CALIFORNIA STATE MINING BUREAU
FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT, State Mineralogist

San Francisco] BULLETIN No. 94 [September, 1924

CALIFORNIA MINERAL PRODUCTION FOR 1923

CALIFORNIA STATE PRINTING OFFICE
JOHN L. KING, Superintendent
SACRAMENTO, 1925

CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

LLOYD L. ROOT — State Mineralogist

San Francisco] — BULLETIN No. 94 — [September, 1924

CALIFORNIA MINERAL PRODUCTION FOR 1923

BY

WALTER W. BRADLEY

CALIFORNIA STATE PRINTING OFFICE
FRANK J. SMITH, Superintendent
SACRAMENTO, 1924

85173

CONTENTS.

Chapter V.

INDUSTRIAL MATERIALS—

Chapter VI.

SALINES—

Chapter VII.

MINERAL PRODUCTION OF CALIFORNIA BY COUNTIES—

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

September, 1924.

To His Excellency, THE HONORABLE FRIEND WM. RICHARDSON,
Governor of the State of California.

SIR: I have the honor to herewith transmit Bulletin No. 94 of the State Mining Bureau, being the annual report of the statistics of the mineral production of California.

The remarkable variety, total valuation, and wide distribution of many of our minerals revealed herein show California's importance as a producer of commercial minerals among the states of the Union.

Respectfully submitted.

LLOYD L. ROOT,
State Mineralogist.

INTRODUCTION.

It is the endeavor of the staff of the State Mining Bureau, in these annual reports of the mineral industries of California, to so compile the statistics of production that they will be of actual use to producers and to those interested in the utilization of the mineral products of our state, while at the same time keeping the individual's data confidential. In addition to the mere figures of output, we have included descriptions of the uses and characteristics of many of the materials, as well as a brief mention of their occurrences.

The compilation of accurate and dependable figures is an extremely difficult undertaking, and the State Mineralogist takes the opportunity of here expressing his appreciation of the cooperation of the producers in making this work possible. A fuller appreciation of the value of early responses to the requests sent out in January will result in earlier completion of the manuscript. Statistics lose much of their value if their publication is unnecessarily delayed.

Some of the data relative to properties and uses of many of the minerals herein described are repeated from preceding reports, as it is intended that this annual statistical bulletin shall be somewhat of a compendium of information on California's commercial minerals and their utilization.

LLOYD L. ROOT,
State Mineralogist.

MINERAL INDUSTRY, CALIFORNIA, 1923.

DATA COMPILED FROM DIRECT RETURNS FROM PRODUCERS IN ANSWER TO INQUIRIES SENT OUT BY THE CALIFORNIA STATE MINING BUREAU, FERRY BUILDING, SAN FRANCISCO, CALIFORNIA.

CHAPTER ONE.

The total value of the mineral output of California for the year 1923 was $344,024,678 being an increase of $98,840,852 over the 1922 total of $245,183,826. There were fifty-four different mineral substances, exclusive of a segregation of the various stones grouped under gems; and all but one of the fifty-eight counties of the state contributed to the list.

As revealed by the data following, herein, the salient features of 1923 compared with the preceding year, were: The continued increase in petroleum yield, although of lower prices per barrel; increases in cement, copper, lead, natural gas, brick and tile, and crushed rock; and decreases in gold and silver values. The net result was an increase in the grand total of all groups of nearly one hundred million dollars, as stated above. Petroleum accounted for an increase of $69,350,044 in total value accompanying an increase in quantity of over 124,000,000 barrels.

Of the metals: copper increased from 22,883,987 pounds worth $3,090,582 to 28,346,860 pounds worth $4,166,989; lead, from 6,511,280 pounds and $358,120 to 9,934,522 pounds and $695,416; quicksilver, from 3466 flasks and $191,851 to 5458 flasks and $332,851. Gold decreased from $14,670,346 to $13,379,013, in spite of which, as in 1922, California continued to account for approximately 30% of the gold output of the United States.

Of the structural group: cement advanced from 8,962,135 barrels valued at $16,524,056 to 10,825,405 barrels and $25,999,203; miscellaneous stone (comprising crushed rock, sand and gravel, paving blocks, and grinding-mill pebbles) from a total valuation of $10,377,783 to $15,395,652; brick and hollow building blocks or tile from $7,994,991 to $9,738,082; magnesite, from 55,637 tons and $594,665 to 73,963 tons and $946,643; with granite and lime also registering gains.

In the 'industrial' group there were a number of fluctuations, the more important increases being shown by diatomaceous earth, limestone, mineral water, pottery clay, gypsum, and talc. One new item, sulphur, was added in 1923 to this list, which has not been produced commercially in California for many years. In the saline group, all items increased, but particularly borates, salt, and potash, the gain for the group amounting to a total of $1,479,570 more than the previous year's figures.

The figures of the State Mining Bureau are made up from reports received direct from the producers of the various minerals. Care is exercised in avoiding duplication, and any error is likely to be on the side of under- rather than over-estimation.

California yields commercially a greater number and variety of mineral products than any state in the United States, and probably more than any other equal area elsewhere of the earth. The total annual value of her output is surpassed by not more than four or five others, and those usually the great coal states of east of the-Mississippi. California was for many years the sole domestic source of borax, chromite and magnesite. We lead all other states in the production of gold, quicksilver, and platinum; and have alternated in the lead with Colorado in tungsten, and with Oklahoma in petroleum.

Apropos of the importance of hydro-electric power development to the mining industry in California which has been noted in previous issues of these mineral statistics reports, the following acknowledgment of the debt owed by the hydro-electric power industry to the miner is worthy of quotation:[1]

"The power business in California had its beginning in the mining business. Miners pioneered the path of the hydro-electric engineers of today. Their methods of construction, the manner in which they moved heavy machinery and material into rocky, remote regions, their designs for flumes, dams, and ditches, their tangential water-wheel, all left a lesson to be learned, and as the hydro-electric engineers of the new day read the record in the rocks the achievements of the sturdy men of the mountains took hold of them and inspired the vision that brought about the wonderful developments of the power industry that have made California the envy of the world.

"None know the story better than the P. G. and E. This company supplied more power to gold mines than all other companies in the State combined. Never an engineer goes over its system but he realizes its debt to the old miners. Ten of the company's twenty-eight water-power plants were originally initiated to provide energy for mining operations. Nine of its plants were installed on canals dug to supply water for mines. Out of that same hunt for gold came ten of the company's reservoirs. Blindly, perhaps, but like a Titan, the old-time miner builded for the future. Tonight his reservoirs, feeding power plants on some Sierra slope, will light homes hundreds of miles away. Some of his canals, blasted out of the rocks in the old pack-train days of the '50's still wind their rugged way through twenty miles and more of mountain in the great wheels that in a twinkling create the spark that spins a thousand factory wheels and makes goods, and work for multitudes, and cargoes for ships, and payrolls, and prosperity.

"It is a stirring tale, a tale too long to be told in a breath. It is a book, a book not yet written and too vast a work for the modest chronicler. The miner made California, and it is still his state, for the age of electricity has but sealed his title."

[1]California's debt to the miner: P. G. & E. Progress, Vol. 1, No. 8, p. 2, July, 1924.

By Substances.

The following table shows the comparative yield of mineral substances of California for 1922 and 1923, as compiled from the returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

Substance	1922		1923		Increase+ Decrease− Value
	Amount	Value	Amount	Value	
Asbestos	30 tons	$1,800	20 tons	$200	$1,600−
Barytes	3,370 tons	18,925	2,925 tons	16,058	2,867−
Bituminous rock	4,624 tons	13,570	2,945 tons	11,780	1,790−
Borates	(a) 39,067 tons	1,068,025	(a) 62,667 tons	1,593,798	525,773+
Calcium chloride	b	b	c	c	c +
Brick and tile	----------	7,994,991	----------	9,738,082	1,743,091+
Cement	8,062,135 bbls.	16,524,056	10,825,405 bbls.	25,999,203	9,475,147+
Chromite	379 tons	6,384	84 tons	1,658	4,676−
Clay (pottery)	277,232 tons	473,184	376,863 tons	697,841	224,657+
Coal	27,020 tons	135,100	1,010 tons	5,090	130,010−
Copper	22,853,987 lbs.	3,090,582	28,346,880 lbs.	4,166,989	1,076,407+
Dolomite	32,400 tons	114,911	69,510 tons	142,615	27,704+
Feldspar	4,587 tons	37,109	11,100 tons	81,809	44,691+
Fuller's earth	6,606 tons	48,758	3,650 tons	55,125	6,369+
Gems	----------	1,312	----------	13,220	11,908+
Gold	----------	14,670,346	----------	13,379,013	1,291,333−
Granite	----------	676,643	----------	760,081	83,438+
Graphite	b	b	----------	----------	b −
Gypsum	47,084 tons	188,336	88,410 tons	288,136	100,800+
Infusorial and diatomaceous earths	b	b	c	c	c +
Iron ore	3,588 tons	18,865	3,102 tons	18,665	205−
Lead	6,511,280 lbs.	358,120	9,984,522 lbs.	695,416	337,296+
Lime	57,875 tons	671,747	70,894 tons	788,834	117,087+
Limestone	94,382 tons	282,181	143,256 tons	348,464	66,283+
Lithia	b	b	----------	----------	---------- −
Magnesite	55,637 tons	594,865	73,953 tons	946,843	351,978+
Magnesium salts	3,030 tons	89,788	3,652 tons	116,031	26,243+
Manganese ore	540 tons	7,650	690 tons	10,620	2,970+
Marble	28,331 cu. ft.	127,792	28,015 cu. ft.	124,919	2,873−
Mineral paint	1,020 tons	12,277	1,049 tons	11,773	1,504−
Mineral water	4,276,346 gals.	486,424	5,437,276 gals.	616,919	130,495+
Natural gas	103,628,024 M. cu. ft.	6,990,039	240,406,897 M. cu. ft.	15,901,433	8,871,403+
Onyx and travertine	10,950 cu. ft.	3,320	14,220 cu. ft.	2,510	810−
Petroleum	138,468,322 bbls.	173,381,265	262,875,690 bbls.	242,731,309	69,350,044+
Platinum	795 fine oz.	90,288	602 fine oz.	78,546	11,742−
Potash	17,776 tons	584,388	29,597 tons	709,836	125,448+
Pumice and volcanic ash	613 tons	4,248	2,586 tons	16,309	12,061+
Pyrites	151,881 tons	570,425	148,004 tons	553,308	16,117−
Quicksilver	3,466 flasks	191,851	5,458 flasks	332,851	141,000+
Salt	223,338 tons	819,187	276,979 tons	1,130,670	311,483+
Sandstone	900 cu. ft.	1,100	7,000 cu. ft.	13,000	11,900+
Shale oil	b	b	c	c	c −
Silica (sand and quartz)	9,574 tons	31,016	7,904 tons	30,620	396−
Sillimanite and andalusite	b	b	c	c	c +
Silver	3,100,065 fine oz	3,100,065	3,559,443 fine oz.	2,918,743	181,322−
Slate	b	b	----------	----------	---------- −
Soapstone and talc	13,378 tons	197,186	17,439 tons	252,661	55,475+
Soda	20,084 tons	573,661	34,385 tons	764,284	190,623+
Stone, miscellaneous(d)	----------	10,377,783	----------	15,395,652	5,017,869+
Sulphur	----------	----------	c	c	c +
Tungsten concentrates	----------	----------	34 tons	19,126	19,126+
Zinc	3,034,430 lbs.	172,963	----------	----------	172,963−
Unapportioned	----------	b380,558	----------	c2,482,047	2,101,489 +
Total values	----------	$245,188,826	----------	$344,094,678	----------
Net increase	----------	----------	----------	----------	$98,840,852+

(a) Recalculated to 40% 'anhydrous boric acid' equivalent.
(b) Unapportioned—includes calcium chloride, graphite, diatomaceous earth, lithia, shale oil, sillimanite-andalusite and slate.
(c) Unapportioned—Includes diatomaceous earth, calcium chloride, shale oil, sillimanite-andalusite, and sulphur.
(d) Includes macadam, ballast, rubble, riprap, paving blocks, sand, gravel, and grinding-mill pebbles.

By Counties.

The following table shows the comparative value of the mineral production of the various counties in the state, for the years 1922 and 1923:

County	1922	1923
Alameda	$2,041,454	$2,487,035
Alpine	2,800	
Amador	2,479,068	1,965,874
Butte	720,625	841,948
Calaveras	1,502,853	1,498,116
Colusa	75,984	75,000
Contra Costa	2,397,312	2,572,944
Del Norte	5,261	34,027
El Dorado	184,525	216,065
Fresno	10,853,433	4,383,331
Glenn	91,259	113,282
Humboldt	125,813	434,706
Imperial	188,739	264,738
Inyo	2,137,681	2,845,581
Kern	68,351,002	41,812,416
Kings	6,806	1,556
Lake	48,289	101,038
Lassen	27,327	7,840
Los Angeles	62,751,671	174,887,459
Madera	476,264	518,035
Marin	403,009	688,881
Mariposa	226,833	170,911
Mendocino	20,526	32,410
Merced	157,379	236,630
Modoc	16,018	8,397
Mono	86,863	92,791
Monterey	255,319	222,022
Napa	312,279	351,592
Nevada	2,906,005	2,870,770
Orange	38,020,087	45,468,269
Placer	405,975	494,513
Plumas	3,814,498	3,784,262
Riverside	3,243,917	7,093,853
Sacramento	2,189,562	2,436,015
San Benito	1,794,248	2,277,908
San Bernardino	8,547,900	13,777,233
San Diego	656,807	831,796
San Francisco	66,409	117,341
San Joaquin	473,395	811,229
San Luis Obispo	141,470	145,249
San Mateo	243,564	329,516
Santa Barbara	4,612,358	5,005,872
Santa Clara	894,080	1,320,393
Santa Cruz	3,608,805	4,225,905
Shasta	1,513,591	1,563,287
Sierra	1,770,525	886,510
Siskiyou	101,463	181,011
Solano	3,108,114	3,876,586
Sonoma	221,941	227,312
Stanislaus	452,167	445,515
Sutter	97	97
Tehama	9,388	6,216
Trinity	197,937	677,174
Tulare	571,845	466,559
Tuolumne	764,938	670,362
Ventura	5,837,078	4,079,684
Yolo	13,431	16,957
Yuba	2,588,316	3,321,129
Total values	$246,185,826	$344,024,678

Total Mineral Production of California, by Years.

The following tabulation gives the total value of mineral production of California by years since 1887, in which year compilation of such data by the State Mining Bureau began. At the side of these figures the writer has placed the values of the most important metal and non-metal items—gold and petroleum.

In the same period copper made an important growth beginning with 1897 following the entry of the Shasta County mines, and more recently Plumas County. Cement increased rapidly from 1902, while crushed rock, sand and gravel as a group parallels the cement increase. Quicksilver has been up and down. Mineral water and salt have always been important items, but the values fluctuate. Borax has increased materially since 1896. War-time increases, 1915–1918, were shown by chromite, copper, lead, magnesite, manganese, silver, tungsten and zinc. Most of these, except silver, have since declined; with structural materials and copper increasing in 1920–1923, also lead and magnesite in 1923.

Total Mineral Production of California by Years, Since 1887.

Year	Total value of all minerals	Gold, value	Petroleum, value
1887	$19,785,868	$13,588,614	$1,357,144
1888	19,469,320	12,760,000	1,380,666
1889	16,681,731	11,212,913	368,048
1890	18,039,666	12,309,798	384,200
1891	18,872,413	12,728,869	401,264
1892	18,300,168	12,571,900	561,333
1893	18,811,261	12,422,811	606,092
1894	20,203,294	13,923,281	1,064,521
1895	22,844,663	15,334,317	1,000,235
1896	24,291,398	17,181,562	1,180,793
1897	25,142,441	15,871,401	1,918,269
1898	27,289,079	15,906,478	2,376,420
1899	29,313,460	15,336,081	2,660,793
1900	32,622,945	15,863,355	4,152,928
1901	34,355,981	16,989,044	2,961,102
1902	35,069,105	16,910,320	4,692,189
1903	37,759,040	16,471,264	7,313,271
1904	43,778,348	19,100,600	8,817,809
1905	48,069,227	19,197,043	9,007,820
1906	46,776,085	18,732,452	9,238,020
1907	55,697,949	16,727,928	16,783,943
1908	66,363,198	18,761,559	26,566,181
1909	82,972,309	20,237,870	32,398,187
1910	88,419,079	19,715,440	37,689,542
1911	87,497,879	19,738,908	40,552,088
1912	88,972,385	19,713,478	41,868,344
1913	96,644,639	20,406,958	48,578,014
1914	93,314,773	20,653,496	47,487,109
1915	96,663,369	22,442,296	43,508,837
1916	127,901,610	21,410,741	57,421,334
1917	161,202,962	20,087,504	86,976,209
1918	190,753,337	16,529,162	127,459,221
1919	195,830,002	16,695,955	142,610,563
1920	242,099,667	14,311,043	178,394,937
1921	268,157,472	15,704,822	203,138,225
1922	245,183,826	14,670,346	173,381,265
1923	344,024,678	13,379,013	242,731,309
Totals	$3,095,775,027	$615,597,567	$1,608,485,225

CHAPTER TWO.

FUELS.

Among the most important mineral products of California are its fuels. This subdivision includes coal, natural gas, and petroleum, the combined values of which made up 75% of the state's entire mineral output for the year 1923.

There are deposits of peat known in several localities in California, small amounts of which are used as a fertilizer, and in stock-food preparations, but none has as yet been recorded as utilized for fuel.

Comparison of values during 1922 and 1923 is shown in the following table:

	1922		1923		Increase+ Decrease−
	Amount	Value	Amount	Value	Value
Coal	27,020 tons	$135,100	1,010 tons	$5,090	$130,010−
Natural gas	176,628,027M cu.ft.	6,960,030	240,305,367M cu.ft.	15,661,433	8,671,403+
Petroleum	138,468,222 bbls.	173,381,365	262,875,600 bbls.	242,731,309	69,350,044+
Total value		$180,506,895		$258,397,852	
Net increase					$77,891,437+

COAL.

Bibliography: State Mineralogist Reports VII, XII, XIII, XIV, XV, XVII, XIX (inc.), pp. 152-157. U. S. G. S. Bulletins 285, 316, 431, 471, 581; An. Rpt. 22, Pt. III.

Coal production in California in 1923 totaled only 1010 tons valued at $5,090, being credited to Mendocino and Riverside counties. None of it was marketed, but it was consumed for local camp purposes and for power and forge use in development work on the deposits. Besides the localities mentioned above, development work was also under way on coal deposits in San Benito and Shasta counties. In the former, at the property of the San Benito Coal Company, it is proposed to install an electric-power generating and by-product plant, rather than to ship the coal, owing to the distance from rail transportation.

Total Coal Production of California.

The very considerable output of coal in the years previous to 1883 was almost entirely from the Mount Diablo district, Contra Costa County. Later the Tesla mine in Corral Hollow, Alameda County, was an important producer for a few years. Stone Canyon, Monterey County, was also an important producer for a short time, and there has been some coal shipped from properties in Amador, Fresno, Orange, Riverside, and Siskiyou counties. The following tabulation gives the annual tonnages and values, according to available records:

Coal Output and Value by Years.

Year	Tons	Value	Year	Tons	Value
1861	6,620	$38,065	1893	72,603	$167,555
1862	23,400	134,550	1894	59,887	139,862
1863	43,200	248,400	1895	79,858	193,790
1864	50,700	291,525	1896	70,649	161,335
1865	60,530	348,048	1897	87,449	196,255
1866	84,020	483,115	1898	143,045	337,475
1867	124,690	716,968	1899	160,941	420,109
1868	143,676	826,137	1900	176,956	535,531
1869	157,234	904,096	1901	150,724	401,772
1870	141,890	815,868	1902	88,460	248,622
1871	152,493	876,835	1903	93,026	265,383
1872	190,859	1,097,439	1904	79,062	376,494
1873	186,611	1,073,013	1905	46,500	144,500
1874	215,852	1,238,274	1906	24,850	61,600
1875	166,638	958,169	1907	23,734	55,849
1876	128,049	736,282	1908	18,496	55,503
1877	107,789	619,787	1909	49,399	216,913
1878	134,237	771,863	1910	11,033	28,484
1879	147,879	850,304	1911	11,047	18,297
1880	236,950	1,362,463	1912	14,484	39,092
1881	140,000	805,000	1913	25,198	85,809
1882	112,592	647,404	1914	11,859	28,806
1883	76,162	380,810	1915	10,299	26,662
1884	77,485	309,950	1916	4,037	7,030
1885	71,615	286,460	1917	3,527	7,691
1886	100,000	300,000	1918	6,343	16,149
1887	50,000	150,000	1919	2,083	8,203
1888	95,000	380,000	1920	2,078	5,450
1889	121,280	288,232	1921	12,467	63,578
1890	110,711	283,019	1922	27,020	135,100
1891	93,801	204,902	1923	1,010	5,090
1892	85,178	209,711			
			Totals	5,205,155	$23,085,678

The tonnages in the above table for the years 1861–1886 (incl.) are taken from the U. S. Geological Survey, "Mineral Resources of the U. S., 1910," p. 107. The values assigned for the years previous to 1883 are those given by W. A. Goodyear (Mineral Res., 1882, pp. 93–94), being an average of $5.75 per ton. From 1887 to date the figures are those of the California State Mining Bureau.

NATURAL GAS.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 3, 16, 19, 69, 73, 89. Monthly Summary, Oil & Gas Supervisor, Dec. 1919; Aug. 1922; Mar. 1923.

Statistics on the production of natural gas in California are in a considerable degree difficult to arrive at, as much of it that is utilized directly at the wells for heating, lighting, and driving gas engines is not measured. Hence, it is necessary to approximate the output of many of the operators in the oil fields, estimated on the number of lights, and on the number and horsepower of gas engines and steam boilers thus operated. The figures here given are for gas utilized locally and also that sold for distribution to consumers; and we consider are not over-estimated, particularly in the six oil-producing counties. It must be remembered that several of our important oil fields are removed many miles from the site of any other industry, and that the gathering of small amounts of gas and transporting it for any considerable distance may not always be profitable. Wherever feasible, casing-head gas is used in driving gas engines for pumping and drilling, and in firing the boilers of steam-driven plants.

The most notable gas developments in California in recent years have been in the Elk Hills and Buena Vista Hills in Kern County, northeast of the Midway district, and in the new oil fields in the Los Angeles basin, Los Angeles County. The yield of natural gas in the last-named district increased many fold in 1923 over that of 1922, the amount actually utilized being six times that of the preceding year. Lack of sufficient pipe-lines and other facilities to handle such an enormous increase made it impossible to prevent large quantities going to waste into the air.

The subject of natural gas production and its utilization in the southern part of the state have been covered in considerable detail by Mr. H. L. Masser,[1] gas engineer for the Railroad Commission of California, and quoted in our statistical report[2] of a year ago, to which the reader is referred.

Production and Value.

There is rather a wide variation in prices quoted for natural gas because a considerable part is used directly in the field for driving gas engines and firing boilers, and is therefore not measured nor sold. Such companies as have placed a valuation on the gas that was thus used in 1923 gave from 2¢–20¢ per 1000 cubic feet, at the well. From the totals shown in the tabulation following herein, the average value for all fields in 1923 works out at approximately 6.5¢. Approximately 7000 cubic feet of gas is equal to one barrel of oil in heating value, and is so accounted for by many operators. In driving gas engines, about 4000 cu. ft. per 24 hr. are consumed by a 25-h.p. engine and 63,700 cu. ft. per day for heating a 70-h.p. steam boiler, which figures have been utilized in compiling this report, in those cases where gas was not metered.

Natural Gas, 1923, by Counties.

County	M cu. ft.	Value
Fresno	1,599,364	$122,703
Kern	42,421,593	2,051,656
Kings	1,990	270
Los Angeles	134,799,452	8,760,961
Orange	55,477,147	3,914,661
Santa Barbara	1,612,287	172,725
Tulare	380	190
Ventura	4,162,318	470,261
Butte, Humboldt, Lake, Mendocino, Sacramento, San Joaquin, Santa Clara, Sutter, Yuba*	330,877	167,807
Totals	240,405,397	$15,661,433

*Combined to conceal output of a single operator in each.

The above totals for 1923 compare with 103,628,027 M cu. ft., valued at $6,990,030 in 1922, being nearly 2½ times the quantity and more than double the value. The Los Angeles County yield jumped from 23,254,549 M cu. ft. to 134,799,452 M cu. ft.; and Orange County from 25,269,402 M cu. ft. to 55,477,147 M cu. ft. Ventura County showed a slight increase, while Fresno, Kern, and Santa Barbara counties dropped slightly.

The 1923 total of quantity is approximately one-half of the previously

[1]Masser, H. L. Natural gas production and utilization in southern California: Cal. State Min. Bur., Summary of Oil Field Operations, Vol. 8, No. 9, pp. 5-56, Mar. 1923.

[2]Cal. State Min. Bur., Bulletin 98, pp. 18-22, 1923.

recorded total for California for the years 1888-1922 inclusive; and the 1923 total of value equals 41% of the total value for the same period.

Natural Gas Production in California, Since 1888.

The production of natural gas in California by years since 1888 is given in the following table. The first economic use of natural gas in California was from the famous Court House well at Stockton, bored in 1854–1858. Beginning about 1883 and for several succeeding years, a number of gas wells were brought in around Stockton. Natural gas was known in a number of other localities, and occasionally utilized in a small way, notably at Kelseyville in Lake County, and in Humboldt County near Petrolia and Eureka, but there are no available authentic records of amounts or values previous to the year 1888. The most important developments in the commercial production of natural gas have been coincident with developments in the oil fields, by utilizing the casing-head gas as well as that from dry-gas wells.

Year	M cubic feet	Value	Year	M cubic feet	Value
1888	[a]12,000	$10,000	1906	168,175	$109,489
1889	[a]14,500	12,680	1907	169,991	114,759
1890	[a]41,250	33,000	1908	842,883	474,581
1891	[a]39,000	30,000	1909	1,148,467	616,982
1892	[a]75,000	55,000	1910	10,579,933	1,678,367
1893	[a]84,000	68,500	1911	[a]5,000,000	491,859
1894	[a][b]85,080	79,072	1912	[a]12,000,000	940,076
1895	[a][b]110,800	112,000	1913	14,210,886	1,053,202
1896	[a][b]131,100	111,457	1914	16,529,963	1,049,470
1897	[a]71,300	62,657	1915	21,392,892	1,706,480
1898	[a]111,165	74,424	1916	28,134,365	2,871,751
1899	115,110	96,000	1917	44,343,020	2,964,922
1900	40,566	34,578	1918	46,373,052	3,289,524
1901	120,800	92,031	1919	52,173,503	4,041,217
1902	120,968	99,443	1920	58,567,772	3,898,286
1903	120,134	75,237	1921	67,043,797	4,704,878
1904	144,437	91,635	1922	108,628,027	6,990,020
1905	148,345	102,479	1923	240,406,397	15,661,433
			Totals	725,497,628	$53,886,745

[a]Quantity, in part, estimated, where values only were reported.
[b]Includes natural CO_2 from a mine in Santa Clara County.

Gasoline From Natural Gas.

More or less gas usually accompanies the petroleum in the oil fields, and such gas carries varying amounts of gasoline. More than 80 plants are in operation recovering gasoline by compression or absorption from this 'casing-head' gas. After the gasoline is extracted, the remaining 'dry gas' is taken into the pipe lines, by which it is distributed to consumers, both domestic and commercial.

In the Midway field, some of the casing-head gasoline is obtained as an incidental product to the compressing of the natural gas preliminary to transmission through the gas pipe lines. Some concerns market casing-head gasoline separately while others turn it into the oil pipe lines, thus mixing this high-gravity gasoline with the crude oil for transportation to the refinery, where it is later regained. A total of 156,263,015 gallons of casing-head gasoline valued at $13,197,578 from all fields was reported by 87 operators, as made during 1923. This

compares with 63,191,381 gallons by 55 operators in 1922. It was distributed by counties, as follows:

County	Gallons	Value
Fresno	440,200	$49,857
Kern	58,516,325	5,393,233
Los Angeles	46,092,588	2,787,519
Orange	39,720,716	3,626,212
Santa Barbara	6,926,040	831,124
Ventura	4,657,146	559,833
Totals	156,263,015	$13,197,578

The usual recoveries of gasoline from natural gas vary from ½ gal. to 3 gal. per 1000 cu. ft. of gas handled, the average being about 1 gal. per 1000 cu. ft.

PETROLEUM.

Bibliography: State Mineralogist Reports IV, VII, X, XII, XIII. Bulletins, 3, 11, 16, 19, 31, 32, 63, 69, 73, 82, 84, 89. Reports of Oil and Gas Supervisor 1915 to date (issued in monthly chapters since April, 1919). U. S. Geol. Surv., Bulletins, 213, 285, 309, 317, 321, 322, 340, 357, 398, 406, 431, 471, 451, 581, 603, 621, 623, 653, 691; Prof. Papers, 116, 117.

The crude oil production of California for 1923 amounted to a total of 262,875,690 barrels of clean oil, valued at $242,731,309 at the well. This total of quantity is compiled from the monthly production reports filed by the operators with the State Oil and Gas Supervisor, to which have been added figures for the output of a number of small operators in the Los Angeles city field not under the jurisdiction of the Supervisor, and from one property in Santa Clara County.

The question of the value of the crude oil yield, at the well, is a difficult one to settle with exactitude, principally because a large part of the output is not sold until after refining. The large refiners are also large producers of crude oil which they send direct from well to plant, hence much of the crude is not sold as such. The values used in the statistical reports of the State Mining Bureau since 1914 have been derived from averages of actual sales of crude oil of all grades in each field of the state, and these averages applied to the total yield of the respective fields. This we feel is a safer measure of commercial values than market quotations, because quotations do not always mean sales.

Features of 1923.

The outstanding feature of the year 1923 in the oil industry of California was the continued increase in Los Angeles and Orange counties due to intensive drilling of new and gusher wells yielding high-gravity oil, with consequent overproduction. This necessitated the continued shutting-in of low-gravity wells in other fields of the state. As in 1922, this resulted in further decreased output of crude oil in Fresno, Kern, and Santa Barbara counties. The peak of production came in the month of August, 1923, when the State's total amounted to 26,440,005 barrels, followed by a figure only slightly less for the month of September. The increase in Los Angeles County alone was more than four-fold, while the Orange County yield was

50% greater than the previous year. As in 1922, Ventura County also increased, to the extent of approximately 25%.

There were three reductions in 1923 in prices quoted for crude oil at the well, above 20° Baumé gravity, announced by the marketing companies, January 6, April 10, and October 9. The reductions were proportionately greater for the specific gravities above 28° than for those below. Both in 1922 and 1923, the price reductions to a limited extent, only, affected the production total by causing the shutting-in of wells yielding oil of the lower gravities and in the districts outside of the areas where intensive campaigns of new developments were taking place. The unprecedented increase in production taxed the storage, transportation, and refining facilities of all of the marketing concerns. Shipments by sea via Panama Canal to Atlantic seaboard points advanced to important amounts and became of vital assistance in the situation.

Estimating in January the output of the year just closed, the State Oil and Gas Supervisor[1] presents the following observations:

"California again broke all previous records in its production of petroleum by producing 268,729,000 barrels in 1923. This is about 36 per cent of the amount produced in the entire United States, and almost double the amount produced by California in 1922, which was a record year. This great increase was due to the intensive and rapid development of the Huntington Beach, Santa Fe Springs and Long Beach fields, where initial productions of nearly all the wells were large. These three fields produced 69.4 per cent of the state's production in 1923. This tremendous production taxed the storage capacity and marketing facilities of the large companies, and caused new markets for California crude oil to be opened. About 92,000,000 barrels of crude was in storage at the end of 1923, as compared with 61,380,000 barrels at the beginning of the year, and notwithstanding about 54,455,000 barrels was shipped through the Panama Canal to eastern refineries.

"During September, 1923, production reached its maximum, and then declined, this decline continuing to the end of the year, in spite of the fact that production was resumed in some of the San Joaquin Valley fields where it had been shut in. In December, 1923, for the first time since December, 1920, storage decreased, or, in other words, consumption which includes oil shipped to eastern ports through the Panama Canal, was greater than the December production, which averaged daily 706,000 barrels. The indicated consumption of oil increased during the year from 451,613 barrels in December, 1922, to 711,459 barrels in December, 1923.

"There were three reductions in the price of oil in 1923; the first reduction was made on January 6, when all grades, including 20 degrees Baumé and above, were reduced, the highest gravity (35 degrees and above) being reduced 53 cents. The next reduction, on April 10, for the refinable oils, amounted to 41 cents for the highest grade. The third reduction, amounting to 18 cents on the highest grade, was made on October 9. Fuel oil, or the grades below 20 degrees Baumé, remained stationary during the year.

"A total of 1400 new wells was started in 1923, as compared with 1439 in 1922. During the year, 980 producing wells were completed.

"At the close of the year with the Santa Fe Springs, Huntington Beach and Long Beach fields almost completely developed, activity in the Los Angeles Basin centered in Torrance field, but this field does not give promise of being as prolific, or of developing as rapidly, as the above mentioned fields, since most of the acreage is held in comparatively large leases by the larger companies. Activity is also gradually increasing in the older fields of the San Joaquin Valley, and the outlook for the petroleum industry for the year 1924 looks bright at the present time. The year started out with an increase in the price of all grades of oil amounting to 25 cents, effective January 22, and the prospect of additional increases during the year is good."

Outlook for 1924.

The outlook for the current year is for a somewhat lower total quantity than in 1923. At the same time, consumption during the first six months showed an unexpected decline, due to a number of causes, as noted by Bush[2]: "a decreased demand for fuel by the largest consumers (the railroads); decreased demand for gasoline in California during the spring and early summer months resulting from the hoof and mouth disease epidemic; decreased demand for gasoline east of

[1]Bush, R. D., Weekly press bulletin No. 431: Dept. of Petr. and Gas; Cal. State.
[2]Bush, R. D., Features of production, first half of 1924; State Min. Bur., Mining Min. Bur., Jan. 26, 1924.

the Rocky Mountains due to weather conditions and to continued over-production of oil in the Mid-Continent fields. The last two factors account for the drop in the amount of oil exported from California to the Atlantic and Gulf ports."

Production Figures.

The following table gives the production and value by counties for 1923, compared with the 1922 figures:

TABLE A.

Production and Value of Oil, by Counties.

County	1922		1923	
	Barrels	Value	Barrels	Value
Fresno	9,265,526	$9,895,582	5,061,542	$3,593,695
Kern	53,512,157	64,803,222	45,952,794	37,629,300
Los Angeles	37,726,367	52,930,093	158,665,019	154,063,733
Orange	31,049,491	38,483,162	46,474,921	40,807,930
San Luis Obispo	33,856	31,892	32,988	19,793
Santa Barbara	3,931,155	3,974,398	3,061,947	2,394,433
Ventura	2,933,685	5,236,628	3,610,794	4,109,084
San Mateo and Santa Clara*	15,985	26,288	15,685	28,341
Totals	138,468,222	$173,381,265	262,875,690	$242,731,309

*Combined to conceal output of a single operator in San Mateo County.

The foregoing totals show a state average price of $0.923 per barrel for the year 1923, as compared to $1.249 in 1922. As already noted in a preceding paragraph, the drop in value was due to an overproduction in the higher grades of crude oil and a consequently greater proportional drop in prices for the higher grades.

TABLE B.

Average Price of Oil per Barrel, by Counties, 1915-1923.

County	1915	1916	1917	1918	1919	1920	1921	1922	1923
Fresno	$0.432	$0.545	$0.516	$0.525	$1.191	$1.228	$1.483	$1.068	$0.710
Kern	.409	.428	.641	.893	1.252	1.850	1.714	1.211	0.819
Los Angeles	.550	.629	.651	1.176	1.340	1.380	1.532	1.403	0.971
Orange	.675	.512	.663	1.003	1.412	1.860	2.138	1.175	0.880
San Luis Obispo	.....	.....	.450	.926	.905	1.040	1.400	0.942	0.600
Santa Barbara	.460	.611	.794	.808	1.235	1.126	1.675	1.011	0.782
Santa Clara	.530	.656	.666	1.387	1.700	1.600	1.485	1.616	1.404
Ventura	1.050	.856	1.045	1.318	1.480	1.635	2.507	1.785	1.138
State average	$0.461	$0.479	$0.636	$0.908	$1.278	$1.409	$1.726	$1.249	$0.923

For several years previous to 1919, the state average value per barrel at the well for crude oil as determined by the statistical returns was noted to practically coincide with the quotations during the same years for 23° gravity oil in the San Joaquin Valley fields. In 1919 and since, the average values have worked out at figures corresponding to quotations up to, in one year as high as 28° oil, due to the large yield of high-gravity oils from the new fields in the Los Angeles-Orange counties area.

TOTAL PETROLEUM PRODUCTION OF CALIFORNIA.

The presence of oil seepages and springs in Los Angeles and Ventura counties was known and utilized in a small way early in the history of California. Some also was shipped to refineries at San Francisco from Santa Barbara and Humboldt counties. In the light of present-day developments, the following reference to the previous year's production of oil and its future prospects as expressed by the San Francisco Bulletin of January 8, 1866, is strikingly prophetic even though skeptical:

"It is possible that the small quantity received (40,000 or 50,000 gallons in 1865) may be the forerunner of many millions which will, at some future time, lubricate the wheels of commerce and set a trade at work excelling in variety any that has thus far been known on this coast. At present, however, we admit to being a little skeptical about the asumption of the astute Professor Silliman that California will be found to have more oil in its soil than all the whales in the Pacific Ocean."

According to Hanks,[1] in 1874 production amounted to 36 bbl. per day from natural flows in Pico Cañon (Newhall), and at Sulphur Mountain (Ventura County), the oil being of 32° gravity average.

[1] "Work was commenced in Pico Cañon in 1875, by drilling three shallow wells with spring pole, all of which yielded oil at depths of from 90 to 250 feet. Actual work of development commenced with steam machinery in 1877."

In 1877 Pico averaged 40-50 bbl. daily, and Ventura 80 bbl. daily. In 1878, there was some production (@ 60 bbl. per day, for a time) from wells in Moody Gulch, near Los Gatos, Santa Clara County, the oil being of 46° Baumé.

The first wells in the Coalinga, Fresno County, and Summerland, Santa Barbara County, fields were drilled in 1890, but Coalinga did not make its influence felt conspicuously on the state's annual output until 1903. The Summerland yield never has been large. The Salt Lake field near Los Angeles began production in 1894 and in 1897 reached over a million barrels annually.

In the Kern County fields, the first well was drilled in Sunset in 1891, Midway in 1900, McKittrick in 1892, Kern River in 1899. The Sunset-Midway district attained a yield of over 4,000,000 bbl. in 1909, and over 20,000,000 bbl. in 1910. Kern River field produced over 3,000,000 bbl. in 1901.

The first well in the Santa Maria-Lompoc group, Santa Barbara County, was drilled in 1901, and the district advanced to a yield of over 3,000,000 bbl. annually in 1905.

The Whittier-Fullerton field in Los Angeles and Orange counties became an important factor in 1902. The Montebello field, Los Angeles County, was the conspicuous addition in 1918-1919; and Elk Hills, Kern County, with Huntington Beach and Richfield, Orange County, in 1920. In 1921, the new fields added were Long Beach and Santa Fe Springs, Los Angeles County; in 1922, Torrance field in Los Angeles County, and Wheeler Ridge field in Kern County; but the production from the large number of new wells started in these new Los Angeles County fields did not reach its peak until August and September, 1923.

The effect of the advent of these various fields to the producing column will be noted in the tabulation herewith, by years:

[1] Hanks, Henry G., Report IV of State Mineralogist, p. 398, 1884.
[2] *Idem*, p. 301.

TABLE C.

Total Petroleum Production in California.

Year	Barrels	Value	Year	Barrels	Value
To and inc. 1875	(a) 175,000	(b) $472,500	1900	4,329,950	$4,152,928
1876	12,000	30,000	1901	7,710,315	2,961,102
1877	13,000	29,250	1902	14,336,010	4,092,189
1878	15,227	30,454	1903	24,340,839	7,313,271
1879	19,858	39,716	1904	29,736,003	8,317,809
1880	40,552	60,828	1905	34,275,701	9,007,820
1881	99,862	124,828	1906	32,624,000	9,238,020
1882	128,636	257,272	1907	40 311,171	16,788,943
1883	142,857	285,714	1908	48,306,010	26,566,181
1884	262,000	655,000	1909	58,191,723	32,398,187
1885	325,000	750,750	1910	77,697,568	37,689,542
1886	(a) 377,145	(b) 870,285	1911	84,648,157	40,552,088
1887	678,572	1,357,144	1912	89,689,250	41,868,344
1888	690,333	1,380,666	1913	98,494,532	49,378,014
1889	803,220	868,048	1914	102,881,907	47,487,109
1890	307,360	384,200	1915	91,146,620	43,303,837
1891	823,600	401,264	1916	90,262,557	57,421,334
1892	385,049	561,333	1917	95,396,309	86,976,209
1893	470,179	608,082	1918	99,731,177	127,450,221
1894	783,078	1,064,521	1919	101,182,062	142,610,563
1895	1,245,339	1,000,235	1920	103,277,361	178,394,937
1896	1,257,780	1,180,793	1921	112,599,660	203,138,225
1897	1,911,599	1,918,269	1922	138,468,222	173,381,255
1898	2,249,088	2,376,420	1923	262,875,690	242,731,309
1899	2,677,875	2,660,793			
			Totals	1,857,529,873	$1,612,091,748

[a] U. S. G. S., Min. Res. of U. S., 1886, p. 440, for quantities to and including 1886.
[b] Values have been estimated for the years to and including 1886, after consulting a number of contemporaneous publications, including the Mining & Scientific Press, Reports of the State Mineralogist, and U. S. Reports. The figures for 1887 to date are from records of the State Mining Bureau.

Well Data.

The following table is compiled from the monthly statements contained in the Standard Oil Bulletin:

TABLE D.

Well Operations, by Fields, 1923.

	Producing Dec., 1922	Producing Dec., 1923	Completed during year	Daily initial output	Abandoned during year	Bbl. per well produced per day Dec., 1923
Kern River	2,159	2,143	1	6		7.4
McKittrick	283	284	1	25	5	20.3
Midway-Sunset	2,156	2,322	140	34,200	24	33.3
Elk Hills	88	85	21	18,907		237.5
Lost Hills-Belridge	417	243	1	10	6	14.5
Coalinga	679	738	3	130	21	23.6
Wheeler Ridge*		7	7	1,225	1	96.3
Watsonville	8	6				9.5
Santa Maria-Lompoc	322	293	3	110	8	26.2
Summerland	135	135				1.1
Ventura-Newhall	557	544	19	4,347	22	16.7
Los Angeles-Salt Lake	620	634			6	5.0
Whittier*	551	179	3	1,515		10.8
Fullerton*		386	7	2,649		21.3
Coyote	284	107	5	720	3	22.7
Santa Fe Springs	70	307	281	684,741	49	581.4
Montebello	116	116	5	755	6	91.4
Richfield	169	177	10	2,653	7	81.0
Huntington Beach	153	265	120	98,813	27	252.7
Long Beach	137	329	250	455,978	72	660.5
Torrance (Redondo)	13	99	102	73,656		317.2
Compton*		1	1	1,250	1	1,282.0
Totals	8,916	9,396	980	1,376,270	258	a75.2

*Segregated records beginning August, 1923.
aState average.

Specific Gravities of Oils Produced.

The proportion of heavy and light oil produced in the various fields is shown in Table E, following, for which we are indebted to the Standard Oil Company. Under present practice, oil below 18° Baumé may be considered as largely refinable for fuel oil and lubricants, while the lighter oils yield varying amounts of the higher refined products with corresponding proportions of residuum and fuel oil. Specific gravities in California range from 8° Baumé in the Casmalia field, Santa Barbara County, to 56° Baumé in Ventura County.

California crude oils are all essentially of asphalt base, with a few notable exceptions. In the following localities are wells yielding crudes containing both asphalt and paraffine constituents: Oil City field, Coalinga; a few deep wells in East Side field, Coalinga; a considerable part of the Ventura County fields; Western Minerals area, south of Maricopa; Wheeler Ridge, Kern County.

TABLE E.

Production of Light and Heavy Oil, by Fields, 1923.

	Under 18° (barrels)	18° and over (barrels)	Total (barrels)
Kern River	6,734,652		6,734,652
McKittrick	2,221,903		2,221,903
Midway-Sunset	9,619,242	26,164,297	35,783,539
Lost Hills and Belridge	482,267	1,341,659	1,823,926
Wheeler Ridge		128,588	128,588
Coalinga	3,598,008	1,536,864	5,134,872
Santa Maria-Lompoc	1,781,971	1,189,361	2,971,332
Ventura-Newhall	61,292	3,641,704	3,702,996
Los Angeles-Salt Lake	1,093,351	128,755	1,222,106
Whittier-Fullerton	668,877	16,825,425	17,494,302
Santa Fe Springs		80,266,082	80,266,082
Huntington Beach	449,653	34,469,316	34,918,969
Signal Hill-Long Beach	78,886	68,838,681	68,917,567
Torrance-Redondo	377,282	2,783,335	3,160,617
Summerland	51,110		51,110
Watsonville	23,725		23,725
Dominguez		155,632	155,632
Totals	27,242,189	237,469,599	264,711,788

As previously noted by the writer,[1] a decided change has taken place in the relative proportions of light and heavy crudes produced in California since 1910, taking 18° Baumé as the dividing line. This subject was also covered in detail and with charts, by Collom and Barnes[2] recently.

[1] Bradley, W. W., Mineral production of California in 1921: Cal. State Min. Bur., Report XVIII, p. 442, Sept. 1922.

[2] Collom, R. E., and Barnes, R. M., California oil production and reserves: Cal. State Min. Bur., Ninth Ann. Rep. of State Oil and Gas Supervisor, Aug. 1923, pp. 5–23.

A marked drop took place in the low-gravity yield from 1910 to and including 1914. From 1914, it has remained almost stationary, with a slight drop in 1921, while the high-gravity yield has increased at a rapid rate since 1915. The proportions have been reversed from approximately 75% low—25% high in 1914 to 25% low—75% high in 1921, and 10% low—90% high in 1923.

This has been an important factor in its effect upon the average price per barrel of the state's output in these years, as well as its effect upon the relative situation between production and consumption. It has been a fortunate development, in view of the increased demand for refinery products (gasoline, in particular), and the lessened demand for fuel oil owing in part to the shutting down of the western copper smelters which were large consumers of California fuel oil.

Oil in 'Storage.'

Field, refinery, pipe-line and tank-farm stocks of crude, residuum and tops totaled 91,925,153 barrels[1] on December 31, 1923, compared with 61,384,164 barrels on December 31, 1922, distributed as follows:

	Dec. 31, 1923	Dec. 31, 1922
Heavy crude, heavier than 20° A. P. I., including residuum	43,614,271	40,837,761
Refined crude, 20° A. P. I. and lighter	35,559,054	17,613,591
Tops	12,751,828	2,912,812
Totals	91,925,153	61,384,164
Total quantity of above products held at refineries	29,763,653	11,809,691
Total quantity of above products held in fields, pipe-lines, and tank-farms	62,161,500	49,574,473
Total stocks as above	91,925,153	61,384,164

Operating Data.

The following tabulation (Table F) is compiled from data published by the Department of Petroleum and Gas,[2] semiannually, and here combined to show the entire year's operations for all fields. The 'districts' are the geographical subdivisions as administered by the Department, and which are outlined on the accompanying map.

It will be noted that the state average yield of oil per well per day was 81.1 barrels for the first six months of 1923 and 101.3 barrels for the second. This is somewhat higher than the figure of 75.2 barrels average for December derived from Standard Oil Company data as shown in Table D, on a preceding page, due in part at least, to the fact that the latter is on a full-time basis, whereas the Bureau figures allow for shut-down time.

[1] Standard Oil Bulletin, February 1924, p. 11.
[2] Summary of operations, California Oil Fields: Cal. State Min. Bur., Ninth Ann. Rep. of State Oil and Gas Supervisor, Aug. 1923, pp. 26–27; Feb. 1924, pp. 6–7.

TABLE F. PRODUCTION AND OPERATING DATA OF CALIFORNIA OIL FIELDS—1923.

Field	January 1 to June 30						July 1 to December 31					
	Average number of producing wells—actual	Oil (bbl.)	Number of days producing	Production per well per day (bbl.)		Percentage of time wells produced	Average number of producing wells—actual	Oil (bbl.)	Number of days producing	Production per well per day (bbl.)		Percentage of time wells produced
				Oil	Water					Oil	Water	
District No. 1—												
Beverly Hills	18	81,838	2,101	38.9	57.4	81.4	14	83,713	2,289	37.4	48.6	88.3
Brea Olinda	370	1,807,901	58,505	30.8	9.6	87.5	380	1,904,027	62,881	30.5	9.9	89.2
Coyote Hills	192	2,282,911	81,390	70.7	26.9	90.9	102	547,284	17,578	31.1	24.7	93.6
Dominguez							1	167,856	122	1,375.7	14.4	66.4
Huntington Beach	166	17,932,536	26,782	670.3	10.3	89.2	232	15,860,629	38,373	413.3	13.3	89.9
*Long Beach	183	26,507,896	29,111	910.6	5.5	87.9	272	41,298,115	46,317	894.0	6.2	88.6
Montebello	116	3,070,294	19,980	163.9	31.1	94.9	116	1,919,589	20,820	94.4	29.2	95.2
Newhall	56	31,480	9,798	3.2	6.5	95.7	54	27,455	9,626	2.9	4.2	96.9
Richfield	171	3,283,180	29,212	112.4	5.8	94.4	179	2,886,483	31,130	92.7	4.4	94.5
Salt Lake	258	394,054	43,186	9.1	14.2	94.8	252	400,501	44,322	9.0	12.7	95.5
*Santa Fe Springs	112	31,753,818	17,172	1,849.1	14.5	84.6	249	49,711,397	40,686	1,221.8	7.7	88.8
*Torrance	19	592,490	2,748	216.6	1.8	79.8	54	2,568,226	7,458	343.7	2.0	75.1
Whittier	158	367,074	24,295	14.7	21.6	87.4	196	368,489	30,619	13.8	20.6	87.2
Totals	1,809	87,075,382	295,227	291.9	14.3	90.2	2,071	117,836,808	345,215	341.3	13.0	90.6
District No. 2—												
Ventura	39	712,306	4,597	158.0	78.1	85.9	27	705,096	4,808	146.6	68.9	96.7
Totals	508	1,825,768	84,539	21.6	5.9	91.9	516	1,783,020	85,675	20.8	5.6	90.2

Field	January 1 to June 30						July 1 to December 31					
	Average number of producing wells—actual	Oil (bbl.)	Number of days producing	Production per well per day (bbl.)		Percentage of time wells produced	Average number of producing wells—actual	Oil (bbl.)	Number of days producing	Production per well per day (bbl.)		Percentage of time wells produced
				Oil	Water					Oil	Water	
Bardsdale	130	196,301	24,680	8.0	1.2	98.1	140	184,915	25,248	7.3	1.2	98.0
Conejo	15	510	2,148	0.2	0.1	79.1	15	255	1,074	0.2	0.1	72.1
Ojai	57	36,225	9,480	3.8	1.8	91.9	75	41,139	11,811	3.5	1.8	86.1
Piru	80	58,898	14,441	4.1	3.4	89.6	94	39,831	15,631	3.8	4.9	90.4
Santa Paula	51	19,468	8,582	2.3	0.8	93.0	49	14,121	6,099	2.3	0.7	82.8
Sespe	34	24,202	5,212	4.8	0.6	84.7	29	21,483	4,866	4.4	0.6	91.2
Simi	52	38,824	8,260	4.7	1.6	87.8	62	36,573	8,336	4.4	1.5	87.1
South Mountain	42	738,564	7,229	102.2	0.3	95.1	44	721,701	7,802	92.5	0.3	96.4

District No. 3—												
Arroyo Grande	19	17,406	2,909	6.0	7.8	84.6	19	15,682	3,081	5.1	6.5	86.7
Casmalia	94	575,273	15,796	36.4	101.5	92.8	88	605,390	14,817	34.1	181.6	91.5
Cat Canyon	25	254,618	3,967	64.2	9.8	87.7	28	281,230	4,660	60.5	9.0	90.3
†Half Moon Bay	4	388	362	1.1	0.3	50.0	4	388	362	1.1	0.3	49.2
Lompoc	12	75,050	1,288	58.4	53.7	59.3	6	40,345	589	68.5	64.0	58.4
Santa Maria	137	624,788	22,586	27.7	84.8	79.4	167	654,128	23,120	28.2	32.6	80.0
Sargent	9	7,340	1,620	4.5	0.0	99.4	9	7,160	1,638	4.4	0.0	98.9
†Summerland	134	26,100	22,305	1.2	12.9	92.0	134	26,100	22,305	1.2	12.9	90.5
Totals	434	1,580,963	70,813	22.3	59.6	86.2	445	1,529,248	70,512	21.7	54.3	86.1
District No. 4—												
Belridge-Lost Hills-Devils Den	380	1,130,088	65,087	17.4	26.4	94.6	267	666,984	41,160	16.2	38.7	83.8
Elk Hills	107	4,016,230	17,554	228.8	2.1	98.6	105	4,071,319	17,266	235.8	1.7	99.4
Kern River	2,160	3,524,969	371,965	9.5	60.4	95.1	2,041	3,043,871	348,762	8.7	50.5	92.9
McKittrick-Temblor	287	1,107,872	47,524	23.3	74.7	91.5	291	1,098,859	50,915	21.6	75.8	96.1
Midway-Sunset	2,230	13,848,475	360,109	37.5	19.7	91.4	2,136	13,306,250	363,333	36.6	19.1	92.4
Wheeler Ridge	1	43,706	154	283.8	0.0	91.7	5	92,171	693	133.0	0.0	75.3
Totals	5,165	23,671,340	871,373	27.2	35.9	93.2	4,845	22,287,454	822,129	27.1	36.5	92.2
District No. 5—												
Coalinga	688	2,412,809	115,246	20.9	14.8	92.6	711	2,648,673	118,037	22.4	14.0	90.2
Grand totals	8,624	116,566,322	1,437,198	81.1	29.2	92.1	8,585	146,080,299	1,441,508	101.3	27.8	91.2
*The exact production for some wells could not be obtained and the following estimates were incorporated in the above figures:												
Long Beach							58	916,068	1,377			
Santa Fe Springs							17	441,600	395			
Torrance							11	116,525	158			

†Estimated.

Financial and Operating Conditions of California Oil Fields, 1923.

Financial results of the oil business during 1923 are shown by the following tables. The features worthy of mention are: (1) The lower price received for the year as shown by the state average of all grades. (2) Decreases in the dividends paid by companies operating in Fresno, Kern, Santa Barbara, and Ventura counties, but a 10% increase in the state total of dividends for the year. (3) Decreases in the number of barrels per well per day yield (see Table I) in most of the older fields. (4) Somewhat lower operating costs per barrel in most of the fields.

With reference to Table I, it should be noted that although it lacks data from the larger operators who have refineries and with interests in more than one field, yet the data given are of economic value and interest in that they indicate the conditions prevailing among the smaller companies and operators.

Operating cost per well is not always lower for the dividend companies than others. Profitable operations seem to depend generally upon large wells, high-grade oil, and proximity to market. Price and profits have usually been greater in the Los Angeles-Orange-Ventura fields than in others, doubtless largely due to the proximity to market and higher grades of oil. Crude oil testing as high as 56° Baumé is obtained from some of the Ventura wells.

TABLE G. CAPITALIZATION.

Field	Number of companies considered*	Per cent of total product of field	Capital	
			Cash	Property
Fresno County—Coalinga	49	45	$3,447,434	21,402,476
Kern County:				
Kern River	39	38	1,088,835	4,380,848
Midway	61	25	16,871,510	5,983,243
Sunset-Maricopa	27		2,764,700	1,135,492
McKittrick, Lost Hills, Belridge, Devils Den, Elk Hills	36	44	2,353,694	3,158,651
Los Angeles County	101	30	17,089,158	30,081,579
Orange County*	44	57	7,989,694	7,989,151
Santa Barbara County	14	54	5,212,072	25,962,386
Ventura County	32	51	430,827	8,038,301
Subtotals	403		$58,156,924	$108,138,122
Miscellaneous and marketing companies†	69	47	352,118,690	159,960,878
Totals	472		$410,275,614	$268,099,000

*See Table I, following.

†Includes companies having refineries, and those operating in several fields whose data could not be segregated as to counties or fields.

TABLE H. Dividends Paid by Oil Companies, 1918-1923.

Field	1918		1919		1920		1921		1922		1923	
	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value
Coalinga	23	$1,055,600	24	$1,352,969	39	$1,397,694	34	$1,142,767	20	$893,210	17	$383,675
Kern River	31	609,294	27	1,225,877	25	783,625	38	390,794	20	594,306	13	187,170
Midway	42	3,015,862	32	8,260,447	30	7,016,819	34	4,311,389	30	2,706,987	19	2,438,695
Sunset and Maricopa	15	638,926	15	595,585	14	681,511	18	980,459	19	958,174	11	259,569
McKittrick, Belridge, Lost Hills, Devils Den, Elk Hills	12	708,981	9	548,234	12	1,331,045	13	2,606,490	10	733,460	11	1,021,602
Santa Barbara County	5	286,768	5	355,490	7	312,332	3	400,335	5	317,014	3	163,000
Ventura County	2	4,400	4	120,584	5	539,942	6	1,382,210	7	1,204,681	4	138,784
Los Angeles County	14	1,201,021	17	2,373,409	20	3,282,497	11	562,224	16	1,442,470	32	5,627,346
Orange County							11	1,395,158	8	331,345	12	897,119
Subtotals	144	$7,520,864	133	$14,642,529	152	$15,255,565	150	$13,121,176	135	$9,189,595	122	$11,105,560
Miscellaneous and marketing companies[1]	11	19,984,138	26	20,476,322	9	31,072,321	11	35,886,119	10	41,080,594	10	44,398,555
Totals	155	$27,504,292	159	$35,118,851	161	$46,337,886	161	$49,015,295	145	$50,190,189	137	$55,504,115

[1] See Table G, preceding.

TABLE I. Average Prices of Light and Heavy Oils, and Operating Data, 1923.

Field	Price				Operating data					
					All companies considered*			Dividend companies†		
	Under 18° Baume	18° and over	Average price	Price to dividend companies	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel
Coalinga	$0.701	$0.788	$0.710	$0.722	18.5	$6.96	$0.377	18.7	$6.63	$0.355
Kern River	0.611		0.611	0.630	8.4	2.60	0.308	7.4	2.08	0.280
Midway	0.610	1.054	0.951	1.077	32.7	10.17	0.311	48.0	12.00	0.253
Sunset and Maricopa	0.702	0.926	0.786	0.824	25.7	12.34	0.428	25.2	16.86	0.647
McKittrick, Lost Hills, Belridge, Devils Den, Elk Hills	0.660	0.827	0.760	0.859	37.9	7.73	0.204	44.4	6.70	0.151
Los Angeles County	0.728	0.975	0.971	1.022	178.8	64.87	0.361	218.6	57.27	0.262
Orange County	0.704	0.880	0.880	0.720	178.9	54.50	0.305	184.4	62.87	0.341
Santa Barbara County	0.568	0.882	0.782	0.890	38.4	12.48	0.325	47.6	12.94	0.272
Ventura County	0.550	1.144	1.135	1.431	19.4	24.44	1.259	7.4	5.93	0.804

*See Table G, preceding. Does not include companies with refineries, nor those operating in several fields whose data could not be segregated as to counties or fields. The data given are of value, however, as showing the conditions obtaining among the smaller operators.

†See Table H, preceding.

It should be noted that in the case of a county like Ventura, with only a few producers, the averages are not as significant as in other fields with a large number of operators. The figures of a single large operator in such a case can materially affect the general average if they should be much above or below the average of the others.

Proved Oil Land.

The total proved oil land of the state increased to 116,868 acres in 1923, from the 112,761 acres of 1922. Kern County increased 3395 acres, and Los Angeles, 1089 acres. Of this 1923 total, 19,932 acres, being owned by federal, state and city governments, or for other reasons, are not assessable for the support of the Department of Petroleum and Gas of the State Mining Bureau. The acreage in 1923 was distributed by counties as follows:

TABLE J.

Proved Oil Land, and Number of Wells, 1923.

County	Land (acres)	Number wells
Fresno	14,600	883
Kern	72,371	5,817
Los Angeles	8,558	1,760
Orange	7,242	915
San Luis Obispo	772	18
San Mateo	-------	4
Santa Barbara	9,303	387
Santa Clara	80	12
Ventura	3,942	516
Totals	116,868	10,332

CHAPTER THREE.

METALS.

The total value of metals produced in California during 1923 was $21,619,969. The chief of these is, and always has been, gold, followed in order in 1923 by copper, silver, lead, quicksilver, platinum, tungsten, iron ore and manganese ore. There was no production of antimony, cadium, molybdenum, nor tin, which have in the past been on the active list. Deposits of ores of nickel and vanadium have also been found in the state; although there has as yet been no commercial output of them. The above-noted total for this group is a net decrease of $80,764 from the 1922 total of $21,700,733, due mainly to decreases registered by gold, silver, and zinc, in spite of increases by copper and lead.

California leads all states in the Union in her gold production and is credited with approximately 30% of the nation's yield in 1923. The precious metal is widely distributed throughout the state. Thirty-two of the fifty-eight counties reported an output in 1923 from either mines or dredges.

Copper, which is second in importance among the metals of the state, occurs in the following general districts: the Shasta County belt, which has been by far the most important; the Coast Range deposits extending more or less continuously from Del Norte in the north to San Luis Obispo County in the south; the Sierra Nevada belt, starting in Plumas and running in a general southerly and southeasterly direction through the Mother Lode counties and ending in Kern; the eastern belt in Mono and Inyo counties; and the southern belt, in San Bernardino, Riverside and San Diego counties.

Silver is not generally found alone in the state, except notably in the Rand district, San Bernardino County; but is associated to a greater or less extent with gold, copper, lead and zinc.

Quicksilver has for many years been one of the state's staple products and California has supplied approximately 75% of the nation's output of this metal.

Tungsten is found in but few other localities of importance in the United States.

Large deposits of iron ore have long been known in several sections of the state, but for various economic reasons this branch of the mineral industry thus far has made only slight progress on the Pacific Coast.

A comparison of the 1923 metal output with that of the 1922 is afforded by the following table:

Substance	1922		1923		Increase+ Decrease− Value
	Amount	Value	Amount	Value	
Copper	23,883,987 lbs.	$3,060,382	28,346,860 lbs.	$4,136,989	$1,076,407+
Gold		14,670,346		13,379,013	1,291,333−
Iron ore	3,588 tons	18,868	3,102 tons	18,665	203−
Lead	6,511,280 lbs.	358,120	9,934,522 lbs.	695,416	337,296+
Manganese ore	540 tons	7,550	690 tons	10,520	2,970+
Platinum	795 fine oz.	90,288	602 fine oz.	78,546	11,742−
Quicksilver	3,466 flasks	191,851	5,458 flasks	332,851	141,000+
Silver	3,100,065 fine oz.	3,100,065	3,359,443 fine oz.	2,918,743	181,322−
Tungsten concentrates			34 tons	19,126	19,126+
Zinc	3,034,430 lbs.	172,962			172,962−
Total values		$21,700,733		$21,619,969	
Net decrease					$80,764−

ALUMINUM.

Bibliography: Report XVIII, p. 198. Bulletins 38, 67. U. S. Geol. Surv., Min. Res. of U. S.

To date there has been no commercial production of aluminum ore in California. Only a single authenticated occurrence of bauxite has thus far been noted in this state, being in Riverside County, southeast of Corona, but as yet undeveloped.

Minerals containing aluminum are abundant, the most widely distributed being the clays. There are only two, however, thus far of consequence, commercially, in the production of the metal: bauxite (to which may be added the related, hydrated oxides, hydrargillite and diaspore), and cryolite. Cryolite is found in commercial quantities only in South Greenland, and was formerly the only ore of aluminum used, being still employed as a flux in the extraction of the metal. Bauxite has been, for some years, the most important source of aluminum and its salts. Its color varies from gray to red, according to the amount of iron present, the composition ranging usually between the following limits: Al_2O_3, 30%–60%; Fe_2O_3, 3%–25%; SiO_2, 0.5%–20%; TiO_2, 0.0%–10%. Besides its reduction to the metal, bauxite is also utilized in the manufacture of: aluminum salts, refractory bricks, alundum (fused alumina) for use as an abrasive; and in the refining of oil (stated to be of growing importance). The most important producing countries, both of bauxite and the metal, are the United States and France, the former yielding more than 60 per cent of the world's output. In 1913 France led.

ANTIMONY.

Bibliography: State Mineralogist Reports VIII, X, XII, XIII, XIV, XV, XVII. Bulletin 38.

Production of antimony in California has been irregular, and small in amount except during the year 1916 when the high war-time prices permitted American producers, for a short period, to compete with Chinese antimony. The principal commercial production of antimony in California has come from Kern, Inyo, and San Benito counties, and other occurrences have been noted in Nevada, Riverside, and Santa Clara counties. The commonest occurrence is in the form of the sulphide, stibnite; but in the Kernville, and Havilah districts in Kern County there were notable deposits of the native metal, being among the few localities of the world where native antimony has been found.

California producers claim that they can not operate profitably unless the price of antimony be above 12 cents per pound. Present New York quotations are around 9 to 11 cents per pound.

Pure antimony metal, and manufactured antimony compounds are of considerable importance as pigments in the ceramic industry. The most important use of the metal, commercially, is in various alloys, particularly type-metal (with tin and lead), babbitt (with tin and copper), and britannia metal (with tin and copper).

Antimony Production of California, by Years.

The production of antimony in California by years since 1887 has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	75	$15,500	1900	70	$5,700
1888	100	20,000	1901	50	8,350
1889			1902		
1893	50	2,250	1915	510	35,695
1894	150	6,000	1916	1,015	64,793
1895	33	1,485	1917	158	18,786
1896	17	2,330	1918		
1897	20	3,500			
1898	40	1,200	Totals	2,363	$199,050
1899	75	13,500			

ARSENIC.

Bibliography: Report XVIII. Bulletin 67. U. S. G. S., Min. Res. of U. S.

Arsenic is found in a number of localities in California in the mineral arsenopyrite (FeAsS), which is frequently gold bearing; and in scorodite ($FeAsO_4+2H_2O$), an oxidation product of arsenopyrite. The occurrence of realgar (AsS) has also been noted. The principal source of the arsenic of commerce in the United States has been as a by-product from the metallurgical treatment of copper, gold, and lead ores. It is usually recovered in the form of the tri-oxide, or 'white arsenic,' for which there is a demand for the preparation of insecticides, for use in agriculture and horticulture, and especially against the cotton-boll weevil in the southern states.

Up to the beginning of 1924, there had been no commercial recovery of arsenic from California ores. Early in the present year, the plant of the Chipman Chemical Company at Bay Point began the preparation of arsenic compounds from Californian and Nevadan ores, by a chemical process.

BERYLLIUM.

Bibliography: Eng. & Min. Jour.-Press, Vol. 118, No. 8, p. 285, Aug. 23, 1924.

Beryllium is a metal resembling aluminum closely in its chemical character, and has a specific gravity of 2.7. Several alloys have been prepared experimentally, of which copper-beryllium has received the most attention. The addition of 5% beryllium produces a golden-yellow alloy.

The compounds of beryllium at present used commercially are the nitrate and oxide. The nitrate is used by incandescent mantle manufacturers to harden the thorium oxide skeleton, the amount varying from 2 gm. to 5 gm. per kilogram of thorium nitrate. The oxide has been added to materials being used for the manufacture of abrasive compounds and in dental cements, and has also been recommended as a

condensing agent in the preparation of certain esters. It is stated that this latter property may prove of value to manufacturers of synthetic perfumes and essences. Beryllium sulphate has been used to some extent in medical research.

There are a number of beryllium minerals, but none have been found in commercial quantities, except beryl, which is a beryllium-aluminum silicate carrying, when pure, 57% silica, 19% alumina, and 14% beryllium oxide. Beryl suitable for commercial purposes should carry from 10% to 12% beryllium oxide. The ore before use is ground to pass 90%–95% through a 200-mesh screen. It should be white in color, free from iron-bearing minerals and metallic iron. The price varies from 4¢ to 5¢ per pound in carload lots, according to demand and percentage of beryllium oxide. The chief use at present for ground beryl is as an addition to porcelain products, where it reduces the coefficient of expansion. Beryllium metal is difficult to separate from aluminum. For this reason, the mineral phenacite (Be_2SiO_4) would be a more desirable source for the metal, and it carries approximately 45% beryllium oxide.

Beryl occurs in California, in the pegmatite dikes of the tourmaline gem district in northern San Diego and southwestern Riverside counties. Thus far there have been no commercial shipments of beryl except for gem purposes (the pink and aquamarine varieties).

BISMUTH.

Bibliography: Bulletins 38, 67. Am. Jour. Sci. 1903, Vol. 16.

Several bismuth minerals have been found in California, notably native bismuth and bismite (the ochre) in the tourmaline gem district in San Diego and Riverside counties near Pala. Other occurrences of bismuth minerals, including the sulphide, bismuthinite, have been noted in Inyo, Fresno, Nevada, Tuolumne, and Mono counties, but only in small quantities. The only commercial production recorded was 20 tons valued at $2,400, in 1904, and credited to Riverside County.

In 1917, a few pounds of bismuthinite (Bi_2S_3) with associated bismutite ($Bi_2CO_5.H_2O$), was taken out at the United Tungsten Copper Mine, in the Morongo district, San Bernardino County. It is associated with scheelite in a contact deposit between limestone and granite.

Recovery of bismuth from blister copper in the electrolytic refinery has been noted,[1] ranging as high as 27.3 pounds of metallic bismuth per 100 tons of blister copper from the Iron Mountain, Shasta County, ores. In the United States, the principal recovery of bismuth is obtained as a by-product from the refining of lead bullion.

The uses of bismuth are somewhat restricted, being employed principally in the preparation of medicinal salts, and in low melting-point or cliché alloys. These alloys are utilized in automatic fire sprinkler systems, in electrical fuses, and in solders.

Present quotations for bismuth are around $2.50 per pound for the refined metal.

CADMIUM.

Bibliography: U. S. G. S., Min. Res. of U. S., 1908, 1918.

During 1917 and 1918, cadmium metal was recovered by the electrolytic zinc plant of the Mammoth Copper Company in Shasta County.

[1] Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217–218.

It was shipped in the form of 'sticks' and amounted to a total of several thousand pounds for the two years, the exact figures being concealed under 'Unapportioned.' That was the first, and thus far the only, commercial production of cadmium recorded from California ore. Cadmium there occurs associated with zinc sulphide, sphalerite, probably as the sulphide, greenockite. Cadmium also occurs in the Cerro Gordo Mine, Inyo County, associated with smithsonite (zinc carbonate).

There are several cadmium minerals, but none of them occur in sufficient quantities individually to be profitable as distinct ores. The cadmium of commerce is derived as a by-product in the reduction of zinc minerals and ores, in nearly all of which it occurs in at least minute proportions, the average ratio being about 1 of cadmium to 200 of zinc. As cadmium behaves metallurgically much the same as zinc, it constitutes a fraction of 1 per cent of nearly all metallic zinc.

Cadmium is produced in United States in two forms—metallic cadmium and the pigment, cadmium sulphide. The principal use of the metal is in low-melting point, or cliché alloys, and its salts are utilized in the arts, medicine, and in electroplating. The sulphide is employed as a paint pigment, being a strong yellow, which is unaffected by hydrogen sulphide gas from coal smoke. It is also employed in coloring glass and porcelain. Cadmium cliché metal is stated to be superior to the corresponding bismuth alloy, for making stereotype plates. Cadmium is also used in bronze telegraph and telephone wires, and gives some promise of being utilized in electroplating.

Present quotations for cadmium are 60¢ per pound for the refined metal, or approximately one-half the price of a year ago.

COBALT.

Bibliography: Report XIV. Bulletin 67. U. S. G. S., Min. Res. of U. S., 1912, 1918.

Occurrences of some of the cobalt minerals have been noted in several localities in California, but to date no commercial production has resulted. Some of the copper ores of the foothill copper belt in Mariposa and Madera counties have been found to contain cobalt up to 3%. The most recent, and notable, occurrence thus far found in this state is in the Mar-John Mine near Sheep Ranch, Calaveras County. Lenses of smaltite ($CoAs_2$) have been uncovered in the vein, there, and several tons taken out in the course of development work. It is hoped that further development work may yield commercial quantities of this valuable mineral.

The most important use of cobalt is in the manufacture of the alloy, stellite, in which it is combined with chromium, for making high-speed lathe tools, and non-tarnishing cutlery and surgeons' appliances. The metal is also used in electroplating, similarly to nickel; and the oxide, carbonate, chloride, sulphate and other salts are used in ceramics for coloring. Some of the organic salts of cobalt (acetate, resinate, oleate) are employed as 'driers' in paint and varnish.

Present quotations for cobalt are $2.50–$3.00 per pound for the refined metal.

COPPER.

Bibliography: State Mineralogist Reports VIII–XVIII (inc.) Bulletins 23, 50, 91.

Copper is second only to gold, among the metals produced in California. For many years Shasta was the leading county in the output of the red metal, but in 1919 Plumas advanced to first place, which it has since retained. This was due to the maintenance of output level by the Engels property and in 1922–1923 by the Walker Mine, also in Plumas County, and to the shutting down of the Mammoth, Mountain and Afterthought groups in Shasta County. Both the Engels and Walker ores are treated by flotation and the concentrate shipped to Utah plants for smelting. The fact that the Engels ore carries appreciable values in gold and silver has been an important factor in the company's maintenance of operations during this period when practically all other copper mines in the state were closed. In 1923, production was resumed by the Calaveras Copper Company, Calaveras County, and by the Mammoth and Mountain Copper properties in Shasta County. A small yield of copper in 1923 was also reported from Del Norte, Inyo, San Bernardino, and Trinity counties.

Although the copper property of the Mountain Copper Company was nonproductive in 1921–1922, and most of 1923, a part of this metal credited to Shasta County the past three years was obtained as a by-product from pyrites which has been sold and utilized in the manufacture of sulphuric acid, after which the copper-bearing cinder was smelted at other plants.

The state's total for 1923 amounted to 28,346,860 pounds valued at $4,166,989, being an increase over the 22,883,987 pounds and $3,090,582, figures of 1922. The average price in 1923 was 14.7¢ per pound, compared with 13.5¢ in 1922, 18.4¢ in 1920, 27.3¢ in 1917, and 13.3¢ in 1913.

Distribution of the 1923 copper output, by counties, was as follows:

County	Pounds	Value
Calaveras	1,598,776	$235,020
Inyo	77,349	11,370
Plumas	23,888,609	3,863,891
San Bernardino	13,323	1,959
Shasta	3,437,962	505,381
Trinity	329,706	48,467
Del Norte, Nevada, Orange*	6,129	901
Totals	28,346,860	$4,166,989

*Combined to conceal output of a single operator in each.

Copper Production of California, by Years.

Although some mining of copper ores in a small way had been done earlier, shipments in appreciable quantities began in 1861 and continued of importance up to the end of 1867, when a total of 68,631 tons (of 2376 pounds) of high-grade ores, and 847 tons of matte or 'regulus'[1] had been shipped to smelters at New York, Boston, and Swansea, Wales. The most important district at that time was Copperopolis and vicinity in Calaveras County, with some shipments also made from Mariposa, El Dorado, and Fresno counties. From 1868 to 1882, the output was insignificant. There are wide discrepancies in the figures currently recorded for copper production previous to 1882 in which year the data of the U. S. Geological Survey begin. The detailed statistics of the California State Mining Bureau began with the year 1894.

[1] Brown, J. Ross, Mineral Resources west of the Rocky Mountains, p. 168, 1867.

Amount and value of copper production in California annually since 1882 is given in the following tabulation:

Year	Pounds	Value	Year	Pounds	Value
1882	826,696	$144,672	1904	29,974,154	$3,969,995
1883	1,600,862	265,743	1905	16,907,489	2,650,606
1884	876,166	124,911	1906	28,726,448	5,522,712
1885	469,028	49,248	1907	32,602,945	6,341,387
1886	430,210	43,021	1908	40,868,772	5,350,777
1887	1,000,000	192,000	1909	65,727,736	8,478,142
1888	1,570,021	235,503	1910	53,721,032	6,689,641
1889	151,505	18,189	1911	36,838,024	4,604,753
1890	23,347	3,502	1912	34,169,997	5,638,049
1891	3,397,405	424,675	1913	34,471,118	5,343,023
1892	2,986,944	342,808	1914	30,491,535	4,055,375
1893	239,682	21,571	1915	40,968,968	7,169,567
1894	735,594	72,486	1916	55,809,019	13,729,017
1895	225,650	21,901	1917	43,534,611	13,249,948
1896	1,992,844	199,519	1918	47,796,046	11,805,883
1897	13,638,626	1,540,666	1919	22,162,605	4,122,246
1898	21,543,229	2,475,168	1920	12,947,299	2,382,908
1899	23,915,486	3,990,531	1921	12,088,053	1,559,358
1900	29,515,512	4,748,242	1922	22,883,987	3,090,582
1901	34,931,788	5,591,782	1923	28,346,860	4,165,989
1902	27,800,162	3,239,975			
1903	19,113,861	2,520,997	Totals	883,765,313	$146,084,256

GOLD.

Bibliography: State Mineralogist Reports I to XX (inc.). Bulletins 36, 45, 57, 91. U. S. Geol. Surv., Prof. Paper 73.

Gold was the first and, for many years, the most important single mineral product of California. Although now surpassed for a number of years in annual value by petroleum, and by cement beginning with 1920, it still heads our metal list, and California continues to outrank all the other gold-producing states of the United States, including Alaska. In fact, at present California is producing approximately 30% of the gold mined in the entire United States.

While there is some renewal of activity in the development of gold lode properties, it has not yet become reflected in an increased yield of the metal. The 1923 figures show a decrease from the 1922 yield. The continued shut-down of most of the copper mines which have always been important producers of by-product gold and silver, has also been an important factor.

Outlook for 1924.

According to the mid-year review of the United States Geological Survey[1] for the first six months of 1924,

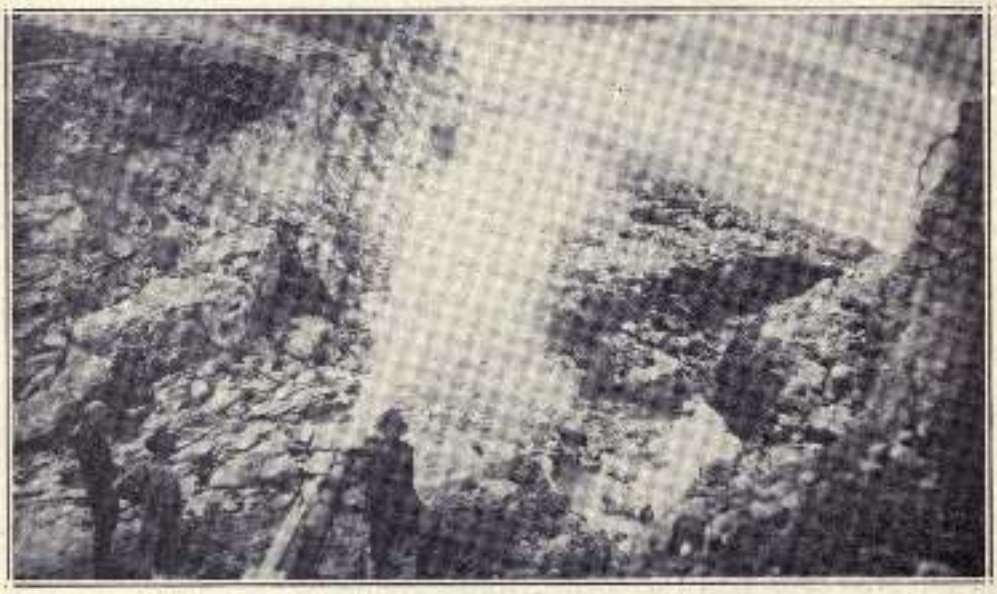
"Metal mining in California was rather active during the first six months of 1924, as shown by reports received from the miners by J. M. Hill, of the San Francisco office of the Geological Survey. Most of the activity has been directed to the development of gold quartz mines rather than to production, for the output of gold and silver was less than in the first six months of 1923. Five of the large Mother Lode mines—The Argonaut, Plymouth, Shawmut, Central Eureka, and Moore—are deepening their shafts. The placer output was small, because of drought; a large number of hydraulic properties in the Klamath and Sierra mountains had almost no water and therefore made but small output. The dredges maintained production at about the normal rate, but fewer boats are working. The silver mines, particularly the California Rand, curtailed production in order to carry on extensive development. The lead producers in the southern part of the state have apparently been working

[1] U. S. Geol. Surv., Press Bulletin July 11, 1924.

at the normal rate. The production of copper has been further increased; the rate during the first six months of 1924 was about 4,000,000 pounds a month. The work of development at the Engels mine may restrict the output there during the rest of the year."

Production in 1923.

The State Mining Bureau has never independently collected statistics of gold and silver production, as there is no necessity for duplicating the very thoroughly organized work of the U. S. Geological Survey covering those metals. The data here given relative to these two metals have been received through the courtesy and cooperation of Mr. J. M. Hill, Statistician in Charge of the San Francisco branch office of the Division of Mineral Resources. Anyone wishing fuller details of the production of these metals may obtain the same by applying to the U. S. Geological Survey, Washington, D. C., or to room 305, U. S. Custom House, San Francisco, California, for a copy of the 'separate' on the subject.



Elephant Deep Hydraulic Mine at Volcano, Amador County, Cal.

The gold production of California for 1923 was distributed, by counties, as follows:

Gold Production by Counties, 1923.

County	Value	County	Value
Amador	$1,734,133	Nevada	$2,282,155
Butte	487,393	Placer	75,732
Calaveras	1,205,784	Plumas	174,871
Del Norte	1,778	Sacramento	1,331,227
El Dorado	30,264	San Bernardino	210,923
Fresno	18,519	San Diego	822
Humboldt	2,260	Shasta	359,487
Imperial, Orange, Riverside*	1,126	Sierra	878,164
Inyo	36,702	Siskiyou	45,633
Kern	107,051	Stanislaus	174,814
Lassen, Merced, Modoc*	661	Trinity	617,841
Los Angeles	714	Tuolumne	261,936
Madera	12,074	Yuba	3,150,405
Mariposa	141,883		
Mono	34,661	Total	$13,379,013

*Combined to conceal output of a single producer in each.

The decline in gold yield from the 1922 figure of $14,670,346 was due to a lower production from the quartz mines, whereas the placer yield showed a slight increase. The tonnage of dry gold ores treated in 1923 was about 200,000 tons less, but the yield of gold from all other classes of ore was greater in 1923 than in 1922.

The following is quoted from the advance chapter on Gold in 1923, by courtesy of Mr. J. M. Hill of the U. S. Geological Survey:

"The accrediting of the gold reported as produced in California to the several counties and to placers and deep mines is difficult, for much of the gold reaches the mint with no means of identifying its origin. A large part of this gold is won by small mine owners who do not respond to the Geological Survey's inquiries, and a considerable part is without doubt the result of operations by "high-graders." In 1923 it is estimated that at least $120,000 of gold belongs in this latter class. Bankers and storekeepers at such centers as Sonora, Angels Camp, Jackson, Nevada City, Grass Valley, Oroville, Redding, and Yreka purchase or ship gold that comes from a considerable territory tributary to those towns, and often no record is kept of the persons for whom the bullion is handled or of its origin. These lots are usually small, but in the course of a year they aggregate a considerable number of ounces, which must be accredited according to the Survey's best judgment.

"In 1923 there were 35 properties producing over 1,000 ounces of gold, which contributed 90.10 per cent of the total gold output of California. Of these 13 were dredges, 17 deep gold-quartz mines, 2 copper mines, 2 silver mines, and 1 lead mine. The ten largest gold-producing companies in California in 1923 in order of rank of production were Yuba Consolidated Gold Fields (6 dredges), Natomas Co. of California (8 dredges), Empire Mines Co. (gold quartz), Carson Hill Gold Mines, Inc. (gold quartz), North Star Mines Co. (gold quartz), Sixteen To One (gold quartz), Kennedy Mg. & Mg. Co. (gold quartz), Marysville Dredging Co. (1 dredge), Central Eureka Mg. Co. (gold quartz), Argonaut Mg. Co. (gold quartz). The gold produced in 5 counties in 1923 was valued at over a million dollars, namely, Yuba dredges ($3,150,405), Nevada quartz ($2,283,155), Amador quartz ($1,734,133), Sacramento dredges ($1,331,227), and Calaveras quartz ($1,305,784).

"In 1923 deep mines produced 51.2 per cent and placer mines 48.8 per cent of the total gold output of California. In 1922 the relative proportion was deep mines 62.5 per cent and placers 37.5 per cent; in 1921 it was deep mines 48 per cent and placers 52 per cent, and in 1920 deep mines produced 51 per cent and placers 49 per cent. Most of the 353 placer mines operated in California in 1923 were relatively small. Aside from the 29 dredges there were only 7 placers, of which 2 were hydraulic, 4 drift, and 1 surface mine, at which more than $10,000 in gold was recovered.

"The placer gold yield in 1923 was valued at $6,522,583, an increase of 19 per cent, as compared with the yield in 1922. Dredges produced 92 per cent, drift mines 2.83 per cent, hydraulic 1.71 per cent, and surface mines 2.48 per cent of the total. During the year there were 29 dredges, 34 drift mines, 92 hydraulic mines, and 168 surface placers, at which gold was produced. Dredges in 1923 produced $1,066,520 more than in 1922, the greater part of the increase was in the Yuba River and Trinity River fields. The dredges in Calaveras, Sacramento, and Shasta counties produced less gold than in 1922.

"The gold produced at drift mines in 1923 was $67,855 less than in 1922, Butte County drift mines being the largest producers in this class. There was a net decrease of $46,447 in the gold yield of hydraulic mines, Siskiyou, Trinity, and Sierra counties still being the largest producers under this method of mining. The production of gold from surface placers increased $70,510 in 1923, as compared with 1922. There was some production from almost every mining county, but the individual production of this class of mining is relatively small.

"The production of gold from deep mines in 1923 was valued at $6,856,430, a decrease of $2,314,061, or 25 per cent, as compared with 1922. Of the 268 deep mines, which reported production in 1923, only 23 yielded more than $20,000 worth of gold, only 5 more than $400,000 worth, and at only 2 deep mines was the value of the gold yield over $1,000,000. Deep mines in Nevada County produced the greatest quantity of gold in 1923 ($2,251,897), followed by Amador County ($1,705,919), Calaveras County ($1,011,022), Sierra County ($853,508), and Tuolumne County ($255,011). There were very large decreases in the gold yield from deep mines in Amador, Calaveras, Nevada, and Sierra counties. The deep mines of Inyo, Kern, Mariposa, Mono, Placer, Shasta, and Siskiyou counties were less productive than in 1922, but increases in the gold output of deep mines in Plumas, San Bernardino, and Tuolumne counties were recorded.

"The dry gold ores mined in 1923, a total of 786,475 tons (a decrease of 198,309 tons compared with 1922) yielded 94 per cent of the gold produced at deep mines and 48 per cent of the total deep and placer gold produced in the state. Dry silver ores (135,683 tons) gave 3 per cent, and copper ores (546,404 tons) carried 2 per cent of the gold from deep mines. Bullion made at gold and silver mills carried 90 per cent, concentrates made at all classes of mills 16 per cent, and smelting ore 1 per cent of the total gold produced by deep mines in 1923."

Total Gold Production of California.

The following table was originally compiled by Chas. G. Yale, of the Division of Mineral Resources, U. S. Geological Survey, but for a num-

ber of years statistician of the California State Mining Bureau and the U. S. Mint at San Francisco. The authorities chosen for certain periods were: J. D. Whitney, state geologist of California; John Arthur Phillips, author of "Mining and Metallurgy of Gold and Silver" (1867); U. S. Mining Commissioner R. W. Raymond; U. S. Mining Commissioner J. Ross Browne; Wm. P. Blake, Commissioner from California to the Paris Exposition, where he made a report on "Precious Metals" (1867); John J. Valentine, author for many years of the annual report on precious metals published by Wells, Fargo & Company's Express; and Louis A. Garnett, in the early days manager of the San Francisco refinery, where records of gold receipts and shipments were kept. Mr. Yale obtained other data from the reports of the director of the U. S. Mint and the director of the U. S. Geological Survey. The authorities referred to, who were alive at the time of the original compilation of this table in 1894, were all consulted in person or by letter by Mr. Yale with reference to the correctness of their published data, and the final table quoted was then made up.

The figures since 1904 are those prepared by the U. S. Geological Survey:

Year	Value	Year	Value
1848	$245,301	1886	$14,716,506
1849	10,151,360	1887	13,688,614
1850	41,273,100	1888	12,750,000
1851	75,938,232	1889	11,212,913
1852	81,294,700	1890	12,309,793
1853	67,613,487	1891	12,728,869
1854	69,433,931	1892	12,571,900
1855	55,485,396	1893	12,422,811
1856	57,500,411	1894	13,923,281
1857	43,628,172	1895	15,334,317
1858	46,591,140	1896	17,181,562
1859	45,846,500	1897	15,871,401
1860	44,095,163	1898	15,906,478
1861	41,884,995	1899	15,336,081
1862	38,864,668	1900	15,863,355
1863	28,501,736	1901	16,989,044
1864	24,071,423	1902	16,910,320
1865	17,930,858	1903	16,471,264
1866	17,123,867	1904	19,109,600
1867	18,265,452	1905	19,197,048
1868	17,555,867	1906	18,732,452
1869	18,229,044	1907	16,727,928
1870	17,458,133	1908	18,761,559
1871	17,477,885	1909	20,237,870
1872	15,482,191	1910	19,715,440
1873	15,019,210	1911	19,738,908
1874	17,264,836	1912	19,713,478
1875	16,876,000	1913	20,406,958
1876	15,610,728	1914	20,653,496
1877	16,501,268	1915	22,442,296
1878	16,839,141	1916	21,410,741
1879	19,626,654	1917	20,087,504
1880	20,030,761	1918	16,529,162
1881	19,223,155	1919	16,695,955
1882	17,146,416	1920	14,311,043
1883	24,316,873	1921	15,704,922
1884	13,600,000	1922	14,670,346
1885	12,661,044	1923	13,379,013
		Total	$1,763,872,282

IRIDIUM (see under Platinum).

IRON ORE.

Bibliography: State Mineralogist Reports II, IV, V, X, XII, XIII, XIV, XV, XVII, XVIII. Bulletins 38, 67, 91. Am. Inst. Min. Eng., Trans. LIII. Min. & Sci. Press, Vol. 115, pp. 112, 117–122; Vol. 123, pp. 94–96, 113–114.

Iron ore to the amount of 3102 tons, valued at $18,665, was produced in California during the year 1923, and utilized for foundry flux and in steel refining at open-hearth plants. There is also some tonnage utilized in the manufacture of paint pigment, and which is credited to 'mineral paint' in these statistical reports. This 1923 yield is a slight decrease from the 3588 tons and $18,868 of 1922.

There are considerable deposits of iron ore known in California, notably in Shasta, Madera, Placer, Riverside and San Bernardino counties, but production has so far been limited for lack of an economic supply of coking coal. Some pig-iron has been made, utilizing charcoal for fuel, both in blast furnaces and by electrical reduction; also, ferro-chrome, ferro-manganese, and ferro-silicon have been made in California.

Total Iron Ore Production of California.

Total iron ore production in California, with annual amounts and values, is as follows:

Year	Tons	Value	Year	Tons	Value
1881*	9,273	$79,452	1911	558	$558
1882	2,073	17,766	1912	2,508	2,508
1883	11,191	106,540	1913	2,343	4,485
1884	4,582	40,983	1914	1,436	5,128
1885	----------	----------	1915	724	2,584
1886	3,676	19,250	1916	3,000	6,000
1887	----------	----------	1917	2,874	11,496
1893	250	2,000	1918	3,108	15,947
1894	200	1,500	1919	2,300	13,796
1896	----------	----------	1920	5,975	40,589
1907	400	400	1921	1,970	12,030
1908	----------	----------	1922	3,588	18,868
1909	108	174	1923	3,102	18,665
1910	579	900			
			Totals	65,748	$521,919

*Productions for the year 1881-1886 (inc.) were reported as "tons of pig iron" (U. S. G. S., Min. Res. 1886), and for the table herewith are calculated to "tons of ore" on the basis of 47.6% Fe as shown by an average of analyses of the ores (State Mineralogist Report IV, p. 212). This early production of pig iron was from the blast furnaces then in operation at Hotaling in Placer County. Charcoal was used in lieu of coke. Though producing a superior grade of metal, they were obliged finally to close down, as they could not compete with the cheaper English and eastern United States iron brought in by sea to San Francisco.

LEAD.

Bibliography: State Mineralogist Reports IV, VIII–XV (inc.), XVII–XIX.

Lead production in California in 1923 increased more than 50% over that of the preceding year, but still below the record yield of the years 1916–1918. The principal output was from lead-silver ores from Inyo County, with smaller but important amounts from Shasta, San Bernardino, and Orange counties. The average price for the year was

7.0¢ per pound as compared with 5.5¢ in 1922, 3.9¢ in 1913, and the high-level average of 8.7¢ per pound in 1917.

The 1923 production was distributed by counties, as follows:

County	Pounds	Value
Inyo	9,541,868	$667,931
Nevada	1,290	99
San Bernardino	24,477	2,413
Shasta	328,115	22,968
Calaveras, Orange, San Diego, Siskiyou*	28,772	2,011
Totals	9,934,522	$695,416

*Combined to conceal output of a single operator in each.

Lead Production of California, by Years.

Statistics on lead production in California were first compiled by this Bureau in 1887. Amount and value of the output, annually, with total figures, to date, are given in the following table:

Year	Pounds	Value	Year	Pounds	Value
1887	1,160,000	$52,200	1907	328,681	$16,690
1888	900,000	38,250	1908	1,124,483	46,863
1889	940,000	35,720	1909	2,685,477	141,897
1890	800,000	36,000	1910	3,016,902	134,082
1891	1,140,000	49,020	1911	1,403,839	63,173
1892	1,360,000	54,400	1912	1,370,067	61,653
1893	666,000	24,975	1913	3,640,951	160,302
1894	960,000	28,500	1914	4,697,400	183,198
1895	1,592,400	49,361	1915	4,796,290	225,426
1896	1,298,500	38,805	1916	12,392,031	855,049
1897	396,000	20,264	1917	21,631,332	1,862,016
1898	655,000	23,907	1918	13,464,869	956,006
1899	721,000	30,642	1919	4,139,562	219,397
1900	1,040,000	41,600	1920	4,906,738	392,300
1901	720,500	28,820	1921	1,149,051	51,707
1902	349,440	12,230	1922	6,511,280	358,120
1903	110,000	3,960	1923	9,934,522	695,416
1904	124,000	5,270			
1905	533,680	25,083	Totals	113,200,742	87,044,312
1906	388,718	19,207			

MANGANESE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV, XVIII. Bulletins 38, 67, 76, 91. U. S. G. S., Bull. 427.

Manganese ore shipments in California in 1923 amounted to a total of 690 tons of all grades, valued at $10,620, being a slight increase in both quantity and value over the 1922 yield which totaled 540 tons and $7,650 value. These ores were utilized mainly by the brick, paint, and glass trade, with a small tonnage of high-grade ore going to electric dry-battery manufacture. The prospects are for an increased production in 1924 owing to an increasing Pacific Coast requirement for ferro-manganese.

Importations of foreign manganese ores in 1923, mainly from Brazil, amounted to a total of 206,048 long tons valued at $3,874,510, compared with 374,451 tons and $3,399,764 in 1922. The Tariff Act of 1922, which became effective Sept. 22 in that year, provides for an import duty of 1¢ per pound on the metallic manganese contained, for "manganese ore or concentrates containing in excess of 30 per centum of metallic manganese." The bulk of such ore is consumed in the large steel-producing centers of the eastern United States.

Domestic Manganese Resources.

The subcommittee on manganese of the Mining and Metallurgical Society of America has recently made public its findings on the situation in the United States as regards apparent domestic resources of manganese ores. We quote, herewith, a summary [1] of portions of their report and conclusions:

"To determine the adequacy or inadequacy of the domestic resources the committee first considers domestic requirements, putting them under two heads, metallurgical and chemical. About 95 per cent of the total amount consumed is used in making steel and, to a small extent, in foundries and for special alloys. It is used principally in three forms: ferromanganese, spiegeleisen, and manganiferous pig iron. The availability of an ore for making any one of these alloys is governed largely by its ratio of manganese to iron.

"The committee, in its estimate, assumes that an output of 50,000,000 tons of steel will be reached in the United States between 1930 and 1935, requiring an amount of metallic manganese estimated at 13 lb. per ton, or 290,000 long tons. To this it adds 10,000 tons metallic manganese for the foundry business and special alloys.

* * * * * * *

"The remaining 5 per cent of total manganese consumed is used in chemical industries, and the ore is therefore termed 'chemical' ore. Most of it goes into dry batteries. Total pre-war requirements were about 35,000 tons.

"In estimating the adequacy of domestic resources the committee first had to define 'ore.' With changing conditions as to cost and price, the report points out, the measure of ore reserved must also change, there being a constant shifting back and forth across the border line between ore and waste. Before the war, save for a few thousand tons, the United States had no high-grade manganese ores. With artificial war conditions, however, prices soared and standards lowered, so that in 1918 the United States produced 305,000 tons of ferro-grade ore, furnishing 23.6 per cent of the manganese used. In addition to this, 86 per cent of the manganese used in low-grade products came from domestic sources. This proved that under *artificial war conditions* the United States possessed considerable domestic resources of high-grade as well as low-grade ores.

"Since the armistice, there has been a strong tendency to revert to the pre-war situation, though impeded by unsettled conditions, particularly in Europe and the Near East, and more recently by the tariff set up by Congress.

"In brief, says the report, *under natural conditions* the United States has practically no commercial high-grade manganese ores.

"The committee, therefore, has sought to find out how highly artificial conditions need be to shift important quantities of manganese-bearing material across the border line from waste to ore. It has reviewed 1850 manganese deposits and prospects and studied all information as to their history, production, and possibilities. It was first necessary to determine upon a yard-stick for measuring ore.

"The committee became convinced that a price equivalent to at least 50 per cent more than the highest price obtaining during the late war would be needed to make really considerable quantities of ferro-grade ore commercially available.

* * * * * * *

"Applying these assumptions to its study of ore deposits the committee arrived at the estimates of ore reserves, by classes of ore and by states, that are given in detail in the report.

* * * * * * *

"Study of these figures shows that the reasonably probable ferro-grade reserves, measured by the high price adopted, would last the country two years, or, if reasonable probabilities are included, a little over four years. Geological conditions are sufficiently well known to make it unlikely that other amounts of importance will be found.

"Of chemical ores there would appear to be about eight years' supply, measured by the $50 index price. Much of this could be produced at lower prices.

"Domestic reserves of spiegel and high manganese pig ores are more abundant, indicating thirty-five to forty years' supply.

"The committee concludes that:

"1. Domestic resources of ferro-grade ores are totally inadequate. No conceivably reasonable legislation can remedy this.

"2. Reserves of chemical ores are adequate for tiding over an emergency, but inadequate from the point of view of continuous supply. Legislation might cause domestic needs to be furnished from domestic sources for a limited time, but the resulting depletion would seriously endanger the country in a time of possible future critical need.

"3. The comparative adequacy of the reserves for spiegel and high-manganese pig ores fairly raises the question whether some measure of protection, designed to foster their adaptation to industry, would be reasonable.

"Discussing this last question, the report talks of a tariff not high enough to bring about any considerable production of domestic ferro-grade ores, but still high enough to increase the price of ferromanganese to a point where there would be a strong inducement to steelmakers to substitute leaner materials, made from the more or less abundant lean domestic ores.

"The conservation of high-grade manganese by substituting high-manganese pig iron for ferro in making additions to the charge is commendable, says the report, but, being already recognized as a possible economy in steel making, the practice will

[1] See Engineering & Mining Journal-Press, Vol. 117, No. 13, p. 545, Mar. 29, 1924.

proceed of its own momentum, and it is doubted if it can be speeded up by a tariff on high-grade materials, which would place a burden on the steel industry.

"Substitution of spiegel for ferro, on the other hand, could no doubt be increased by a high tariff on ferro and ferro ores, says the report. Possibly as much as a half of the total steel output could be made with spiegel. But the report points out that among steel makers there is strong prejudice against changing practice in this direction, because ferro is easier to use, surer in its results, and for these reasons cheaper.

"A brief description of foreign resources, at the end, serves to show the comparative insignificance of domestic reserves, and demonstrates why the United States has drawn its supplies from these outside sources.

"The subcommittee concludes:

"1. The domestic resources of ferro-grade and chemical ores are so out of balance with the major foreign resources that, under natural conditions of foreign exchange, imports of such ores can be efficiently stopped only at great cost.

"2. Should legislation be passed which should effect a measurable substitution of domestic for foreign ferro ores, the chief result, aside from cost, would be the dangerous depletion of reserves, which as it is are inadequate for domestic needs.

"3. Domestic resources of low-grade reserves, on the other hand, are comparatively adequate. Any effective attempt, however, to force their adaptation to the country's needs beyond the normal development which may be looked for through increase in skill and a vigorous educational campaign would result in a cost so enormous as to be quite disproportionate to the purpose to be served."

The report is signed by C. M. Weld, chairman; J. W. Furness, D. F. Hewett, Robert Linton, John A. Mathews, J. V. W. Reynders, and Bradley Stoughton.

Manganese Ore Production in California, by Years.

Production of manganese ore in California began at the Ladd Mine, San Joaquin County, in the Tesla District in 1867. When shipments of this ore to England ceased late in 1874, upwards of 5000 tons had been produced by that property. For some years following that, the output was small. The tabulation herewith shows the California output of manganese ore, annually, since 1887, when the compilation of such figures was begun by the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1887	1,000	$9,000	1906	1	$30
1888	1,500	13,500	1907	1	25
1889	53	901	1908	321	5,785
1890	386	3,176	1909	3	75
1891	705	3,880	1910	265	4,285
1892	300	3,000	1911	2	40
1893	270	4,050	1912	22	400
1894	523	5,512	1913	----	----
1895	860	8,200	1914	150	1,500
1896	518	3,415	1915	4,013	49,096
1897	504	4,080	1916	13,404	274,601
1898	440	2,102	1917	15,515	396,659
1899	295	3,165	1918	28,075	979,235
1900	131	1,310	1919	11,569	451,422
1901	425	4,405	1920	2,592	62,323
1902	870	7,140	1921	1,005	12,219
1903	1	25	1922	540	7,650
1904	60	900	1923	690	10,620
1905	----	----	Totals	85,369	$2,333,619

MOLYBDENUM.

Bibliography: Reports XIV, XVII. Bulletin 67. U. S. Bur. of Min., Bulletin 111. Proc. Colo. Sci. Soc., Vol. XI.

Molybdenum is used as an alloy constituent in the steel industry, and in certain forms of electrical apparatus. Included in the latter,

is its successful substitution for platinum and platinum-iridium in electric contact making and breaking devices. In alloys it is used similarly to and in conjunction with chromium, cobalt, iron, manganese, nickel, tungsten, and vanadium. The oxides and the ammonium salt have important chemical uses.

The two principal molybdenum minerals are: the sulphide, molybdenite; and wulfenite, lead molybdate; the former furnishing practically the entire commercial output. Molybdenite is found in or associated with acidic igneous rocks, such as granite and pegmatite. The chief commercial sources have been New South Wales, Queensland, and Norway, with some also from Canada.

Deposits of disseminated molybdenite are known is several localities in California, and in at least two places it occurs in small masses associated with copper sulphides. The only recorded commercial shipments of molybdenum ore in California were during the war, 1916–1918. Some development work has recently been done on a high-grade deposit at the head of the Kaweah River, Tulare County.

Present quotations for molybdenum ore are @ 80¢ per pound for 85% MoS_2 concentrates.

The California production of molybdenum ore by years is summarized in the following tabulation:

Year	Tons	Value
1916	8	$9,945
1917	243	9,014
1918	*	300
Totals	251	$19,259

*300 pounds of 90% MoS_2 concentrate.

NICKEL.

Bibliography: Reports XIV, XVII. U. S. G. S., Bulletin 640-D.

Nickel occurs in the Friday Copper Mine in the Julian District, San Diego County. The ore is a nickel-bearing pyrrhotite, with some associated chalcopyrites. Some ore has been mined in the course of development work, but not treated nor disposed of, as they were unable to get any smelter to handle it for them. Nickel ore has also been reported from other localities in California, but not yet confirmed.

Present quotations for nickel are around 27¢ per pound, for the refined metal.

OSMIUM (see under Platinum).

PALLADIUM (see under Platinum).

PLATINUM.

Bibliography: State Mineralogist Reports IV, VIII, IX, XII–XVIII. Bulletins 38, 45, 67, 85, 91. U. S. Geol. Surv. Bulletins 193, 285. Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217–218.

In California, platinum is obtained as a by-product from placer operations for gold. The major portion of it comes from the dredges working in Butte, Calaveras, Sacramento, Shasta, Stanislaus, and Yuba counties, with smaller amounts from the hydraulic and surface-sluicing mines of Del Norte, Humboldt, Nevada, Siskiyou and Trinity.

During recent years, quite a number of prospectors and small operators, working with rockers and panning have recovered amounts of platinum which, though individually small, have in the aggregate added materially to the state's total yield. This is particularly true of the Beegum Creek District in southwestern Shasta County; also the New River and Hayfork districts in Trinity County.

The production of platinum-group metals in California for 1923 totaled 665 ounces, crude, containing 602 fine ounces, valued at $78,546. Of this amount, a total of 578 ounces, crude, or 87%, came from the gold dredges. This is a decrease of 193 fine ounces in quantity, and $11,742 in value compared with the 1922 figures, due to one dredge in Shasta County having worked out its grounds and ceased operations. The prices prevailing in 1923 were higher than in 1922. Up to $117 per fine ounce was paid for platinum, and $275 per fine ounce for iridium content in 1923.

The above-noted total of 602 fine ounces includes 286 fine ounces of osmiridium and iridium, also some palladium. Most of the platinum refiners pay for the osmiridium on the basis of its iridium content. Crude 'platinum' is really a mixture of the metals of that group, and carries varying percentages of platinum, iridium, and osmiridium or iridosmine, with occasionally some palladium. Some platinum and palladium are also recovered in the electrolytic refining of blister copper. Iron in greater or less amount is always alloyed naturally with native platinum, and usually some iridium and osmium.

For further detailed information on California's platinum resources, analyses, tests, et al., the reader is referred to Bulletin 85, issued by the State Mining Bureau, and to the April, 1922, issue of 'Mining in California,' pages 158–172.

In addition, there is usually some platinum recovered as a by-product in the gold refinery of the Mint, but which can not be assigned to the territory of its origin for lack of knowing to which lots of gold it belongs. The San Francisco Mint is stated to have recovered as high as 100 ounces of platinum in a single year from this source, some of which unquestionably came from California mines.

For 1923, the distribution of California's platinum yield was as follows:

County	Fine Ounces	Value
Butte	19	$2,601
Shasta	299	43,326
Siskiyou	3	339
Trinity	18	2,050
Yuba	158	16,974
Calaveras, Del Norte, Humboldt, Nevada, Sacramento[a], Stanislaus*	105	13,356
Totals	602	$78,546

[a]Includes palladium.
*Combined to conceal output of a single operator in each.

Russia, previous to 1916, was producing from 90% to 95% of the world's platinum, but for several years following was reduced to practically nothing; and has not yet recovered her former position. Colombia ranked in second place, but now leads. California is the leading producer in the United States.

Uses, Markets, and Consumption.

Besides its well-known uses in jewelry, dentistry and for chemicalware an important industrial development of recent years employs platinum as a catalyzer in the 'contact process' of manufacturing concentrated sulphuric acid. It is also necessary for certain delicate parts of the ignition systems in automobiles, motor boats, and aeroplanes. Experiments have been made to find alloys which can replace platinum for dishes and crucibles in analytical work, but so far with only slight success.

According to Hill [1] the total consumption of platinum metals in the United States in 1923 was 190,783 troy ounces, an increase of 4% over that consumed in 1922, distributed as follows:

"Platinum metals consumed in the United States as reported by refiners, 1922 and 1923, by industries, in troy ounces.

Industry	Platinum	Iridium	Palladium	Others	Total	Percentage of total
1922						
"Chemical	8,834	172	438	271	9,735	5
Electrical	24,988	1,537	2,736	----------	29,260	16
Dental	11,651	83	5,535	----------	17,269	10
Jewelry	108,527	2,588	9,852	1,190	122,157	67
Miscellaneous	2,838	1,064	636	----------	4,538	2
	156,838	5,444	19,216	1,461	182,959	100
1923						
"Chemical	8,037	190	485	266	9,578	5
Electrical	18,596	1,675	3,666	----------	23,937	13
Dental	16,288	153	10,116	----------	26,557	14
Jewelry	105,699	3,073	14,948	190	123,910	65
Miscellaneous	3,156	1,403	986	1,356	6,901	3
	152,376	6,494	30,201	1,712	190,783	100

"Stocks.

"At the end of 1923 the stocks of platinum metals in the United States had decreased about 7 per cent as compared with those in 1922.

"Stocks of platinum metals in hands of refiners in the United States December 31, 1919-23, in troy ounces.

Metal	1919	1920	1921	1922	1923
"Platinum	29,228	46,747	88,514	41,900	36,554
Iridium	3,359	4,196	4,991	7,559	5,208
Palladium	10,235	16,585	21,042	24,975	20,266
Others	610	216	3,113	1,583	2,697"

[1] Hill, J. M., Platinum and allied metals in 1923: U. S. Geol. Surv., Press Bulletin, May 12, 1924.

Platinum Production of California by Years.

The annual production and value since 1887, have been as follows:

Year	Ounces	Value	Year	Ounces	Value
1887	100	$400	1906	91	$1,647
1888	500	2,000	1907	300	6,255
1889	500	2,000	1908	706	13,414
1890	600	2,500	1909	416	10,400
1891	100	500	1910	337	8,386
1892	80	440	1911	511	14,873
1893	75	517	1912	663	19,731
1894	100	600	1913	368	17,738
1895	150	900	1914	463	14,816
1896	162	944	1915	667	21,149
1897	150	900	1916	888	42,642
1898	300	1,800	1917	619	43,719
1899	300	1,800	1918	571	42,788
1900	400	2,500	1919	*418	30,611
1901	250	3,200	1920	477	68,977
1902	39	468	1921	613	58,754
1903	70	1,052	1922	795	90,288
1904	123	1,849	1923	602	78,546
1905	200	3,320	Totals	13,627	$642,424

*Fine ounces, beginning with 1919.

QUICKSILVER.

Bibliography: State Mineralogist Reports IV, V, XII-XV, XVII-XIX (inc.). Bulletins 27, 78, 91. U. S. Geol. Surv., Monograph XIII. U. S. Bur. of Mines, Tech. Papers 96, 227.

Quicksilver was produced in California in nine counties during 1923, to the amount of 5458 flasks, valued at $332,851, being approximately a 60% increase both in amount and value over the 1922 output of 3466 flasks and $191,851. The average price received during 1923, according to the producers' reports to the State Mining Bureau, was $60.98 per flask, as against $55.35 in 1922, and the record average of $114.03 for the year 1918.

The average of San Francisco quotations for 1923 was $65.68 per flask, the price declining from $70.70 in the first week of January to $59.75 in the last week of December. For the current year, 1924, the quotations are ranging somewhat higher.

According to the Bureau of Foreign and Domestic Commerce records, there was imported a total of 18,073 flasks of quicksilver in 1923, mainly from Spain and Italy; and there were 318 flasks exported. The tariff act of 1922 provides for an import duty of 25¢ per pound, or $18.75 per flask (75 pounds, net), which became effective September 21, 1922.

The U. S. Geological Survey reports the total production of the United States for 1923 at 7937 flasks, valued at $521,302 (using the $65.68 average of quotations). Outside of California, the principal yield was from Texas, with a few flasks from Nevada, Oregon and Idaho. California's contribution was 69% of the total.

The increase in 1923 was due to resumption of production at the New Idria mine, San Benito County. There was no production from the Guadalupe mine, Santa Clara County, nor from the Oceanic mine, San Luis Obispo County. A rotary furnace has been installed at the Rinconada mine, in the latter county, and production begun.

The 1923 quicksilver production of California was distributed by counties, as follows:

Quicksilver Production by Counties, 1923.

County	Flasks	Value
Lake	17	$1,050
Napa	157	9,759
Sonoma	528	31,147
Kings, Monterey, San Benito, San Luis Obispo, Santa Clara, Solano*	4,756	290,895
Totals	5,458	$332,851

*Combined to conceal output of a single operator in each.

Uses.

The most important uses of quicksilver are the recovery of gold and silver by amalgamation, and in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus. By far the greatest consumption is in the manufacture of fulminate and drugs.

Total Quicksilver Production of California.

Total amount and value of the quicksilver production of California, as given in available records, is shown in the following tabulation. Though the New Almaden Mine in Santa Clara County was first worked in 1824, and has been in practically continuous operation since 1846 (though the yield was small the first two years), there are no available data on the output earlier than 1850. Previous to June, 1904, a 'flask' of quicksilver contained 76½ pounds, but since that date 75 pounds. In compiling this table the following sources of information were used: for 1850–1883, table by J. B. Randol, in Report of State Mineralogist, IV, p. 336; 1883–1893, U. S. Geological Survey reports; 1894 to date, statistical bulletins of the State Mining Bureau; also State Mining

Bureau, Bulletin 27, "Quicksilver Resources of California," 1908, p. 10:

Year	Flasks	Value	Average price per flask	Year	Flasks	Value	Average price per flask
1850	7,723	$768,052	$99 45	1887	33,760	1,430,749	$42 38
1851	27,779	1,859,243	66 93	1888	33,250	1,418,125	42 50
1852	20,000	1,166,600	58 33	1889	26,464	1,190,880	45 00
1853	22,284	1,235,648	55 45	1890	22,926	1,203,615	52 50
1854	30,004	1,663,722	55 45	1891	22,904	1,030,406	45 25
1855	33,000	1,767,150	53 55	1892	27,993	1,139,595	40 71
1856	30,000	1,549,500	51 65	1893	30,164	1,108,527	36 75
1857	28,204	1,374,381	48 73	1894	30,416	934,000	30 70
1858	31,000	1,492,730	47 83	1895	36,104	1,357,131	37 04
1859	18,000	828,600	63 18	1896	30,765	1,075,449	34 96
1860	10,000	535,500	53 55	1897	26,691	993,145	37 28
1861	35,000	1,471,750	42 05	1898	31,002	1,188,626	38 23
1862	42,000	1,526,700	36 35	1899	29,454	1,405,045	47 70
1863	40,531	1,705,544	42 08	1900	26,817	1,182,786	44 94
1864	47,489	2,179,745	45 90	1901	26,720	1,285,014	48 46
1865	53,000	2,432,700	45 90	1902	29,552	1,276,524	43 20
1866	46,550	2,473,202	53 13	1903	32,094	1,335,834	42 25
1867	47,000	2,157,300	45 90	1904	*28,876	1,086,323	37 62
1868	47,728	2,190,715	45 90	1905	24,655	886,081	35 94
1869	33,811	1,551,925	45 90	1906	19,516	712,334	36 50
1870	30,077	1,725,818	57 38	1907	17,379	663,178	38 16
1871	31,686	1,999,287	63 10	1908	18,039	763,520	42 33
1872	31,621	2,084,773	65 93	1909	16,217	773,788	47 71
1873	27,642	2,220,482	80 33	1910	17,665	799,002	45 23
1874	27,766	2,919,376	105 18	1911	19,109	879,203	46 01
1875	50,250	4,238,538	84 15	1912	20,600	866,024	42 04
1876	75,074	3,303,256	44 00	1913	15,661	630,042	40 23
1877	79,890	2,961,471	37 30	1914	11,373	557,816	49 05
1878	63,880	2,101,632	32 90	1915	14,199	1,167,449	81 52
1879	73,684	2,194,074	29 85	1916	21,427	2,003,425	93 50
1880	59,926	1,837,706	31 00	1917	24,382	2,396,466	98 29
1881	60,851	1,815,185	29 83	1918	22,621	2,579,472	114 03
1882	52,732	1,488,624	28 23	1919	15,209	1,353,381	89 04
1883	46,725	1,343,344	28 75	1920	10,278	775,527	75 46
1884	31,913	973,347	30 50	1921	3,157	140,666	44 56
1885	32,073	986,245	30 76	1922	3,466	191,851	55 35
1886	29,981	1,064,826	35 50	1923	5,458	332,851	60 98
				Totals	2,137,906	$107,366,208	

*Flasks of 75 lbs. since June, 1904; of 76½ lbs. previously.

SILVER.

Bibliography: State Mineralogist Reports IV, VIII, XII–XIX (inc.). Bulletins 67, 91. Min. & Sci. Press, March 1, 1919.

Except for the silver mines of the Randsburg district in San Bernardino County the past five years, the production of silver in California is largely as a by-product from its association with copper, lead, zinc, and gold ores. As explained under Gold, the State Mining Bureau does not collect the statistics of silver production independently of the U. S. Geological Survey.

The average price of domestic silver during 1923 was 82¢ per ounce at New York as compared with $1.00 (under the Pittman Act) in 1922 and 1921, and 54.8¢ in 1914. Purchases of silver by the Government, under the Pittman Act ceased after June, 1923.

The following paragraph is quoted from the U. S. Geological Survey, Advance Chapter on 1923, by courtesy of Mr. J. M. Hill, statistician in charge of the San Francisco branch office:

"Of the total silver output of California in 1923 the 44 properties producing over 1,000 ounces contributed 99.16 per cent. At 22 properties between 1,000 and 5,000 ounces were produced, at 11 mines between 5,000 and 10,000 ounces, at 7 mines between 10,000 and 50,000 ounces, at 4 mines between 100,000 and 200,00 ounces, and at only 1 property (California Rand Silver, Inc.) was more than 2,500,000 ounces produced. Of the mines with an output of over 100,000 ounces 2 were lead mines in Inyo County and 2 were copper mines in Plumas County. San Bernardino County held first rank in silver production, followed by Inyo, Plumas, and Shasta counties. The 10 largest silver producers in the state, named in order of rank, were California Rand Silver, Inc. (Ag.), Engels Copper Co. (Cu.), Walker Mining Co. (Cu.), Darwin Silver Co. (Pb.), Tecopa Consolidated Mg. Co. (Pb.), Zenda Mg. Co. (Ag.), Mammoth Copper Co. (Cu.), Cerro Gordo Mines Co. (Pb), Empire Mines Co. (Au.), Mountain Copper Co. (Cu.).

"The increase in the quantity of silver produced in California in 1923 was due largely to the increased shipments from the Rand silver mines, in San Bernardino County, and the lead ores produced in Inyo County, though the Zenda mine, in the Amelia district, Kern County, made a considerable increase. Notable increases in silver production were also made in Nevada, Orange, Shasta, and Trinity counties.

"The output of silver from placer mines in 1923 was 20,306 ounces, valued at $16,650, an increase of 4 per cent in quantity and a decrease of 15 per cent in value, as compared with 1922. Dredges saved 6 per cent more and surface mines 62 per cent more silver than in 1922, but the drift and hydraulic mines each made 31 per cent less silver than in 1922.

"The production of silver from deep mines in 1923 was 3,539,138 ounces, valued at $2,902,093, an increase of 15 per cent in quantity but a decrease of 6 per cent in value, as compared with 1922. The Kelly mine, of the California Rand Silver, Inc., at Randsburg, was by far the largest producer of silver in the state. Lead ores from Inyo County gave the second largest output of silver, and copper ore from Plumas County the third largest contribution to the total silver output in 1923. Dry gold ores gave 2.31 per cent, silver ores 77.34 per cent, copper ores 9.59 per cent, and lead ores 9.28 per cent of the total silver yield. The recovery of silver at gold and silver mills in 1923 was 4 per cent, and smelters recovered 96 per cent of the total. Concentrates carried 72 per cent, and ore sent direct to smelters 24 per cent of the total silver produced at deep mines."

The distribution of the 1923 silver yield, by counties, was as follows:

Silver Production by Counties, 1923.

County	Value	County	Value
Amador	$15,153	Nevada	$30,534
Butte	1,756	Placer	297
Calaveras	7,316	Plumas	243,970
Del Norte	9	Sacramento	2,566
El Dorado	185	San Bernardino	2,225,959
Fresno	128	San Diego	144
Humboldt	12	Shasta	47,706
Imperial, Orange, Riverside*	16,736	Sierra	6,134
Inyo	265,623	Siskiyou	298
Kern	33,151	Stanislaus	833
Lassen, Merced, Modoc*	54	Trinity	5,816
Los Angeles	6	Tuolumne	2,901
Madera	541	Yuba	6,760
Mariposa	1,735		
Mono	3,120	Total	$2,918,743

*Combined to conceal output of a single producer in each.

Silver Production of California, by Years.

The value of the silver produced in California each year since 1880 has been as follows, the data previous to 1887 being taken from the

reports of the Director of the Mint. There are no data available for the years previous to 1880:

Year	Value	Year	Value
1880	$1,140,556	1902	$616,412
1881	750,000	1903	517,444
1882	845,000	1904	873,525
1883	1,460,000	1905	678,404
1884	(a) 4,185,161	1906	817,830
1885	2,568,030	1907	751,646
1886	1,610,628	1908	873,057
1887	1,682,004	1909	1,091,092
1888	1,700,000	1910	993,646
1889	1,066,281	1911	973,336
1890	1,060,613	1912	799,584
1891	953,157	1913	932,563
1892	463,602	1914	813,938
1893	537,158	1915	951,129
1894	297,332	1916	1,687,345
1895	599,790	1917	1,462,955
1896	422,464	1918	1,427,861
1897	452,789	1919	1,240,051
1898	414,055	1920	1,859,896
1899	501,012	1921	3,629,223
1900	(b) 724,500	1922	3,100,065
1901	(b) 571,849	1923	2,918,743
		Total	$52,367,750

[a] Lawver, A. M., in Production of Precious Metals in United States: Report of Director of Mint, 1884, p. 175; 1885.
[b] Recalculated to 'commercial' from 'coining value,' as originally published.

TIN.

Bibliography: Reports XV, XVII, XVIII. Bulletins 67, 91.

Tin is not at present produced in California; but during 1891–1892, there was some output from a small deposit near Corona, in Riverside County, as tabulated below. Small quantities of stream tin have been found in some of the placer workings in northern California, but never in paying amounts.

Two occurrences have also been noted, in northern San Diego County. Crystals of cassiterite were found there, associated with blue tourmaline crystals, amblygonite and beryl. No commercial quantity has been developed, only small pockets having been taken out. A lode deposit has recently been reported as found in Shasta or Siskiyou County, but not as yet confirmed officially.

The principal sources of the world's supply of tin are the islands of Banka, Billiton and Singkep, Netherlands India (Dutch East Indies), followed by the Federated Malay States (Perak, Pahang, Negri Sembilan and Selangor). Bolivia, Siam, Cornwall, Transvaal, New South Wales, Queensland and Tasmania are also important sources. A measurable amount of the metal is also recovered by de-tinning scrap and old cans.

Total Output of Tin in California.

Year	Pounds	Value
1891	125,289	$27,564
1892	126,000	32,400
Totals	251,289	$59,964

TUNGSTEN.

Bibliography: Reports XV, XVII, XVIII. Bulletins 38, 67, 91. U. S. G. S. Bull. 652. Proc. Colo. Sci. Soc. Vol. XI. South Dakota School of Mines, Bulletin No. 12. Eng. and Min. Jour.-Press, Vol. 113, pp. 666–669, Apr. 22, 1922.

Tungsten ore has been produced in California principally in the Atolia-Randsburg district in San Bernardino and Kern counties, followed by the Bishop district in Inyo County, with small amounts coming from Nevada County and from the district near Goffs, in eastern San Bernardino. Most of the California tungsten ore is scheelite (calcium tungstate), though wolframite (iron-manganese tungstate) and hübnerite (manganese tungstate) also occur. The deposits at Atolia are the largest and most productive scheelite deposits known,[1] and the output has in some years equaled or exceeded that of ferberite (iron tungstate) from Boulder County, Colorado. It is interesting in this connection to note that, in practically all other tungsten producing districts of the world, wolframite is the important constituent. Burma, the largest producer, reported [2] for 1917–1919, yields of 4537, 4443, and 3577 tons of wolframite concentrates, respectively, most of which was obtained from placers, in part associated with cassiterite (tin oxide).

Imports of foreign tungsten ores and alloys into the United States during 1923 amounted to 275 long tons, valued at $215,580, compared with 1665 long tons of ore valued at $281,251 in 1922, 1441 long tons at $276,757 in 1921, 1740 long tons, at $779,593 in 1920, 8400 long tons at $6,261,190 in 1919, and 10,362 long tons valued at $11,409,237, in 1918, which ores were duty free up to September 22, 1922. Owing to lack of protection against the cheap coolie labor of Asiatic tungsten mines, and the low market prices, practically all of the tungsten mines in the United States were closed down from the middle of 1919 to the latter part of 1923. Quotations during 1922 ranged around $2.50 per unit, up to September. Present quotations are $8.50–$9.00, on a basis of 60%. The Tariff Act of 1922, which became effective September 22, 1922, placed a duty on tungsten ore or concentrates of 45¢ per pound on the metallic tungsten contained therein. Duties are also provided for imported tungsten-bearing alloys.

[1] U. S. G. S., Bull. 652, p. 32.
[2] U. S. Commerce Reports, No. 78, April 5, 1921, p. 35.

The value of the ore is based upon the content of tungstic trioxide (WO_3), and quotations are commonly made per unit (each 1%) of WO_3 present.

In California in 1920–1922, there was no output of tungsten, neither of ore nor concentrates, for the first time since the beginning of tungsten mining in this state, but production was resumed in a small way late in 1923. There will be some further increase for the current year, 1924, as the Atolia company has given leases on portions of its ground. The 1923 yield amounted to a total of 34 tons, valued at $19,126. The tonnages here shown are recalculated to a basis of 60% WO_3. Concentrates usually carry 59% to 63% WO_3.

The metal, tungsten, is used mainly in the steel industry and in the manufacture of electrical appliances, including the well-known tungsten filament lamps. Because of its resistance to corrosion by acids, it is valuable in making certain forms of chemical apparatus. Its employment in tool-steel alloys, permits the operation of cutting tools, such as in lathe work, at a speed and temperature at which carbon steel would lose its temper—hence the name 'high speed' steels for these tungsten alloys. As made in the United States, tungsten forms 13% to 20% of such steels. Some chromium, nickel, cobalt, or vanadium, are sometimes also included. Tungsten compounds are used in the manufacture of colors.

Tungsten is introduced into the molten steel charge, either as the powdered metal or as ferro-tungsten (containing 50%–85% tungsten). The specific gravity of the pure metal, 19.3–21.4, is exceeded only by platinum, 21.5; iridium, 22.4; and osmium, 22.5. Its melting point is 3267° C. (5913° F.), being higher than any other known metal. Though millions of tungsten filament lamps are now made, the wires are so fine that the metal they contain represents but a few tons of tungsten concentrates annually.

Total Tungsten Ore Production of California.

The annual amount and value of tungsten ores and concentrates produced in California since the inception of the industry is given herewith, with tonnages recalculated to 60% WO_3:

Year	Tons at 60% WO_3	Value	Year	Tons at 60% WO_3	Value
1905	57	$18,800	1914	420	$180,575
1906	485	189,100	1915	962	1,005,467
1907	287	120,587	1916	2,270	4,571,521
1908	105	37,750	1917	2,466	3,079,013
1909	577	190,500	1918	1,982	2,832,222
1910	457	208,245	1919	214	212,316
1911	387	127,706	1920		
1912	572	206,000	1923	34	19,126
1913	550	234,673	Totals	11,834	$13,240,601

VANADIUM.

Bibliography: Report XV. Bulletin 67. Proc. Colo. Sci. Soc., Vol. XI. U. S. Bur. of Mines, Bulletin 104.

No commercial production of vanadium has yet been made in California. Occurrences of this metal have been found at Camp Signal, near Goffs, in San Bernardino County, and two companies at one time did considerable development work in the endeavor to open up paying quantities. Each had a mill under construction in 1916, but apparently no commercial output was made. Ore carrying the mineral euprodescloizite and reported as assaying 4% V_2O_5 was opened up. Some ore carrying lead vanadate has been developed in the 29 Palms, or Washington district, on the line between Riverside and San Bernardino counties, but no shipments reported.

The principal use of vanadium is as an alloy in steels, especially in tool steel, and in those varieties where resistence to repeated strains is required. Present New York quotations for vanadium ore are @ $1.00–$1.25 per pound of contained V_2O_5 (guaranteed minimum of 18% V_2O_5).

ZINC.

Bibliography: State Mineralogist Reports XIV, XV, XVII, XVIII, Bulletins 38, 67, 91.

There was no production of recoverable zinc reported from California ores in 1923.

The zinc ores of Shasta and Calaveras counties are associated with copper, while those of Inyo and San Bernardino are associated principally with lead-silver and zinc-silver ores.

The principal uses of zinc are for 'galvanizing' (plating on iron to prevent rust), for zinc oxide (used in rubber goods and paint), and for brass (an alloy of copper and zinc). These outlets for the metal take approximately 80% of the quantity produced. Of the remaining 20% a large portion is rolled into plates and sheets, and utilized in the building industry for sheathing, roofing, leaders, and eaves-troughs. Zinc is particularly desirable and efficient for roofing and siding where corrosive gases are present, as at smelters, refineries and chemical plants.

Total Zinc Production of California.

Total figures for zinc output of the state are as follows, commercial production dating back only to 1906:

Year	Pounds	Value	Year	Pounds	Value
1906	206,000	$12,566	1916	15,960,565	$2,137,375
1907	177,759	10,598	1917	11,854,804	1,209,190
1908	54,000	3,544	1918	5,565,561	506,466
1909	----------	----------	1919	1,384,192	101,046
1910	----------	----------	1920	1,188,009	96,229
1911	2,679,842	152,751	1921	846,184	42,309
1912	4,331,391	298,866	1922	3,084,430	172,963
1913	1,157,947	64,845	1923	----------	----------
1914	399,641	20,381			
1915	13,043,411	1,617,389	Totals	61,873,736	$6,446,512

CHAPTER FOUR.

STRUCTURAL MATERIALS.

Bibliography: State Mineralogist Report XII–XX (inc.). Bulletin 38. See also under each substance.

As indicated by this subdivision heading, the mineral substances herein considered are those more or less directly used in building and structural work. California is independent, so far as these are concerned, and almost any reasonable construction can be made with materials produced in the state. This branch of the mineral industry for 1923 was valued at $53,782,362, as compared with a total value of $36,992,001, for the year 1922, the increase being due to continued activity in all building and construction operations.

Deposits of granite, marble and other building stones are distributed widely throughout this state, and transportation and other facilities are gradually being extended so that the growing demand may be met. The largest single item, cement, has had an interesting record of growth since the inception of the industry in California about 1891. Not until 1904 did the annual value of cement produced reach the million-dollar mark, following which it increased 500% in nine years; though from 1914 to 1918 there was a falling off common to all building materials. The 1923 output establishes a new high-level mark, both in quantity and value.

Crushed rock production is yearly becoming more worthy of consideration, due to the strides recently taken in the use of concrete, as well as to activity in the building of good roads. Brick, with an average annual output for a number of years worth approximately $2,000,000, had difficulty in holding its own, due to the popularity of cement and concrete. In 1920, however, the sales increased to nearly double the previous record figure of the year 1907, with only a slight decrease in 1921; but 1923 showed advances to new record figures. This item will, no doubt, continue to be an important one, and a market for fire and fancy brick of all kinds will unquestionably never be lacking.

Fifty-five counties contributed to this structural total for 1923, and there is not a county in the state which is not capable of some output of at least one of the materials under this classification.

The following summary shows the value of the structural materials produced in California during the years 1922-1923 with increase or decrease in each instance.

Substance	1922		1923		Increase + Decrease − Value
	Amount	Value	Amount	Value	
Bituminous rock	4,324 tons	$13,570	2,945 tons	$11,780	$1,790−
Brick and tile		7,994,991		9,738,082	1,743,091+
Cement	8,982,135 bbls.	16,534,056	10,825,405 bbls.	25,309,203	9,476,147+
Chromite	379 tons	6,334	84 tons	1,658	4,676−
Granite		676,643		760,081	83,438+
Lime	57,875 tons	671,747	70,804 tons	788,854	117,087+
Magnesite	56,637 tons	594,655	73,903 tons	945,643	351,978+
Marble	38,821 cu. ft.	127,792	28,015 cu. ft.	124,919	2,873−
Onyx and travertine	10,950 cu. ft.	3,330	14,220 cu. ft.	2,520	810−
Sandstone	900 cu. ft.	1,100	7,000 cu. ft.	13,000	11,900+
Slate	*	*			
Stone, miscellaneous		10,377,783		15,395,652	5,017,869+
Total values		$36,992,001		$53,782,362	
Net increase					$16,790,361+

*Concealed under 'Unapportioned.'

ASPHALT.

Bibliography: State Mineralogist Reports VII, X, XII–XV (inc.), XVII, XVIII. Bulletins 16, 32, 63, 67, 69, 91.

Asphalt was for a number of years accounted for in the statistical reports by the State Mining Bureau, because in the early days of the oil industry, considerable asphalt was produced from outcroppings of oil sand, and was a separate industry from the production of oil itself. However, at the present time most of the asphalt comes from the oil refineries, which produce a better and more uniform grade; hence, its value is not now included in the mineral total, as to do so would be in part a duplication of the crude petroleum figures. Such natural asphalt as is at present mined is in the form of bituminous sandstones, and is recorded under that designation.

BITUMINOUS ROCK.

Bibliography: State Mineralogist Reports XII, XIII, XV, XVII, XVIII.

Small amounts of bituminous rock are still occasionally used for road dressing in those districts adjacent to available deposits, though the manufacture of asphalt at the oil refineries has almost eliminated the direct use of the native material. During 1923, a total of 2945 tons valued at $11,780 was shipped from quarries in Santa Barbara and Santa Cruz counties, compared with 4624 tons and $13,570 in 1922. This material is essentially an unecmented sandstone which is saturated with and held together by a natural asphaltic constituent probably the residue from the evaporation of a petroleum deposit.

The following tabulation shows the total amount and value of bituminous rock quarried and sold in California, from the records compiled by the State Mining Bureau, annually since 1887:

Year	Tons	Value	Year	Tons	Value
1887	36,000	$160,000	1906	16,077	$45,204
1888	50,000	257,000	1907	24,122	72,835
1889	40,000	170,000	1908	30,718	109,818
1890	40,000	170,000	1909	34,123	116,436
1891	39,962	134,164	1910	87,547	165,711
1892	24,000	72,000	1911	75,125	117,279
1893	32,000	192,036	1912	44,073	87,467
1894	31,214	115,193	1913	37,541	78,479
1895	38,921	121,586	1914	66,119	166,618
1896	49,456	122,500	1915	17,789	61,468
1897	45,470	128,173	1916	19,449	66,561
1898	46,836	137,575	1917	5,590	18,580
1899	40,321	116,097	1918	2,561	9,067
1900	25,306	71,495	1919	4,614	18,537
1901	24,052	66,354	1920	5,450	27,825
1902	33,490	43,411	1921	8,298	43,192
1903	21,944	53,106	1922	4,624	13,570
1904	45,280	175,680	1923	2,945	11,780
1905	24,753	60,436			
			Totals	1,175,770	$3,617,233

BRICK and TILE.

Bibliography: State Mineralogist Reports VIII, X, XII–XV (inc.), XVII–XIX (inc.). Bulletin 38. Preliminary Report, No. 7.

Bricks of many varieties and in important quantities are annually produced in California, as might be expected in a state with such

diversified and widespread mineral resources. The varieties include common, fire, pressed, glazed, enamel, fancy, vitrified, and others. So far as possible, the different kinds have been segregated in the tabulation herewith accompanying.

We also include under this heading the various forms of hollow building 'tile' or blocks. The application of these tile to residence construction as well as to other structures is growing; and their total value for 1923 shows an 11% increase over that for 1922.

The aggregate value for all kinds of brick in 1923 shows an increase of 23% or nearly $2,000,000 over the 1922 output. Individually, the various groups all made material advances, and especially common brick which increased from $4,363,629 in 1922 to $5,194,527 in 1923. The total sales of common brick in Los Angeles County alone, both in 1922 and 1923, exceeded the entire state's total of common for 1921 (202,417 M and $2,880,124). This item, of itself, is an indication of the continued activity in construction operations during the past year. This, too, even in the face of the increasing use of reinforced concrete in structural building.

The detailed figures of brick and tile production for 1923, by counties, are given in the following tabulation. 'Production' in this case means *sales* of product of California manufacture; and 'value' is *net price* at the works, f. o. b. cars, trucks, or boats.

BRICK AND TILE PRODUCTION FOR 1923, BY COUNTIES.

County	Common		Fire		Glazed, pressed, fancy, vitrified, paving		Hollow building tile or blocks		Total value
	Amount, M	Value	Amount, M	Value	Amount, M	Value	Tons	Value	
Alameda	*		2,275	$144,983	5,591	$232,300	28,354	$308,308	$705,591
Fresno	11,979	$195,162	*		*		*		195,162
Kern	5,371	68,375							68,375
Los Angeles	281,932	3,662,975	5,599	381,892	a 22,865	1,233,101	53,199	522,890	5,830,858
Orange	8,409	103,428							103,428
Riverside	2,584	36,585	*		*		*		36,585
San Joaquin	7,834	96,132	*						96,132
Santa Clara	22,314	282,997							282,997
Alameda, Contra Costa, Humboldt, Imperial, Marin, Sacramento, San Diego, Tehama, Tulare*	57,141	718,872							718,872
Amador, Contra Costa, Fresno, Placer, Riverside, Sacramento, San Joaquin*			20,445	939,272					939,272
Contra Costa, Fresno, Merced, Placer, Riverside, Sacramento*					9,067	347,870			347,870
Fresno, Merced, Placer, Riverside, Sacramento, San Diego*							40,981	412,939	412,939
Totals	397,754	$5,164,527	28,320	$1,466,147	37,525	$1,813,271	122,534	$1,244,137	$9,738,082

*Combined to conceal output of a single operator in each.
a Includes 'segment blocks.'

Brick and Tile Production of California, by Years.

Record of brick production in the state has been kept since 1893 by this Bureau, the figures for building tile being also included since 1914. The annual and total figures, for amount and value, are given in the following table:

Year	Brick, M.	Building blocks, tons	Value
1893	103,900		$801,750
1894	81,675		457,125
1895	131,772		672,360
1896	24,000		524,740
1897	97,408		563,240
1898	100,102		571,362
1899	125,950		754,730
1900	137,191		905,210
1901	130,766		860,488
1902	169,351		1,306,215
1903	214,403		1,999,546
1904	281,750		1,994,740
1905	256,618		2,273,786
1906	277,762		2,538,848
1907	302,167		3,438,951
1908	332,872		2,506,495
1909	333,816		3,050,929
1910	340,882		2,934,731
1911	327,474		2,638,121
1912	337,239		2,940,290
1913	358,754		2,915,350
1914	270,791		2,288,227
1915	180,538		1,678,756
1916	206,960		2,096,570
1917	192,269	29,348	2,532,721
1918	136,374	34,818	2,363,481
1919	156,328	36,026	3,087,067
1920	245,842	99,208	5,704,390
1921	228,922	67,100	5,570,875
1922	374,859	105,969	7,994,591
1923	397,754	122,594	9,738,082
Totals	6,966,168	494,943	$79,713,170

CEMENT.

Bibliography: State Mineralogist Reports VIII, IX, XII, XIV, XV, XVII, XVIII. Bulletin 38.

Cement is the most important single structural material in the output of the state. During 1923, there was produced a total of 10,825,405 barrels, valued at $25,999,203 f. o. b. plant, being an increase both in quantity and value over that of any previous year in the history of the cement industry in California. As in the preceding two years, the output came from nine operating plants in seven counties, and in 1923 employing a total of 3448 men.

The three plants in San Bernardino County, in 1923, made a total of 3,554,764 barrels of cement, valued at $8,478,612, the balance of the state's product coming collectively from a single plant in each of the following counties: Contra Costa, Kern, Riverside, San Benito, Santa Cruz, and Solano. Two new plants are under construction, one at Merced in Merced County and the other at Redwood City, San Mateo

County, both of which are expected to be in operation before the close of the current year (1924). The last named will utilize deposits of marine shells from the shores of San Francisco Bay.

'Portland' cement was first commercially produced in California in 1891; though in 1860 and for several years following, a natural hydraulic cement from Benicia was utilized in building operations in San Francisco.

[1] "The Benicia Cement Company in 1859–60 was turning out 50 to 100 barrels of cement a day and San Francisco was using about 12,000 barrels a year. The mill price of the product was then $4 a barrel. By 1865, the San Francisco rate of consumption had increased to 100,000 barrels yearly, brick buildings largely taking the place of frame structures, and the price of cement had fallen to $3.50 a barrel, about the same as it is today."

The growth of the industry became rapid after 1902; since which time cement has continued to be an important factor in the industrial

Plant of Monolith Portland Cement Company at Monolith, Kern County.

life of the state. Although the total cement figures, to date, are not of the same magnitude as those for gold and petroleum, it is interesting to note that the value of California's cement yield beginning with 1920 has since annually exceeded the value of her gold output. The 1923 figures are a new high record for cement.

According to reports of the U. S. Geological Survey, California ranks third as a cement producer, being surpassed only by Pennsylvania and Indiana; but our net increase in the period 1910-1923 (inc.) has been exceeded only by Pennsylvania. In per capita consumption, however, California leads all others with an average in 1923 of 2.69 barrels as against the average of 1.21 barrels for the entire United States.

[1] Monthly Review, of Mercantile Trust Co. of Cal., Vol. XIII, No. 3, p. 55, Mar. 1924.

Cement Production of California, by Years.

Annual production of cement in California has been as follows:

Year	Barrels	Value	Year	Barrels	Value
1891	5,000	$15,000	1908	1,629,615	$2,359,692
1892	5,000	15,000	1909	3,779,205	4,969,437
1893			1910	5,453,193	7,485,715
1894	8,000	21,600	1911	6,371,369	9,085,625
1895	16,383	32,556	1912	6,198,634	6,074,661
1896	9,500	28,250	1913	6,167,806	7,743,024
1897	18,000	66,000	1914	5,109,218	6,558,148
1898	50,000	150,000	1915	4,918,275	6,044,956
1899	60,000	180,000	1916	5,289,507	6,210,293
1900	52,000	121,000	1917	5,796,734	7,544,282
1901	71,800	159,842	1918	4,772,921	7,969,909
1902	171,000	423,600	1919	4,645,289	8,591,990
1903	640,868	968,727	1920	6,709,160	14,962,945
1904	969,538	1,539,807	1921	7,404,221	18,072,120
1905	1,265,553	1,791,916	1922	8,962,135	16,524,056
1906	1,286,000	1,941,260	1923	10,825,405	25,999,208
1907	1,613,563	2,585,577	Totals	100,278,892	$166,296,135

CHROMITE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV, XV, XVII, XVIII. Bulletins 38, 76, 91. Preliminary Report 3. U. S. G. S., Bull. 430. Min. & Sci. Press, Vol. 114, p. 552.

Chromic iron ore, or chromite, to the amount of 78 short tons of all grades (or 84 tons, recalculated to a basis of 45% Cr_2O_3), valued at $1,658 f. o. b. shipping point, was sold in California during the year 1923. The ore shipped analyzed from 45% to 50% Cr_2O_3 and came from mines in Placer and San Luis Obispo counties, being utilized for refractory purposes.

As will be noted from the tabulation below, chromite mining in California since the World War has all but become extinguished; and the immediate future is not encouraging, unless a local or Pacific coast market develops for it. Development of the steel industry and the resumption of copper smelting may create some demand for California chromite.

Occurrence.

Until 1916, when some shipments were made from Oregon and smaller amounts from Maryland, Wyoming and Washington, practically our only domestic production of chromite for many years came from California. From 1820 to 1860 the deposits in Pennsylvania and Maryland supplied the world's consumption.

Chromite is widely distributed in California, the principal production, thus far, having come from El Dorado, San Luis Obispo, Del Norte, Shasta, Siskiyou, Placer, Fresno, and Tuolumne counties. In 1918 a total of 29 counties contributed to the state's output. There are two main belts in California yielding this mineral, one along the Coast Ranges from San Luis Obispo County to the Oregon line, including the Klamath Mountains at the north end, and the other in the Sierra Nevada from Tulare County to Plumas County. Chromite occurs as lenses in basic igneous rocks such as peridotite and pyroxenite, and in serpentines which have been derived by alteration of such

basic rocks. For the most part, so far as developments have yet shown, the lenses have proved to be small, relatively few of them yielding over 100 tons apiece. A notable exception to this was the deposit on Little Castle Creek, near Dunsmuir, from which upwards of 15,000 tons was shipped before it was exhausted. Deposits worked in Del Norte County during 1918 promised well for a large tonnage. On the whole the orebodies in the northwestern corner of the state appear to average larger in size than the chromite lenses in other parts of California.

Concentration became an accomplished fact in several localities, thus utilizing some of the disseminated and lower-grade orebodies which have been found. In fact, an important part of the 1918–1920 production came from that source.

Imports.

Importations of foreign chromite, mainly from Rhodesia, New Caledonia, and India, totaled 128,763 long tons in 1923, valued at $1,123,120 compared with 90,081 tons and $741,186 in 1922.

The major consumption of chromite ore is for use as a refractory lining in smelting furnaces for steel and copper. A smaller portion is used in the preparation of ferro-chrome for chrome-steel alloys, and of chromium chemicals.

Total Chromite Production of California.

Production of chromite in California began, apparently, about 1874, principally in San Luis Obispo County. There was considerable activity from 1880 to 1883, inclusive, and a total of 23,238 long tons (or 26,028 short tons), valued at $329,924 was shipped from that county up to the beginning of 1887. Some ore also was shipped from the Tyson properties in Del Norte County. The tabulation herewith shows the output of chromite in California, annually, including the earliest figures so far as they are available. The figures from 1887 to date are from the records of the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1874–1886 (San Luis Obispo Co.)	26,028	$329,924	1905	40	$800
1887	3,000	40,000	1906	317	2,859
1888	1,500	20,000	1907	302	6,040
1889	2,000	30,000	1908	350	6,195
1890	3,599	53,985	1909	436	5,309
1891	1,372	20,580	1910	749	9,707
1892	1,500	22,500	1911	985	14,197
1893	3,319	49,785	1912	1,270	11,260
1894	3,680	39,980	1913	1,189	12,700
1895	1,740	16,795	1914	1,517	9,434
1896	786	7,775	1915	3,725	38,044
1897	----------	----------	1916	48,943	717,244
1898	----------	----------	1917	52,379	1,130,298
1899	----------	----------	1918	73,955	3,649,497
1900	140	1,400	1919	*4,314	97,164
1901	130	1,950	1920	1,770	43,031
1902	315	4,725	1921	347	6,870
1903	150	2,250	1922	379	6,334
1904	123	1,845	1923	84	1,658
			Totals	242,374	$6,412,485

*Recalculated to 45% Cr_2O_3, beginning with 1919.

GRANITE.

Bibliography: State Mineralogist Reports X, XII–XVIII (inc.). Bulletin 38.

The value of the granite output of California for 1923 was the highest recorded for any year since 1892 with the exception of the year 1913, due mainly to the increase in shipments of stone for 'monumental' and decorative purposes. This group increased from a total of 61,931 cubic feet valued at $204,832 in 1922 to 119,239 cubic feet worth $428,198 in 1923. The building stone group showed an increase in quantity but a decrease in total value. The net result was an increase in total value of the several groups from $676,643 to $760,081. We have included under this heading some rhyolite and tuff utilized for dimension building stone, as we have no other dimension stone grouping for statistical purposes in this report except marble and sandstone.

Crushed rock, rubble, and paving blocks derived from granite quarries are given under the heading of 'Miscellaneous Stone.'

So far as possible, granite production has been segregated in the table herewith into the various uses to which the product was put. It will be noted, however, that a portion of the output has been entered under the heading 'unclassified.' This is necessary because of the fact that some of the producers have no way of telling to what specific use their stone was put after they had quarried and sold the same in the rough.

Varieties.

For building purposes, the granites found in California, particularly the varieties from Raymond in Madera County, Rocklin in Placer County, and near Porterville in Tulare County, are unexcelled by any similar stone found elsewhere. The quantities available, notably at Raymond and Porterville, are unlimited. Most of California's 'granite,' particularly that found in the Sierra Nevada Mountains, is technically 'granodiorite' (that is, both plagioclase and orthoclase feldspars are present).

Granites of excellent quality for building and ornamental purposes are also quarried in Riverside and San Diego counties. Near Lakeside, San Diego County, there is a fine grained, 'silver gray' granite of uniform texture and color, especially suited for monumental and ornamental work.

The Fresno County stone is a dark, hornblende diorite, locally called 'black granite,' whose color permits of a fine contrast of polished and unpolished surfaces, making it particularly suitable for monumental and decorative purposes. There is also a similar 'black granite' in Tulare County, near Success.

GRANITE PRODUCTION BY COUNTIES, FOR 1923.

County	Building stone		Monumental		Curbing		Unclassified		Total value
	Cubic feet	Value	Cubic feet	Value	Linear feet	Value	Cubic feet	Value	
Fresno	*		16,010	$83,730	*		*		$83,730
Los Angeles	[a]124,000	$40,000							40,000
Madera	141,958	186,417	62,896	271,134			14,510	$29,119	486,670
Placer			1,451	3,406	*		*		3,406
Riverside	3,014	3,521	3,627	11,971			40,886	14,286	29,778
Sacramento	22,400	22,400	480	1,440			6,900	6,900	30,740
San Diego	*		13,413	33,400	*		*		33,400
Fresno, Inyo,[b] Nevada, Plumas, San Diego, Tulare*	18,080	13,040							13,040
Nevada, Plumas, Tulare, Tuolumne*			21,866	43,117					43,117
Fresno, Nevada, Placer, San Diego*					5,773	$6,879			6,879
Fresno, Placer, Plumas, San Diego, Tulare, Tuolumne*							5,780	9,321	9,321
Totals	309,452	$265,378	119,239	$428,198	5,773	$6,879	68,083	$59,626	$760,081

*Combined to conceal output of a single operator in each.
[a]Includes rhyolite used for building stone.
[b]Tuff used for building stone.

Granite Production of California, by Years.

The value of granite produced, annually, since 1887, has been as follows:

Year	Value	Year	Value
1887	$150,000	1906	$344,088
1888	57,000	1907	878,376
1889	1,329,018	1908	512,923
1890	1,200,000	1909	376,891
1891	1,300,000	1910	417,898
1892	1,000,000	1911	355,742
1893	531,322	1912	362,975
1894	228,816	1913	981,277
1895	224,329	1914	628,786
1896	201,004	1915	227,928
1897	188,024	1916	535,339
1898	147,732	1917	221,997
1899	141,070	1918	139,861
1900	295,772	1919	220,743
1901	519,285	1920	495,782
1902	255,239	1921	725,901
1903	678,670	1922	676,643
1904	467,472	1923	760,061
1905	353,897		
		Total	$17,628,709

LIME.

Bibliography: Reports XIV, XV, XVII, XVIII. Bulletin 38.

Lime to the amount of 70,894 tons, valued at $788,834, was produced by nine plants in six counties during 1922, as compared with 57,875 tons valued at $671,747 in 1922. There were two plants each, in Kern, San Bernardino, and Santa Cruz counties, and one each in Shasta, Siskiyou, and Tuolumne County. Previous to this present report the lime output has been recorded in 'barrels'; but as that unit is variable, and as most of the operators are now reporting in 'tons', we have adopted the short ton instead and have converted the figures in the table of annual production to that unit, as shown below.

So far as we have been able to segregate the data, these figures include only such lime as is used in building operations. A portion is hydrated lime. Limestone utilized in sugar making, for smelter flux, as a fertilizer, and other special industrial uses, are classified under 'Industrial Materials.' That consumed in cement manufacture is included in the value of cement.

Reports from the San Francisco district indicate that the market there is being adversely affected by the importation of Canadian lime against which there is an inadequate duty.

Lime Production of California, by Years.

The following tabulation gives the amounts and value of lime produced in California by years since 1894 when compilation of such records was begun by the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1894	37,350	$318,700	1909	52,076	$577,824
1895	39,776	386,094	1910	47,951	477,683
1896	30,275	261,505	1911	42,959	390,988
1897	28,780	252,900	1912	52,212	464,440
1898	29,786	254,010	1913	61,344	528,547
1899	29,985	314,575	1914	43,996	378,663
1900	31,252	283,699	1915	35,653	286,304
1901	31,738	334,668	1916	49,364	390,475
1902	44,866	369,616	1917	50,073	311,380
1903	49,659	418,280	1918	43,684	461,315
1904	57,945	571,749	1919	42,070	552,043
1905	61,700	555,322	1920	46,314	567,282
1906	68,927	763,060	1921	46,353	610,619
1907	68,422	756,376	1922	57,875	671,747
1908	39,639	379,243	1923	70,894	788,834
			Totals	1,392,917	$13,667,911

MAGNESITE.

Bibliography: State Mineralogist Reports XII, XV (inc.), XVII–XX. Bulletin 38. U. S. G. S., Bulletins 355, 540; Min. Res. 1913, Pt. II, pp. 450–453. Min. & Sci. Press, Vol. 114, p. 237. "Magnesite"—Hearings before the Comm. on Ways and Means, House of Repr., on H. R. 5218, June 16, 17 and July 17, 1919. Eng. Soc. W. Penn., Proc. 1913, Vol. 29, pp. 305–388, 418–444. Eng. & Min. Jour.-Press, Vol. 114, July 29, and Dec. 2, 1922.

The production of magnesite in California during 1923 amounted to a total of 73,963 tons of crude ore valued at $946,643. Only a small part of it was sold 'crude,' however, as it is practically all shipped in the calcined form. The reports at hand show a total of 30,294 tons shipped calcined, of which 3,475 tons were dead-burned and sold for refractory purposes, the balance going to the plastic trade. From 2 to 2½ tons of crude material are mined to make one ton of the calcined. The 1923 output is an increase both in quantity and value over the 1922 figures of 55,637 tons crude valued at $594,665. The average of the values reported for 1923 is $12.80 per ton, as against $10.50 for 1922.

The more important producing properties in 1923 were: Maltby No. 1 (Western Magnesite Development Co., operated under lease by C. S. Maltby) on Red Mountain, Santa Clara County; and the Sierra Magnesite Company's group near Porterville, Tulare County; followed, in order, by the Sampson Peak Mine (Maltby No. 3), San Benito County, Maltby No. 2 in Chiles Valley, Napa County, and the California Magnesite Co. (old Harker mine) at Porterville. Lesser amounts were reported mined in Stanislaus, Tuolumne and Fresno counties, in the order named. Descriptions of recent operations at most of the above-mentioned properties were given by the writer, in the January, 1924, issue of 'Mining in California'.[1]

[1] Bradley, W. W., District reports of mining engineers; Cal. State Min. Bur., Report XX of State Mineralogist, pp. 23, 26–31, Jan. 1924.

The increase in value for 1923 is due in part to the somewhat higher prices prevailing as compared to 1922. On the whole, the magnesite industry is in a fairly satisfactory condition; the market is firm, and the use of this material, particularly the plastic form, is increasing on the Pacific Coast. Because of high freight rates, California can not compete in the Atlantic sea-board states with foreign importations, but can at least hold its own as far east as the Mississippi River, under present conditions.

Distribution of the 1923 product, by counties, was as follows:

County	Tons	Value
Santa Clara	36,390	$472,620
Tulare	24,058	298,272
Fresno, Napa, San Benito, Stanislaus, Tuolumne*	13,515	175,751
Totals	73,963	$946,643

*Combined to conceal output of a single operator in each.

Occurrence.

Magnesite is a natural carbonate of magnesium, and when pure contains 52.4% CO_2 (carbon dioxide) and 47.6% MgO (magnesia). It has a hardness of 3.5 to 4.5, and specific gravity of 3 to 3.12. It is both harder and heavier than calcite (calcium carbonate), and also contains a higher percentage of CO_2 as calcite has but 44%.

Most of the California magnesite is comparatively pure, and is ordinarily a beautiful, white, fine-grained rock with a conchoidal fracture resembling a break in porcelain. The Grecian magnesite is largely of this character; but the Austrian varieties usually contain iron, so that they become brown after calcining. The Washington magnesite resembles dolomite and some crystalline limestones in physical appearance. Its color varies through light to dark gray, and pink.

In California the known deposits are mostly in the metamorphic rocks of the Coast Ranges and Sierra Nevada Mountains, being associated with serpentine areas. The notable exceptions are the sedimentary deposits, at Bissell in Kern County and at Afton in San Bernardino County. Several thousand tons have been shipped from the Bissell deposit; and small shipments have been made from the Afton property.

The Washington deposits are associated with extensive strata of dolomitic limestone. The magnesite there appears to contain more iron than most of the California mineral, which makes it desirable for the steel operators. However, recent experience has proved that several California localities have sufficient iron in their magnesite to be serviceable in the steel furnaces. This is particularly true of the Refractory Magnesite Company's mine near Preston in Sonoma County, the White Rock Mine at Pope Valley and the Blanco Mine in Chiles Valley, Napa County. There is some also at the Sampson Peak property in San Benito County.

Uses.

The principal uses include: Refractory linings for basic open-hearth steel furnaces, copper reverberatories and converters, bullion and other metallurgical furnaces; in the manufacture of paper from wood pulp; and in structural work, for exterior stucco, for flooring, wainscoting, tiling, sanitary kitchen and hospital finishing, etc. In connection with building work it has proved particularly efficient as a flooring for steel

railroad coaches, on account of having greater elasticity and resilience than 'Portland' cement. For refractory purposes the magnesite is 'dead burned'—*i. e.*, all or practically all of the CO_2 is expelled from it. For cement purposes it is left 'caustic'—*i. e.*, from 2% to 10% of CO_2 is retained. When dry caustic magnesite is mixed with a solution of magnesium chloride ($MgCl_2$) in proper proportions, a very strong cement is produced, known as oxychloride or Sorel cement. It is applied in a plastic form, which sets in a few hours, as a tough, seamless surface. It has also a very strong bonding power, and will hold firmly to wood, metal, or concrete as a base. It may be finished with a very smooth, even surface, which will take a good wax or oil polish. As ordinarily mixed there is added a certain proportion of wood flour, cork, asbestos, or other filler, thereby adding to the elastic properties of the finished product. Its surface is described as 'warm' and 'quiet' as a result of the elastic and nonconducting character of the composite material. The cement is frequently colored by the addition of some mineral pigment to the materials before mixing as cement.

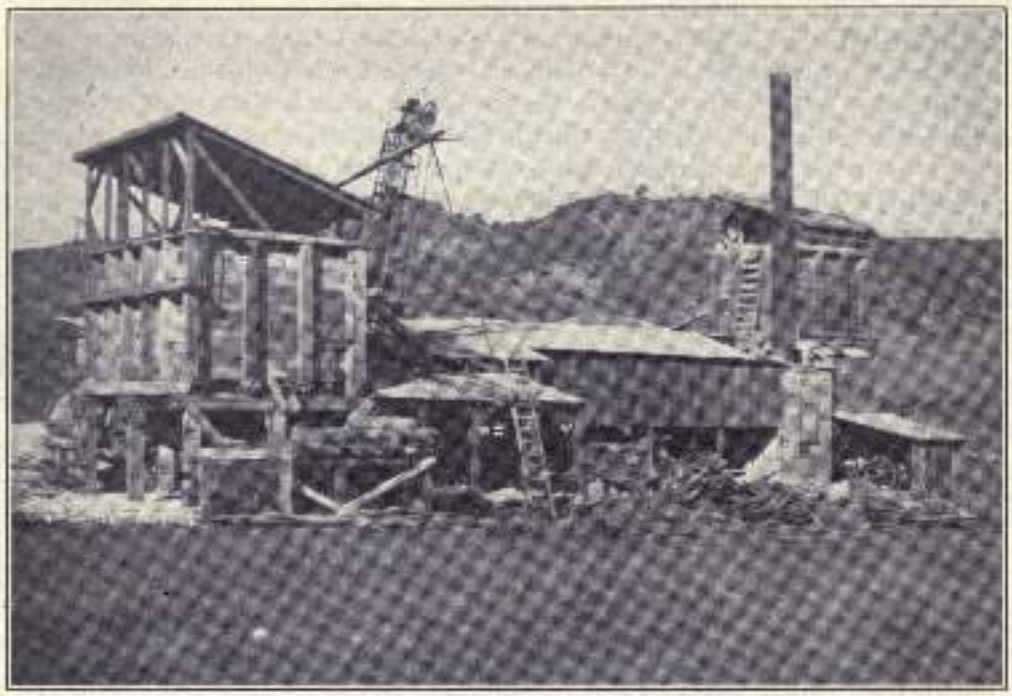
For refractory purposes the calcined magnesite is largely made up into bricks similar to fire-brick for furnace linings. It is also used unconsolidated, as 'grain' magnesite. For such, an iron content is desirable, as it allows of a slight sintering in forming the brick. Dead-burned, pure, magnesia can not be sintered except at very high temperatures; and it has little or no plasticity, so that it is hard to handle. Its plasticity is said to be improved by using with it some partly calcined or caustic magnesite. Heavy pressure will bind the material sufficiently to allow it to be sintered.

A coating of crushed magnesite is laid on hearths used for heating steel stock for rolling, to prevent the scale formed from attacking the fire-brick of the hearth.

Imports and Domestic Production.

Reports of the U. S. Bureau of Foreign and Domestic Commerce show imports of calcined magnesite to have been 172,591 long tons in 1913; 144,747 in 1914, and 63,347 in 1915; most of it coming from Austria-Hungary and some from Greece. For the same years the production of crude (from 2 to 2½ tons of crude ore required to yield one ton of the calcined) magnesite in California (the sole producer of those years, in the United States) was: 9632 short tons, 11,438 tons, 30,721 tons, respectively. For 1916 the California output leaped to 154,052 tons of crude and to 209,648 tons in 1917, but following which it dropped considerably on account of resumption of foreign importations, which totaled 52,483 long tons in 1921, valued at $776,384 being then admitted duty free. Shipments from Washington were begun late in 1916; and during the following three years assumed important proportions.

The Tariff Act of 1922, which became effective September 22d, of that year, placed the following import duties on magnesite: Crude magnesite 5/16¢ per lb., caustic-calcined magnesite 5/8¢ per lb.; dead-burned and grain magnesite, not suitable for manufacture into oxychloride cements, 23/40¢ per lb.; magnesite brick, ¾¢ per lb. and 10% ad valorem. The figures of imports for 1923 as published by the U. S. Bureau of Foreign and Domestic Commerce, show a total of



Calcining plant at Maltby No. 2 Magnesite Mine, Chiles Valley, Napa County, California. Producing dead-burned magnesite in a rotary kiln.

Calcining plant at the Sampson Magnesite Mine, west of Idria, San Benito County, California. Producing dead-burned magnesite in a rotary kiln.

76,813 long tons of calcined ore valued at $1,132,113, as compared with 119,690 long tons and $2,253,227 in 1922.

Total Magnesite Production of California.

The first commercial production of magnesite in California was made in the latter part of 1886 from the Cedar Mountain district,[1] southeast of Livermore, Alameda County. Shipments amounting to 'several tons' or 'several carloads' were sent by rail to New York; but there is apparently no exact record of the amount for thaf first year. The statistical records of the State Mining Bureau began with the year 1887, and the table herewith shows the figures for amount and value, annually, from that time. Shipments of magnesite from Napa County began in 1891 from the Snowflake Mine; from the Red Mountain deposits in Santa Clara County, in 1899; and from Tulare County in 1900.

Production of Magnesite in California, Since 1887.

Year	Tons	Value	Year	Tons	Value
1887	600	$9,000	1906	4,032	$40,320
1888	600	9,000	1907	6,405	57,720
1889	600	9,000	1908	10,582	80,822
1890	600	9,000	1909	7,942	62,588
1891	1,500	15,000	1910	16,570	113,887
1892	1,500	15,000	1911	8,858	67,480
1893	1,093	10,930	1912	10,512	105,120
1894	1,440	10,240	1913	9,632	77,056
1895	2,200	17,000	1914	11,438	114,380
1896	1,500	11,000	1915	30,721	288,461
1897	1,143	13,671	1916	154,052	1,311,893
1898	1,263	19,075	1917	209,648	1,976,227
1899	1,280	18,480	1918	83,974	808,492
1900	2,252	19,333	1919	44,696	452,094
1901	4,726	43,057	1920	83,695	1,033,491
1902	2,830	20,655	1921	47,837	511,102
1903	1,361	20,515	1922	55,687	594,665
1904	2,850	9,298	1923	73,963	946,643
1905	3,933	16,221			
			Totals	903,465	$8,927,866

MARBLE.

Bibliography: State Mineralogist Reports XII–XV (inc.), XVII, XVIII. Bulletin 38. U. S. Bur. of Mines, Bull. 106.

Marble is widely distributed in California, and in a considerable variety of colors and grain. During 1923, production from one operator each in Imperial, Inyo, and San Diego counties, and two in Tuolumne, amounted to 28,015 cubic feet, valued at $124,919, being a decrease both in quantity and value from the 1922 figures.

California has many beautiful and serviceable varieties of marble, suitable for almost any conceivable purpose of construction or decoration. In the decorative class are deposits of onyx marble of beautiful coloring and effects. There is also serpentine marble suitable for electrical switchboard use.

[1] See U. S. Geol. Surv.; Mineral Resources of U. S., 1886, pp. 6 and 696.

Marble Production of California, by Years.

Data on annual production since 1887, as compiled by the State Mining Bureau, follows. Previous to 1894 no records of amounts were preserved.

Year	Cubic feet	Value	Year	Cubic feet	Value
1887	----------	$5,000	1906	31,409	$75,800
1888	----------	5,000	1907	37,512	118,006
1889	----------	87,030	1908	18,853	47,665
1890	----------	80,000	1909	79,600	238,400
1891	----------	100,000	1910	18,960	50,200
1892	----------	115,000	1911	20,201	54,108
1893	----------	40,000	1912	27,820	74,120
1894	38,441	98,326	1913	41,654	113,282
1895	14,864	58,568	1914	25,436	48,832
1896	7,883	32,415	1915	22,136	41,518
1897	4,102	7,289	1916	25,854	50,280
1898	8,060	23,524	1917	24,755	62,950
1899	9,082	10,550	1918	[a]17,428	49,896
1900	4,103	5,891	1919	25,020	74,482
1901	2,945	4,630	1920	[b]29,531	92,899
1902	19,305	37,616	1921	30,292	93,295
1903	84,624	97,354	1922	38,321	127,792
1904	55,401	91,208	1923	28,015	124,919
1905	73,303	129,450	Total value	----------	$3,373,511

[a]Includes onyx and serpentine.
[b]Includes onyx.

ONYX and TRAVERTINE.

Bibliography: State Mineralogist Reports XII–XV (inc.), XVII, XVIII. Bulletin 38.

Onyx and travertine are known to exist in a number of places in California, but there has been only a small and irregular production since the year 1896. As there was but a single operator, the Tolenas Springs quarry, Solano County, in 1918 and 1920, the figures for those years were combined with those of the marble output. In 1923 there were two operators in Solano County and one in Mono, and a total of 14,220 cubic feet, valued at $2,510, was shipped. In the latter county, the travertine deposits near Bridgeport are being reopened by the Dineen Marble Company of Oakland. Operations are also under way at a new quarry being opened up at Kernville in Kern County. The Solano County material is, in part, being utilized for terrazzo.

Onyx Production of California, by Years.

Production by years was as follows:

Year	Value	Year	Value
1887	$900	1896	$24,000
1888	900	1918	*
1889	900	1919	----------
1890	1,500	1920	*
1891	2,400	1921	1,294
1892	1,800	1922	3,320
1893	27,000	1923	2,510
1894	20,000	Total	808,524
1895	12,000		

*See under Marble.

SANDSTONE.

Bibliography: State Mineralogist Reports XII–XV, XVII, XVIII. Bulletin 38. U. S. Bur. of M., Bull. 124.

An unlimited amount of high-grade sandstone is available in California, but the wide use of concrete in buildings of every character, as well as the popularity of a lighter-colored building stone, has curtailed production in this branch of the mineral industry during recent years almost to the vanishing point. In 1923 two counties—Santa Barbara and Ventura—turned out 7000 cubic feet, valued at $13,000; compared with 900 cubic feet and $1,100 in 1922. The main feature of the loss since 1914 is the closing of the well-known Colusa quarries, on account of the competition of lighter colored materials.

Sandstone Production of California, by Years.

Amount and value, so far as contained in the records of this Bureau, are presented herewith, with total value from 1887 to date:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887		$175,000	1906	182,076	$164,068
1888		150,000	1907	159,573	148,148
1889		175,598	1908	93,301	55,151
1890		100,000	1909	79,240	37,032
1891		100,000	1910	165,971	89,443
1892		50,000	1911	255,313	127,314
1893		26,314	1912	66,487	22,574
1894		113,592	1913	62,227	27,870
1895		35,373	1914	111,691	45,322
1896		28,379	1915	63,850	8,438
1897		24,086	1916	17,270	10,271
1898		46,384	1917	31,090	7,074
1899	56,264	103,384	1918	900	400
1900	378,468	254,140	1919	5,400	3,720
1901	266,741	192,182	1920	10,500	2,300
1902	212,123	142,506	1921	10,150	2,112
1903	353,002	585,309	1922	900	1,100
1904	363,487	567,181	1923	7,000	13,000
1905	302,813	483,268	Total value		$4,108,983

SERPENTINE.

Bibliography: State Mineralogist Report XV. Bulletin 38.

Serpentine has not been produced in California to a very large extent at any time. A single deposit, that on Santa Catalina Island, has yielded the principal output to date. Some material was shipped from there in 1917 and 1918, being the only output recorded since 1907. It was used for decorative building purposes and for electrical switchboards. As there was but a single operator, the figures were combined with those of marble output for those years.

Serpentine Production of California, by Years.

The following table shows the amount and value of serpentine from 1895 as recorded by this Bureau:

Year	Cubic feet	Value	Year	Cubic feet	Value
1895	4,000	$4,000	1904	200	$2,310
1896	1,500	6,000	1905		
1897	2,500	2,500	1906	847	1,694
1898	750	3,000	1907	1,000	3,000
1899	500	2,000	1917	a	a
1900	850	2,000	1918	b	b
1901	89	890	1919		
1902	512	5,065			
1903	99	800	Totals	12,347	$33,259

[a] Under 'Unapportioned.'
[b] See under Marble.

SLATE.

Bibliography: State Mineralogist Reports XV, XVIII. Bulletin 38. U. S. Geol. Surv., Bull. 586. U. S. Bur. of Mines, Bull. 218.

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, but since then it has been irregular. Large deposits of excellent quality are known in the state, especially in El Dorado, Calaveras and Mariposa counties, but the demand has been light owing principally to competition of chapter roofing materials.

'Slate' is a term applied to a fine-grained rock that has a more or less perfect cleavage, permitting it to be readily split into thin, smooth sheets. Varieties differ widely in color and have a considerable range in chemical and mineralogical composition. Excepting certain rare slates of igneous origin (of which the green slate of the Eureka quarry, El Dorado County, California, is an example) formed from volcanic ash or igneous dikes, slates have originated from sedimentary deposits consisting largely of clay. By consolidation, and the pressure of superimposed materials, clays become bedded deposits of shale. By further consolidation under intense pressure and high temperature incident to mountain-building forces, shales are metamorphosed to slates. The principal mineral constituents are mica, quartz, and chloride, with smaller varying amounts of hematite, rutile, kaolin, graphite, feldspar, tourmaline, calcite, and others.

The color of slate is of economic importance. The common colors are gray, bluish gray, and black, though reds and various shades of green are occasionally found.

The permanency of slate for roofing is well known. It is stated that there are slate roofs in Pennsylvania and Maryland over 100 years old.[1] "In England and Wales, and in France, many buildings constructed in the 15th and 16th centuries were roofed with slate, and the roofs are still in excellent condition. There is a record of a chapel in Bedford-on-Avon in Wiltshire, England, roofed with slate in the 8th century, and after 1200 years of climatic exposure is moss-covered but in good condition."

Contrary to the general impression, however, the major portion of the slate produced in the United States is used on the inside rather than

[1] Bowles, O., Slate as a permanent roofing material: U. S. Bur. of M., Reports of Investigations, Serial No. 2267, July, 1921, p. 4.

the outside of buildings. Its interior uses include stationary washtubs, electrical switchboards, and blackboards.

A square of roofing slate is a sufficient number of pieces of any size to cover 100 square feet of roof, with allowance generally for a three-inch lap. The sizes of the pieces of slate making up a square range from 7 x 9 inches to 16 x 24 inches, and the number of pieces in a square ranges from 85 to 686. The Ferry Building, San Francisco, is roofed with Eureka slate from El Dorado County.

In California, at present, there are prospects of commercial output being renewed. Two quarries near Placerville, El Dorado County, are reported preparing to market material before the close of the current year (1924).

Total Production of Slate in California.

A complete record of amount and value of slate produced in California follows:

Year	Squares	Value	Year	Squares	Value
1889	4,500	$18,089	1904	6,000	$50,000
1890	4,000	24,000	1905	4,000	40,000
1891	4,000	24,000	1906	10,000	100,000
1892	3,500	21,000	1907	7,000	60,000
1893	3,000	21,000	1908	6,000	60,000
1894	1,800	11,700	1909	6,961	45,660
1895	1,350	9,450	1910	1,000	8,000
1896	500	2,500	1911	----	----
1897	400	2,800	1915	1,000	5,000
1898	400	2,800	1916	----	----
1899	810	5,900	1920	8	80
1900	3,500	26,250	1921	----	----
1901	5,100	38,250	1922	*	*
1902	4,000	30,000	1923	----	----
1903	10,000	70,000	Totals	88,829	$676,479

*Concealed under 'Unapportioned.'

MISCELLANEOUS STONE.

Bibliography: State Mineralogist Reports XII–XX. Bulletin 38.

'Miscellaneous stone' is the name used throughout this report as the title for that branch of the mineral industry covering crushed rock of all kinds, paving blocks, sand and gravel, and pebbles for grinding mills. The foregoing are very closely related from the standpoint of the producer; therefore it has been found to be most satisfactory to group these items as has been done in recent reports of this Bureau. So far as it has been possible to do so, crushed rock production has been subdivided into the various uses to which the product was put. It will be noted, however, a very large percentage of the output has been tabulated under the heading 'Unclassified.' This is necessary because of the fact that many of the producers have no way of telling to what specific use their rock was put after they have quarried and sold the same to distributors and contractors.

In addition to amounts produced by commercial firms, both corporations and individuals, there is hardly a county in the state but uses more or less gravel and broken rock on its roads. Of much of this, particularly in the country districts, there is no definite record kept.

Estimates have been made for some of this output, based on the mileage of roads repaired.

For the year 1923 miscellaneous stone shows an increase both in total tonnage and value over the preceding year, being $15,395,652 as compared with $10,377,783 in 1922. Sand and gravel showed a slight decrease in average unit values reported, but crushed rock prices remained practically the same. The crushed rock tonnage increased from a total of 5,737,337 in 1922 to 8,519,611 in 1923, with sand and gravel advancing from 7,312,307 tons to 11,320,690 tons. Continuance of general building work and highway paving are responsible.

The largest increase was shown by Los Angeles County, which for some years past has led all others by a wide margin, with an output valued at $5,408,808 (compared with $3,390,477 in 1922); followed by Alameda, second, with $965,465; Fresno, third, $863,087; Riverside, fourth, $714,899; Sacramento, fifth, $649,939; Contra Costa, sixth, $629,216; Orange, seventh, $536,767; Marin, eighth, $516,936; followed in turn by San Benito, Humboldt, San Bernardino, San Diego, Butte, Santa Clara, and San Joaquin, in the order named, each with a total value in excess of a quarter-million dollars.

Paving Blocks.

The paving block industry has decreased materially of recent years, almost to the vanishing point, because of the increased construction of smoother pavements demanded by motor-vehicle traffic. The blocks made in Solano County were of basalt; those from Sonoma are of basalt, andesite, and some trachyte, while those from Placer, Riverside, San Bernardino, and San Diego are of granite.

Production in 1923 amounted to only 15 M, valued at $880.

The amount and value of paving block production annually since 1887 has been as follows:

Year	Amount M	Value	Year	Amount M	Value
1887	*10,000	$350,000	1906	4,206	$173,432
1888	10,500	367,500	1907	4,604	199,347
1889	7,308	297,226	1908	7,660	334,780
1890	7,000	245,000	1909	4,503	199,803
1891	5,000	150,000	1910	4,484	198,916
1892	*3,000	96,000	1911	4,141	210,819
1893	2,770	96,950	1912	11,018	573,355
1894	2,517	66,861	1913	6,364	363,505
1895	2,332	73,338	1914	6,053	270,598
1896	4,161	77,584	1915	3,285	171,092
1897	1,711	35,235	1916	1,822	54,362
1898	1,144	21,725	1917	938	38,567
1899	305	7,861	1918	372	17,000
1900	1,192	23,775	1919	27	1,350
1901	1,920	41,075	1920	63	3,155
1902	3,502	112,437	1921	4	280
1903	4,854	134,642	1922	72	3,924
1904	5,977	161,752	1923	15	880
1905	3,408	134,347	Totals	135,664	$5,313,003

*Figures for 1887–1892 (inc.) are for Sonoma County only, as none are available for other counties during that period; though Solano County quarries were then also quite active.

Grinding Mill Pebbles.

Production of pebbles for tube and grinding mills began commercially in California in 1915. Owing to the decreased imports and higher prices of Belgium and other European flint pebbles, due to the war, there was a serious inquiry for domestic sources of supply. One of the shipments made in that year was of pebbles selected from gold-dredger tailings in Sacramento County, for use in a gold mill in Amador County employing Hardinge mills.

The important development in this item, however, took place in San Diego County. At several points along the ocean shore from Encinitas south to near San Diego, there are beaches of washed pebbles varying from 1 inch to 6 inches in diameter, which come from conglomerate beds made up of well-rounded water-worn pebbles of various granitic and porphyritic rocks with some felsite and flint. The wave action has broken down portions of the cliffs for considerable distances and formed beaches of the pebbles which are well washed and cleaned of the softer materials. The rocks sorted out for shipment are mainly basalt and diabase, with an occasional felsite and flint pebble. There is a tough black basalt which is stated to give satisfactory results. In Fresno County pebbles have been selected from the gravel beds of the San Joaquin River near Friant. Shipments have been made to metallurgical plants in California, Nevada, Montana and Utah.

Imports in 1923 amounted to 14,243 long tons, valued at $130,974 compared with 14,321 tons and $145,805 in 1922.

California output for 1923 was 2650 tons, valued at $14,936, an increase over the 1922 figures.

The amount and value of grinding mill pebbles, annually, follows:

Year	Tons	Value
1915	340	$2,810
1916	20,232	107,567
1917	21,450	90,588
1918	8,628	61,268
1919	2,607	19,372
1920	2,104	17,988
1921	247	1,418
1922	1,571	7,628
1923	2,650	14,936
Totals	59,829	$253,425

Sand and Gravel.

The distribution of the 1923 output of sand and gravel, by counties, is given in the following table:

County	Tons	Value	County	Tons	Value
Alameda	[a][b]970,034	$686,272	Placer	5,450	$5,050
Amador	29,430	28,515	Riverside	[b]114,532	138,700
Butte	230,333	150,730	Sacramento	[b]235,435	215,343
Calaveras	24,000	21,325	San Benito	31,564	36,857
Colusa	100,000	75,000	San Bernardino	582,154	158,567
Contra Costa	52,058	21,852	San Diego	[b]219,307	216,023
Del Norte	6,000	3,000	San Joaquin	[c]653,511	260,543
El Dorado	3,500	2,600	San Luis Obispo	37,402	32,818
Fresno	447,268	331,329	San Mateo	10,116	11,338
Glenn	286,017	114,282	Santa Barbara	14,006	9,324
Humboldt	177,410	227,428	Santa Clara	357,118	271,012
Imperial	126,526	55,438	Santa Cruz	7,080	5,440
Inyo	6,627	4,000	Shasta	60,000	54,500
Kern	10,340	3,973	Sierra	3,274	3,312
Lake	37,000	25,000	Siskiyou	62,000	72,500
Lassen	10,000	4,000	Sonoma	[d]140,032	95,432
Los Angeles	4,630,490	3,159,461	Stanislaus	302,065	207,965
Mariposa	10,000	18,200	Trinity	2,200	3,000
Merced	110,500	111,125	Tuolumne	6,850	4,300
Modoc	40,248	8,109	Ventura	[b]55,114	53,531
Mono	14,665	10,000	Yuba	284,511	216,850
Monterey	[b]132,650	127,370	Madera, Marin, San Francisco, Solano, Tehama, Yolo[e]	112,628	63,407
Napa	93,581	64,820			
Nevada	2,621	2,464			
Orange	568,140	536,767	Totals	11,325,090	$7,940,480

[a]Combined to conceal output of a single operator in each.
[b]Includes roofing gravel.
[c]Includes molding sand.
[d]Includes molding, blast, filter, roofing, building, and stucco sand, mainly from ocean beaches.
[e]Includes pea gravel, washed and graded sand and gravel.

Included in the above is a total of 33,194 tons of molding sand, valued at $66,634, f. o. b. pit, from two operators in San Diego County, and one each in Alameda, Monterey, Riverside, Sacramento, and Ventura. This item is each year assuming a more important position in the commercial minerals list of California.

Crushed Rock.

To list the kinds and varieties of rocks utilized commercially under this heading would be to run almost the entire gamut of the classification scale. Much depends on the kind available in a given district. Those which give the most satisfactory service are the basalts and other hard, dense, igneous rocks which break with sharp, clean edges. In many localities, river-wash boulders form an important source of such material. In such cases, combined crushing and washing plants obtain varying amounts of sand and gravel along with the crushed sizes. In Sacramento and Butte counties the tailings piles from the gold dredgers are the basis of like operations.

The values given are based on the selling prices, f. o. b. cars, barges, or trucks, at the quarry.

County	Macadam and Ballast		Rubble and Riprap		Concrete		Unclassified		Totals	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Alameda	52,338	$39,404	150	$720	44,215	$46,494	[a]129,410	$192,575	226,153	$279,193
Contra Costa	50,622	31,878	4,398	5,057	59,009	56,389	618,350	494,540	732,967	607,864
Del Norte	4,000	2,500					137,960	25,868	141,960	28,368
El Dorado	3,800	3,300							3,800	3,300
Humboldt	54,667	92,000	[b]*		*				54,667	92,000
Imperial	20,000	20,000	25,333	4,375	80,000	32,000			73,333	46,375
Kern	4,059	5,252							4,059	5,252
Lake	16,000	30,000							16,000	30,000
Lassen	3,000	2,200	500	200	2,000	1,200			5,500	3,600
Los Angeles	1,370,446	1,077,289	102,600	288,000	544,538	608,026	[c,d]295,134	244,809	2,402,118	2,238,824
Marin	150,452	145,552	*						150,452	145,552
Mariposa	2,000	1,500			1,000	2,500			3,000	4,000
Mendocino	20,933	44,360					5,000	4,000	25,933	48,360
Merced	9,738	9,738			6,600	13,200			16,338	22,938
Monterey	29,346	13,354							29,346	13,354
Napa	36,834	54,317	1,056	500	58,709	93,975	9023	1,744	97,324	150,536
Nevada	38,820	39,845							38,820	39,845
Placer	45,013	78,773	53,837	55,406					98,850	134,179
Riverside			62,659	88,176	*		*		62,659	88,176
San Bernardino			*		*		63,658	48,470	63,658	48,470
San Diego	*		12,600	14,000	84,000	78,000	11,100	11,000	107,700	103,000
San Francisco	12,000	12,000			*		*		12,000	12,000
San Luis Obispo	12,104	9,321	1,033	4,340					13,137	13,661
San Mateo	94,112	66,349			13,056	18,008	500	1,125	106,668	85,477
Santa Cruz	*		*		5,435	8,298			5,435	8,298
Shasta	[e]130,000	32,000							130,000	32,000
Siskiyou	[f]40,239	26,791			40,000	30,000			80,239	56,791
Sonoma	89,455	87,400	866	674	376	282	5,575	4,271	96,304	92,627
Tuolumne	3,000	3,000					[g]*		3,000	3,000
Butte, Calaveras, Fresno, Inyo, Sacramento, San Benito, San Diego, Santa Barbara, Santa Clara, Santa Cruz, Ventura[h]	2,087,896	1,326,083							2,087,896	1,326,083
Humboldt, Marin, Sacramento, San Bernardino, Santa Cruz, Tulare[i]			442,206	593,073					442,206	593,073
Humboldt, Riverside, San Benito, San Bernardino, San Francisco, Tehama, Stanislaus[k]					849,310	709,676			849,310	709,676
Butte[l], Calaveras[b], Fresno, Inyo[c], Riverside, Sacramento, San Francisco, San Joaquin, Santa Clara, Solano, Stanislaus, Tulare, Tuolumne, Ventura[m]							826,797	373,484	826,797	373,484
Totals	4,392,894	$3,275,106	794,670	$1,054,321	1,737,938	$1,688,043	1,594,109	$1,421,885	8,519,611	$7,439,356

[a]Combined to conceal output of a single operator in each.
[b]Includes red shale for roofing granules.
[c]Greenstone granules for roofing.
[d]Includes yellow dolomitic marble granules used for stucco dash.
[e]Green, red, and white silica for roofing granules.
[f]Includes roofing and stucco dash granules.
[g]Includes rhyolite used for terrazzo.
[h]Obsidian used for stucco dash.
[i]Large 'sling rock,' granite up to twenty tons, used for harbor jetty construction.
[k]Includes old smelter slag used for railroad ballast.
[l]Includes volcanic ash 'cinders' used for railroad ballast.
[m]White marble granules for stucco dash coat.

Miscellaneous Stone Production of California, by Years.

The amount and value, annually, of crushed rock (including macadam, ballast, rubble, riprap, and that for concrete), and sand and gravel, since 1893, follow:

Crushed Rock, Sand and Gravel, by Years.

Year	Tons	Value	Year	Tons	Value
1893	371,100	$456,075	1909	5,531,561	$2,708,326
1894	661,900	604,838	1910	5,827,828	2,777,690
1895	1,254,688	1,095,939	1911	6,487,223	3,610,357
1896	960,819	839,884	1912	8,044,987	4,332,598
1897	821,123	600,112	1913	9,817,616	4,823,056
1898	1,177,365	814,477	1914	9,288,397	3,960,973
1899	964,898	786,892	1915	10,879,427	4,609,278
1900	789,287	561,642	1916	9,951,069	4,009,500
1901	530,396	641,037	1917	8,069,271	3,505,662
1902	2,056,015	1,249,529	1918	6,641,144	3,325,839
1903	2,215,625	1,678,581	1919	6,919,188	3,678,322
1904	2,296,898	1,641,877	1920	9,792,122	6,782,414
1905	2,624,257	1,716,770	1921	10,914,145	7,834,640
1906	1,555,372	1,418,406	1922	13,049,644	10,266,231
1907	2,288,868	1,915,015	1923	12,840,301	15,379,838
1908	3,998,945	3,241,774	Totals	165,621,389	$101,222,722

A comparison of the above table of annual production of these materials with the similar table for cement (see *ante*), reveals the fact that the important growth of the crushed rock and gravel business has been coincident with the rapid development of the cement industry from the year 1902.

CHAPTER FIVE.

INDUSTRIAL MATERIALS.

Bibliography: Reports XII–XX (inc.). Bulletin 38. Min. & Sci. Press, Vol. 114, March 10, 1917. See also under each substance.

The following mineral substances have been arbitrarily arranged under the general heading of Industrial Materials, as distinguished from those which have a clearly defined classification, such as metals, salines, structural materials, etc.

These materials, many of which are mineral earths, are, with four or five exceptions, as yet produced on a comparatively small scale. The possibilities of development along several of these lines are large and with increasing transportation and other facilities, together with steadily growing demands, the future for this branch of the mineral industry in California is promising. There is scarcely a county in the state but might contribute to the output.

Up to within the last few years, at least, production has been in the majority of instances dependent upon more or less of a strictly local market, and the annual tables show the results of such a condition, not only in the widely varying amounts of a certain material produced from year to year, but in widely varying prices of the same material. Furthermore, the quality of this general class of material will be found to fluctuate, even in the same deposit.

The more important of these minerals thus far exploited, so far as shown by value of the output, are limestone, mineral water, pyrites, pottery clays, diatomaceous earth, gypsum, talc, dolomite. Two new substances were added to the commercial list in 1922, namely, shale oil and andalusite-sillimanite; and sulphur in 1923.

This group as a whole showed an increase of nearly 100% in the total value, from $2,834,748 in 1922 to $5,595,816 for 1923. The principal gains were by diatomaceous earth, clay, dolomite, gypsum, limestone, mineral water and talc.

The following table gives the comparative figures for the amounts and value of industrial minerals produced in California during the years 1922 and 1923.

Substance	1922		1923		Increase+ Decrease− Value
	Amount	Value	Amount	Value	
Asbestos	50 tons	$1,800	20 tons	$200	$1,600−
Barytes	3,370 tons	18,925	2,925 tons	16,058	2,867−
Clay (pottery)	277,232 tons	473,184	376,863 tons	697,841	224,657+
Dolomite	52,109 tons	114,911	69,519 tons	142,615	27,704+
Feldspar	4,587 tons	37,109	11,100 tons	81,800	44,691+
Fuller's earth	6,606 tons	48,750	8,650 tons	55,125	6,369+
Gems	*	1,312		13,230	11,918+
Graphite		*			−
Gypsum	47,084 tons	188,336	86,410 tons	282,136	100,800+
Infusorial and diatomaceous earths	*	*	*	*	+
Limestone	84,382 tons	282,181	143,366 tons	348,464	66,283+
Lithia	*	*			−
Mineral paint	1,620 tons	13,277	1,049 tons	11,773	1,504−
Mineral water	4,275,346 gals.	486,424	5,487,276 gals.	616,919	130,495+
Pumice and volcanic ash	613 tons	4,248	2,236 tons	16,309	12,061+
Pyrites	151,381 tons	570,425	148,004 tons	555,308	15,117−
Shale oil	*	*	*	*	−
Silica (sand and quartz)	9,874 tons	31,016	7,364 tons	30,420	596−
Sillimanite and andalusite	*	*	*	*	+
Soapstone and talc	13,378 tons	197,180	17,439 tons	252,661	55,475+
Sulphur	----------	----------	*	*	+
Unapportioned[a]	----------	305,638	----------	2,467,967	2,162,329+
Total values	----------	$2,834,748	----------	$5,595,815	----------
Net increase	----------	----------	----------	----------	$2,761,068

[a]Combined under "unapportioned."
*In 1922 includes graphite, diatomaceous earth, lithia, shale oil, sillimanite; in 1923 includes diatomaceous earth, shale oil, andalusite-sillimanite, sulphur.

ASBESTOS.

Bibliography: State Mineralogist Reports XII–XIX (inc.). Bulletins 38, 91. Canadian Dept. of M., Mines Branch Bulletin 69. Min. & Sci. Press, April 10, 1920, pp. 531–533. Eng. & Min. Jour.–Press, Vol. 113, pp. 617–625; 670–677.

In 1923, a total of 20 tons of crude asbestos ore valued at $200 was shipped from California properties, being a decrease from the 50 tons and $1,800 reported in 1922. The material was of short-fibre mill grade, and was utilized mainly in magnesite-cement stucco and flooring.

The future of asbestos mining in California is dependent largely upon the development of uses in quantity for the short-fibre mill grades. There are apparently large resources of such material that can be made available. Besides magnesite-cement stucco and flooring mentioned above, it can be utilized in steam-pipe covering, composition fire-proof shingles, and roofing paper. It is also being tried out as a filler with asphalt in street pavement surfacing. For some of these purposes, the amphibole variety is also serviceable.

Some spinning-grade fibre has also been found in this state, notably in Nevada, Calaveras, and Monterey counties, but the commercial production to date has been small. Other counties with possibilities for yielding good-quality fibre, though short, include Fresno, Lake, Napa, San Benito, Shasta, Siskiyou, and Trinity. There are extensive serpentine areas in the Coast Ranges, in the Klamath Mountains, and in several sections of the Sierra Nevada Mountains which are within the range of possible asbestos producers, as chrysotile is a fibrous form

of serpentine. These localities all yielded chromite in greater or less amounts during the World War period.

Value and Production of Asbestos in California, by Years.

Total amount and value of asbestos production in California since 1887, as given in the records of this Bureau, are as follows:

Year	Tons	Value	Year	Tons	Value
1887	30	$1,800	1906	70	$3,500
1888	30	1,800	1907	70	3,500
1889	30	1,800	1908	70	6,100
1890	71	4,260	1909	65	6,500
1891	66	3,960	1910	200	20,000
1892	30	1,830	1911	125	500
1893	50	2,500	1912	90	2,700
1894	50	2,250	1913	47	1,175
1895	25	1,000	1914	51	1,530
1896	----------	----------	1915	143	2,860
1897	----------	----------	1916	145	2,380
1898	10	200	1917	136	10,225
1899	30	750	1918	229	9,903
1900	50	1,250	1919 } *	131	6,240
1901	110	4,400	1920 }		
1902	----------	----------	1921	410	19,275
1903	----------	----------	1922	50	1,800
1904	10	162	1923	20	200
1905	112	2,625	Totals	2,756	$128,975

*Annual details concealed under 'Unapportioned.'

BARYTES.

Bibliography: State Mineralogist Reports XII, XIV, XV, XVII. Bulletin 38. Eng. & Min. Jour.-Press, Vol. 114, p. 109, July 15, 1922; Vol. 115, pp. 319–324, Feb. 17, 1923.

The output of crude barytes in California during 1923 amounted to a total of 2925 tons valued at $16,058 f. o. b. rail shipping point, as compared with 3,370 tons valued at $18,925 in 1922. The 1923 product came mainly from Nevada County, with smaller amounts from Mariposa and Shasta counties, and was consumed principally in the manufacture of lithopone. More than half of the total tonnage of barytes utilized in the United States is taken in the manufacture of lithopone, which is a chemically-prepared, white pigment containing approximately 70% barium sulphate and 30% zinc sulphide. This is one of the principal constituents of 'flat' wall paints.

The principal uses for barytes, after washing and grinding, are as an inert pigment and filler in paint, paper, linoleum, oilcloth and rubber manufacture, and in the preparation of lithopone and a number of chemicals. The most important of such chemicals, other than lithopone, are: barium binoxide (used in preparation of hydrogen peroxide); barium carbonate (used by pressed brick and by rubber manufacturers to neutralize sulphur content); barium chloride (used in battery plates, and as a mordant by dry-color manufacturers, and in tanning leather); barium nitrate (used in munitions and in making 'red fire' material); barium sulphate precipitated, or 'blanc fixe' (used in rubber manufacture; for painting on interior steel of battle-

ships and other sea-going vessels; also as a detector in taking X-ray pictures of the human body).

Present quotations for barytes vary from $5 to $9 per ton, crude, f. o. b. rail shipping point, depending on quality. Most baryte has to be washed and acid treated to remove iron stains or other impurities before being suitable for paint use.

Known occurrences of this mineral in California are located in Inyo, Los Angeles, Mariposa, Monterey, Nevada, San Bernardino, Shasta and Santa Barbara counties. The deposit at El Portal, in Mariposa County, has given the largest commercial production to date, in part witherite (barium carbonate, $BaCO_3$).

Total Barytes Production of California.

The first recorded production of barytes in California, according to the statistical reports of the State Mining Bureau, was in 1910. The annual figures are as follows:

Year	Tons	Value	Year	Tons	Value
1910	860	$5,640	1918	100	$1,500
1911	309	2,207	1919	1,501	18,065
1912	564	2,812	1920	3,029	20,795
1913	1,600	3,690	1921	901	4,809
1914	2,000	3,000	1922	3,870	18,925
1915	410	620	1923	2,925	16,058
1916	1,606	5,516			
1917	4,420	25,693	Totals	23,595	$129,360

CLAY (pottery).

Bibliography: State Mineralogist Reports I, IV, IX, XII–XV, XVII–XIX (inc.). Bulletin 38. Preliminary Report No. 7.

At one time or another in the history of the state, pottery clay has been quarried in thirty-three of its counties. In this report, 'pottery clay' refers to all clays used in the manufacture of red and brown earthenware, china and sanitary ware, flowerpots, floor, faience and ornamental tiling, architectural terra cotta, sewer pipe, drain and roof tile, etc., and the figures for amount and value are relative to the crude material at the pit, without reference to whether the clay was sold in the crude form, or whether it was immediately used in the manufacture of any of the above finished products by the producer. It does not include clay used in making brick and building blocks.

There are many other important uses for clays besides pottery manufacture. Among these may be enumerated, paper, cotton goods, and chemicals. Being neutral, clay does not have an injurious effect upon other constituents used in the manufacture of such articles. In paper making, clay is used as a filler in news and similar grades, and as a coater or glazer in the more highly finished art papers. A large part of the china clay used in the United States is imported from England. Clays of the montmorillonite and halloysite group ('rock soap') are being utilized successfully in the manufacture of soaps.

During 1923, a total of 48 producers in 16 counties reported an output of 376,863 short tons of pottery clay, having a total value of $697,841 f. o. b. rail-shipping point, for the crude material, as com-

pared with the 1922 production of 277,232 tons worth $473,184. This is a high-record total for the clay industry in California.

Because of the fact that a given product often requires a mixture of several different clays, and that these are not all found in the same pit, it is necessary for most clay-working plants to buy some part of their raw materials from other localities. For these reasons, in compiling the clay industry figures, much care is required to avoid duplications. So far as we have been able to segregate the figures, from the data sent in by the operatives, we have credited the clay output to the counties from which the raw material originated; and have deducted tonnages used in brick manufacture, as bricks are classified separately, herein.

A tabulation of the direct returns from the producers, by counties, for the year 1923, is shown herewith.

Pottery Clay, In 1923.

County	Tons	Value	Used in the manufacture of—
Alameda	2,870	$10,422	Drain tile, floor tile, flue lining, refractories.
Amador	45,887	58,196	Refractories and various.
Contra Costa	9,024	12,755	Architectural terra cotta, sewer pipe, sanitary ware.
Los Angeles	[a][b]125,823	59,272	Roofing tile, fire clay, faience tile, sewer pipe, drain tile, stoneware, architectural terra cotta, electrical conduit, cleanser preparations, crushed brick for roofing, refractories and various.
Fresno	[a]82,919	143,097	Architectural terra cotta, sewer and chimney pipe, mantel, faience, roofing and drain tile, fire clay, sanitary ware and various.
Riverside	[a][c]85,185	246,684	Architectural terra cotta, tile, fire clay and grog, sewer pipe, stoneware, drain tile, terra cotta flues, and various.
San Bernardino	830	12,630	Paint filler, porcelain.
San Diego	[d]5,603	100,977	Architectural terra cotta, floor, faience, and roofing tile, crushed tile for roofing, cleanser.
Santa Clara	2,202	3,954	[e]Refractories, floor tile, flower pots.
Calaveras, Fresno[a], Humboldt, Kern, Marin, Orange, San Joaquin[a]	13,518	50,505	Sewer and chimney pipe, fire clay, drain and roofing tile, crushed brick for roofing, and refractories.
Totals	376,863	$807,841	

[a]Combined to conceal output of a single operator in each.
[b]Includes fire clay.
[c]Includes clay used in manufacturing 'cleanser' preparations.
[d]Includes ball clay.
[e]Includes 'Cornwall stone.'
[f]Includes 'bleaching clay.'

Pottery Clay Products.

The values of the various pottery clay products made in California during 1923 totaled $10,523,168, compared with $7,562,698 in 1922, their distribution being shown in the following tabulation:

Product	Number of Producers	Value
Architectural terra cotta	5	$2,390,653
Chimney pipe, terra cotta, and flue linings	8	879,974
Drain tile	10	126,070
Roofing tile	7	1,065,149
Sewer pipe	8	2,076,022
Stoneware and chemical stoneware	5	290,500
Sanitary ware	4	3,023,974
Chinaware and semi-vitreous tableware	4	568,301
Red earthenware	4	177,256
Floor, faience, mantel, glazed and hand-made tile	15	1,160,162
Miscellaneous art pottery, terra cotta, garden furniture, mortar colors, vitrified conduit, bisque ware, grog and fire clay	9	366,407
Total value		$10,523,168

Important increases were shown by all of the above groups.

Pottery Clay Production of California, by Years.

Amount and value of crude pottery clay output in California since 1887 are given in the following table:

Year	Tons	Value	Year	Tons	Value
1887	75,000	$37,500	1906	167,267	$162,283
1888	75,000	37,500	1907	160,335	254,454
1889	75,000	37,500	1908	208,042	325,147
1890	100,000	50,000	1909	299,424	465,647
1891	100,000	50,000	1910	249,028	324,099
1892	100,000	50,000	1911	224,570	252,759
1893	24,856	67,284	1912	198,605	215,653
1894	28,475	35,078	1913	231,179	261,273
1895	37,600	29,685	1914	179,043	167,552
1896	41,907	62,900	1915	157,866	133,724
1897	24,592	30,290	1916	184,636	146,538
1898	28,947	33,747	1917	166,226	154,602
1899	40,600	42,700	1918	112,423	166,788
1900	59,636	60,956	1919	135,708	245,019
1901	55,679	39,144	1920	203,997	440,689
1902	67,933	74,163	1921	225,120	362,172
1903	90,972	99,907	1922	277,232	473,184
1904	84,149	81,952	1923	376,883	697,841
1905	133,805	130,146			
			Totals	4,953,398	$6,909,901

DOLOMITE.

Bibliography: Reports XV, XVII, XVIII. Bulletins 67, 91.

The production of dolomite for the year 1923 totaled 69,519 tons valued at $142,615, being an increase over the 52,409 tons and $114,911 of 1922, and came from a total of six quarries in Inyo, Monterey, and San Benito counties.

An important part of the tonnage being shipped is utilized as a refractory lining in the bottoms of open-hearth steel furnaces, as a substitute for magnesite. Part of the Inyo County material is used for its CO_2 by the chemical plants on Owens Lake, in the manufacture of soda ash and bicarbonate from the waters of the lake. Some also is used for terrazzo and for stucco dash-coat.

The 1923 output was distributed as follows:

County	Tons	Value
Inyo	47,542	$79,793
Monterey and San Benito*	21,977	62,822
Totals	69,519	$142,615

*Combined to conceal output of a single quarry in each.

Dolomite Production of California, by Years.

Previous to the 1915 statistical report of the State Mining Bureau, dolomite was included under limestone, as the two minerals are closely related, chemically; but since dolomite, as such, has been found to have certain distinctive applications, we have given it a separate classification.

Amount and value of the output of dolomite, annually, have been as follows:

Year	Tons	Value
1915	4,192	$14,504
1916	13,313	46,566
1917	27,911	66,416
1918	24,560	79,441
1919	24,502	67,953
1920	42,388	132,791
1921	31,195	99,155
1922	53,409	114,911
1923	69,519	142,615
Totals	289,989	$764,352

FELDSPAR.

Bibliography: Reports XV, XVII, XVIII. Bulletins 67, 91. U. S. Bureau of Mines, Bulletin 92. Eng. & Min. Jour.-Press, Vol. 115, pp. 535–538, Mar. 24, 1923.

Feldspar was produced by five operators in two counties (Riverside and San Diego) during 1923, to the amount of 11,100 tons, valued at $81,800, being more than double both the quantity and value of 1922 which were 4587 tons and $37,109.

The product was used in the ceramic industry, principally in pottery, porcelain, enamel wares, also enamel brick and tile, being a constituent of both the body and the glaze, but more especially the latter. For the characteristics, grades, and marketing data of feldspar, the reader is referred to the excellent paper by Prof. Watts[1] and quoted in our report of last year.[2]

The requirements of the pottery trade demand that in general the percentage of free silica associated with the feldspar be less than 20%, and in some cases the potters specify less than 5%. An important factor, also, is the iron-bearing minerals frequently present in pegmatites and granites, such as biotite (black mica), garnet, hornblende, and black tourmaline. Feldspar for pottery uses should be practically free of these. The white, potash-mica, muscovite, is not particularly objectionable except that, being in thin, flexible plates, it does not readily grind to a fineness required for the feldspar.

Present quotations are from $4 to $7 per ton, crude, according to quality.

The most important recent developments in feldspar deposits in California have taken place in San Diego and Riverside counties, where large deposits of massive, high-grade spar are being opened up. These deposits are unusually free from black mica and other deleterious iron-bearing minerals objectionable in pottery work. The important districts are near Lakeside and Campo in San Diego County, and near Lakeview, Murrietta, and Elsinore, in Riverside County. No production has been reported from Monterey and Tulare counties, for the past three years.

[1] Watts, A. S., The marketing of feldspar: Eng. & Min. Jour.-Press, Vol. 115, pp. 535–538, Mar. 24, 1923.

[2] Bradley, W. W., California mineral production for 1922: Cal. State Min. Bur., Bulletin 93, pp. 108–110, 1923.

Total Feldspar Production of California.

Total amount and value of feldspar production in California since the inception of the industry are given in the following table, by years:

Year	Tons	Value	Year	Tons	Value
1910	760	$5,720	1918	4,132	$22,061
1911	740	4,560	1919	1,272	12,965
1912	1,382	6,180	1920	4,518	26,189
1913	2,129	7,850	1921	4,349	28,343
1914	3,530	16,565	1922	4,387	27,199
1915	1,860	9,000	1923	11,100	81,800
1916	2,630	14,350			
1917	11,792	46,411	Totals	54,721	$319,098

FLUORSPAR.

Bibliography: Reports XVII, XVIII. Bulletins 67, 91. Eng. & Min. Jour.-Press, Vol. 117, pp. 489–492, Mar. 22, 1924.

Fluorspar, which is calcium fluoride, CaF_2, is one of the most important non-metallic minerals from an industrial standpoint. About 80% of the commercial mineral is prepared in the 'gravel' form and utilized as a flux in the manufacture of steel, for which use no substitute has yet been found. In the United States, under normal business conditions the consumption for that purpose is 125,000 to 150,000 tons annually. Fluorspar is also used in aluminum smelting, and in the manufacturing of enameled ware, glazed tile and brick, opalescent glass, and certain chemicals, particularly hydrofluoric acid and its derivatives. The mineral is marketed in three forms: lump, gravel, and ground.

[1]"Of the three physical forms of fluorspar of commerce, lump, gravel, and ground, two grades of each form are marketed. Lump and gravel are sold as metallurgical or fluxing grades, and acid grades; ground is sold as glass-enamel-ceramic grade, and acid grade. Lump spar of either grade should not be too large, and small lump, not exceeding 6 in. in diameter, is preferred by the trade. Specifications for physical form of metallurgical lump spar demand a minimum content of gravel fluorspar, as fines, in any carload, say not exceeding one ton. Metallurgical gravel spar should not be too fine, and coarse gravel with minimum content of fluorspar sand, as fines, is more acceptable to the trade. Size specifications for metallurgical gravel spar demand that it shall pass through a 1-in. ring.

"The market specifications for standard fluorspar in any form are mainly chemical and governed by analysis. Guaranteed analysis for standard metallurgical of fluxing grade spar, lump or gravel, is minimum of 85 per cent calcium fluoride, and maximum of 5 per cent silica. Merchantable grade acid-spar, lump, gravel and ground, varies somewhat with different users. Not exceeding 3 per cent silica and under 97 per cent calcium fluoride are the limits. Part of the trade insists on a guaranteed minimum of 98 per cent calcium fluoride and maximum of 1 per cent silica, though some consumers are satisfied with a guaranteed minimum of 97 per cent calcium fluoride and maximum of 2 per cent silica. Glass-enamel-ceramic grade ground fluorspar specifications are flexible, the users of that class of spar particularly demanding fine grinding, preferably 150 to 200 mesh, and thorough washing free from alumina; also freedom from contamination of metallic ores and barytes. Analyses for glass-enamel-ceramic spar vary from 90 to 95 per cent calcium fluoride, 2 to 5 per cent silica, and 2 to 8 per cent calcium carbonate.

"The usual impurities in fluorspar are silica and calcium carbonate, which are penalized, as a rule. Minor impurities in fluorspar are ores of lead and zinc, generally the sulphides, and pyrites and barytes, all of which are objectionable, and sometimes penalized.

"No premiums are allowed on fluorspar shipments, but there is a penalty for inferior material. Trade specifications demand that for each point of calcium fluoride less than 85 per cent there shall be deducted 1/85th of the delivered cost, and for each point of silica over 5 per cent there shall be deducted 1/40th of the delivered cost."

[1] Reed, A. H., Marketing of fluorspar: Eng. & Min. Jour.-Press, Vol. 117, p. 489, Mar. 22, 1924.

Imports of fluorspar into the United States in 1923 amounted to 42,226 short tons, the largest since 1910, and came principally from England, with smaller amounts from British South Africa, Italy, China, and Netherlands. The 1923 imports were equivalent to 35% of the domestic shipments of fluorspar as compared with 23% in 1922, according to the U. S. Geological Survey.

In California deposits have been reported in Los Angeles, Mono, Riverside and San Bernardino counties, but no commercial production has resulted except in 1917–1918, when a total of 79 tons valued at $991 was shipped from Riverside County.

In 1921, at the King Mine under development near Afton, San Bernardino County, some fluorspar was mined but not shipped. Field examinations have indicated a considerable deposit there of merchantable spar.

The Tariff Act of 1922 places a duty of $5.60 per ton on foreign importations of fluorspar.

Present quotations (Engineering and Mining Journal-Press, New York, Sept. 6, 1924) are: f. o. b. Middle Western mines, per net ton. Not less than 80% CaF_2 and not over 5% SiO_2, $22; not less than 85% CaF_2 and not over 5% SiO_2, $23.50. Ground and acid grades, up to 98.5% CaF_2 and down to 1% SiO_2, as high as $45 per ton in bulk.

FULLER'S EARTH.

Bibliography: Reports XIV, XVII, XVIII. Bulletins 38, 91. U. S. Bureau of Mines, Bulletin 71.

Fuller's earth includes many kinds of unctuous clays. It is usually soft, friable, earthy, nonplastic, white and gray to dark green in color, and some varieties disintegrate in water. In California, fuller's earth has been used in clarifying both refined mineral and vegetable oils, and for special chemical purposes; although its original use was in fulling wool, as the name indicates. Production has come mainly from Calaveras and Solano counties, with other deposits noted also in Riverside, Fresno, Inyo, and Kern counties.

Clays of the montmorillonite and halloysite group ('rock soap') are being utilized by some of the oil refineries in lieu of true fuller's earth in the refining of petroleum products.

The production of 3650 tons, valued at $55,125, here credited to 1923, as 'fuller's earth' is in reality colloidal clay of the montmorillonite class (sold under such local names as: 'bentonite,' 'otaylite,' 'shoshonite,' derived from the locality where found). Because of its being used for clarifying and filtering processes, we have placed it, for the purposes of this statistical report, under the 'fuller's earth' heading. After all, the practical test of a fuller's earth is not so much a chemical one, as a practical one; that is, its physical capacity to absorb basic colors and to remove these colors from solution in animal, vegetable or mineral oils, also from water.

The 1923 production in California shows a decrease in tonnage but an increase in value, and came from three properties, in Inyo and San Diego counties.

Fuller's Earth Production of California, by Years.

Fuller's earth was first produced commercially in this state in 1899, and the total amount and value of the output since that time are as follows:

Year	Tons	Value	Year	Tons	Value
1899	620	$12,400	1912	876	$6,500
1900	500	3,750	1913	460	3,700
1901	1,000	10,500	1914	760	5,928
1902	987	19,246	1915	632	4,002
1903	250	4,750	1916	110	550
1904	500	9,500	1917	220	2,180
1905	1,344	38,000	1918	87	333
1906	440	10,500	1919	365	3,310
1907	100	1,000	1920	600	6,000
1908	50	1,000	1921	1,185	8,295
1909	459	7,385	1922	6,606	48,756
1910	340	3,820	1923	3,650	55,125
1911	460	5,294			
			Totals	22,637	$291,324

NOTE.—Above production, in 1923, was montmorillonite (hydrous aluminum silicate) a colloidal clay, sometimes called 'rock soap,' and in part locally called 'shoshonite' from its being found near Shoshone in Inyo County; and in part 'otayllite' from Otay, San Diego County.

GEMS.

Bibliography: State Mineralogist Reports II, XIV, XV, XVII, XVIII. Bulletins 37, 67, 91. U. S. G. S., 'Mineral Resources of the U. S.'; Bull. 603, p. 208. Bull. Dept. Geol. Univ. of Cal., Vol. 5, pp. 149–153, 331–380. Am. Jour. Sci., Vol. 31, p. 31.

The production of gem materials in California has been somewhat irregular and uncertain since 1911. The compilation of complete statistics is difficult owing to the widely scattered places at which stones are gathered and marketed in a small way. The materials reported in 1923 totaled $13,220 in value, the increase over the figure of $1,312 in 1922 being due mainly to a slight renewal of activity in the tourmaline district of northern San Diego County, and in part to shipments of quartz crystals from Calaveras County.

The following table shows the distribution of rough, uncut gem and jeweler's materials during 1923:

County	Value	Kind
San Diego	$8,530	Tourmaline, kunzite, essonite and spessartite garnets, aquamarine and pink beryl, blue topaz, quartz crystals.
Butte	*$4,690	Diamonds.
Calaveras		Quartz crystals.
Inyo		Turgite, opals, chalcedony, lapis lazuli.
Riverside		Quartz crystals, green beryl.
San Bernardino		Topaz, thomsonite.
Total value	$13,220	

*Combined to conceal output of a single operator in each.

Varieties of California Gem Stones.

Diamonds have been found in a number of localities in California; but in every case, they have been obtained in stream gravels while

working them for gold. The principal districts have been: Volcano in Amador County; Placerville, Smith's Flat and others in El Dorado County; French Corral, Nevada County; Cherokee Flat, Morris Ravine, and Yankee Hill, Butte County; Gopher Hill and upper Spanish Creek, Plumas County. The most productive district of recent years has been Cherokee in Butte County.

California *tourmalines* are decidedly distinctive in coloring and 'fire' as compared to foreign stones of this classification. The colors range from deep ruby to pink, and various shades of green; also a blue tourmaline has been found.

One of our California gem stones, *benitoite*, has not been found elsewhere; and in but a single locality here: The Dallas Mine in San Benito County.

Kunzite, a gem variety of spodumene, was first found in the Pala district in San Diego County. It has thus far been found in only one locality (Madagascar) outside of California. It is of a lilac color, and is described in detail in Bulletin 37 of the State Mining Bureau.

Beryls of excellent fire and delicate colors are also obtained in the Pala district, of which the *aquamarine* (blue) and *morganite* (pink) varieties deserve special mention. Morganite, like kunzite, has thus far been found elsewhere only in Madagascar.

Californite, or 'California jade,' is a gem variety of *vesuvianite*, and is green or white in color. It is found in Butte, Fresno, and Siskiyou counties.

Some *rhodonite* has been mined in Siskiyou County, and used for decorative purposes, its value being included in the marble figures.

Chrysoprase has been produced in Tulare County.

Turquoise has been found in the desert section of San Bernardino County, but none produced commercially in recent years.

Sapphires have been reported recently found in San Bernardino and Riverside counties, but not as yet confirmed.

Rubies have been identified by the laboratory of the State Mining Bureau, occurring in limestone from the Baldy Mountains, San Bernardino County. Thus far no stones of commercial size have been taken out.

Total Production of Gem Materials in California.

The value of the gem output in California annually since the beginning of commercial production is as follows;

Year	Value	Year	Value
1900	$20,500	1913	$13,740
1901	40,000	1914	3,970
1902	162,100	1915	† 3,565
1903	110,500	1916	† 4,752
1904	136,000	1917	† 3,049
1905	148,500	1918	650
1906	497,090	1919	5,425
1907	282,642	1920	36,056
1908	208,950	1921	10,954
1909	193,700	1922	1,312
1910	287,475	1923	13,220
1911	51,824		
1912	23,050	Total	$2,159,024

GRAPHITE.

Bibliography: State Mineralogist Reports XIII, XIV, XV, XVII. Bulletin 67. U. S. G. S., Min. Res., 1914, Pt. II.

Graphite has been produced from time to time in the state, coming principally from Sonoma and Los Angeles counties. It is difficult for these deposits, which must be concentrated, to compete with foreign supplies, which go on the market almost directly as they came from the deposit. Graphite ores are concentrated with considerable difficulty, and the electric process of manufacturing artificial graphite from coal has been perfected to such a degree that only deposits of natural graphite of a superior quality can be exploited with any certainty of success.

According to the U. S. Geological Survey, operators in this country who are working disseminated flake deposits must depend on their No. 1 and 2 flake for their profit. Graphite dust is merely a by-product and is salable only at a low price. Improved methods of graphite milling adopted promise to increase largely the production of flake of better grade.

The principal value of graphite is on account of its infusibility and resistance to the action of molten metals. It is also largely used in the manufacture of electrical appliances, of 'lead' pencils, as a lubricant, as stove polish, paints, and in many other ways. Amorphous graphite, commonly carrying many impurities, brings a much lower price. For some purposes, such as foundry facings, etc., the low-grade material is satisfactory. Among the interesting uses for graphite is the prevention of formation of scale in boilers. The action is a mechanical one. Being soft and slippery, the graphite prevents the particles of scale from adhering to one another or to the boiler and they are thus easily removed.

The price increases with the grade of material, the best quality crystalline variety being quoted at present at 5.2¢–6¢ per pound (Ceylon lumps); with crude amorphous $15–$35 per ton.

The coarser flakes are necessary for crucibles, as they help to bind the clay together in addition to their refractory service. Since the close of hostilities in Europe, prices have declined to pre-war levels; and imports have been resumed from Ceylon, Canada, Madagascar, Mexico and Korea, of a total of 19,817 tons valued at $606,336 in 1923.

Occurrence of graphite has been reported at various times from Calaveras, Fresno, Imperial, Los Angeles, Mendocino, San Bernardino, San Diego, Siskiyou, Sonoma and Tuolumne counties.

During 1923 there was no commercial production of graphite in California. For several years past, a single plant in Los Angeles County has been concentrating graphite from a disseminated ore, the product being utilized for paint and for foundry facing.

Graphite Production of California, by Years.

According to the records of the State Mining Bureau, the graphite production of California, by years, has been as follows:

Year	Pounds	Value
1901	128,000	$4,480
1902	84,000	1,680
1903	----------	----------
1913	2,500	25
1914	----------	----------
1915	----------	----------
1916	29,190	2,335
1917		
1918	*770,000	37,225
1919		
1920		
1921	*624,000	28,160
1922		
1923	----------	----------
Totals	1,637,690	$71,905

*Annual details concealed under 'Unapportioned,' on account of a single producer.

GYPSUM.

Bibliography: Reports XIV, XV, XVII, XVIII. Bulletins 38, 67, 91. U. S. Geol. Surv., Bull. 223, 413, 430, 697.

During 1923, one operator each in Imperial, Kern, Riverside and San Bernardino counties produced a total of 86,410 tons of gypsum valued at $289,136, compared with 47,084 tons, worth $188,336 in 1922. The material was utilized mainly in cement manufacture, plaster, and for fertilizer. The 1923 shipments of gypsum were the largest in the history of the industry in California, the increase being due to the opening up of a deposit in western Imperial County, by the Imperial Gypsum and Oil Company.

Uses.

The most important use of gypsum from the quantity standpoint is in the calcined form where it is utilized in the manufacture of various hard-wall plasters and plaster board. As plaster of paris, it plays a very important part in surgical work. Approximately 2% of raw gypsum is added to the manufacture of Portland cement just before the final grinding. In this application, the gypsum acts as a retarder to the set of the cement. The use of gypsum tile for non-bearing fireproof partitions, stairway and elevator enclosures, and the protection of steel columns, girders and beams, has increased greatly.

Land plaster may be applied to the soil by drilling, or scattered in the hill, or it may be sowed broadcast, in quantities ranging from 200 to 500 pounds to the acre.

Total Production of Gypsum in California.

Production of gypsum annually in California since such records have been compiled by this Bureau is as follows:

Year	Tons	Value	Year	Tons	Value
1887	2,700	$27,000	1906	21,000	$69,000
1888	2,500	25,000	1907	8,900	57,700
1889	3,000	30,000	1908	24,600	155,400
1890	3,000	30,000	1909	30,700	138,176
1891	2,000	20,000	1910	45,294	129,152
1892	2,000	20,000	1911	31,467	101,475
1893	1,620	14,280	1912	37,529	117,388
1894	2,446	24,584	1913	47,100	135,050
1895	5,158	51,014	1914	29,734	78,375
1896	1,310	12,580	1915	20,200	49,953
1897	2,200	19,250	1916	33,384	59,588
1898	3,100	23,800	1917	30,825	56,840
1899	3,663	14,950	1918	19,695	37,176
1900	2,522	10,088	1919	19,813	50,579
1901	3,875	38,750	1920	20,507	92,535
1902	10,200	53,500	1921	37,412	78,875
1903	6,914	46,441	1922	47,084	188,336
1904	8,350	56,592	1923	86,410	289,136
1905	12,858	54,500			
			Totals	661,052	$2,455,808

INFUSORIAL and DIATOMACEOUS EARTH.

Bibliography: State Mineralogist Reports II, XII–XVI (inc.), XV, XVII–XIX (inc.). Bulletins 38, 67. Am. Inst. Min. Eng., Bull. 104, August, 1915, pp. 1539–1550. U. S. Bur. of Mines, Rep. of Investigations: Serial No. 2431, Jan., 1923. Eng. & Min. Jour.-Press, Vol. 115, pp. 1152–1154, June 30, 1923.

Infusorial and diatomaceous earths—sometimes called tripolite—are very light and extremely porous, chalk-like materials composed of pure silica (chalk, being calcareous) which have been laid down under water and consist of the remains of microscopical infusoria and diatoms. The former are animal remains, and the latter are from plants. The principal commercial use of this material is as an absorbent. It is also employed in the manufacture of scouring soap and polishing powders; for filtration purposes; in making some classes of refractory brick; and as an insulating medium both in heating and refrigeration. It is a first-class nonconductor of heat, where high temperatures are employed, such as around steel and gas plants and power houses. In such cases, it is built in as an insulating layer in furnace walls. In Germany, under the name 'kieselguhr,' it was used as an absorbent for nitroglycerine in the early manufacture of dynamite.

As a nonconductor of heat it has been used alone or with other materials as a covering for boilers, steam pipes, and safes and in fireproof cements. It is used largely by paint manufacturers as a wood filler. Boiled with shellac it is made into records for talking machines. It has been used for absorbing liquid manures so that they could be utilized as fertilizers, and as a source of silica in making water-glass as well as in the manufacture of cement, tile glazing, artificial stone, ultramarine and other pigments of aniline and alizarine colors, paper filling, sealing wax, fireworks, hard-rubber objects, matches, and papier maché, and for solidifying bromide. For making insulating brick the material is

sawed into blocks, and for all other purposes it is ground and screened.

The most important deposits in California thus far known are located in Monterey, Orange, San Luis Obispo, and Santa Barbara counties. The Santa Barbara material is diatomaceous and is of a superior quality. Infusorial or diatomaceous earths are also found in Fresno, Kern, Los Angeles, Plumas, San Benito, San Bernardino, San Joaquin, Shasta, Sonoma, and Tehama counties.

As practically 90% of the output in California is from a single operator, we have concealed the exact figures under the 'Unapportioned' item in the state and county totals. There were seven operators in 1923 in Los Angeles, Monterey, San Luis Obispo, and Santa Barbara counties.

The material shipped was utilized for insulation, filtration, paint pigment, and for clarification of gasoline and kerosene.

Total Production of Diatomaceous Earth in California.

The first recorded production of these materials in California occurred in 1889; total amount and value of output, to date, are as follows:

Year	Tons	Value	Year	Tons	Value
1889	39	$1,335	1907	2,531	$28,048
1890			1908	2,950	32,012
1891			1909	500	3,500
1892			1910	1,843	17,617
1893	50	2,000	1911	2,194	19,670
1894	51	2,040	1912	4,129	17,074
1895			1913	8,645	35,868
1896			1914	12,840	80,350
1897	5	200	1915	12,400	62,000
1898			1916	15,322	80,619
1899			1917	24,901	127,510
1900			1918	35,903	189,459
1901			1919	40,200	217,800
1902	422	2,532	1920	60,764	1,056,260
1903	2,703	16,015	1921	*90,739	1,016,675
1904	6,950	112,282	1922		
1905	8,000	15,000	1923	*	
1906	2,430	14,400			
			Totals	330,971	$3,151,296

*Annual details concealed under 'Unapportioned.'

LIMESTONE.

Bibliography: State Mineralogist Reports IV, XII–XV (inc.), XVII–XIX (inc.). Bulletins 38, 91. Oregon Agr. College, Extension Bulletin 305.

'Industrial' limestone was produced in nine counties during 1923, to the amount of 143,266 tons, valued at $348,464, being an increase both in quantity and value over the 1922 output of 84,382 tons, worth $282,181.

The amount here given does not include the limestone used in the manufacture of cement nor for macadam and concrete, nor of lime for building purposes; but accounts for that utilized as a smelter and foundry flux, for glass and sugar making, and other special chemical

and manufacturing processes. It also includes that utilized for fertilizers (agricultural 'lime'), 'roofing gravel,' paint filler, whiting for paint, putty, kalsomine, terrazzo, paving dust, concrete filler, chicken grit, carbon dioxide gas, 'paving compound,' and facing dust for concrete pipe. That indicated in the table below as coming from Santa Clara County and a part of that from Los Angeles is calcareous marl sold for agricultural purposes. Of the total product in 1923 approximately 23,000 tons valued at $101,000 was used for agricultural purposes.

Distribution of the 1923 output was as follows:

County	Tons	Value
El Dorado	95,274	$163,987
Los Angeles	2,717	8,779
San Bernardino	5,859	28,224
Santa Clara	8,252	49,572
Santa Cruz	6,733	14,342
Tuolumne	3,140	7,680
Tulare	15,500	57,500
Contra Costa, Kern, Shasta*	5,791	18,440
Totals	143,266	$348,464

*Combined to conceal output of a single operator in each.

Limestone Production of California, by Years.

The following tabulation gives the amounts and value of 'industrial' limestone produced in California by years since 1894 when compilation of such records was begun by the State Mining Bureau. These tonnages consist principally of limestone utilized for flux, glass and sugar making, agricultural, chemical, and other special industrial purposes. That utilized in cement manufacture is not included.

Year	Tons	Value	Year	Tons	Value
1894	15,420	$19,276	1910	684,685	$581,208
1895	71,355	71,690	1911	516,398	452,790
1896	68,184	71,112	1912	613,375	570,248
1897	36,796	36,556	1913	301,918	274,455
1898	27,686	24,548	1914	572,272	517,713
1899	30,760	29,186	1915	146,324	156,288
1900	32,791	31,532	1916	187,521	217,733
1901	76,937	99,445	1917	237,279	356,396
1902	71,422	90,524	1918	208,566	456,258
1903	125,919	163,988	1919	88,291	248,145
1904	40,207	87,207	1920	90,120	298,197
1905	192,749	323,325	1921	75,921	305,912
1906	80,262	162,827	1922	84,382	282,181
1907	230,985	406,041	1923	143,266	348,464
1908	273,880	237,264			
1909	337,676	419,921	Totals	5,663,316	$7,402,128

LITHIA.

Bibliography: State Mineralogist Reports II, IV, XIV. Bulletins 38, 67, 91.

Lithia mica, lepidolite (a silicate of lithium et al.) utilized in the manufacture of artificial mineral water, fireworks, glass, etc., has been mined in San Diego County since 1899, except between 1905 and 1915. Some amblygonite, a lithium phosphate, has also been obtained from

pockets associated with the gem tourmalines. The lepidolite marketed in 1922 was utilized in glass manufacture. There was none shipped in 1923.

Lithia mica total production in the state has been as follows:

Year	Tons	Value	Year	Tons	Value
1899	124	$4,600	1916	71	$1,065
1900	440	11,000	1917	880	8,800
1901	1,100	27,500	1918	4,111	73,998
1902	822	21,880	1919	800	14,400
1903	700	27,300	1920	10,046	153,502
1904	641	25,000	1921	*1,365	20,781
1905	25	276	1922		
1906			1923		
1915	91	1,365	Totals	21,216	$401,457

*Annual details concealed under 'Unapportioned.'

MICA.

Bibliography: State Mineralogist Reports II, IV. Bulletins 38, 67, 91. U. S. Geol. Surv., Bull. 740; Min. Res. of U. S. Eng. & Min. Jour.-Press, Vol. 115, pp. 55–60, Jan. 13, 1923.

No commercial production of mica has recently been reported in California. Production in previous years has been as follows:

Year	Tons	Value
1902	50	$2,500
1903	50	3,300
1904	50	3,000
Totals	150	$9,300

Classification and Uses.

Practically all marketable mica is of the muscovite or phlogopite varieties. There are three main commercial classes: Sheet mica, including punch; splittings, and scrap. Sheet mica is used chiefly for electrical purposes and for glazing; splittings are made into built-up mica; scrap is ground to a powder. Mica to be classified as sheet must yield a rectangle of at least 1½ x 2 in., must split evenly and freely, be free from cracks, rulings, or plications, and reasonably free from inclusions of foreign matter, though stains of a nonconducting character are permissible for some uses. Ability to withstand heat and high electrical resistance have led to a wide application of sheet mica in the electrical industries. The electrical uses of sheet mica greatly exceed all others in quantity and value of the material used.

As a heat-resisting transparent medium, sheet mica has various uses. It is widely employed for stove windows, though this use has declined to a considerable extent. A hard and rigid mica that is nearly clear is best suited for stove fronts. High-grade stove mica commands a higher price than electrical mica, because for the most part larger sizes are demanded. Mica is also used in furnace and bake-oven sight-holes, heat screens, lamp chimneys, canopies and shades, particularly for gas mantles, and also for military lanterns and in lantern slides.

Its ability to withstand shocks and strains, combined with its transparency, has led to wide use in motor goggles, spectacles, diver's helmets, smoke helmets, compass cards, gage fronts, and in windows subject to shock, as in the conning towers of warships. On account of its heat-resisting qualities, ground mica is used in railroad car axle packings, in pipe and boiler coverings, in fire-proof paints, and in rubber tires. Ground mica is used as a component in roofing, as a filler in rubber and other products, in calico printing, and as a tire powder. It is used also in tinsel decorations, and as 'Santa Claus snow' for Christmas tree and window decorations. It is used as a lubricant for wooden bearings, and mixed with oil for metal bearings.

MINERAL PAINT.

Bibliography: State Mineralogist Reports XII–XIX (inc.). Bulletins 38, 91.

Mineral paint materials were produced in California in 1923 from a total of five properties in the following three counties: Nevada, Stanislaus, and Ventura. The total amounted to 1049 tons at $11,773, being a decrease from the 1620 tons and $13,277 of 1922. The material shipped from Nevada County is hematite; from Stanislaus, yellow ochre; and that from Ventura, red ochre.

Mineral Paint Production of California, by Years.

The first recorded production of mineral paint materials in the state was in the year 1890. The output, showing annual amount and value, since that time, is given herewith:

Year	Tons	Value	Year	Tons	Value
1890	40	$480	1906	335	$2,250
1891	22	880	1909	805	2,325
1892	25	750	1910	200	2,040
1893	590	26,795	1911	186	1,184
1894	610	14,140	1912	300	1,800
1895	750	8,425	1913	303	1,780
1896	395	5,540	1914	182	847
1897	578	8,166	1915	311	1,756
1898	653	9,695	1916	643	3,860
1899	1,704	20,294	1917	520	2,700
1900	529	3,993	1918	728	4,738
1901	325	875	1919	1,780	17,055
1902	580	1,533	1920	779	8,477
1903	2,370	3,720	1921	446	4,748
1904	270	1,985	1922	1,620	13,277
1905	754	4,025	1923	1,049	11,773
1906	250	1,720			
1907	250	1,720	Totals	19,741	$188,448

MINERAL WATER.

Bibliography: State Mineralogist Reports VI, XII–XVIII (inc.). U. S. G. S., Water Supply Paper 338. Min. Res. 1914, 1916. 'Mineral Springs and Health Resorts of California,' by Dr. Winslow Anderson, 1890. U. S. Dept. of Agr., Bur. of Chem., Bulletin 91.

A widespread production of mineral water is shown annually in California. These figures refer to mineral water actually bottled for sale, or for local consumption. Water from some of the springs having a special medicinal value brings a price many times higher than the average shown, while in some cases the water is used merely for drinking purposes and sells for a nominal figure. Health and pleasure resorts are located at many of the springs. The waters of some of the hot springs are not suitable for drinking, but are very efficacious for bathing.

From a therapeutic standpoint, California is particularly rich in mineral springs. The counterparts of many of the world-famed spas of Europe and the eastern United States can be found here. Radioactivity has been noted in at least two localities in California: At The Geysers in Sonoma County, and Arrowhead Hot Springs in San Bernardino County. It doubtless exists at others, but the State Mining Bureau has not as yet had funds available to conduct the necessary investigations along this line.

Commercial production of mineral water in California for 1923 amounted to a total of 5,487,276 gallons valued at $616,919, being an increase both in quantity and value over the 1922 figures which were 4,276,346 gallons and $486,424. These are also the highest figures recorded for any year in the history of the state's industry. The 1923 output was distributed by counties, as follows:

Mineral Water Production, by Counties, 1923.

County	Gallons	Value
Butte	3,700	$3,300
Calaveras	1,626	569
Lake	63,730	44,788
Los Angeles	440,583	24,787
Napa	69,639	55,757
Riverside	83,855	5,277
San Diego	59,795	6,570
Santa Barbara	81,200	80,300
Siskiyou	200,150	4,042
Sonoma	30,661	7,106
Contra Costa, Humboldt, Marin, Monterey, San Benito, San Bernardino, San Luis Obispo, Santa Clara, Solano*	4,472,357	384,473
Totals	5,487,276	$616,919

*Combined to conceal output of a single operator in each.

The production above tabulated was in part bottled with artificial carbonation, in part natural and a large part was used in the preparation of soft drinks with flavors.

Although some of the operators complain that prohibition has all but killed off the mineral water business, the reports of actual production of mineral water bottled and sold indicate an encouraging growth and a material increase annually both in total quantity and value.

Mineral Water Production of California, by Years.

Mineral water was bottled for sale, at the Napa Soda Springs, Napa County, as early as 1860, and at other springs in California, notably The Geysers, Sonoma County, also at early dates; but there are no figures available earlier than the year 1887. Amounts and values, annually, since that year are shown herewith:

Year	Gallons	Value	Year	Gallons	Value
1887	618,162	$144,368	1906	1,585,690	$478,186
1888	1,112,202	252,990	1907	2,924,269	544,016
1889	808,625	252,241	1908	2,789,715	560,507
1890	258,722	89,786	1909	2,449,894	465,488
1891	334,553	139,959	1910	2,335,259	522,009
1892	331,875	162,019	1911	2,637,869	590,654
1893	383,179	90,667	1912	2,497,791	529,384
1894	402,275	184,481	1913	2,850,792	599,748
1895	701,397	291,500	1914	2,443,572	478,169
1896	808,843	337,434	1915	2,274,267	487,738
1897	1,508,192	845,363	1916	2,273,817	410,112
1898	1,429,809	213,817	1917	1,942,020	340,566
1899	1,338,537	406,681	1918	1,808,781	375,650
1900	2,456,115	268,607	1919	2,233,842	340,117
1901	1,555,328	559,057	1920	2,391,791	421,643
1902	1,701,142	612,477	1921	3,446,278	367,476
1903	2,056,340	558,201	1922	4,276,346	486,424
1904	2,430,320	426,946	1923	5,487,276	616,919
1905	2,194,150	538,700	Totals	70,578,788	$14,538,610

PHOSPHATES.

Bibliography: Bulletins 67, 91.

No commercial production of phosphates has been recorded from California, though occasional pockets of the lithium phosphate, amblygonite, Li (AlF) PO_4, have been found associated with the gem tourmaline deposits in San Diego County. Such production has been classified under lithia.

PUMICE and VOLCANIC ASH.

Bibliography: State Mineralogist Reports XII, XIV, XV, XVII, XVIII. Bulletin 38 (See 'Tufa').

The production of pumice and volcanic ash for the year 1923 amounted to 2,936 tons valued at $16,309 and came from properties in Imperial, Inyo, and Kern counties. This is an increase both in tonnage and value over the 1922 shipments. The material from Imperial County is of the vesicular, block variety and was sold for abrasive purposes and for concrete aggregate; that from Inyo and

Kern is the volcanic ash, or tuff variety, and was employed in making soap and cleanser compounds.

Commercial production of pumice in California was first reported to the State Mining Bureau in 1909, then not again until 1912, since which year there has been a small annual output, as indicated by the following table:

Year	Tons	Value	Year	Tons	Value
1909	50	$500	1917	525	$5,295
1910			1918	2,114	28,069
1911			1919	2,388	43,657
1912	100	2,500	1920	1,537	25,890
1913	3,590	4,500	1921	406	6,310
1914	50	1,000	1922	613	4,248
1915	380	6,400	1923	2,936	16,809
1916	1,246	18,092	Totals	15,935	$163,870

PYRITES.

Bibliography: Report XVIII. Bulletins 38, 91. Min. & Sci. Press, Vol. 114, pp. 825, 840.

A total production of 148,004 short tons of pyrites, valued at $555,308, was reported shipped in California during 1923, from properties operated in Alameda, Mariposa, and Shasta counties. This was a slight decrease in both tonnage and value from the figures of 151,381 tons and $570,425 in 1922. The material was mostly used in the manufacture of sulphuric acid, but a portion was utilized directly in the preparation of agricultural fertilizer and insecticide. The sulphuric acid made is mainly used in the manufacture of explosives and of fertilizers.

This does not include the large quantities of pyrite, chalcopyrite and other sulphides which are otherwise treated for their valuable metal contents. Some sulphuric acid is annually made as a by-product in the course of roasting certain tonnages of Mother Lode auriferous concentrates while under treatment for their precious-metal values.

Pyrites Production in California, by Years.

The total recorded pyrites production in California to date is as follows:

Year	Tons	Value	Year	Tons	Value
1898	6,000	$30,000	1911	54,225	$182,954
1899	5,400	28,620	1912	69,872	208,470
1900	3,642	21,133	1913	79,000	218,537
1901	4,578	18,429	1914	79,267	230,038
1902	17,525	60,306	1915	92,462	298,148
1903	24,311	94,000	1916	120,525	372,969
1904	15,043	62,992	1917	111,325	323,704
1905	15,503	63,958	1918	128,329	425,012
1906	46,689	145,895	1919	147,024	540,300
1907	82,270	251,774	1920	146,001	530,581
1908	107,081	610,335	1921	110,025	473,735
1909	457,867	1,389,802	1922	151,381	570,425
1910	42,621	179,882	1923	148,004	555,308
			Totals	2,265,970	$7,877,357

SHALE OIL.

Bibliography: State Mineralogist Report XIX. U. S. Geol. Surv., Bulletins 322, 729, U. S. Bur. of Mines, Bull. 210. Eng. & Min. Jour.-Press, Vol. 118, No. 8, pp. 290–292, Aug. 23, 1924.

Oil shale is defined by Gavin[1] as follows:

"Oil shale is a compact, laminated rock of sedimentary origin, yielding over 83 per cent of ash and containing organic matter that yields oil when distilled, but not appreciably when extracted with the ordinary solvents for petroleum.

* * * * * * *

"Oil shales contain a substance, or substances, usually classed as a pyro-bitumen, that by destructive distillation, or pyrolysis, yields oils somewhat similar to petroleum. These substances have been termed 'kerogen' from two Greek words meaning producer of wax."

The Scottish oil shales are also known as 'torbanite.'

The so-called 'oil shales' of California do not for the most part conform to the above definition, as the greater part of the oil obtained from them occurs as such and can be extracted by suitable solvents. The most extensive deposits in this State are part of the Monterey formation of Tertiary age, and physically and chemically are different from the oil shales of Scotland and from other oil shales in the United States. The mineral matter of this shale is diatomaceous; the beds that yield oil occur in massive formation; and when freshly broken smell strongly of petroleum. Most geologists consider the Monterey shales to have been the origin of the oil in some of the oil fields of California.

Although the extraction of shale oil has been a matter of commercial practice on a considerable scale for many years in Scotland, France, and Australia, it has not attained any great commercial importance as yet in the United States. Technical knowledge of the subject, however, is increasing. With the gradual depletion of the underground reserves of liquid oil, it is merely a matter of time until the development of the oil shales of the United States will be an economic necessity. The recovery of by-product ammonium sulphate is an important feature of the process.

Two plants on a more or less experimental scale have been in operation in California the past three or four years, with commercial production beginning in a small way in 1922. The product, in part, has been sold for utilization as a flotation oil in metallurgical work, and part has been consumed as fuel at the plants. Both plants report output for 1923, the amount and value being concealed under the 'unapportioned' item.

SILICA (Sand and Quartz).

Bibliography: State Mineral Reports, IX, XIV, XV, XVII, XVIII. Bulletins 38, 67, 91.

We combine these materials because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manu-

[1] Gavin, M. J., Oil shale, an historical, technical, and economic study: U. S. Bur. of Mines, Bull. 210, p. 26, 1924.

facture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

A portion of the tonnage of vein quartz in California in 1916 and 1917 was employed in the preparation of ferro-silicon by the electric furnace. At present, some is utilized as a foundry flux, and for steel-casting moulds. A portion of the silica sold (both sand and quartz) is also used in glazes for porcelain, pottery and tile, and in the body of the ware to diminish shrinkage; and some of the sand for the preparation of sodium silicate ('water glass'). Manufacturers of paint use finely ground silica, which forms as much as one-third of the total pigment in some paints. For certain purposes finely ground crystalline material is superior in paints to other materials because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear afford a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. It is also preferable for soaps and polishing powders.

We do not include under this heading such forms of silica as: quartzite, sandstone, flint, tripoli, diatomaceous earth, nor the gem forms of 'rock crystal,' amethyst, and opal. Each of these has various industrial uses, which are treated under their own designations.

The production of silica in California in 1923 amounted to 7,964 tons valued at $30,420, from eleven properties in five counties, distributed as follows:

County	Tons	Value
Placer	3,656	$10,040
Riverside	2,300	15,000
Los Angeles, Monterey, San Diego*	2,008	6,280
Totals	7,964	$30,420

*Combined to conceal output of a single operator in each.

Of the above total, 610 tons was of sand, and 7354 tons of vein and boulder quartz. For making the higher grades of glass, most of the sand is imported from Belgium. There are various deposits of quartz in California which could be utilized for glass making, but to date they have not been so used owing to the cost of grinding and the difficulty of preventing contamination by iron while grinding.

Silica sand has been produced in the following counties of the state: Alameda, Amador, El Dorado, Los Angeles, Monterey, Orange, Placer, Riverside, San Diego, San Joaquin, and Tulare. The chief producing centers have been Amador, Monterey, and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class colorless glass; for such, it must be essentially iron-free. Even a fractional per cent of iron imparts a green color to the glass.

Belgium sand is also displacing local material in the manufacture of sodium silicate ('water glass'), causing the closing down of operations in January of last year of the sand plant of the Philadelphia Quartz Company in Amador County.

Total Silica Production of California.

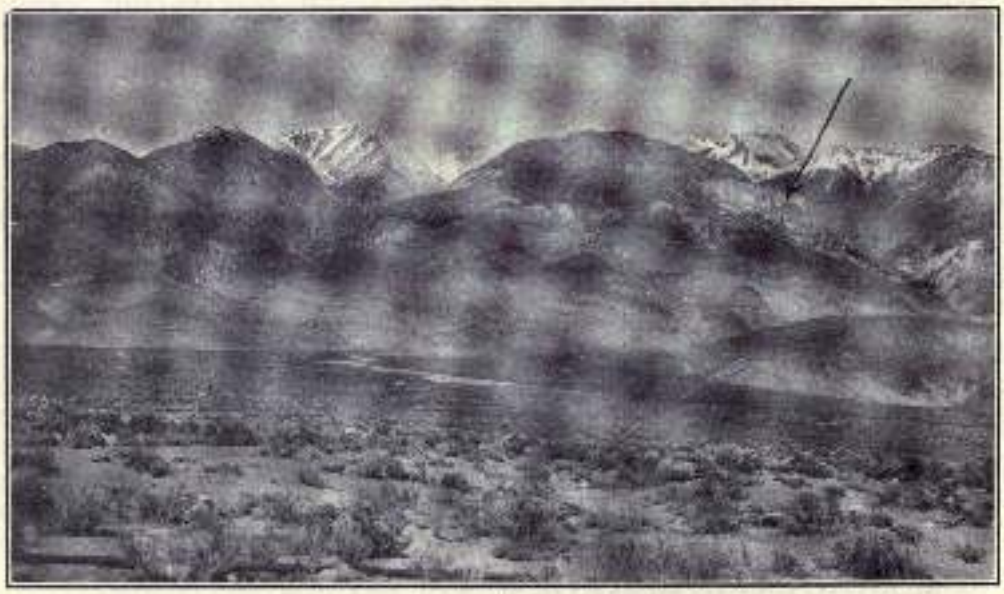
Total silica production in California since the inception of the industry, in 1899, is shown below, being mainly sand:

Year	Tons	Value	Year	Tons	Value
1899	3,000	$3,500	1912	13,075	$15,404
1900	2,200	2,200	1913	18,618	21,899
1901	5,000	16,250	1914	28,538	22,688
1902	4,500	12,225	1915	28,904	24,322
1903	7,725	7,525	1916	20,580	48,908
1904	10,604	12,276	1917	19,376	41,166
1905	9,257	8,121	1918	23,257	88,930
1906	9,750	13,375	1919	15,659	101,609
1907	11,065	8,178	1920	25,324	96,799
1908	9,255	22,045	1921	10,569	49,179
1909	12,259	25,517	1922	9,874	31,016
1910	19,224	18,265	1923	7,964	30,420
1911	8,620	8,672			
			Totals	336,897	$740,474

SILLIMANITE and ANDALUSITE.

Bibliography: State Mineralogist Report XX. Bulletins 67, 91. Dana's Mineralogy.

Sillimanite and andalusite are both aluminum silicates (Al_2SiO_5), having the same composition and formula, but with slightly different physical characteristics. Though both crystallize in the orthorhombic

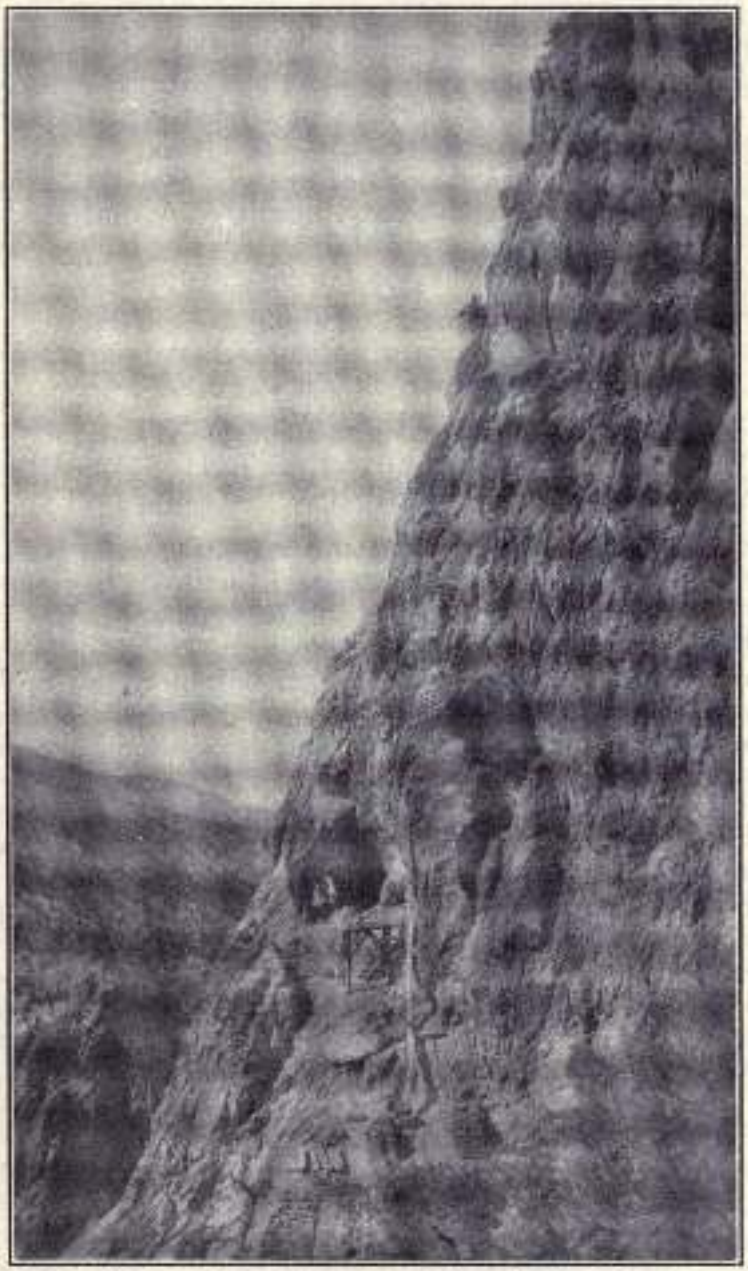


White Mountains, Mono County, California, showing location of andalusite mine of Champion Porcelain Company, at elevation of 10,000 feet above sea-level. Photo by courtesy of J. A. Jeffery.

system, their crystal habits are different: Andalusite being usually in coarse prismatic forms, the prisms nearly square in shape; also occurs massive, imperfectly columnar, and sometimes radiated and granular. Sillimanite commonly occurs in long, slender crystals, not distinctly terminated; prismatic faces striated and rounded; often in close

parallel groups, passing into fibrous and columnar massive forms, sometimes radiating. Colors are similar. Hardness, andalusite 7.5, sillimanite 6–7. Andalusite is slightly lighter in specific gravity.

A massive deposit of andalusite, found in Dry Creek Canyon in the White Mountains of the Inyo Range, in Mono County, is being mined



Andalusite mine of Champion Porcelain Company, in White Mountains, Mono County, California. Photo by courtesy of J. A. Jeffery.

by the Champion Porcelain Company of Detroit, Michigan. The material is shipped East and utilized in the manufacture of porcelain for automobile spark plugs, and for other high-tension electric insu-

lators. The function and behavior of andalusite are described by Peck[1] in a recent paper, to which the reader is referred for details. This is apparently the only deposit of either andalusite or sillimanite thus far found in the United States at least in sufficient quantity to be of commercial consequence. Commercial shipments began in 1922, but as there is only the one operator, the annual tonnages and values are concealed under the 'unapportioned' item.

Cyanite is also an aluminum silicate (Al_2SiO_5), of the same chemical composition as andalusite and sillimanite, but crystallizing in the triclinic system. Occurs usually in long-bladed crystals, rarely terminated; hardness 5–7.25; gravity 3.56–3.67 (being heavier than the other two); color, blue. A deposit of cyanite, apparently in quantity, has been located in Imperial County, near Ogilby, but as yet no shipments made except for experimental purposes. If its physical and chemical behavior prove to be similar to andalusite, it too will have commercial possibilities.

SOAPSTONE and TALC.

Bibliography: State Mineralogist Reports XII, XIV, XV, XVII, XVIII. Bulletins 38, 67, 91. U. S. Bur. of Mines, Bulletin 213. Rep. of Investigations, Serial No. 2253, May, 1921.

The total output of talc and soapstone in California in 1923 amounted to 17,439 tons valued at $252,661, compared with 13,378 tons valued at $197,186 in 1922. More than two-thirds of the product was high-grade talc from Inyo and San Bernardino counties, which material was utilized mainly in toilet powders, paint, paper, and rubber manufacture, and in part in magnesite flooring and stucco. The 'soapstone' grades were used mainly for roofing and as a filler in roofing paper, and part also in magnesite cement.

The increase in production in 1922–1923 was due, in part to improvement in the eastern demand for California talc on account of its high quality, in part to a 10% reduction in freight rates in July, 1922, and in part to the increases in tariff duties placed on foreign importations of talc by the Tariff Act of 1922 which became effective in September. It is reported that California talc is steadily replacing imported talc in the toilet trade on the basis of quality. The largest production of talc in the United States comes from Vermont and New York, and of massive soapstone from Virginia.

Composition and Varieties.

Talc is a hydrous magnesium silicate with the chemical formula $H_2Mg_3(SiO_3)_4$. It is also called soapstone, and steatite. The term 'talc' properly includes all forms of the pure mineral, whereas 'steatite' denotes particularly the massive, compact variety, and 'soapstone' the impure, massive forms containing as low as 50% of talc. When pure, talc is soft, having a hardness of 1, but impurities increase the hardness up to 3 or 4. The color varies from pure white and silvery white

[1] Peck, A. B., Note on andalusite from California, a new use and some thermal properties; Cal. State Min. Bur., Mining in Cal., being April chapter, 1924, of State Mineralogist Report XX, pp. 149–154. Also: American Mineralogist, June 1924.

through gray, green, apple green, to dark green, also yellow, brown, and reddish when impure. It is commonly compact or massive, or in fine granular aggregates, and often in foliated plates or in fibrous aggregates.

Uses.

Although the uses of talc and soapstone are many and varied, some of them are not in general well known nor fully developed; and although few of their uses can justly be considered essential in the sense that no substitutes can be used, there are several which are of great importance. The widest use of talc is in the powdered form, and the value depends upon color (whiteness), uniformity, fineness of grain, freedom from grit, 'slip,' and sometimes freedom from lime. The white varieties, free from grit and iron, low in lime, ground to 200-mesh and finer, are largely used as a filler for paper, rubber and paint, and the very highest grade as toilet powder. Ground talc is also used in dressing and coating cloth, in making soap, rope, twine, pipe-covering compounds, heavy lubricants, and polishes. Ground talc and soapstone are used for foundry facings, either alone or mixed with graphite; and a coarser grade is used in the manufacture of asphalt-coated roofing felts and papers, both as a filler and as a surfacing. Massive, close-grained talc, free from iron and grit, is cut into blanks and baked, forming the material used for gas tips and electrical insulation, commercially known as 'lava.' Its hardness, its resistance to heat, acids and alkalies, and its great dielectric strength make it very useful for electric insulation, and no satisfactory substitute for it has been found.

Massive varieties of talc, pyrophyllite, and high grades of soapstone are cut into slate pencils, and steel-workers' crayons. 'French chalk' or 'tailor's chalk' is a soft, massive talc. In China, Japan, and India, massive talc (steatite) is carved into grotesque images and other forms, and is often sold as imitation jade. Soapstone is usually cut into slabs of 1 to 2 inches in thickness and sold as griddles, footwarmers, and fireless-cooker stones, or fabricated into laundry sinks and tubs, laboratory-table tops, hoods, tanks, and sinks, electric switchboards, and for other uses in which the properties of resistance to heat, acids, and alkalies, and electricity are essential.

A detailed description of the classification and uses of talc and soapstone was given in the statistical report for 1923 (Bulletin 93) issued by the State Mining Bureau, copies of which are still available for distribution.

Imports.

Foreign importations of high-grade white talc suitable for the manufacture of toilet powder have come mainly from Canada, Italy and France. Foreign producers have the benefit of cheap labor, and a low tariff import duty. In addition to these disadvantages, California operators have to contend with transcontinental freight rates to the eastern manufacturing centers. In 1923, importations totaled 19,406 tons valued at $409,600.

Californian Production, 1923.

California's production of talc and soapstone in 1923 was distributed by counties as follows:

County	Tons	Value
El Dorado	2,670	$15,729
Inyo	5,981	104,978
San Bernardino	7,288	123,216
Amador, Butte, Los Angeles*	1,540	8,740
Totals	17,489	$252,661

*Combined to conceal output of a single operator in each.

Talc Production of California, by Years.

Production has been intermittent in the state since 1893, as shown in the following table:

Year	Tons	Value	Year	Tons	Value
1893	400	$17,750	1909	33	$280
1894	----------	----------	1910	740	7,260
1895	25	375	1911	----------	----------
1896	----------	----------	1912	1,750	7,350
1897	----------	----------	1913	1,350	6,150
1898	----------	----------	1914	1,000	4,500
1899	----------	----------	1915	1,663	14,750
1900	----------	----------	1916	1,703	9,331
1901	10	119	1917	5,267	45,279
1902	14	288	1918	11,760	85,584
1903	219	10,124	1919	8,764	115,991
1904	228	2,315	1920	11,327	221,382
1905	800	8,000	1921	8,752	130,078
1906	----------	----------	1922	13,878	197,186
1907	----------	----------	1923	17,489	252,661
1908	3	48	Totals	86,125	$1,131,331

STRONTIUM.

Bibliography: Bulletins 67, 91. U. S. G. S., Bull. 540; 660–I.

There has been no production of strontium minerals in California since 1918, though in that year both celestite ($SrSO_4$), and the carbonate, strontianite ($SrCO_3$) were shipped. The first recorded commercial output of strontium minerals in California was in 1916. The occurrence of the carbonate is particularly interesting and valuable, as it appears to be the first considerable deposit of commercial importance so far opened up in the United States. Shipments reported as averaging 80% $SrCO_3$ have been made. The deposit is associated with deposits of barite, near Barstow, San Bernardino County. The carbonate has also been found in massive form near Shoshone, Inyo County. In addition to Imperial County, celestite is found near Calico and Ludlow, and in the Avawatz Mountains in San Bernardino County, but as yet undeveloped.

Production of strontium minerals in California, by years, has been as follows:

Year	Tons	Value
1916	57	$2,850
1917	3,050	87,000
1918	2,900	33,000
1919	----------	----------
Totals	6,007	$72,850

The principal use for strontium in the United States is in the form of the nitrate in the manufacture of red flares, or Costen and Bengal lights and fireworks. Previous to 1914, the nitrate was imported from Germany, England, and Sicily. In Germany and Russia, strontium in the form of the hydroxide is used in the manufacture of beet sugar. It is stated that strontia is more efficient and satisfactory in that process than lime, as it gives an additional recovery of 6% to 8%.

Of the two minerals, strontianite (carbonate) and celestite (sulphate), the carbonate is the more desirable as it is easier to convert to other salts; but it is scarcer. Celestite is found with limestone and sandstone and is sometimes associated with gypsum. Strontianite is also found with limestone, but associated with barite and calcite.

SULPHUR.

Bibliography: State Mineralogist Reports IV, XIII, XIV. Bulletins 38, 67, 91.

In 1923 there was a small production of sulphur, from a single property in Kern County. This is the first commercial output of native sulphur in California for many years although this mineral has been found to some extent in Colusa, Imperial, Inyo, Kern, Lake, Mariposa, San Bernardino, Shasta, Sonoma, Tehama, and Ventura counties.

Sulphur was produced at the famous Sulphur Bank mine in Lake County, during the years 1865–1868 (inc.), totaling 941 tons, valued at $53,500; following which the property became more valuable for its quicksilver. The Elgin quicksilver mine, near Wilbur Springs, Colusa County is a similar occurrence.

The principal sources in the United States are the stratified deposits in Louisiana and Texas, extraction being accomplished by a unique system of wells with steam pipes. It is stated that the three large companies operating there are capable of producing more than 1,000,000 tons annually in excess of our normal consumption in the United States, which averages about 600,000 tons. The mines at Freeport, Texas, are in a peculiarly favorable location in that they are practically at tidewater.

Formerly considerable sulphur was imported from Italy and from Japan; but the situation is now reversed, so that in 1923, a total of 472,525 long tons valued at $7,105,260 was exported from the United States, principally to Europe and Canada.

CHAPTER SIX.

SALINES.

Bibliography: State Mineralogist Reports III, XIV, XV, XVII–XX (inc.). Bulletin 24.

Under this heading are included borax, common salt, soda, potash, and other alkaline salts. The first two have been produced in a number of localities in California, more or less regularly since the early sixties. Except for a single year's absence, soda has had a continuous production since 1894. Potash, magnesium chloride and sulphate, and calcium chloride have only recently been added to the commercial list, while the nitrates are still prospective.

Our main resources of salines are the lake beds of the desert regions of Imperial, Inyo, Kern, Los Angeles, San Bernardino, and San Luis Obispo counties, and the waters of the Pacific Ocean.

The total value for this group shows an increase to $4,614,619 in 1923 from the 1922 figure of $3,135,049, as detailed in the following tabulations:

Substance	1922		1923		Increase + Decrease − Value
	Tons	Value	Tons	Value	
Borates	[a]39,087	$1,008,025	[a]62,657	$1,813,798	$805,773+
Calcium chloride	*	*	*	*	*
Magnesium salts	3,086	89,788	3,662	116,031	26,243+
Potash	17,776	584,388	22,597	709,836	125,448+
Salt	223,228	819,187	275,979	1,130,670	311,483+
Soda	29,084	573,661	34,885	756,284	190,623+
Total value		$3,135,049		$4,614,619	
Total increase					$1,479,570+

*Concealed under 'Unapportioned.'
[a]Recalculated to 40% 'anhydrous boric acid' equivalent.

BORATES.

Bibliography: State Mineralogist Reports III, X, XII–XV (inc.), XVII–XX (inc.). Bulletins 24, 67, 91.

During 1923 there was produced in California, a total of 118,601 tons of borate materials, compared with a total of 74,998 tons for the year 1922. The material shipped in 1923 included crude and selected colemanite ore from Inyo, Los Angeles, and San Bernardino counties, varying from 18.29% to 28.24% anhydrous boric acid ("A.B.A."),

also crystallized borax recovered from evaporation of brines at Searles Lake in San Bernardino County.

As the crude ore is not sold, as such, and is almost entirely calcined before shipping to the refinery for conversion into the borax of commerce, it is difficult to arrive at a valuation of the crude ore mined. For this reason and the fact that the material varied widely in boric acid content, we have re-calculated the tonnage to a basis of 40% A. B. A. This is approximately the average A. B. A. content of the colemanite material after calcining, in which condition it is shipped to the refinery. A valuation of 50¢ per unit of 'anhydrous boric acid' was reported for the calcined material. Recalculated as above, the 1923 production totals 62,667 tons valued at $1,893,798, an increase over the similar figures for 1922 which were 39,087 tons and $1,068,025.

Colemanite is a calcium borate, and the material mined is mostly shipped to eastern chemical plants for refining. Refined 'borax' (sodium tetraborate) is used in making the enameled coating for cast-iron and steel-ware employed in plumbing fixtures, chemical equipment, and kitchen utensils. It is also a constituent of borosilicate glasses which are utilized in making lamp chimneys, baking dishes, and laboratory glassware. Other important uses of borax are in the manufacture of laundry and kitchen soaps, in starch, paper sizing, tanning, welding, and in the preparation of boric acid, which is employed as an antiseptic and in preserving meats.

Total Production of Borate Materials in California.

Borax was first discovered in California in the waters of Tuscan Springs in Tehama County, January 8, 1856. Borax Lake, in Lake County, was discovered in September of the same year by Dr. John A. Veach. This deposit was worked in 1864–1868, inclusive, and during that time produced 1,181,365 pounds of refined borax. The bulk of it was exported by sea, to New York. This was the first commercial output of this salt in the United States, and California is still today the leading American producer of borax, having been for many years the sole producer.

Production from the dry lake 'playa' deposits of Inyo and San Bernardino counties began in 1873; but it was not until 1887 that the borax industry was revolutionized by the discovery of the colemanite beds at Calico, in San Bernardino County. These have since been largely worked out, and the output for a number of years has been coming from similar beds in Inyo and Los Angeles counties. In 1920 San Bernardino County again entered the field with shipments of such ore from near Daggett. The colemanite deposits of Ventura County are at present unworked, owing to lack of transportation facilities. Some production of colemanite is being made from deposits recently opened up in Clarke County, Nevada.

The total production of borate materials in California is shown in the following table:

Year	Tons	Value	Year	Tons	Value
1864	12	$9,478	1894	5,770	$807,807
1865	126	94,099	1895	5,959	595,900
1866	201	132,598	1896	6,754	675,400
1867	220	156,187	1897	8,000	1,080,000
1868	32	22,384	1898	8,300	1,153,000
1869			1899	20,867	1,139,882
1870			1900	25,837	1,013,251
1871			1901	22,221	982,389
1872	140	89,600	1902	[a]17,202	2,234,994
1873	515	255,440	1903	34,430	661,400
1874	915	259,427	1904	45,647	608,810
1875	1,168	289,030	1905	46,384	1,019,158
1876	1,437	312,587	1906	58,173	1,132,410
1877	998	193,706	1907	59,413	1,200,913
1878	373	66,257	1908	22,200	1,117,000
1879	364	65,443	1909	18,628	1,163,960
1880	609	149,245	1910	16,828	1,177,960
1881	690	189,750	1911	50,945	1,456,672
1882	732	201,300	1912	42,135	1,122,713
1883	900	265,500	1913	55,051	1,491,530
1884	1,019	188,705	1914	62,500	1,483,500
1885	942	155,430	1915	67,004	1,663,521
1886	1,285	173,475	1916	103,523	2,409,375
1887	1,015	116,659	1917	109,944	2,561,955
1888	1,406	196,636	1918	88,772	1,967,905
1889	965	145,473	1919	66,791	1,717,192
1890	3,201	480,152	1920	127,065	2,794,206
1891	4,267	640,000	1921	50,136	1,096,328
1892	5,525	828,787	1922	[b]39,087	1,068,925
1893	3,955	593,292	1923	62,667	1,593,798
			Totals	1,975,679	$46,821,508

[a]Refined borax. [b]Recalculated to 46% 'anhydrous boric acid' equivalent beginning with 1922.

CALCIUM CHLORIDE.

Bibliography: U. S. Geol. Surv., Min. Res. 1919, Pt. II. Engineering and Contracting, Roads & Streets monthly issue, Feb. 6, 1924. 'How to Maintain Roads,' manual of instruction of Dow Chemical Company.

Calcium chloride is hygroscopic, that is, it has an affinity for water. This property is taken advantage of by utilizing this salt as a drying agent. It is also sprinkled on dirt roads and playgrounds to keep down dust by absorbing moisture. In refrigerating machinery for ice factories, meat-packing houses and cold-storage warehouses, a calcium-chloride solution is stated to have some advantages over salt brine. In fire buckets this solution has an advantage over pure water, in that it has a lower freezing point, does not corrode metal, and tends to keep the buckets full due to its absorbing moisture from the atmosphere. Powdered calcium chloride is used in drying gases, fruits and vegetables.

For dust prevention on roads, it is stated that the flake form of the chloride gives better results than the granulated. Immediately after spreading, the flake begins to absorb moisture from the air—"in fact,

absorbs three times its weight in water, dissolves itself into the surface material of the road, remains there, holds the moisture and prevents dust." It is recommended that the first application in the spring should be made as soon as the roads are partly dried and the spring rains over, in order to prevent the accumulation of the first dust during the season. From 1 to 2 pounds of flake chloride are used per square yard according to the nature of the road surface. Ordinarily a second application, of from ½ to 1 pound per square yard, should follow in from four to six weeks depending upon conditions; and sometimes a light, third application may be necessary during a long, dry summer. The most satisfactory method for applying large quantities of flake calcium chloride is to use an agricultural lime or fertilizer spreader attached by a short tongue to the rear of a truck. Excellent results are reported with the following kinds of road surfaces: gravel, water-bound gravel, water-bound macadam, sand-clay, clay-sand, cinders, mine tailings. It can not be used to advantage on roads of heavy clay, oil-treated surfaces, heavy rolling sand, or the ordinary dirt road which is composed almost entirely of fine dead material. The last named should first have a resurfacing or application of gravel.

A very important and growing use for calcium chloride is its application to curing concrete pavements instead of the slower and more expensive earth and water-covering method. It is stated that one application of the flake chloride will absorb a sufficient amount of moisture from the air to keep the pavement wet continuously 24 hours per day when properly applied. As soon as the newly laid concrete has taken on enough set to permit an application without marring the surface, the chloride should be spread on at the rate of 2 to 2½ pounds per square yard, depending upon the dryness of the weather. It should be evenly spread. There is no need of applying an earth covering and hence no subsequent earth removal, and no extra water pumping, thereby eliminating these items of expense. Not only that, but experience has proved that the time of set for the concrete is shortened by use of the chloride, so that pavements so treated can be opened to traffic in one-half the time required if cured by ponding or by earth and water. In the case of patching broken pavements, if calcium chloride is mixed in with the concrete as laid, in proper proportions, and a further application spread on the finished surface, the patched pavement can be opened to traffic in 48 hours without injury to the concrete.

Californian Production.

Commercial production of calcium chloride in California was first reported to the State Mining Bureau in 1921, from two plants in San Bernardino County, being obtained as a by-product in the refining of salt from deposits in certain of the desert dry lakes. In 1922 and 1923, there was only a single operator, so that the annual details are concealed under the 'unapportioned' item.

Year	Tons	Value
1921	683	$22,980
1922} *	1,204	26,580
1923}		
Totals	1,887	$49,560

*Annual details concealed under 'unapportioned,' on account of a single producer.

MAGNESIUM SALTS.

Bibliography: Bulletin 91. 'Dictionary of Applied Cheristry,' by Thorpe. U. S. Geol. Surv., Min. Res. of U. S.

The production of magnesium chloride and sulphate in California during 1923 totaled 3,662 tons, valued at $116,031, an increase both in quantity and value over the 1922 figures of 3,036 tons and $89,788. This was nearly all chloride, sold for use in magnesite stucco and cement mixtures (Sorel cement), and was prepared from residual bitterns at salt plants in Alameda, Los Angeles, San Diego, and San Mateo counties. It was in part marketed in the liquid form. With the use of magnesite cement and stucco coming more into vogue in building construction on the Pacific coast, the demand for magnesium chloride is increasing here; but the domestic article has to meet the competition of the cheaper, imported German chloride.

The average value reported for the chloride in 1923 was $31.60 per ton, f. o. b. plant.

Total Production of Magnesium Salts in California.

Commercial production of magnesium chloride in California was begun in 1916 by some of the salt companies, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride. In addition, some magnesium sulphate, or 'epsom salts' is also made, annually, but in smaller amount.

The total production of magnesium salts in California since the beginning of the industry here, is shown in the following tabulation:

Year	Tons	Value
1916	851	$6,407
1917	1,004	84,973
1918	1,008	29,955
1919	1,616	82,457
1920	3,150	107,787
1921	4,153	160,140
1922	3,036	89,788
1923	3,662	116,031
Totals	18,540	$673,538

NITRATES.

Bibliography: Report XV. Bulletins 24, 67, 91. U. S. G. S., Press Bulletin No. 373, July, 1918.

Nitrates of sodium, potassium and calcium have been found in various places in the desert regions of the state, but no deposit of commercial value has been developed as yet. It is hoped that a closer search may some day be rewarded by workable discoveries. At present the principal commercial source of nitrates is the Chilean saltpeter (sodium nitrate) deposits in South America.

The fixation of atmospheric nitrogen electrically has been accomplished successfully in Germany and Scandinavia. The possibilities of cheap hydro-electric power in California make the subject one of interest to us, as we have also the natural raw materials and chemicals to go with the power. Sodium and potassium cyanides can be made by fixation of atmospheric nitrogen electrically.

POTASH.

Bibliography: Reports XV, XVIII. Bulletins 24, 61. U. S. G. S., Min. Res. 1913, 1914, 1915. Senate Doc. No. 190, 62d Congress, 2d Session. Mining & Sci. Press, Vol. 112, p. 155; Vol. 114, p. 789. Eng. & Min. Jour.-Press, Vol. 117, p. 557, Apr. 5, 1924.

During 1923, a total of 29,597 tons of potash salts of all grades was produced in California, valued at $709,836, compared with 17,776 tons and $584,388 in 1922. This included potassium chloride from salt-works bitterns and from Searles Lake brine, and sulphate from portland-cement dust. The quality varied from 34% to 60.5% equivalent K_2O content, the salt being produced at plants in San Bernardino, San Mateo, and Santa Cruz counties. Some potassium chloride was also made at one plant in Alameda County, but not sold as it is intended to convert it into other forms. The product sold was utilized for the manufacture of fertilizers.

Imports of crude potash into the United States in 1923, according to the U. S. Geological Survey, amounted to 748,101 short tons, containing 209,581 short tons of K_2O, valued at $15,354,755. Of this amount 712,441 short tons of crude potash, containing 194,079 short tons of K_2O, valued at $10,624,475 were salts used mainly in the fertilizer industry. Germany and France are the foreign sources of supply.

According to MacDowell[1]

"The principal potash salts used in commercial fertilizer mixtures and the basis on which they are sold are as follows:

	Purity in per cent	Sold on basis in per cent	Form
Muriate of potash	80-85	80 KCl	Potassium chloride
Sulphate of potash	90-95	90 K_2SO_4	Potassium sulphate
Double manure salt	48-52	48 K_2SO_4	Potassium sulphate
Manure salt	30	30 K_2O	Double salt of magnesium and potassium chloride
Manure salt	20	20 K_2O	Double salt of magnesium and potassium chloride
Kainite	12.4 K_2O		Mostly potassium chloride

"The above salts are in crystallized form, of standard analysis. In the higher grades of muriate and sulphate, material is in the form of very fine crystals barely detectable by the eye. In the lower grades of manure salt and kainite the crystals are larger, the material being ground to pass a 4-mesh screen.

* * * * * * *

"The records of the Potash Syndicate in Germany indicate that production of K_2O during the last eight years varied from 356,056 metric tons in 1915 to 614,834 metric tons in 1922. These figures represent minimum and maximum yearly production.

"Prices on potash for fertilizers over a period of years, exclusive of the war, have been maintained on a fairly uniform basis. The net cost to the manufacturer over a period of years has not varied, excepting during the war, as much as other raw materials. Kainite testing 12.4 per cent of potash has varied from $5.50 to $9 per ton; 20 per cent manure salts from $7.50 to $12 per ton; muriate from $30 to $36 per ton, basis 80 per cent; sulphate from $40 to $46 per ton, basis 90 per cent. At the present time the Germans have a practical monopoly on the manufacture of sulphate of potash, as little kieserit is found in the Alsatian field. Owing to the high cost of fuel and labor, they have recently increased the price $2.25 per ton. During the war, domestic potash sold at from $4 to $5 a unit K_2O. German muriate as high as $500 a ton and sulphate at $400 a ton. There is no indication on the sellers' part of raising prices still further, and unless the German and French producers reach an agreement, which does not now seem probable, the potash requirements of the fertilizer industry seem assured for the present at a comparatively low price."

[1]MacDowell, C. H., Marketing of potash: Eng. & Min. Jour.-Press, Vol. 117, p. 558, Apr. 5, 1924.

Other uses for potash salts, besides those noted above, are in the manufacture of the best liquid soap and some higher-grade cake soaps, of some finer grades of glass, and in matches. The chemical requirements included tanning, dyeing, metallurgy, electroplating, photography, and medicine.

Total Production of Potash in California.

Potash production began commercially in California in 1914, with a small yield from kelp. Considerable time and money has been spent on research work incident to developing deposits of potash-bearing residues and brines in the old lake beds of the desert regions, and production there has been accomplished on a commercial scale at plants on Searles Lake, San Bernardino County. Some is also made annually from salt-works bitterns, and from portland-cement dust, as above noted.

The annual amounts and value of these potash materials since their beginning in California in 1914, are shown by the following table:

Year	Tons	Value
1914	10	$460
1915	1,076	19,391
1916	17,908	663,605
1917	129,022	4,202,889
1918	49,881	6,808,976
1919	28,118	2,415,963
1920	26,286	1,465,463
1921	14,506	390,210
1922	17,776	584,288
1923	29,397	709,836
Totals	313,902	$17,267,181

SALT.

Bibliography: State Mineralogist Reports II, XII–XV (inc.), XVII-XX (inc.); Bulletins 24, 67, 91. U. S. Geol. Surv., Bull. 669. U. S. Bur. of Mines, Bull. 146.

Most of the salt production in California is obtained by evaporating the water of the Pacific Ocean, plants being located on the shores of San Francisco, Monterey and San Diego bays, and at Long Beach. Additional amounts are derived from lakes and lake beds in the desert regions, mainly in Kern and San Bernardino counties. A small amount of valuable medicinal salts is obtained by evaporation of the water of Mono Lake, Mono County.

Distribution of the 1923 salt production of California, by counties, was as follows:

County	Tons	Value
Alameda	177,389	$585,585
Kern	18,921	97,336
San Bernardino	17,350	65,550
San Mateo	35,767	199,192
Los Angeles, Mono, Monterey, San Diego*	26,562	183,007
Totals	275,979	$1,130,670

Medicinal salts. *Combined to conceal output of a single operator in each.

The above returns show an increase both in tonnage and value over the 1922 figures, establishing a new record for this industry in California. There were eight plants operating in Alameda County, and a total of ten plants in the other counties tabulated, being a decrease of four from the total number operated in 1922. The outlook for the current year, 1924, is that there will be an overproduction in the San Francisco Bay district at least, due to the dry season.

Production of Salt in California, by Years.

Amount and value of annual production of salt in California from 1887 is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	28,000	$112,000	1906	101,650	$213,228
1888	30,800	92,400	1907	88,063	310,967
1889	21,000	63,000	1908	121,764	281,469
1890	8,729	57,085	1909	155,680	414,708
1891	20,094	90,303	1910	174,920	395,417
1892	23,570	104,788	1911	173,832	324,255
1893	50,500	213,000	1912	185,721	383,370
1894	49,131	140,087	1913	204,407	462,681
1895	53,031	150,576	1914	223,806	583,553
1896	64,743	153,244	1915	189,028	368,737
1897	67,851	157,620	1916	186,148	455,694
1898	93,421	170,555	1917	227,825	584,373
1899	82,654	149,588	1918	212,076	806,328
1900	89,338	204,764	1919	233,904	896,963
1901	126,218	366,376	1920	230,638	972,648
1902	115,208	295,876	1921	197,989	832,702
1903	102,895	211,365	1922	223,238	819,187
1904	95,968	187,300	1923	275,979	1,130,670
1905	77,118	141,925	Totals	4,386,527	$13,208,993

SODA.

Bibliography: State Mineralogist Reports XII, XIII, XV, XVII, XVIII, XX; Bulletins 24, 67, 91. U. S. Geol. Surv. Bull. 717.

The production of natural carbonates and sulphate of sodium in California in 1923 included: soda ash and bicarbonate from plants at Owens Lake, Inyo County; trona ('sesqui-carbonate,' a double salt of Na_2CO_3 and $NaHCO_3$) from Searles Lake, San Bernardino County; and salt cake (sodium sulphate) from the Salton Basin, Imperial County, and from the Carrizo Plains, San Luis Obispo County. The Salton Basin mineral is the anhydrous sulphate, thenardite (Na_2SO_4). The total amounted to 34,885 tons, valued at $764,284, being an increase both in tonnage and value over the 1922 figures of 20,084 tons and $573,661.

The dense ash and bicarbonate were used in the manufacture of soap, sal soda, glass, and chemicals; the salt cake, by pulp mills and in glass making; and the trona for neutralizing, in flotation concentration.

Sodium compounds are replacing potassium compounds, either wholly or in part, in glass and soap making, in photography, in match making, in tanning, and in the manufacture of cyanide for extracting gold and silver from their ores.

Soda Production of California, by Years.

The total output, showing amount and value of these materials in California since the inception of the statistical records of the State Mining Bureau, is given in the table which follows:

Year	Tons	Value	Year	Tons	Value
1894	1,530	$20,000	1910	8,125	$11,862
1895	1,900	47,500	1911	9,023	52,887
1896	3,000	65,000	1912	7,200	37,094
1897	5,000	110,000	1913	1,861	24,936
1898	7,000	154,000	1914	6,522	115,396
1899	10,000	250,000	1915	5,799	83,485
1900	1,000	50,000	1916	10,593	264,825
1901	8,000	400,000	1917	24,505	928,578
1902	7,000	50,000	1918	20,447	855,428
1903	18,000	27,000	1919	21,294	721,958
1904	12,000	18,000	1920	32,407	1,164,898
1905	15,000	22,500	1921	14,828	438,996
1906	12,000	18,000	1922	20,084	573,601
1907			1923	34,885	784,284
1908	9,600	14,400			
1909	7,712	11,593	Totals	336,315	$7,296,276

CHAPTER SEVEN.

BY COUNTIES.

Introductory.

The State of California includes a total area of 158,360 square miles, of which 155,980 square miles are of land. The maximum width is 235 miles, the minimum, 148 miles; and the length from the northwest corner to the southeast corner is 775 miles. The state is divided into fifty-eight counties. The 1920 census figures show a total population for California of 3,437,709. Minerals of commercial value exist in every county, and during 1923 some active production was reported to the State Mining Bureau from all but one of the fifty-eight.

Of the first ten counties in point of total output for 1923, the first three, Los Angeles, Orange, Kern owe their position mainly to petroleum, as do also Santa Barbara (sixth), Fresno (seventh), Ventura (eighth). Los Angeles, due to its oil, leads all the others, being credited with practically 50% of the entire state's total for 1923, having passed Kern which has led for many years. San Bernardino owes its place chiefly to cement, silver, potash, and borax; Riverside to cement, brick and tile; Santa Cruz to cement; Plumas to copper; Yuba to gold. Twenty-two counties have each a total in excess of a million dollars for 1923. Cement is an important item in seven of these counties, and magnesite in one. In point of variety and diversity, San Bernardino County led all the others in 1923, with a total of 20 different mineral products on its commercial list, followed by San Diego and Los Angeles with 17 each; Inyo with 16; Kern, 15; Riverside, 14; Shasta, 13, Nevada, 11; Calaveras, Fresno, Orange, Santa Clara, 10 each; Butte, Monterey, Placer, Santa Barbara, and Tuolumne, 9 each. The counties with their mineral resources, production for 1923, etc., are considered in detail in the following paragraphs.

Value of California's Mineral Production by Counties for 1923. Arranged in the Order of Their Importance.

County	Value	County	Value
1. Los Angeles	$174,367,459	31. Placer	$494,513
2. Orange	46,468,989	32. Tulare	466,559
3. Kern	47,812,415	33. Stanislaus	445,515
4. San Bernardino	13,777,253	34. Humboldt	434,708
5. Riverside	7,093,853	35. Napa	351,593
6. Santa Barbara	5,005,872	36. San Mateo	329,816
7. Fresno	4,883,331	37. Imperial	264,783
8. Ventura	4,679,684	38. Merced	235,630
9. Santa Cruz	4,225,905	39. Sonoma	227,812
10. Plumas	3,784,262	40. Monterey	222,022
11. Yuba	3,391,129	41. El Dorado	216,065
12. Solano	3,276,885	42. Siskiyou	181,011
13. Inyo	2,845,581	43. Mariposa	170,911
14. Contra Costa	2,672,944	44. San Luis Obispo	145,249
15. Alameda	2,487,035	45. San Francisco	117,841
16. Sacramento	2,436,015	46. Glenn	113,282
17. Nevada	2,370,770	47. Lake	101,038
18. San Benito	2,277,903	48. Mono	92,791
19. Amador	1,955,874	49. Colusa	75,000
20. Shasta	1,563,387	50. Mendocino	53,410
21. Calaveras	1,498,119	51. Del Norte	34,027
22. Santa Clara	1,320,393	52. Yolo	16,957
23. Sierra	886,610	53. Modoc	8,397
24. Butte	847,948	54. Lassen	7,840
25. San Diego	821,796	55. Tehama	6,216
26. San Joaquin	811,229	56. Kings	1,555
27. Marin	688,881	57. Sutter	97
28. Trinity	677,174	58. Alpine	
29. Tuolumne	670,362		
30. Madera	518,085	Total	$344,024,678

ALAMEDA.

Area: 843 square miles.
Population: 344,177 (1920 census).
Location: East side of San Francisco Bay.

Alameda County, while in no sense one of the 'mining counties,' comes fifteenth on the list with a value of mineral products for 1923 of $2,487,035, an increase over the 1922 total, which was $2,041,454. The mineral resources of this county include asbestos, brick, chromite, clay, coal, limestone, magnesite, manganese, pyrite, salt, soapstone, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Brick and tile		$828,048
Clay (pottery)	3,850 tons	10,422
Salt	177,289 tons	586,586
Stone, miscellaneous		965,465
Other minerals*		97,515
Total value		$2,487,035

*Includes Magnesium salts, pyrites.

ALPINE.

Area: 776 square miles.
Population: 243 (1920 census).
Location: On eastern border of state, south of Lake Tahoe.

Alpine has at times in the past shown a small production mainly of gold and silver. For 1923 there was no commercial production.

This county lies just south of Lake Tahoe, in the high Sierra Nevada range of mountains. Transportation is by auto, wagon, or mule back, and facilities in general are lacking to promote development work of any kind.

The mineral resources of this section are varied and the country has not yet been thoroughly prospected. Occurrences of barium, copper, gold, gypsum, lead, limestone, pyrite, rose quartz, silver, tourmaline, and zinc have been noted here.

AMADOR.

Area: 601 square miles.
Population: 7,793 (1920 census).
Location: East-central part of state—Mother Lode district.

The value of Amador County's mineral production decreased from $2,479,063 in 1922 to $1,955,874, placing it number nineteen on the list of counties in the state as regards total value of mineral substances marketed. The drop was due mainly to gold.

Although having an output consisting of 7 different minerals, the leading product, gold, makes up approximately 89% of the entire total.

Amador at one time led the state in gold production, but was exceeded in 1920-1923 by Yuba and Nevada counties.

The mineral resources of this county include asbestos, brick, chromite, clay, coal, copper, gold, lime, quartz crystals, glass-sand, sandstone, silver, soapstone, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Clay (pottery)	45,887 tons	$58,196
Gold		1,734,133
Silver		15,158
Stone, miscellaneous		28,515
Other minerals*		119,877
Total value		$1,955,874

BUTTE.

Area: 1,722 square miles.
Population: 30,030 (1920 census).
Location: North-central portion of state.

Butte, twenty-fourth county in California in regard to the value of its mineral output, reported a commercial production of nine mineral substances, having a total value of $841,948 as compared with $720,625 in 1922. As will be noted in the following tabulation, gold is by far the most important item. Butte stands eighth among the gold-producing counties of the state. Among the mineral resources of this section are asbestos, barytes, chromite, gems, gold, limestone, marble, mineral water, platinum group, silver, and miscellaneous stone.

Commercial value for 1923 was as follows:

Substance	Amount	Value
Gold		$487,393
Mineral water	3,700 gals.	3,300
Platinum	19 fine oz.	2,601
Silver		1,756
Miscellaneous stone		340,250
Other minerals*		6,648
Total value		$841,948

*Includes diamonds, natural gas, soapstone.

CALAVERAS.

Area: 1,027 square miles.
Population: 6,183 (1920 census).
Location: East-central portion of state—Mother Lode district.

Calaveras County reported production of 10 different minerals, valued at $1,498,119 during the year 1923 as compared with the 1922 output of $1,502,883. Gold, copper, and silver are the chief mineral substances. In regard to total value of mineral output, Calaveras stands twenty-first among the counties of the state, and fifth in gold. The decrease, as compared with 1922, is due mainly to gold.

The principal mineral resources developed and undeveloped are: Asbestos, chromite, clay, copper, fullers' earth, gold, limestone, marble, mineral paint, mineral water, platinum group, pyrite, quartz crystals, silver, soapstone, and miscellaneous stone.

Commercial output for 1923 was as follows:

Substance	Amount	Value
Copper	1,598,776 pounds	$235,020
Gold		1,205,784
Mineral water	1,626 gals.	569
Silver		7,316
Stone, miscellaneous		39,825
Other minerals*		9,605
Total value		$1,498,119

*Includes clay (pottery), crystal quartz, lead, platinum.

COLUSA.

Area: 1,140 square miles.
Population: 9,920 (1920 census).
Location: Sacramento Valley.

Colusa County lies largely in the basin of the Sacramento Valley. Its western border, however, rises into the foothills of the Coast Range

of mountains, and its mineral resources—largely undeveloped—include coal, chromite, copper, gypsum, manganese, mineral water, pyrite, quicksilver, sandstone, miscellaneous stone, sulphur, and in some places traces of gold and silver.

The value of the 1923 production was $75,000, a slight decrease from the 1922 figures of 75,934, giving it forty-ninth place, and was as follows:

Substance	Value
Stone, miscellaneous	$75,000

CONTRA COSTA.

Area: 714 square miles.
Population: 53,889 (1920 census).
Location: East side of San Francisco Bay.

Contra Costa, like Alameda County, lies on the eastern shores of San Francisco Bay, and is not commonly considered among the mineral-producing counties of the state. It stands fourteenth on the list in this respect, however, with an output valued at $2,672,944 for the calendar year 1923. Various structural materials make up the chief items, including brick, cement, limestone, and miscellaneous stone. Among the others are asbestos, clay, coal, gypsum, manganese, mineral water, and soapstone.

Commercial production for 1923 was as follows:

Substance	Value
Clay and clay products	$281,742
Stone, miscellaneous	629,316
Other minerals*	1,761,886
Total value	$2,672,944

*Includes cement, limestone, mineral water.

DEL NORTE

Area: 1,024 square miles.
Population: 2,759 (1920 census).
Location: Extreme northwest corner of state.
Transportation: Motor, wagon and mule back; steamer from Crescent City.

Del Norte almost rivals Alpine County in regard to inaccessibility. Like the latter county also, given transportation and kindred facilities, this portion of the state presents a wide field for development along mining lines especially. Its chief mineral resources, largely untouched, are chromite, copper, gems, gold, iron, platinum group, silver, and miscellaneous stone. The 1923 output was an increase over the figure of $6,261 in 1922, due to crushed rock used on highway construction.

Commercial production for 1923, giving it fifty-first place, was as follows:

Substance	Value
Gold	$1,778
Silver	9
Stone, miscellaneous	31,368
Other minerals*	872
Total value	$34,027

*Includes copper and platinum.

EL DORADO.

Area: 1,753 square miles.
Population: 6,426 (1920 census).
Location: East-central portion of the state, northernmost of the Mother Lode counties.

El Dorado County, which contains the locality where gold in California was first heralded to the world, comes forty-first on the list of counties ranked according to the value of their total mineral production during the year 1923. In addition to the segregated figures here given, a large tonnage of limestone is annually shipped from El Dorado for use in cement manufacture, and whose value is included in the state total for cement. The increase over the 1922 figure of $184,525 was due to limestone.

The mineral resources of this section, many of them undeveloped, include asbestos, barytes, chromite, clay, copper, gems, gold, iron, molybdenum, limestone, quartz crystals, quicksilver, slate, soapstone, silver, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Gold		$30,264
Limestone	95,274 tons	163,287
Silver		185
Soapstone	2,670 tons	15,729
Stone, miscellaneous		5,900
Total value		$216,065

FRESNO.

Area: 5,950 square miles.
Population: 128,779 (1920 census).
Location: South-central portion of state.

Fresno County, seventh in importance as a mineral producer among the counties of California, reported an output for 1923 of ten mineral substances, with a total value of $4,883,331, a decrease from the reported 1922 production, which was worth $10,853,433. The bulk of the above is derived from the petroleum production of the Coalinga field, with miscellaneous stone also important.

The mineral resources of this county are many, and, aside from crude oil, are in the main not fully developed. They include asbestos, barytes, brick, chromite, copper, gems, gold, graphite, gypsum, magnesite, natural gas, petroleum, quicksilver, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Clay and clay products		$317,880
Gold		18,519
Granite		84,920
Natural gas	1,599,354 M	122,702
Petroleum	5,061,542 bbls.	3,593,695
Silver		125
Stone, miscellaneous		863,087
Other minerals		2,400
Total value		$4,883,331

GLENN.

Area: 1,259 square miles.
Population: 11,853 (1920 census).
Location: West side of Sacramento Valley.

Glenn County, standing forty-sixth, owes its position among the mineral-producing counties of the state mainly to the presence of large deposits of sand and gravel which are annually worked, the product being used for railroad ballast, etc. In 1917 and 1918, chromite was also an important item. In the foothills in the western portion of the county, deposits of chromite, copper, manganese, sandstone, and soapstone have been found.

Commercial production for 1923 was as follows, being an increase over the $91,250 of the previous year:

Substance	Value
Stone, miscellaneous	$113,282

HUMBOLDT.

Area: 3,634 square miles.
Population: 37,857 (1920 census).
Location: Northwestern portion of state, bordering on Pacific Ocean.

Humboldt County is almost entirely mountainous, transportation within its limits being very largely by auto and wagon road, and trail, and until recent years was reached from the outside world by steamer only. The county is rich in mineral resources, among which are brick, chromite, coal, clay, copper, gold, iron, mineral water, natural gas, petroleum, platinum, silver, and miscellaneous stone.

Nine mineral substances, as shown by the table given below, having a total value of $434,706, were produced in 1923, as compared with the 1922 output, worth $125,613, the increase being due to the large amount of rock being used in jetty construction at Humboldt Bay (Eureka Harbor). Humboldt ranks thirty-fourth among the counties of the state for the year.

Commercial production for 1923 was as follows:

Substance	Value
Gold	$2,360
Silver	12
Stone, miscellaneous	422,619
Other minerals*	9,915
Total value	$434,706

*Includes clay and clay products, mineral water, natural gas, platinum.

IMPERIAL.

Area: 4,089 square miles.
Population: 43,383 (1920 census).
Location: Extreme southeast corner of the state.

During 1923 Imperial County produced eight mineral substances having a total value of $264,733, as compared with the 1922 output, worth $188,739. Its rank is thirty-seventh. This county contains

deposits of gold, gypsum, lead, marble, pumice, salt, silver, sodium, and strontium, largely undeveloped.

Commercial production for 1923 was as follows:

Substance	Value
Stone, miscellaneous	$101,833
Other minerals*	162,900
Total value	$264,733

*Includes brick, gold, gypsum, pumice, silver, soda (salt cake).

INYO.

Area: 10,019 square miles.
Population: 7,031 (1920 census).
Location: Lies on eastern border of state, north of San Bernardino County.

Inyo, the second largest county in the state, and containing less than one inhabitant per square mile, is extremely interesting from a mineralogical point of view. It is noted because of the fact that within its borders are located both the highest point, Mount Whitney (elevation 14,502 feet), and the lowest point, Death Valley (elevation 290 feet below sea level), in the United States. In the higher mountainous sections are found many vein-forming minerals, and in the lake beds of Death Valley saline deposits exist.

Inyo's mineral production during the year 1923 reached a value of $2,845,581, standing thirteenth among the counties of the state in this respect. The 1922 value was $2,137,681, the increase being due mainly to lead, borates, silver, and soda. Its mineral resources include antimony, asbestos, barytes, borates, copper, gems, gold, gypsum, lead, marble, soda, sulphur, talc, tungsten, and zinc.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Copper	77,349 lbs.	$11,370
Dolomite	47,542 tons	79,792
Gold		86,702
Lead	9,541,868 lbs.	667,981
Silver		265,023
Talc	5,981 tons	104,976
Soda	24,116 tons	863,747
Stone, miscellaneous		19,500
Other minerals*		227,339
Total value		$2,845,581

*Includes building stone, borates, fuller's earth, gems, marble, pumice (ash), tungsten concentrates.

KERN.

Area: 8,003 square miles.
Population: 54,843 (1920 census).
Location: South-central portion of state.

Kern County, because of its immensely productive oil fields, for many years stood preeminent among all counties of California in the value of its mineral output, the exact figures for 1923 being $41,812,415. This was surpassed by both Los Angeles and Orange counties in 1923, for which petroleum is also responsible. The 1922 mineral output for Kern County was worth $68,551,002. The decrease was due to the lower prices for crude oil of all grades, and to the fact that a large

number of wells in the San Joaquin valley fields were 'shut in' owing to the over-production of high-gravity oil in the new gusher fields of the Los Angeles basin.

Among the mineral resources, developed and undeveloped, of this section are: Antimony, asphalt, borax, brick, clay, copper, fuller's earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, salt, silver, soapstone, soda, sulphur, and tungsten.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Brick	5,271 M	$65,375
Gold		197,051
Lime	17,985 tons	214,188
Natural gas	42,421,592 M	2,051,656
Petroleum	45,952,794 bbls.	37,629,300
Salt	18,921 tons	97,336
Silver		53,151
Stone, miscellaneous		9,325
Other minerals*		1,602,133
Total value		$41,812,415

*Includes clay (pottery), cement, gypsum, limestone, pumice (ash), sulphur.

KINGS.

Area: 1,159 square miles.
Population: 22,031 (1920 census).
Location: South-central portion of the state.

Little development has taken place in Kings County along mineral lines to date. Deposits of fuller's earth, gypsum, mineral paint, natural gas, and quicksilver, of undetermined extent, have been found in the county. Some drilling for oil has been under way, but there has, as yet, been no commercial output recorded.

Tulare Lake is in Kings County, though now largely drained, and the land under cultivation.

In fifty-sixth place, commercial mineral production in this county for 1923 was as follows:

Substance	Amount	Value
Natural gas	1,990 M	$970
Other minerals		585
Total value		$1,555

LAKE.

Area: 1,278 square miles.
Population: 5,542 (1920 census).
Location: About fifty miles north of San Francisco Bay and the same distance inland from the Pacific Ocean.

On account of its topography and natural beauties, Lake County is sometimes referred to as the Switzerland of America. The mineral resources which exist here are many and varied, actual production being comparatively small, as shown by the table below, and in the past composed mainly of quicksilver, and mineral water. Some of the leading minerals found in this section, in part as yet undeveloped, are

borax, chromite, clay, copper, gems, gold, gypsum, mineral water, quicksilver, silver, and sulphur.

In forty-seventh place, commercial production for 1923 was as follows:

Substance	Amount	Value
Mineral water	63,730 gals.	$4,738
Quicksilver	17 flasks	1,050
Stone, miscellaneous		55,000
Other minerals		250
Total value		$101,038

LASSEN.

Area: 4,531 square miles.
Population: 8,507 (1920 census).
Location: Northeast portion of state.

Lassen County is one of the little-explored sections of California. Since about 1912 a railroad traversing the county north and south has been in operation, thus affording opportunity for development along mineral and other lines.

Among the mineral resources of this county are copper, gems, gypsum, gold, silver, and sulphur. In the past, some gold had been produced, but not for some years, until 1921, when the yield again became important. In fifty-fourth place, commercial production for 1923 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$7,600
Other minerals*		240
Total value		$7,840

*Includes gold and silver.

LOS ANGELES.

Area: 4,067 square miles.
Population: 936,438 (1920 census).
Location: One of the southwestern coast counties.

Mineral production in Los Angeles County for the year 1923 amounted in value to $174,367,459 as compared with the 1922 output, worth $62,751,671. This increase to nearly three times the value of the preceding year accounts for practically 50% of the entire state's total for 1923, and ranks Los Angeles County first in the state as a mineral producer, having passed Kern County which has been leading for several years. The advance was due to the large increase in the petroleum yield, and also in part to an increase in the output of bricks, building tile, natural gas, and miscellaneous stone.

Its output of brick and tile was nearly nine million dollars, and that of petroleum amounted to over one hundred and fifty-four million dollars. Among the mineral resources may be noted asphalt, barytes, borax, brick, clay, fuller's earth, gems, gold, gypsum, infusorial earth, limestone, marble, mineral paint, mineral water, natural gas, petroleum, salt, glass-sand, sandstone, serpentine, silver, soapstone, and miscellaneous stone. Some potash has been obtained from kelp.

Commercial production for 1923, consisting of 17 substances, was as follows:

Substance	Amount	Value
Brick	310,897 M	$5,307,968
Building stone	----------	40,000
Building tile	58,199 tons	522,890
Clay (pottery)	128,825 tons	59,272
Gold	----------	714
Limestone marl	2,717 tons	8,779
Mineral water	440,568 gals.	24,787
Natural gas	134,799,452 M	8,760,961
Petroleum	158,666,019 bbls.	154,063,733
Silver	----------	6
Stone, miscellaneous	----------	5,408,808
Other minerals*	----------	169,641
Total value		$174,367,459

*Includes borates, diatomaceous earth, magnesium chloride, salt, silica, soapstone.

MADERA.

Area: 2,112 square miles.
Population: 12,203 (1920 census).
Location: East-central portion of state.

Madera County produced five mineral substances during the year 1923, having a total value of $518,053, as compared with the 1922 output worth $476,264. This county contains deposits of copper, gold, granite, iron, lead, molybdenum, pumice, silver, and building stone.

In thirtieth place, commercial production for 1923 was as follows:

Substance	Value
Gold	$12,074
Granite	486,670
Silver	541
Other minerals	18,750
Total value	$518,035

MARIN.

Area: 529 square miles.
Population: 27,342 (1920 census).
Location: Adjoins San Francisco on the north.

Mineral production in Marin County during the year 1923 reached a value of $688,881, as compared to the 1922 output, worth $403,099, the increase being due to crushed rock, and brick. This county is not especially prolific in minerals, although among its resources along these lines are brick, gems, manganese, mineral water, soapstone, and miscellaneous stone.

In twenty-seventh place, commercial production for 1923 was:

Substance	Value
Stone, miscellaneous	$516,936
Other minerals*	171,945
Total value	$688,881

*Includes brick, clay, mineral water.

MARIPOSA.

Area: 1,463 square miles.
Population: 2,775 (1920 census).
Location: Most southerly of the Mother Lode counties. East-central portion of state.

Mariposa County is one of the distinctly 'mining' counties of the state, although it stands but forty-third on the list of counties in regard to the value of its mineral output for 1923 with a total of $170,911, as compared with the 1922 figure of $226,832, the decrease being due to gold.

Its mineral resources are varied; among the more important items being barytes, copper, gems, gold, lead, marble, silver, slate, soapstone, and miscellaneous stone.

The Yosemite Valley is in Mariposa County.

Commercial production in 1923 was as follows:

Substance	Value
Gold	$141,883
Silver	1,735
Stone, miscellaneous	22,200
Other minerals*	5,093
Total value	$170,911

*Includes barytes and pyrites.

MENDOCINO.

Area: 3,453 square miles.
Population: 24,116 (1920 census).
Location: Joins Humboldt County on the south and bounded by the Pacific Ocean on the west.

Mendocino's annual mineral production has usually been small, the 1923 output being valued at $53,410, ranking it fiftieth among the counties. That of 1922 was worth $20,526.

Deposits of in part undetermined value of asbestos, chromite, coal, copper, graphite, magnesite, and mineral water have been found, as well as traces of gold, platinum, and silver.

Commercial production for 1923 was as follows:

Substance	Value
Stone, miscellaneous	$48,360
Other minerals*	5,050
Total value	$53,410

*Includes coal and natural gas.

MERCED.

Area: 1,995 square miles.
Population: 24,579 (1920 census).
Location: About the geographical center of the state.

Merced County as a whole lies in the San Joaquin Valley, and it figures as one of the lesser mineral producing counties of the state.

The 1923 mineral output was valued at $235,630 compared with $157,579 in 1922, the increase being due to building tile and miscellaneous stone. Gold, platinum, and silver were formerly obtained in important amounts by dredging, which ceased in this county in 1918, though a small yield from other sources still continues. Undeveloped deposits of antimony, magnesite, quicksilver, and limestone have been noted in this county in addition to the foregoing.

In thirty-eighth place, commercial production during 1923 was as follows:

Substance	Value
Stone, miscellaneous	$134,063
Other minerals*	101,567
Total value	$235,630

*Includes brick, building tile, gold, silver.

MODOC.

Area: 3,823 square miles.
Population: 5,425 (1920 census).
Location: The extreme northeast corner of the state.

Modoc County, like Lassen, has only in recent years had the benefit of communication with the outside world by rail. Among its known mineral resources are: Clay, coal, gold, iron, quicksilver, salt, and silver. In fifty-third place, commercial production for 1923 was as follows:

Substance	Value
Stone, miscellaneous	$8,109
Other minerals*	288
Total value	$8,397

*Includes gold and silver.

MONO.

Area: 3,030 square miles.
Population: 960 (1920 census).
Location: Is bordered by the State of Nevada on the east and is about in the central portion of the state measured on a north and south line.

Gold mining has been carried on in portions of Mono County for many years, although taken as a whole it lies in a somewhat inaccessible country so far as rail transportation is concerned. It is in the continuation of the highly mineralized belt which was noted in Inyo County and contains among other mineral resources barytes, clay, copper, gold, limestone, molybdenum, pumice, salt, silver, and travertine.

In forty-eighth place, commercial production for 1923 was as follows:

Substance	Value
Gold	$34,661
Silver	3,120
Stone, miscellaneous	10,000
Other minerals*	45,010
Total value	$92,791

*Includes andalusite, onyx, salt (medicinal).

MONTEREY.

Area: 3,330 square miles.
Population: 27,980 (1920 census).
Location: West-central portion of state, bordering on Pacific Ocean.

Monterey County produced nine mineral substances during the year 1923, having a total value of $222,022, as compared with the 1922 output worth $255,319, the decrease being due to coal, although dolomite and miscellaneous stone made material advances. Its mineral resources include brick, clay, copper, coal, dolomite, feldspar, fuller's earth, gold, gypsum, infusorial earth, limestone, mineral water, petroleum, quicksilver, glass-sand, sandstone, silver, and miscellaneous stone.

In fortieth place, commercial production for 1923 was as follows:

Substance	Value
Stone, miscellaneous†	$140,724
Other minerals*	81,298
Total value	$222,022

†Includes molding, building, blast, filter, stucco, and roofing sand.
*Includes asbestos, diatomaceous earth, dolomite, mineral water, quicksilver, salt, silica (glass-sand).

NAPA.

Area: 783 square miles.
Population: 20,678 (1920 census).
Location: Directly north of San Francisco Bay—one of the 'bay counties.'

Napa, because of its production of structural and industrial materials and mineral water, stands thirty-fifth on the list of mineral-producing counties in California. Its mineral resources include chromite, copper, gypsum, magnesite, mineral water, quicksilver, sandstone, and miscellaneous stone. In the past this county has been one of the important producers of quicksilver.

In 1923 the value of the output increased to $351,592 over the 1922 figure of $312,270, due mainly to miscellaneous stone and magnesite.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Mineral water	69,639 gals.	$55,757
Quicksilver	157 flasks	9,759
Stone, miscellaneous	----------	215,356
Other minerals	----------	70,720
Total value		$351,592

NEVADA.

Area: 974 square miles.
Population: 10,860 (1920 census).
Location: North of Lake Tahoe, on the eastern border of the state.

Nevada, one of the mountain counties of California, for some years alternated with Amador in the gold lead, but both were passed by Yuba in 1918–1921, also 1923. In 1922, Nevada again led. Nevada County stands seventeenth on the list in regard to value of its total

mineral output, with a figure of $2,370,770 as compared with the 1922 production worth $2,966,005. The decrease is due mainly to gold.

While this county actually produces mainly gold and silver, its resources cover a wide scope, including antimony, asbestos, barytes, bismuth, chromite, clay, copper, gems, iron, lead, mineral paint, pyrite, soapstone, and tungsten.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Gold		$2,282,155
Lead	1,290 lbs.	90
Silver		30,534
Stone, miscellaneous		43,309
Other minerals*		15,682
Total value		$2,370,770

*Includes asbestos, barytes, copper, granite, mineral paint, platinum.

ORANGE.

Area: 795 square miles.
Population: 61,375 (1920 census).
Location: Southwestern portion of state, bordering Pacific Ocean.

Orange County is one of the many in California which on casual inspection appears to be anything but a mineral-producing section. It stood for several years, however, as the second county in the state in regard to the total value of mineral output, on account of its highly productive oil fields. It was passed in 1922 by Los Angeles, the credit for which is also due to oil, and in turn Orange passed Kern County in 1923.

This county shows an increase in 1923, with a total value of mineral products of $45,468,989, compared to the 1922 output, worth $38,926,087. Orange passed Shasta County in 1917, which previously for a number of years had exceeded all other counties in California, except Kern.

Aside from the substances actually produced and noted in the table below, coal, gypsum, iron, infusorial earth, sandstone, and tourmaline have been found in Orange County.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Brick	8,499 M	$103,428
Natural gas	55,477,147 M	3,914,661
Petroleum	46,474,931 bbls.	40,897,930
Stone, miscellaneous		536,767
Other minerals*		16,203
Total value		$45,468,989

*Includes clay (pottery), copper, gold, lead, silver.

PLACER.

Area: 1,395 square miles.
Population: 18,584 (1920 census).
Location: Eastern border of state directly west of Lake Tahoe.

While standing only thirty-first on the list of mineral-producing counties, Placer contains a wide variety of mineral substances, some of which have not been commercially exploited. Its leading products include gold, chromite, granite, copper, and clay. Other mineral resources are: Asbestos, brick, coal, gems, iron, lead, limestone, mag-

nesite, manganese, marble, quartz crystals, glass-sand, silver, and miscellaneous stone.

Commercial production for 1923 was as follows, compared to a total value of $405,975 for the preceding year:

Substance	Amount	Value
Clay (pottery)	82,919 tons	$143,697
Gold	----------	75,732
Granite	----------	5,146
Silica (quartz)	3,656 tons	10,040
Silver	----------	297
Stone, miscellaneous	----------	139,829
Other minerals*	----------	120,372
Total value		$494,513

*Includes brick, building tile, chromite.

PLUMAS.

Area: 2,594 square miles.
Population: 5,681 (1920 census).
Location: Northeastern border of state, south of Lassen County.

A considerable portion of the area of Plumas County lies in the high mountain, and deposits of the metals, especially gold and copper, are found there. Lack of transportation and other facilities has retarded its growth, but its future is promising. Mineral production for 1923 was valued at $3,784,262, as compared with the 1922 output, worth $3,314,498, the increase being due to copper, though there were decreases in gold and silver. This placed the county tenth in rank. In 1919 Plumas passed Shasta in the copper lead, owing to the Shasta smelters being closed down, which position Plumas still retains.

Among its mineral resources are: Chromite, copper, gold, granite, iron, lead, limestone, manganese, molybdenum, platinum, silver, and zinc.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Copper	22,883,609 lbs.	$3,363,891
Gold	----------	174,871
Silver	----------	243,970
Stone, miscellaneous	----------	780
Other minerals	----------	750
Total value		$3,784,262

RIVERSIDE.

Area: 7,240 square miles.
Population: 60,297 (1920 census).
Location: Southern portion of state.

Riverside is the fourth county in the state in size and the fifth in regard to the total value of mineral output for 1923. Within its borders are included mountain, desert, and agricultural land. Its mineral resources include metals, structural and industrial materials, and salines, some of the more important being brick, cement, clay, coal, copper, feldspar, gems, gold, gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, salt, soapstone, silver, miscellaneous stone and tin. In point of variety Riverside County showed fourteen different minerals commercially produced in 1923. The increase in 1923 over the 1922 value of $3,243,917 was due to cement.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Brick and tile		$676,584
Clay (pottery)	85,185 tons	246,033
Feldspar	5,000 tons	39,000
Granite		29,778
Mineral water	62,855 gals	5,277
Silica (quartz)	2,300 tons	15,000
Stone, miscellaneous		714,899
Other minerals*		5,367,282
Total value		$7,093,853

*Includes cement, coal, gems, gold, gypsum, silver.

SACRAMENTO.

Area: 983 square miles.
Population: 90,978 (1920 census).
Location: North-central portion of state.

Sacramento stands sixteenth among the counties of the state as a mineral producer, the output, principally gold, for 1923, being valued at $2,436,015, as compared with the 1922 production, worth $2,189,562. In regard to gold output alone, this county ranks fourth, being exceeded only by Yuba, Nevada, and Amador counties, the Sacramento product coming from the dredges. Its mineral resources include: Brick, clay, gold, granite, natural gas, platinum, silver, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Value
Brick and tile	$327,636
Gold	1,331,327
Granite	30,740
Silver	2,586
Stone, miscellaneous	649,939
Other minerals*	93,907
Total value	$2,436,015

*Includes natural gas and platinum.

SAN BENITO.

Area: 1,392 square miles.
Population: 8,995 (1920 census).
Location: West-central portion of state.

Although eighteenth among the counties of the state in regard to value of total mineral production, San Benito has led for some years in one important branch of the mineral industry, namely, quicksilver. In spite of the shut-down of the quicksilver mines in 1921–1922, San Benito County retained its position on account of cement, which showed an increased yield over both the 1921 and 1922 figures.

Its other mineral resources, many of them undeveloped, include: Antimony, asbestos, bituminous rock, chromite, coal, dolomite, gems, gypsum, limestone, magnesite, mineral water, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$424,854
Other minerals*		1,853,049
Total value		$2,277,903

*Includes asbestos, cement, dolomite, magnesite, mineral water, quicksilver.

SAN BERNARDINO.

Area: 20,157 square miles.
Population: 73,401 (1920 census).
Location: Southeastern portion of state.

San Bernardino, by far the largest county in the state, in area, ranks fourth as regards the value of its mineral output for 1923 with a total of $13,777,253, as compared with the 1922 total of $8,547,900. The increase is due mainly to cement, and in part to borates, potash, and gold.

San Bernardino for several years (except 1918) had led all other counties in the state in point of variety of minerals, producing commercially during 1923 a total of 20 different substances. This county also ranks first as a silver producer in the state, from the mines of the Randsburg district. In fact, the California Rand mine, there, has been the largest, single, silver producer in the United States for the past three years.

This county, consisting largely of mountain and desert country, is highly mineralized, the following being included among its resources: Asbestos, barytes, borax, brick, cement, clay, copper, gems, gold, granite, gypsum, iron, lead, limestone, manganese, marble, mineral paint, mineral water, nitre, potash, salt, soapstone, soda, miscellaneous stone, strontium, talc, tungsten, vanadium, and zinc.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Cement	3,554,764 bbls.	$8,478,612
Clay (pottery)	830 tons	13,630
Copper	13,328 lbs.	1,959
Gold	----------	210,923
Lead	34,477 lbs.	2,413
Limestone	5,859 tons	28,324
Salt	17,350 tons	65,550
Silver	----------	2,225,959
Talc	7,248 tons	123,216
Stone, miscellaneous	----------	351,151
Other minerals*	----------	2,276,516
Total value		$13,777,253

*Includes borates, calcium chloride, gems, gypsum, lime, mineral water, potash, soda (trona), tungsten concentrates.

SAN DIEGO.

Area: 4,221 square miles.
Population: 112,248 (1920 census).
Location: Extreme southwest corner of state.

San Diego ranks twenty-fifth in the total value of its mineral output and tied for second place with Los Angeles County in point of variety with a record of 17 different commercial minerals for the year. The value for 1923 equaled $821,776, as compared with the 1922 output worth $656,807. In 1918 for the only time in several years, there was no production of gems, in which San Diego County has led the state. Aside from minerals commercially produced, as shown below, San Diego County contains occurrences of bismuth, lithia, marble, nickel, soapstone, and tin. Potash has been produced from kelp.

A development of recent years is the shipping of pebbles for grinding mills.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Clay (pottery)	5,603 tons	$100,977
Feldspar	6,100 tons	42,800
Gems		8,530
Gold		823
Granite		40,600
Mineral water	59,795 gals.	6,570
Silver		144
Stone, miscellaneous		343,959
Other minerals*		277,394
Total value		$821,796

*Includes brick and tile, fuller's earth, lead, magnesium chloride, marble, salt, silica (quartz).

SAN FRANCISCO.

Area: 43 square miles.
Population: 506,676 (1920 census).

Surprising as it may appear at first glance, San Francisco County is listed among the mineral producing sections of the state, actual production consisting mainly of crushed rock, sand and gravel. Small quantities of various valuable mineral substances are found here, including cinnabar, gypsum, lignite, and magnesite, none, however, in paying quantities. Some pumice has been produced.

In forty-fifth place, commercial production for 1923 was as follows:

Substance	Value
Stone, miscellaneous	$117,341

SAN JOAQUIN.

Area: 1,448 square miles.
Population: 79,905 (1920 census).
Location: Central portion of state.

San Joaquin County reported a mineral production for the year 1923 having a total value of $811,229, as compared with the 1922 output worth $473,395.

Comparatively few mineral substances are found here, the chief ones being brick, clay, manganese, natural gas, glass-sand, and miscellaneous stone. Gold, platinum, and silver have been obtained by dredging in the Mokelumne River, which forms the boundary between this county and Amador on the northeast.

In twenty-sixth place, commercial production for 1923 was as follows:

Substance	Value
Clay and clay products	$473,858
Stone, miscellaneous	260,597
Other minerals*	77,774
Total value	$811,229

*Includes manganese ore and natural gas.

SAN LUIS OBISPO.

Area: 3,334 square miles.
Population: 21,893 (1920 census).
Location: Bordered by Kern County on the east and the Pacific Ocean on the west.

The total value of the mineral production of San Luis Obispo County in 1923 was $145,249, as compared with the 1922 output, worth $141,-

470, the increase being due to miscellaneous stone. Among its mineral resources, both developed and undeveloped, are: Asphalt, bituminous rock, brick, chromite, coal, copper, gypsum, infusorial earth, iron, limestone, marble, mineral water, onyx, petroleum, quicksilver, soda, and miscellaneous stone.

In forty-fourth place, commercial production for 1923 was as follows:

Substance	Amount	Value
Petroleum	32,988 bbls.	$19,793
Stone, miscellaneous	----------	46,479
Other minerals*	----------	78,977
Total value		$145,249

*Includes chromite, diatomaceous earth, mineral water, quicksilver, soda (salt cake).

SAN MATEO.

Area: 447 square miles.
Population: 36,781 (1920 census).
Location: Peninsula, adjoined by San Francisco on the north.

San Mateo's most important mineral products are stone and salt, the last-named being derived by evaporation from the waters of San Francisco Bay. The total value of all mineral production during 1923 equaled $329,816, as compared with the 1922 figures of $243,984, the increase being due to both salt, and stone.

Small amounts of barytes, chromite, infusorial earth, and quicksilver have been noted in addition to the items of economic value given below.

Bricks have also been produced commercially.

In thirty-sixth place, commercial production for 1923 was as follows:

Substance	Amount	Value
Salt	35,757 tons	$199,192
Stone, miscellaneous	----------	96,815
Other minerals*	----------	33,809
Total value		$329,816

*Includes magnesium chloride, petroleum, potash.

SANTA BARBARA.

Area: 2,740 square miles.
Population: 41,097 (1920 census).
Location: Southwestern portion of state, adjoining San Luis Obispo on the south.

Santa Barbara County owes its position of sixth in the state in regard to its mineral output to the presence of productive oil fields within its boundaries. The total value of its mineral production during the year 1923 was $5,005,872, as compared with the 1922 output of $4,613,358.

Aside from the mineral substances listed below, Santa Barbara County contains asphalt, diatomaceous earth, gilsonite, gypsum, magnesite, and quicksilver in more or less abundance.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Mineral water	31,200 gals.	$80,800
Natural gas	1,612,287 M cu. ft.	172,725
Petroleum	3,061,947 bbls.	2,394,133
Stone, miscellaneous	----------	14,324
Other minerals*	----------	2,344,090
Total value		$5,005,872

*Includes bituminous rock, diatomaceous earth, sandstone, shale oil.

SANTA CLARA.

Area: 1,328 square miles.
Population: 100,588 (1920 census).
Location: West-central portion of state.

Santa Clara County reported a mineral output for 1923 of $1,320,393 as compared with the 1922 figures of $894,036, the increase being due to brick, magnesite, and miscellaneous stone.

This county, lying largely in the Coast Range Mountains, contains a wide variety of mineral substances, including brick, chromite, clay, limestone, magnesite, manganese, mineral water, petroleum, quicksilver, soapstone, and miscellaneous stone.

In twenty-second place, commercial production for 1923 was as follows:

Substance	Amount	Value
Brick	23,514 M	$282,997
Clay (pottery)	3,202 tons	3,954
Limestone and marl	8,252 tons	49,512
Magnesite	36,390 tons	472,620
Stone, miscellaneous		314,935
Other minerals*		196,375
Total value		$1,320,393

*Includes mineral water, natural gas, petroleum, quicksilver.

SANTA CRUZ.

Area: 435 square miles.
Population: 26,269 (1920 census).
Location: Bordering Pacific Ocean, just south of San Mateo County.

The mineral output of Santa Cruz County, a portion of which is itemized below, amounted to a total value of $4,225,905, giving the county a standing of ninth among all others in the state in this regard.

The increase over the 1922 figure of $3,608,805 is due to cement.

The commercial production for 1923 was as follows:

Substance	Amount	Value
Lime	15,766 tons	$203,632
Limestone	6,733 tons	14,242
Stone, miscellaneous		15,361
Other minerals*		3,992,668
Total value		$4,225,905

*Includes bituminous rock, cement, potash.

SHASTA.

Area: 3,858 square miles.
Population: 13,311 (1920 census).
Location: North-central portion of state.

Shasta County stood twentieth in California among the mineral producing counties for 1923, with an output valued at $1,563,387, as compared with the 1922 production worth $1,513,591, the increase being due to copper.

The market decrease in 1918–1921 was due to the falling off in the output of copper, the large plants of the Mammoth and Mountain copper companies being shut down. Not taking petroleum into account, Shasta for a number of years led all of the counties by a wide margin;

but in 1919–1923 has been passed by San Bernardino, Plumas, Yuba, Inyo, Sacramento, Nevada, and Amador, among the 'metal' counties.

Shasta's mineral resources include: Asbestos, barytes, brick, chromite, coal, copper, gold, iron, lead, lime, limestone, mineral water, molybdenum, pyrite, silver, soapstone, miscellaneous stone, and zinc.

Lassen Peak is located in southeastern Shasta County.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Copper	3,437,963 lbs.	$505,331
Gold		359,487
Lead	323,115 lbs.	22,968
Platinum	299 fine oz.	43,326
Silver		47,706
Stone, miscellaneous		86,500
Other minerals*		498,019
Total value		$1,563,387

*Includes asbestos, barytes, iron ore, lime, limestone, pyrites.

SIERRA.

Area: 923 square miles.
Population: 1,783 (1920 census).
Location: Eastern border of state, just north of Nevada County.

Sierra County reported a mineral production of $886,610 mainly of gold and silver, during the year 1923, as compared with the 1922 output, worth $1,770,626, the decrease being due to gold. Considering gold output alone this county stands sixth; and as to total mineral yield, twenty-third.

Aside from the metals itemized below, Sierra County contains deposits of asbestos, chromite, copper, iron, lead, platinum, serpentine, and talc.

Commercial production for 1923 was as follows:

Substance	Value
Gold	$878,164
Silver	6,134
Stone, miscellaneous	2,312
Total value	$886,610

SISKIYOU.

Area: 6,256 square miles.
Population: 18,545 (1920 census).
Location: Extreme north-central portion of state, next to Oregon boundary.

Siskiyou, fifth county in California in regard to size, located in a highly mineralized and mountainous country, ranks forty-second in regard to the value of its mineral output for 1923. The increase over 1922 was due mainly to stone and gravel used in highway construction.

Although the county is traversed by a transcontinental railroad in a north and south line, the mineral-bearing sections are almost without exception far from transportation and other facilities. A large part of the county is accessible by trail only. Future development and exploitation will increase the productiveness of this part of the state to a considerable degree.

Mount Shasta is located in Siskiyou County.

Among Siskiyou's mineral resources are: Chromite, clay, coal, copper, gems, gold, lead, limestone, manganese, marble, mineral water, pumice, quicksilver, sandstone, silver, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Gold		$45,633
Mineral water	300,156 gals.	4,042
Platinum	3 fine oz.	339
Silver		298
Stone, miscellaneous		129,291
Other minerals*		1,408
Total value		$181,011

*Includes lead and lime.

SOLANO.

Area: 822 square miles.
Population: 40,602 (1920 census).
Location: Touching San Francisco Bay on the northeast.

Solano, while mostly valley land, produced mineral substances during the year 1923 to the total value of $3,376,885, ranking twelfth among the counties of the state, the increase over the 1922 figures of $3,108,114 being due to cement. Among her mineral resources are: Brick, cement, clay, fuller's earth, limestone, mineral water, natural gas, onyx, quicksilver, salt, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$113,545
Other minerals*		3,263,340
Total value		$3,376,885

*Includes cement, mineral water, onyx and travertine, quicksilver.

SONOMA.

Area: 1,577 square miles.
Population: 51,990 (1920 census).
Location: South of Mendocino County, bordering on the Pacific Ocean.

Sonoma ranked thirty-ninth among the counties of California during the year 1923, with a mineral production of $227,312, as compared with its 1922 output worth $221,941. More paving blocks have been turned out here than in any other section of the state, but this industry has now practically ceased, owing to the construction of smooth-surface pavements both in the cities and on the highways.

Among Sonoma's mineral resources are: Brick, chromite, clay, copper, graphite, infusorial earth, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Mineral water	30,661 gals.	$7,106
Quicksilver	628 flasks	31,147
Stone, miscellaneous		189,059
Total value		$227,312

STANISLAUS.

Area: 1,450 square miles.
Population: 43,557 (1920 census).
Location: Center of state, bounded on south by Merced County.

Gold has usually been the chief mineral product of Stanislaus County, but it was exceeded in 1918–1919 by manganese, and in 1921–1923 by

miscellaneous stone. Brick, clay, gypsum, mineral paint, quicksilver, and silver are found here to some extent as well. This county for 1923 ranks thirty-third in the state in regard to value of minerals, with an output of $445,515 as compared with $452,167 in 1922, the decrease being due to magnesite and miscellaneous stone, though there was an increase in gold yield. Gold, platinum, and silver are obtained mainly by dredging.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Gold		$174,814
Mineral paint	1,023 tons	10,745
Silver		883
Stone, miscellaneous		231,965
Other minerals*		27,158
Total value		$445,515

*Includes magnesite, manganese ore, platinum.

SUTTER.

Area: 608 square miles.
Population: 10,115 (1920 census).
Location: Bounded by Butte County on the north and Sacramento on the south.

Sutter is one of only two counties in the state which for a number of years reported no commercial output of some kind of mineral substance. In 1917 some crushed rock was taken out, from the Marysville Buttes, but there was no production in 1918, nor 1919. There has been some utilization of natural gas. The 1923 mineral yield was valued at $97, being concealed under 'unapportioned.' Both coal and clay exist here, but deposits of neither mineral have been placed on a productive basis.

TEHAMA.

Area: 2,893 square miles.
Population: 12,882 (1920 census).
Location: North-central portion of the state, bounded on the north by Shasta.

Tehama stands fifty-fifth among the mineral producing counties of the state for 1923, when its output was valued at $6,216, as compared with the 1922 yield worth $9,388.

Among its mineral resources are listed: Brick, chromite, copper, gold, manganese, marble, mineral water, salt, and miscellaneous stone.

The 1923 yield was distributed as follows:

Substance	Value
Stone, miscellaneous	$4,900
Other minerals	1,316
Total value	$6,216

TRINITY.

Area: 3,166 square miles.
Population: 2,551 (1920 census).
Location: Northwestern portion of state.

Trinity, like its neighbor, Siskiyou County, requires transportation facilities to further the development of its many and varied mineral resources. Deposits of asbestos, barytes, chromite, copper, gold, mineral

water, platinum, quicksilver, silver, and building stone are known here, but with the exception of gold, chromite, copper, quicksilver, and platinum, very little active production of these mineral substances has been made as yet. The 1923 output of $677,174 shows an increase over the 1922 figure of $197,937, due to gold and copper, giving the county rank of twenty-eighth, for the year:

Substance	Amount	Value
Copper	329,796 lbs.	$48,467
Gold		617,841
Platinum	13 fine oz.	2,060
Silver		6,816
Stone, miscellaneous		3,000
Total value		$677,174

TULARE.

Area: 4,856 square miles.
Population: 59,031 (1920 census).
Location: Bounded by Inyo on the east, Kern on the south, Fresno on the north.

Tulare stands thirty-second on the list of mineral-producing counties, the increase over the 1922 value being due mainly to magnesite. This county's mineral resources, among others, are: Brick, clay, copper, feldspar, graphite, gems, limestone, magnesite, marble, quartz, glass-sand, soapstone, miscellaneous stone, and zinc. Tulare for a number of years led the state in magnesite output, except in 1918 when it was passed by Napa County, and in 1921–1923 by Santa Clara.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Limestone	15,500 tons	$57,500
Magnesite	24,058 tons	398,272
Natural gas	380 M cu. ft.	190
Stone, miscellaneous		1,990
Other minerals*		108,607
Total value		$466,559

*Includes brick and granite.

TUOLUMNE.

Area: 2,190 square miles.
Population: 7,768 (1920 census).
Location: East-central portion of state—Mother Lode District.

Tuolumne ranks twenty-ninth among counties of the state relative to its total value of mineral output for 1923. This county ranks first as a producer of marble in the state. The decrease in the year's valuation to $670,362 for 1923 from the 1922 figure of $764,938 was due to miscellaneous stone, though there was a gain in gold output.

Chromite, clay, copper, gold, lead, limestone, marble, mineral paint, platinum, soapstone, silver, and miscellaneous stone are among its mineral resources.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Gold		$261,956
Limestone	3,140 tons	7,680
Silver		2,801
Stone, miscellaneous		9,800
Other minerals*		388,145
Total value		$670,382

*Includes granite, lime, magnesite, marble.

VENTURA.

Area: 1,878 square miles.
Population: 28,724 (1920 census).
Location: Southwestern portion of state, bordering on Pacific Ocean.

Ventura is the eighth county in the state in respect to the value of its mineral production for 1923, the exact figure being $4,679,684, as compared with the output for 1922, worth $5,837,078, the decrease being due to lower petroleum prices.

The highest gravity petroleum produced in the state is found here.

Among its other mineral resources are: Asphalt, borax, brick, clay, mineral water, natural gas, sandstone, and miscellaneous stone.

Commercial production for 1923 was as follows:

Substance	Amount	Value
Natural gas	4,162,318 M	$470,261
Petroleum	3,610,791 bbls.	4,109,084
Stone, miscellaneous		88,211
Other minerals*		12,128
Total value		$4,679,684

*Includes mineral paint and sandstone.

YOLO.

Area: 1,014 square miles.
Population: 17,105 (1920 census).
Location: Sacramento Valley, bounded by Sutter on the east and Colusa on the north.

The mineral production from Yolo County during the year 1923 consisted mainly of miscellaneous stone, valued at $16,957, ranking it in fifty-second place. Deposits of undetermined value of iron and sandstone have been discovered within the confines of this county. Quicksilver has also been produced.

YUBA.

Area: 639 square miles.
Population: 10,375 (1920 census).
Location: Lies west of Sierra and Nevada counties; south of Plumas.

Yuba is eleventh of the mineral-producing counties of the State, and first in regard to gold output for 1923, regaining its lead over Nevada County in that metal. Iron and clay deposits have been reported in this county aside from the following commercial production shown for the year 1923. The increase over the 1922 figure of $2,588,316 was due mainly to gold obtained by the dredgers, which also yield silver and platinum, and also due in part to sand. The 1921 dredge yield of gold was a record for the county.

The 1923 production of Yuba County was distributed as follows:

Substance	Amount	Value
Gold		$3,150,405
Platinum	158 fine oz.	16,974
Silver		6,760
Stone, miscellaneous		216,890
Other minerals		100
Total value		$3,391,129

APPENDIX.

MINING BUREAU ACT.

Chapter 679.

[Stats., 1913.]

An act establishing a state mining bureau, creating the office of state mineralogist, fixing his salary and prescribing his powers and duties; providing for the employment of officers and employees of said bureau, making it the duty of persons in charge of mines, mining operations and quarries to make certain reports, providing for the investigation of mining operations, dealings and transactions and the prosecution for defrauding, swindling and cheating therein, creating a state mining bureau fund for the purpose of carrying out the provisions of this act and repealing an act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all acts amendatory thereof and supplemental thereto or in conflict herewith.

[Approved June 16, 1913. In effect August 10, 1913.]

The people of the State of California do enact as follows:

SECTION 1. There is hereby created and established a state mining bureau. The chief officer of such bureau shall be the state mineralogist, which office is hereby created.

SEC. 2. It shall be the duty of the governor of the State of California and he is hereby empowered to appoint a citizen and resident of this state, having a practical and scientific knowledge of mining, to the office of state mineralogist. Said state mineralogist shall hold his office at the pleasure of the governor. He shall be a civil executive officer. He shall take and subscribe the same oath of office as other state officers. He shall receive for his services a salary of three hundred dollars ($300) per month, to be paid at the same time and in the same manner as the salaries of other state officers. He shall also receive his necessary traveling expenses when traveling on the business of his office. He shall give bond for the faithful performance of his duties in the sum of ten thousand dollars ($10,000), said bond to be approved by the governor of the State of California.

SEC. 3. Said state mineralogist shall employ competent geologists, field assistants, qualified specialists and office employees when necessary in the execution of his plans and operations of the bureau, and fix their compensation. The said employees shall be allowed their necessary traveling expenses when traveling on the business of said department and shall hold office at the pleasure of said state mineralogist.

SEC. 4. It shall be the duty of said state mineralogist to make, facilitate, and encourage, special studies of the mineral resources and mineral industries of the state. It shall be his duty: to collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the state mining bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, and sciences of mineralogy and geology, and arts of mining and metallurgy, such library constituting the library of the state mining bureau; to make a collection of models, drawings and descriptions of the mechanical appliances used in mining and metallurgical processes; to preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours; to maintain, in effect, a bureau of information concerning the mineral industries of this state, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it; to issue from time

to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state.

SEC. 5. It is hereby made the duty of the owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character, within the state, to forward to the state mineralogist, upon his request, at his office not later than the thirtieth day of June, in each year, a detailed report upon forms which will be furnished showing the character of the mine, the number of men then employed, the method of working such mine and the general condition thereof, the total mineral production for the past year, and such owner, lessor, lessee, agent, manager or other person in charge of any mine within the state must furnish whatever information relative to such mine as the state mineralogist may from time to time require for the proper discharge of his official duties. Any owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character within the state, who fails to comply with the above provisions shall be deemed guilty of a misdemeanor.*

SEC. 6. The state mineralogist now performing the duties of the office of state mineralogist shall perform the duties of the office of state mineralogist as in this act provided until the appointment and qualification of his successor as in this act provided.

SEC. 7. The said state mineralogist shall take possession, charge and control of the offices now occupied and used by the board of trustees and state mineralogist and the museum, library and laboratory of the mining bureau located in San Francisco as provided for by a certain act of the legislature approved March 23, 1893, and hereafter referred to in section fourteen hereof, and shall maintain such offices, museum, library and laboratory for the purposes provided in this act.

SEC. 8. Said state mineralogist or qualified assistant shall have full power and authority at any time to enter or examine any and all mines, quarries, wells, mills, reduction works, refining works and other mineral properties or working plants in this state in order to gather data to comply with the provisions of this act.

SEC. 9. The state mineralogist shall make a biennial report to the governor on or before the fifteenth day of September next preceding the regular session of the legislature.

SEC. 10. All moneys received by the state mining bureau or any officer thereof (except such as may be paid to them by the state for disbursement) shall be receipted for by the state mineralogist or other officer authorized by him to act in his place and at least once a month accounted for by him to the state controller and paid into the state treasury to the credit of a fund which is hereby created and designated "state mining bureau fund." All moneys now in the possession of the state mining bureau or any officer thereof received from any source whatsoever, shall be immediately paid over to the state mineralogist and by him accounted for to the controller and paid into the state treasury to the credit of said fund. Said fund shall be used and is hereby appropriated for the use of said bureau in carrying out the purposes of this act.

SEC. 11. The said state mineralogist is hereby authorized and empowered to receive on behalf of this state, for the use and benefit of the state mining bureau, gifts, bequests, devices and legacies of real or other property and to use the same in accordance with the wishes of the donors, and if no instructions are given by said donors, to manage, use, and dispose of the gifts and bequests and legacies for the best interests of said state mining bureau and in such manner as he may deem proper.

SEC. 12. The state mineralogist may, whenever he deems it advisable, prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the state.

SEC. 13. The state mineralogist is hereby empowered to fix a price upon and to dispose of to the public, at such price, any and all publications of the state mining bureau, including reports, bulletins, maps, registers or other publications, such price shall approximate the cost of publication and distribution. Any and all sums

*Sec. 19 of the Penal Code of California provides: "Except in cases where a different punishment is prescribed by this code, every offense declared to be a misdemeanor is punishable by imprisonment in a county jail not exceeding six months, or by a fine not exceeding five hundred dollars, or by both."

derived from such disposition, or from gifts or bequests made, as hereinbefore provided must be accounted for by said state mineralogist and turned over to the state treasurer to be credited to the mining bureau fund as provided for in section ten. He is also empowered to furnish without cost to public libraries the publications of the bureau, and to exchange publications with other geological surveys and scientific societies, etc.

SEC. 14. The state mineralogist provided for by this act shall be the successor in interest of the board of trustees of the state mining bureau, and the state mineralogist, under and by virtue of that certain act, entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management, and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all books, papers, documents, personal property, records, and property of every kind and description obtained or possessed, or held or controlled by the said board of trustees of the said state mining bureau, and the state mineralogist, and the clerks and employees thereof, under the provisions of said act of March 23, 1893, or any act supplemental thereto or amendatory thereof, shall immediately be turned over and delivered to the said state mineralogist herein provided for, who shall have charge and control thereof.

SEC. 15. That certain act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, and to provide for the appointment, duties and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction, and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, together with all acts amendatory thereof and supplemental thereto and all acts in conflict herewith are hereby repealed.

PUBLICATIONS OF THE CALIFORNIA STATE MINING BUREAU.

During the past forty-four years, in carrying out the provisions of the organic act creating the California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the state, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have often been limited, many of the reports and bulletins mentioned were printed in limited editions which are now entirely exhausted.

Copies of such publications are available, however, in the Bureau's offices in the Ferry Building, San Francisco; Pacific Finance Building, Los Angeles; in Sacramento; Santa Maria; Santa Paula; Coalinga; Taft; Bakersfield. They may also be found in many public, private and technical libraries in California and other states, and foreign countries.

A catalog of all publications of the Bureau, from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the offices of the State Mining Bureau and enclosing the requisite amount in the case of publications that have a list price. The Bureau is authorized to receive only coin, stamps or money orders, and it will be appreciated if remittance is made in this manner rather than by personal check.

The prices noted include delivery charges to all parts of the United States. Money orders should be made payable to the State Mining Bureau.

REPORTS.

Asterisks (**) indicate the publication is out of print.

	Price
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. By Henry G. Hanks	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50
Mines and Mineral Resources, Del Norte, Humboldt, and Mendocino Counties, 59 pp., paper	.25
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pages, paper	----
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	.35
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----
Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915:	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou, and Trinity Counties, 974 pp., 275 illustrations, cloth	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915–1916, Fletcher Hamilton:	
Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	.65
Same, including geological map of Inyo County	1.25
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter, and Tehama Counties, 91 pp., paper	.50
Mines and Mineral Resources, El Dorado, Placer, Sacramento, and Yuba Counties, 198 pp., paper	.65

REPORTS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties, 183 pp., paper	$0.65
Mines and Mineral Resources, Los Angeles, Orange, and Riverside Counties, 136 pp., paper	.50
Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	.65
Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917:	
A general Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	3.75
Chapters of the State Mineralogist's Report, Biennial Period 1917–1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper	.75
Mines and Mineral Resources of Plumas County, 188 pp., paper	.50
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50
Seventeenth Report of the State Mineralogist, 1920, Mining in California during 1920, Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75
Eighteenth Report of the State Mineralogist, 1922, Mining in California, Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, March, April, May, June, July, August, September, October, November, December, 1922	Free
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	Free
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy	.25
Subscription, $1.00 in advance (by calendar year, only).	
Chapters of State Oil and Gas Supervisor's Report:	
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:	
**April, **May, June, **July, **August, **September, **October, November, **December, 1919	Free
January, February, March, April, **May, June, July, **August, September, October, November, December, 1920	Free
January, **February, **March, **April, May, June, **July, August, **September, **October, **November, **December, 1921	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1922	Free
January, February, March, April, May, June, July, August, September, October, November, December, 1923	Free
January, February, March, April, May, June, July, August, September, 1924	Free

BULLETINS.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 1. A Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887.)	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 80 pp., 46 illustrations	.50

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 7. Mineral Production of California, by Counties for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties for the year 1895, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	----
**Bulletin No. 10. A bibliography Relating to the Geology, Palæntology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----
**Bulletin No. 12. Mineral Production of California, by Counties for 1896, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 13. Mineral Production of California, by Counties for 1897, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 14. Mineral Production of California, by Counties for 1898, by Charles G. Yale	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means. 1899	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----
**Bulletin No. 17. Mineral Production of California, by Counties for 1899, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, and 9 maps	$0.50
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 26. Mineral Production of California for the past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet	----
**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----
**Bulletin No. 28. Mineral Production of California, for 1902, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	----
**Bulletin No. 30. Bibliography Relating to the Geology, Palæntology, and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905, 120 pp., 66 illustrations, 3 maps	----
Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunta. 1905, 168 pp., 54 illustrations	$0.25
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet	----
**Bulletin No. 41. Mines and Minerals of California, for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.	----
Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.	.30
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 48. Mineral Production of California for Twenty Years. 1906, by Charles G. Yale	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman, 366 pp., 74 illustrations. (Revised edition.)	1.00
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, 1907, by D. H. Walker. Tabulated sheet	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker, 62 pp.	----
**Bulletin No. 54. Mineral Production of California, by Counties, by D. H. Walker, 1908. Tabulated sheet	----
**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker. 78 pp.	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations and 10 maps	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker, 1909. Tabulated sheet	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker, 1909. Tabulated sheet	----
**Bulletin No. 60. Mineral Production for 1909, County Maps and Mining Laws of California, by D. H. Walker. 94 pp.	----
**Bulletin No. 61. Mineral Production of California, by Counties for 1910, by D. H. Walker. Tabulated sheet	----
**Bulletin No. 62. Mineral Production of California for Twenty-four Years, by D. H. Walker, 1910. Tabulated sheet	----
**Bulletin No. 63. Petroleum in Southern California, by P. W. Prutzman. 1912, 430 pp., 41 illustrations, 6 maps	----
**Bulletin No. 64. Mineral Production for 1911, by E. S. Boalich. 49 pp.	----
**Bulletin No. 65. Mineral Production for 1912, by E. S. Boalich. 64 pp.	----
**Bulletin No. 66. Mining Laws of the United States and California. 1914, 89 pp.	----

BULLETINS—Continued.

Asterisks (**) indicate the publication is out of print.

	Price
**Bulletin No. 67. Minerals of California, by Arthur S. Eakle. 1914, 226 pp.	----
**Bulletin No. 68. Mineral Production for 1913, with County Maps and Mining Laws, by E. S. Boalich. 160 pp.	----
**Bulletin No. 69. Petroleum Industry of California, with Folio of Maps (18 by 22), by R. P. McLaughlin and C. A. Waring. 1914, 519 pp., 13 illustrations, 83 figs. [18 plates in accompanying folio.]	----
**Bulletin No. 70. Mineral Production for 1914, with County Maps and Mining Laws. 184 pp.	----
**Bulletin No. 71. Mineral Production for 1915, with County Maps and Mining Laws, by Walter W. Bradley. 193 pp., 4 illustrations	----
Bulletin No. 72. The Geologic Formations of California, by James Perrin Smith. 1916, 47 pp.	$0.25
Reconnaissance Geologic Map (of which, Bulletin 72 is explanatory), in 23 colors. Scale: 1 inch equals 12 miles. Mounted	2.50
**Bulletin No. 73. First Annual Report of the State Oil and Gas Supervisor of California, for the fiscal year 1915–16, by R. P. McLaughlin. 278 pp., 26 illustrations	----
Bulletin No. 74. Mineral Production of California in 1916, with County Maps, by Walter W. Bradley. 179 pp., 12 illustrations	Free
**Bulletin No. 75. United States and California Mining Laws, 1917. 115 pp., paper	----
Bulletin No. 76. Manganese and Chromium in California, by Walter W. Bradley, Emile Huguenin, C. A. Logan, W. B. Tucker and C. A. Waring, 1918. 248 pp., 51 illustrations, 5 maps, paper	.50
Bulletin No. 77. Catalogue of Publications of California State Mining Bureau, 1880–1917, by E. S. Boalich. 44 pp., paper	Free
Bulletin No. 78. Quicksilver Resources of California, with a Section on Metallurgy and Ore-Dressing, by Walter W. Bradley, 1918. 389 pp., 77 photographs and 42 plates (colored and line cuts), cloth	1.50
Bulletin No. 79. Magnesite in California. (In preparation.)	------
Bulletin No. 80. Tungsten, Molybdenum and Vanadium in California. (In preparation.)	----
Bulletin No. 81. Foothill Copper Belt of California. (In preparation.)	----
**Bulletin No. 82. Second Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1916–1917, by R. P. McLaughlin, 1918. 412 pp., 31 illustrations, cloth	----
Bulletin No. 83. California Mineral Production for 1917, with County Maps, by Walter W. Bradley. 179 pp., paper	Free
**Bulletin No. 84. Third Annual Report of the State Oil and Gas Supervisor, for the fiscal year 1917–1918, by R. P. McLaughlin, 1918. 617 pp., 28 illustrations, cloth	----
**Bulletin No. 85. Platinum and Allied Metals in California, by C. A. Logan, 1919. 10 photographs, 4 plates, 120 pp., paper	.50
Bulletin No. 86. California Mineral Production for 1918, with County Maps, by Walter W. Bradley, 1919. 212 pp., paper	Free
**Bulletin No. 87. Commercial Minerals of California, with notes on their uses, distribution, properties, ores, field tests, and preparation for market, by W. O. Castello, 1920. 124 pp., paper	----
Bulletin No. 88. California Mineral Production for 1919, with County Maps, by Walter W. Bradley, 1920. 204 pp., paper	Free
**Bulletin No. 89. Petroleum Resources of California, with Special Reference to Unproved Areas, by Lawrence Vander Leck, 1921. 12 figures, 6 photographs, 6 maps in pocket, 186 pp., cloth	1.25
Bulletin No. 90. California Mineral Production for 1920, with County Maps, by Walter W. Bradley, 1921. 218 pp., paper	Free
Bulletin No. 91. Minerals of California, by Arthur S. Eakle, 1923, 328 pp., cloth	1.00
Bulletin No. 92. Gold Placers of California, by Chas. S. Haley, 1923. 167 pp., 36 photographs and 7 plates (colored and line cuts, also geologic map), cloth	$1.50
Extra copies of the Geologic Map (in 4 colors)	.50

Bulletin No. 93. California Mineral Production for 1922, by Walter W. Bradley, 1923 ---------- Free
Bulletin No. 94. California Mineral Production for 1923, by Walter W. Bradley, 1924 ---------- Free

PRELIMINARY REPORTS.

Asterisks (**) indicate the publication is out of print.

Price

**Preliminary Report No. 1. Notes on Damage by Water in California Oil Fields, December, 1913. By R. P. McLaughlin. 4 pp.---------- ----
**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin. 4 pp.---------- ----
Preliminary Report No. 3. Manganese and Chromium, 1917. By E. S. Boalich. 32 pp.---------- ----
Preliminary Report No. 4. Tungsten, Molybdenum and Vanadium. By E. S. Boalich and W. O. Castello, 1918. 34 pp. Paper---------- Free
Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper-- Free
Preliminary Report No. 6. A Review of Mining in California During 1919. Fletcher Hamilton, 1920. 43 pp. Paper---------- Free
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper---------- ----
Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. Fletcher Hamilton, 1922. 68 pp. Paper---------- ----

MISCELLANEOUS PUBLICATIONS.

Asterisks (**) indicate the publication is out of print.

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.---------- ----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.---- ----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.---------- ----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.---------- ----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.---------- ----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.---------- ----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894.---------- ----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper---------- ----
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper---------- Free
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923 ---------- Free

MAPS.

Registers of Mines With Maps.

Asterisks (**) indicate out of print.

	Price
**Register of Mines, with Map, Amador County	$0.25
**Register of Mines, with Map, Butte County	.25
**Register of Mines, with Map, Calaveras County	----
**Register of Mines, with Map, El Dorado County	----
**Register of Mines, with Map, Inyo County	----
**Register of Mines, with Map, Kern County	----
**Register of Mines, with Map, Lake County	----
**Register of Mines, with Map, Mariposa County	----
**Register of Mines, with Map, Nevada County	----
**Register of Mines, with Map, Placer County	----
**Register of Mines, with Map, Plumas County	----
**Register of Mines, with Map, San Bernardino County	----
**Register of Mines, with Map, San Diego County	----
**Register of Mines, with Map, Santa Barbara County	.25
**Register of Mines, with Map, Shasta County	----
**Register of Mines, with Map, Sierra County	----
**Register of Mines, with Map, Siskiyou County	----
**Register of Mines, with Map, Trinity County	----
**Register of Mines, with Map, Tuolumne County	----
**Register of Mines, with Map, Yuba County	----
Register of Oil Wells, with Map, Los Angeles City	----

OTHER MAPS.

Asterisks (**) indicate the publication is out of print.

**Map of California. Showing Mineral Deposits (50 x 60 in.)	
Map of Forest Reserves in California—	
Mounted	.50
**Unmounted	----
**Mineral and Relief Map of California	----
**Map of El Dorado County, Showing Boundaries, National Forests	----
**Map of Madera County, Showing Boundaries, National Forests	----
**Map of Placer County, Showing Boundaries, National Forests	----
**Map of Shasta County, Showing Boundaries, National Forests	----
**Map of Sierra County, Showing Boundaries, National Forests	----
**Map of Siskiyou County, Showing Boundaries, National Forests	----
**Map of Tuolumne County, Showing Boundaries, National Forests	----
**Map of Mother Lode Region	----
**Map of Desert Region of Southern California	----
Map of Minaret District, Madera County	.20
Map of Copper Deposits in California	.05
**Map of Calaveras County	----
Map of Plumas County	.25
**Map of Trinity County	----
Map of Tuolumne County	.25
Geological Map of Inyo County. Scale 1 inch equals 4 miles	.60
Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	.25
Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Mounted	2.50
Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels. In 4 colors	.50

OIL FIELD MAPS.

These maps are revised from time to time as development work advances and ownerships change.

	Price
Map No. 1—Sargent, Santa Clara County	$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	.75
Map No. 3—Santa Maria, including Casmalia and Lompoc	.75
Map No. 4—Whittier-Fullerton, including Olinda, Brea Canyon, Puente Hills, East Coyote and Richfield	.75
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello	.75
Map No. 6—Salt Lake, Los Angeles County	.75
Map No. 7—Sunset and San Emido and Kern County	.75
Map No. 8—South Midway and Buena Vista Hills, Kern County	.75
Map No. 9—North Midway and McKittrick, Kern County	.75
Map No. 10—Belridge and McKittrick, Kern County	.75
Map No. 11—Lost Hills and North Belridge, Kern County	.75
Map No. 12—Devils Den, Kern County	.75
Map No. 13—Kern River, Kern County	.75
Map No. 14—Coalinga, Fresno County	.75
Map No. 15—Elk Hills, Kern County	.75
Map No. 16—Ventura-Ojai, Ventura County	.75
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County	.75
Map No. 18—Piru-Simi-Newhall Oil Fields	.75
Map No. 19—Arroyo Grande, San Luis Obispo County	.75
Map No. 20—Long Beach Oil Field	1.00
Map No. 21—Portion of District 4, Showing Boundaries of Oil Fields, Kern and Kings counties	.75
Map No. 22—Portion of District 3, Showing Oil Fields, Santa Barbara County	.75
Map No. 23—Portion of District 2, Showing Boundaries of Oil Fields, Ventura County	.75
Map No. 24—Portion of District 1, Showing Boundaries of Oil Fields, Los Angeles and Orange counties	.75
Map No. 26—Huntington Beach Oil Field	.75
Map No. 27—Santa Fe Springs Oil Field	.75
Map No. 28—Torrance, Los Angeles County	.75
Map No. 29—Dominguez, Los Angeles County	1.00

DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

INDEX.

35173 1-26 2500

THE STATE MINING BUREAU

CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE

MINERAL RESOURCES OF CALIFORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the state, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the state mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily
Saturday, 9 a.m. to 12 m.

Lloyd L. Root,
State Mineralogist.

Third floor, Ferry Building, San Francisco, Cal.
Branch Offices: Pacific Finance Building, Los Angeles; Chamber of Commerce Building, Sacramento; Bakersfield, Taft, Coalinga, Santa Maria, Santa Paula.