), p. 194.

Chambers Ranch. On the ranch of C. M. Chambers, in Sec. 24, T. 13 N., R. 10 W., 6 miles south of Lakeport, there are several springs,

one of which has been analyzed. They are at present not utilized, except privately.

Complexion Springs are on the Williams-Bartlett stage road, near the eastern boundary of the county, in Sec. 10, T. 15 N., R. 6 W., but they are not utilized, except by occasional camping parties. As the name implies, they are claimed to have the property of improving one's complexion. The water has a milky appearance, similar to some "arsenic" springs. The principal constituents are sodium chloride and ammonia.

Bibl.: R. of M., Lake County, p. 5; U. S. G. S. Water Sup. Pap. 338, p. 297.

Copsey Springs (see *Spiers*).

Crabtree Springs, in Sec. 25, T. 17 N., R. 9 W., about 12 miles northwest from Bartlett Springs, are owned by S. T. Packwood of Upper Lake, who reports that he is planning to build a resort there.

Bibl.: R. of M., Lake County, p. 5; R. XI, p. 61; U. S. G. S. Water Sup. Pap. 338, p. 106.

Dennison (see *Hazel*).

Dollar Springs. These springs, formerly known locally as Warm Springs, are located on Black Mountain, in Sec. 8, T. 11 N., R. 5 W., 11 miles northeast from Middletown. They are said to have been used for many years by Indians. The present owner, B. Norman of Richmond, reports having sent out a trial shipment of bottled water the past summer.

Grizzly Medical Springs. These springs, at one time called "Richardson's" are owned by Samuel Richardson, and are near the eastern line of the county, 5 miles west of Sulphur Creek (Colusa County) post office in Sec. 3, T. 13 N., R. 6 W. Their elevation is 1365 feet (bar.). They were first used forty-two years ago, and the present owner has had them since 1908. He has been bottling water, in a small way, since 1909. Both the "Grizzly" and the "Bath" springs have a temperature of 70° F. Water from the latter is heated artificially for bathing. There are a few cottages and space for campers. There are several other springs not at present utilized. Probably one of these is the "Iodine" spring mentioned in some of the early reports (see Bibliography), as no iodine is indicated in the analyses of either of the springs above named.

Bibl.: R. IV, p. 230; VI, Pt. I, p. 63; X, p. 264; U. S. G. S. Bull. No. 32, p. 205; Water Sup. Pap. 338, p. 193; ANDERSON (op. cit.), p. 183.

Harbin Hot Springs. This is one of the well known groups of springs of Lake County; and is located 20 miles north of Calistoga, 3½ miles northwest of Middletown, at an elevation of 1625 feet (bar.). The springs were first used by white men about fifty years ago, and by the Indians previous to that time. The property is owned by Mrs. Margaret Matthews of Vallejo, and is under lease to Booth, Carr and Booth. There are accommodations for 300 people. No water has been bottled of recent years. There are steam baths and two swimming pools, the larger one being in the open air. One of the steam baths is a covered pool from the "hot sulphur" spring.

The following temperatures were taken at the point of outflow of the individual springs: "hot sulphur," 120.5° F. (stated to flow 1500 gallons per hour); "iron," 118° (60 gallons per hour); "magnesia," 66° (small flow); "cold white sulphur," 76° (new spring, small flow); "mud foot bath," 101° in water on top and 121° in mud and fine rocks below. There is also a fresh water spring which fills a 30,000 gallon tank in two days (used for fire purposes). The "arsenic" spring was caved in at the time of our visit.

Bibl.: VIII, p. 327; X, p. 230; XII, p. 336; XIII, p. 511; R. of M., Lake Co., p. 6; U. S. G. S. Bull. No. 32, p. 205; Water Sup. Pap. 338, pp. 93–95; ANDERSON (op. cit.), pp. 164–168.

Hachinhama (see *Borax Springs*).

Hazel Springs were formerly known locally as Dennison Springs. They are in Sec. 26, T. 16 N., R. 9 W., 6 miles northeast of Upper Lake, and are owned by Amos Ogden. He reports preparations being made to develop and utilize the springs, also to bottle the water.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 202.

Highland Springs are 14 miles east of Pieta on the main stage road to Lakeport. The springs are in Sec. 31, T. 13 N., R. 9 W.; but there are 2300 acres in the property which is maintained in the nature of a hunting and fishing preserve in connection with the resort. Craig & Stephens, Inc., of Woodland, are the owners, with W. I. Allen, manager. There is a resident physician during the summer season. There are accommodations for 315 guests. No water is bottled for sale.

There are twelve principal springs in active use, and over twenty others. All have more or less excess carbonic acid gas bubbling from them—the "Magic" spring being especially vigorous. The temperatures are: "Neptune," 79° F.; "Iron," 73°; "Diana," 80°; "Seltzer," 61.5°; "Kidney," 80°; "Magic," 80°; two "Magnesia," 71.5° and 73° (20 inches apart); "Sulphur," 59.5°; "Dutch" or "Ems," 75°, and "Arsenic," 77°. The fissures from which these last two flow are but

18 inches apart in the edge of the creek bed, and are unique not only in situation but in appearance as well (see photo No. 4). The Dutch is crystal clear, while the Arsenic is milky. The springs at Highland are principally in serpentine. Gas is seen bubbling up through the water in the creek at several points. At places in the serpentine were observed rounded nodules of the original, unaltered sedimentaries

Photo No. 4. "Arsenic" and "Ems" springs, at Highland Springs, Lake County, California.

(sandstone and shale), as noted by Becker in U. S. G. S. Mon. XIII (pp. 277 and 278).

Bibl.: R. VI, Part I, p. 62; VIII, p. 328; XII, p. 336; XIII, p. 511; R. of M., Lake County, p. 6; U. S. G. S. Bull. No. 32, pp. 205, 212; Water Sup. Pap. 338, pp. 183–185; ANDERSON (op. cit.), pp. 169, 175.

Hoppin Estate. There are two springs on land owned by the Hoppin Estate, adjoining the Bartlett Springs property. They are about 100 feet apart, and about 100 yards from Bartlett's "soda-magnesia." They are not utilized at present, except locally. These are the two springs included in Register of Mines of Lake County (p. 5) under Bartlett, as "Iron, No. 4" and "Magnesia, No. 5." Their temperatures are: "magnesia," 60° F.; "iron," 59°.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 201.

Hough Springs. These springs are on the main Williams-Bartlett stage road, 8 miles east of the latter, in Sec. 10, T. 15 N., R. 7 W., elevation 1800 feet (bar.). They are on the north fork of Cache Creek, at a point where the canyon widens out into a flat of several acres in extent. The springs are on the hillside near the hotel, the two principal ones being: "soda," 60° F.; and "iron and magnesia," 61°. Besides these, the well at the hotel is an "iron" water, and there is a "white sulphur" spring in the creek bank, below, not at present utilized. The hotel, cottages, and tents will accommodate about 150. The soda spring is an excellent "seltzer" water, with plenty of snap due

Photo No. 10. Soda Spring and Grotto at Hough Springs, Lake County, California.

to the large excess of carbonic acid gas; and has a picturesque natural grotto around it (see photo No. 10). None of the water is bottled. Bartels Bros. are the owners.

Bibl.: R. VI, Pt. I, p. 63; R. of M., Lake County, p. 6; U. S. G. S. Bull. No. 32, p. 206; Water Sup. Pap. 338, p. 197; ANDERSON (op. cit.), p. 180.

Howard Springs. Howard Springs owe their name to their first locator, who took them up about 1871. They are owned by W. J. Laymance of Oakland, and R. J. Yates is lessee. They are in Sec. 30, T. 12 N., R. 7 W., 7 miles southwest of Lower Lake, and 14 miles

northwest from Middletown, at an elevation of 2150 feet (bar.). They are on the edge of a small basin, surrounded by rolling hills. There are something like forty separate flows, but fourteen of them, however, being in active use. The principal ones are: "Excelsior" (lithia), 79.5° F.; "Alum," 80°; "Alum-Sodium," 82°; "Borax," 86°; "Twins," 82° and 102° ("Prince and Princess," about 7 feet apart); "Eureka," 108°; "Hot Sulphur and Iron," 110°; "Old Man's Friend" (Neptune in list of analyses), 87°; "Bohemian," 71°; "Soda," 65° (about ¼ mile distant from others). Water from the "lithia," "Eureka," and "Bohemian" were bottled at one time—previous to 1911. There are accommodations for 80, mostly in cottages. The bath house utilizes the water from the hot iron and sulphur spring.

Bibl.: R. VI, Part I, p. 63; VIII, p. 328; XII, p. 337; XIII, p. 511; R. of M., Lake County, p. 6: U. S. G. S. Bull. No. 32, p. 206; Water Sup. Pap. 338, p. 95; ANDERSON (op. cit.), pp. 180 and 181.

Mills Springs (see *Castle Springs*).

Newman Spring. This place is known locally as "Soap Creek," on account of borax being a prominent constituent in the water. It is used as a bathing resort, there being a walled-in swimming pool. It is 1½ miles north of Bartlett Springs, in Sec. 35, T. 16 N., R. 8 W., and is owned by Geo. Young of Bartlett Springs, being leased to W. W. Tallman.

Bibl.: R. X, p. 254; R. of M., Lake County, p. 6; U. S. G. S. Water Sup. Pap. 338, p. 202.

Pierson Springs (see *Saratoga Springs*).

Red Wing Spring (see *Spiers Springs*).

Richardson (see *Grizzly*).

Saratoga Springs (Pierson). About twenty years ago these springs were known under the name of Pierson. The post office at the springs is called Bachelor. They are in Sec. 4, T. 15 N., R. 10 W., 22 miles north of east from Ukiah and 6 miles west of Upper Lake, at an elevation of 1500 feet (bar.). John Martens Estate is the owner. The flow of the springs has not been measured, but it is stated that the strongest one can not be bailed out completely by hand with a 2-gallon bucket. No water is bottled for sale. There are 13 springs in use, the principal ones being: "magnesia" (No. 1), 59° F. and (No. 2) 61.5°;

"arsenic" 60°; "sulphur" 60°; "soda" 61.5°; " iron" 61.5°; "seltzer" 59°.

Bibl.: R. VI, Part I, p. 63; VIII, p. 328; XII, p. 337; XIII, p. 511; R. of M., Lake County, p. 7; U. S. G. S. Bull. No. 32, p. 207; Water Sup. Pap. 338, p. 179; ANDERSON (op. cit.), pp. 220 and 242.

Seigler Hot Springs. This resort is owned by the Seigler Springs Company, with A. J. McGill, president; Robert Forbes, secretary, and W. H. Roberts, manager. It is in Sec. 24, T. 12 N., R. 8 W., 5 miles southwest from Lower Lake, 30 miles north of Calistoga, and at an elevation of 2230 feet (bar.). There is quite a variety of springs

Photo No. 17. Hotel at Seigler Hot Springs, Lake County, California.

here, both cold and hot. The principal ones are: "hot iron" 107° F.; "hot sulphur" 107°; "small sulphur" 118.5°; "big sulphur" 126°; "lithia" 67°; "soda" 64° "magnesia" 72°; arsenic" 94°; one not named 97°; "geyser" was choked up. At the "Big Sulphur" spring there is considerable excess gas escaping, and there is a large sinter deposit beside it. This spring is the principal one supplying the swimming pool (30 feet wide, 200 feet long, and 3 to 10 feet deep) made by damming the small ravine at the upper end of which several springs issue. Besides this, several of the other springs have stone bathhouses built over them, large enough for swimming exercise. The hotel is supplied with farm and dairy products from the ranch maintained as a part of the resort, comprising a total of 700 acres. There are accommodations for 250 people. No water has been bottled for sale, but it is stated that they contemplate doing so. There is a body of light

colored, volcanic tuff a short distance from the hotel, which has been used for building purposes around the resort, including the main dining room and a part of the hotel (see photo 17).

Bibl.: R. VI, part I, p. 63; VIII, p. 328; X, p. 230; XII, p. 337; XIII, p. 511; R. of M., Lake County, p. 7; U. S. G. S. Bull. 32, p. 207; Water Sup. Pap. 338, pp. 96–98; ANDERSON (op. cit.) p. 243.

Soap Creek (see *Newman*).

Soda Bay Springs. At Soda Bay on the west shore of Clear Lake, 4 miles northeast of Kelseyville, are a number of "soda" springs, both on shore and out in the lake. One, particularly of note, out in the lake, by reason of the large excess of carbonic acid gas escaping raises the level of the water about a foot over an area of a square yard. These springs are not utilized except locally.

Bibl.: R. VIII, p. 328; X, p. 242; R. of M., Lake County, p. 7; ANDERSON (op. cit.) p. 245; U. S. G. S., Water Sup. Pap. 338, pp. 191–192.

Spiers or Red Wing Spring (Copsey). This was originally known as Copsey's Spring, from the locator. The land adjacent to the spring and the riparian rights have been in litigation between Joshua Spiers and M. Hoberg (of Cobb post office); and at the time of our visit both were bottling water from the spring, under the name of "Spiers" and "Red Wing," respectively. The temperature of the water is 80° F. The hotel is owned and operated by Hoberg. There is a second, smaller spring near-by not utilized. They are on Seigler Creek, on the opposite side from the stage road, 8 miles west of north from Middletown, in Sec. 5, T. 11 N., R. 7 W., elevation 1380 feet (bar.).

Bibl.: R. of M., Lake County, pp. 5 and 7; U. S. G. S., Water Sup. Pap. 338, p. 190.

Sulphur Bank (see under *Quicksilver*).

Witter Springs. The first authentic record of use of these springs by white men in 1862. They are in Sec. 5, T. 15 N., R. 10 W., 21 miles east of Ukiah and 7 miles west of Upper Lake, at an elevation of 1800 feet (bar.). The property is owned by Witter Medical Springs (Inc.), W. F. Detert, president, and W. C. Marsh, secretary, with offices at 311 California street, San Francisco. There are several springs, all cold, but the principal one, "Witter," is purely a medicinal water, owing to its high mineral content (1019 grains per gallon), and can not be used freely. This is the one which has been bottled up to the present time. The "Humming Bird" spring is practically fresh water, having only 24 grains of mineral per gallon, and it is proposed to

blend some of this with the "Witter" water and bottle it, carbonated, for table use. Witter water is put up in a special 24-ounce bottle, and packed 36 in a case. There is a fine, large hotel here of 113 rooms; and there are 15 cottages.

Bibl.; R. VI, Part I, p. 64; VIII, p. 329; XII, p. 337; XIII, p. 511; R. of M., Lake County, p. 7; U. S. G. S. Bull 32, p. 209; Water Sup. Pap. 338, pp. 177–179; ANDERSON (op. cit.) p. 265.

In addition to the springs described above there are innumerable mineral springs in the county, both on unlocated ground and on patented land, which are not utilized at present or at least only privately. Among these may be mentioned the following:

"Alum" Springs, in Sec. 11, T. 14 N., R. 7 W., Hiram Kennedy, Lower Lake, owner.

Astorg, near Glenbrook, in Sec. 28, T. 12 N., R. 8 W.

Chalk Mountain, carbonated springs on Chalk Mountain, 11 miles east of north from Lower Lake, near the Dinsmore and Alum.

Dinsmore (soda and iron) in Sec. 11, T. 14 N., R. 7 W., R. Dinsmore, Lower Lake, owner.

Elliott (soda and iron) near Highland Springs, in Sec. 8, T. 12 N., R. 9 W., C. C. Hopkins and C. E. Miller, owners.

England (same as Elliott).

Glen Alpine, on west bank of Scott Creek, 6 miles southwest of Lakeport, on the Hopland road.

Gordon, in Sec. 20 T. 11 N., R. 7 W., Estate of E. A. Hoffman, owner.

Hayvilla Sulphur Spring, 5 miles northwest of Upper Lake.

Kelseyville (soda), in Sec. 14, T. 13 N., R. 9 W., Farmers' Savings Bank, Lakeport, owner.

Lee Soda, in Sec. 33, T. 14 N., R. 10 W., J. F. Lee, Lakeport, owner.

Lyons, Mrs. J. H. Lyons, owner; 6 miles north of Lakeport.

McIntyre Ranch, 6 miles from Kelseyville; an iron spring. Murdock McIntyre, owner.

Morton (See *Roaring Soda*).

Paramore (soda and iron), near Upper Lake in Sec. 21, T. 17 N., R. 9 W., E. R. Smith, owner.

Quigley Soda Springs. On the Quigley ranch at Arabella.

"Roaring Soda" (also called *Morton*), near Hullville, in Sec. 15, T. 18 N., R. 10 W., J. M. Macdonough, owner. Used by occasional camping parties.

Royal, in Sec. 7, T. 16 N., R. 8 W., Dr. E. S. Holway, Colusa, owner.

Spring Hill Farm Resort, a small "iron and magnesia" spring in Sec. 8, T. 10 N., R. 8 W., near Middletown, L. S. Peterson, owner.

Sulphur Spring, near Blue Lakes Resort.

At Upper Lake, water for domestic purposes is obtained from numerous artesian wells. They all carry more or less mineral, principally iron and soda.

The surface water is stated to stand at about 6 feet depth, and the artesian stratum at about 50 feet. West of town the two string bean canneries use artesian wells for irrigating. One of them (Mendenhall's) has sixteen wells on 100 acres; and it is said that when these sixteen (about ½ mile distant) are flowing that the flow of the wells in town is noticeably lowered. A mile south of town on the Taylor place there is a very vigorous artesian "soda" well, with considerable excess gas. It is capped, and not utilized at present.

On the road from Lower Lake to Knoxville, three or four mineral springs were passed, one of them called *Baker Soda Spring.* They are not utilized. Two of them had large calcareous sinter deposits below them.

Bibl.: R. X., pp. 230 *et seq.*, R. of M., Lake County, pp. 5–7; U. S. G. S. BULL. 32, pp. 203, 205, 208, 209; Water Sup. Pap. 338, pp. 93, 181, 182, 186, 188, 196, 197, 202–204, 268, 358; ANDERSON (op. cit.) pp. 164, 176, 247, 267, 269.

NATURAL GAS.

At Kelseyville is a gas well, which was used for a time for illuminating purposes; but the gas was not dried, and it is stated that acid in the moisture corroded the supply pipes. The gas flow was struck at a depth of 158 feet. The buildings connected with it were burned, and have not been rebuilt. The gas is also said to have been tried in a gas engine. It is not utilized at present; and the well is capped.

Bibl.: R. VII, p. 184; VIII, p. 326; X, pp. 241, 271; XI, p. 63; ANDERSON (op. cit.) pp. 182, 266–269; U. S. G. S., Water Sup. Pap. 338, p. 181.

ONYX.

There is a small undeveloped deposit of "onyx marble" in Sec. 12, T. 18 N., R. 10 W., near Hullville.

Bibl.: Reg. of Mines, Lake County, p. 3.

PETROLEUM.

There are oil seepages reported on the east, southeast and northeast of Morgan Valley, in the southeastern part of Lake County. The valley has flat-lying sandstones, and it is thought they "may have oil underneath."

Some of the seepages have been prospected, and a small amount of high grade oil (paraffine base) said to have been obtained. Some light oil was found a few miles southeast of here, in the Knoxville quicksilver mine, on the 400-foot level at the sandstone contact, and was used as a lubricant around the mine machinery.

QUICKSILVER.

Prospecting and exploitation of quicksilver deposits in Lake County began in the early sixties, and the Abbott mine was a producer as early as 1870. There was no notable production, however, until 1873. As will be noted by reference to the Table of Mineral Production, quicksilver mining was most active in this county from 1875 to 1882. The high-water mark in the price of quicksilver in California was reached in 1874 (the highest quotation being $118.55 per flask), with $105.18 the average San Francisco figure for that year. This was preceded by an average of $80.33 in 1873, and followed by $84.15 in 1875. The following year it dropped to $44. The low record sales price was $25.25 in 1879, but 1882 was the lowest year, with average of $28.23. The average price for 1913 was $40.23.* The variations in the market price of quicksilver have been decidedly erratic, as will be noted by reference to the table in Bulletin 27, page 10.

There was a revival of quicksilver mining in Lake County between the years 1891 and 1896; but beginning with 1905 there has been a rapid decline, until at the present time it has reached an almost insignificant figure. There were but two producers in 1913—the Helen and the Wall Street, both of them being near Middletown. It may be noted here that in some of the early reports and press notices the Knoxville mines (Manhattan, Lake, Redington, Boston) were erroneously referred to as being located in Lake County. They are in Napa County.

The principal consumption of quicksilver is in the manufacture of fulminate for explosive caps, in the recovery of gold and silver from their ores by amalgamation, the preparation of certain drugs, and the manufacture of vermilion, of electric lighting apparatus and scientific

*The average price for the first seven months of 1914 was $38.61, the monthly figure varying between $39.25 for January and $37.50 for July. The outbreak of the war in Europe in August at once changed the aspect of the quicksilver situation, as it did many other lines. The monthly averages to date since that have been as follows:

August, 1914	$80 00
September	76 25
October	53 00
November	55 00
December	53 10
January, 1915	51 90
February	60 00
March	78 00
April	77 50
May	75 00
June	90 00
Closing June figure, per flask	90 00

W. W. B., July 1, 1915.

apparatus. A new and interesting use now coming into vogue is for "floating" the revolving lights of lighthouses. About 600 pounds of quicksilver are required (depending on the size of the light)—being placed in a circular groove or channel. The lighting unit is set on a pontoon which, in turn, rests and revolves on the mercury. As the metal is not consumed, the loss after installation is insignificant.

In "Mineral Resources of the United States for 1912" H. D. McCaskey says:

> Owing to the generally low prices prevailing, the domestic quicksilver industry was not particularly prosperous in 1912. The great majority of the producers are operating old mines in which high grade ore is now rarely encountered, and there was no new rich ore shoots reported for the year. In most cases special skill is required to prevent the plants running at a loss. * * * Although each well-developed property is equipped with its own plant and presumably run at lowest costs, the margin of profit in many cases is so small upon low-grade ores that during periods of low prices the mining activity is likely to be considerably curtailed. * * * It is true that further improvements in metallurgical treatment, particularly in preventing furnace losses, should result in a better margin of profit. But little improvement can be made with low market prices and uncertainty of ore supplies. The domestic market for quicksilver appears to demand from 20,000 to 25,000 flasks for consumption per annum. The foreign market is not profitable to American producers in competition with large European supplies available at lower prices. At low prices and normal output there is little importation, but at high prices importation of foreign supplies reacts to curtail output by cutting prices to a low margin of profit. It would seem, therefore, that unless rich ore, workable under favorable conditions at a large profit, be available, or industrial chemistry find new uses for the metal and an increase in domestic demand results thereby, the present producers must continue to operate under somewhat unfavorable conditions, and new producers and small mines must compete with established mines and plants now operated presumably at minimum costs and with special skill and knowledge of the art.

The increasing adoption of the cyanide process in place of amalgamation in the treatment of gold and silver ores, has materially decreased the demand for quicksilver of recent years, particularly in the western United States and in Mexico. The present low tariff, of $5.25 per flask, also affects domestic prices. (See Min. Res. of U. S., 1911, Part I, p. 917.)

As to metallurgical improvements in the reduction of quicksilver ores, besides those looking to the prevention of furnace losses, the question of concentration will no doubt play an important part in the near future. Egleston ("The Metallurgy of Silver, Gold and Mercury in the United States, Vol. II, 1890, p. 804") says: "The attempts of mechanical concentration of quicksilver ores have usually not been successful, because cinnabar is so friable that a greater portion floats off with the water." Just there has been the mistake—too fine crushing or grinding. *Grinding* should be avoided. In the writer's opinion rolls are best adapted for crushing cinnabar bearing ores, as they give a better average product with a minimum of fines. G. V. Northey at the Manzanita mine at Sulphur Creek, Colusa County (see Bull. 27, pp. 198-202; also Eng. and Min. Jour. Vol. 96, p. 783), proved conclusively that cinnabar can be concentrated successfully and handled

economically, even using so crude a device as the old Gilpin County bumping table. Also, at the present time, concentration is being practiced at both the Ætna and the Oat Hill mines in Napa County (see under Napa County).

Of course, there are a number of details to be worked out, not only in the ore dressing end, but in the reduction of the metal from the concentrates. This material, because of its high specific gravity and its finely divided condition, packs in the retort and needs some sort of rabbling or shaking up to allow of a complete expelling of the quicksilver. So far only retorts have been used—both "D" and pipe. Possibly some form of a rotary roaster may be evolved; or, a small tile shaft furnace of the Hüttner-Scott type, but with a narrower shaft and a narrow "shelf-slit."* There are a good many quicksilver properties in California idle as well as operating, particularly in Napa, Lake and Sonoma counties, where it would seem worth while to investigate the feasibility of concentration. Then, too, there are the mines like the old Rattlesnake and the Socrates, in Sonoma County, whose ores contain a large percentage of native quicksilver. Some scheme of washing and settling, or concentrating would seem to be the solution of the problem of dressing these ores.

There are four recognized quicksilver districts either wholly or in part located in Lake County: (1) *Mayacmas,* the largest, is in southwestern Lake and extends over into northeastern Sonoma, and northwestern Napa; (2) *Clear Lake* district is around the eastern, southern and southwestern sides of Clear Lake; (3) *Knoxville* district is at the junction of Lake, Yolo, and Napa, being principally in the last named; (4) *Sulphur Creek* district is almost wholly in Colusa but includes the Abbott mine which is on the eastern edge of Lake County.

Bibl.: State Mining Bureau Reports IV, pp. 328-344; V, pp. 95, 96; VI, Part II, pp. 72, 73; VIII, pp. 324, 325; X, pp. 238, 239, 270; XI, pp. 61-65, 239; XII, p. 360; XIII, pp. 595-597; Reg. of Mines, Lake County, p. 3; Bull. 27, pp. 35-42, 46-72, 197-255. U. S. G. S. Mon. XIII; Min. Res. of U. S. 1883, pp. 389, 395; 1884, pp. 492, 494; 1888, pp. 97-99; 1891, pp. 117-121; 1892, pp. 138-168; 1902, pp. 251, 252; 1906, p. 497; 1907, Part I, p. 679; 1908, Part I, p. 686; 1909, Part I, pp. 552, 553; 1910, Part I, pp. 697, 698; 1911, Part I, p. 901; 1912, Part I, pp. 940-942; An. Rep. XVI, Part III, pp. 598, 599; XXI, p. 277.

GEOL. SURV. OF CAL., GEOLOGY, Vol. I, pp. 96-100; Vol. II, pp. 124, 125.

*Since the above was written, the author has seen such a furnace in successful operation at the New Idria quicksilver mine in San Benito County, for treating soot instead of retorting it. The tile aperture is 3-inch instead of 6-inch as in the larger furnaces. This furnace has a capacity of 9 tons, and 8 tons of fine ore are mixed with each ton of dried soot on charging.

Min. Res. West of Rocky Mts., 1868, p. 266; 1873, p. 11; 1874, pp. 30 *et seq.;* 1875, pp. 13-20, 173-178, 493; 1876, pp. 18-21.
Trans. A. I. M. E. XXII, p. 86; XXIII, pp. 225 *et seq.;* XXXIII, p. 751; Genesis of Ore Deposits, pp. 32, 66, 256.
Richard's "Ore Dressing," Vol. II, p. 1074.
Min. and Sci. Press, May 27, 1905. Eng. and Min. Journal, Vol. 96, pp. 783, 828.
American Jour. of Science, Vol. XXIV, 3d Series, pp. 23 *et seq.*

An extended bibliography on quicksilver for North America is given in Mineral Resources of the United States 1910, Part I, pp. 705-710; 1911, Part I, p. 920.

Abbott Mine. The Abbott mine is on the eastern border of Lake County, in Sec. 32, T. 14 N., R. 5 W., about 1 mile in an air line and 2 by the road from Sulphur Creek post office, Colusa County. It was formerly operated by the Empire Consolidated Quicksilver Mining Company. Jas. H. Boyer, 1106 Merchants' National Bank Building, San Francisco, R. A. Boggess et al. are owners; but the property has been in litigation for some time, and apparently is still unsettled. The plant was shut down in 1906, after having been in operation (the last period) for about sixteen years. The mine was discovered in 1862, and began production in 1870, continuing to 1879. It was idle from 1879 to 1889. The Disturnell is included with the Abbott in the property. The mine is credited with a total production of 30,465 flasks. The underground workings are quite extensive, the greatest depth, however, being only 350 feet below the collar of the "Boggess" shaft. As the mine and adjacent ground has been fully described in several reports previously published, and there being no new developments since, details of the geology will not be entered into here, except to recall to notice the occurrence of a light, inflammable hydrocarbon gas in considerable quantities here, an unusual feature among metal mines (at least, as regards quantity), though other hydrocarbons, and bitumens are not uncommon in quicksilver mines. The reduction equipment consists of a 48-ton Scott furnace, with an ore drier located between the crusher and furnace.

Bibl.: R. IV, p. 336 (Table); XI, p. 239; XII, p. 360; XIII, p. 595; Bull. 27, pp. 46-48; R. of M., Lake County, p. 3; U. S. G. S. Mon. XIII, p. 368; Min. Res. of U. S. 1902; GEOL. SURV. OF CAL. GEOLOGY, Vol. II, p. 124; MIN. RES. W. OF ROCKY MTS. 1876, p. 19.

American (see *Helen*).

Anderson Prospects, owned by members of the Anderson family of Anderson Springs. They are in Secs. 25 and 35, T. 11 N., R. 8 W., near Middletown, but have not been developed.

Bibl.: Bull. 27, p. 48.

Bacon, abandoned. R. of M., Lake County, p. 3; Rep. IV, table op. p. 336.

Baker Mine. In Sec. 16, T. 12 N., R. 6 W., 6 miles southeast of Lower Lake. It is owned by the Baker Quicksilver Mining Company. No work, except annual assessments has been done for several years.

Bibl.: R. XI, p. 67; XII, p. 360; XIII, p. 595; R. of M., Lake County, p. 3; U. S. G. S. Mon. XIII, p. 368; GEOL. SURV. OF CAL. GEOLOGY, Vol. II, p. 125.

Bear Canyon (see *Thorn*).

Big Injun Group, the *Big Injun* of the New Phoenix Mining Company and the *Digger Injun* of the Congress Mining Company, have been idle for several years. They are west of Middletown, and near the Helen mine.

Bibl.: Bull. 27, p. 50.

Bradford (see *Mirabel*).

The *Bullion* mine is 4 miles southwest of Middletown, between the Mirabel and Great Western, Ralph H. Read, Middletown, owner. It was formerly worked by the Mirabel Company, and had been abandoned for several years, but was relocated in August, 1913.

Bibl.: R. XII, p. 360; XIII, p. 595.

Chicago Mine (Ural). This property is owned by the Chicago Quicksilver Mining Company, 522 Bank of San Jose Building, San Jose, Cal. It is in Sec. 1, T. 10 N., R. 8 W., about ½ mile west of the Wall Street mine, near Middletown. It has been idle for some time. The last operations here were in 1911 on the construction of a fine-ore furnace of 15 tons capacity, with concrete walls. The furnace was not finished, and consequently never operated. It would be interesting to note the behavior of the concrete when heated. It looks to be an experiment with rather a doubtful outcome.

Bibl.: R. XIII, p. 595; Bull. 27, p. 51; R. of M., Lake County, p. 3; U. S. G. S. Min. Res. of U. S. 1909, Part I, p. 552; 1910, Part I, p. 697; 1911, Part I, p. 901; 1912, Part I, p. 940.

Destinell (see *Abbott*).

Digger Injun (see *Big Injun Group*).

Franklin (see *Jewess*).

Great Western Mine. The Great Western mine is 4 miles southwest of Middletown, 2 miles northwest of the Mirabel, at an elevation of 1860 feet. This mine had the longest continuous record as a producer of any quicksilver mine in Lake County. It was opened up in 1873, and was a constant producer up to 1909. It is credited with a total yield of 98,296 flasks. The last quicksilver produced by this mine was a few flasks recovered in 1912 in cleaning up around the old furnaces. The company has been disincorporated, the furnaces torn down, and the mine abandoned as being worked out. As might be expected from its output record, the Great Western has extensive underground workings, and to a depth of 750 feet. The mine and its geology are described at some length in the reports noted under Bibliography. The property was equipped with a 40-ton Litchfield furnace.

Bibl.: R. X, p. 270; XI, p. 64; XII, p. 361; XIII, p. 595; Bull. 27, pp. 52, 53; R. of M., Lake County, p. 3; U. S. G. S. Mon. XIII, pp. 358-362, 470; Min. Res. of U. S. 1883, 1884, 1892, 1902, 1906, 1907, Part I, 1908, Part I; 1909, Part I; 1910, Part I; 1912, Part I; MIN. RES. WEST OF ROCKY MTS., 1874, 1875, 1876.

Helen Mine (*American*). The Helen mine, owned by Andrew Rocca, is in Sec. 1, T. 10 N., R. 8 W., 6 miles west of Middletown, at an elevation of 2675 feet (barometric reading at bottom of furnace). It consists of two claims, the Helen and the Austin, which were patented in 1874 by Pushbecker, later sold to the American company and to the present owner in 1900. The property includes between 600 and 700 acres (partly timbered) besides the mineral claims' area. The timber, somewhat scattered for the most part, consists of pine, oak, madrone and "fir." The mine is at the head of the north branch of Dry Creek. Its first recorded production was 128 flasks in 1873. The mineralized ledge is 100 to 200 feet wide, in serpentine, and has a black gouge on the hanging-wall. The vein outcrop is prominent, and strikes a little north of west, dipping to the south at 30° to 40°. There are two main levels at present operated, both being by tunnels, one of which is in 2000 feet giving a depth of 316 feet below the outcrop. They have two ore-shoots—one on the footwall side 100 feet long by 40 feet wide on which they have gone down 90 feet; and one on the hanging, 200 feet long by 40 feet wide. The ledge has been proven underground by drifting, for 1000 feet in length. The ore is cinnabar, intermixed with more or less pyrite, and occurs in seams, sometimes an inch or two thick, of solid cinnabar. These seams are approximately parallel to the ledge, and are crossed at high angles by other and rather minute ore

seams. The serpentine is in part silicified and carries lenses of hard, fine-grained black "jasperoid."

At the time of our visit (August, 1913), both the mine and the furnace were in operation, with 16 men, all told, at work—9 underground, 3 on top, and 4 on the furnace. On the outcrop some good ore was being stoped out to the surface. The furnace is a 50-ton Scott (see photo No. 19), and has special condenser arrangements designed by Mr. Rocca, in which the draft is controlled by dampers. It is said

Photo No. 19. Fifty-ton Scott furnace at the Helen Mine, near Middletown, Lake County, California. Old dumps of the Wall Street Mine in the distance.

to work satisfactorily. The owner states that the ore being reduced averages 0.6 per cent quicksilver, and that he can handle at a profit ore carrying down to 0.25 per cent of the metal. Soot from the condensers, and occasional small lots of rich ore are treated in "D" retorts of 1000 pounds per day capacity. A small gasoline engine, run intermittently, furnishes power for the rock breaker. The furnace consumes 1¼ cords of firewood per twenty-four hours. The ore is trammed, horse-drawn, from mine to furnace in trains carrying 3 tons per trip. As the upper parts of the mine are difficult to work on account of water in the wet season, only development work on the lower levels is done in winter. The mine is credited with a total production of something over 5000 flasks to date.

Bibl.: R. XII, p. 362; Bull. 27, p. 55; R. of M., Lake County, p. 8; U. S. G. S. Mon. XIII, p. 375; Min. Res. 1902, 1907, Part I; 1908,

Part I; 1909, Part I; 1911, Part I; 1912, Part I, pp. 940–942; MIN. RES. W. OF ROCKY MTS. 1874, p. 30.

Jewess Prospect (*Franklin.*) It is near the Helen and Wall Street mines, but so far as known has never produced any quicksilver. It has been idle several years.

Bibl.: Bull. 27, p. 157.

King of All Group. This group owned by Lem Stanley of Lower Lake is in Secs. 29 and 32, T. 12 N., R. 7 W., about 10 miles north of Middletown and 1 mile southeast from Howard Springs. None but assessment work has been done for several years. The geology is described in Bulletin 27.

Bibl.: Bull. No. 27, p. 57; R. of M., Lake County, p. 3; U. S. G. S. Min. Res. 1912, Part I, p. 940.

Lucitta Mine (*Uncle Sam*). The Lucitta group of four claims (also known locally as the Uncle Sam), is owned by the Mount Sam Mining Company, and is located on the south slope of Mount Konocti (or Uncle Sam), in Secs. 20 and 21, T. 13 N., R. 8 W., about 7 miles southeast of Kelseyville. The mine has not been worked recently nor has it reported any production for several years past. The geology is described in Bulletin 27.

Bibl.: R. V, p. 96; Bull. 27, p. 58; R. of M., Lake County, p. 3.

The *Maypole* prospect, 7 miles west of Middletown has been abandoned.

Bibl.: R. XIII, p. 596.

The *Middletown* prospect, half a mile southwest from the Jewess, has been abandoned.

Bibl.: Bull. 27, p. 59.

Mirabel (*Bradford*) *Mine.* This mine was first opened up in 1887, as the Bradford, and later renamed Mirabel, being owned by the Standard Quicksilver Company. It is 4 miles south of Middletown. For ten years it was one of the important producers of Lake County, but in 1897 was abandoned as worked out; and the mine has filled with water. In 1908 a small production was reported as having been made from a clean-up around the old furnace. The property has yielded a total production of about 30,600 flasks. Underground, a vertical depth of 500 feet was reached, with 22,500 linear feet of drifts, and 750 feet

of shaft work. More extended descriptions of the mine and its geology will be found in the references noted under Bibliography.

Bibl.: R. VIII, p. 325; X, p. 270; XI, p. 64; XII, p. 361; XIII, p. 595; R. of M., Lake County, p. 3; U. S. G. S. Mon. XIII, p. 375; Min. Res. 1888, p. 97; 1891, p. 117; 1892, p. 160; TRANS. A. I. M. E., XXII, p. 86.

Red Elephant. This prospect, owned by W. G. Tremper of Lower Lake, is in Sec. 3, T. 11 N., R. 5 W., near the Napa County line, ½ mile west of Knoxville. Only sufficient development, mostly surface work, has been done to cover annual assessments.

Bibl.: Bull, 27, p. 92; R. of M., Lake County, p. 3.

Shamrock Prospect. This group of two claims is on Rocky Creek, a branch of Cache Creek, in Sec. 23, T. 13 N., R. 6 W., about 10 miles northeast of Lower Lake. It is owned by the Shamrock Development Company (Jas. Daly, W. P. Swift et al.), Napa. The property is idle.

Bibl.: Bull. 27, p. 60; R. of M., Lake County, p. 3.

Standard (see *Mirabel*).

Sulphur Bank Mine. This mine is one of the notable and much written about quicksilver mines of the world. It is extremely interesting from many standpoints—those of chemistry, mineralogy and geology, as well as metallurgy and mining. It was first worked in 1865 for sulphur, and in the four years to and including 1868 produced a total of nearly 2,000,000 pounds of that mineral, valued at $53,500. The property was at that time owned by the California Borax Company which during the same period was also producing borax from Borax Lake, near-by. The two are still intact, being owned at present by W. S. Tevis, of San Francisco, and leased out as part of a cattle range. During the time of working the surface cuts for sulphur, some difficulty was experienced in refining the material because of the presence of cinnabar, which darkened the product. The proportion of cinnabar increased with depth. Cost of transportation to the market and a rapid fall in the price of sulphur caused a cessation of operations, but the mine was reopened and developed for its quicksilver in 1873, being a steady and important producer until 1883. After four years of idleness, work was resumed and continued until 1897, when it was again shut down. In 1899 the mine was reopened and worked until December, 1905, the shaft being kept unwatered until June, 1906, since which time it has been idle. As a producer of quicksilver, the Sulphur Bank mine is credited with a total output of 92,000 flasks. It is said that at the time of the last closing down of the mine (due to financial

Panoramic photo. Sulphur Bank Mine, Lake County, California, from eastern wall of old open cuts. Mt. Konocti in right distance.

troubles as well as the increasing difficulties of ventilation and pumping in consequence of the hot waters and deleterious gases) they had opened up a good body of high grade ore underground from the Empire shaft.

The Sulphur Bank is a low, rounded hill (see photo No. 22), on the eastern shore of Clear Lake in Sec. 6, T. 13 N., R. 7 W., about 10 miles north of Lower Lake. It is also reached by launch from Lakeport. The elevation is 1350 feet at the lake level. The old surface cuts much resemble those of a placer mine with its tailings piles of boulders, except

Photo No. 22. Sulphur Bank Mine from lake side.

that over it all is a pulverulent, white powdery material, the result of the continuing decomposition of the rocks by the solfataric vapors and waters still present (see panoramic photo). The glare is almost blinding on a sunny day. The rounded boulders due to concentric decomposition, as described by Becker (U. S. G. S. Mon. XIII) can be plainly seen. The evidences of solfataric activity are numerous and striking. Iron rails, nails, cables, etc., are sulphurized and oxidized. Wood is blackened and rotted. There are abundant sulphur crystals in crevices and flour sulphur around vents where vapors are issuing. At the mouth of an abandoned shaft, now caved, near the eastern edge of the surface workings (either the Hermann shaft or Hermann air shaft—see map, Bull. 27, p. 63), hot, moist, sulphurous gases are still escaping, and under a noticeable pressure. The odor of sulphur dioxide is very strong, so that it was difficult to breathe while placing a thermometer in one of the openings to observe the temperature. It showed 108° F.—this being at the surface. Becker (op. cit., p. 259), recorded temperatures up to 176° F. at a depth of

300 feet. The rocks about the opening and protruding sticks of timber are heavily coated with a deposit of flour sulphur. There is a sound as of a roaring furnace from below. How any one could breathe in such an atmosphere, much less work, is a matter for wonderment. There was a dead rat lying at one of the openings. At the upper end of the "Western Cut," there are a number of warm springs with considerable excess gas escaping with the water—the whole having the appearance of a series of boiling cauldrons. (Photo No. 25). The

Photo No. 25. Hot springs in bottom of "Western Cut," Sulphur Bank Mine, Lake County, California.

appearance is deceiving, however, as the temperatures are much lower than one would expect. The following temperatures were obtained: 84° F.; 108° (water inky, with a black deposit forming about it); 100°; 97° (in upper corner). The Empire shaft (the latest sunk), was filled with water to within 15 feet of the collar at the time of my visit (August, 1913), and escaping gases were bubbling up through the water. "The gases escaping from the waters are carbon dioxide, hydrogen sulphide, sulphur dioxide, and marsh gas. The waters contain chiefly carbonates, borates, and chlorides of sodium, potassium and ammonium; but alkaline sulphides are also present." (Becker, op. cit., p. 463.)

As to the mode of occurrence of cinnabar at Sulphur Bank, it is well summarized by Becker (op. cit., p. 257), as follows: "It does not occur in sensible quantities at or near the surface, but is found to a considerable extent mixed with sulphur in the lower portion of the zone of oxidation. The principal deposits are below this level. They are found in the more or less decomposed basalt, in the underlying recent lake bottom, and in the Knoxville shales and sandstones. The cinnabar is associated chiefly with silica, in part crystalline and in part amorphous. In the lava it appears as small seams, which commonly follow either the original cracks between the blocks or the concentric surfaces of the decomposed masses. In the lake deposits below the basalt the cinnabar is found as impregnations or irregular seams. In the workings from the Hermann shaft the ore occurs exactly as it does in most of the quicksilver mines of California, more or less completely filling interstices in shattered rock masses. * * * Dr. Melville has found small quantities of gold and copper in the marcasite accompanying the cinnabar. * * * The intimate association of the ore with the sulphur, opal, quartz, pyrite, and to a smaller extent with calcite, is amply sufficient to show that it has been deposited from water." Also (p. 263): "Excepting for the solfataric springs the underground mine at Sulphur Bank resembles the other principal quicksilver mines of California. * * * This fact is an important one, for it proves that deposits indistinguishable from those found in the Redington, New Almaden, and other mines may be formed in the same manner as those at Sulphur Bank, by precipitation from hot springs of volcanic origin."

The property was equipped with a Knox-Osborne 25-ton furnace. 3 Hüttner-Scott furnaces of 40, 17 and 30 tons, respectively, and a battery of 9 "D" retorts.

At the "Little Sulphur Bank," above ½ mile south of Borax Lake, some prospecting has been done. Here, the same sulphurous odors are noticeable as at Sulphur Bank.

Bibl.: R. IV, pp. 157, 330, 339; V, p. 96; VI, Part I, p. 136; VIII, p. 324; X, pp. 238, 239; XI, p. 63; XII, p. 363; XIII, p. 597; Bull. 27, pp. 61–70; R. of M., Lake County, p. 3; U. S. G. S. Mon. XIII, p. 251–270, 463; Min. Res., 1883, pp. 394–397; 1884, p. 492; 1892, pp. 146, 148, 160; 1902, pp. 251, 252; Water Sup. Pap. 338, pp. 98–99; Geol. Surv. of Cal., Geol., Vol. I, p. 99; Trans. A. I. M. E., XXIII, pp. 225 *et seq.;* XXXIII, p. 751; Genesis of Ore Dep., pp. 32, 66, 256; Min. Res., W. of Rocky Mts., 1868, p. 266; 1876, p. 20; Am. Jour. of Sci., Vol. XXIV, 3d Ser., pp. 23 *et seq.*

Thorn Mine (*Bear Canyon*). It is west of Middletown, in Sec. 36, T. 11 N., R. 8 W., near Anderson Springs. H. W. Herrick of Middle-

town is the owner. Only assessment work has been done for several years past, but it is said no ore bodies of any consequence have been developed. In 1909, a small production was reported from ore taken out during development work.

Bibl.: Bull. 27, p. 70; U. S. G. S. Min. Res. 1909, p. 552.

Uncle Sam Mine (see *Lucitta*).

Ural Mine (see *Chicago*).

Utopia Mine. The Utopia is on the eastern shore of Clear Lake in Sec. 25, T. 15 N., R. 9 W., near Bartlett Landing, northeast from Lakeport. It is owned by the Utopia Quicksilver Mining Company of Lakeport, A. Spurr, secretary. It has not been operated recently, as it is said they were driven out by water, the ore body running under the lake.

Bibl.: R. XIII, p. 597; Bull. 27, p. 70; R. of M., Lake County, p. 3.

Wall Street Mine. This mine was a producer as early as 1875, about which time it was patented, but abandoned by the original owners in 1878. The present owner, W. H. Parsons, acquired the property in 1898, by purchase of tax title from the state, and has been reporting an output of a few flasks of quicksilver annually for the past seven years. It is located in Sec. 1, T. 10 N., R. 8 W., on a branch of Dry Creek, 6 miles west of Middletown. The elevation is 2275 feet (bar.) on the road at the retort. The old workings are largely inaccessible. The owner works the mine single-handed, assisted by a pack-horse for handling ore, timbers and firewood. The Wall Street mine is about ½ mile down the canyon from the Helen from which it appears to have been broken by a northeast-southwest fault. Their main mineralized ledges have several characteristics in common and are marked by the same prominent outcrop. The Wall Street, however, has a considerable proportion of native quicksilver which does not appear at the other. There is a narrow quartz vein in the main ledge near its hanging-wall side, and parallel to its dip—30° SW. The vein, which has a comb structure, carries in its numerous cavities and pores much native metal. Parsons states that the serpentine from 1 to 3 feet above and below the quartz carries some 4% of both native metal and cinnabar in about equal proportions. The silicified ore-bearing serpentine lies above the softer serpentine and carries the quartz vein, cinnabar, pyrite, and lenses of jasperoid. In the mill there is a 20 h.p. Westinghouse compressor (being a locomotive air-brake pump, 9½-inch diameter by 10-inch stroke), steam driven, which furnishes power for an air hammer drill in underground work. There is also a small Chilian mill, and two homemade, table concentrators, said to have a capacity of

3½ tons per day. Some of the soft ore is concentrated, but the jasperoid and disseminated ores are retorted direct. One "D" retort is used—14 inches high, 30 inches wide and 8 feet long—which consumes 1½ cords of firewood per flask of quicksilver produced. This retort has a capacity of 600 pounds of ore per day. The old company is said to have expended $100,000 and produced 140 flasks. The total output to the end of 1913 has been about 300 flasks.

Bibl.: R. IV, p. 183; V, p. 96; VI, Pt. I, p. 110; XII, p. 362; XIII, p. 597; Bull. 27, p. 71; R. of M. Lake County, p. 3; U. S. G. S. Mon. XIII, p. 375; Min. Res. 1907, Part I, p. 679; 1908, Part I, p. 686; 1909, Part I, p. 552; 1910, Part I, p. 698; 1911, Part I, p. 901; 1912, Part I, pp. 940–942.

STONE INDUSTRY.

Except for occasional local uses, there has been no development of the stone industry in Lake County. The board of supervisors reported macadam to a value of $10,000 used on road work in 1908, but they have done nothing but minor repairs since that time. There is said to be a red volcanic rock near Lower Lake which makes an excellent macadam, particularly when mixed with some clay.

SULPHUR.

Sulphur Bank Mine. As has already been noted (see under *Quicksilver*), the Sulphur Bank mine was originally operated for sulphur, of which it produced some 2,000,000 pounds (in round numbers), valued at $53,500, in the four years 1865–1868, inclusive. In the upper portions of the oxidized zone sulphur was abundant, and the material was taken out by quarrying. The sulphur was extracted by sublimation in cast iron retorts, then further refined by treating, while melted, in iron kettles to remove the dark color due to the presence of cinnabar, and finally poured into moulds. Cost of transportation and the decreasing market price caused a cessation of mining for sulphur. There is still much of this material in evidence at the Sulphur Bank, today, but it is doubtful if it can be made economically available, in competition with the Louisiana product and that from Japan (which latter is practically pure in its natural state, and requires no refining for most commercial uses), at least not until cheap transportation is established. The same statement applies to the borax deposits of Borax Lake on the same property.

Bibl.: R. IV, p. 379; V, p. 96; VI, Part I, p. 136; VIII, p. 324; X, pp. 238, 239; XI, p. 63; XII, p. 410; XIII, p. 646; Bull. 38, p. 372; U. S. G. S. Mon. XIII, pp. 254, 463; Geol. Surv. of Cal., Geology, Vol. I, p. 99; Min. Res. W. of Rocky Mts. 1867, p. 187; 1868, p. 266; 1872, pp. 447–450.

MARIN COUNTY.

Field Work in November, 1913.

Exclusive of San Francisco County, Marin is the smallest county in California, having a land area of only 529 square miles. The Pacific Ocean is its western boundary, Sonoma County on the north and east, San Pablo and San Francisco bays on the east, with the latter and the Golden Gate on the south. Its topography is quite rugged and picturesque, with occasional small and fertile valleys. Its most prominent topographic feature is Mount Tamalpais which overlooks both bay and ocean region from an elevation of 2600 feet. Other notable features are Tomales, Drakes, Bodega and Bolinas bays, on the ocean side, and Richardson's Bay on the inland side. Angel and Belvedere islands are included in Marin County. The areas around San Rafael, Mill Valley, Sausalito, and intermediate points are popular suburban residence sections.

The mineral resources of Marin County, while limited numerically, are none the less important individually. They are mainly structural and industrial materials. In the order of their production to date (see table) they are: brick, stone industry, mineral water, granite, salt, and copper. Their total recorded output is $3,869,799 to the end of 1913.

In addition to the above, occurrences have been noted of asphaltum and petroleum, chrome, coal, jasper, garnets, manganese, and natural gas. Attempts have been made to exploit some of these, but without commercial success so far.

ASPHALTUM AND PETROLEUM.

Along the shore-line cliffs west of Bolinas from Duxbury Point north for a distance of over 3 miles there are several small occurrences of asphaltum which appear to be residues from oil seepages. The principal ones are at Duxbury Point, Bolinas Point and Abalone Beach. Specimens of the material were collected and have been placed in the museum of the State Mining Bureau. There are pebbles and rock fragments imbedded in the asphaltum (see photo No. 165).

At Abalone Beach there is said to be an oil seepage which is uncovered at extreme low tide, but the tide was not low enough to see it during my visit. The shales here dip to the south and east at a rather flat angle (20° to 30°). At the south end of this beach, and about 1¼ miles north of Bolinas Point, is an unconformity between two series of shales, the upper series being more massive than the other. The top of the lower series is marked by a thin layer of pebbles partially stuck together with asphaltum.

Table of Mineral Production.

Year	Brick		Stone industry		Mineral water		Miscellaneous and unapportioned	Value
	1,000	Value	Tons	Value	Gallons	Value		
1888	1,600	$10,000						
1889	*2,000	12,000						
1890	*5,000	30,000						
1891	*10,000	60,000						
1892	*12,000	72,000						
1893	18,000	108,000						
1894	28,500	172,500		$16,850				
1895	29,000	145,000		7,790			7,000 cubic feet granite	$5,000
1896	15,000	85,000	7,849	8,260				
1897	15,000	89,000	6,000	7,200				
1898	15,500	66,000	1,710	1,800				
1899	16,500	76,000	4,400	5,150				
1900	25,000	200,000	3,000	2,500				
1901	14,320	100,240	34,000	27,987				
1902	14,600	97,700	149,450	105,350			700 tons salt	1,400
1903	13,819	78,095	144,715	140,332				
1904	20,500	132,000	216,576	170,995				
1905	22,877	163,585	113,000	44,250				
1906	23,900	199,300	54,000	53,000			150 tons salt	300
1907	16,000	118,000	157,100	134,111				
1908	10,000	50,000	111,686	66,700	52,000	$12,050		
1909	4,500	105,000	132,010	67,010	47,500	5,075		
1910	22,497	99,185	112,000	74,700	100,000	10,000		
1911	19,695	87,445	173,646	108,783	328,740	36,500		
1912	18,000	88,200	5,300	3,000	260,000	31,000		
1913	16,000	70,500	428,357	198,953	60,000	9,000		
Totals	409,808	$2,514,750	1,854,799	$1,244,724	848,240	$103,625		$3,700

*Estimated.

Totals.

Brick	$2,514,750
Stone industry	1,244,724
Mineral water	103,625
Miscellaneous	6,700
Total to end of 1913	$3,869,799

Photo No. 172. Duxbury Point and Reef, Marin County, California, looking southeast. Dip of shale beds is to west (right).

Photo No. 165. Asphaltic residue from oil seepage, at base of sea-cliff, northwest from Bolinas, Marin County, California.

From Bolinas Point to Duxbury Point the shale strata, which are somewhat indurated, strike southeast and dip to the west at an angle of 45° to 50°. At the latter place the beds are massive and continue for some distance into the sea, forming the well-known and dangerous Duxbury Reef (see photo No. 172). In the cliffs at this point the asphaltum appears in thin seams cutting across and nearly normal to the dip of the strata. There are small dabs of asphaltum sticking on the washed reef throughout this section from Duxbury Point to Abalone Beach. On first thought these "dabs" might appear to be artificial (i. e. sea-drift washed from passing vessels), but observation showed them to occur only in the vicinity of the oil seepages.

At Bolinas, about ⅓ of a mile west of the entrance to the Lagoon, the division between the soft, yellow sandstone to the east and the shale to the west is marked by a vertical fault plane. The dip of the sandstone is east, 10° to 15°. In this sandstone at a few feet above the beach level is a stratum of shells, 6 to 8 inches thick, distinctly marking the bedding planes.

On the mesa back of Duxbury Point (apparently an old sea terrace) two wells were drilled for oil about 1902. It is said that in the second well, which was a few yards from the sea cliff, a small flow of oil was obtained and several drumsful pumped out; that a charge of dynamite was exploded in the well to open up the flow more but that it became choked off entirely instead. Others state that the oil in the well was some of that hauled out there for fuel for the boilers.

Bibl.: R. XI, p. 249; XIII, p. 36.

BRICK AND CLAY.

At the *Bothing Home,* near Fairfax, pottery is being made on a small scale by the inmates, from clay obtained nearby.

Kaolin has been found near Duncan Mills. R. V, p. 108.

McNear Brick Company (formerly Fortin Brick Company). J. A. McNear, president, E. B. McNear, manager and superintendent. This plant is on tidewater at McNear's Point, 4 miles east of San Rafael. There is no railroad accommodation nearer than San Rafael, but the product is shipped by barges to the various bay points (see photo No. 131). Bricks were first made here about 30 years ago, and the fires in the present plant have not been out in the past 14 years. The property is part of the Spanish grant, "Rancho Santa Margarita y Las Gallinas."

The clay and shale beds which are on the northwest face of the hill are underlaid by Franciscan metamorphic sandstone. In the quarry, blasting is done by battery, and the material is loaded into cars by a small Bucyrus steam shovel (Class 14-B—on turntable like a locomotive crane). The cars are horsedrawn in trains to the storage bins.

From there the clay goes through the crushers, elevators and screens to the pug-mill. The "dry-pan process" is used. The dampened clay is mixed in the pug-mill and discharged into an auger, stiff-mud

Photo No. 131. Plant and furnaces of the McNear Brick Company, near San Rafael, Marin County, California.

machine. From this it is forced in a slow-moving continuous stream, rectangular in cross-section and cut into proper lengths by a wire brick-cutting machine. The belt conveyor leading from the cutter

Photo No. 128. Drying sheds, McNear Brick Company, Marin County, California.

travels slightly faster than the clay stream and so separates the blocks after they are cut. From there the "green" bricks are taken to the drying sheds (see photo No. 128).

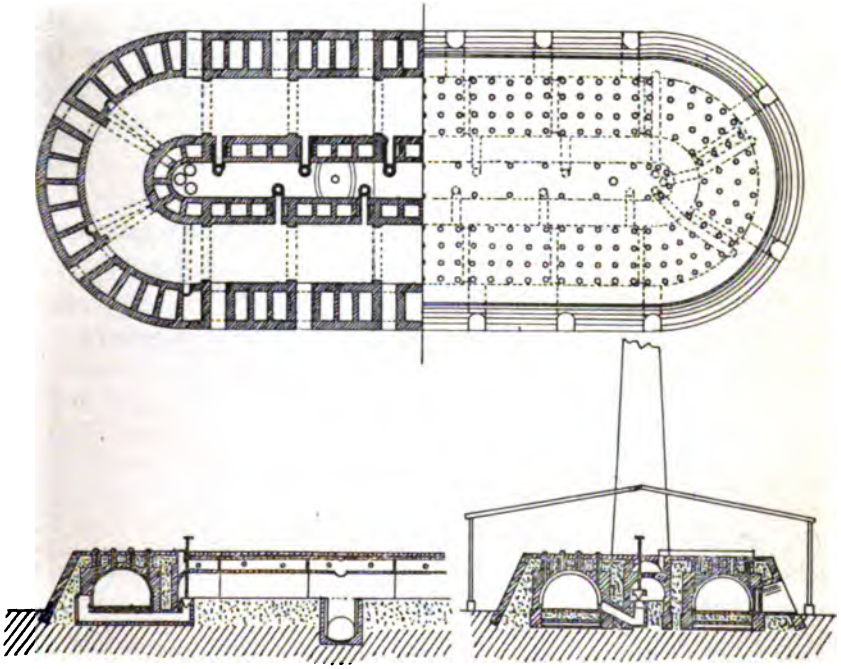
The brick forming end of the plant has a capacity considerably in excess of that of the furnaces. The excess is stored in the drying sheds during the summer months for burning in the winter when outside work is curtailed on account of the weather. The yearly capacity of the plant is 20,000,000 bricks. About ninety men are employed. There are two Hoffmann continuous kilns, coal fired (see photo No. 126 and drawing). The draft is from the top of the furnace down through the charge of bricks to the under-floor flues that carry it to the stack.

Photo No. 126. Top of Hoffmann brick kiln, McNear Brick Company, near San Rafael, Marin County, California.

The Hoffmann kiln consists of an arched, tunnel-shaped, firing chamber, either circular or oval in plan, or of two parallel tunnels joined by circular ends. The furnaces at the McNear plant are of the last-named type. This produces an endless kiln capable of being subdivided into a series of chambers of nearly equal size by means of cross partitions of a temporary character. From each chamber three flues lead respectively to: the central stack; the chamber preceding it in the series; and the chamber following it. Each of these flues may be closed at will by the insertion of a partition of sheet iron. Each compartment also has a doorway connected with the outside for charging and discharging. Slack or other fine coal is fed in at the top of the chambers (see photo No. 126) and one chamber is fired. Some plants use crude oil. The flues leading to the stack are closed except that from the newest chamber charged, behind the one fired. The inter-

chamber flues are left open except the one between the fired chamber and that behind it in the series. By this arrangement the hot gases from the fired chamber pass successively through the other charged chambers, finally passing out from the last one to the central stack. When the bricks in the fired chamber are sufficiently burned, it is allowed to cool by closing its flues, and the next chamber ahead is fired. After removing the burned bricks the compartment is recharged and its flues opened *to* the stack and *from* the chamber behind it.

Bibl.: R. VIII, p. 342; XII, p. 382; XIII, p. 615; Bull. 38, p. 249.



Hoffmann continuous brick kiln. Plan and vertical sections.

There is clay on the *Mailliard Ranch,* on Spring Creek near Lagunitas Station, about 8 miles northwest from San Rafael. The Lagunitas Development Company, 202 Commercial Building, San Francisco, is owner. Occurrences of chromite and manganese are also reported on the same property.

Bibl.: R. XI, p. 253; XII, pp. 329, 382; XIII, p. 506; Bull. 38, p. 362.

Patent Brick Company. Home office, 1218 Merchants' Exchange Building, San Francisco. The plant is at Gallinas Station on the Northwestern Pacific Railroad, 4 miles east of north from San Rafael. It is also on a tidal canal for barges via Gallinas Creek. The present

company began operations here about 1870; but the plant has been idle the past five years on account of low prices and small demand. The increasing use of concrete has cut heavily into the demand for bricks. The company still has some stock on hand which is being disposed of inland at rail connections. It is intended to resume operations whenever prices and conditions improve.

The plant has a capacity of 1,500,000 per month, and uses the dry-pan process. There is also a pressed brick department. The equipment includes: three dry-pan grinders, pug-mill, brick machine, cutters, press, drying kilns, two Hoffmann continuous kilns (coal fired), one circular kiln (oil fired) for pressed, Roman and fancy brick. A third furnace, now old and abandoned, is said to have been the first Hoffmann brick kiln built in America. The clay deposits are on the hillsides back of the plant.

Bibl.: R. XII, p. 382; XIII, p. 615; Bull. 38, p. 250.

Remillard Brick Company. This company for many years operated a plant at Greenbrae, 2 miles south of San Rafael, but it has now been idle for some time and the machinery disposed of.

Bibl: R. VIII, p. 342; XII, p. 382; XIII, p. 615; Bull. 38, p. 250.

CHROME.

(See Mailliard Ranch, under Brick and Clay.)

COAL.

(See Escalle under Stone Industry.)

There is a specimen of lignite in the museum of the State Mining Bureau from the Overton Ranch, on Tomales Bay.

COPPER.

In 1863 two or three companies did some work on a series of copper prospects about a mile east of Woodville (then Dogtown), north of Bolinas, and a small tonnage of sorted ore was shipped for treatment.

The Bolinas Copper Mining Company, T. P. H. Whitelaw, manager, in 1900 shipped some copper ore from the same locality, but nothing has been done since.

Bibl: R. V., p. 98; XI, p. 253; XIII, p. 59; Bull. 20, p. 14; Bull. 50, p. 168.

GRANITE.

There is a specimen of granite in the museum of the State Mining Bureau from Porter's Point, and the records show a production of 7000 cubic feet valued at $5,000 reported in 1895.

Bibl.: Bull. 8; Bull. 38, p. 364.

GRAPHITE.

Graphite has been reported from Marin County, but the locality is not definitely known.

Bibl.: R. IV, p. 224.

JEWELERS' MATERIALS.

Garnets in mica schist are found near California City on the Tiburon Peninsula and on the Reed Ranch.

So-called *moonstones* (principally translucent quartz) are found as pebbles along the ocean beach, particularly near Bolinas Point.

Jasper is found quite plentifully in Marin County in connection with the Franciscan cherts. Dr. S. M. Augustine of San Rafael has a large and beautiful collection of polished specimens of red and yellow jasper and banded chalcedony from around San Rafael, Sausalito, and other parts of Marin County. It makes beautiful jewelry but is too expensive to collect and prepare. It is highly siliceous and very hard, but is not obtainable in large enough pieces for building decoration. There is an infinite variety of coloring and figures.

Bibl.: Bull. 37, pp. 52, 78; Bull. 38, p. 366.

MANGANESE.

(See Mailliard Ranch under Brick and Clay). Manganese has also been found near Tomales and Sausalito.

Bibl.: R. IV, p. 316; Bull. 38, p. 368.

MINERAL WATER.

Ancha Vista Spring. J. Richards, Sausalito, owner. Dave Davis, lessee. The spring is on the slope of Red Hill at San Anselmo, elevation 150 feet (U. S. G. S.). It has been known for over thirty years but utilized medically only the last few years. It is in sandstone. Analysis said to be by the Medical Department, University of California, shows 21 grains per gallon, principally magnesia and lithia. The flow is ordinarily about 100 gallons per day and a portion of the output is shipped in 5-gallon carboys. The hotel and cottages are on the adjoining property owned by Mr. Davis.

El Toro Spring is on the Taylor ranch near Novato. It is not utilized at present.

Bibl.: R. XI, p. 251; XIII, p. 512; U. S. G. S., Water Sup. Pap. 338, p. 255.

Rocky Point Hot Sulphur Springs are on the beach at Rocky Point, 8 miles southeast of Bolinas. They are not utilized except locally.

Bibl.: R. XI, p. 250; XIII, p. 512; U. S. G. S., Water Sup. Pap. 338, p. 80.

Sausalito Spring Water Company., Sausalito. This is plain water, not mineral.

Tamalpais Mineral Water Spring. Borello Bros., owner. This is a drilled well at First and Hayes streets, San Rafael, elevation 50 feet (U. S. G. S.). The well was sunk in 1903, and the water analyzed in December, 1904, followed immediately by bottling operations. It is 26 feet deep, not artesian, and has no contained gas. It is bottled, carbonated, and is also used in the manufacture of soda water and other flavored, soft drinks. Temperature 60° F. A 3 h.p. electric motor runs the pump and bottling machines.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 307.

NATURAL GAS.

An inflammable gas escapes from the reef at Duxbury Point, near Bolinas. It can be observed only at extreme low tide. It is stated that natural gas has also been found near Nicasio.

Bibl.: R. VII, p. 184; XIII, p. 567.

PETROLEUM.

(See under Asphaltum).

SALT.

Salt was first made from the bay water by evaporation at San Rafael in 1867. More recently the Golden Gate Salt Company reported an output for a time but there has been no plant in operation since 1909.

Bibl.: Bull. 24, p. 106.

STONE INDUSTRY.

Angel Island Quarry (see Fort McDowell).

Daniel Contracting Company (Bull Quarry, also McNear). Home office, 503 Market street, San Francisco. John H. Hopps, consulting

Photo No. 125B. Panoramic view of Daniel Contracting Company's quarry at San Pedro Point, six miles east of San Rafael, Marin County, California. Face 1200 feet wide.

engineer. This company is operating under lease one of the quarries on land owned by the McNear Company, Inc., at Point San Pedro, 6 miles east of San Rafael. It was known as the Bull quarry at one time, and for several years was operated by Wetmore Bros. The present operators have contracts aggregating approximately 1,000,000 tons of rubble—600,000 tons to the "Key Route" mole, Emeryville, and 400,000 tons to the San Francisco seawall. They have opened up a quarry face of 1200 feet in width (see photo No. 125B), and are shipping (June, 1914) an average of 2500 tons per day.

Photo No. 114. Daniel Contracting Company's loading pier and barges at San Pedro Point, Marin County, California.

In advance of the quarry face the thin skin of surface dirt was hydraulicked off. Machine drills are used and occasionally a short tunnel is driven into the face about 25 feet, branching right and left at the end. The tunnel is charged with 5 to 10 tons of dynamite, wired in duplicate, and exploded with a 220-volt current. The rock is mostly a hard, bluish, Franciscan metamorphic sandstone, though in part it is yellowish brown where oxidized. The formation is massive and more or less fractured. Pieces up to 3 or 4 feet across are shipped —as large as can be handled conveniently by the steam shovel. There is a small amount of clay on some of the fractures, and there is clay and shale at the north end of the sandstone. The material is loaded

by the steam shovels into side-tipping dump cars and run out onto the loading pier (see photos Nos. 114 and 115) in trains by small steam locomotives. There it is dumped onto a grizzly with 2½-inch openings. The coarse drops into a skip with bottom discharge in which it is transferred to the barges alongside by an overhead traveling electric crane of seven tons capacity. The fines are elevated by two belt conveyors (each driven by a 15-h.p. motor) to the waste bin from which they are hauled and dumped along the shore. The company has in service twelve "skip" barges (see foreground of photo No. 114),

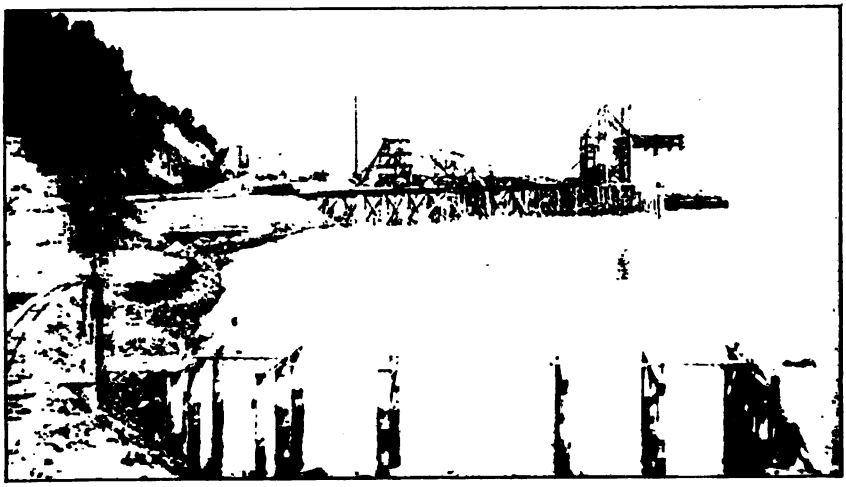


Photo No. 115. Daniel Contracting Company's pier and quarry at San Pedro Point, Marin County, California.

two deck barges (for large single stones), two bottom dump (note barge "B" in background of photo No. 114) and two side-dump barges. The first named hold 40 to 50 skips of four cubic yards capacity each—a barge capacity of 200 to 300 tons. The bottom dump barges carry 900 tons each, and the side dumps about 700 tons. These last two classes are used for subaqueous dumping, and the skips when the fill has reached above the level of the water or for fills ashore.

The equipment, which has a rated capacity to ship 4000 tons per two ten-hour shifts, besides that already noted, includes: three steam shovels (with two cubic yard buckets); eight "dinky" locomotives (six in service); air compressor, 150 h.p., electric driven. Crude oil fuel is used. Seventy-five to 90 men are employed. There is also a crushing and screening plant of 250 cubic yards per day (ten hours) capacity, which is operated only intermittently.

Bibl.: Bull. 38, p. 318.

Dodge & Croker (see Short Ranch).

Escalle Quarry. Jean Escalle, owner. This is a small quarry in a ravine at Escalle Station. The rock is a blue metamorphic sandstone, broken up by streaks of black slickensided serpentine. There is also a small broken vein of coal—a shaly lignite. There is considerable overburden of soil and oxidized rock. The county at one time had a portable crushing plant here getting out road material.

Forbes Quarry. Miss Kate Forbes, San Rafael, owner. This red chert quarry is in a hill at the north edge of town and has been utilized for street and concrete work. The material is much foliated and breaks up small without requiring a crushing plant. There is also some sandstone and shale interbedded. Idle in 1913.

Bibl.: R. XII, p. 389; XIII, p. 625; Bull. 38, p. 318.

Fort Baker Quarry. U. S. Government, owner. Palmer, McBride & Quayle of San Francisco have a contract to deliver to the Exposition grounds in San Francisco 75,000 cubic yards or more (but not to exceed 120,000 cubic yards) for road building. They are equipped to handle 1500 tons per day at the quarry, but the unloading facilities at the Exposition can as yet take care of only 500 tons. A steam shovel, oil burning, is used and two small locomotives with dump car trains. The barges carry 250 to 300 cubic yards and a locomotive crane with clamshell bucket unloads them. Twenty-three men were employed (November, 1913).

The rock is taken from the hill back of the guardhouse and the barracks. It is a much altered and fractured Franciscan metamorphic sandstone, dark greenish and brown in color and fine grained. Back of the hospital there is a small quarry in red chert, which is used occasionally for road repairs around the reservation.

Fort Barry (see Point Bonita quarry).

Fort McDowell Quarry (formerly called Angel Island quarry). U. S. Government, owner; under supervision of the constructing quartermaster, U. S. Army, Fort McDowell. As the earlier name implies, this quarry is on Angel Island. It is on a rocky point on the east side of the island and was first opened up about 1890 by the engineering corps. The old crushing plant, steam driven, had a capacity of 40 tons per day. This has been displaced in 1913 by a new plant using electric power and having a capacity of 40 tons per hour. The new bunkers, with a storage capacity of 800 tons, load direct to barges.

Electric power is brought to the island by submarine cable from Sausalito. The equipment includes a No. 5 Symons gyratory crusher, bucket elevator, and a trommel. Three sizes of product are made: screenings, ¾-inch and 1½-inch. The new plant cost $15,000, but it is estimated that it will save the government $60,000.

The rock is a blue-gray metamorphic sandstone in massive beds, with some partly oxidized material at the surface. Up to October, 1913, a total of 45,000 cubic yards of clean rock and 40,000 cubic yards of oxidized have been produced, the latter being used on roads and fills. It is estimated that there are 150,000 cubic yards yet available for quarrying, of which 70,000 cubic yards will be used for road work.

This quarry has furnished rock for concrete and other construction at several of the Bay posts, including Fort Mason, the Presidio and Alcatraz Island. With sand also obtained on the island this rock was employed in constructing the new buildings of the enlarged recruit depot of Fort McDowell, just above the quarry. These reenforced concrete structures represent an expenditure of $600,000 for materials alone, as the labor, except skilled civilian foremen, was furnished entirely by military prisoners. There is a barracks building and a mess hall with a normal capacity for 2000 men each. The upper floor of the mess hall is a drill hall. There is also a guardhouse, hospital, post exchange, administration building, and quarters for both commissioned and non-commissioned staff, all of concrete.

Gray Bros. (see San Francisco Quarries Company).

Hoffman Quarry. B. H. Hoffman, owner. This is a small quarry 3 miles north of San Rafael, on the Petaluma road, which is used occasionally for road work nearby. Idle in 1913.

Bibl.: Bull. 38, p. 319.

Hotaling Quarry. Hotaling Estate Company, owners, Merchants' Exchange Building, San Francisco. Steffini-Bartini Company at one time worked it under lease. It is at the south end of Clark street, San Rafael, and is operated intermittently on a royalty basis of $1 per load (about 2 cubic yards). The rock, which is a blue metamorphic sandstone, is used for curbings and rubble walls. The Presbyterian Church in San Rafael is built with rubble from this quarry. Production to date has been about 10,000 cubic yards. There is no plant.

Bibl.: R. XII, p. 389; XIII, p. 625; Bull. 38, p. 319.

Jordan Quarry (see San Francisco Quarries Company).

Marin Rock Company. S. Brizzolara, president, 119 Jackson street, San Francisco; C. A. Macomber, superintendent, San Anselmo. This quarry is on the west edge of San Anselmo, at an elevation of 100 feet (U. S. G. S.). Work began in 1909. The rock is a metamorphic sandstone, in parts serpentinized. There are also streaks of a soft black clay gouge, slickensided. The hardest and cleanest of the rock is used for rubble. A derrick raises the rock in skips to the crusher. A 30 h.p. motor runs the compressor, and a 7½ h.p. the hoist. There are

two other motors for the crushing and screening machinery, 10 and 5 h.p. A gasoline engine was formerly used. The coarser breaking is done with a jaw crusher, and the finer by a Gates "D" gyratory. The revolving screens make four sizes of product. The company also has a Springfield traction road roller for street work. Twelve or fifteen men are required when in full operation (50 tons per day capacity). The waste is used for fills about town.

McNear Quarries (see Daniel Contracting Company and San Francisco Quarries Company).

J. Martin Miller has 5 acres near Schuetzen Park Station, containing rock suitable for road work. Only small amounts have been used so far as there is no regular quarry opened up.

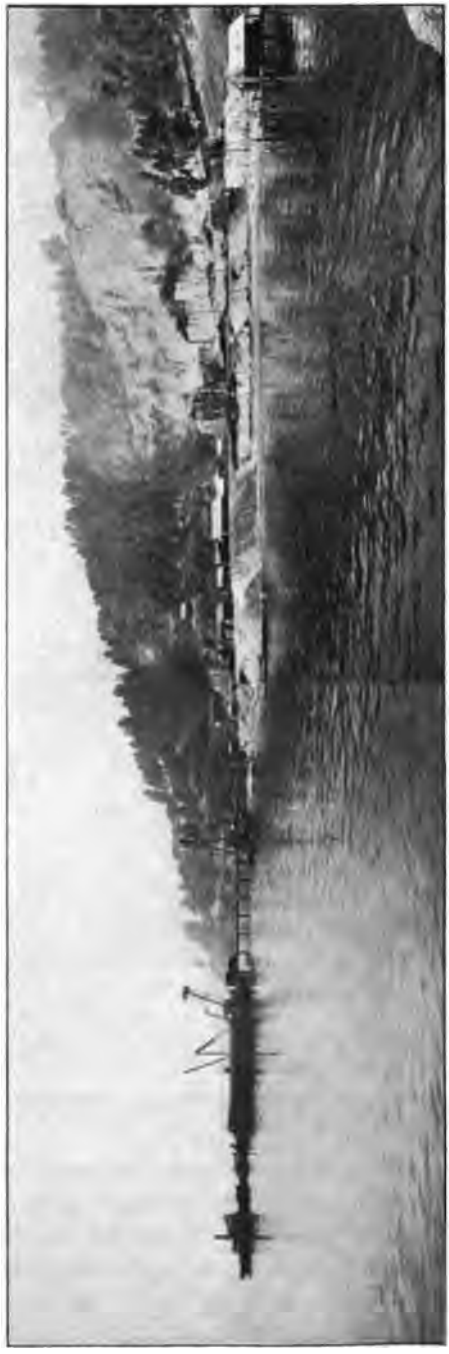
The Mount Tamalpais Cemetery Quarry is in the cemetery northeast of San Rafael. The rock is metamorphic sandstone and has been employed for curbings and other uses about the grounds. It is worked only intermittently.

Bibl.: R. XII, p. 389; Bull. 38, p. 319.

Northwestern Pacific Railroad Company. General offices, Phelan Building, San Francisco. In extending and regrading its ferry and train terminal at Sausalito this company is completing (May, 1914) a fill of 50,000 cubic yards. The rock has been taken from land owned by the Roys Estate at Roys, above Manor Station. It is mostly a blue metamorphic sandstone, with some oxidized material. The company also has quarries at Black Point, Tiburon Point, and at Waldo, used intermittently for ballast and fills. The material from these cuts is decomposed and much fractured.

Bibl.: Bull. 38, p. 319.

Point Bonita Quarry (Fort Barry). U. S. Government, owner, under Engineer Corps, No. 414 Custom House, San Francisco. This quarry is on the sea cliff within the Fort Barry reservation, just inside of the Golden Gate; elevation 50 to 100 feet (U. S. G. S.). The quarry was opened up in 1900 to provide rock for concrete work in the fortifications. Since the first large job it has been worked only occasionally. The plant of 80 tons daily capacity is equipped with a No. 5 Gates gyratory crusher, 60 h.p. steam boiler (coal fired), 40 h.p. upright engine for hoist, 25 h.p. Westinghouse "Junior" engine, wire screen (for two sizes), and bucket elevator. The rock is a metamorphic sandstone with occasional fine limestone streaks. At two or three other points on the reservation there are small cuts in red Franciscan chert, utilized for road material.



Panoramic photo. Quarry and pier of San Francisco Quarries Company at San Pedro Point, Marin County, California.

Raymond Land Company (see Short Ranch).

San Francisco Quarries Company (one time called Jordan Quarry, also San Francisco Bay Improvement Company). Anson Blake, president; L. A. Wittenmyer, secretary; S. H. Whitney, superintendent. Home office, Balboa Building, San Francisco. This is one of the three McNear quarries at San Pedro Point, 6 miles east of San Rafael.

Photo No. 120. Barge "San Pablo" (self-dumping) of San Francisco Quarries Company at pier, Marin County, California. Showing bin arrangement.

Beginning January, 1914, this company also has a lease on the third quarry which is between its present working face and the McNear Brick Company plant. This third quarry was at one time operated by Gray Bros. and later by the Western Development Syndicate, but has been idle for several years.

The San Francisco Company's main quarry was opened up originally in 1876 by Dennis Jordan, and this company has been operating it the past ten years. The quarry is credited with a total output to date of

about 3,000,000 cubic yards. "Sling" rock (large single pieces), rubble, and crushed rock are supplied. It is on the bay shore (see panoramic photo). The rock is hauled in skips on cars to the wharf and loaded onto the barges by a derrick.

The rock is a massive, hard, blue-gray metamorphic sandstone, and a fine face of up to 200 feet high (see photo No. 122) and about 500 feet wide is now exposed. There are occasional small lime and quartz seams. Steam operated machine drills are used. There are four derricks, with steam hoists, burning coal. The crushing plant, with a capacity of 700 tons per day, uses electric power. In addition, 300

Photo No. 121. Barge "San Pablo" of San Francisco Quarries Company, at pier. Side view.

tons of rubble per day can be handled, making a total daily capacity for the quarry of 1000 tons, with about 100 men employed. The output varies with the market demands. Crushed rock is delivered in San Francisco at $1.20 per cubic yard, or it is sold at the quarry pier at 90 cents to $1. These prices are for large tonnages.

The company has six barges with capacities of 400 to 600 tons each. The 600-ton barge (see photos No. 120 and No. 121) is self-discharging and carries a crew of five men. In the hold there is a dynamo run by a 50 h.p. gasoline engine. This furnishes power for the motor driving the conveyer belt under the pockets and the motor at the head of the bucket elevator. The bucket elevator can be raised and lowered and swung sideways on an arc so as to vary the point and height of dis-

charge as required. It is stated that this barge cost $40,000 to build and equip. From 4 to 5 hours are required to load 500 cubic yards into it by derrick, but at the San Pablo quarry (Contra Costa County) of the same company, the same amount is loaded by two conveyer belts in 1½ hours.

Bibl.: Bull. 38, p. 319.

Photo No. 122. Two hundred-foot high quarry face of San Francisco Quarries Company, Marin County, California.

The San Rafael Development Company has a quarry of red rock at the end of Mission street (Pine Hill), San Rafael, but it has not been operated recently.

Short Ranch Quarries. Dodge & Croker, San Anselmo, and the Raymond Land Company, 1048 Mills Building, San Francisco, each has a small quarry on land formerly a part of the Short ranch, 1 mile north from San Anselmo. They are both operated intermittently, and the product is used for curbs and rubble walls, being sold at $2 to $5

per load (about 2 cubic yards). The rock is a blue metamorphic sandstone.

Steffini-Bartini Company (see Hotaling).

Tiburon Point Quarry (see Northwestern Pacific Railroad Company).

Western Development Syndicate (see San Francisco Quarries Company).

Wetmore Bros. (see Daniel Contracting Company).

NAPA COUNTY.

Field Work in September, 1913.

Napa County, with a land area of 783 square miles, is about 50 miles north and south, by 26 miles in width. It runs nearly to a point at both extremities, its southern end touching San Francisco Bay. It is bounded on the east by Yolo and Solano counties and on the west by Lake and Sonoma counties. The main drainage system of the county is that of the Napa Valley; in addition to which, Putah Creek flows across the northeast corner, southeasterly to the Sacramento River. Mt. St. Helena is in the northwest corner, at the junction with Lake and Sonoma counties. The principal mineral resources include quicksilver, cement, mineral water, stone industry and magnesite; with infusorial earth, limestone, copper, iron, chromite, gold, silver, and mineral paint also occurring, but of minor importance (at least in their present lack of development).

The available published records show for Napa County, to the end of 1913, a total value of quicksilver produced of practically $15,000,000, and of mineral water nearly $2,000,000. That these values are below the actual output is known, as there are no segregated figures for mineral water previous to 1894; and also as the product of some of the quicksilver mines was included in the earlier reports of the state's production, under "various mines." In fact, the Knoxville mines alone are said to have produced $17,000,000 in quicksilver, while Oat Hill is credited with another $5,000,000, to say nothing of the Aetna and others. There being but the one cement plant in the county, the value of the cement output is included under "unapportioned," it being the policy of the Bureau not to make private business public. Magnesite production in Napa County began at the Chiles Valley mines in 1891; but the figures for 1892 and 1893 were not segregated, being combined with those of Alameda County. The value of the materials included under "stone industry" is showing a healthy, steady advance. Mineral water shows considerable fluctuation, but continues an important factor.

CEMENT.

Standard Portland Cement Corporation. The manufacture of cement in Napa County began with the operation of this company's plant on March 17, 1903, since when it has been a continuous, steady producer. The capacity has been doubled from its initial figure, being now 2500 barrels of cement daily. Geo. F. Cameron is president, L. F. Young, secretary, with A. G. Lang superintendent at the plant; home office, Crocker Building, San Francisco. The plant is in Sec. 19, T. 4 N., R. 3 W., ½ mile from Napa Junction station of the Southern

acific Railroad, with which it is connected by spur tracks direct to the mill. Tidewater is only 1½ miles distant, but not utilized as yet. The same company also has a 12,000-barrel per day plant at Davenport in Santa Cruz County.

For the benefit of those who may not be familiar with the process of making "Portland" cement, a short description is here given:

*"By a Portland cement is meant the product obtained from the heating or calcining up to incipient fusion of intimate mixtures, either natural or artificial, of argillaceous with calcareous substances, the calcined product to contain at least 1.7 times as much of lime, by weight, as of the materials which give the lime its hydraulic properties, and to

Photo No. 44. Clay pit of the Standard Portland Cement Company, Napa Junction, Napa County.

be finely pulverized after said calcination, and thereafter additions or substitutions for the purpose only of regulating certain properties of technical importance to be allowable to not exceeding 2 per cent of the calcined product."

This definition lacks the requirement of pulverizing or artificial mixing of the materials prior to burning; and thus permits the inclusion of some "natural Portlands" under the specifications.

The ideal Portland cement would consist essentially of lime and silica in the proportions of 73.6 per cent and 26.4 per cent respectively (tricalcic silicate, $3CaO, SiO_2$), but as such a material can not be clinkered, except in the oxyhydrogen blowpipe or the electric furnace, it is

*Professional Paper No. 28, Corps of Engineers, U. S. A., p. 30.

impossible to produce it commercially at the present time. For this reason it is necessary in actual practice to have other ingredients present to act as a flux and thus lower the temperature of fusion, permitting the combination of the lime and the silica. Alumina (Al_2O_3) and iron oxide (Fe_2O_3) fill this role. The raw mixture, before burning, is made up approximately as follows: 75 per cent lime carbonate ($CaCO_3$); 20 per cent silica, alumina and iron oxide together; 5 per cent impurities, including magnesia, sulphur and alkalies, some of

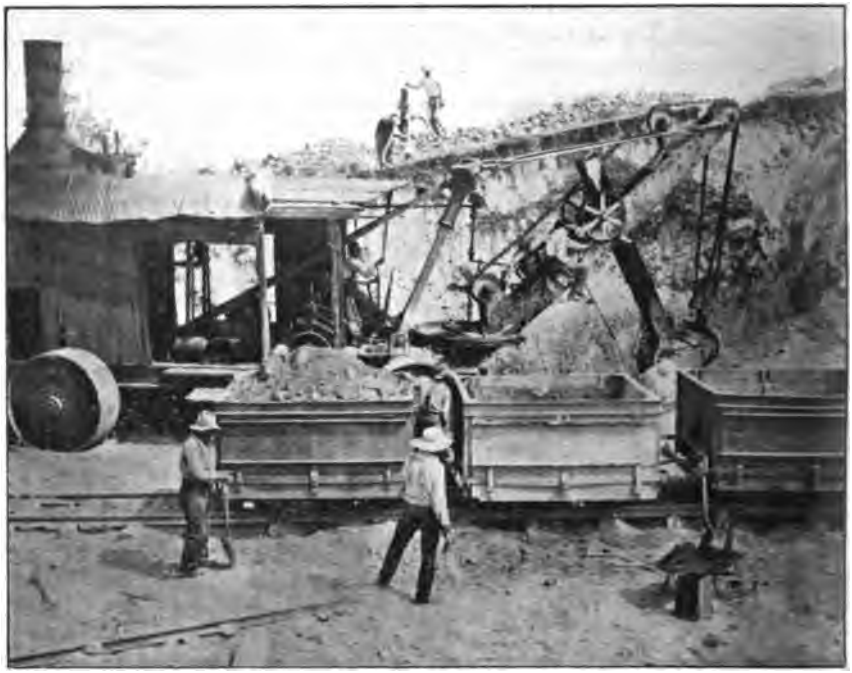


Photo No. 46. Steam shovel in limestone quarry of Standard Portland Cement Company, Napa Junction, Napa County.

which are always present. These materials, after being dried, are ground fine, the grinding accomplishing also the additional purpose of thoroughly mixing the constituents. Then they are heated to the point of incipient fusion (2500°–3500° F. in the hottest zone), thus forming "clinker"—a bluish black in color, and more or less porous in appearance. The clinker, in turn, is finely ground (up to 2 per cent of gypsum being added to retard setting), so that 90 per cent to 95 per cent will pass 100-mesh screen, and 75 per cent to 85 per cent through 200-mesh. This almost impalpable powder is the Portland cement of commerce, named "Portland" originally, not from the locality where it was made, but from its resemblance after setting to the oolitic limestone found at Portland, England.

Eckel ("Cements, Limes and Plasters," 1905, p. 494) says that normally a 60-foot kiln, working on a dry mixture will produce from 140 to 180 barrels of cement per day of twenty-four hours. Of coal as kiln fuel, 120 to 140 pounds are required per barrel of cement. One gallon of crude oil is equivalent to 10 pounds of coal, or 11 to 14 gallons of oil are required per barrel of cement. The capacity of a given kiln is lower with oil than with coal. Oil is used principally in California and Colorado. Of natural gas, 20,000 cubic feet are required as the equiva-

Photo No. 47. Rotary driers in mill of Standard Portland Cement Company, Napa Junction, Napa County.

lent of one ton of coal. Gas is used principally in Kansas and Ohio. For kiln linings, bricks of the following materials are used: Cement clinker, alumina, magnesia (calcined magnesite) and bauxite. The power and machinery required for grinding the clinker are about the same as for the raw materials; for, though the tonnage to be handled is only about two thirds, the material is much harder.

At the plant of the Pacific Portland Cement Corporation limestone and clay are obtained from pits close by the mill, though at present, owing to a decrease in the lime content, a portion of high grade lime rock from near Santa Cruz is added, to "sweeten" the charge, before passing through the drier. In the quarry the clay is loaded by hand, and the limestone by a Marion steam-shovel (1½ cubic yards dipper), oil-fired (photos Nos. 44 and 46). The cars are drawn to the foot of the mill incline by cables and by a small steam locomotive. After pass-

ing through the gyratory crushers (one No. 9, three No. 5, Allis-Chalmers), the material goes to bins from which the rotary driers are fed. There are two rotary driers, oil-fired, 6′ x 40′, set on a grade of ¾ inch per foot, and running at 3½ r.p.m. (photo No. 47). A steel "drag conveyer" takes the dried product to the ball mill bins. The excess over the ball mill feed, on day shift, goes to storage bins for the night shift feed, as the quarries are not worked at night. There are thirteen ball mills, running 24 r.p.m., divided between the raw crushing and the clinker ends of the process. After the ball mills, the

Photo No. 49. Rotary kilns in mill of Standard Portland Cement Company, Napa Junction, Napa County.

mixture is further ground in tube mills (seventeen in entire plant, each 5′ x 22′, running 24 r.p.m.) and then passes to the rotary kilns, where it is clinkered.

Samples are taken of the raw material after the drier, and again at the end of the ball mills. The finished product is sampled after the tube mills. This plant has two rotary kilns (photo No. 49), 7′ 6″ diameter x 125′ long, and ten, 6′ diameter x 60′ long. The larger ones are run at ½ r.p.m. and the others at 1 revolution per 1¼ minutes. All are set at a grade of ¾ inch per foot. The capacity of the two large kilns is about 1000 barrels per day, while that of the ten small ones is about 1500 to 1600 barrels. They all use crude oil for fuel. As the clinker falls from the kiln it is sprayed with water, partly to

cool it but principally to break it up, and then elevated to the cooling tower (seen in the right edge of the photograph). The cooling towers have baffle plates to check the fall, and have air circulation. The desirable average size of the clinker is about that of a hickory nut. The higher the percentage of lime, the smaller is the clinker; while with a lower lime content, the mixture has a tendency to fuse more and form larger masses. The lime content is kept at about 74.5 per cent $CaCO_3$ before entering the kilns, the balance being clay. Gypsum is added to the clinker as it goes to the ball mills, and is represented by 1.75 per cent SO_3 in the finished product. As the California

Photo No. 51. Final tube mills in mill of Standard Portland Cement Company, Napa Junction, Napa County.

plants all burn oil, it is not necessary to take into account the addition of fuel ash, as in the eastern plants using powdered coal. It is advisable to carry alumina as low as possible, to give the cement a slower set and greater ultimate strength.

As there are times during inclement weather when the quarries can not be worked, the raw end of the plant has a capacity somewhat in excess of the finishing, and the surplus clinker is stored. Belt conveyers are used both to and from this storage pile. The next step is grinding the clinker, a repetition of that preceding the burning—first in ball mills and finishing in tube mills (photo No. 51). From the discharge end of the tube mill, the finely ground powder is drawn by a suction blower through a tube to the storage bins. The storage bins

have a capacity of 125,000 barrels of cement. Here it is sacked (95 pounds each) using a mechanical filling device and loaded directly into the freight cars. Electric power is used throughout the mill, and belt and other mechanical conveyers wherever possible. About 3500 h.p. is consumed, there being two 800 h.p. motors besides a large number of smaller ones. The tubemills are all of the trunnion type. The company has 200 men at work, with a monthly payroll of $16,000 to $18,000. The mill is operated continuously throughout the twenty-four hours. Twenty-five thousand gallons of water are used per day.

As the geology of the deposit is described in Bulletin 38 (pages 180–182), it will only be summarized here. The limestone occurs in beds, 1 to 4 feet thick, which dip to the north at 40°. It is fossiliferous and

Photo No. 54. Standard Portland Cement Company, general view of plant from southeast.

party crystalline, and is overlaid by a yellow, calcareous clay. "The clay at the east end of the quarry is very calcareous, but at the extreme west end it is more argillaceous. Overlaying all is a dark brown adobe." About ½ mile south of the main pit, the company is opening a new quarry in a low, rounded hill, exposing beds of crystalline limestone mixed with some clay. Photo No. 54 is a general view of the plant from the southeast. It shows the clinker storage pile on the right, and part of the clay pit in the foreground.

Bibl.: Bull. 38, pp. 178-182; U. S. G. S., Bull. 243, p. 121; Bull. 522, p. 121; Min. Res. 1912, Pt. II, p. 518; CEMENTS, LIMES AND PLASTERS, E. C. Eckel, 1905.

CHROMITE.

There are undeveloped deposits of chromite, east of Napa, in Pope and Chiles valleys and near St. Helena.

Bibl.: R. IV, p. 136; V, p. 102; VI, Pt. I, p. 100; XIII, p. 49; Bull. 38, p. 363.

COAL.

It is reported that coal was struck at a depth of 30 feet, in digging a well on the ranch of H. P. Wallace, in Pope Valley.

COPPER.

There are a number of copper prospects in Napa County, but nothing of consequence has as yet been developed. The following locations may be named:

Napa Copper Company, 5 miles north of Calistoga, on Mount St. Helena, in Sec. 17, T. 10 N., R. 5 W.; T. A. Taylor, secretary, St. Helena.

Search group, 4 miles west of Yountville, in Sec. 5, T. 6 N., R. 5 W. E. F. Rossan, Glen Ellen, owner.

There are specimens of copper ore in the Mining Bureau museum from near Monticello by Koethen and More.

Juniper group, Manhattan (Knoxville), by F. K. McAllister; and

White Rock group, Manhattan, by Thos. A. Finnell.

Bibl.: Bull. 50, p. 165.

GOLD AND SILVER.

Brown and Smith Consolidated (*Mountain View,* also *Red Cloud*). This claim was located about twenty years ago, in Kings Canyon, near the Palisade mine, 3 miles north of Calistoga. They found nothing of value.

Bibl.: R. XIII, p. 234.

Calistoga Mine (see *Silverado*).

P. Flynn claims to have found a vein carrying gold values, on his ranch on the Oat Hill road north of Calistoga, in Sec. 30, T. 9 N., R. 6 W.

Griffith Prospect, on Alta Peak, 17 miles northeast of Napa. Some development work was done in 1895, but no values found.

Bibl.: R. XIII, p. 234.

Grigsby Mine (see *Palisade*).

Manuel Prospect. This prospect is located on patented (Mexican grant) land, 1 mile east of Calistoga, elevation 650 feet (bar.), and owned by Mrs. A. F. Mason. There is a quartz vein, showing about 300 feet of outcrop, striking northerly across a small ridge, and dipping east at about 50°. A crosscut adit has been run in about 200 feet, at a depth of 100 feet below the outcrop, and shows a quartz stringer in

the face said to carry values in gold; but the main vein has not yet been cut. A lease has recently been given, under which development work will be done.

Palisade Mine. This silver mine (locally called *"Grigsby"*) is in Sec. 24, T. 9 N., R. 7 W., 3½ miles northeast of Calistoga, elevation 625 feet (bar.). It was opened up in 1876 and the mill ran from 1888 to the spring of 1893. The two principal claims, Old Discovery and Ida Easley, are patented. R. F. Grigsby is the owner and still lives on the property, having a small ranch there also. The vein mineral is quartz carrying antimonial silver sulphide. A depth of 250 feet has been reached on the vein, and opened up by drifts for 1400 feet. It is situated on a north-south spur off the ridge which runs southeasterly from Mount St. Helena. The mill is equipped with 10 stamps (dry crushing), a 7-ton pulverizer, White revolving roaster, and amalgamation pans (four) and settlers (two) (Washoe process.) It is stated that 90 per cent extraction was obtained. In the four years during which the mill was operated, Grigsby states that he shipped 7,000 to 10,000 ounces of bullion per month. The average assay value of the ore was $24.50 per ton ($1 of which was in gold). The last ore treated assayed $35, but with silver down to 60 cents per ounce, it was not profitable. The water system (including water rights) was installed at a cost of $10,000. There are two pipe lines, each 3 miles in length, supplied by springs. This is at present in part utilized for running a small dynamo for lighting the buildings about the place.

Bibl.: R. V, p. 93; VI, Pt. I, p. 77; VIII, pp. 413–415; X, p. 363; XII, p. 376; XIII, p. 606; U. S. G. S. Mon. XIII, p. 370.

Silverado Mine (*Calistoga*). This mine, which is on the southeastern slope of Mount St. Helena at an elevation of about 2400 feet, in Sec. 2, T. 9 N., R. 7 W., 5 miles north from Calistoga, is owned by Harry Patten, Calistoga, R. F. D. The mine was opened up in 1872, and the 10-stamp mill operated four months in the latter part of 1874, being credited with a production of $93,000 from 2300 tons of ore. The vein which strikes about north with dip 73° W., is from 6 to 12 feet wide and carries silver sulphide with some values in gold. The ore at present exposed in the mine is stated to average $14 to $15 per ton in silver. In 1902, there were 34 tons of sorted ore shipped to the Selby smelter; and the same year, 1000 tons of ore from one of the old dumps were shipped to the smelter of the Copper King Smelting Company, on Suisun Bay, for use as flux, on account of its quartz. This ore assayed $1.10 per ton

in gold and $2.65 in silver. The owner reports a lease under consideration.

Bibl.: R. VI, Pt. I, p. 77; X, p. 363; XII, p. 376; XIII, p. 606; MIN. RES. W. OF ROCKY MTS., 1874, pp. 63-65; 1875, p. 178; U. S. G. S. Mon. XIII, p. 370.

It is stated that on the east side of Conn Creek, placer gold "prospects" have been found, consisting of flour gold, and pear seed sized nuggets; but no ledge has ever been located there.

INFUSORIAL EARTH.

There is a deposit of infusorial earth on the ranch of Mrs. Kettlewell in Friends Valley west of Calistoga. It is not utilized. Also, there is a specimen of this mineral in the Mining Bureau museum, by R. E. Wood, from a small, undeveloped deposit 4 miles southeast of St. Helena.

IRON.

There are undeveloped deposits of iron ores at the head of Sulphur Creek, and in Conn Valley, also west of St. Helena. There is a specimen of hematite in the Mining Bureau museum from the "Stirling Iron Mine," by Dr. J. W. Hood of St. Helena.

Bibl.: R. II, p. 200; IV, pp. 229, 242, 258; XII, p. 327; XIII, p. 504; Bull. 38, p. 365.

LIME AND LIMESTONE.

In Pope Valley there were at one time two kilns in operation, but they have been idle for several years.

Bibl.: R. XIII, p. 629.

MAGNESITE.

The first commercial production of magnesite in California was from the deposits near Livermore, in 1886 (see U. S. G. S. Min. Res. 1886, p. 696), followed by shipments in 1891 from the Snowflake mine in Napa County. As will be noted by reference to the Table of Mineral Production, the industry in this county was active for about ten years, and then dropped off very abruptly. With the exception of a small tonnage from the Pope Valley deposit in 1912, these properties have been idle for the past ten years. The main drawback to the development and exploitation of these deposits is the lack of transportation. They are variously situated from 10 to 16 miles from Rutherford, their railroad shipping point.

The industrial uses for magnesite are many and varied, and the demand will no doubt increase materially in the next few years, particularly after the Panama Canal gives the California product a cheaper entry into the eastern markets. For most purposes magnesite is cal-

cined before using. The largest tonnage at the present time is used in the manufacture of bricks for the lining of basic Bessemer converters both in steel and copper smelters. It is also employed in copper reverberatories and other special metallurgical furnaces such as for handling bullion; silver slimes; electric smelting; heating, welding and melting furnaces; calcium carbide kilns; and in the burning zone of rotary kilns in Portland cement plants. Wide variations of temperature, exposure, while hot, to currents of cold air or to contact with water or oil, will cause magnesia bricks to shatter and spall; so that the best results are obtained in furnaces where continuous heats are used. Not as high a purity of material is necessary in furnace liners, particularly for steel, as in some other uses; for in the case of basic open hearth steel furnaces, while the magnesite must be free (or at least very low) from silica, it can carry a noticeable percentage of iron oxide or serpentine without impairing its efficiency. In fact, by some it is considered an advantage, as such impurities permit the sintering of brick at a lower temperature than is possible with pure magnesite. "Dead-burned" magnesite—that from which *all* the CO_2 has been driven off—is hard to handle, having little or no plasticity. Its plasticity is said to be improved by adding partly calcined or caustic magnesite; also, heavy pressure will bind it sufficiently to allow the material to be sintered. As magnesia can be melted in an electric furnace, it would seem that it ought to be profitable to sinter such products in an electric furnace where electric power is as cheap as in California.

Another extensive and expanding field for the employment of magnesite is in the manufacture of artificial stone, flooring, tiles, wainscoting, etc. These products are put on the market under various trade names, among which may be mentioned: idealite, marbleoid, karbolith, monolith, American art marble, chemolith, artolith, asbestone, etc. The magnesite floors being put in steel railroad coaches for the Pennsylvania Railroad Company in the east, and the Southern Pacific Company in California, are by the Monolith Company of Milwaukee, Wis.; and those for the Pullman Company are by the Carbolith Company of Boston, Mass. The reaction made use of is that a moistened mixture of MgO and $MgCl_2$ will form a strong cement (known as oxchloride or Sorel cement); but there should be an absence of lime, as calcium chloride is hygroscopic and on hydrating swells, destroying the usefulness of the material. "In using the cement for flooring, wainscoting, etc., it is mixed with sawdust or sand and coloring matter to give it the desired tint. It may be laid in a continuous sheet over considerable areas and is said to crack much less easily than Portland cement. The use of sawdust makes the material very much lighter in weight than cement, less hard, and more resilient" (U. S. G. S. Bull. 355, p. 13). Soluble silicates of the nature of water glass are also used. A similar magnesia

cement is used as a paint, but, of course, applied thinner. Such a "magnesite paint" was used as a finishing coat on the concrete building of the First National Bank at Healdsburg (see photo No. 153). "Porcelith" and "liquid stone" are two brands prepared by San Francisco firms from California magnesite. The former has been used on a number of buildings in San Francisco, notably the Hotel Shasta at Kearny and Bush streets. It is applied with a brush. The manufacturers state that "in using porcelith on brick or concrete walls, a gallon will cover about 70 square feet (two coats), and for cement plaster or smooth surfaced concrete walls from 110 to 120 square feet to the gallon

Photo No. 153. First National Bank Building, Healdsburg, California. A concrete building finished with a magnesite paint.

according to the porosity of the walls." For use on wood it may be mixed thinner and sprayed on. For wood, it acts as a fire retardant.

In paper manufacture, in the "sulphite" process, a milk of lime and magnesia (calcined magnesite) is used as a carrier for SO_2, the gas being held in the mixture under pressure and thus introduced into the digester. The sulphurous gas digests the wood, leaving the fiber which is washed and used in making newspaper stock, wrapping paper, and the poorer grades of other printing and writing papers. The uses of the carbonic acid gas derived from calcinging magnesite are well known: carbonating beverages, refrigeration, etc. For these purposes it is liquefied by compression, to facilitate its transportation. CO_2 from magnesite is also used in borax refining. At the present time, however, as lime rock is obtained more cheaply, no magnesite is being used on the Pacific Coast for the manufacture of carbonic acid gas. Magnesite is used, mixed with asbestos, in boiler and steam pipe coverings. For these purposes the dolomitic varieties (containing lime) are serviceable,

as they are lighter in weight. When magnesite is burned at a light red heat, the resulting magnesia has a low specific gravity (3.0), possesses sufficient plasticity to be molded into shapes, and will gradually absorb water and CO_2 from the air, similar to quicklime. If, however, the calcination is at a higher temperature, the resulting magnesia is heavier (sp. gr. 3.6 to 3.8), has no plasticity and will not recarbonate on exposure. In making magnesia bricks, a mixture of the two forms is employed—the light magnesia making up 16 per cent to 25 per cent.

Bibl.: R. VI, Pt. I, p. 119; XII, p. 328; XIII, p. 505; Bull. 38, pp. 327–334; U. S. G. S. Bull. 355; Min. Res. 1886, p. 696; 1891, p. 584; 1903, p. 1134; 1904, p. 1172; 1912, Pt. II, pp. 1072–1077; CEMENTS, LIMES AND PLASTERS, E. C. Eckel, 1905, pp. 149–167.

Berthenia Mine, in Soda Canyon, 12 miles east of Rutherford, S. H. Delmater, Chiles, owner; and adjoins the Matthai group. It has been idle for several years.

Bibl.: R. XII, p. 328; XIII, p. 505.

Blanco (see *Snowflake*).

Cleveland (see *Matthai*).

Matthai Mines. This group is owned by Frank Matthai, St. Helena, R. F. D., and located in Sec. 36, T. 8 N., R. 4 W., the "North Mine" (formerly Cleveland) being in Soda Creek Canyon just above the road, and the "South Mine," ¼ mile to the southeast and on the north bank of Greasy Camp Creek. At the former magnesite outcrops in irregular masses in the serpentine, but at the latter there is a 5-foot vein of good quality. Several years ago, a fair tonnage was shipped from surface cuts here; but nothing has been done of recent years.

Bibl.: Bull. 38, p. 328; U. S. G. S. Bull. 355, p. 31.

Pope Valley Deposit (*Walters,* also *White Rock*). There are two claims White Rock and Fairweather in this group, owned by J. B. Duvall et al., Pope Valley post office, in Sec. 2, T. 9 N., R. 5 W., 14 miles northeast from St. Helena, and 16 miles from Rutherford, its shipping point. The older of these two claims—"White Rock"—was located in the '70s, but no mineral was shipped from it till about 1894. A total of about 2000 tons is reported to have been shipped during a period of five years, since which no production has been made except a small tonnage in 1912. The deposit is about 400 feet above the level of Pope Creek, on an open hillside, bare except for scattered chamiso brush, and the bold white outcrop and quarry face can be seen from the valley below for several miles around. There are three main groups of veins—two on the east side and one on the west side of a small

ravine—the entire grouping totaling a width of over 300 feet on the surface. The country rock is a "serpentinized lherzolite" (U. S. G. S. Bull. 355, p. 28). The western vein of the main east group shows up to 10 feet wide, of which 5 feet on the footwall is solid white magnesite, the upper 5 feet containing inclusions of serpentine. The veins strike northwest and dip to the east. The deposit is prospected by 400 feet of tunnels and a shaft of 90 feet, besides several surface cuts. Most of the magnesite is high grade and pure white, but in the large cut there is considerable cream-colored material. The geology of the deposit is described in detail in the references noted.

Bibl.: Bull. 38, p. 330; U. S. G. S. Bull. 355, p. 28.

Priest Mine. On the Priest ranch in Chiles Valley, in Sec. 23, T. 8 N., R. 4 W., 13 miles north of east from Rutherford, there is a deposit of magnesite, on which some development work was done, but it has been idle since about 1900. Mrs. D. C. Priest, St. Helena, is the owner.

Bibl.; Bull. 38, p. 328; U. S. G. S. Bull, 355, p. 31.

Russell Deposit. In Sec. 24, T. 8 N., R. 4 W., in Chiles Valley, 15 miles from Rutherford, there are several small veins outcropping, and a small tonnage was shipped at one time, but nothing has been done of recent years. T. B. Eddington, Napa, agent.

Bibl.: Bull. 38, p. 329; U. S. G. S. Bull. 355, p. 31.

Snowflake and Blanco Mines. These mines are in Sec. 29, T. 8 N., R. 4 W., 11 miles south of east from Rutherford, and about 2 miles south of the old Chiles mill in Chiles Valley. The present owners are San Francisco parties; T. B. Eddington, Napa, agent. Operated by Stanley and Bartlett, these mines, as already noted, began shipments in 1891, and produced over 1000 tons of magnesite per year for a period of nine or ten years. The ore was calcined before shipment, in wood-burning kilns. The country rock is a dark green to black serpentine, and the veins are from 1 to 6 feet in thickness. Some of the veins are considerably mixed with serpentine, and there is extensive silicification along the footwalls of some. In the brecciated portions there is crystalline magnesite, pale green to yellowish green in color. Analyses of magnesite from this property are given in U. S. G. S. Bull. 355 (loc. cit.). No work has been done of recent years.

Bibl.: R. XII, p. 328; XIII, p. 505; Bull. 38, p. 329; U. S. G. S. Bull. 355, pp. 29–31; MIN. RES. 1891, p. 584.

Walters (see *Pope Valley*).

White Rock (see *Pope Valley*).

MANGANESE.

There are specimens of manganese ore in the Mining Bureau museum from near St. Helena by J. Graham and by F. W. Keeney; also from Moore Creek by R. A. Coleman; but the deposits are undeveloped. The former, which is in Sec. 19 or 20, T. 7 N., R. 5 W., 3 miles west of Oakville, has recently been located by Thos. P. Bacon, 1446 Fernside boulevard, Alameda, and F. W. Keeney.

MINERAL PAINT.

The *Carl Browne* paint mine is on Benali mountain, 2 miles south of Calistoga, but has been abandoned for several years.

William Hansen reports that he has mineral paint near the Carl Browne deposit.

The property formerly known as the *Paint M. and M. Company,* or the California Paint M. and M. Company, 1½ miles east of Calistoga, is now owned by Mrs. Ellen M. Knoles. No work has been done on it for several years.

Bibl.: Bull. 38, p. 339.

MINERAL WATER.

As regards mineral springs, Napa County has many of the characteristics noted under this heading in the description of Lake County (*q. v.*). Napa, however, is more advantageously situated in the matter of transportation facilities. The Napa Valley runs northwesterly and southeasterly along the entire western side of the county, and has two lines of railroad (the Southern Pacific, and the Napa Valley Electric) connecting with tidewater at Vallejo and terminating at Calistoga in the north. Chiles, Pope and Berryessa valleys are in the eastern half of the county, and are connected with the western part by well kept county roads.

Ætna Springs. The Ætna Springs, owned by the Len D. Owens Company, are in Sec. 1, T. 9 N., R. 6 W., on a branch of Pope Creek, 16 miles north of St. Helena. Elevation 1000 feet (barometric reading). Lidell post office is at the springs. This property, now covering 1000 acres, includes the old Valley quicksilver mine, which was a producer of that metal in the later '60s and early '70s. It is maintained as a family pleasure resort, and is now kept open throughout the year. It is attractively situated and well kept, many improvements having been made of recent years. There are 5½ acres of lawn about the main

buildings. There are accommodations for 130 guests. Water from the "Ætna" spring is bottled for sale. The following are the temperatures of the principal springs: "American Ems," 93° Fahrenheit (so-called from its similarity to the famous Ems of Germany); "Iron," 77°; Ætna, 68° (also called "Potassium"); "Soda," 94°; one other, 4 feet from "Iron," 86°. There are sulphur incrustations around the iron spring.

Bibl.: R. II, p. 10; IV, p. 330; VI, Pt. I, p. 68; VIII, p. 416; XI, p. 72; XII, p. 341; XIII, pp. 514, 597; U. S. G. S. Mon. XIII, pp. 371, 402; Bull. 32, pp. 203, 210; Water Sup. Pap. 338, pp. 156–159; GEOL. SURV. OF CAL., Geol. Vol. I, p. 91; MIN. RES. W. OF ROCKY MTS., 1873, p. 11; W. ANDERSON, "Mineral Springs and Health Resorts of California," pp. 69–72.

Calistoga Hot Springs. These springs, among the earliest known in California, are on the eastern edge of town, hardly five minutes walk from the railroad stations. This property, covering 108 acres, was owned for many years by the Leland Stanford Estate and rented for resort purposes; but in August, 1913, it was sold to H. S. White, 650 Brannan street, San Francisco. The new owner is planning to build a 100-room hotel, pipe the hot water to it from the springs, and otherwise improve the property. The design is so planned that other wings may be added as future demands may require. Because of the refusal to give a long-time lease, the place has remained without adequate improvements heretofore. Being situated on two railroad lines, and within about three hours ride of San Francisco, these springs have the making of an excellent resort.

The elevation is 365 feet (Southern Pacific Company). There is a flat, semimarsh area of 200 acres or more on the eastern side of Napa Creek, in which the hot sulphur springs occur. It is necessary to dig down only a foot or two anywhere in this area to get hot water. The mud is said to yield native quicksilver, on panning. The following temperatures were observed: 135° F. (well with hand pump); 171° (curbed with a barrel); 82°; 160° (much H_2S); 124°; 111°; 153°; 158° and 156°. The odor of sulphuretted hydrogen gas is more or less noticeable at all of them. It is stated that bathing in these hot waters has proven efficacious in the treatment of rheumatism and similar complaints. No water is bottled from these springs.

Bibl.: R. I, p. 8; VI, Pt. I, p. 67; VIII, p. 416; X, pp. 349, 355; XII, p. 341; XIII, p. 514; U. S. G. S. Bull. 32, pp. 204, 210; Mon. XIII, p. 403; Water Sup. Pap. 338, p. 108; GEOL. SURV. OF CAL., Geol. Vol. I, p. 87; W. ANDERSON (op. cit.) pp. 114–116.

Congress Spring. Jessie W. Hamilton, owner; 3½ miles southwest of Napa.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 156.

Guillaume's (see *Pope*).

Hotel Calistoga. The Hotel Calistoga is on Lincoln avenue in the center of town of Calistoga; Owen Kenny, owner; B. F. Hughes, manager. There is a bored well from which hot water is pumped to a large concrete swimming pool and to a tank for bath service in the hotel. Water was struck at 2 feet depth, and tapping the same subsurface hot sulphur water as characterizes the Calistoga Hot Springs. When the pump is not running the well overflows a small stream. The temperature is 112° F. at the pump discharge.

Bibl.: W. ANDERSON (op. cit.), pp. 114–116; U. S. G. S., Water Sup. Pap. 338, p. 108.

Indian Spring (see *Pope*).

Jackson's (see *Napa Soda*).

Lathrop Hot Sulphur and Mud Spring, 1 mile south of Calistoga. This is similar to the Calistoga hot springs. There is a small bath establishment here, used locally.

Myrtledale Farm. This resort, 2 miles northwest of Calistoga is in a flat semimarsh area of 50 acres or so, similar in character to that in which the Calistoga hot springs are located, but is nearly 200 feet higher above sea level (550 feet bar.). The owner is R. R. Leveira. There is a bored well on the place which flows a small stream when the pump is not running; temperature 99° F. at pump discharge. At 300 to 500 feet from this well, are several mud springs which have the following temperatures: 128°, 134°, 112° F. There are accommodations for thirty in tents.

Napa Rock (see *Priest's Soda*).

Napa Soda Springs. Familiarly designated for many years "Jackson's Napa Soda," this is one of the oldest and best known springs of California, both as a resort and from its bottled water. This water has been on the market since 1860, the plant at the present time having a capacity of 1000 dozen splits per day. Contrary to the usual practice, "splits" (3 per quart) are used here instead of "quart" bottles (5 per gallon). The bottles have "Napa Soda," etc., blown in them, so that it is not necessary to use any labels. The spring has an air-tight cap fitted over it to retain the gas, which is again mixed with the water

by agitation during pumping to the automatic bottle filling machine. Electric power is used; and an ice machine is included in the installation. Ten men are employed, including drivers of two 6-horse teams, which haul the product to Napa, 8 miles south. The bottling works are operated throughout the year.

The springs are in Sec. 2, T. 6 N., R. 4 W., at an elevation of 900 feet (U. S. G. S.) and are owned by Chas. H. Jackson, with Fiege and Hennings, lessees. Napa Soda Springs is the post office. It is said

Photo No. 39. At Napa Soda Springs, looking down lower drive.

that this series of chalybeate springs situated along the hillside overlooking the Napa Valley, was originally used by the Nah-pah Indians; and that the Spaniards called them "Soda de Nah-pah," which, previous to 1850, was shortened to the present form—Napa. Several of the buildings are of stone (see photos Nos. 39 and 41)—a volcanic tuff from a quarry on the property. The grounds are well laid out, with flowers, ferns, palms, trees, etc., and threaded by numerous, broad-cut trails. There is a swimming pool which, being above the level of the buildings, serves as an emergency reservoir in case of fire. There are accommodations for 230. The springs showed the following temperatures; "Lemon," 66° F. (flow, 1 gallon in 5 minutes); old bottling house spring, 67° (flow 1 gallon in 2 minutes); "Napa Soda," 67° (flow, 1 gallon per minute); "Pagoda," 66°. The last two have considerable excess gas (CO_2).

Bibl.: R. VI, Pt. I, p. 69; VIII, p. 416; X, p. 362; XII, p. 341; XIII, p. 514; U. S. G. S. Bull. 32, pp. 207, 211; Water Sup. Pap. 338, p. 155; W. ANDERSON (op. cit.), pp. 201–207.

Napa Valley Mineral Water Company (see *Priest's Spring*).

Napa Vichy Spring. This spring, situated on the edge of the Napa Valley, 4 miles northeast of Napa, at an elevation of 90 feet (U. S. G. S.), is owned by John Lepori. This water, which is lightly mineralized, was first bottled in 1895. Previous to that, the place was maintained as a resort. The bottled product is artificially carbonated. The bottling works use electric power. The temperature of the spring is 66° F.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 255.

Photo No. 41. "The Rotunda" at Napa Soda Springs, Napa County.

Original White Sulphur Springs (formerly *White Sulphur Springs*). These springs are 2 miles south of west from St. Helena, in Secs. 3 and 4, T. 7 N., R. 6 W., at an elevation of 400 feet (bar.); John Sandford, owner. They are picturesquely situated, as there is considerable timber on the property (625 acres), consisting principally of redwood, "fir," and oak, with madrone and manzanita. The springs were discovered in 1845, and there have been three separate hotels destroyed by fire here. At present there are accommodations for 150, but it is intended to enlarge the capacity. No water is bottled for sale. The springs are all of the "white sulphur" variety, and sulphuretted hydrogen gas is given off from most of them. The following temperatures were observed: "Tank spring," 81° F.; back of bathhouse, 85°; "Mary Phillips' well," 78°; on road below "Mary Phillips," 83° (seepage

from rock wall of canyon, indurated sandstone); cold sulphur, 59° (on bank of creek); "Mission Father's well," 69°.

Bibl.: VI, Pt. I, p. 69; VIII, p. 417; XII, p. 341; XIII, p. 514; U. S. G. S. Bull. 32, p. 209; Water Sup. Pap. 338, p. 254; GEOL. SURV. OF CAL., Geol. Vol. I, p. 87; W. ANDERSON (op. cit.), pp. 263, 264.

Phillips Soda Springs, 15 miles east of St. Helena; Bank of Halfmoon Bay, Halfmoon Bay, owner.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 161.

Pope Mineral Spring (Indian Spring). This spring, owned by Peter Guillaume, Yountville, is in Sec. 29, T. 9 N., R. 4 W., 21 miles northeast from Rutherford, and a mile west of Samuels Soda Springs. Bottling began in July, 1913. A portion of the water is put up at the spring, but the major part marketed is hauled in barrels to Yountville and there bottled, carbonated.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 162.

Priest's Soda Spring. This property, formerly a part of the Priest ranch, is now owned by A. Meyer, 3650 Grove street, Oakland, operating under the corporate name of Napa Valley Mineral Water Company. The bottling works are at St. Helena. The spring is in Sec. 23, T. 8 N., R. 4 W., 16 miles east of St. Helena. The present owner was the first to bottle the water, in 1898. It is hauled in a tank wagon holding 500 to 600 gallons, and bottled, carbonated, under the name of "Priest Soda Water" and "Napa Rock." There are two springs, the one not bottled carrying iron and magnesium. The principal one is stated to flow 12,000 to 15,000 gallons per day.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 161.

Samuel Soda Springs. These springs are in Sec. 28, T. 9 N., R. 4 W., at an elevation of 775 feet (bar.) on Trout Creek, a branch of Pope Creek. They are 10 miles northwest of Monticello, 24 miles northeast from Rutherford, or 30 miles northwest from Winters. They have been utilized for about forty years, the present owner being Robert J. Little. The water is hauled in drums to St. Helena and bottled by the St. Helena Bottling and Cold Storage Company. There are accommodations at the spring for sixty boarders, in addition to which there are camping grounds, also. The following are the principal springs: "Samuel Soda," 62° F., "Kidney," 64°; others 60°, 62°, 63°.

respectively. There is also a "magnesia" spring, ¼ mile from the hotel, and a "white sulphur" ½ mile distant.

Bibl.: R. XII, p. 341; XIII, p. 514; U. S. G. S. Water Sup. Pap. 338, p. 159.

Sequoia Resort. It is 8 miles northwest of Napa; elevation, 800 feet. Owner, Theo. Gier, Oakland. There are two springs—one fresh water, the other "sulphur," the latter of which is said to show, on analysis, in parts per million: sodium sulphate, 12.3; sodium chloride, 28.5; magnesium and calcium carbonates, 10. There are tents and cottages in addition to the hotel. C. M. Troppman is manager.

St Helena Bottling and Cold Storage Company (see *Samuel Soda*).

St. Helena White Sulphur (see *Original White Sulphur*).

Walters Springs. These springs are in Sec. 12, T. 10 N., R. 5 W., 16 miles northeast from St. Helena. H. L. Connor, owner; post office, Pope Valley. They are in a short side canyon on the north side of Pope Creek, at an elevation of 1170 feet (bar.), and are reached by a well graded wagon road. These springs have been known since about 1869, and in 1909 all of the buildings were destroyed in a forest fire. There are at present accommodations for fifty people. A small amount of water is bottled, regularly. There are two mineral springs—upper, 68° F.; lower, 66°. At both Walters and Samuel springs (5 miles to southeast) serpentine is the predominating rock. Between them there are sharp ridges of chert, along the north side of Pope Creek. Samuel Springs are on the south side of the creek.

Bibl.: U. S. G. S., Water Sup. Pap. 338, p. 159.

White Sulphur (see *Original White Sulphur*).

Zem Zem Spring (see under *Onyx Marble*).

ONYX MARBLE.

There are specimens of onyx marble in the museum of the State Mining Bureau, from a locality formerly called "Zem Zem," near Knoxville. The deposit is not developed. There are calcareous springs near-by.

Bibl.: Bull. 37, p. 111; Bull. 38, p. 369; W. ANDERSON (op. cit.), p. 269; U. S. G. S., Water Sup. Pap. 338, p. 268.

PAVING BLOCKS (see Stone Industry).

PETROLEUM.

Petroleum and gas have been found in small quantities in sandstone west of Napa and Yountville, but not developed.

The *East Napa Mining Company* drilled to a depth of between 1000 and 1200 feet at the southern edge of Napa City, and at that

depth claim to have found "oil indications," though they did not expect oil until a depth of 2500 feet was reached. Work stopped for lack of funds. A. Zeller owns the property.

Bibl.: R. XIII, p. 582.

QUICKSILVER.

Development work began on the quicksilver mines of both the Knoxville and the Pope Valley sections about 1860. In the former, the Lake (afterward merged with the Manhattan) was the pioneer, followed

Photo No. 29. Mill at Ætna Quicksilver Mine, Napa County.

closely by the Redington; and in the latter district, the Valley mine (now a part of the Ætna mineral springs property) was the first. Although the industry had its ups and downs, Napa County was one of California's most important producers from 1864 to 1903, since which later date the decline has been very rapid. Though the present outlook is not particularly encouraging,* the success attending concentration experiments at the Ætna and Oat Hill mines, gives promise of at least a partial revival. (For more extended remarks regarding concentration, see introduction to Quicksilver under Lake County.) As has already been noted, Napa County's quicksilver mines are credited

*Since the above was written, the price of quicksilver has more than doubled as a result of the European war.

officially with a production valued at $15,000,000, but with a reputed output in excess of $22,000,000.

Ætna Quicksilver Mine (formerly *Ætna Consolidated*). The Ætna group is at the southeast end of the Mayacmas district near the head of a branch of Pope Creek, on the ridge separating it from James Creek. It is in Secs. 2 and 3, T. 9 N., R. 6 W., 2 miles southeast from the Oat Hill mine and 9 miles northeast of Calistoga, though St. Helena (18 miles) is its railroad shipping point on account of

Photo No. 30. Concentrators in Mill of Ætna Quicksilver Mine, Napa County.

better roads and easier grades. Post office is Lidell. The group consists of Phoenix, Silver Bow, Red Hill, Washington, Pope, and Star claims, all patented. Quicksilver ore is said to have been discovered here in 1854 by Lawley. It was later sold to Haufmeister et al., then to the Ætna Consolidated Quicksilver Company; then in 1904 the present owners, Lawley Brothers, Calistoga. Bror Soderhjelm, Lidell, is lessee. The earliest production was from the Phoenix. The most important producing periods of the Ætna group were between 1877 and 1887, and for about six years beginning with 1892. As the early figures were not segregated the total output can not be stated exactly, but it is estimated to be in excess of 36,000 flasks. The last two or

three years that the Ætna Consolidated Company had the mine mainly prospecting was done. In 1910–1912, a small production was made from clean-up by leasers around the old furnaces, and the retorting of small lots of sorted ore. An extended description of the geology and the underground workings is given in Bulletin 27, pp. 72–76; and in U. S. G. S. Monograph XIII, pp. 354, 371–374. In the Star mine, the shaft reaches a depth of 800 feet, and in the Silver Bow the tunnel (No. 9, in 3557 feet) attains a depth of 900 feet below the outcrop. No. 7 tunnel (7226 feet long) starts in the Phoenix and goes into the Silver Bow, while No. 9 (200 feet lower) starts in the Star and is driven into the Silver Bow. It was in the Silver Bow ground tapped by these two tunnels that the largest and most important ore body of the group was found, during the Ætna Consolidated regime. Above the No. 7 the vein was not over 3 or 4 feet wide, and with a steep dip. At that depth it flattened out, and widened to 20 feet between walls, extending to the No. 9—a veritable bonanza. Of mineralogical interest, it may be mentioned here that millerite (nickel sulphide) has been noted in the Ætna mine associated with cinnabar.

The present lessee has built a concentrating mill (see photos No. 29 and No. 30), which at the time of our visit (September 1, 1913) was equipped with a Dodge crusher, Griffin mill and six Gilpin County bumping tables, the whole being operated by a 40 h.p. distillate engine. It was observed that the Griffin mill made a considerable proportion of slimes. The Gilpin County bumpers seemed to collect most of the coarser cinnabar, but lost the fines. As we have already pointed out (see Lake County, introduction to quicksilver), it is very important to avoid sliming of cinnabar, as it is extremely friable. The use of a common power unit for both crushers and concentrators is also objectionable for effective concentration, on account of the variations of speed caused by the rock breaker. Having discussed these points with Mr. Soderhjelm at the time above noted he writes, under date of January 23, 1914, that he has taken out four of the bumpers and put one New Standard (Llewellyn Iron Works, Los Angeles) table in their place, "but the Standard table had too much to do; so I have ordered another, and if that is not enough I will have some more of the same kind, as the Standard seems to take kindly to the slime." Also, the concentrators are now being driven by a separate 5 h.p. engine. Ore from the surface cuts is soft and clayey, while that from underground is in part hard and siliceous. The capacity of the mill is stated to be 64 tons per eight hours. An 18-mesh screen is used on the Griffin mill. The concentrates are reduced in two "D" retorts, arranged with both a fan and a water-jet for draught. In the same letter above quoted: "I found that lime was not so good as charcoal with air in the retort, and I have to use lots of it, too, besides shaking

it up two or three times." He had (September, 1913) seven men at work in the mine and five in the mill. Only hand drilling is done, and the ore is trammed by hand.

Bibl.: R. V, p. 96; XI, p. 72; XII, p. 362; XIII, p. 597; Bull. 27, pp. 72–76; U. S. G. S. Mon. XIII, pp. 354, 371–374; Min. Res. 1884, p. 492, 1892, p. 148, 1902, p. 252, 1909, Pt. I, p. 553, 1910, Pt. I, p. 698, 1911, Pt. I, p. 901, 1912, Pt. I, p. 942; MIN. RES. W. OF ROCKY MTS., 1872, p. 523, 1873, p. 11, 1874, p. 30, 1876, p. 20; GEOL. SURV. OF CAL., Geol. Vol. I, p. 91; ENG. AND MIN. JOUR., November 1, 1913, p. 828.

Bella Union Quicksilver Company. The Bella Union Company, W. H. Hamilton, 556 Mills Building, San Francisco, attorney, owns the Bella Union and Oakville mines in Sec. 20, T. 7 N., R. 5 W., 1½ miles west of Oakville. The Oakville was a producer in 1872–73 (about 400 flasks) and the Bella Union is credited with 271 flasks in 1876; but the exact total figures are not available. The ore carries cinnabar with pyrite and calcite, and "forms seams in the slates and irregular bunches connected by stringers of ore" (Becker). In October, 1909, the Bella Union Company gave a working contract for the purchase of the mine, under which contract certain of the old tunnels were opened up, exposing some good ore. About April, 1910, work under the contract ceased and the contract forfeited; but the holder brought suit to have the company deed over the property upon payment of the agreed purchase price. The company prevailed in the suit. No work has been done since that time.

Bibl.: R. IV, p. 336, table; X, p. 362; XII, p. 364; XIII, p. 599; Bull. 27, p. 76; U. S. G. S. Mon. XIII, p. 377; Min. Res. 1909, Pt. I, p. 553; MIN. RES. W. OF ROCKY MTS., 1873, p. 11; 1874, p. 30.

Boston Mine (see *Redington*).

Calistoga (see *Calistoga Hot Springs* under *Mineral Water*).

Corona Mine. The Corona is owned by the Vallejo Quicksilver Mining Company, J. B. McCauley, president; E. J. McCauley, 409 Carolina street, Vallejo, secretary. It is in Secs. 32 and 33, T. 10 N., R. 6 W., 9 miles southeast of Middletown, between the Oat Hill on the northeast and Twin Peaks mine on the south; elevation 2200 feet (bar.). The mine is on the contact of the sandstone of the Oat Hill mine and a serpentine belt. The geology of the deposit is described in Bulletin 27, page 79. The mine was opened up in 1895, but closed down in 1906, following a heavy winter, being driven out by water in excess of the pumping capacity. They also had furnace troubles on

account of the large amount of pyrite occurring with the cinnabar. The pyrite rendered the ore self-burning, making it difficult to regulate the furnace temperatures, and the condensing. A white powder (probably sulphate of mercury) formed as an incrustation in the condensers, the result of reaction between the released quicksilver and SO_2 gas. This incrustation had to be broken out and retorted. The furnace, of the Scott type, is of 50 tons capacity. The mine is credited with a total production valued at $250,000.

Bibl.: R. XIII, p. 597; Bull. 27, p. 79; U. S. G. S. Min. Res., 1902, p. 252; 1908, Pt. I, p. 686.

Etna Mine (see *Ætna*).

James Creek prospect (see *Philadelphia*).

Knoxville Mine (*Boston, Redington*). This mine, known for years as the Redington, and later as the Boston, was first called "Excelsior" (Geol. Surv. of Cal., Geol. Vol. I, p. 92), being owned by the X. L. C. R. Mining Company. It was discovered in cutting a grade for a highway, and first appears in the producing column with 444 flasks in 1862. In 1867, the company was reorganized as the Redington Quicksilver Company. The present owner is F. E. Johnston, 4 Masonic Temple, Napa. The mine continued an important producer up to 1883. From that time to 1893 the output was only nominal (126 to 881 flasks per year), followed by five years of prosperity, since which, with the exception of 1908, the production has been small. The total has been 115,933 flasks to the end of 1912, exceeded in California (which also means the United States) by only two mines—New Almaden and New Idria. It is at Knoxville in the northeast corner of Napa County.

The geology and the underground workings are described in detail in several of the reports noted under Bibliography. There are three parallel, principal veins in the mineralized zone, and enclosed in serpentine. The cinnabar is associated with pyrite and quartz, the gangue mineral being principally a black opaline, in part resembling obsidian. Sulphurous waters in the mine are said to have caused trouble with iron pipes and machinery. At the time of our visit, one "D" retort was in operation, putting through a little sorted ore with material from the old Scott fine-ore furnace, which was being torn down. The ore was from the 150-foot level of the intermediate shaft (west of a line between the two older shafts), where a small body of fair grade ore was being blocked out. Three men underground (one miner, single-hand drilling, and two muckers) with five on top (including foreman and Chinese cook) were at work. Ore was hauled by wagon to the retort. Extensive tailings dumps around and below the furnaces indicate the former activity of this mine, which at one time employed over

600 men. During the seventies, the Redington Company had a contract with the Comstock mines for 400 flasks of quicksilver per month.

Bibl.: R. IV, pp. 179, 261, 289, 317, 329, 336 (table), 339, 340; VI, Pt. I, p. 122; X, p. 358; XI, pp. 69–71; XII, p. 363; XIII, p. 599; Bull. 27, pp. 76–79; U. S. G. S., Mon. XIII, pp. 10, 271–290, 464; Min. Res., 1883, pp. 394–396; 1884, p. 492; 1892, pp. 148, 160; 1902, p. 251; 1907–1912 (inc.), Pt. I; GEOL. SURV. OF CAL., Geol. Vol. I, pp. 92 and 99; Vol. II, pp. 128–132; MIN. RES. W. OF ROCKY MTS., 1867, p. 178; 1868, p. 264; 1871–1876 (inc.); TRANS. A. I. M. E., Vol. III, pp. 279, 285, 292, 301.

Lake Mine (see *Manhattan*).

La Joya Mine. Owned by James Rennie, Olympic Club, San Francisco, is in Sec. 24, T. 7 N., R. 6 W., 3 miles southwest of Rutherford. The property has been idle for several years, only a watchman being in charge.

Bibl.: Bull. 27, p. 80.

Manhattan Mine. This group, which includes the old Lake mine, is owned by the Lake Mining Company; R. B. Knox, Pacific Building, San Francisco, president. Besides the mining claims, the company has 320 acres of land in addition. It is in Sec. 6, T. 11 N., R. 4 W., and Sec. 1, T. 11 N., R. 5 W., 1 mile northwest of Knoxville and 20 miles southeast from Lower Lake. The mine was first worked in 1863, the place being then known as Johntown, and the ore reduced in the furnaces of the Redington mine. It was idle from 1877 to 1884, from which time to about 1907 it was again in the producing list. Its total production has been 15,933 flasks. No work has been done recently. As the mine and its geology have been described at considerable length in Bulletin No. 27, and in U. S. G. S. Monograph XIII, it will not be entered into here.

Bibl.: R. IV, p. 336, Table; V, p. 95; VI, Pt. I, p. 33; VIII, p. 412; XI, p. 71, 72; XII, p. 363; XIII, p. 598; Bull. 27, pp. 81–89; GEOL. SURV. OF CAL., GEOL. Vol. I, p. 92; Vol. II, pp. 126–128; MIN. RES. W. OF ROCKY MTS., 1867, p. 178; 1871, p. 15; 1874, p. 30; 1876, p. 20; U. S. G. S. Mon. XIII, p. 282; Min. Res., 1892, pp. 147, 160; 1902, p. 252; 1908, Pt. I, p. 686.

Mountain View (see *Simmons*).

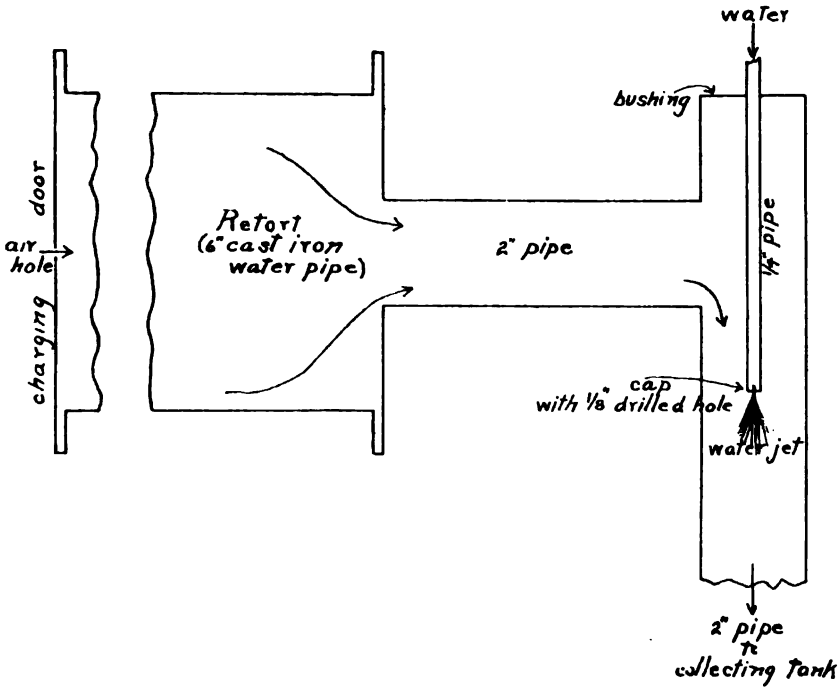
Napa Consolidated (see *Oat Hill*).

Northern Light prospect about 2½ miles west of Knoxville, near Lake County line; Fr. Josh, Lower Lake, owner. Idle.

Bibl.: Bull. 27, p. 92.

Oakville Mine (see *Bella Union*).

Oat Hill Mine (*Napa Consolidated*). This mine was for many years one of the important producers of California, having been opened up in 1867 and operated continuously up to 1909, when it was closed by the Napa Consolidated Company as being worked out. The present



Plan of water-jet condenser for quicksilver retort at Oat Hill Mine, Napa County.

owner, E. J. Sittig, Berkeley, took it over in 1910. R. P. Newcomb, Middletown, is lessee. There are 17 claims in the group, all patented, lying at the junction of Secs. 27, 28, 33 and 34, T. 10 N., R. 6 W., between James and Bucksnorter creeks, and 9 miles southeast of Middletown. The total production is stated to have been between $5,000,000 and $6,000,000 in value.

The older worked ore shoots were on the Mercury and Manzanita veins, the later developments being to the southwest and around on the other side of the ridge, on the Escape, Eureka, Humboldt and Osceola veins. While the ore was connected with the veins and on their footwall, there was little cinnabar in the siliceous vein matter

itself. The values occurred almost entirely as impregnations in the soft, light gray sandstone. The lenses of ore were all near to the surface, the deepest one, on the Eureka, reaching only a depth of 400 feet. In places, the stopes broke through to daylight. The largest single lenses were opened upon the Humboldt and Osceola veins, in both cases being stoped for a length of 500 feet. During the last two years that the Napa Consolidated Company operated, the territory outside of the zone explored by underground operations was prospected by boring numerous holes to a depth of 200 to 350 feet from the surface, with a Davis-Calyx core drill. During their last year, no underground development was carried on, only the ore then in sight being extracted.

Photo No. 28. Dumps of low grade ore at Oat Hill Quicksilver Mine, Napa County, from Eureka, Osceola and Humboldt veins.

It is estimated from the maps of the property that there are over 21 miles of underground workings in the mine. The elevation is 2250 feet (bar.) at the office. Equipment included two 50-ton Scott furnaces, which were dismantled and cleaned up when the mine was closed.

The present lessee, R. P. Newcomb, during the summer of 1913, had in operation one New Standard concentrating table (Llewellyn Iron Works, Los Angeles,) as a trial plant, screening, sluicing and concentrating material from the old, low-grade, mine dumps. At the time of our visit (September 1st) he was shipping in two additional tables, a revolving screen and another gasoline engine. A 5 h.p. engine operates the screen and a 1½ h.p. engine the concentrators. He estimates that there are in excess of 250,000 tons of ore on the dumps (photo No. 28 shows part of them) which can be economically treated by this method, and that he can handle at a profit material carrying as low as 0.15 per cent quicksilver (3 pounds per ton). Being a friable sandstone with impregnated cinnabar, and having lain out in the weather for some years, it is more or less disintegrated and air-slaked, requiring no crushing; so that it is particularly favorable for low-cost concentration treatment. The concentrates are retorted in a

series of pipe retorts, using a water jet for draught and condensing purposes (see sketch). From the test plant runs Newcomb estimated that he could handle the material for about 40 cents per ton, or a cost of $10 per flask of quicksilver reduced, on a 0.15 per cent Hg basis. Four men are required for the 3-table plant to dispose of 50 tons daily. On the trails and roadways about the Oat Hill mine, after a rain, cinnabar can be seen concentrated among the rocks and small crevices of the water courses.

Bibl.: R. V., p. 96; VIII, p. 413; X, p. 270; XI, pp. 65, 72; XII, p. 364; XIII, p. 598; Bull. 27, pp. 89-91; U. S. G. S. Mon. XIII, pp. 354-358, 469; Min. Res., 1883, pp. 394-397; 1884, p. 492; 1888, p. 97; 1892, pp. 145, 160; 1902, p. 251; 1906, p. 497; 1907, Pt. I, p. 679; 1908, Pt. I, p. 686; 1909, Pt. I, p. 553; 1910, Pt. I, p. 698; 1911, Pt. I, p. 902; Eng. & Min. Jour., Nov. 1, 1913, p. 828.

Philadelphia (*James Creek* prospect). This prospect is near (southeast from) the Oat Hill mine. It has been abandoned since the death, a year or two ago, of the owner, Martin Pluth.

Bibl.: Bull. 27, p. 93.

Phoenix Mine (see *Ætna*).

Redington Mine (see *Knoxville*).

Silver Bow Mine (see *Ætna*).

R. C. Simmons, Yountville, has a quicksilver prospect in Sec. 2, T. 6 N., R. 5 W., about 1½ miles west of Yountville. It was worked some years ago, but is idle at present. This is probably the "Mountain View" (Rep. X, p. 362).

Summit Mine. It is 3 miles southwest from Rutherford, and was a producer in the early seventies. Idle.

Bibl.: R. XII, p. 365; XIII, p. 599; Bull. 27, p. 92; Min. Res. W. of Rocky Mts., 1874, p. 30.

Twin Peaks Mine. This mine near Oat Hill joins the Corona mine on the south, and is in Sec. 33, T. 10 N., R. 6 W., about 10 miles south of Middletown. It is owned by W. H. and E. L. Herrick, Middletown. The mine has been closed since 1906, in the two years previous tc which it had produced a total of $40,000 in quicksilver from a lens of ore. As the surplus is stated to have been all paid out in dividends and none used for further development, the mine was closed for lack of funds for development, when the pocket had been worked out. Assessment work only has been done since.

Bibl.: Bull. 27, p. 92; U. S. G. S., An. Rep. XXI, Pt. VI, p. 278; Min. Res., 1902, p. 252; 1907, Pt. I, p. 679; 1911, Pt. I, p. 902.

Valley Mine (see *Ætna Mineral Springs,* under *Mineral Water*).

Washington Mine (see *Ætna*).

Whitney Prospect. This prospect is in Sec. 21, T. 10 N., R. 5 W., 10 miles southeast of Middletown, on agricultural patented land owned by G. B. Whitney of Calistoga; Oscar Jacobson, Lidell, lessee. The property was not visited, but we were shown specimens of the ore, which is an impregnation of cinnabar in a schistose sandstone. The country rock is said to be sandstone and serpentine. Development consists of a short drift and winze, and several prospect holes. Jacobson writes he has "found ore for 50 feet across the ledge."

SAND AND GRAVEL (see Stone Industry).

SANDSTONE (see Stone Industry).

SILVER (see Gold and Silver).

STONE INDUSTRY.

Under this heading is included building stone, crushed rock, macadam, paving blocks, rubble, sand and gravel, and sandstone. In the hills along the western side of the Napa Valley basalt occurs, which has been quarried for paving blocks near St. Helena and Napa. At the surface, it appears mostly in the form of boulders which are the result of disintegration along cracks and flow lines. The interior of the boulders is for the most part hard, bluish and compact. There are occasional vesicles. Along the eastern side of the valley trachytic tuffs are abundant. There is considerable variation in texture and hardness, but much of it is suitable for rough work such as bridges, walls, and rubble construction. Wooden and iron bridges throughout Napa County have gradually been replaced by stone. The same liberal policy is also maintained by the county in road construction and repairs; so that it is a pleasure to ride or drive over its well-kept roads with their picturesque stone bridges (see photos Nos. 35 and 43). The rock is taken from the quarry nearest to the point where it is to be utilized. Napa County is more fortunately situated than many other counties of the State in thus having close at hand an abundant supply of stone suitable for such purposes. Even where stone work is more expensive than in this county, it would still be economical in the long run as it makes a more permanent structure as well as picturesque, when compared to wood or even steel.

Sandstone is found in the ridges surrounding Berryessa, Pope and Wooden valleys, which are east of the main Napa Valley.

Bachelder Quarry, C. S. Bachelder, Napa, owner. It is on the eastern edge of the city, at an elevation of 100 feet (U. S. G. S.), and ¾ mile from tidewater. The rock is a reddish rhyolite, in part compact, fine-grained, felsitic, and in portions of the deposit partly altered by devitrification and leaching. The quarry was opened up in 1908. The crushing and screening equipment, driven by gasoline engine, has a capacity for handling 125 tons per nine-hour day. No rock was taken out in 1913. The product is used for road and concrete work.

Photo No. 35. "Little Trancas" bridge, near Napa, Napa County. Stone from Wing Quarry, 1908.

Bieber Quarry, P. P. Bieber, St. Helena, owner. It is 1 mile northwest from St. Helena post office and ¼ mile from the county road, at an elevation of about 500 feet. The rock is basalt and was first quarried in 1911 under lease, for paving blocks. Not operated in 1913.

Brown Quarry, Mrs. M. Myers, Fairfield, owner. It is 2 miles southeast of Calistoga, and was originally part of the Nettie Brown ranch. The stone is trachytic tuff and has been used locally for building purposes. No production has been made for several years past.

Bibl.: Bull. 38, p. 155.

Buck Ranch. Rock for county road work was quarried from the Buck ranch, southwest of Napa, in 1911.

Carver Quarry (see *Jursch*).

Connors Quarry or "Cement Rock Pit," N. Connors, Calistoga, owner. It is in the western part of Calistoga, on the side of a hill running southeasterly. The material is a tough, clay-like in part, volcanic ash or tuff, and has been used locally for a number of years as a road dressing. It is said to pack quite hard after wetting.

Davis Quarry, Dr. C. E. Davis, St. Helena, owner. On the Davis ranch, 2 miles from St. Helena on the Sanitarium road, is a hard, reddish trachytic tuff which has been used locally for building purposes. At the time of our visit rock was being taken out for the bridge at the

Photo No. 43. "Big Trancas" bridge near Napa, Napa County. Stone from Wing Quarry, 1913.

north end of Main street, St. Helena. Dr. Davis also owns a deposit of softer stone nearer town on the same road, but no quarrying has been done there.

Bibl.: Bull. 38, p. 155.

Errington Quarry, George E. Errington, Napa, owner. This quarry, about 1 mile east of the railroad station at Napa, produces crushed rock for road metal and concrete work. The crushing plant has a capacity of 100 cubic yards per day, and is driven by a gasoline engine. Four sizes of product are made. It is operated only about six months per year, principally in the summer season. Fourteen men are employed when in full operation. The rock is rhyolite similar to that at the Bachelder quarry, north of this.

Bibl.: Bull. 38, p. 320.

Gardner Quarry, W. G. Gardner, Napa, owner. This sandstone quarry is in Wooden Valley about 10 miles northeast of Napa. The stone is a light buff in color, and fine-grained; and has been used principally for building bridges in the vicinity, though some has also been used for road metal. Idle in 1913.

Bibl.: R. XIII, p. 636; Bull. 38, p. 131.

Harris Ranch. The county has contracted for about 15,000 cubic yards of crushed rock for road work in 1914 to be taken from the Henry Harris ranch southwest of Napa.

Howell Mountain Quarry, H. Overacker, St. Helena, owner. This quarry of trachytic tuff is on the east side of the ridge, elevation 750 feet, on the Glendale ranch, 3 miles northeast of St. Helena. From

Photo No. 32. St. Helena High School. Stone from Howell Mountain Quarry, Napa County, 1912.

it, stone of fair-sized dimensions has been taken. Stone from this quarry was employed in the new St. Helena High School building erected in 1912 (see photo No. 32).

Bibl.: R. IX, p. 291; XIII, p. 640; Bull. 38, p. 156.

Jursch Quarry (formerly *Carver*), Mrs. Lovella Priest, Sacramento, owner. This quarry, about 1¼ miles northeast from St. Helena, has been idle several years. The stone is trachytic tuff.

Bibl.: Bull. 38, p. 156.

Lenz Quarry, S. Lenz, St. Helena, owner. It is on the Calistoga road, 2 miles north of St. Helena post office. The rock is basalt, and paving blocks have been made there in the past. It is proposed to put in a crushing plant of 80 cubic yards daily capacity to utilize the spalls and waste from block operations for road work.

Linscott Quarry, L. C. Martin, Calistoga, owner. This quarry, 2 miles southeast of Calistoga, on the St. Helena road, has been idle for about 10 years. The stone is trachytic tuff.

Bibl.: Bull. 38, p. 156.

Manuel Quarry (see *Newman*).

Mee Ranch. A little stone (tuff) has been taken recently from the Mee ranch, 2½ miles from St. Helena on the east side near the creamery.

Moffatt Quarry, Moffatt Estate, owner; B. Bruck, St. Helena, superintendent. It is 2 miles northwest from St. Helena, and has not been worked for several years.

Bibl.: Bull. 38, p. 156.

Photo No. 33. Crusher and bins at Napa County Rock Plant, near Yountville.

Napa County Rock Plant. The county owns 3 acres on the hill at the turn of the county road 1 mile northwest from Yountville. The crushing and screening plant is driven by a 20 horsepower electric motor, power being bought from the Napa Valley Electric Railway, whose tracks as well as those of the Southern Pacific Company, are within 100 feet distant (see photo No. 33). The quarry was opened up about 1909, and is worked principally during the summer months. The capacity of the plant is 100 cubic yards per day, and requires 15 men when in full operation. The rock is a somewhat decomposed volcanic. The product is used for road metal in the surrounding district, and is hauled from the plant in wide-tired, bottom-dump wagons holding 6 cubic yards each. These wagons are owned by the county, which pays 50 cents to 65 cents per cubic yard, according to distance, for the hauling, horses being furnished by the drivers. The total cost

is stated to be about $1 per cubic yard of rock, laid down at the point of use.

Napa Sandstone Company, J. B. Newman, Napa, owner. This sandstone quarry, in Clark Canyon, west of Napa, was first opened up in 1873. In 1901 and 1902 some stone was quarried for bridge construction and for the Behlow Block, Napa; but none recently. It is suitable only for rough work, and no large pieces are obtainable.

Bibl.: Bull. 38, p. 132.

Newman Quarries (see also *Wing*). J. B. Newman, Napa, owns two quarries of trachytic tuff; one, on the Berryessa road, 5 miles northeast of Napa, and the other back of the state asylum, 3 miles southeast of Napa (the latter formerly known as Manuel). Both are at an elevation of about 700 feet (U. S. G. S.). The stone is only rough, quarry-dressed, as it is coarse and used only for bridges and foundation work. The quarry near the asylum has not been operated recently.

Bibl.: R. X, p. 361; XIII, p. 640; Bull. 38, p. 157.

Olsen Quarry (see *Zollner*).

Phelan Quarry. This sandstone quarry, 4 miles south of Monticello on the west side of Berryessa Valley, has been idle for several years.

Bibl.: Bull. 38, p. 132.

Pickett Quarry, C. N. Pickett, Calistoga, owner. No stone (tuff) has been taken from this quarry for about 10 years past. It is 1¼ miles east of Calistoga.

Bibl.: Bull. 38, p. 157.

Rose Quarry, D. C. Willis, Calistoga, agent. This was originally a part of the Brown ranch. It has been idle for about ten years past. The stone is trachytic tuff.

Bibl.: Bull. 38, p. 157.

Salmina Quarry. Matilda Wilson, Napa, owner. It is 7 miles north of Napa, and has not been operated recently. The stone is trachytic tuff.

Bibl.: R. XIII, p. 640; Bull. 38, p. 157.

Southern Pacific Company Gravel Pit. The Southern Pacific Railroad Company has six acres in the creek bed at the south end of Main street, St. Helena, and adjoining the Watt gravel pit. A spur track

connects with the main line. The material is utilized for ballast, but none was taken out during the year 1913.

Tychson Quarry. Mrs. J. Tychson, St. Helena, owner. On the Tychson place, 2 miles northwest of St. Helena on the Calistoga road, a paving-block quarry was opened up in 1911. The rock is a fine-grained, bluish basalt. The spalls and waste will be utilized for crushed rock for road work around St. Helena, under contract awarded by the county supervisors in September, 1913.

Watt Gravel Pit. Miss Margaret Watt, St. Helena, owner. About eight acres of this property at the south end of Main street, St. Helena, is in the creek bed and available for recovery of gravel. The balance is in orchard. Operations were begun in 1908, and the excavations show the gravel bed to be 6 to 10 feet in depth to the clay below. The major portion of the material sold is taken for ballast by the Napa Valley Electric Railway, which has a spur track into the pit. It is also used locally for street and road work. Those taking out the gravel employ their own labor, and pay a certain price per wagon or car load for the gravel removed.

Williams. There is a small quarry on the Williams place north of Calistoga.

Wing Quarry (Newman). H. W. Wing, Napa, owner. The Wing and the Newman quarries, adjoining, on the Berryessa road about 6 miles northeast of Napa, were originally one, owned by Newman & Wing. This quarry was first opened up in 1878. Elevation, 600 feet. The stone is a light, yellowish to gray, trachytic tuff, showing flow structure, so that, at a little distance, in part it resembles bedded sandstone strata. The stone here is of better quality, harder and more compact than the average of the tuff used in Napa County for buildings and bridges. The "Little Trancas" (Milliken Creek, U. S. G. S.) and the "Big Trancas" (Napa River, U. S. G. S.) bridges, north of Napa City were constructed of stone from the Wing quarry, the latter of which was just being finished when visited in September, 1913 (see photos Nos. 35 and 43). This bridge required 75,000 cubic feet of stone, and the average cost was stated to be 27 cents per cubic foot as laid in cement mortar.

Bibl.: R. XIII, p. 640; Bull. 38, p. 158.

Zollner Quarry (formerly *Olsen*). Estate of J. F. Zollner, owner. It is 2¾ miles south of Napa, and has both basalt and a hard gray trachyte, the former of which has been utilized for paving blocks. Idle in 1913.

Bibl.: R. XIII, p. 633; Bull. 38, pp. 158, 320, 342.

In addition to the above quarries, the following occurrences of stone have been noted, though as yet they are undeveloped:

There is *sandstone* in Maxwell Canyon, Pope Valley, 15 miles north of Rutherford, on the Maxwell and Hardin ranches; also in Gordon Valley, 11 miles east of Napa.

There is columnar *basalt* in Clark's Canyon, 12 miles west of Napa, Charles Clark, Napa, owner; also on the east slope of Mt. St. Helena, 6 miles west of Kellogg.

There is *steatite* and *serpentine* in Chiles Valley, northeast of Rutherford. There is a specimen of steatite (soapstone) in the museum of the State Mining Bureau, from the Fir Hill ranch, 2 miles west of Chiles post office.

About ½ mile west of the Corona quicksilver mine, northeast of Calistoga, is a body of light colored volcanic tuff, some of which was quarried for building purposes at the Corona. It did not weather well, as it was too soft.

Bibl.: R. V, p. 107; XII, p. 399; XIII, pp. 612, 639; Bull. 38, p. 131.

VOLCANIC ASH.

Under the name of "Callustro," and sold for use as a polishing powder, a deposit of volcanic ash about 3 miles west of Calistoga was exploited some years ago. There was a small mill on the property, for grinding and screening the material, but it has been idle since 1898. W. C. Sharpstein is the present owner.

Bibl.: R. X, p. 362.

SOLANO COUNTY.

Field Work in September, 1913.

Solano, one of the "north of the bay" counties, is surrounded by Yolo County on the north, on the east Yolo and Sacramento, on the south Sacramento and Contra Costa, and on the west by Napa. San Pablo and Suisun bays and the Sacramento River are on its south, the latter forming also a portion of its eastern boundary, while Putah Creek defines a part of the northern line. The total area of the county is 900 square miles, of which 822 square miles represents the land surface. It is about 35 miles north and south by 45 miles extreme width east and west. The main drainage system of the county is tributary to the Sacramento River, and a portion to the bays. Only the western section of the county has contributed to its mineral output, as Solano's principal resources are agricultural. Her mineral products in the order of their production to date are: cement, stone industry, quicksilver, mineral water, lime and limestone, brick, natural gas, salt and fuller's earth. Solano first entered the producing column in 1860 with a natural hydraulic cement from Benicia, followed in 1873 by the operation of the St. Johns quicksilver mine, which remained an important factor for seven years. By far the most important development, however, has been the most recent one, *i. e.*, Portland cement, which began in 1900.

As will be noted from the table, the total production for the county, to the end of 1913, has been $17,205,665.

ARAGONITE (see Onyx Marble).

BITUMINOUS ROCK.

(See Vulcan Rock Quarry under Stone Industry).

BRICK AND CLAY.

High Fire-Pressed Brick Company (see Houze).

Houze Brick and Cement Company. This property, which has been variously known under the names of: High Fire Pressed Brick Company, Pressed Brick and Supply Company, Vallejo Hydraulic Pressed Brick Company, and the Houze Brick and Cement Company, is about 2 miles north of Vallejo and adjoins the Vallejo Brick and Tile Company on the south. Christian Hoffmann, of Santa Cruz, is the present owner. Its area is 52 acres, and the plant includes a Hoffmann furnace of 10,000 per day capacity. It has been idle since 1909.

Bibl.: R. XIII, p. 619; Bull. 38, p. 258.

Vallejo Brick and Tile Company, Consolidated. J. F. C. Hagens, 343 Sansome street, San Francisco, manager. This plant is 2 miles north of

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west from Vallejo post office, at tide water on the north waterfront. Rail connections are 2 miles distant. Operations began in 1909, and except for four months in winter were continuous up to the latter part of September, 1913, when the plant was closed as the result of a combination of circumstances, the principal ones being lack of water and labor difficulties. Water was obtained from the Vallejo city mains and cost $75 to $100 per month. The equipment includes one 16-chamber kiln (40,000 capacity per chamber; heated at four corners of each chamber; down-draft, oil fired); one round down-draft kiln 30 feet diameter; two dry pans (capacity 25,000 per day each); one pug mill;

Photo No. 62. Pacific Portland Cement Company, Cement, Solano County. General view from south of old and new mills.

one brick machine; one automatic cutting table (capacity 50,000 per nine hours); two represses; one dry press (20,000 capacity per day). Steam power used with oil as fuel.

The following analysis of yellow shale from the company's clay beds was made by J. F. Pfleuger & Company, Bremen, Germany:

Loss on ignition (moisture and carbonic acid)	8.03%
Silica	57.83%
Alumina	19.52%
Iron oxides	7.46%
Calcium oxides	1.24%
Magnesium oxides	2.06%
Alkalies (balance)	3.86%
	100.00%

Trial runs have shown that a good vitrified brick for paving purposes can be made from this shale.

In addition to the above named plants there were at one time two others: McKenzy & Reid's pottery at Benicia, which used clay from Ione (Amador County) and from Hoyt's farm near Goodyear Station; and the Union Pressed Brick and Terra Cotta Company, with six kilns at Vallejo. These have both been abandoned for a number of years.

Bibl.: R. VIII, p. 631; XIII, p. 619; Bull. 38, p. 258.

CEMENT.

Benicia Works. This property, at Benicia, owned by Jas. Clyne, has not been operated of recent years, but previous to the rise of the Portland cement industry in California was an important producer.

Photo No. 63. Orange-peel bucket excavator in quarry of Pacific Portland Cement Company, Solano County.

The product is a "hydraulic limestone" or natural cement and was first put on the market in 1860.

Bibl.: R. VIII, p. 632; IX, p. 309; XII, p. 380; XIII, p. 612; Bull. 38, p. 185; MIN. RES. W. OF ROCKY MTS., 1868, p. 245; GEOL. SURV. OF CAL., Geol. Vol. I, p. 101.

Pacific Portland Cement Company, Consolidated. F. G. Drum, president; F. E. Erline, secretary; home office, 832 Pacific Building, San Francisco. F. D. Wood, superintendent at the plant. This plant at Cement, northeast of Fairfield, is in two units, as will be noted from the photograph (No. 62), the new one being on the right, with capacities of 2500 barrels and 3500 barrels per day respectively. The older

plant began operations in 1900, and was enlarged in 1903 and 1905, while the new plant has been producing since 1907.

The original source of both their limestone and clay, and from which a portion of the supply is still drawn, was the hill immediately above the works. The limestone here was a series of travertine or tufa deposits from calcareous springs, and largely superficial. They formed terraces and cascades on the southwestern slopes of the hill, similar to the terraced deposits which may be seen forming at the present time in the Yellowstone Park, Wyoming. In the quarry at the top of the hill the limestone was found more massive and to a greater depth, but

Photo No. 67. Tube mills and hoppers, for crushing raw materials in new mill of Pacific Portland Cement Company, Solano County.

over only a limited area. Fossils have been found in this travertine and also in the clay beds nearby; the latter have been identified by the Department of Palaeontology, University of California, as "*Inoceramus* cf. *Whitneyi*." The old low-grade dumps are now being reclaimed and sent to the mill along with the fresh material from the quarry. A Hayward orange-peel excavator (photo No. 63) is used to load the material. The so-called "Suisun marble" (see under Onyx Marble) was at one time quarried from this travertine, and for a number of years previous to the establishment of cement-making here it was a source of both lime and limestone production. The remains of the old lime kiln on the Dickey ranch, part of the property, are still

to be seen. Shipments were made to the Selby smelter for fluxing purposes. It was also used as macadam. As the limestone in these deposits has diminished both in quantity and quality, the charge is sweetened by the addition of a clean lime rock from the "Great Crevice," owned by the company, at Murderer's Bar on the American River, 9 miles from Auburn, Placer County. They have their own railroad connecting the quarry with the Southern Pacific at Flint Station, and ship 1200 to 1500 tons of rock per day. The principal clay supply is at present obtained from the flat below the mills, using a

Photo No. 69. Rotary kilns in new mill of Pacific Portland Cement Company, Solano County.

steam shovel. The clay beds are 40 feet in depth. The clay layers on the hill, which stand more or less vertical, are interstratified with a shaly sandstone.

In the older mill the lime rock and clay are dumped into separate bins, then weighed and carried by trolley car to the driers. The mixture is made of the coarse materials before drying. In the new plant the mixture is made with the dried ground materials between the ball and the tube mills, the limestone content being maintained at 76 per cent $CaCO_3$, before clinkering. This new unit embodies a number of improvements as compared with the older one, not only in the arrangement of the plant itself, but also in the addition and functions of new appliances and machinery.

There are cement-lined tunnels running under the mill, which contain the oil, water and sewer pipes, the power cables and some of the

electrical machinery. This makes them easy of access and also free from the excessive dust of the plant.

Just above the mill there are eighteen circular steel bins holding about 100 tons each, which are used for limestone and clay storage. Each bin is sampled so that the quality of its contents is known before being drawn off into the mill. Following the ball mills are eight Berquist bins of 100 tons capacity each—four each for lime and clay—which are used for a reserve before the mix. The materials are automatically weighed and dumped into a double-screw mixing machine, delivering to an elevator which serves the individual bins for the tube-mill feed.

Photo No. 72. Solano County Jail at Fairfield. Built with "Golden Gate" cement.

The tube mills are 5′ 6″ x 22′, trunnion type (see photo No. 67). Photo No. 69 shows the discharge and fire-box end of a battery of rotary kilns in the new unit. They are using for kiln linings a brick made up of clinker and cement with a small percentage of fire clay. A temperature of 2700° F. is attained in the kilns. They are set on a grade of ¾-inch per foot. Crude oil, topped, of 16° B. gravity and 17,000 B. T. U. is used for fuel at the rotary kilns. The oil is shipped in barges via Suisun Slough to Fairfield, whence it is pumped to a tank on the hill above the plant at Cement, a distance of about 5 miles.

The discharged clinker is sprayed with water and handled by McCaslin conveyors to the rotary coolers. These coolers are like an open-ended tube mill, with longitudinal baffle plates, and a current of cold air is drawn through them. When sending the clinker to the storage

pile in place of the ball mills, instead of going to the rotary coolers it is put through cooling towers similar to those described in the plant of the Standard Portland Cement Company at Napa Junction (see under Napa County). Gypsum, 2 to 2½ per cent, is added to the clinker before grinding. The tube mills designedly do not grind the product in a single stage to its desired ultimate fineness. The discharge goes to an "Emerick Air Separator." This consists of a series of horizontal revolving discs, from which the fines are drawn up by suction to the stock house, and the coarse particles which work to the periphery of the discs are returned to the mills.

Photo No. 76. Concrete Bridge at Vacaville, Solano County (1911).

In the stock house automatic sacking machines are used and a belt conveyor takes the filled sacks of "Golden Gate Brand" cement to the waiting railroad cars alongside. The Solano County jail at Fairfield (see photo No. 72) is of reinforced concrete, in which Golden Gate cement was used. The Cement, Tolenas and Tidewater Railroad, owned by the company, connects Cement with Tolenas Station on the main line of the Southern Pacific, 2 miles to the south.

A large and well equipped laboratory is maintained for chemical analyses and physical testing. It is supplied with natural gas from the well of the Rochester Oil Company, 5 miles southeast of Cement. Included in the equipment of the two mills are 250 electric motors, varying from 580 h.p. down to 1 h.p., and there are eight 6′ x 60′, eleven 7′ x 80′, and one 8′ x 100′ rotary kilns. From 6000 to 7000 h.p. per day are consumed, and about 500 men are employed. The water

supply comes from wells—one at the works and others at Vacaville, where the company has a pumping plant.

(For a more detailed description of the general process of cement manufacture, see Cement under Napa County.)

Bibl.: R. X, p. 670; XII, p. 395; XIII, p. 632; Bull. 38, pp. 185–189; GEOL. SURVEY OF CAL., Geol. Vol. I, p. 104; U. S. G. S., Bull. 243, p. 120; Bull. 522, pp. 118, 121.

CHROMITE.

Chromite is reported to occur near Fairfield. There is a specimen in the museum of the State Mining Bureau, said to have come from that locality, but the deposit is undeveloped.

Bibl.: R. IV, p. 137; VI, Pt. I, p. 101; VIII, p. 632; Bull. 38, p. 363.

COAL.

Lignite is reported as occurring in the southwestern part of the county, but no development work has been done.

Bibl.: R. VI, Pt. I, p. 118; VII, p. 151; GEOL. SURV. OF CAL., Geol. Vol. I, p. 106.

FULLER'S EARTH.

Western Fuller's Earth Company (Joice ranch). This is on the Joice ranch, ½ mile northeast from the railroad station at Vacaville. Mrs. Clara I. Hopkins, Fairfield, and the Joice Estate, owners. The deposit consists of a series of bedded strata in a low rounded ridge about ½ mile in length, strike northwest and dip about 40° E. Elevation 200 feet (U. S. G. S.). The open cut has exposed these strata for a thickness of over 30 feet. The color varies from white to light brown. There is no plant, the material being simply sacked as broken out, and shipped.

The typical fuller's earth is a non-plastic clay, which falls to pieces easily in water, and which has a strong affinity for grease in cloth and coloring matter in oils. While it is now well understood that chemical analyses are no criterion in determining whether or not a particular clay should be classified as "fuller's earth," this Vacaville material is not a clay, but "Monterey shale." It has a slight clay odor and adheres to the tongue, but does not break down readily in water. Under the microscope it is seen to be a fine, angular volcanic ash, with an occasional circular diatom. But the practical test is a physical one—whether or not it will do the work of a fuller's earth. The Vacaville earth answers this specification. Charles L. Parsons (U. S. Bureau of Mines, Bull. 71, Mineral Technology No. 3, on "Fuller's Earth," 1913, p. 24),

in a table giving "Bleaching Tests of Fuller's Earth" on cottonseed oil, indicates that the Vacaville earth gave only a slight reduction in color, and notes: "Indeed, as regards edible oils, several of these clays should not be classified as fuller's earth at all." In "Mineral Resources of the U. S., 1912," Vol. II, p. 1020, it states: "California had only two producers of fuller's earth in 1912—the Eight Oil Company at Bakersfield, and the Western Fuller's Earth Company at Vacaville. The fuller's earth in California is reported as having been used in refining animal fats and vegetable oils."

In verification of this latter statement, the packing-house of the Western Meat Company, at South San Francisco, was visited recently by the writer. This company is using a considerable tonnage of both English earth and the Vacaville variety, the latter giving nearly as good results as the standard English fuller's earth. M. J. Levy, the company's chemist, in my presence, made a comparative bleaching test on "prime summer yellow cottonsed oil," using the English and Vacaville materials (through 100-mesh screen). Identical 300-gram samples of the oil were heated to 216° F., 21 grams of the earths severally added, and agitated for three minutes, then filtered and the colors compared with the Lovibond color scale. To the unaided eye the difference in color was but slightly noticeable. The figures were as follows:

	Yellow	Red
Unbleached oil	35	6.0
Through English earth	20	2.3
Through Vacaville earth	20	2.8

The following figures are the result of a series of similar tests made by Levy, October 28, 1912 (samples through 100-mesh screen, except as noted):

	Yellow	Red
English	20	2.1
Florida	20	2.2
Vacaville	20	2.6
Vacaville (floated)	20	2.7
Bakersfield	20	3.4

In bleaching edible oils, a given charge of fuller's earth is used but once—5% to 10% of the weight of the oil to be bleached being the amount of earth taken. The oil is heated to a little above that of boiling water, the earth added and the mixture agitated three or four minutes, then filter-pressed.

With mineral oils the earth (through 15 to 80 mesh) is charged into a tall cylinder about 15 feet in height and the oil is allowed to percolate through this. The oil may or may not be heated before filtering, depending on its viscosity. A given charge of earth may be used ten to sixteen times. After blowing out the percolator with air, then washing with naphtha, and finally blowing out with steam, the fuller's earth is revivified by heating to a dull red heat in a rotary kiln similar (but smaller) to those used in Portland cement manufacture. In pursuance of experiments for a thesis in the Department of Mineralogy and Geology, University of California, in 1912, one of the students found that samples of Monterey shale, from a certain locality in Santa Cruz County, "possessed the properties of a first class fuller's earth." A sample of similar material from Pinole, Contra Costa County, gave similar results. These tests were made with mineral oil, a "heavy distillate S. G. O. 95, black in color." No mention is made of having tested samples of the Vacaville material, so it would seem worthy of investigation to determine its suitability for decolorizing petroleum.

Bibl.: Bull. 38, p. 273; U. S. G. S., Bull. 315, pp. 268, 290; Bull. 365 and 475; Min. Res. 1907, 1911, 1912; U. S. Bur. of Min., Bull. 71.

LIME AND LIMESTONE.

As has been noted under "Cement" the travertine deposits on the A. A. Dickey ranch, now owned by the Pacific Portland Cement Company, were at one time quarried, and the material calcined for lime. There are similar deposits, but smaller in extent, at Tolenas Springs (see under "Onyx Marble," also "Mineral Water"). The "hydraulic limestone" at Benicia has been mentioned under "Cement."

Bibl.: R. VIII, p. 631; X, pp. 669, 670; XII, p. 632; Bull. 38, p. 61.

MARBLE (see Onyx Marble).

MINERAL WATER.

Tolenas Springs. Donald Lamont et al., San Francisco, owners; H. W. Conkle, box 63, Suisun, lessee. The springs are at the head of Soda Springs Creek, 5½ miles north of Fairfield, at an elevation of 800 feet (U. S. G. S.). The following temperatures were noted: Tolenas 66° F.; spring at aragonite deposit on road below house, 76° F. There was much gas escaping from this latter spring, and it was surrounded by a considerable deposit of calcareous sinter. Water from the former is bottled for sale. It has a noticeable salty taste from the sodium chloride it carries—216 grains per gallon. The escaping gas (CO_2) is caught in a gasometer and pumped into the water in

bottling. There are no accommodations for guests. There is also a white sulphur spring about ¼ mile below. Some years ago this "onyx marble," or aragonite, was quarried and sold as "Tolenas onyx," but there was too small a body of it. Some beautifully banded pieces could be obtained, but not in sufficient size. There are several of these deposits around the springs and in the near-by hills.

Bibl.: R. VI, Pt. I, p. 74, X, pp. 668, 670; XII, p. 346; XIII, p. 521; Bull. 24, p. 138; U. S. G. S., Bull. 32, p. 209; Water Sup. Pap. 338, pp. 162–163; "MINERAL SPRINGS AND HEALTH RESORTS OF CAL.," W. Anderson, p. 255.

Vallejo White Sulphur Springs (also known as White Sulphur and Vallejo Sulphur Springs). Manuel Madrid, Vallejo, owner. They are in Sec. 10, T. 3 N., R. 3 W., 5 miles northeast of Vallejo, elevation 400 feet (U. S. G. S.), at the head of Sulphur Springs Creek. The springs are at the foot of the sharp ridge of rocks known as Sulphur Springs Mountain. The main spring is stated to have an average flow of about 100,000 gallons per twenty-four hours. The temperatures are: Blue Rock, 67° F.; Small Sulphur, 69.5°, Big Sulphur, 68°. Water from the first named is bottled. There are accommodations for 100 guests.

Bibl.: R. XII, p. 347; XIII, p. 520; U. S. G. S., Bull. 32, p. 209; Water Sup. Pap. 338, p. 255; W. ANDERSON (op. cit.), p. 260.

NATURAL GAS.

Rochester Oil Company (formerly Hurley's ranch). J. R. Chadbourne, president; Geo. Trainor, secretary, Suisun. The well is on land owned by J. L. Freitas, and leased to the company, in Sec. 24, T. 5 N., R. 1 W., 8 miles north of east from Suisun and 6½ miles south of Elmira; elevation 50 feet. The well was drilled in 1901 for oil because of a seepage near-by. Gas was struck at a depth of 1520 feet. They drilled on to 1820 feet, but nothing further was obtained and the well was abandoned for three years. Four other holes were drilled without result. Salt water comes up with the gas (see under Salt). The flow of gas is stated to be about 20,000 cubic feet per day, and it is distributed by its own pressure through pipes to Suisun, Fairfield and Cement. There is a gasometer of about 20,000 cubic feet capacity at the well. We were informed by the chemist at the cement works that it is an efficient gas but contains considerable moisture.

In addition to the above, the following occurrences of natural gas are noted:

M. Allen Ranch in Sec. 2, T. 4 N., R. 1 W., used for domestic purposes by the owner.

Hilborn Bros. Well in an "anticlinal valley," in the Potrero Hills, in the northern part of T. 4 N., R. 1 W. Not utilized.

L. A. Lambrecht Ranch in Sec. 12, T. 4 N., R. 1 W., used by owner for domestic purposes. This one and the Allen well are in the marsh land at the edge of tidewater, while that of the Rochester Oil Company is on the low flat land just above the marshes.

Bibl.: R. VIII, p. 185; X. pp. 659, 660; XIII, p. 569; Bull 3, p. 5.

ONYX MARBLE.

Under the name of "Suisun marble" some stone was at one time quarried from the travertine deposits on the Dickey ranch, now owned by the Pacific Portland Cement Company, near Suisun. Some pieces showing a beautifully banded and wavy structure were obtained, but for the most part stone of only small dimension could be cut out. The same thing is true of the deposits at the Tolenas Springs, 4 miles west of these. Aragonite has also been found at Vacaville.

Bibl.: R. I, p. 17; IV, p. 73; V, p. 67; VI, Pt. I, pp. 22, 91; VIII, p. 631; X, pp. 668–670; XII, p. 403; XIII, pp. 632, 641; Bull. 37, p. 112; Bull. 38, p. 114; GEOL. SURV. OF CAL., Geol. Vol. 1, p. 104; U. S. G. S., Water Sup. Pap. 338, p. 162.

PETROLEUM.

Midas Petroleum Company, C. J. Reeves, secretary; home office, Call Building, San Francisco. This company is drilling for oil on the Ryerson ranch above Glen Cove, southeast of Vallejo. The company has a well equipped plant and drill rig and were down over 300 feet in September, 1913, expecting to go to 2000 feet depth. They claim to have obtained favorable indications and some oil seepage.

Rochester Oil Company (see under Natural Gas).

Vallejo and Napa Gas and Oil Company. Mrs. Jennie Hartzell, president; Wallace Rutherford, Napa, attorney and director. The company has 20 acres back of the cemetery north of Vallejo, where they propose to drill for oil.

QUICKSILVER.

St. John's Mines Company (formerly St. John's Consolidated Quicksilver Mining Company). Clifford B. Dennis, Vallejo, manager, C. F. Colmar, Alaska Commercial Building, San Francisco, secretary. The surface rights are owned by C. M. Wilson, of Los Angeles. The St. John's mine is in Sec. 33, T. 4 N., R. 3 W., 6 miles northeast from Vallejo, with an excellent oiled road to within 1 mile of the furnaces. It is at the northern end of the ridge called Sulphur Springs

Mountain. Its first period of operation was 1873–1880, when it produced a total of 11,530 flasks. The St. John's Consolidated Company reopened the mine in 1899 and continued production up to 1909, since which time only a small amount of development work and occasional retimbering to keep the mine open has been done. Total production to date has been 14,523 flasks of quicksilver.

The country rocks are an indurated shale and metamorphic sandstone, the latter of which is in part quartzite. The ore carries cinnabar with pyrite, marcasite and some quartz, which has been deposited principally along the fissure planes and jointages in both the sandstone and schist. Cinnabar also occurs as an impregnation in the sandstone, resembling the ore of the Oat Hill mine, Napa County, except that here it is harder. A thick, dark brown mineral oil which burns readily when a candle is applied to it, is found in the jointages and fissures in and near the ore bodies.

The shaft is down 400 feet, reaching a depth of about 650 feet vertical, below the outcrop. There are three main levels from the shaft and five intermediates. The main adit is above the furnace level, connecting with the shaft at the 300, and is in over 1100 feet. There are six main stopes in the work of later years, the largest of which is 250 feet long by 20 feet wide and 20 feet high, extending diagonally down through three levels. There are two coarse ore furnaces of 20 tons capacity, and one 24-pipe retort, the former of which it is proposed to replace by a fine-ore furnace with larger capacity.

Since the mine was visited (September, 1913), the newly organized company noted above has taken over the rights and equities of the older company under an option to purchase. Development work will be increased and a furnace built. It is stated that experiments are being made on concentration of the cinnabar by an oil flotation process, with satisfactory results.

Bibl.: R. I, p. 26; VIII, p. 631; X, p. 661; XIII, p. 599; Bull. 20, p. 19; Bull. 27, pp. 93-97; U. S. G. S. Mon. XIII, p. 378; An. Rep. XXI, Pt. VI, p. 278; Min. Res. 1907, 1908, 1909, 1910, 1911, 1912; MIN. RES. WEST OF ROCKY MTS., 1874, p. 20; 1875, pp. 14, 178; 1876, p. 20. MINING AND SCIENTIFIC PRESS, Vol. 109, p. 585.

SALT.

Rochester Oil Company (see also under Natural Gas). J. R. Chadbourne, president, Geo. Trainor, secretary, Suisun. The company has a natural gas well in Sec. 24, T. 5 N., R. 1 W., 8 miles north of east from Suisun. Salt water flows from the well with the gas, and is run out into a shallow basin of about 10 acres in extent and dried by solar evaporation. The basin has a hard-pan bottom and the brine

is run in to a depth of 4 to 5 feet in the spring, the salt being gathered in August or September. The excess brine is piped to the slough. After evaporation the top material is thrown up with forks, then hauled in wagons to the bank, where it is piled in cones and afterward sacked. No refining is done. It is sold at $3 per ton at the well, principally for stock salt, pickling, etc.

STONE INDUSTRY.

Benicia Rock Crushing Company (see Vulcan Rock Company).

Cordelia Quarry (see Thomasson).

County Macadam Quarry. F. A. Steiger, Vacaville, owner. It is 1 mile north of Vacaville, and the county at one time obtained crushed

Photo No. 58. Rock Crushing Plant of E. B. & A. L. Stone Company, at Thomasson ("Cordelia" Quarry), Solano County.

rock here for road work, but it has been idle for several years. The rock is basalt. It is stated that there is another and larger body of basalt a short distance north of this one, on the Garnet ranch, but undeveloped.

McNaughton's Quarry (see Thomasson).

Thomasson Quarry (known locally as the "Cordelia" quarry, also formerly as McNaughton's). E. B. & A. L. Stone Company, owner. E. B. Stone, president, R. P. McDonald, secretary, 401 Phelan Building, San Francisco; T. Griffiths, superintendent at the plant. The quarry is in an isolated hill of basalt at the edge of the marsh

land 1 mile east from Cordelia. It is connected by a spur track with the Southern Pacific Railroad at Thomasson Station. The quarry was first opened up about 1875, and for about twenty years produced principally paving blocks, for which the rock is well suited, being a compact, olivine basalt, dark blue to gray in color, with a straight, clean fracture. When visited (September, 1913) there were but three men making blocks, as the market for such is dull, nearly all of the output being as crushed rock for road metal, concrete, etc.

Near the surface the basalt shows in the form of rounded boulders, the result of concentric decomposition. Lower down it is more massive, but oxidized to yellow and gray along fracture planes. In one part of the quarry the stone exhibits the hexagonal jointing (vertical here) common in basaltic masses. In places a vesicular structure is encountered, and at the south end of the hill there is a tuff.

The plant (photo No. 58) is equipped for a daily capacity of about 1000 tons, but the output varies according to the demands of the market and the supply of labor. The product is classified into four sizes by revolving screens. Waste material and dust is taken out through a tunnel below and utilized by the railroad for filling and ballast. The quarrying is done by contract at 25 cents per ton and an output of about 10 tons per man per day is made. Ten quarry faces are at present worked. Electric power is used throughout the plant, the equipment of which includes six motors (200 h.p. largest), one No. 9, two No. 5, one No. 4, and three No. 2 gyratory crushers. Conveyer belts and bucket elevators are used, and there are 12 bunkers with a total capacity of 2000 tons.

The following is the result of a test on road material from this quarry by the Division of Tests, U. S. Department of Agriculture, Bureau of Chemistry, dated February 28, 1905:

Material: Olivine basalt.

Specific gravity	2.78
Weight per cubic foot	174.64 pounds
Water absorbed per cubic foot	0.93 pounds
Per cent of wear	2.27
French coefficient of wear	17.65
Hardness	17.5
Toughness	30
Cementing value	14 dry; 214 wet

"REMARKS—This rock has a fair cementing value when tested dry, but develops a very high value when ground wet. This indicates that plenty of water should be used under the roller when laying the upper course. The resistance to wear is good and the rock should make an excellent road material."

Bibl.: R. X, p. 659; XII, p. 390; XIII, pp. 627, 634; Bull. 38, pp. 325, 342.

P. Siebe has a small quarry opening opposite the station at Cordelia, from which a light-colored tuff has been taken for road dressing, but it has not been worked recently.

Bibl.: Bull. 38, p. 326.

Southern Pacific Railroad Company. The railroad company has a quarry for rock ballast about 3 miles north of Benicia. Worked intermittently.

Vulcan Rock Company (formerly Benicia Rock Crushing Company, also Benicia Crushed Stone Company). Geo. U. Hind, president. Home office, 153 Sutter street, San Francisco. E. F. Rogers, Benicia, superintendent. The company has the quarry rights on the ranch of J. H. Hoyt, 7 miles northeast of Benicia. The shipping point is Hoyt siding, at the crusher, 1 mile north of Goodyear Station on the Southern Pacific. The quarry is on the edge of the range of hills which borders the west side of the Suisun marsh. The rock varies from a blue-black, fine grained basalt, with an occasional feldspar phenocryst, to a tuff. There is some vesicular material, in part oxidized to red. Compressed air drills are used and the rock is hauled in horse-drawn trains to the crusher, which has a daily capacity of 300 tons. Electric power is used, and the product is screened into four sizes: "screenings," to 2½ inches. The waste is run to dumps. Most of the output is used for macadam, but some for concrete. Fifteen to thirty-five men are employed, varying with the demand. This quarry was at one time reported to be producing "bituminous" rock, but the deposit is not bituminous.

Bibl.: R. X, p. 669; XII, p. 390; XIII, p. 627; Bull. 38, p. 325.

In addition to the above there are two small quarries of *tuff* in the northwest corner of the county, owned by Sacket Bros., of Winters, and by D. L. Tucker et al., Winters, respectively. The former extends across Putah Creek north into Yolo County. Also two small *sandstone* quarries northwest of Vacaville, owned by F. Frietas and F. B. Kington, respectively. No stone has been taken from these quarries of recent years.

Bibl.: R. X. p. 791; Bull. 38, pp. 141, 162.

SONOMA COUNTY.

Field Work in October and November, 1913.

INTRODUCTION.

Sonoma County is both a coast county and one of the "North of the Bay" group; being bounded on the west by the Pacific Ocean and Marin County, on the north by Mendocino, on the east by Lake and Napa, and on the south by San Pablo Bay. It has a land area of 1577 square miles. The drainage of the northern two thirds of the county is to the Pacific Ocean, principally by the Russian River, and its branches; while the southern end drains to San Pablo Bay, through Petaluma and Sonoma creeks. Though part of two separate drainage areas, the main valley through the center of the county is some 60 miles north and south by about 25 miles wide.

The mineral resources of Sonoma County are quite varied, as will be noted by the Table of Mineral Production. In the order of their value to date they are: Stone industry, quicksilver, brick and clay products, mineral water, mineral paint, magnesite, graphite, lime, gems and infusorial earth. Their total recorded production to date, has been approximately $7,600,000. The actual output must certainly have been considerably in excess of this, as there are no figures for stone industry earlier than 1887, though paving blocks have been made in Sonoma County since 1864 (Tenth Census Report, Vol. X, Pt. 3, p. 97); nor are there any figures for bricks earlier than 1887, nor for mineral water earlier than 1895. Though in this latter case some of the springs are known to have reported sales for at least ten years previously, the figures are not available.

In addition to the minerals above noted as produced in commercial quantities, occurrences of the following have been found: Chrome, coal, copper, gold, iron, manganese, silicified wood, onyx marble, garnets and sulphur.

ABRASIVES (see Garnets under Gems).

BRICK AND CLAY.

Beltane Clay (see Weise Clay Pit).

California Brick and Pottery Company. This plant at Glen Ellen, now partly dismantled, has not been operated for some four years past. C. Hidecker et al., of San Francisco, were operators. Common bricks burned in field kilns were first made, followed by the manufacture of hollow, building tile. For this latter, it is stated that about one third of their raw material was obtained from Ione, Amador

County. Steam drying sheds were used. There are five circular brick and pottery kilns (see photo No. 135), which were oil fired.

Bibl.: R. XII, p. 384; Bull. 38, p. 258.

Healdsburg Brick Company. W. Burgett, Healdsburg, owner. Idle since 1906.

Bibl.: Bull. 38, p. 258.

James Henderson on his ranch near Glen Ellen is stated to have small deposits of high grade pottery clay, but they are not utilized.

Pure Clay Brick and Tile Company (formerly Hilton Brick Co.). J. H. Stack et al., 103 Main street, San Francisco, owners. This plant

Photo No. 135. Circular Brick Kilns of California Brick and Pottery Company, Glen Ellen, Sonoma County.

is at Hilton near Guerneville, on the Russian River. No bricks have been burned here since 1912.

Bibl.: R. VIII, p. 635; Bull. 38, p. 258.

At Skaggs Springs there is a deposit of yellow clay, which is stated to be suitable for terra cotta. Peter J. Curtis, owner.

Weise Clay Pit (also known as Beltane Clay). J. H. Weise, Glen Ellen, owner; J. T. Stanton, 315 Merchants National Bank Building, San Francisco, lessee. This deposit of white kaolin is in a hill about ¼ mile northeast of Beltane station, between Glen Ellen and Kenwood.

It is a high grade aluminum silicate, as will be noted from the analyses. It appears to have been originally a fine grained acid volcanic material, which has been very thoroughly kaolinized. In the lower part of the deposit, which has been opened up by several short tunnels, the kaolin is soft and has a greasy feel; while at the top of the hill it has been hardened by a subsequent infiltration of silica.

A considerable tonnage of this siliceous material has been employed by the Gladding, McBean Company, mixed with their Amador County clay in the manufacture of fire brick. The Beltane clay is stated to decrease the shrinkage. The Santa Cruz Portland Cement Company has been using the softer material from the lower levels in the preparation of a special white cement for decorative and statuary work. The fusion point of this clay is said to be very high—about 4500° F.

Analysis of "Beltane clay" by Smith, Emery & Company, Chemists, San Francisco.

	No. 1 (hard)	No. 2 (medium)	No. 3 (soft)
SiO_2	74.60%	56.29%	58.10%
Al_2O_3	15.97%	31.13%	26.79%
TiO_2	.21%	.31%	.56%
Fe_2O_3	.50%	.59%	1.17%
MnO	Trace		Trace
CaO	.18%	.05%	.32%
MgO	.06%	.05%	.05%
Loss on ignition	8.80%	11.67%	12.66%
	100.32%	100.09%	99.65%

There are specimens of clay in the museum of the State Mining Bureau from Agua Caliente, Guerneville, Healdsburg, Mark West Springs, Santa Rosa and Sonoma, but the deposits are not at present utilized.

CEMENT BLOCKS.

George Reilly, 300 Olive street, Santa Rosa, has a plant where he makes concrete building blocks, sewer pipe, culverts and railroad ties. The equipment includes an electric motor, concrete mixer and a planer for dressing the artificial stone blocks. California cement is employed with sand and gravel from local deposits, principally from the bed of Santa Rosa Creek, near by.

Mr. Reilly has recently obtained patents on a clamp for fastening railroad rails to concrete ties, and also on a device for forming holes for new clamp anchorages in concrete or stone (*e. g.,* for placing switches, turnouts, etc.). He is placing these on the market in connection with his concrete ties for railroad use.

Sonoma Stone and Construction Company, Santa Rosa. Defunct.

Bibl.: Bull. 38, p. 170.

CHROME.

Chromite deposits are known at several localities in Sonoma County, but none of them are at present being utilized commercially, though a few small shipments have been made in the past. Among these occurrences may be noted the following:

Three miles west of Geyserville, south of wagon road.

At Asti Colony, three miles south of Cloverdale.

Dotta ranch near Healdsburg, Mrs. L. H. Dotta and sons, owners.

Chromite float is found along the ridge east of Healdsburg, running north from Fitch Mountain.

Near Lytton Springs, there is also chromite.

There is a deposit of chromite near the Madeira magnesite property, 5 miles north of Guerneville. George Madeira, Healdsburg, owner.

Sonoma Magnesite Company, adjoining on the east these magnesite deposits north of Cazadero, chromite is found in T. 9 N., R. 12 W.

Bibl.: R. IV, p. 137; XIII, p. 50; U. S. G. S. Bull. 430, p. 168.

COAL.

Some small strata of coal are known at several points in Sonoma County, but they are not utilized. Some of these are:

At the head of a gulch ¼ mile from the beach near Fort Ross.

Eight miles east of Stewart's Point on the road to Skaggs Springs.

Pierson Mine, on the Wrightson ranch, in Sec. 27, T. 8 N., R. 8 W., on the road to Mark West Springs; N. E. McGrew, owner. In 1910 and 1911 some development work was done.

On the *Taylor ranch,* 2 miles south of Santa Rosa, considerable money was spent in development work about twenty years ago. Though a fair quality of coal was found, the strata were too much broken up.

Bibl.: R. VII, Pt. I, p. 118; VII, pp. 151, 190; VIII, p. 634; X, p. 676; XI, p. 259; XII, p. 61; XIII, p. 55.

COPPER.

Altamont Group, in Sec. 17, T. 7 N., R. 10 W., 2 miles southeast from Monte Rio. Small detached masses and specimens of copper were found here, and some development work done, but no definite ore body uncovered.

Bibl.: Bull. 50, p. 167.

Archer Tract Prospect, in Sec. 30, T. 8 N., R. 10 W., east of Guerneville; Geo. K. Thornton, owner. Idle.

Bibl.: Bull. 50, p. 166.

Cornucopia Copper Mining Company (formerly Squaw Creek; also known locally as the *Healdsburg Copper*), W. M. Jacobs, Healdsburg (president and manager); H. A. Jacobs, Healdsburg (secretary). This group of three claims is in Secs. 33 and 34, T. 12 N., R. 9 W., 14 miles northeast from Cloverdale. The stage road to the Geysers runs within two miles of the claims, which are reached by trail. They were first located about 1902, and the present owners have been working them since 1912.

To uncover the ore body, the surface has been ground sluiced. It is stated there are two main "veins" (85 feet and 10 feet wide, one being a brecciated zone), also a third one, smaller, and that they have been traced for ¾ of a mile on the surface. The strike is northwest and the dip northeast, nearly vertical. The country rock is much altered. The ore carries copper carbonates at the surface, with chalcopyrite below, the gangue minerals being calcite and some quartz. There is a 40-foot shaft in the canyon, and a tunnel in 315 feet. In November, 1913, two men were driving this tunnel, which was expected to cut the ore in another 50 feet at 200 feet below the outcrop.

Gray Prospect, E. F. Bean, Healdsburg, owner. It is on Devil Creek, a branch of Austin Creek, north of Guerneville. Idle.

Grizzly Claim and *Healdsburg Lode,* north of Healdsburg. Idle.

Bibl.: R. V, p. 97; Bull. 50, p. 167.

Copper is also stated to have been found near *Skaggs Springs.*

Bibl.: R. V, p. 98.

Squaw Creek Copper Mines (see Cornucopia Company).

Wall Prospect. Copper indications were found at the Wall Spring Quicksilver mine, but nothing developed. H. C. Wall, Hilton, owner.

Bibl.: Bull. 50, p. 166.

Ward Tract, J. W. Ward, Healdsburg, owner. Copper float has been found on the Ward ranch in Sec. 22, T. 9 N., R. 10 W., but nothing has been developed.

Bibl.: Bull. 50, p. 167.

DIATOMACEOUS EARTH (see Infusorial earth).

GARNETS (see under Gems).

GEMS.

Garnets, of two varieties, are found in Sonoma County. On the Cox ranch, Mrs. Nate Cox, owner, 3 miles west of Healdsburg, *almandite*

garnets occur abundantly in a chloritic schist. Many of them would be suitable for watch jewels if they could be separated economically from the enclosing schist. Their most likely commercial utilization, however, will probably be as an abrasive.

Grossularite occurs near Petaluma in association with copper minerals.

Bibl.: R. IV, pp. 99, 182; VI, Pt. I, p. 91; Bull. 37, p. 52.

Opals, of gem quality and a fair play of "fire," have been found in association with the kaolin deposit on the Weise ranch between Glen Ellen and Kenwood. Some of these have been cut and sold in San Francisco. J. H. Weise, Glen Ellen, owner.

GOLD.

Traces of gold have been found at several places in Sonoma County, but nothing of consequence ever developed.

Bibl.: R. XIII, p. 436.

GRANITE.

Through an error, production of granite from Sonoma County was reported both to this Bureau and to the United States Geological Survey, for several years. I found, on visiting the quarries, that the material so reported from Agua Caliente is a vitrophyre associated with trachytic tuff. That classed under "curbing" from other parts of the county is the andesite from which most of the paving blocks are made.

Bibl.: Bull. 38, p. 376.

GRAPHITE.

On the property of the *Healdsburg Paint Company* (see also under *Mineral Paint*), southwest of Healdsburg, a deposit of graphite was uncovered, but it has not been developed.

Bibl.: Bull. 38, p. 281.

McPherson Ranch Deposit, L. McPherson, Healdsburg, owner. There is an undeveloped deposit of graphite of fair quality on this ranch in Secs. 13, 14, 24 and 25, T. 9 N., R. 10 W., 4 miles west from Healdsburg. There are specimens from this deposit in the museum of the State Mining Bureau. The material is suitable for use in paint manufacture or for stove polish. By washing and floating it could be used in lubricating compound.

Skinner Graphite Company, R. M. Skinner et al., Petaluma, owners. This graphite is on the Skinner ranch, in Sec. 14, T. 4 N., R. 7 W., 4 miles south of Petaluma on the San Rafael road. It was opened up in 1894, and the material shipped to San Francisco for paint manufacture. The output was valued at $9,000. Idle for several years.

Bibl.: Bull. 38, p. 281.

There is said to be a deposit of graphite 2 miles west of Cazadero. It is undeveloped. Specimens are also reported from other parts of the county.

Bibl.: R. VI, Pt. I, p. 111.

INFUSORIAL EARTH.

Collings Deposit, A. F. Collings, 1001 Orchard street, Santa Rosa, owner; John Frey, Eighth and Hooper streets, San Francisco, lessee. It is in Sec. 10, T. 8 N., R. 8 W., 1 mile north of Mark West Springs and 6 miles east of Windsor on the Northwestern Pacific railroad; elevation 600 feet (bar.). There is a bed of infusorial earth 5 feet thick, striking east and west, and dipping north at a flat angle. It is below a layer of soft, coarse-grained volcanic tuff; and has been worked by a small open cut and drift. A small tonnage was shipped in 1913.

Mt. Pisgah Vineyard Deposit, E. L. Goldstein Company, 333 Kearny street, San Francisco, owners. This is an undeveloped deposit of infusorial earth, said to indicate a large available tonnage. It is in Sec. 30, T. 6 N., R. 5 W., 2 miles northeast of Agua Caliente.

IRON.

There are indications of iron ore along the second ridge back from the shore line, beginning about 6 miles east of Fort Ross and continuing northwesterly into Mendocino County. The more important localities are:

Hooper Ranch, J. W. Hooper, owner, 5 miles north of Nobles.

Lancaster Ranch, W. M. Richardson, Plantation House, owner; east of Fisk's Mill. Both yellow ocher and hematite occur. Some of it is siliceous, and suitable for paint.

Fort Ross, a large body six miles east of Fort Ross.

Bibl.: R. IV, p. 182; XI, p. 461; Bull. 38, pp. 304, 365.

KAOLIN (see under Brick and Clay).

LIMESTONE.

Black Ranch Quarry, L. S. Black, Modesto, owner. This deposit is 6 miles north of Geyserville on Little Sulphur Creek. The Sonoma County Lime Company, A. H. Ingram, Santa Rosa, manager, burned some lime here in 1906–1907; but it is stated that they could not market the product on account of a labor boycott. No work has been done since.

Bibl.: R. XII, p. 396; XIII, p. 633; Bull. 38, p. 93.

Photo No. 176. Magnesite from Kolling deposit near Preston, Sonoma County, California, showing shrinkage cracks. Two thirds natural size.

There is a large deposit of limestone in Secs. 1 and 2, T. 9 N., R. 12 W., 15 miles west of north from Cazadero. It is stated to be traceable for a mile in length, and in places up to 300 feet in width. It could be used for building stone or for cement manufacture. It is a hard, fine-grained, compact limestone, red, white and cream colored. The deposit was at one time located by the Healdsburg Marble Company but abandoned on account of being too far from a railroad.

MAGNESITE.

There are numerous deposits of magnesite in Sonoma County, both large and small, as regards surface showings; but, on the whole, there has been too little development work to state anything definite yet as to their future productiveness. The largest deposits are handicapped so far by a lack of transportation facilities; but this feature will doubt-

Photo No. 177. Small Vein of Magnesite in serpentine, showing botryoidal forms and shrinkage cracks. Two thirds natural size. Kolling deposit, Sonoma County, California.

less be improved before long. The total recorded production for the county has been but 870 tons to the end of 1913.

For a statement of the properties and uses of magnesite see *Magnesite* under *Napa County.*

Bibl.: Bull. 38, pp. 331–333; U. S. G. S., Bull. 355, pp. 22–28; Bull. 540, pp. 490–498.

Ferdinand Albertz has an undeveloped deposit of magnesite on his ranch 1 mile southwest of Cloverdale.

Louis R. Ball, of Presidio, San Francisco, Cal., has an undeveloped deposit of magnesite near the Gilliam Creek deposits north of Guerneville, which are described below.

Brush Deposit, F. W. Brush took out about 250 tons of magnesite from a pocket on his ranch three miles east of Cloverdale. No further work has been done since 1909.

Bibl.: Bull. 38, p. 331.

Creon Deposit (see Kolling).

Cummings Ranch, Chas. G. Flick, owner. This deposit of magnesite in Sec. 23, T. 11 N., R. 11 W., about 2 miles southwest of Cloverdale, was worked for a short time by the Sotoyome Magnesite Company of Healdsburg. It has now been idle several years.

Bibl.: Bull. 38, p. 332; U. S. G. S. Bull. 355, p. 24.

Eckert Ranch (see *Yordi*).

Gilliam Creek Deposits (see *Healdsburg Marble Company,* and *Western Carbonic Acid Gas Company*).

Healdsburg Marble Company (also known as the *Madeira Deposit*), George Madeira, Healdsburg, manager. It is in the southwest corner of Sec. 31, T. 9 N., R. 10 W., 5½ miles north from Guerneville; elevation 1700 feet (bar.). There is a series of magnesite veins in serpentine from a few inches to 10 feet wide, and occurring over a width of about 1400 feet. They strike west of north and dip west at about 70°. The larger veins are of very good quality. There is a considerable tonnage in sight at the surface which can be cheaply quarried; but except for a couple of short tunnels there has been no development work underground.

At the west end, the veins are narrow and are banded with a green dolomitic material, chalcedony and quartz, forming a variety of "verde antique marble." It was for this that the deposit was originally located (1894), with the intention of putting it on the market as an ornamental building stone. This is the deposit described by Hess (see Bibl.) as "un-named."

The property has no transportation outlet as yet, but it is only a half mile from the claim of the Western Carbonic Acid Gas Company, which has a wagon road to Guerneville. The claims are patented.

Bibl.: R. XIII, p. 640; Bull. 37, p. 112; Bull. 38, pp. 114, 333, 369; U. S. G. S. Bull. 355, pp. 25, 26; Bull. 540, p. 497.

Kolling Deposit (formerly *Creon*), J. Kolling, Preston, owner. This is in Sec. 32, T. 12 N., R. 10 W., 2 miles north of Cloverdale and 2 miles

east of Preston on the Northwestern Pacific Railroad; elevation 1500 feet (bar.). The wagon road to Preston has a heavy grade, but it is all down hill. It is stated to cost $1.50 per ton to haul the magnesite to the railroad. There are four small, disconnected deposits of magnesite, the geology of which has been described by F. L. Hess (U. S. G. S., Bull. 355, p. 22). The characteristic botryoidal forms and shrinkage cracks are abundant in parts of these deposits, and the edges of the veins are more or less mixed with serpentine. (See photos Nos. 176, 177).

Photo No. 178. Magnesite from Kolling deposit, Sonoma County, California, showing pitted surface due to weathering. Two thirds natural size.

A peculiar pitted weathering effect was also noted (photo No. 178). Something over 500 tons of magnesite have been shipped from the property, but no work has been done the past five years (to January, 1914).

There is some heavy magnesite float on the north bank and in the bed of Big Sulphur Creek, just above the mouth of the canyon. This is below and about a mile south of the Kolling ground.

Bibl.: Bull. 38, pp. 331, 332; U. S. G. S. Bull. 355, pp. 22, 23.

Madeira (see *Healdsburg Marble Company*).

Magnesite float was found by the writer in Mark West Creek a short distance above Mark West Springs, but its source was not located.

On land owned by *M. C. Meeker,* of Camp Meeker, in Secs. 2 and 3, T. 8 N., R. 11 W., northwest of Guerneville, are scattered indications of magnesite, but no development work has been done.

Norton Ranch, E. M. Norton, owner. The Sotoyome Magnesite Company, of Healdsburg, took out a small tonnage of magnesite from an irregular deposit on the Norton ranch on Dry Creek, about 10 miles northwest of Healdsburg and 4 miles from Geyserville. No further work has been done.

Bibl.: Bull. 38, p. 333; U. S. G. S. Bull. 355, p. 28.

Photo No. 158. Upper tunnel, Cecilia Claim ("Red Slide"), Sonoma Magnesite Company, near Cazadero, Sonoma County, California.

Red Slide Deposits (see *Sonoma Magnesite Company*).

Sonoma Magnesite Company, U. S. Webb, president; Frank A. Janda, Chicago, Ill., secretary; H. P. Bee, manager; John M. Nordheim, superintendent. San Francisco office, Humboldt Bank Building.

Since my visit to the property (November, 1913), the control of the company has been transferred from A. B. Davis et al., of San Francisco, to the above-named. The new owners are proceeding to patent the claims and propose to increase development and improve the transportation facilities. The ground was at one time located by Geo.

Madeira, of Healdsburg, but lost through litigation. (Bull. 38, p. 333; Bull. 66, pp. 58, 59.)*

There are 30 claims in this group covering what are known as the Red Slide deposits on East Austin Creek.

The claims as indicated on the map are named as follows:

1.	Flora	9.	Otto	17.	Arthur No. 2	25.	Henry
2.	Cecilia	10.	James	18.	Francis	26.	Charles
3.	Marie	11.	Josef	19.	Ford	27.	Phillip
4.	Seymour	12.	Yard	20.	Clara No. 2	28.	Vera
5.	Cyril	13.	Marquise	21.	Alfred No. 2	29.	Empire
6.	Henrietta	14.	Peterson	22.	Vera No. 2	30.	Standard
7.	Constance	15.	Burris	23.	Trent No. 2		
8.	Manson	16.	Bertram No. 2	24.	Bertram		

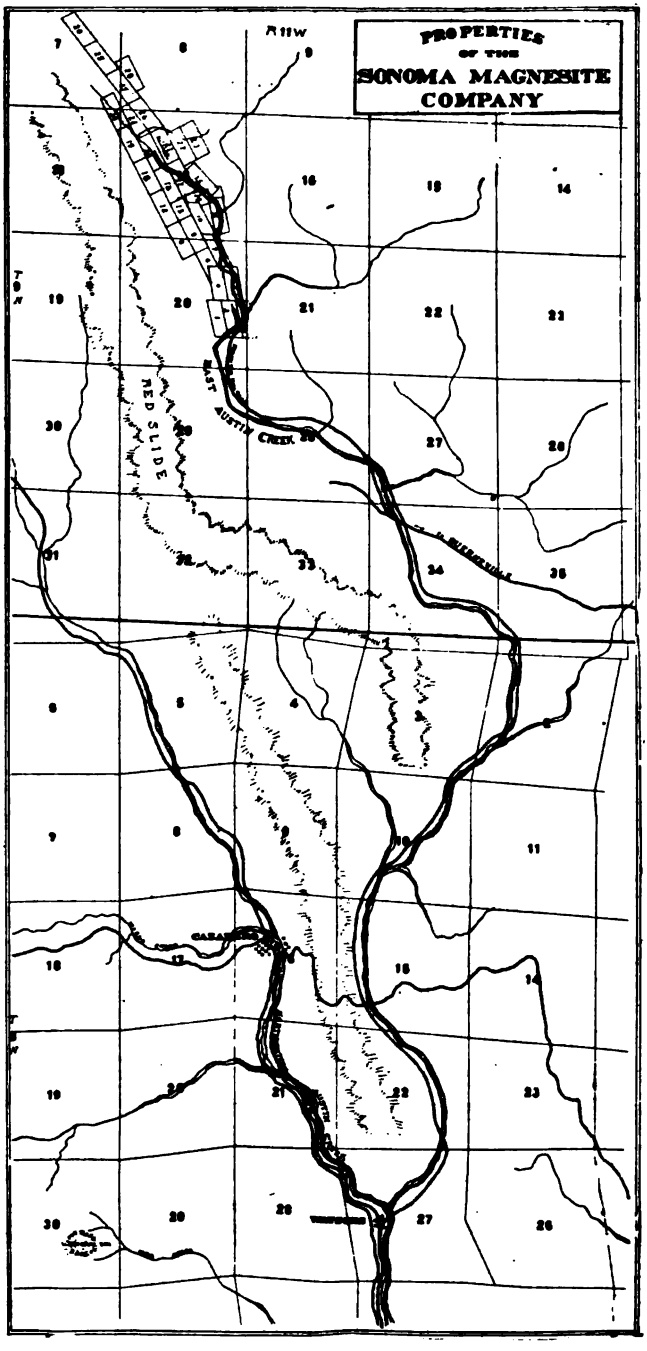
They are in Secs. 6, 7, 8, 17 and 20, T. 9 N., R. 11 W., 6 miles north from Cazadero (see map), but at present reached by road from Guerneville, 12 miles to the southeast. The company has a wagon grade about two thirds completed to connect with Watson station on the Northwestern Pacific Railroad, a distance of 11 miles. At the time of my visit this was the only work being prosecuted. By reason of inclement weather and a lack of time, a detailed study of the geology was not made.

There are three groups of magnesite outcrops with a northwest trend, in a large belt of serpentine. No work has been done on the northernmost one, which was not visited. Of the other two the principal work has been done on the lower group, mainly on the "Cecilia" claim at a sharp turn in the creek. Here there are two adits, the lower one of which is in over 200 feet, starting as a drift on the outcrop of a vein about 9 feet wide; but after 50 feet, turning to the northwest and running as a crosscut for about 180 feet, where a small step-faulted vein of magnesite was struck.

The upper Cecilia tunnel, which is supposed to cut the same formations as the lower, also starts on a large outcrop (see photo No. 158), but is run entirely as a crosscut. It is 50 feet above the lower tunnel and has cut veins showing widths of 12 feet, 5 feet, 15 inches, 18 inches, 6 inches, and 8 inches, as well as some smaller ones. This magnesite is of high grade as will be noted from the analyses quoted below. Magnesite outcrops in the creek bed here, and continues for a short distance

*Since this description of the property was put in type, the new company has completed its transportation connections, built a calcining plant, and is now making regular shipments. A 24-inch gauge railroad was laid on the road grade, and a distillate engine furnishes the motive power. Connection is made with the Northwestern Pacific at Magnesia station on a spur of about one-half mile from Watsons.

The magnesite is being mined at the lower deposit, where a quarry face has been opened up. In the calcining plant, a rotary kiln, oil-fired, is in operation, with capacity of 30 tons per 24 hours. A second kiln is stated to be enroute for installation. The crude mineral is crushed to pass a 2-inch ring before charging to the kiln; and the calcined material is pulverized after cooling in steel bins. Power is obtained by an oil-burning steam plant. The kiln consumes ¾ bbl. of oil per ton of calcined magnesia obtained, which is reduced to 5% CO_2. The finished product is packed in paper-lined duck bags for Pacific Coast consumption, and in 400-pound paper-lined barrels for the eastern market. Shipments are now being made to New York via the Panama Canal, an ocean rate of $5.00 per ton from tidewater, San Francisco, to New York having been secured. Seventy men are at work. —W. W. B., July, 1915.


PROPERTIES
OF THE
SONOMA MAGNESITE
COMPANY
R11W
RED SLIDE
EAST AUSTIN CREEK
GARAGE

up over the hill, but apparently does not cross the creek to the south. The general trend of the veins is about N. 25° W., and the dip northeast. There are a few hundred tons of broken magnesite on the dumps of these tunnels and as float below. Besides the usual characteristics, specimens were found exhibiting parallel shrinkage cracks (see photo No. 179). Almost no drifting has been done so far, so that the continuity or the extent of these veins underground is as yet uncertain.

Photo No. 179. Magnesite from "Red Slide" deposit—Sonoma Magnesite Company, Sonoma County, California. Showing parallel shrinkage cracks. Two thirds natural size.

At the upper claims the principal outcrop is on the Alfred (see photo No. 159). It appears to be at least 25 feet thick at the center, dipping at about 40° NE., and is stated to have been traced for a total length of about 1000 feet. It thins out, however, in both directions from the center. The only development work on this group is a crosscut tunnel started near the creek over 200 feet below the outcrop, and which is in about 100 feet. It has not yet cut any magnesite. Vera No. 2 adjoins the Alfred.

There is also on the claims a good stand of cypress suitable for mine timbers, and some "fir" (Douglas spruce) and redwood.

It is intended when development has proceeded sufficiently to warrant it, to erect calcining furnaces on the property, a gas plant and possibly a brick plant, and to convert the wagon grade into a railroad so as to handle the products direct to tidewater without transshipment.

It is stated that with properly equipped furnaces one barrel of crude oil will produce one ton of calcined magnesite. Mr. Davis has gone quite thoroughly into the subject of the uses for magnesite, and its market, and he estimates that with rail facilities to tidewater the material can be shipped to Chicago, New York and other eastern points via Panama Canal at a rate which can compete with the Grecian and Austrian product. The market in Japan and China can also be reached profitably.

ANALYSES.

Sample from—	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	CO_2	$MgCO_3$	Undetermined
[1]Cecilia (upper tunnel)	7.67	0.26	0.29	0.04	43.42	48.08	----	0.24
[2]Cecilia	3.66	.75	.44	.20	44.90	49.20	----	0.85
[3]Alfred	[6]2.50	0.55		[7]2.80	----	----	93.92	.36 [9].37
[4]Alfred	2.50	2.2		----	46.0	[8]49.3	----	----
[5]Vera No. 2 (calcined)	.74	5.05		None	94.21	----	----	----
[5]Alfred (calcined)	6.66	10.22		.52	82.60	----	----	----
[5]Vera (calcined)	7.85	.21	4.68	----	87.31	----	----	----

[1]Analysis by A. J. Peters (U. S. Geological Survey).
[2]Analysis by W. C. Wheeler (U. S. Geological Survey).
[3]Analysis by Stauffer Chemical Company, San Francisco.
[4]Analysis by Selby Smelting and Lead Company, Selby, California.
[5]Analysis by Booth, Garrett & Blair, Philadelphia, Pa.
[6]Silicates.
[7]Calcium carbonate.
[8]Calculated.
[9]Moisture.

It appears from these analyses that some of the magnesite from the upper claims carries more iron than that from the lower group; also that the content of silica is variable. As has already been noted (see introduction to *Magnesite* under *Napa County*), in the manufacture of magnesia brick for basic open-hearth liners in the steel process, a small percentage of iron (up to say 10 per cent) is not only permissible but desirable. So, if the eastern market can be reached economically, it would seem that this lower grade material of the Sonoma Magnesite Company may be made available some day.

Bibl.: Bull. 38, p. 333; Bull. 66, pp. 58, 59; U. S. G. S. Bull. 355, p. 26; Bull. 540, pp. 490–495.

Photo No. 159. Magnesite outcrop on Alfred Claim ("Red Slide") of Sonoma Magnesite Company, Sonoma County, California.

Sotoyome Magnesite and Mineral Paint Company (see *Healdsburg Paint Company,* under *Mineral Paint*).

Sotoyome Magnesite Company (see *Norton Ranch*).

Western Carbonic Acid Gas Company, Chas. S. Harker, Agnew, president and manager. This group is at the head of Gilliam Creek, in Sec. 6, T. 8 N., R. 10 W., 5 miles north from Guerneville, from which it is reached by wagon road, the last mile having been built by the company. This deposit is similar to that of the Healdsburg Marble Company, above it near the top of the ridge and about a half mile to the north. There are several large outcrops of magnesite occurring in serpentine. Very little development work has been done—a few surface cuts.

The following analyses of material from this group are given by H. S. Gale (U. S. G. S. Bull. 540, p. 497):

	No. 1	No. 2
SiO_2	3.51%	10.21%
Al_2O_3	1.10%	.31%
Fe_2O_3	.80%	.74%
CaO	1.46%	.59%
MgO	43.65%	41.06%
CO_2	49.16%	44.76%
Undetermined	.32%	2.33%
	100.00%	100.00%

Yordi Ranch (formerly *Eckert*), Mrs. Grace P. Yordi, Cloverdale, owner. It is 2 miles southeast of Cloverdale, on the east side of the Russian River; elevation 425 feet (bar.). Several years ago about 700 tons of magnesite are reported to have been dug from the soil-covered hillside above the road, and 400 tons shipped. It was not until 1912 that the balance was shipped to San Francisco. The magnesite was apparently residual boulders in the soil overlying a serpentine bedrock.

Bibl.: Bull. 38, p. 333; U. S. G. S. Bull. 335, p. 23; Bull. 540, p. 498.

MANGANESE.

Shaw Prospect, Estate of I. E. Shaw, Cloverdale, owner. There is a deposit of high grade manganese ore on the Shaw ranch, 7 miles northwest of Cloverdale, on which a small amount of development work has been done.

Bibl.: R. XII, p. 330; XIII, p. 507; Bull. 38, p. 337; U. S. G. S. Bull. 427, p. 163.

Besides the above, there are specimens of manganese ore in the museum of the State Mining Bureau from Freestone, Guerneville, Mark West Springs and Santa Rosa.

Bibl.: R. IV, p. 316; Bull. 38, p. 368.

MARBLE.

Healdsburg Marble Company (see under Magnesite; also under Limestone).

MINERAL PAINT.

Brown's Ochre Mine (see *Meeker*).

Healdsburg Paint Company, T. S. Merchant et al., Healdsburg, owners. This property was at one time known as the Indian Metallic Red Paint Mine, and also under the name of Sotoyome Magnesite and Mineral Paint Company. It is on Porter Creek in T. 8 N., R. 10 W., about 10 miles by road southwest of Healdsburg. The material is a low grade hematite, high in silica, and a considerable tonnage was shipped out some years ago, but none since 1906.

Bibl.: R. XI, p. 462; R. XII, p. 406; XIII, p. 643; Bull. 38, p. 340.

Lancaster Ranch (see under Iron).

Meeker's Ochre Deposit (formerly *Brown's*) M. C. Meeker, Camp Meeker, owner. This deposit of ochreous clay is in Sec. 21, T. 7 N., R. 10 W., 1½ miles north of Camp Meeker. Several years ago there were four or five carloads of paint shipped from this property, but none since.

Bibl.: Bull. 38, p. 340.

Occidental Deposit, J. D. Connelly, owner. There is an undeveloped deposit of ochreous clay, just west of the hotel at Occidental.

There is said to be a small spring deposit of yellow ochre 5 miles northeast of Cazadergo.

Skinner Graphite Company (see under Graphite).

Sotoyome Magnesite and Mineral Paint Company (see *Healdsburg Paint Company*).

MINERAL WATER.

Sonoma County, like its neighbors, Lake, Napa, and Mendocino counties, has a large number and variety of mineral springs. Some of these are well known, and have a world-wide reputation. They vary in character and composition from the cold "seltzer" of Lytton's to the boiling hot waters and steam vents of The Geysers. Most of them are well equipped with comfortable hotels and cottages, and are fairly accessible to transportation lines. Sonoma County is one of the "playgrounds" of California and many of her summer resorts are located around these mineral springs.

Agua Caliente Springs, Theodor Richards, Agua Caliente, owner. These springs are at Agua Caliente on the Northwestern Pacific Railroad, 2½ miles northwest from Sonoma; elevation 131 feet (Northwestern Pacific). It is stated that originally the hot spring here was merely a mud hole used for many years by the Indians. The present owner has drilled six wells, and put in a large swimming tank, a bathhouse, and a bottling works. The water is pumped, though it is stated that in the winter the wells have a small artesian flow.

The water pumped to the swimming tank shows a temperature of 102° F. at the pump (2 wells combined, 1 of which is said to be warmer than 102°). The well from which water is bottled shows a temperature of 95° F. at the pump, and is discharged into a tank to cool before bottling. Electric power is used, and there is an auxiliary gasoline engine for emergency use. There is a capping machine, carbonator, and mechanical labeler. There are accommodations for 300 guests in the hotel and cottages.

Bibl.: R. XI, p. 458; XIII, p. 521; U. S. G. S., Water Sup. Pap. 338, p. 113.

Agua Rica Hot Sulphur Spring (see *Boyes*).

Alder Glen Springs, William Lang, Pioneer Soda Water Company, Oakland, owner; J. A. Serres, lessee. These springs are in Sec. 3, T. 11 N., R. 11 W., 3 miles northwest of Cloverdale; elevation 525 feet (bar.). McCray station on the Northwestern Pacific is the railroad point during the summer season. The springs are in serpentinized sandstone, and the four principal ones have the following temperatures: Sulphur, 58° F.; Magnesia, 56°; Soda, 57°; Iron, 57°. Water from the soda springs is bottled "natural" at the spring. Some is also shipped in barrels to Oakland and sold in siphons, carbonated. The hotel and cottages are picturesquely situated in a beautiful canyon of alders, redwoods and oaks.

Bibl.: WINSLOW ANDERSON, "Mineral Springs and Health Resorts of California," p. 76, U. S. G. S. Water Sup. Pap. 338, p. 166.

Altamont Medical Springs, J. D. Connelly, Occidental, owner. This is a lightly mineralized spring in Sec. 34, T. 7 N., R. 10 W., at Occidental on the Northwestern Pacific Railroad. None is bottled for sale. There is a hotel in connection.

Barcal Spring, Barcal Water Company, operators; J. Kolling, Preston, manager. This calcic-magnesic spring is near the Kolling magnesite deposit in Sec. 32, T. 12 N., R. 10 W., about 2 miles east of Preston on the Northwestern Pacific Railroad at an elevation of 1375 feet (bar.). They have been bottling for about seven years past, originally at the spring itself, but now the water is piped 9000 feet to the works at Preston station. Electric power is used and three men are employed. The product is put up both carbonated and natural. There is no resort in connection with this spring. Near-by there is also an iron spring, but not utilized.

Boyes Hot Springs (at one time called *Agua Rica*), Boyes Hot Springs Company, owners; Henry Trevor, San Francisco, president; Thos. P. Boyd, Santa Rosa, secretary; R. G. Lichtenberg and Dr. E. L. Parramore, managers. The post office and railroad station are both named Boyes Springs. It is 2 miles northwest of Sonoma; elevation 129 feet (Northwestern Pacific). The property was formerly owned by Captain Boyes, and has been operated by the present company for seven years.

Water is obtained from both springs and wells. It is pumped to tanks to give pressure for the bathhouse use, and also pumped to the bottling works, where it is cooled before bottling. Electric power is used. The bottling is done under lease from the company by John W. Kelly. Most of the production is carbonated, but a few cases per month, "still."

There is a fine large swimming pool and a well-appointed bathhouse. The temperature of the water of the principal spring was 112° F., taken at the pump. There are accommodations for 300 guests in the hotel, cottages and tents.

Bibl.: R. XI, p. 458; XII, p. 347; XIII, p. 521 U. S. G. S. Water Sup. Pap. 338, p. 112.

Burns Springs, F. M. Hathaway, owner. These springs are on the Hathaway ranch, 3½ miles east of Glen Ellen, but are not utilized except by the occupants.

Bibl.: R. XII, p. 347; XIII, p. 521.

California Geysers (see *The Geysers*).

Camp Rose. There is stated to be a sulphur water spring at the Camp Rose resort, 1½ miles from Healdsburg.

Chimney Rock Spring, J. A. Watson, Guerneville, owner. This sulphur water spring is at the corner of Secs. 26, 27, 34 and 35, T. 8 N., R. 11 W., 6 miles west of Guerneville; and is so called because of its proximity to a natural topographic feature of the same name. The elevation is 900 feet (bar.). It is stated that water has been bottled here in a small way by hand for about twenty-five years.

Eleda (see *Fetters*).

Fetters Hot Springs (one time called *Eleda*), George Fetters, owner. This resort at the post office of the same name is between Boyes and Agua Caliente springs in the warm water belt, extending northwesterly from Sonoma. Elevation 124 feet (Northwestern Pacific). There are 3 wells, stated to be artesian in winter, the first one of which was drilled in 1908. The warm water was struck at a depth of 300 feet. It is pumped, using electric power, to a tank, for swimming and bathing. A small amount is bottled, carbonated, for use at the hotel. The temperatures of the two principal wells are said to be 114° F. and 90° F., respectively, but as they are capped, and the pump was not running, I was unable to take a thermometer reading at the time.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 114.

Geysers (see *"The Geysers"*).

Hoods Hot Springs, O. R. Baldwin, Cloverdale, owner. In the canyon of Dry Creek, 15 miles north of west from Cloverdale. Two springs. Temperature 100° F. Small flow. Used locally for bathing.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 82.

Kawana Springs (formerly *Taylor's White Sulphur Springs*), J. S. Taylor, Santa Rosa, owner; P. Criblet, lessee. These springs are in Sec. 36, T. 7 N., R. 8 W., 2½ miles southeast from Santa Rosa; elevation 276 feet (bar.). The principal spring has a temperature of 57° F. The hotel has accommodations for about 100.

Bibl.: R. VI, Pt. I, p. 75; X, p. 676; U. S. G. S. Bull. 32, p. 209; Water Sup. Pap. 338, p. 256: ANDERSON (op. cit.), p. 264.

Lytton Springs (see *Salvation Army*).

Mark West Springs, J. O. Wickham, Santa Rosa, owner. These well known springs are in Sec. 14, T. 8 N., R. 8 W., 10 miles north of Santa Rosa, from which city they are reached by automobile stage; elevation 450 feet (bar.). The warm springs are on the edge of Mark West Creek. The following temperatures were observed: Bath Spring, 93° F. (strong flow); Magnesia, 90°; "Plunge," 92° (has excess gas); Sulphur, 90°; Arsenic, 65°; two, iron 58° each; one, iron 54°; two "iron" across creek from others, 67°. The Bath Spring water, when a higher temperature is desired, is heated artificially.

The hotels and tents will accommodate about 150 guests. One picturesque feature of this resort is the large wild grape arbor in front of the hotel. There are eleven trunks up to 8 inches in diameter, which are twined around the porch posts, and the vines spread out on the arbor frame over the driveway.

Bibl.: R. VI, Pt. I, p. 75; VIII, p. 634; XII, p. 347; XIII, p. 522; U. S. G. S. Bull. 32, p. 206; Water Sup. Pap. 338, p. 115; ANDERSON (op. cit.), p. 192.

On the *James O'Brien Ranch,* one mile northwest of Sea View, in Sec. 7, T. 8 N., R. 12 W., there is a cold mineral water well. It is at a station on the stage road west from Cazadero.

O'Donnell's Sulphur Spring is near Glen Ellen.

Ohms Springs—a drilled well ½ mile southeast of Boyes Springs. A small resort. Mrs. F. Shirley, Sonoma, owner.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 113.

Salvation Army's Boys and Girls Industrial Home and Farm (inc.) (formerly Lytton Springs; also Golden Gate Orphanage), Major C. W. Bourne, president; A. E. Marpurg, secretary; post office, Lytton. These springs were originally and for many years known as Lytton Springs. The property is now maintained as an orphans' home by the Salvation Army. There are two principal springs, with the following temperatures: Soda, 64° F.; Seltzer, 62°. The soda spring is at an elevation of 425 feet (bar.), or 200 feet higher than the "seltzer" and ½ mile

distant. The latter makes a very pleasant table water. A few cases of water per month are put on the market, being hauled in barrels to Healdsburg, and there bottled by a local company. The management desires to lease the bottling privilege.

Bibl.: R. VI, Pt. I, p. 74; VIII, p. 634; X, p. 675; XII, p. 347; XIII, p. 522; U. S. G. S. Bull. 32, pp. 205, 206, 211; Water Sup. Pap. 338, p. 165; ANDERSON (op. cit.), pp. 188–190.

Skaggs Hot Springs, Peter J. Curtis, Skaggs, owner. This group of well known hot springs is on Warm Spring Creek, in Secs. 23 and 24, T. 10 N., R. 11 W., 9 miles west of Geyserville, from which it is reached by a good automobile road. There has been a resort here since previous to 1875. The present owner bought the property in 1913, having had it leased for the five years previous.

There are three principal springs, all with good strong flows, and all have excess carbonic acid gas, especially the third one noted below, which is very vigorous. While nearly all of the hot springs, which have been observed by the writer, are more or less sulphurous, these at Skaggs are noticeably free from sulphuretted hydrogen. The following temperatures were recorded: 124° F., 125° and 130°. The last mentioned is inclosed by a concrete curb, and the others by brick. There is a cold soda spring about 300 yards above. There are accommodations for 200 in the hotel, cottages and tents. When visited (November, 1913), a swimming tank 30 feet by 60 feet was being built, and other improvements planned.

Bibl.: R. VI, Pt. I, p. 75; VIII, p. 634; X, p. 675; XII, p. 347; XIII, p. 522; U. S. G. S. Bull. 32, pp. 207, 211; Water Sup. Pap. 338, pp. 81, 82; ANDERSON (op. cit.), p. 244.

The State Home at Eldridge has a warm spring similar to the others in the Sonoma Valley.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 114.

Taylor White Sulphur Spring (see *Kawana*).

"The Geysers," D. and H. A. Powell, San Francisco, owners; Chas. Boldsdorff, 199 Fourth street, San Francisco, lessee; post office, "The Geysers." These famous hot springs are in the northern corner of Sonoma County, in Sec. 13, T. 11 N., R. 9 W., 18 miles east of Cloverdale; elevation 1450 feet (bar.) on the hotel porch. During the summer months an automobile stage line runs to The Geysers from both Healdsburg and Cloverdale. From the latter it is a picturesque ride up the winding and rugged canyon of Big Sulphur Creek, one time called the Pluton River. Formerly there was also a stage line from Calistoga on the east.

These "geysers" themselves (though there are no true geysers that spout high in the air, as at the Yellowstone Park, Wyoming) are a series of boiling hot springs in two short tributary canyons on the north side of the creek, opposite the hotel (see photo No. 146 and No. 151). The ebullition is so violent in the one called the "Devil's Teapot" that a column of water about a foot across is continually projected 10 to 12 inches above the surface of the small surrounding pool. Because of this violent bubbling, I was unable to take the temperature of this particular spring, not having a registering thermometer. Scalded fingers were the reward of attempting to get it with the ther-

Photo No. 146. The Geysers Canyon, Sonoma County, California, from across Big Sulphur Creek.

mometer carried. Around this pool is a black deposit of iron sulphide. A small vent near-by gave 206° F., while at the "Devil's Kitchen" just below, over a space of several feet, temperatures of 130° to 202° were obtained. At a steam vent above, 210° was obtained and 206° at another black sulphur spring. Sulphur crystals are continually forming around the steam vents. Epsomite and other minerals, the result of deposition from the vapors and of efflorescence, are abundant.

Just over a small ridge from the main group and in another ravine to the east, is the "Steamboat Geyser." This steam vent roars with sufficient pressure that a 2-inch rock dropped on it is thrown off violently before it has a chance to cover the aperture. The temperature is 212° F. In the early days of the resort, this vent was capped

with a steam whistle (hence the name); but it is stated to have been blown off. Because of the noise it never was replaced.

On the edge of the main creek below these ravines, are a number of other springs, the principal ones having the following temperatures: "White Sulphur," 68° F.; "Hot Sulphur," 100°; "Hot Iron," 130°; "Hot Magnesia," 143°. The last named is the one from which water is bottled for sale. Formerly the bottling was done at The Geysers. Now, except for a few cases per month for use at the hotel, it is shipped

Photo No. 151. Looking down the Geysers Canyon, Sonoma County, California.

in barrels to San Francisco and Richmond for bottling. The hotel, which has accommodations for 150, is usually closed from October to May first.

Because of the neighboring quicksilver districts, these solfataric springs have been much described and discussed in relation to the association of hot springs with the genesis of quicksilver ores. Along Big Sulphur Creek, both above and below Geyser Canyon, are several other places of similar deposits but where activity is now extinct. There is a "sulphur bank" a short distance below. The "Little Geysers" are 3 or 4 miles above the main group.

Bibl.: R. IV, p. 182; VI, Pt. I, p. 75; VIII, p. 635; X, pp. 672–675; XII, p. 347; XIII, p. 521; U. S. G. S. Mon. XIII, p. 377;

Bull. 32, pp. 204, 206; Water Sup. Pap. 338, pp. 83–88; ANDERSON (op. cit.), pp. 136–154; GEOL. SURV. OF CAL., Geology Vol. I, pp. 93 *et seq.*

Wall Spring, H. C. Wall, Hilton, owner. This is a magnesia spring in Sec. 30, T. 8 N., R. 9 W., northeast of Hilton. There was formerly a resort here but it has been closed the past two years.

Bibl.: U. S. G. S. Water Sup. Pap. 338, p. 257.

In addition to the above springs there is a cold magnesia spring on Mt. Jackson near Guerneville, *G. F. Austin,* owner; a cold sulphur water spring on the *J. C. Junker* ranch above the Great Eastern quicksilver mine near Guerneville; a warm sulphur water spring on land of the *Sonoma Magnesite Company,* north of Cazadero; *Los Guilicos Warm Springs,* 1½ miles southwest of Kenwood; and *McEwan Ranch,* 3 miles southwest of Kenwood. About ½ mile south of Glen Ellen, on the edge of the creek, there is a spring; temperature 76° F.; with excess CO_2, though it has no distinct mineral taste. None of these springs are at present utilized. There are also a number of small, locally known, cool sulphur springs on Sulphur Creek and Little Sulphur Creek, near Cloverdale.

Bibl.: U. S. G. S. Water Sup. Pap. 338, pp. 114, 258.

NATURAL GAS.

At several places, in the vicinity of Geyserville and in the valleys of Sonoma and Petaluma creeks, an inflammable natural gas has been encountered in well boring operations, but no commercial supply developed.

Bibl.: R. VII, p. 181; XI, p. 458.

ONYX MARBLE.

(See *Healdsburg Marble Company,* under Magnesite).

OPALS (see Gems).

PAVING BLOCKS (See Stone Industry).

PETROLEUM.

There are some small outcrops of oil-stained sand (asphaltic base) on the Ducker ranch, three miles due east of Petaluma; elevation 280 feet (bar.). The Petaluma Oil and Development Company, M. S. Meeks, secretary, has a lease on the ground, but no work has been done since the spring of 1910. Under sublease from this company, the Ramona Oil

Company drilled three shallow holes and the Petaluma Home Oil Company one.

The log of well No. 1 was as follows:

Buff sand	65 feet
Blue clay	597 feet
Brown sand	38 feet
Blue clay	100 feet
Total depth	800 feet; gas struck

It is stated that the gas showed a pressure of 217 pounds and a flow of 690,000 cubic feet per 24 hours. It was utilized under the boilers in sinking the second well until the flow was cut off by the well clogging up.

The log of well No. 2 shows oil sands at depths of 335 to 340, 346 to 352, 397 to 399 feet, followed by a succession of shale, shell and gumbo strata to 910-foot depth. The strata exposed in the bed of a small creek about 300 feet west of the derrick show a strike east and west and a dip of about 40° to the south.

Oil seepages and gas are reported in Bennett Valley on the Parsons ranch, 7 miles due north from Petaluma.

Bibl.: Report XI, pp. 453–463; Bull. 69, p. 472.

QUICKSILVER.

Outside of the New Almaden mine in Santa Clara County, the Sonoma County quicksilver deposits (particularly those of the Pine Flat district) are among the oldest known in the state. They vary in character from the ordinary, mainly cinnabar-bearing ores, and the less common meta-cinnabarite, to the purely native mercury type as in the Rattlesnake and the Socrates. This last named group is found in the Pine Flat district, southeast of The Geysers; and has proven so far the most difficult to handle both from a mining and a metallurgical standpoint.

Prospecting and exploitation of the Pine Flat belt of deposits began in the early sixties and in 1861 some 33,000 feet of claims had been located on it (Geol. Surv. of Cal., Geology, Vol. I, p. 89). Among the claims being worked in that year were the Cincinnati, Dead Broke, Pittsburg, Pioneer (later renamed Socrates), and Denver. Though small amounts of quicksilver were produced by a retort from the Pioneer's native mercury ore, the result was not profitable from a pecuniary standpoint. The first definitely recorded output of quicksilver in the county was from the Sonoma mine in the same district in 1873 (Min. Res. West of the Rocky Mts., 1874, p. 30).

As will be noted from the table of mineral production (see page 144), there have been two principal periods of activity in the yield of quicksilver from Sonoma County mines—1874 to 1883 and 1888 to 1906. From 1882 to 1894, the Great Eastern mine was the only producer.

The total recorded output for Sonoma County to the end of 1913 was 61,407 flasks valued at $2,533,228. (For further descriptions as to market values, also metallurgy, see introduction to Quicksilver under Lake County.)

Bibl.: R. IV, p. 336; V, pp. 95, 96; VI, Pt. I, p. 102; VIII, p. 632; X, p. 675; XI, p. 460; XII, p. 371; XIII, pp. 602, 603; Bull. 20, p. 19; Bull. 27, pp. 97–117; GEOL. SURV. OF CAL., Geol., Vol. 1, pp. 88–91; U. S. G. S., Mon. XIII, pp. 362–364, 369, 376, 377; Min. Res. 1883, 1884, 1888, 1902, 1906, 1907, 1908, 1909, 1910, 1911, 1912, An. Rep. XVI, Pt. III, p. 598; XX, Pt. VI, p. 271; XXI, Pt. VI, p. 278; Trans. A. I. M. E., Vol. III, pp. 273, 275, 276, 290, 300, 304.

Almaden, Incandescent and Tunnel Site Group. These prospects near the Socrates mine have been abandoned several years. A 10-pipe retort was built.

Bibl.: Bull. 27, p. 97.

Altamont Copper Group. Quicksilver has been reported on these copper claims north of Camp Meeker, but no definite vein or ore body has been found.

Bacon Consolidated Group. On Pine Mountain. Abandoned.

Bibl.: Bull. 27, p. 97.

Big Chief Claim (see *Squaw*).

Black Bear Mine (see *Culver-Baer*).

Boston Group. These prospects about a mile east of the Pine Flat schoolhouse have been idle for the past 8 years. It is stated that a homestead has been lately filed on the land by Charles Acy.

Bibl.: Bull. 27, p. 97.

Bright Hope Mine. F. P. Tiran, Cloverdale, owner. This prospect is on an 80-acre piece of land held under an agricultural patent. It is on the Geysers road 15 miles east of Cloverdale, and 2 miles above the Cloverdale mine on the opposite side of Big Sulphur Creek; elevation 1475 feet (bar.). There are two crosscut tunnels on the stage road level, one in 180 feet and the other 450 feet. The latter attains a depth of 100 feet below the surface, and has drifts of 75 feet west and 60 feet east, also a 50-foot winze. The country rocks are sandstone and serpentine. The ore occurs partly in a ledge and partly as an impregnation in the sandstone. Both cinnabar and native quicksilver are present, with quartz as the principal gangue mineral, mixed with some serpen-

tine. No ore has been taken out as yet except that in the course of development. There is no reduction equipment.

Buckeye Claim. F. Baumeister and George Hemenway, Cloverdale, owners. Elevation 2100 feet (bar.). This was formerly the Mt. Vernon claim of the Cloverdale group, which it adjoins, and was located by the present owners in 1910. Subsequent court proceedings confirmed their title to the ground, which it is intended to patent after this year's (1914) assessment work is done.

The ore-bearing zone is stated to be 100 feet wide and is made up of chert, impregnated sandstone, and stock-works, carrying cinnabar. This zone, which strikes northwest and southeast in the Cloverdale, turns abruptly to the south at the Squaw and Buckeye, crossing to the opposite side of Big Sulphur Creek; then turning again runs south of east through the Bright Hope, passing to the south of The Geysers and continuing southeasterly through the Socrates in the Pine Flat section. In the Cloverdale the dip is northeast at about 70°, east at the Buckeye, and southwest at the Socrates. While native mercury is a characteristic in the southern part of this zone, none is found in it north of Big Sulphur Creek. The Buckeye is being developed on three levels by an open cut and two tunnels, the lowest of which will give 200 feet of backs. There is a shaft of 50 feet and a tunnel of 300 feet, which were driven by the original locators. There are 200 tons of ore said to average 5 per cent, broken in the open cut.

Bibl.: Bull. 27, p. 99.

Cinnabar King Group. Cinnabar Mining Company, owners. Eli Bush, Healdsburg, treasurer. This group of 5 patented claims in Sec. 11, T. 10 N., R. 8 W., has been idle the past five years. The occurrence of ozocerite has been noted in this mine, associated with quicksilver.

Bibl.: R. XI, p. 461; XII, p. 371; XIII, p. 602; Bull. 27, p. 98; U. S. G. S. Min. Res., 1910, Pt. I, p. 701.

Cloverdale Mine. F. E. Johnston, Napa, and Harry Patten, Calistoga, owners. This group consists of the Cloverdale, already patented, and 5 other claims and a millsite which the owners are preparing to patent. The mine has had a somewhat intermittent history, having first been opened up in 1872. Its total production to the end of 1912 has been 5077 flasks, valued at $250,000. It is in Sec. 4, T. 11 N., R. 9 W., 12 miles east from Cloverdale, on the ridge between Big Sulphur and Squaw creeks, at their junction, the mine workings and reduction plant being on the slope toward the former. The topography is very steep,

the elevation being 1000 feet at the furnace and 2200 feet (bar.) at the top of the ridge.

The ore body is characterized by "ledges of thinly stratified chert, inclosed by sandstone." The cinnabar occurs as "face metal" and incrustations in the fissures of the more compact chert beds, and as richer seams and bunches in the crushed portions. The chert is highly siliceous. The deposit has been opened up at several different levels, by both open cuts and tunnels. The earthquake of 1906 is stated to have disclosed the edge of an ore shoot in the "Glory Hole" cut, from which about $40,000 in quicksilver was produced. As a whole the underground workings are not very extensive, the major portion of the output having come from the open cuts. With topography decidedly in their favor, the ore is handled a surprisingly unnecessary number of times between the mine and the furnace. The latter, which is of 25 tons capacity, is an incline, tile furnace with reverberatory hearth.

The property has been idle the past two years except for a small tonnage of ore retorted, to "sample" the ore body. Mr. Johnston states they are not operating on account of the unsatisfactory labor situation and the low price of quicksilver.*

Bibl.: R. X, p. 675; Bull. 27, pp. 98–102, 215, 217; U. S. G. S. An. Rep. XXI, Pt. VI, p. 278; Min. Res. 1902, p. 253; 1907, Pt. I, p. 554; 1910, Pt. I, p. 701; 1911, Pt. I, p. 904; 1912, Pt. I, p. 944; Min. Res. W. of Rocky Mts., 1875, pp. 14, 177; 1876, p. 20.

Clyde Mine (see *Culver-Baer*).

Crown Point Quicksilver Mining Company (see *Sonoma*).

Culver-Baer Mine, Culver-Baer Mining Company, owners; C. E. Humbert, president; J. P. Menihan, secretary; home office, Cloverdale. The holdings of this company now include, besides the Culver-Baer group, proper, the Black Bear, Clyde, Kentucky, Missouri and Sonoma groups. The last named group was bought about three years ago and its 24-ton Scott fine ore furnace removed to the Culver-Baer. With the exception of the Sonoma, these claims are at the head of Devil's Den, a branch of Little Sulphur Creek, in Sec. 23, T. 11 N., R. 9 W., 20 miles south of east from Cloverdale. The Culver-Baer group proper includes the old Geyser and Oakland mines, of early days, which were producers for several years previous to 1880. In 1875 the Oakland mine was producing 100 flasks per month with six retorts. The property is credited with a total production to the end of 1912 of 8154 flasks.

The topography is rugged; elevation 2200 feet (bar.) at the stable. The ledge is characterized by a bold outcrop of silicified sandstone with abundant yellow ochre, and is traceable on the surface for a mile in

*Since the above was written, we are informed that a concentration plant is being installed; also, the price of quicksilver has gone up on account of the European war.

length. The vein filling is mostly quartz with some lime and chalcedony. The ore carries cinnabar, meta-cinnabarite and some native mercury. The ledge averages 100 feet in width but only 35 feet on the footwall is stoped. It strikes northwest, dips northeast on an average of 60° and has been drifted on, all told, for a length of 1200 feet. The hanging-wall is serpentine.

The three main levels are the upper tunnel of 700 feet in length, the lower tunnel in 2000 feet, and 300 feet below, and an intermediate level which does not come to the surface. These two tunnels are connected by a raise from the 1200-foot point in the lower one. At the time the mine was visited (October, 1913) it was idle, only a watchman being retained; but since then a few men have been put on to drive a new raise, starting at 1960 feet in the lower tunnel. One stope from the No. 1 raise is 25 feet wide by 90 feet long and has 400 feet of backs. They have not yet reached the ground worked by the old company.

The equipment includes an air compressor driven by a 25 horsepower Fairbanks-Morse gasoline engine; also Cleveland stopers and an 8-inch by 10-inch jaw crusher. There is a 16-ton Knox Osborne coarse ore furnace, a 24-ton, Scott fine ore furnace and a retort. A small steam engine drives the furnace blower. A field kiln of 118,000 bricks for furnace work was burned three or four years ago from clay near the mine.

Bibl.: R. IV, p. 336 (table); V, p. 96; XI, p. 461; XII, p. 371; XIII, pp. 602, 603; Bull. 27, pp. 102–105, 113, 215; U. S. G. S. Mon. XIII, p. 377; Min. Res. 1902, p. 253; 1907, Pt. I, p. 680; 1908, Pt. I, p. 690; 1909, Pt. I, p. 554; 1910, Pt. I, p. 701; 1911, Pt. I, p. 904; 1912, Pt. I, p. 944; MIN. RES. W. OF ROCKY MTS., 1875, pp. 14, 175, 177, 493; TRANS. A. I. M. E. Vol. III, pp. 276, 304.

Crystal (see *Pacific*).

Double Star, near Pine Flat. Abandoned. No ore was found after considerable development.

Bibl.: Bull. 27, p. 105.

Eureka Mine (originally *Flagstaff*), Eureka Quicksilver Mining Company, owner; James B. Barber, 1421 High street, Oakland, president. This group of four claims and three millsites, part of which is patented, is in the Pine Flat district, in Sec. 32, T. 11 N., R. 8 W., about 25 miles by road northeast from Healdsburg and the same distance northwest from Calistoga. Outside of a small amount of prospecting work done as assessments to hold the unpatented claims, the property has

been idle the past ten years. It is northwest of and adjoins the Socrates.

The ore body is on the contact between a serpentine hanging-wall and sandstone footwall, being in part altered and gouge material from both. Values occur as cinnabar, meta-cinnabarite and native mercury, about 50 per cent being native. There is one tunnel in about 1000 feet, giving 300-foot backs, and several other shorter ones above. The lowest tunnel has drifts of 250 feet and 100 feet, respectively. Another tunnel has been started at a still lower level. There is a 10-ton, modified Livermore-Fitzgerald furnace, a gasoline engine and a small compressor included in the equipment. A few flasks of quicksilver were produced in 1904.

Bibl.: Bull. 27, pp. 106–108; U. S. G. S. Mon. XIII, p. 376; MIN. RES. W. OF ROCKY MTS., 1875, pp. 14, 176.

Great Eastern Mine, Great Eastern Quicksilver Mining Company, owner; George Roeth, 125 Market street, Oakland, president. This mine is in Sec. 16, T. 8 N., R. 10 W., 4 miles northeast of Guerneville by a good road; elevation 360 feet (bar.). Production of quicksilver began here with an output of 412 flasks in 1875; and the mine is credited with a total output to date of 40,923 flasks, or about two thirds of the total output of Sonoma County to the end of 1912. This includes the yield of the Mt. Jackson mine adjoining, as the two were operated in conjunction for a number of years, and their individual figures are not separable. As has already been noted (see introduction to Quicksilver), from 1882 to 1894, the Great Eastern mine was the only producer in Sonoma County.

This Great Eastern-Mt. Jackson lode is peculiar because of its isolation from other workable quicksilver deposits and from any known eruptives. It resembles somewhat the Culver-Baer ledge with its bold, ochreous outcrop between a serpentine hanging-wall and sandstone footwall. The strike is north of west and dips north at 50° to 60°, being steeper at the surface. The Great Eastern vertical shaft is down 550 feet, with two winzes of 160 feet each sunk from the 500-foot level. There is also a 400-foot drift on the 500. The collar of the shaft is about 200 feet below the upper outcrop, and at that level there is a tunnel in 1100 feet, with connecting drifts and stopes in the ledge above. From the shaft there are levels at 150, 220, 360 and 500 feet, respectively.

The ore shoot is enclosed within the ledge of opalized rock which was originally probably mostly serpentine. Becker (U. S. G. S. Mon. XIII, p. 364) considers that this silicification "preceded the deposition of ore, though somewhat closely connected with it." Occasionally a

little pyrite accompanies the cinnabar. There are also small seams of a hard bitumen associated with the ore body.

The geology is discussed in detail by Becker (op. cit.), and in Bull. 27 of the State Mining Bureau (pp. 108–112).

For several years previous to 1905 (in which year it expired), the Great Eastern Company had a lease on the Mt. Jackson ground adjoining and worked it through the Great Eastern levels. The earthquake of April 18, 1906, shook from the outcrop cliff near-by a large rock which rolled into the shaft, killing three men coming up in the cage. It also partially wrecked the shaft. The damage to the shaft has been repaired, but the mine has not been operated since. At the present time (January, 1914) they are investigating the practicability of concentrating the ore. There is an abundant water supply from several springs on the property.

The hoist is operated by a wood-burning steam plant. The crusher is at the hoist, and a gravity tram conveyed the ore to the furnaces. The reduction equipment includes a 4-ton coarse-ore furnace, a 16-ton Hüttner-Scott fine ore furnace and a "D" retort.

Bibl.: R. IV, p. 336 (Table); V, p. 95; VIII, p. 633; XI, p. 460; XII, 371; XIII, p. 602; Bull. 27, pp. 108–112, 226, 239, 246; U. S. G. S. Mon. XIII, pp. 362–364; An. Rep. XX, Pt. VI, p. 271; MIN. RES. 1883, pp. 394, 396, 397; 1902, pp. 251, 253; 1907, Pt. I, p. 680; 1908, Pt. I, p. 690; MIN. RES. W. OF ROCKY MTS., 1875, p. 14; 1876, p. 20; MINING AND SCIENTIFIC PRESS, Vol. 89, p. 391.

Great Northern. Abandoned.

Bibl.: Bull. 27, p. 112.

Hope Claims (see *Sonoma Consolidated*).

Hurley Prospect. Abandoned.

Bibl.: Bull. 27, p. 112.

Lookout Group. Abandoned.

Bibl.: Bull. 27, p. 113.

Lucky Stone Group. Abandoned.

Bibl.: Bull. 27, p. 113.

Maricoma Prospect (*Santa Rita*). Abandoned.

Bibl.: Bull. 27, p. 113.

Mercury Mining Company. F. A. Huntington et al., San Francisco, owners. For several years nothing but a small amount of assessment work has been done on these prospects in Secs. 32 and 33, T. 11 N., R. 8 W., near the Socrates mine.

Bibl.: Bull. 27, p. 113, U. S. G. S., Min. Res. 1902, p. 252; MIN. RES. W. OF ROCKY MTS., 1875, p. 14.

Missouri Mine (see *Culver-Baer*).

Mt. Jackson Quicksilver Mining Company, O. T. Hassett, Geyserville, R. F. D., president. This mine adjoins the Great Eastern mine (*q. v.*) near Guerneville on the northwest, but has no plant of its own, having been worked for a number of years through the Great Eastern levels. It has been idle since 1905.

Bibl.: R. VIII, p. 633; XII, p. 371; XIII, p. 602; Bull. 27, pp. 108–112.

Napa Prospect. Abandoned.

Bibl.: Bull. 27, p. 113.

Occidental and Healdsburg Group. Abandoned.

Bibl.: Bull. 27, p. 114.

Old Chapman Prospect. Abandoned.

Bibl.: Bull. 27, p. 114.

Pacific Group (*Crystal or Red Cloud*), A. Abbey, George Roeth et al., Oakland, owners. They consist of four patented claims in Secs. 5 and 6, T. 10 N., R. 8 W., near the Sonoma group in the Pine Flat section. No work has been done for several years. A watchman only is employed.

Bibl.: R. XIII, p. 603; Bull. 27, p. 114; U. S. G. S., Min. Res. 1902, p. 253.

Pontiac Group (see *Socrates*).

Rattlesnake Mine. Parrott Estate et al., San Francisco, owners. This mine is in Sec. 31, T. 11 N., R. 8 W., on the road between the Culver-Baer and the Sonoma mines. It is credited with a production of 65 flasks in 1875, entirely from native quicksilver. Not only was the metal entirely in the native state, but it is claimed that there was so much mercurial vapor in the underground workings that if a lunch bucket were left in over a day or two, the solder would become amalgamated and the bottom drop out. The mine has been idle for years,

and is now inaccessible. Like the Socrates, the difficulty here was to handle the native metal economically. If the underground situation could be handled successfully and safely, it would seem that the ore-dressing end might be solved by some system of concentrators or hydraulic settlers.

Bibl.: R. IV, p. 336 (table); XIII, p. 603; Bull. 27, p. 115; U. S. G. S., Mon. XIII, p. 377; MIN. RES. W. OF ROCKY MTS., 1874, p. 37; 1875, pp. 14, 176; TRANS. A. I. M. E., Vol. III, p. 273.

Red Cloud Claim (see *Pacific*).

Santa Rita Claim (see *Maricoma*).

Socrates Mine (originally *Pioneer*). Socrates Consolidated Mining Company, owner; L. T. Carr, 412 Montgomery street, San Francisco. This group of patented claims is at the junction of Secs. 32 and 33, T. 11 N., R. 8 W., and Secs. 4 and 5, T. 10 N., R. 8 W., on the divide between Big Sulphur and Little Sulphur creeks, 6 miles southeast of The Geysers. The Pioneer of this group was the first quicksilver claim located in Sonoma County. It is in the Pine Flat section. Owing to the difficulty of handling the native metal which makes up the major portion of the values here, the mine was idle for many years. The occurrence of selenide of mercury has also been noted in the Socrates. During its last period of operation attempts were made to recover the quicksilver with a rotary roasting furnace. Their surface plant was destroyed by a forest fire in the fall of 1907. During 1908 and 1909, the Socrates Development Company, operating the property under bond, made a small output of quicksilver, employing a Huntington mill and a Woodbury concentrator. The concentrates were retorted. Since that time the mine has been closed, only a watchman being employed.

Bibl.: Bull. 27, p. 115; U. S. G. S., Mon. XIII, p. 376; Min. Res. 1902, p. 253; 1906, pp. 493, 497; 1907, Pt. I, p. 680; 1908, Pt. I, p. 690; 1909, Pt. I, p. 554; 1910, Pt. I, p. 701; GEOL. SURV. OF CAL. Geol., Vol. I, pp. 88–91; MIN. RES. W. OF ROCKY MTS., 1875, pp. 14, 177; MINING AND SCIENTIFIC PRESS, Vol. XC, p. 22.

Sonoma Consolidated Group (Crown Point and Hope). This group in Secs. 4 and 5, T. 10 N., R. 8 W., Pine Flat district, is now owned by the Culver-Baer Company (*q. v.*). This company bought the property particularly for its surface equipment, which has been transferred to the Culver-Baer mine 5 miles to the northwest. The Sonoma

was last operated by the Crown Point Company. Production began with an output of 50 flasks in 1873.

Bibl.: R. XIII, p. 503; Bull. 27, pp. 102, 112; U. S. G. S. Mon. XIII, p. 377; Min. Res. 1902, p. 253; MIN. RES. W. OF ROCKY MTS., 1874, p. 30; 1875, p. 14; TRANS. A. I. M. E., Vol. III, p. 290.

Squaw and Big Chief Claims. L. D. Kissack and John June, Cloverdale, owners. These claims are in Sec. 4, T. 11 N., R. 9 W., adjoining the Cloverdale mine, 12 miles east from Cloverdale; elevation 2200 feet (bar.). The ore is similar to that of the Cloverdale. A tunnel and a short incline from it have been driven in about 60 feet, and a few sacks of high grade ore sorted from the material taken out. It is intended to patent the Squaw soon.

Walker Prospect. On patented ground near Guerneville, owned by M. C. Meeker, of Camp Meeker. A few stringers carrying cinnabar are said to have been found, but nothing of consequence developed.

Bibl.: Bull. 27, p. 116.

Wall Spring Prospect. H. C. Wall, Hilton, owner. Idle.

Bibl.: Bull. 27, p. 117.

STONE INDUSTRY.

The stone quarries' products have been one of Sonoma County's most important assets for many years. The majority of the paving blocks employed in street work in the cities of the state have come from the quarries of this county. For a considerable period this particular branch was much more prominent than it is at the present time, and gave employment to several thousand men. Following the San Francisco fire of 1906, the demand for paving blocks was good for a time and the year 1912 was a prosperous one; but the Block Makers' Union demanded raises in the contract price successively from $25 to $30, then to $35 per 1000. This, coupled with the increasing number of motor driven vehicles and their demand for a smoother pavement, caused a heavy slump in the business. As a consequence, the year 1913 saw operations at many of the quarries shut down altogether, while others were curtailed to the output of only a few men. It is stated that one man will make an average of 100 to 150 blocks per day. At the time they were visited (October, 1913) there were approximately 1,600,000 blocks piled up at the various quarries and at the railroad shipping points, awaiting a market.

In addition to the $35 per 1000 for making, those operators who are leasing pay $3 to $3.50 per 1000 royalty to the owners. It costs from $2 to $5 per 1000, depending on the distance, to haul them to the rail-

road. In case they can not be loaded directly onto the cars but have to be temporarily piled beside the track, it costs an additional $1.50 per 1000 to put them on the cars. The blocks sell at $45 to $50 per 1000, f. o. b. the rail shipping point.

Though they are loosely designated by the trade as "basalt blocks," the rock for the most part is andesite. Particularly is this the case along the ridge which starts above Rincon Valley, northeast of Santa Rosa, and trends southeasterly to near Kenwood. Locally, in places, it grades to basalt, and at others to trachyte. This stone is also employed for making curbing, and as such was erroneously reported for a number of years under the head of "granite" (as has already been noted. See under *Granite*).

The following table gives the production of paving blocks for Sonoma County, from 1887, though the Petaluma quarry was worked as early as 1864:[1]

Table of Paving Block Production.

Year	Thousand	Value
1887	10,000	$350,000
1888	10,500	367,500
1889	[2]7,308	297,236
1890	[2]7,000	245,000
1891	[2]5,000	150,000
1892	3,000	96,000
1893	2,900	92,800
1894	2,217	56,881
1895	2,186	67,808
1896	3,679	61,092
1897	1,295	28,085
1898	704	13,310
1899	200	3,780
1900	1,042	20,275
1901	1,690	32,675
1902	2,866	82,227
1903	3,879	80,492
1904	2,163	65,197
1905	2,145	66,785
1906	3,071	128,444
1907	2,698	112,797
1908	5,226	228,630
1909	3,006	134,223
1910	3,429	153,810
1911	3,278	162,392
1912	5,781	264,677
1913	2,761	126,747
Totals	98,969	$3,488,813

[1]Tenth U. S. Census Report, Vol. X, Pt. 3, pp. 97, 279.
[2]Eleventh U. S. Census, Report on Mineral Industries, p. 605.
[3]Estimated.

At a number of the quarries the spalls and waste from block-making operations are utilized for crushed rock for macadam and concrete work. In addition to the igneous rocks already mentioned, there is a tuff east of Freestone and sandstone along the coast from Fort Ross to Stewart's Point. The latter are undeveloped (R. X, p. 678; XI, p. 462; XII, p. 400; XIII, p. 638; Bull. 38, p. 141).

Aguillon Quarry, C. Aguillon, owner. It is ½ mile north of Sonoma, adjoining the Vallejo Estate. Idle.

Bibl.: Bull. 38, p. 162.

Annadel Quarry (see *Hutchinson*).

Bacigalupi Ranch (*Norris;* also *Roy Bert*), N. Bacigalupi, Santa Rosa, owner. On this place in Rincon Valley northeast of Santa Rosa, are several quarry pits (one formerly known as Norris quarry) from which paving blocks were made for several years. A few were made in the spring of 1913, but none shipped during the year.

Bibl.: Bull. 38, pp. 343, 344, 345.

Barbera Quarry, Antonio Barbera, R. R. No. 6, box 89, Santa Rosa, owner. This is a small quarry on the Rincon Valley road near its junction with the Santa Rosa-Sonoma road, 2½ miles east of Santa Rosa. It is on land adjoining the vineyard of the same owner, who makes a few paving blocks a day, working at odd hours.

Barnes Quarry (see *Craig*).

Beason Quarry (see *Lichau*).

Boca Quarry. F. Boca et al., Glen Ellen, owners. This quarry, 1½ miles east of Glen Ellen, has been idle the past two years.

Bibl.: R. XII, p. 396; XIII, p. 634; Bull. 38, p. 343.

Borg Quarry (see *Hutchinson ranch*).

On the *H. Calleaud* place at Buena Vista, 2 miles east of Sonoma, some stone was being taken out in 1913 by J. Newman, of Napa, for the new county bridge at Shellville.

Carpenter Quarry (see Clough).

John Cassaretto, of 345 Berry street, San Francisco, takes gravel from Sonoma Slough below Sonoma by means of a suction dredge, working mainly during high tides. The gravel is loaded into barges or scow schooners and carried to San Francisco, where it is screened. The dredge has a capacity of 200 to 300 cubic yards per day.

City Improvement Company (see *Violetti*).

City Street Improvement Company (see McDonald).

Claasen Quarry. Mrs. J. P. Claasen, R. F. D., Petaluma, owner. This quarry, south of town and adjoining the Petaluma Rock Quarry, has been idle for several years.

Bibl.: Bull. 38, p. 326.

Clough Quarry (*Carpenter*). M. S. Clough and Mrs. Young, Petaluma, owners; L. Green, manager. It is on the west edge of Petaluma,

and is operated intermittently by the county under lease for road metal. The rock is principally andesite, in part grading to basalt, and varying in color from red to black. There are two faces, at the newer one of which the leasers have a No. 3 Austin gyratory crusher and a 25 h.p. gasoline engine, both on portable frames. There is a bucket elevator to the bin, but no screens.

Clute Quarry (see *Titania*).

Cooney Quarry. J. Cooney, Petaluma, owner. It is 2 miles east of Penn Grove. Idle for several years past.

Bibl.: R. XII, p. 396; XIII, 634; Bull. 38, p. 343.

Photo No. 139. Coutts Bros.' paving block quarry, Kenwood, Sonoma County, California.

Coutts Bros. Quarry (one time called *Maroni*), Sonoma Farms Company (Grace Bros.), Santa Rosa, owners; J. L. Coutts & Company, Kenwood, lessees. This paving block quarry is 1¼ miles northeast from Kenwood station; elevation 800 feet (bar.). It is near the top of and partly encircles a steep hill, being visible from the valley for several miles around. (See photo No. 139.) The present portion of the quarry was opened up by Coutts Brothers in January, 1910, though Maroni had operated here some years previously. The rock, which is a hornblende andesite grading in places to a basalt, is mostly massive breaking into blocks 10 feet to 15 feet through. The quarry extends for about a quarter of a mile around the hill with faces up to 50 feet high. Up to July, 1913, they had 40 to 50 men at work, since when but 6 have been kept on.

Bibl.: R. XII, p. 397; XIII, p. 635.

Craig Quarry (formerly *Barnes*), D. N. Craig, Penn Grove, owner. The quarry is on a low rounded ridge 1½ miles northeast from Penn Grove; elevation 150 feet. The stone is a dark gray, medium grained basalt, with hornblende phenocrysts. There is considerable vesicular material. Principally curbing is made, though formerly a large number of paving blocks were turned out. The curbing blocks are 10 inches deep by 5 inches wide and 11 inches long (requiring 92 per running foot). The men are paid 9 cents per running foot for the making, and the blocks sell for 10½ cents per foot. The output is all sold in Petaluma. Two men were employed during 1913.

In addition to curbing, Craig also sells gravel to the county for road work, from Petaluma Creek on another part of the same ranch.

Bibl.: R. X, p. 678; XII, p. 396; XIII, p. 634; Bull. 38, p. 343.

Cronin Quarry (see *Petaluma Rock*).

Davis Quarry, Henry Davis et al., Penn Grove, owners. Two miles east of Penn Grove. Idle for 12 or 13 years.

Bibl.: R. XII, p. 397; XIII, p. 634; Bull. 38, p. 343.

Dickinson Quarry, northeast of Petaluma. Idle for some years.

Bibl.: R. XII, p. 397; XIII, p. 634; Bull. 38, p. 343.

Elliott Quarry (see *McDonald*).

Fairville Quarry and Gravel Company, A. W. Foster, Jr., Flood Building, San Francisco, manager. This quarry at Quarries post office on the Northwestern Pacific Railroad, near Fairville, was opened up in 1907, and for a time produced at the rate of 5000 cubic yards of crushed rock per month; but it has been idle since 1910 owing to high freight rates. The product sold for 75 cents per ton f. o. b. Quarries, either on cars or barges (via Sonoma Creek). The equipment includes a No. 5 McCully crusher and a No. 2 Austin, with an oil burning steam plant.

Flinn & Treacy (see *Hutchinson Ranch*).

Frugoli Quarry, G. Frugoli, owner. It is on the Rincon Valley road, 6 miles northeast of Santa Rosa. Paving blocks. Idle.

Bibl.: Bull. 38, p. 343.

Gravel for road work throughout the county is obtained at the most convenient nearby point, and is under the direction of each supervisor in his district. Along the Russian River it is taken out free, while on the creeks the land owners are paid 10 cents to 25 cents per load (about 2 cubic yards).

Gray Quarry, J. W. Gray, 208 Lincoln street, Santa Rosa, owner. This paving block quarry is on the Rincon Valley road, in Sec. 6, T. 7 N., R. 7 W., 3 miles northeast from Santa Rosa. Block making began here in 1908, and in the spring of 1913 there were 12 to 15 men at work. Later, however, the quarry was idle, but it is intended to resume with a few men.

Hardin Quarry, J. M. Hardin, Petaluma, owner. This paving block quarry east of Penn Grove has been idle 10 years.

Bibl.: R. XIII, p. 634; Bull. 38, p. 344.

Harney Quarry (see *Melitta*).

Hill Quarry, Mrs. Josephine Hill, and E. B. Hill, Petaluma, owners. There is a crushing plant at this quarry near Petaluma. Idle since 1911.

John Hugert, of Agua Caliente, has been working a small paving block quarry on the J. Bower ranch 3 miles east of Melitta. Idle in 1913.

Bibl.: Bull. 38, p. 344.

Hutchinson Ranch Quarries (*Borg, Oleson, Annadel, Flinn & Treacy*), Thomas Hutchinson, Santa Rosa, owner. There are several quarries on this property east of Santa Rosa. E. and J. B. Laurent, of Kenwood, are operators on the Annadel group, shipping via Annadel siding on the Southern Pacific Railroad; while Flinn & Treacy, of San Francisco, have the Borg or Oleson quarries, shipping from Oleson siding. The quarries are at an elevation of about 800 feet. There are 3850 acres in the property, of which about 1000 acres have stone suitable for quarrying. The rock is principally a dark gray andesite; but grading in part to a black, fine-grained basalt. There is also some vesicular material.

Borg first opened up the Oleson quarry about 1893. Flinn & Treacy bought 15 acres of this which they worked out and they are now operating on a royalty basis on the west end of the ranch. They made an average of over 250,000 blocks per year, for 12 years up to the beginning of 1913; but when visited (October, 1913) there were only three men employed.

Laurent Brothers have been working the Annadel quarries for about seven years, previous to which they were about 15 years on the Wymore property at Melitta. During 1912 they shipped 200,000 blocks per month for several months, but were idle in 1913.

Bibl.: R. X, p. 376; XI, p. 463; XII, p. 396; XIII, p. 634; Bull. 38, pp. 343, 344.

Kellas Quarry (see *McNeill*).

Laurent Brothers (see *Hutchinson Ranch*).

Lawndale Quarry (formerly *Stacy*), Lawndale Forward Movement Syndicate, owner; T. S. Fritz, president; M. B. Sheehan, secretary; home office, 346 Monadnock Building, San Francisco; post office, Kenwood. There are several quarry openings on this ranch, 3 miles northwest from Kenwood, some of which have been worked by leasers, and some by the company. Except for one lease with two men employed, they were idle the last half of 1913. Both andesite and basalt occur, the latter showing a little olivine. The present company took over the property in 1909, principally for the purpose of growing eucalyptus trees for wood and lumber. It is stated that up to 1913 they had planted 110,000 trees. The shipping point is Lawndale switch on the Southern Pacific Railroad.

Bibl.: R. XI, p. 463; XII, p. 397; XIII, p. 635; Bull. 38, p. 345.

Lichau Quarry (*Beason*), A. C. Lichau, owner; 4 miles northeast of Penn Grove. Idle for years.

Bibl.: Bull. 38, p. 344.

Lounibos Quarry (one time *Cady*), W. C. Booth, 2220 Ashby avenue, Berkeley, owner; John Newman, Napa, lessee. This quarry of trachytic tuff in Sec. 36, T. 6 N., R. 5 W., about a mile east of Agua Caliente, is operated intermittently. The lessee was taking out stone (October, 1913) for the new county bridge at Shellville south of Sonoma. Stone from this quarry is also employed for curbings and other uses in the cemetery at Sonoma. There is a black vitrophyre associated with this tuff. They are apparently from the same magma, but cooled at different rates. One large boulder was found showing both phases, and grading into each other. This vitrophyre is the "granite" referred to in Bull. 38, p. 376.

Bibl.: Bull. 38, p. 162.

Lynch Quarry, John Lynch, Petaluma, owner; 6 miles east of Petaluma near the Hardin ranch. Idle for years.

Bibl.: R. XIII, p. 634; Bull. 38, p. 344.

Madison Quarry, Hans Madison, R. R. No. 5, Box 196, Santa Rosa, owner. This is a small paving block quarry, 2 miles east of Santa Rosa, across the road from the Titania quarry; elevation 300 feet (bar.). The owner works it single-handed intermittently.

On the *Mahoney Brothers* place on the Two Rock road west of Petaluma small amounts of rock are taken out occasionally for road work. It is a partly disintegrated material.

H. C. Manuel formerly operated a paving block quarry under lease on the English and Burnett ranch at Kenwood, but is now leasing on the Vallejo Estate (q. v.) at Sonoma.

Bibl.: R. XII, p. 397; XIII, p. 634.

Maroni Quarry (see *Coutts;* also *Titania*).

McDonald Ranch Quarries, C. D. Barnett et al., 629 Fourth street, Santa Rosa, owners. These quarries are at and south of Baku switch, 2 miles east from Santa Rosa. They are among the oldest in the county, having been opened up by McDonald in 1880. Until the railroad was built down the Sonoma Valley, the blocks were hauled to Santa Rosa for shipment. The "Elliott" quarry is included in this group. The City Street Improvement Company operated these quarries from 1891 to 1913, when their lease expired. In October, 1913, they still had about half a million blocks at Baku siding waiting shipment. In 1906 they had 100 men at work, and in earlier years a greater number. C. Lawrence and J. Percy each have leases on small areas of the property and are making a few blocks (October, 1913). All told many millions of paving blocks have come from this property.

The quarry pits are in a low, flat-topped ridge, elevation 350 to 400 feet (bar.); and the rock is a dark gray andesite. Matthews & Company, under a lease, have put up a rock crushing plant of about 30 tons per day capacity to utilize the spalls and waste for macadam and concrete work. They have a 20 h.p. electric motor, 16″ x 24″ jaw crusher, revolving screen and bins for three sizes of product. Stone from this place was used in the following buildings in Santa Rosa: Northwestern Pacific Depot, St. Rose Church (1900), Carnegie Library (1903).

Bibl.: R. VIII, p. 635; X. p. 675; XII, p. 396; XIII, pp. 634, 635; Bull. 38, pp. 163, 343, 344, 345.

McNear's Quarry, McNear Company, Petaluma, owner. This is a small quarry at the north end of Main street. The rock is basalt, in part weathered and disintegrated, and a few loads are occasionally taken out for road work.

Bibl.: Bull. 38, p. 326.

McNeil Ranch Quarry (*Kellas;* also *Wilkinson*), F. Riebli et al., lessees. It is near Penn Grove. Idle in 1913.

Bibl.: R. XII, p. 397; XIII, p. 635; Bull. 38, p. 345.

On the *F. Meacham Ranch* on the Sebastopol road northwest of Petaluma, rock is occasionally obtained for road work. It is a somewhat soft and broken up material.

Bibl.: Bull. 38, p. 327.

Melani Quarry, Melani Estate, owner. It is a small quarry adjoining the Schocken quarries at Sonoma. Idle past ten years.

Bibl.: Bull. 38, p. 344.

Melitta Stone Quarries (*Wymore;* also *Harney*), C. C. Wymore, R. F. D. No. 5, Santa Rosa, owner; W. W. and G. H. Wymore, Anglo Building, San Francisco, lessees. This group of quarries is 1 mile

Photo No. 142. Paving blocks. Melitta (Wymore) stone quarry, Melitta, Sonoma County, California.

south from Melitta, 6 miles east of Santa Rosa, at an elevation of 900 feet (bar.). These large cuts (see photo No. 142) are visible from Santa Rosa. Operations were first begun here about 1888 by the Laurent Brothers, who continued for 15 years, and the present lessees since then. During the 9 years to 1913 production was at an average rate of 100,000 blocks per month. Idle since April, 1913.

There is a gravity tramway of 3200 feet which delivers the paving blocks in side-tipping cars to bunkers at the railroad. The rock, which is a medium-grained, gray olivine basalt, occurs principally in the form of boulders, the result of concentric decomposition. On a field examination only it might be mistaken for a trachyte or an andesite, because

of its light color and the fact that the olivines are largely altered; but the microscope shows it to be a basalt.

Bibl.: R. X, p. 676; XI, p. 463; XII, p. 397; XIII, p. 634; Bull. 38, p. 345.

Mt. Pisgah Quarry (see *Petaluma Rock*).

Natomas Consolidated of California (formerly *Schocken*), Natomas Consolidated of California, Alaska Commercial Building, San Francisco, owner. This quarry (or rather series of quarries) is on a steep hill ½ mile north of Sonoma; elevation 400-500 feet (U. S. G. S.); and was first opened up in 1876. In 1880 it was bought by S. Schocken who operated it up to 1909, when the present owners took it over. About 1888, an average of 100,000 paving blocks per month were shipped from here, with 60 men at work. Some curbing and small dimension building stone have also been produced. Only two men were working, October, 1913.

The rock is a gray andesite, some of it having abundant, white feldspar phenocrysts. The surface of the hill near the summit is extensively potholed, with openings from a few square feet to one over an acre in extent and with a 100-foot bank. It is stated that the Natomas bought the property as a source of supply for crushed rock, as the spall piles are numerous and extensive. This feature has not yet been developed. In the early days of this quarry before the advent of the railroad, the paving blocks were hauled in wagons to the Embarcadero on Sonoma Creek, where they were loaded on barges.

Bibl.: R. VIII, p. 635; XI, p. 463; XII, p. 397; XIII, p. 635; Bull. 38, p. 345.

Norris Quarry (see *Bacigalupi*).

The *Northwestern Pacific Railroad Company*, has a gravel pit on the Russian River at McCray station north of Cloverdale. Some gravel for ballast was taken out in 1913.

Oleson Quarry (see *Hutchinson Ranch*).

Pedroncelli Quarry, F. Pedroncelli, owner. It is near Kenwood, but has not been worked for a number of years.

Bibl.: Bull. 38, p. 344.

Petaluma and Santa Rosa Electric Railway Company (see *Stony Point*).

Petaluma Municipal Rock Crusher, Conway Brothers, Petaluma, owners; City of Petaluma, lessee. This quarry near the west end of B street, was opened up and equipped by the city in January, 1910, under

a lease, with privilege of removing plant at termination of lease. The rock, which is a black, close-grained basalt with some olivine and augite phenocrysts, occurs somewhat fractured, producing angular blocks up to three feet across. The quarry is worked only during the summer months. The product is screened to No. 1, No. 2, and No. 3 sizes and "dust." Electric power is used.

The following is an extract from the report of F. B. Singley, city auditor of Petaluma, for the fiscal year 1912-1913:

"The rock crusher account from the beginning (January, 1910) to June 30, 1913. Summary as follows:

DEBIT.

Plant and tools to June 30, 1913		$11,458 75
Operating expenses to June 30, 1913—		
Labor	16,637 25	
Supplies	3,398 32	
Power	1,192 05	
Royalty	1,654 21	
Sundries	599 64	
Total	$23,481 47	

CREDIT.

Crushed rock sold to June 30, 1913, 22,387.4 cubic yards for	$22,124 96	
		$1,356 51

"Against this adverse balance of $1,356.51 in the operating expenses: The city has used on her streets 5,009.2 yards; and there were in the bunkers June 30, 1913, 480 yards; a total of rock crushed, 27,876.6 yards; which cost exclusive of the plant, 84¼ cents per yard.

"The 22,387.4 yards sold brought 98¾ cents per yard; and the total used by the city and on hand of 5,489.2 yards, cost the city $1,356.51, or 24¾ cents per yard, exclusive of the plant.

"Previous to the installing of city crusher, the city and contractors paid $1.25 per yard for rock."

Petaluma Rock Quarry (*Cronin;* also *Mt. Pisgah*), P. Cronin, Petaluma, owner; E. B. & A. L. Stone, 401 Phelan Building, San Francisco, lessees; F. L. Marty, superintendent at quarry. One time leased to Union Construction Company. This quarry in Sec. 3, T. 4 N., R. 7 W., 1½ miles south of Petaluma, was opened up in 1864 (10th U. S. Census Report, Vol. X, Pt. 3, p. 279). It is at tidewater on Petaluma Creek (one time called Rudesill's landing), and at McNear's spur on the Northwestern Pacific. The rock is basalt with fine, white feldspar phenocrysts.

Previous to 1890 this quarry was worked for paving blocks, but at present solely for crushed rock. In the quarry face the material is shoveled to cars and trammed to the screen which takes out the clay; then by gravity tram (in balance) to crushers (see photo No. 164). From this point a belt conveyor carries it to the revolving screen, four sizes being made: $\frac{5}{16}$, ¾, 1¼, 2 inches. A 30 h.p. electric motor dump-

car of 4 cubic yards capacity transfers the product to the various storage bins. The plant has a capacity of 7000 tons per month, and the bunkers will hold 2000 tons of rock.

A new quarry face was being started (October, 1913), at the crusher level, which will do away with the gravity tram above. Nine men were at work, but 28 are required when in full operation. This quarry in 1913 supplied rock for the State Highway near Ukiah.

Bibl.: R. V, p. 108; VI, Pt. I, p. 27; X, p. 678; XI, p. 463; XII, p. 397; XIII, p. 634; Bull. 38, p. 345; 10TH U. S. CENSUS REP. Vol. X, Pt. III, pp. 97, 279.

Photo No. 164. Plant at Petaluma Rock Quarry (E. B. & A. L. Stone Company), near Petaluma, Sonoma County, California.

Lorenz Pietzoli has a small paving block quarry near Gray's on the Rincon Valley road northeast of Santa Rosa, which he works single-handed.

Purrington Quarry, 1¾ miles southwest of Petaluma. Idle several years, except for an occasional load.

Bibl.: Bull. 38, p. 327.

On the W. D. Reynolds property, 2 miles east of Santa Rosa is a quarry equipped with a crushing plant, for a time leased by D. C. Albers. Idle past two years.

A. Rigoni has a small paving block quarry, adjoining Frugoli, on the Rincon Valley road northeast of Santa Rosa.

Roberts Quarry, Mary E. Roberts, Penn Grove, owner. This is 2 miles east of Penn Grove, but has been idle since 1910. When last operated, two men worked about three years on curbing and paving blocks.

Bibl.: R. XII, p. 397; XIII, p. 635; Bull. 38, p. 345.

Roblar Mining Company, J. A. Ronsheimer, Petaluma, president. Garrett Hyatt, R. F. D., Petaluma, secretary. It is at Roblar station on the Petaluma and Santa Rosa Electric Railway, 11 miles north of

Photo No. 155. Drag-line excavator of Russian River Gravel Company, Healdsburg, Sonoma County, California.

Petaluma; elevation 175 feet (bar.). There is a quartz vein here 12 to 15 feet wide, in serpentine; strike south of west, and dip north nearly vertical. It has been worked by open-cut and mill hole and by chambering. A cross-cut adit has been run in 300 feet, then drifts 300 feet west and 100 feet east. To the west, the vein appears to be cut off by a fault, and to the east it splits up into several small stringers. The quartz is crushed with rolls, then sized with shaking screens to four sizes: No. 5 mesh to No. 6; No. 6 to No. 10; No. 10 to No. 22; through No. 22. The three larger sizes are sold for chicken grit, and the fines for plaster work and to painters for sanding. This quartz is said to carry some small values in gold and copper.

Roy Bert Quarry (see *Bacigalupi*).

Russian River Gravel Company, J. D. Grant, Williams Building, San Francisco, owner; J. F. Bailache, Healdsburg, superintendent. This plant is on a gravel bar on the Russian River ¼ mile east from Healds-

burg station with which it is connected by a Northwestern Pacific spur track. The first plant was built in 1906 and the present enlarged one in October, 1911. A 3-cubic-yard drag-line scraper (see photo No. 155) raises the gravel to a revolving screen (1½-inch aperture), and the oversize is crushed.

The material is then hauled by cable in side-tipping cars to the upper plant where it is screened to "sand," "roofing" (¾-inch ring) and "rock" (¾-inch to 1½-inch). Electric power is used. The "roofing" sells for $1 per ton at the plant, and the "rock" at 35 cents. Railroad cars can be run directly to the lower bins as well as the upper plant. In 1913, they were supplying gravel for the State Highway between Healdsburg and Santa Rosa. The screening plant has a capacity to load eight railroad ballast cars per day. The gravel is made up of Coast Range rocks, principally quartz, chert and hard sandstone.

Santa Rosa Bank Quarry (see *Titania*).

Santa Rosa Basalt Rock Quarry (see *McDonald*).

Schocken Quarry (see *Natomas*).

Sonoma City Rock Crusher. The city of Sonoma owns this plant, which is situated on land leased for quarrying purposes from the Vallejo Estate, ½ mile north of Sonoma. It was built in 1910. There is a 30 h.p. electric motor, bucket elevator, jaw crusher and screen (3 sizes); capacity 50 to 75 yards per day. The plant is subleased to R. E. Murphy, who furnishes rock to the city for 85 cents per cubic yard. A royalty of 5 cents per cubic yard is paid the owner.

Stacy Quarry (see *Lawndale*).

Stone, E. B. and A. L. (see *Petaluma Rock*).

Stony Point Quarry. Petaluma and Santa Rosa Electric Railway Company, owner; E. M. Van Frank, president; E. T. McMurray, secretary; operating office, Petaluma. It is at Quarry Station, about halfway between Sebastopol and Petaluma; elevation 220 feet (bar.). The earliest settlers used this rock for fireplace construction, but it is now used only for ballast and road metal. The waste is used for fills. The rock is a light, greenish to yellow trachytic tuff. A 70 h.p. electric motor runs the plant and a No. 5 Allis-Chalmers gyratory crusher is used. There are no screens. It is operated principally in the summer, with 18 to 20 men. Capacity 200 cubic yards per day.

Stone from this quarry was employed in the bank at Sebastopol and the Carnegie Library (1904) at Petaluma (see photo No. 163); also the front of the Phoenix Block on Main street, Petaluma, built in 1858. The copings of this oldest building still have sharp edges, and the structure has survived two earthquakes and a fire on both sides of it.

Bibl.: R. XII, p. 405; Bull. 38, p. 163.

Swank Quarry (see *Titania*).

Titania Quarry (*Clute*; *Swank*; also *"Santa Rosa Bank"*). P. Maroni, 925 Ripley street, Santa Rosa, owner. This quarry, 2 miles east of Santa Rosa, was first opened up in 1885 by Clute and, up to seven years ago when the present owner took it over, produced only paving blocks and building stone. At present, besides crushed rock, some curbing and small dimension stone for buildings are turned out. Stone for the La Rose Hotel in Santa Rosa came from this quarry. The rock is a dark gray andesite. A 25 h.p. gasoline engine is used and fourteen men are employed. The crushing plant has a daily capacity of 40

Photo No. 163. Carnegie Library, Petaluma, Sonoma County. Stone from Stony Point Quarry.

cubic yards. The crushed rock is sold at $1.60 per cubic yard in Santa Rosa and $1.10 at the plant. Gravel from Santa Rosa Creek on the same property is also sold by Maroni.

Bibl.: R. XII, p. 396; XIII, p. 634; Bull. 38, pp. 163, 345.

Union Construction Company (see *Petaluma Rock*).

Vallejo Estate Quarries. Mrs. L. V. Emparon, Sonoma, owner; H. C. Manuel, lessee. There are several quarry openings on this property ½ mile north of Sonoma. The series of rocks here shows all gradation stages from a fine-grained black basalt through andesite and vitrophyre to tuff. Paving blocks are made from the basalt by Manuel, who had (October, 1913) seven men at work (previously 15 to 20); while the other rocks have been used locally for building stone. As has already

been noted, the city of Sonoma has a small rock crushing plant here to utilize the spalls from block-making.

Bibl.: R. XI, p. 462; XII, p. 405; Bull. 38, p. 164.

Violetti Quarry (*City Improvement Company*). Andrew Nelson, Sonoma avenue, Santa Rosa, owner. This paving block quarry near Melitta has been idle several years.

Bibl.: R. XII, p. 397; XIII, p. 635; Bull. 38, p. 343.

Weyl Quarry. Weyl Estate, owner. This is a small paving block quarry adjoining the Schocken property. Idle the past ten years.

Bibl.: R. XII, p. 397; XIII, p. 635; Bull. 38, p. 345.

Wilkinson Quarry (*see McNeill*).

Wymore Quarry (*see Melitta*).

SULPHUR.

Native sulphur occurs at The Geysers and near-by, but no commercial production has been made.

TRAVERTINE AND ONYX.

(See *Healdsburg Marble Company*, under *Magnesite*).

YOLO COUNTY.

Field Work in September, 1913.

Yolo County is one of the central California counties, with Colusa on its north, Sutter and Sacramento on the east, Solano on the south, Lake and Napa on the west. Its area is 1017 square miles. The Sacramento River is its eastern boundary line, and Putah Creek forms most of the southern line. Cache Creek enters the county at the northwestern corner, flowing across to the center of the eastern side where it joins the Sacramento River. Being one of the Sacramento Valley counties, Yolo's resources are principally agricultural. Like Colusa, Glenn and Solano, its mineral resources are largely confined to its western, hilly section. As will be noted from the Table of Mineral Production (see page 196), but two substances up to the present time have been subject to commercial development: quicksilver and sandstone. Their total value to date has been a little in excess of $600,000.

In addition to these minerals there are in the museum of the State Mining Bureau, from Yolo County, specimens of asbestos from the California quicksilver mine west of Rumsey; basalt from near Winters; iron from near Capay. There are also mineral springs, whose locations are noted under that head.

Yolo is one of only two counties of California's fifty-eight which reported no mineral production in 1912 and 1913.

Bibl.: R. X., pp. 773-794; Bull. 38, pp. 264, 360, 365.

BRICK.

To supply a local demand, bricks were for several years made in this county, utilizing clay from beds near Woodland, Winters and Capay, but not for over ten years past.

Bibl.: R. X., p. 791; Bull. 38, p. 259.

COAL.

Some small veins of coal have been found in the western part of T. 9 N., R. 2 W., and also farther north, but no commercial production has ever resulted.

Bibl.: R. X., p. 790.

GOLD.

At one time placer mining in a small way was carried on along both Cache and Putah creeks. Some low grade quartz is also reported to have been found, but no development of any consequence made.

Bibl.: R. X., p. 790.

YOLO COUNTY—Table of Mineral Production.

Year	Quicksilver		Sandstone		Miscellaneous and unapportioned
	Flasks	Value	Cubic feet	Value	
1873	*995	$79,928			
1874	3,000	315,540			
1875					
1876	965	42,460			
1877	1,516	56,547			
1878	1,640	53,956			
1879	1,110	33,134			
1880	422	13,062			
1881					
1882					
1883					
1884					
1885					
1886					
1887					
1888					
1889					
1890					
1891					
1892					
1893					
1894			2,500	$1,000	
1895			542	1,873	
1896			252	378	
1897					
1898			264	384	
1899			264	384	
1900			908	1,760	
1901			1,540	2,300	
1902			328	450	
1903			280	144	
1904			180	720	
1905			175	200	
1906			160	204	
1907			250	350	
1908			140	1,150	
1909					
1910					
1911					
1912					
1913					
Totals	9,648	$594,647	7,783	$11,297	

*Flasks of 76½ pounds.

Totals.

Quicksilver	$594,647
Sandstone	11,297
Total to end of 1913	$605,944

LIMESTONE.

A deposit of limestone is reported in Secs. 30 and 31, T. 10 N., R. 2 W., 3 miles south of Cadenassa Station, on land owned by E. M. Nash, of Saratoga.

MANGANESE.

Manganese is reported on the Nash ranch, 3 miles south of Cadenassa Station. E. M. Nash, Saratoga, owner.

MINERAL WATER.

There are a number of mineral springs in the hills of the western part of the county, but none of them have so far been utilized except locally. Among them the following may be noted:

A *saline* spring on the line between Secs. 25 and 26, T. 12 N., R. 5 W., near Reed mine, now owned by F. A. Kauffman, of San Francisco, as a cattle range.

On the *Smith Ranch,* 4 miles west of Guinda, is an excellent sulphur-iron-magnesia spring which is used privately; also two white sulphur springs not utilized. Dr. R. E. Smith, Sacramento, owner.

A soda spring on the *Scribner Ranch* near the Reed mine west of Rumsey.

A sulphur spring above Fiske Creek, on the Rumsey-Reed mine road.

Several sulphur springs on Putah Creek near Devil's Gate, west of Winters.

Bibl.: R. X., p. 793.

QUICKSILVER.

California Mine (see *Reed*).

Harrison Mine (see *Ruby*).

New England Mine (see *Ruby*).

Reed Mine (formerly the California). F. A. Kauffman, 110 Market street, San Francisco, owner. This mine at the junction of Secs. 23, 24, 25 and 26, T. 12 N., R. 5 W., was in its early history known as the California. It is first mentioned as operating in 1870, and appears in the producing list in 1873, with an output of 995 flasks of quicksilver. The J. B. Randol table (Report of State Mineralogist, Vol. IV, p. 336) credits the mine with a production of 5,653 flasks between 1876 and 1880. It has not been operated since that time, and the buildings have been destroyed by fire.* The ore carried is principally metacinnabarite. The property is now owned as part of a cattle range.

Bibl.: R. IV, pp. 261, 289, 336 (table); V, p. 95; VI, pt. I, pp. 122, 336; X, pp. 358, 793; XI, p. 68; XIII, p. 604; Bull. 27, p. 117; GEOL. SURV. OF CAL., Geol. Vol. II, p. 133; MIN. RES. W. OF ROCKY MTS., 1873, p. 10; 1874, p. 30; 1875, pp. 14, 174, 493.

Ruby Mine (also known as *Harrison* and *New England*). Mrs. Madge Harrison, Georgetown, owner. In Secs. 26 and 35, T. 12 N., R. 5 W., south of west from Rumsey. Idle for years.

Bibl.: R. XII, p. 363; XIII, p. 598; Bull. 27, p. 117; U. S. G. S. Mon. XIII, p. 283

STONE INDUSTRY.

Sandstone beds occur along the ridge near the western boundary of the county, but they have so far been developed commercially at only one point—at Devil's Gate on Putah Creek, west of Winters. Gravel for road work is obtained from the creek beds throughout the county, the owners of the land being paid a per load rate for the privilege. The Southern Pacific Railroad Company formerly took considerable gravel for ballast from Cache Creek near Capay.

Putah Creek Quarry. E. F. Searles, San Francisco, owner, in Sec. 29, T. 8 N., R. 2 W., 9 miles west of Winters. The Michael Building (1895) Woodland, and several in Winters, are constructed of stone from this quarry, but it has now been idle for some years. The rock is a blue-gray sandstone similar in appearance to the well-known Colusa sandstone found to the north of here, but a shade lighter in color.

Bibl.: R. X., pp. 791, 793; XIII, p. 638; Bull. 38, p. 146.

Sackett Quarry. Sackett Bros. owners. On the Sackett ranch, 5 miles west of Winters, there is a body of light-colored volcanic tuff which has been utilized locally for building purposes, but not recently.

Bibl.: R. X., p. 791; XIII, p. 640; Bull. 38, p. 164.

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