CONTAINS

1. TALC, SOAPSTONE & Pyrophyllite Production in CA during 1948, by Counties.

2. "ASBESTOS"

   - FENELON F. DAVIS

3. "TALC, SOAPSTONE, & PYROPHYLLITE

   - LAUREN A. WRIGHT

4. DIRECTORY OF PRODUCERS... 1948

   - ASBESTOS

   - TALC, SOAPSTONE, PYROPHYLLITE.

PLAINTIFF'S EXHIBIT
CAM-18

☑ Pltf. ☐ Deft.
Exhibit No. 34 I.D.
Patricia Ruby, N.P. 8-12-88
Witness Mulrogan

34

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

SAN FRANCISCO — BULLETIN 156 — AUGUST 1950

MINERAL COMMODITIES OF CALIFORNIA

GEOLOGIC OCCURRENCE, ECONOMIC DEVELOPMENT, AND UTILIZATION OF THE STATE'S MINERAL RESOURCES

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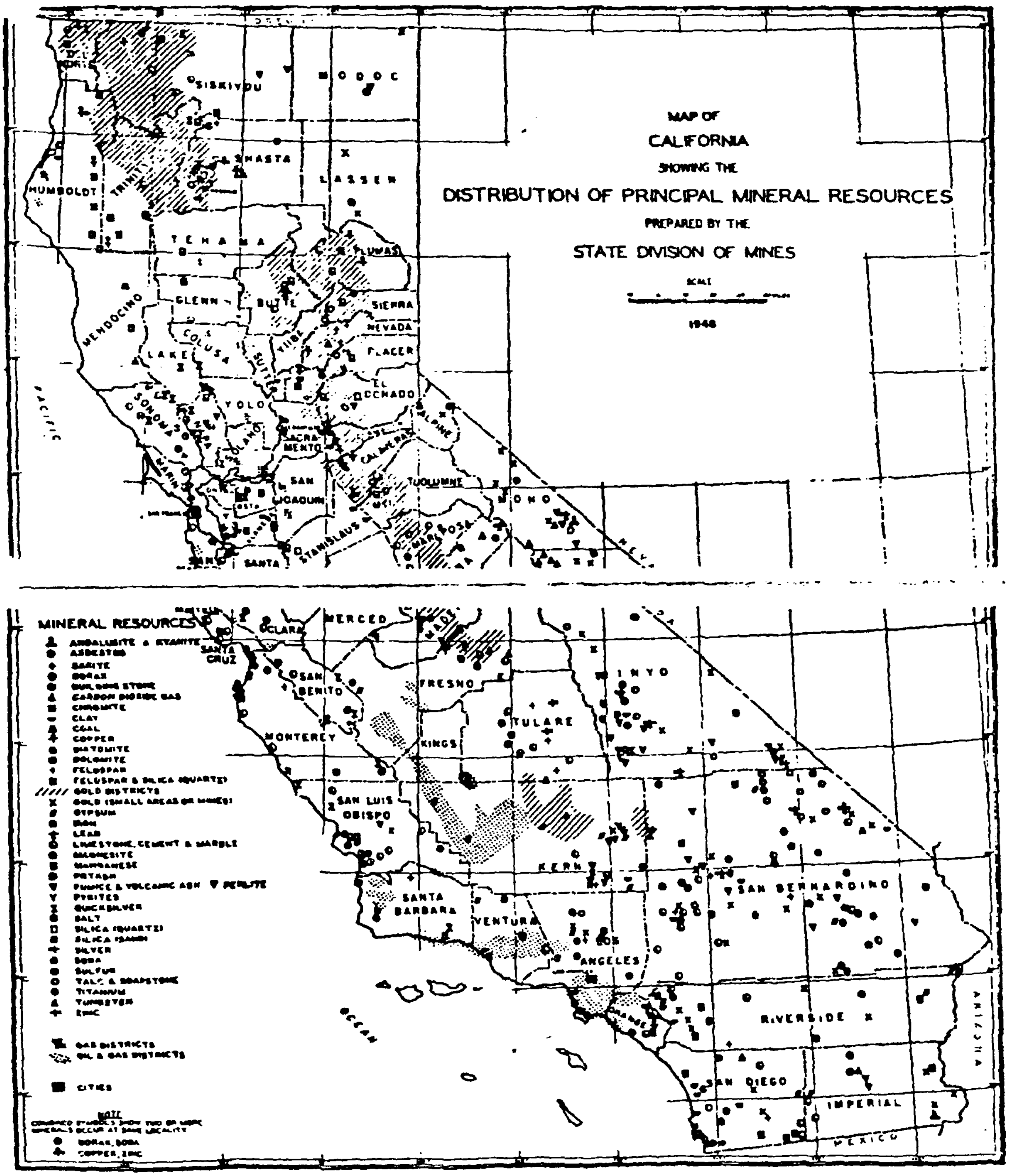

MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
MINERAL RESOURCES
BARITE
CHROMITE
CLAY
COAL
COPPER
FELDSPAR
GOLD DISTRICTS
LEAD
PYRITES
SALT
SILICA (QUARTZ)
SILVER
SODA
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
PLACER
COLUSA
LAKE
YUBA
SUTTER
EL DORADO
SONOMA
YOLO
ALPINE
NAPA
SOLANO
SACRA-MENTO
MARIN
CALAVERAS
SAN JOAQUIN
TUOLUMNE
MONO
STANISLAUS
MARIPOSA
SANTA
MERCED
SANTA CRUZ
SAN BENITO
FRESNO
INYO
TULARE
MONTEREY
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
SAN DIEGO
IMPERIAL
MEXICO
ARIZONA
PACIFIC
OCEAN

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Stone production of California during 1948, by counties.

County	Ton	Value
Alameda	1,002,200	$742,900
Amador	21,270	(2)
Butte	224,770	158,895
Contra Costa	409,110	566,904
El Dorado	176,130	490,086
Fresno	416,530	618,440
Humboldt	23,310	(2)
Lake	2,430	(2)
Los Angeles	4,425,270	4,323,480
Monterey	197,150	281,166
Napa	58,130	78,812
Orange	116,130	(2)
Riverside	7,160	12,583
San Bernardino	1,195,070	1,563,225
San Diego	91,570	280,626
San Mateo	780,390	728,065
Santa Barbara	301,800	(2)
Santa Clara	255,040	189,341
Shasta	128,410	(2)
Siskiyou	177,770	57,843
Sonoma	135,800	189,836
Trinity	19,900	20,530
Tuolumne	23,100	223,861
Yolo	45,800	12,250
Other counties [1]	1,801,420	2,607,425
Totals	11,936,240	$13,155,464

[1] Includes Del Norte, Imperial, Inyo, Lassen, Marin, Placer, Sacramento, San Benito, San Francisco, San Joaquin, San Luis Obispo, Santa Cruz, Tulare, and Ventura Counties.
[2] Value included under other counties.

Stone sold or used by producers in California in 1948.

Kind of stone	Dimension		Crushed	
	Short tons	Value	Short tons	Value
Granite	5,330	$285,214	1,662,010	$1,466,917
Basalt	(1)	(1)	1,312,000	1,379,086
Marble	...	...	3,140	56,466
Limestone	1,540	7,210	778,840	1,948,366
Sandstone	6,900	49,815	1,322,120	1,403,923
Miscellaneous stone	700	7,915	6,742,780	6,553,339
Totals	[4] 14,560	[4] $349,354	11,921,880	$12,808,100

[1] Fewer than three producers.
[4] Incomplete total—dimension basalt data not included.

Strontium. During 1948 no shipments of strontium minerals were reported in California. The last production reported was in 1946, from properties in Imperial and San Bernardino Counties.

Sulfur. The sulfur mined and shipped during 1948 in California came from two properties, one in Alpine County and one in Inyo County. The 1947 sulfur output came from two properties in Inyo County.

Talc, Soapstone, and Pyrophyllite. The talc, soapstone, and pyro-phyllite mined and shipped in California during 1948 totaled 98,6[illegible] short tons worth $1,773,764, and came from properties in El Dorado, Inyo, Los Angeles, Mono, San Bernardino, and San Diego Counties. The 1947 output totaled 91,537 short tons worth $1,595,422. The materi[illegible] 1948 from El Dorado and Los Angeles Counties was soaps[illegible]

the production from San Bernardino County and part of the production from Inyo County was high-grade talc; the production from Mono and San Diego Counties, and part of the production from Inyo County was pyrophyllite.

Talc, soapstone, and pyrophyllite production in California during 1948, by counties.

County	Tons	Value
Inyo	33,546	$471,596
San Bernardino	52,622	1,160,255
El Dorado, Los Angeles, Mono, San Diego	12,513	141,913
Totals	98,681	$1,773,764

Titanium. Titanium concentrate (ilmenite) was produced in California during 1948 from two properties in Sand Canyon near Saugus, Los Angeles County.

Tungsten. High-grade tungsten ore and concentrates mined and shipped in California during 1948 totaled 1,767 short tons (60 percent WO_3 basis). The 1948 output of tungsten ore and concentrates showed a marked increase over that of 1947 when 394 short tons (60 percent WO_3 basis) worth $548,233 was shipped. Eighteen operating properties reported shipments of concentrates and high-grade ore in 1948; these were located in Alpine, Fresno, Inyo, Kern, Madera, Mono, San Bernardino, and Tulare Counties.

Zinc. The recoverable zinc produced in California during 1948 totaled 10,650,000 pounds valued at $1,416,450, as compared with 10,830,-000 pounds worth $1,310,430 in 1947. The most important production in 1948 was made at the lead-zinc properties of the Anaconda Copper Mining Company at Darwin and Tecopa, Inyo County. The Coronado Copper and Zinc Company (Afterthought mine at Ingot, Shasta County) was the only large new zinc producer. The San Bernardino County zinc concentrates came from the Carbonate King mine near Nipton.

The average price of prime western-grade slab zinc in 1948, East St. Louis, was 13.3 cents per pound, compared with an average value of 10.5 cents per pound in 1947, and 11.7 cents per pound in 1946, including United States Government premium.

Zinc production in California during 1948, by counties.

County	Pounds	Value
Inyo	9,320,000	$1,239,560
San Bernardino	438,000	58,254
Shasta	892,000	118,636
Totals	10,650,000	$1,416,450

Details of mineral production for each county, 1948 and 1947 ³—Continued.

Fresno County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Clay products, heavy clay (other than pottery and refractories)		....	3	....	3
Gold	troy ounces	234	$8,225	3	3
Gypsum, crude	short tons	3	3	15,443	$23,271
Mercury	flasks	3	3	....	....
Natural gas	M cu. ft.	68,636,000	6,943,000	69,644,000	7,224,000
Natural gasoline and allied products:					
Natural gasoline ⁴	gallons	75,468,000	3,900,000	26,823,000	3,199,000
Liquefied petroleum gases ⁴	do	41,170,000	1,042,000	22,262,000	1,400,000
Petroleum	barrels	44,137,000	75,560,000	48,841,000	111,920,000
Sand and gravel	short tons	1,031,322	1,141,346	932,804	1,022,031
Silver	troy ounces	37	33	3	3
Stone	short tons	164,910	282,835	416,530	618,450
Tungsten concentrates (60% WO_3 basis)	short tons	3	3	11	15,646
Unapportioned (raw clay and items indicated by footnote 2)		....	48,768	....	27,800
Total value		....	$89,828,207	....	$124,450,346

Glenn County

Production in Glenn County in 1947-48 consisted of natural gas and sand and gravel.

Humboldt County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Clay products, heavy clay (other than pottery and refractories)		....	3	....	3
Gold	troy ounces	139	$4,865	3	3
Sand and gravel	short tons	261,063	221,278	350,243	$293,016
Silver	troy ounces	22	20	3	3
Stone	short tons	60,120	3	23,310	3
Unapportioned (raw clay, natural gas, and items indicated by footnote 2)		....	92,201	....	114,[illegible]
Total value		....	$318,364	....	$407,[illegible]

Imperial County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gold	troy ounces	....	....	171	$5,[illegible]
Mica (scrap)	short tons	3	3	....	....
Sand and gravel	do	232,704	3	488,277	3
Silver	troy ounces	....	....	93	[illegible]
Stone	short tons	....	....	3	3
Unapportioned (crude gypsum and items indicated by footnote 2)		....	$907,843	....	1,951,[illegible]
Total value		....	$907,843	....	$1,9[illegible]

Details of mineral production for each county, 1948 and 1947 ³—Continued.

Inyo County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Antimony ore	short tons	....	....	5	$1,467
Copper	pounds	232,000	$48,720	508,000	129,768
Gold	troy ounces	1,974	69,090	1,794	62,790
Lead	short tons	8,990	2,589,120	8,620	3,085,960
Sand and gravel	do	3	3	105,178	111,937
Silver	troy ounces	1,235,998	1,118,578	573,283	518,850
Slate		....	....	....	3
Stone	short tons	60,320	118,471	3	3
Sulfur ore	long tons	898	9,074	3	3
Talc and pyrophyllite	short tons	30,444	482,007	33,540	471,598
Zinc	do	702	109,884	4,060	1,239,500
Unapportioned (boron minerals, raw clay, diatomite, fuller's earth, molybdenum, pumice and pumicite, sodium salts, tungsten concentrates, and items indicated by footnote 2)		....	1,991,52[illegible]	....	4,664,870
Total value		....	$6,506,468	....	$10,286,796

Kern County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Clay products, heavy clay (other than pottery and refractories)		....	3	....	3
Clay, raw	short tons	213,475	$746,372	218,963	$768,280
Feldspar, crude	long tons	....	....	3	3
Gold	troy ounces	6,228	217,980	6,176	216,160
Gypsum, crude	short tons	⁴ 352,977	⁴ 558,200	271,908	414,233
Natural gas	M cu. ft.	88,753,000	8,666,000	84,803,000	8,414,000
Natural gasoline and allied products:					
Natural gasoline	gallons	134,520,000	6,830,000	143,854,000	11,845,000
Liquefied petroleum gases	do	90,458,000	3,452,000	107,801,000	6,781,000
Petroleum	barrels	108,058,000	178,781,000	105,420,000	253,636,000
Sand and gravel	short tons	806,874	871,917	581,495	663,945
Silver	troy ounces	7,686	6,956	13,509	12,226
Stone	short tons	3	3	....	....
Unapportioned (boron minerals, cement, pumice and pumicite, quartz, salt, tungsten concentrates, and items indicated by footnote 2)		....	11,218,422	....	11,002,378
Total value		....	$209,037,916	....	$293,773,132

Details of mineral production for each county, 1948 and 1947[a] —*Continued.*

Kings County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gypsum, crude	short tons	3	3	3	3
Natural gas	M cu. ft.	41,113,000	$4,404,000	40,310,000	$4,545,000
Natural gasoline and allied products:					
Natural gasoline[1]	gallons	83,834,000	3,812,000	118,075,000	9,587,000
Liquefied petroleum gases[4]	do	36,525,000	1,317,000	88,480,000	4,182,000
Petroleum	barrels	7,804,000	15,217,000	6,861,000	17,965,000
Sand and gravel	short tons			3	3
Unapportioned (items indicated by footnote 2)					58,310
Total value			$24,750,000		$36,337,310

Lake County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Mercury	flasks	304	3	3	3
Sand and gravel	short tons	70,284	3	125,608	3
Stone	do	3	3	2,430	3
Unapportioned (items indicated by footnote 2)			$107,232		$110,78[illegible]
Total value			$107,232		$110,78[illegible]

Lassen County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gold	troy ounces	1	$35	121	$4,22[illegible]
Silver	do	6	5	102	[illegible]
Stone	short tons	42,980	3	3	3
Unapportioned (sand and gravel and items indicated by footnote 2)			71,788		23,8[illegible]
Total value			$71,828		$28,1[illegible]

Details of mineral production for each county, 1948 and 1947[a] —*Continued.*

Los Angeles County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Clay products, heavy clay (other than pottery and refractories)			[1] $10,936,000		[1] $14,791,000
Clay, raw	short tons	477,011	436,148	491,187	368,784
Gold	troy ounces	48	1,880	218	7,625
Lime	short tons	3	3		
Natural gas	M cu. ft.	98,435,000	5,586,000	102,763,000	11,588,000
Natural gasoline and allied products:					
Natural gasoline	gallons	299,343,000	16,098,000	313,871,000	25,923,000
Liquefied petroleum gases	do	10,036,000	401,000	19,982,000	1,257,000
Petroleum	barrels	91,807,000	184,496,000	91,096,000	223,002,000
Quartz	short tons	3	3		
Sand and gravel	do	11,088,319	8,868,923	11,809,817	8,086,435
Silver	troy ounces	6	5	36	33
Stone	short tons	4,284,150	3,187,850	4,435,270	4,323,468
Titanium concentrates (ilmenite)	do			3	3
Unapportioned (cement, diatomite, iodine, soapstone, and items indicated by footnote 2)			3,386,229		3,881,047
Total value			$303,528,633		$278,436,293

Madera County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Copper	pounds			10,000	$2,170
Feldspar	long tons	3	3		
Gold	troy ounces	197	$6,895	3	3
Pumice and pumicite	short tons	21,730	153,473	8,311	22,719
Sand and gravel	do			28,309	19,040
Silver	troy ounces	67	61	3	3
Stone	short tons	3	3		
Tungsten concentrates (60% WO_3 basis)	do	3	3	58	3
Unapportioned (natural gas and items indicated by footnote 2)			146,749		342,608
Total value			$307,178		$446,827

Marin County

Production in Marin County in 1947 and 1948 consisted of *raw clay, sand and gravel, and stone.*

Details of mineral production for each county, 1948 and 1947 [a]*—Continued*

Mariposa County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Copper	pounds	4,000	$840	...	...
Gold	troy ounces	6,363	222,705	7,525	$263,375
Platinum metals (crude)	do	...	...	1	1
Quartz	short tons	1	1	...	...
Sand and gravel	do	1	1	17,127	13,231
Silver	troy ounces	1,933	1,749	2,166	1,960
Slate		...	...	...	...
Stone	short tons	1	1		1
Unapportioned (barite and items indicated by footnote 2)		...	108,307	...	2,073
Total value		...	$333,601	...	$280,739

Mendocino County

Production in Mendocino County in 1947 and 1948 consisted of sand and gravel.

Merced County

Production in Merced County in 1947 and 1948 consisted of gold, crude platinum metals, sand and gravel, and silver.

Modoc County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gold	troy ounces	...	...	141	$4,935
Pumice	short tons	1	1	14,165	79,086
Sand and gravel	do	108,513	1	114,018	61,304
Silver	troy ounces	...	...	72	65
Stone	short tons	79,180	1	...	...
Unapportioned (items indicated by footnote 2)		...	$116,170	...	...
Total value		...	$116,170	...	$145,390

Details of mineral production for each county, 1948 and 1947 [a]*—Continued*

Mono County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Copper	pounds	18,000	$3,780	...	...
Gold	troy ounces	41	1,435	83	$2,905
Lead	short tons	17	4,896	2	716
Pumice	do	4,738	220,088	9,583	257,235
Silver	troy ounces	7,323	6,627	788	713
Stone	short tons	1	1	...	...
Tungsten concentrates (60% WO_3 basis)	do	1	1	...	...
Unapportioned (pyrophyllite, sand and gravel, and items indicated by footnote 2)		...	96,067	...	94,828
Total value		...	$332,893	...	$356,407

Monterey County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gold	troy ounces	...	...	24	$840
Sand and gravel	short tons	648,973	$1,022,058	808,150	1,525,800
Silver	troy ounces	...	...	6	5
Stone	short tons	147,730	232,980	197,150	281,186
Unapportioned (lime, magnesium compounds, petroleum, salt, and ground sand and sandstone)		...	1,724,259	...	2,389,144
Total value		...	$2,979,297	...	$4,196,755

Napa County

Product		1947 Quantity	1947 Value	1948 Quantity	1948 Value
Gold	troy ounces	...	...	2	$70
Pumice, crude	short tons	...	...	1	1
Sand and gravel	do	1	1	37,670	32,800
Silver	troy ounces	...	...	29	26
Stone	short tons	181,440	$202,386	58,130	78,512
Unapportioned (mercury, pumice and pumicite, and items indicated by footnote 2)		...	157,525	...	192,177
Total value		...	$359,911	...	$303,585

more than tripled in 1915 and for several years following. From 1922-34 production continued at a 54 tons per year average, but from 1935-40 no asbestos was produced in California. Production was resumed in 1941 and has continued to the present at an average rate of more than 100 tons per year.

A chrysotile deposit 7 miles southeast of Copperopolis, Calaveras County, was one of the first to be systematically developed.[3] Work began in 1904 and continued intermittently until 1923. Equipment included a crusher, hammer mill, and compressor. A small tonnage of fiber was produced and used in acoustical and fire-proof plaster. Further experimental work was done in 1927.

A short-fiber chrysotile was produced in small quantities between 1917 and 1923 from a serpentine area near Washington, Nevada County.[4] The rock was mined in an open pit and crushed in a 20-stamp mill equipped with air-suction and fiberizers. The stamps were later replaced by crushing rolls.

Chrysotile in a serpentine belt on the southwest slope of Sampson Peak near Hernandez, San Benito County [5] was mined by hand methods between 1921 and 1925. The crude ore was run through a mill consisting of a crusher and some air-suction equipment. No dryer was included in the flow sheet, and the property was worked only during the dry season.

A small production of chrysotile from Monterey County and amphibole from Riverside County was reported in 1930. These were used for test purposes and as packing in the manufacture of automobile battery boxes, respectively.

Chrysotile produced in Napa County during 1933-34 was used for test purposes and for experiments in mill design. Short-fiber chrysotile was obtained from a deposit in Steel Canyon, Napa County,[6] from 1941-45. The ore was mined from an open cut. The mill consisted of a jaw-crusher, rotary dryer, two cyclones, shaking screens, two disintegrators, and a bagger. The product was used in plaster and stucco for fireproofing war-plant buildings.

Small lenses and pockets of tremolite in peridotite at Mears Creek in the northwestern corner of Shasta County [7] have been mined, and shipped from 1942 to the present. This fiber after hand sorting and shipping is processed by the Powhatan Mining Company and made into acid filter pads for the Gooch crucibles used in chemical laboratories.

A vein of white slip-fiber tremolite is found near Iowa Hill, Placer County, at the serpentine-slate bedrock contact in the old hydraulic mine workings. The vein ranges from six to 15 feet in width and fibers 9 inches long have been reported. A small production of these fibers for use in acid filters has been reported from 1942 to the present.

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[3] Logan, C. A., Auburn field division—Calaveras County: California Min. Bur. Rept. 18, p. 98, 1922.
Logan, C. A., and Franke, Herbert, Mines and mineral resources of Calaveras County: California Div. Mines Rept. 32, p. 226, 1936.
[4] MacBoyle, Errol, Mines and mineral resources of Nevada County: California Min. Bur. Rept. 16, pp. 67-70, 1918.
[5] Laizure, C. McK. San Benito County: California Min. Bur. Rept. 22, pp. 223, 1926.
Averill, C. V., Mines and mineral resources of San Benito County: California Jour. Mines and Geology, p. 47, 1947.
[6] Davis, Fenelon F., Mines and mineral resources of Napa County: California Jour. Mines and Geology, p. 163, 1948.
Weaver, Charles E., Geology and mineral deposits of an area north of San Francisco Bay: California Div. Mines Bull. 149, 1950.
[7] O'Brien, J. C., Current and recent mining activities in the Redding district: California Jour. Mines and Geology, pp. 334-355, 1948.

Utilization.[8] Asbestos is of two commercial classes; spinning and non-spinning fiber. The long, strong, flexible fibers are spun into yarn, which is woven into heat-resisting fabrics such as brake linings, tape, and cloth. Chrysotile is best adapted to this use, although the better grades of crocidolite, amosite, and sometimes tremolite, can also be used. Some of the longer grades are used in magnesia block and pipe insulation consisting of 85 percent magnesia and 12 percent asbestos. Here, as well as in cements, plasters, and molded articles, the asbestos acts as a binder.

The shorter non-spinning grades are made into shingles, siding, and paper. The use of asbestos-cement pipe for gas, sewer, and water mains is increasing, as this pipe is resistant to acid and corrosion, and is non-conductive, and shock-proof. The fiber waste or shorts are used in making asbestos plaster, flooring, and as fillers in grease and paint. The best grades of tremolite and anthophyllite are acid-resistant and are used as filters in chemical laboratories. The low-iron variety of chrysotile found in Arizona is valuable in making electrical insulation tapes. Many new uses and adaptations for asbestos fibers are constantly being developed in the insulation and other industries. A typical example is the use of spray-coated insulation for metal, concrete, wood, and other surfaces.

Mining Methods and Treatment.[9] Because large commercial deposits of asbestos such as those in Quebec cover extensive areas, and the fiber content of the host rock averages only from 5 to 10 percent, open-cut large-tonnage operations are almost always employed in the early stages of development. The rock is blasted, loaded with power shovels, and trucked to the recovery plant. At a later period in the life of a property underground mining methods may be introduced. Both shrinkage-stope and block-caving methods have been successfully used for final-stage operations in the Canadian mines.

Milling [10] consists of separating the fiber from the barren rock by repetitive crushing, screening, and air-suction. A typical mill flow sheet would include primary and secondary rock crushing to 3-inch size, furnace drying to remove moisture, and third-stage crushing to free the fiber. The third-stage crushing product, about ½-inch size, flows to a longitudinal shaking screen. Gravity concentration occurs as the material moves along the screen, producing a layer of light-weight fiber on top and a layer of heavier rock on the bottom. The light-weight fiber is removed through a suction hood installed at the end of the screen. The oversize rock flows over the end and the undersized rock drops through the screen. The oversize is crushed to ¼-inch size and rescreened as outlined above. The undersize is fed to a fiberizer, consisting of high-speed hammers which break the rock by impact, making a further separation of rock and short fibers. The latter are separated by another suction-screening operation. When free, the fiber is passed to a two-level screen for size classification. The shorts drop through both screens, the medium-length fiber is removed by air-suction from the end of the lower screen, and the long fiber is similarly removed at the end of the top screen.

Markets.[11] Many of the world's largest asbestos companies mine and mill the crude material at company-owned deposits, and then manu-

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[8] The uses of asbestos and asbestos products, in the Asbestos Factbook, 2d ed., pp. 5-15, Philadelphia, Secretarial Service, 1944.
[9] Smith, C. V., Asbestos mining methods: Asbestos, vol. 26, nos. 3, 4, 5, 1944.
[10] Kelleher, J. C., Milling asbestos: Asbestos, vol. 27, nos. 3, 4, 6, 1945.
[11] Ross, J. G., and Jenkins, George F., op. cit.

facture the finished products in their own plants. Other producers sell to consumers of raw material, either directly or through agents and mineral dealers. In the latter case it is customary for the producer or dealer to submit samples for the approval of the consumer. Sales contracts are usually based on the type and length of fiber, but may also specify fiber strength, color, flexibility, and chemical content.

In 1948 high-grade Canadian crudes and spinning fibers commanded an average price of $609 per short ton. Only one-tenth of 1 percent of the Canadian production was placed in this classification. An intermediate grade of Canadian fibers used in shingles and sheeting averaged $107 per short ton. About 34 percent of the production was in this category. Short fibers averaged $33 per ton, according to the Department of Mines, Province of Quebec, Canada.[12] Most of the production, 66 percent, fell in this class.

The price on amphibole asbestos produced in California in 1948 ranged from $50 to $200 per short ton depending on iron content and ignition loss.

The production of asbestos in the United States was approximately 34,000 short tons in 1948, and currently constitutes about 4 percent of the country's consumption. The sources of domestic chrysotile in 1948 were the mines of The Ruberoid Co., near Eden, Vermont, and mines near Globe, Arizona. Amphibole was produced in California, Georgia, and North Carolina. The difference between domestic production and domestic demand was balanced by the importation of 687,163 net short tons of asbestos minerals from foreign deposits. Canadian chrysotile from the province of Quebec accounted for about 94 percent of the imports, or 644,915 net short tons according to the U. S. Bureau of Census.[13] The remainder of the imported fiber originated chiefly in South Africa and consisted of amosite, crocidolite, and chrysotile. An extensive program of underground development and mill expansion is underway in Canada to meet the increasing demand for Canadian chrysotile.

ASPHALT AND BITUMINOUS ROCK

By Gordon B. Oakeshott

The use of natural California asphalt has been traced back to prehistoric time when Indians used it to caulk their plank canoes.[1] In the early development of roads in California, local sources of asphalt and bituminous rock were used for surfacing. In later years, natural asphalt was replaced by the heavy products of petroleum refineries which have proved to be more uniform, of higher grade, and to permit better control of specifications. The largest production of natural asphalt was during the years 1910 and 1911; in 1947-48 there was only one producer in the state. In the last few years there has been renewed interest in the large deposits of bituminous rock of central and southern California, as a possible source of raw material for power development, and as a direct source of petroleum.

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[12] Personal communication; also see Josephson, G. W., and Marsh, Dorothy I., Asbestos: Minerals Yearbook, 1946, p. 150, 1948.

[13] Monthly imports and exports: Asbestos, vol. 28, no. 11, May 1949.

[1] Heizer, Robert F., Aboriginal use of bitumen by the California Indians: California Div. Mines Bull. 118, p. 74, 1943.

Composition. Natural asphalt consists of heavy liquid, semi-solid, and solid hydrocarbon residues left when liquid petroleum migrates upward into surface and near-surface rocks and soil and loses its lighter fractions by evaporation. This process results in various types of accumulations of bituminous material, from seeps and pools of almost pure heavy petroleum to rock in which dry petroleum fills a fraction of the pore space. Such terms as "tar sand," "oil shale," and "asphalt rock" are included in the more general term "bituminous rock," which refers to any rock carrying a substantial amount of petroleum. The so-called "oil shale" in California contains hydrocarbons in the form of natural petroleum, while elsewhere, as near Rifle, Colorado, the term "oil shales" may refer to rocks that contain a carbon compound, referred to as kerogen, which is not petroleum, but which may be processed to yield petroleum products.

Various peculiar hydrocarbon substances which are usually considered as separate mineral species, but are closely related to asphaltum (the general name applied to pure solid asphalt), are found in widely separated localities in the Coast Ranges of California. Examples are *gilsonite*, found at Sisquoc in Santa Barbara County; *amber*, found in the Simi Valley in Ventura County; *curtisite*, occurring in serpentine in San Francisco, and with cinnabar in Lake, Napa, and Sonoma Counties; *aragotite*, associated with cinnabar in Napa and Santa Clara Counties; *napalite*, found in cinnabar mines in Napa County; and *posepnyte*, occurring in the cinnabar mines of Lake and Napa Counties. Chemically, they are hydrocarbons, consisting of compounds of hydrogen and carbon, often with oxygen also present. These peculiar hydrocarbon minerals have not proved to be of commercial importance in California.

General Geologic Occurrence. The bituminous materials that are found in bituminous sandstone and shale and in oil or tar seeps originated in organic shales and migrated in a fluid state into porous and permeable reservoir rock such as sandstone, conglomerate, diatomite, and fractured shale and chert. The organic source shales in California range in age from Upper Jurassic to Pliocene, but Miocene shale, including diatomite, is nearly always found in the areas of bituminous rock and appears to have been the major source of the petroleum. Large areas of bituminous rock represent oil sands or shales which have been exposed by erosion, allowing evaporation of the lighter petroleum fractions; the exposed sands may grade down dip into wet oil sands capable of yielding oil by drilling. In such rocks the natural tar seal aids in trapping liquid petroleum at depth. Tar seeps, deposits of asphaltum, and bituminous sandstone in zones of fracture, faulting, and severe folding, commonly occur along fold axes, at contact surfaces between different rock types, and along bedding planes in stratified rocks. Dikes and sills of bituminous sandstone are also common; some are large enough to be of commercial importance. Pressure from earth movements and overlying formations forces the easily deformed and relatively plastic oil sands along zones or planes of relative weakness.

Asphalt, bituminous rock, and tar seeps are found quite generally in the petroleum-producing areas of the state. In the early history of drilling in California, wells were most often located by such signs without regard to geologic formations or structure. The most northerly oil seeps in California are in southern Humboldt County, where they dioxide is oxidized to sulfur trioxide; platinum, or vanadium pentoxide is used as a catalyst. The sulfur trioxide is subsequently absorbed in concentrated sulfuric acid.[1]

Hydrogen sulfide gas used in making sulfuric acid is selectively absorbed from oil-refinery gases by liquid sodium phenolate. It is later regenerated from solution.[2]

Utilization. Sulfuric acid is used in greater volume and has more applications than any other industrial chemical. As it is used by nearly every industry, the demand for sulfuric acid is an accurate and sensitive indicator of general business conditions.

Sulfuric acid is the cheapest acid per unit of chemical activity. Its outstanding chemical characteristics are its ability to decompose most metals and other substances, to remove organic matter, and to neutralize alkalies. Among its most important industrial uses are the manufacture of fertilizers, soap, paper, storage batteries, and explosives. It is also widely used in processes of electroplating, electrodeposition, and oil refining.

Marketing. Marketing of sulfuric acid is generally restricted to areas surrounding centers of manufacture. This is necessitated by its bulk, the expense of packaging, and the high cost and danger of transporting the acid compared with like considerations in transporting sulfur pyrites, and niter used to produce it. Prices vary widely, depending on the lot sizes and the area of production.[3]

TALC, SOAPSTONE, AND PYROPHYLLITE

By Lauren A. Wright

The commodities talc, soapstone, and pyrophyllite customarily are discussed as a group, and the U. S. Bureau of Mines combines the annual production of these materials in a single figure. The pyrophyllite occurrences of California, however, can be conveniently considered separately and are included under a separate heading of this section. In 1948 the state's combined production of talc, soapstone, and pyrophyllite was nearly 100,000 tons. In recent years talc mining has increased sharply and pyrophyllite has been mined in quantity for the first time. Soapstone, as a relatively impure variety of talc, was mined in California long before the first production of either pyrophyllite or high-quality talc. The soapstone output, however, has always been small compared with the current output of high-quality talc.

TALC AND SOAPSTONE

Mineralogy and Geology. To the mineralogist "talc" is a distinct mineral species with a composition of $H_2Mg_3(SiO_3)_4$, but in commercial usage the term commonly alludes to a mixture of minerals most of which are high-magnesium silicates. The mineral talc is usually, but not necessarily, a prominent constituent. Other common minerals in such mixtures include tremolite $[Ca_2Mg_5Si_8O_{22}(OH)_2]$, serpentine (a hydrous magnesium silicate), chlorite (an alumino-silicate of iron and magnesium),

[1] Fairlie, A. M., Sulfuric acid manufacture, pp. 21-48, New York, Reinhold Publishing Co., 1936.

[2] Stockman, L. P., Standard Oil operating sulfur recovery unit at El Segundo: Oil and Gas Jour., vol. 35, no. 23, p. 46, 1936.

[3] Kreps, T. J., The economics of the sulfuric acid industry, pp. 1-284, Stanford Univ. Press, 1938.

anthophyllite $[(Mg,Fe)_7Si_8O_{22}(OH)_2]$, olivine $[(Mg,Fe)_2SiO_4]$, carbonate minerals, and quartz. The chemical compositions of many commercial tales, therefore, do not approximate the composition of the pure mineral.[1] The industrial usage to which the material is put determines whether a particular mineral of this group is beneficial, harmless, or undesirable.

Soapstone commonly contains a higher proportion of the mineral talc than do some commercial "talcs." But the term soapstone, as ordinarily used, implies the presence of impurities that prevent the use of the material as a high-grade commercial talc. Compactness is also an implied characteristic of soapstone.

Commercial talc deposits are ordinarily alterations of dolomite, limestones, or ultrabasic rocks. Most of the talc now produced in California has altered from dolomite or limestone. The soapstone deposits are most commonly associated with bodies of serpentine or talc-actinolite schist.

Talc Deposits of Eastern California. The talc deposits in California that have formed by the alteration of dolomite or limestone are largely confined to a 200-mile belt which parallels the California-Nevada line from the Inyo Range, Inyo County, southwestward to the vicinity of Baker, San Bernardino County. Included in this belt are three contrasting talc-bearing areas which have been designated respectively as the Inyo Range, southern Death Valley-Kingston Range, and Silver Lake talc provinces.[2] Each province contains deposits which are geologically similar. Each also contains a mine which was first opened in the period 1915-19 and which has since produced more than 100,000 tons of talc.

Inyo Range Province. Most of the talc deposits of the Inyo Range province are exposed on the east and west slopes of the range itself and in an area between Darwin and Keeler near the southern end of the range. The talc in this province has formed by the hydrothermal alteration of Paleozoic dolomite and, to a lesser extent, of silica rock and granitic rock.[3] Many of these deposits contain talc of the type known to the ceramic industry as "steatite." Steatite is an unusually pure material which is composed almost wholly of the mineral talc and which can be used as an ingredient in the manufacture of high-frequency insulator bodies. Magnesium silicate minerals other than talc are uncommon in the Inyo Range deposits. Individual talc bodies in this province are characteristically pod-like or irregularly shaped. The largest known bodies, however, are more regular than the average and have lengths of more than 500 feet and maximum widths of 50 feet. In many of the deposits the alteration has apparently been guided by shears and fractures.

The Talc City mine, about 13 miles southeast of Keeler, Inyo County, has produced over 200,000 tons since 1915 when it was first worked. This is the largest output of any talc mine in California. During World War II this property was the nation's principal source of steatite which was critically needed in the manufacture of electrical equipment for the armed forces.

[1] In this report the term "talc," unless otherwise qualified, will be used in its commercial meaning.

[2] Wright, L. A., California talcs: Min. Eng., vol. 187, no. 1, pp. 122-128, Jan. 1950.

[3] Page, B. M., Some California talcs of steatite grade: Min. and Ind. News, vol. 16, no. 1, p. 12, Jun. 1948.

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The White Mountain mine, on the southeastern flank of the Inyo Range, was also an important war time steatite producer. This mine was first worked in 1935 and has been operated nearly continuously during the past 10 years. Approximately 15 other talc mines in the province have been active in the past, but none have total outputs comparable with those of the Talc City and White Mountain properties.

Southern Death Valley-Kingston Range Province. Another province that contains geologically similar talc deposits extends from the southeast portion of the Panamint Range eastward across the southern end of Death Valley to the east side of the Kingston Range. In this area all of the commercial talc has formed by the alteration of the lowermost carbonate beds in a late pre-Cambrian sedimentary series. At or near the base of the carbonate beds a diabase sill is everywhere present and is in contact with or proximate to the talc bodies. The talc, carbonate strata, and diabase are all part of the Crystal Spring formation. At several localities the talcose horizon is exposed for a distance of well over a mile, but commercial talc concentrations within it are ordinarily less continuous.

Though all talc deposits in this province have nearly the same stratigraphic position, they differ markedly in mineralogic detail. Some deposits consist almost wholly of fibrous or micaceous varieties of the mineral talc. Other deposits contain two or more types of commercial talc. These types include compact, fine-grained and thinly laminated tremolite rock; coarse-grained mixtures of tremolite, and the mineral talc; and a massive, crudely laminated variety of the mineral talc, as well as the fibrous and micaceous types.

The Western mine, immediately south of Tecopa Pass in San Bernardino County, has been the principal talc producer in the province. Since the property was first worked in 1917, it has yielded well over 150,000 tons. Most of this production has come from a single talcose zone which is more than 5000 feet long and from 20 to 90 feet wide. The zone is underlain by a diabase sill and overlain by siliceous dolomite.

Within recent years several other properties in the province have become active. These include the Excelsior mine on the west flank of the Kingston Range; the closely grouped Monarch, Pleasanton, and Ibex mines at the southern end of the Ibex Hills; the Superior and White Cap mines near Saratoga Spring at the southernmost tip of Death Valley; and the Warm Spring mine in Warm Springs Canyon in the southeastern portion of the Panamint Range. The general geologic features at all of these properties are similar to those of the Western mine and some of the deposits are being worked on a comparable scale. At the Superior and White Cap mines the commercial talc bodies lie beneath, instead of above, the diabase sill. Numerous other talc deposits in the province have been mined in the past and still others remain to be developed. At least three are scheduled to be worked for the first time in 1950 or 1951.

Silver Lake Province. The southernmost province in the eastern California talc-bearing belt is in the vicinity of Silver Lake, San Bernardino County. Three properties are currently active in this area. The largest of these operations, the Silver Lake mine, is about 10 miles north-northwest of Baker. It has been operated since 1918, and has yielded approximately 150,000 tons of talc and talc-tremolite rock. The commercial bodies are in a persistent feldspar- and diopside-rich member of a highly metamorphosed sedimentary series. Igneous rocks that range from mafic to felsic in composition have extensively invaded the metasediments. Individual talc bodies, the largest of which has an 800-foot surface exposure, are narrow and lenticular, and represent a nearly complete replacement of carbonate strata.

Most of the talc is highly tremolitic, but relatively pure concentrations of the mineral talc are common next to the footwalls of the commercial bodies. Talc concentrations also occur, though less commonly, within the talc-tremolite bodies and next to their hanging walls.

In the Silver Lake province two other deposits, the Calmasil and Pomona mines, are being worked. These are in the vicinity of Yucca Grove, about 12 airline miles north-northeast of the Silver Lake mine. Here, as at Silver Lake, the talc bodies are tremolitic and represent alterations of carbonate strata in metasedimentary rocks. Here, also, igneous rocks are extensively exposed.

Talc and Soapstone Deposits of the Sierran Foothill Belt. In California the talc-rich rock obtained from deposits in the talc-actinolite schist and serpentine bodies of the western foothills of the Sierra Nevada has ordinarily been called soapstone. The high iron content typical of this material has made it unsuitable for most of the uses cited for the so-called high-grade talcs. Though mined in much smaller quantity than talcs of the eastern California belt, the soapstone has been in steady demand for many years. Relative nearness to markets and inexpensive mining favor the development of these deposits.

Since 1895 soapstone production has been recorded from 17 properties in seven Sierran foothill counties. Previously, soapstone had been mined and used as a construction material in this area, but specific data on this earlier production are not available. Most operations were small, and but few continued for periods greater than 10 years.

The Swift deposit near Latrobe, El Dorado County, was operated during the period 1916-24 and was again worked for about 4 years beginning in 1936. The Prouty talc mine, 1½ miles south of Shingle Springs, El Dorado County, was worked intermittently from 1919-28. The McLean deposit in Butte County was worked from 1923-40, and the Pacific Minerals Company deposit, about 3 miles northeast of Latrobe in El Dorado County has been worked from 1929 to the present.

Other properties contributing soapstone within the last 30 years include one in Butte County, two in Calaveras County, three in El Dorado County, one in Tulare County, two in Tuolumne County, and five in Amador County.

Miscellaneous Talc and Soapstone Deposits. Talcose material has also been produced from several other deposits scattered throughout the state. Talc deposits on Santa Catalina Island, which were worked in the eighteen-nineties, are among the first for which there is a recorded output. In 1917 and 1923 a small amount of talcose rock is reported to have been obtained from a deposit near Acton, Los Angeles County. Since 1940 talc has been intermittently obtained from the Ganim mine, a gold property near Schilling, Shasta County. The talc bodies at the Ganim mine are in an altered zone in meta-andesite.

Uses and Marketing of Talc and Soapstone. Most of the talc mined in California is milled in Los Angeles; the remainder is processed at plants in the desert area, in the San Francisco Bay area, and at Ogden,

LIST OF SMELTERS AND MINERAL DEALERS REPORTING PURCHASE OF CALIFORNIA METALS PRODUCED IN 1948.

Name	Address	Location of plant	Metals reported purchased
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Garfield, Utah	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Hayden, Arizona	Copper, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Murray, Utah	Lead, copper, gold, silver
American Smelting & Ref. Co.	405 Montgomery St., San Francisco	Selby, California	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Tacoma, Washington	Copper, lead, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N. Y.	Great Falls, Mont.	Copper, lead, zinc, gold, silver
Bethlehem Pacific Coast Steel Corporation	20th and Illinois Sts., San Francisco	San Francisco	Iron ore
Bradley & Ekstrom	220 Market St., San Francisco	San Francisco	Manganese, chromite, iron ore
Braun Corporation	2260 E. 15th St., Los Angeles	Los Angeles	Quicksilver
Coast Chemical Division F. W. Berk & Co., Inc.	Sharon Bldg., San Francisco	San Francisco	Quicksilver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Tooele, Utah	Copper, lead, zinc, gold, silver
Kaiser Co., Inc.	P.O. Box 217, Fontana	Fontana	Iron ore, manganese ore, chromite
Mefford Chemical Co.	1026 Santa Fe, Los Angeles	Los Angeles	Quicksilver
Pacific Vegetable Oil Co., Bernard T. Rocca	62 Townsend St., San Francisco	San Francisco	Quicksilver
Quicksilver Producers Ass'n., Irving Ballard, Sec'y.	407 Sansome St., San Francisco	San Francisco	Quicksilver
Twining Laboratories	2527 Fresno St., Fresno	Fresno	Tungsten ore
U. S. Mint	Duboce & Market Sts., San Francisco	San Francisco	Gold, silver
U. S. Smelting, Refining & Mining Co.	Newhouse Bldg., Salt Lake City, Utah	Midvale, Utah	Copper, lead, zinc, gold, silver
Western Gold & Platinum Works	589 Bryant St., San Francisco	San Francisco	Platinum, gold, silver*
Wildberg Bros. Smelting & Ref. Co.	742 Market St., San Francisco	San Francisco	Platinum, gold, silver*

* Gold and silver in special high-grade ores only.

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LIST OF MINERAL DEALERS, CUSTOM MILLS, AND COMMERCIAL GRINDING PLANTS IN CALIFORNIA

FIRM	NOTES
American Minerals Co., 840 Mission Rd., Los Angeles, Calif.	Commercial grinding of minerals.
Atkins, Kroll & Co., 230 California St. San Francisco 4, Calif.	Dealer in tungsten ores, mercury, gypsum and limerock.
Baroid Sales Division, National Lead Co., 830 Ducommun St., Los Angeles, Calif.	Talc and other soft non-metallic minerals ground by contract or purchased.
Bishop Concentrate & Cleaning Co., Bishop, Calif.	Custom mill; purchase tungsten ores and base metal ores.
Bond, Harry E., Co., 2028 Alhambra Ave., Los Angeles, Calif.	Dealer in industrial sand and silica products.
Blue Star Mines, Ltd., 957 S. Anderson, Los Angeles, Calif. (Mill at Zurich)	Dealer in talc, clay, and limestone.
Bond Bros. & Co., 461 Market St., San Francisco 5, Calif.	Dealer in export minerals.
Bradley & Ekstrom, 220 Market St., San Francisco 11, Calif.	Dealer in all commercial minerals.
Bromley-Donaldson Co., 257 Howard St., San Francisco 5, Calif. and 3050 E. Slauson Ave., Huntington Park, Calif.	Dealer in sand, clay, limestone, dolomite, and other minerals.
Burton Bros., Rosamond, Calif.	Custom cyanide mill. Gold and silver ores purchased.
Butte Lode Mining Co., Randsburg, Calif.	Custom amalgamation mill, gold-silver ore.
Commercial Minerals Co., 810 Irwin St., San Francisco 7, Calif.	Commercial grinding by contract or minerals purchased.
Dailey Chemical Laboratories, Box 228, Oroville, Calif.	Custom mill for black sands.
Empire Star Mines Co., Ltd., Grass Valley, Calif.	Amalgamation and cyanide mill; gold ore purchased.
Gladding Co., 600 S. Mission Rd., Los Angeles, Calif.	Clay grinding plant; non-metallic minerals ground by contract or purchased.
Hill Bros. Chemical Co., 2150 Bay St., Los Angeles, Calif.	Grinding asbestos, and custom milling of small lots of soft non-metallic minerals.
Huntley Industrial Minerals, P. O. Box 305, Bishop, Calif.	Dealer in talc, pyrophyllite, asbestos, and garnet sands.
Industrial Minerals & Chemical Co., 836 Gilman St., Berkeley, Calif.	Non-metallic minerals ground by contract or purchased.
Kennedy Minerals Co., 2550 E. Olympic Blvd., Los Angeles, Calif.	Non-metallic minerals ground by contract or purchased.

andalusite deposit described in the section on andalusite, kyanite, and sillimanite in this bulletin. Pyrophyllite is now being obtained at operations near the north and south ends of a pyrophyllitic zone which is exposed for a distance of about 2 miles along the lower west face of the White Mountains east of the Shealy rail siding. The pyrophyllitic zone lies to the west of the quartzose, andalusite-bearing zone and is, itself, bordered on the west by micaceous schists. Surface exposures of the pyrophyllitic zone are commonly several hundred feet in width, though not all of the zone has yet proven to be of commercial material. Both mines are quarrying operations.

Pyrophyllite has also been obtained from a recently developed deposit about 5 miles north-northwest of Aberdeen, Inyo County. Here a pyrophyllitic layer is overlain by crinoidal limestone. The extent of the deposit is largely obscured by alluvium which overlaps it on three sides.[4]

Since 1945 pyrophyllite has been obtained from the Pioneer mine in the San Dieguito area of west-central San Diego County. The pyrophyllite bodies are elongate lenses representing the alteration of Jurassic (?) volcanic rocks which are intermediate to felsic in composition.[5] Exposures of the pyrophyllite-bearing volcanics are confined to an area of approximately 1 square mile. The primary layering in the volcanics and the long direction of the pyrophyllite lenses generally strike northwest.

The highest grade pyrophyllite schist is a lens at least 150 feet long and 15 feet in average thickness. The main workings are open cuts and have been developed primarily in this body.

Uses of Pyrophyllite. Pyrophyllite and talc are employed in many similar uses, though in California and throughout the world talc is mined in much larger quantity.

In recent years pyrophyllite has been used principally as an insecticide diluent, and as a filler in hard rubber. It is also employed as a raw material in the manufacture of wall tile and refractory ceramic bodies. Other materials in which pyrophyllite serves effectively as a filler include roofing, cotton cordage, textiles, special plasters, paper, oilcloth and linoleum, plastics, and soap. Small amounts have been used as a base for cosmetic preparations. Nearly all of the pyrophyllite mined in California to date has been marketed as insecticide dust, but in mid-1949 material from the Huntley deposit in Mono County was being shipped to the Los Angeles area as a red-burning tile ingredient.

Processing and Prices of Pyrophyllite. Like talc, pyrophyllite is dry-ground to a fine size and to standard grades. California operators have valued unground pyrophyllite at the mine in the range of $10 to $20 per ton.

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[4] Oakeshott, G. B., oral communication.

[5] Jahns, R. H., and Lance, J. F., Geology of the San Dieguito pyrophyllite area, San Diego County, California, in preparation.

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PART IV

METALS

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Utah. Milling consists simply of dry grinding, but care is taken to maintain standard grades. Much of the talc is sold unblended, but the blending of different talc types is a common practice.

More than half of California's current talc output is consumed by the ceramic industry. Steatite from the Inyo Range is shipped to factories in the eastern United States where it is used as the principal raw material in high-frequency insulator bodies. A large part of the production of both tremolitic and non-tremolitic talc mined in the Death Valley and Silver Lake areas is marketed as an ingredient in wall tile. The principal market for this product is in the Los Angeles area, but wall-tile talc is also shipped to other western cities. Smaller quantities of California talc are used as a raw material in other ceramic ware.

Most of the remainder of the talc produced in eastern California is consumed by the paint, rubber, and textile industries. The fibrous talcs of the Death Valley area are widely used as a paint extender and for this purpose are shipped to many out-of-state consumers. The fibrous talcs are also marketed to textile mills in the eastern United States. Talc is marketed to the rubber industry both as a filler and as a lubricant. Smaller amounts are used in insecticide carriers, in cosmetics, and for various minor industrial applications.

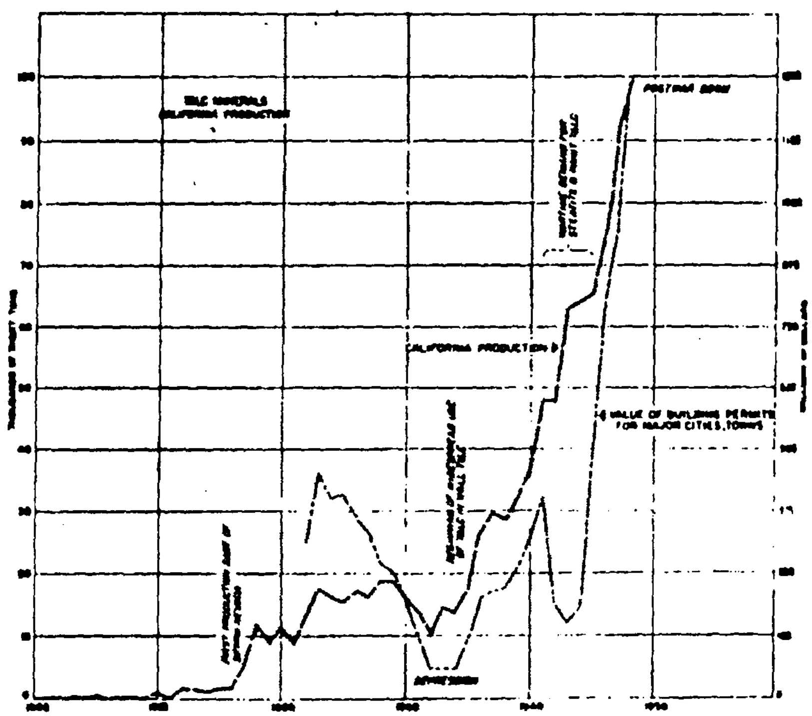

FIGURE 1. Chart showing production of talc, soapstone, and pyrophyllite in California 1900-48, compared with value of California building permits, 1922-48.

Most of the past production of talc and soapstone from the Sierran foothill belt has been used as a filler in the manufacture of roofing. In recent years the material has been used principally as an insecticide dust.

Mining Methods. In California talc mines, underground methods are ordinarily employed, though recently a relatively large tonnage of talc at the Silver Lake mine has been removed in surface operations.

Early operations at the Talc City mine employed a glory-hole method, but underground caving was later used. More recently the ore has been removed from overhand stopes that are supported by timbers where necessary.

In the early development of most of the talc mines in the southern Death Valley-Kingston Range area adits were employed. But in their later histories mining by shafts or winzes has become necessary. Production at the Western mine is currently obtained through inclined shafts spaced at intervals along the talc body. From these and appended cross-cuts, drifts have been driven along the deposit. Most of the talc has been removed by overhand stoping. A similar method has been employed at the Superior mine.

The Monarch mine has been developed by successively longer adits that have encountered the deposits at successively deeper points. Square-set timbers have been extensively used in stoping at this property. The talc bodies at Warm Spring are mined by closely spaced parallel adits driven from a canyon wall. The adits are joined by low-angle raises that are progressively enlarged to form a modified room and pillar system.

The steeply dipping deposits at Silver Lake have been most commonly developed by shafts that are sunk to the keel of the deposits. At several levels drifts are driven to the along-strike limits of the ore bodies; the talc is removed by overhand stoping and is hoisted to the surface.

The talc and soapstone mines of the Sierran foothill belt have been chiefly quarrying operations.

Prices of Talc and Soapstone. The value of California talc as mined has been, in general, difficult to determine because the producers ordinarily market the talc after it is transported to the mill, ground, and sacked. In recent years, producers in the eastern talc belt have set values ranging from $10.00 to $18.00 per ton for material at the mine. Soapstone from the Sierran foothill belt has been valued in the range of $3.00 to $10.00 per ton at the mine.

PYROPHYLLITE

Mineralogy and Geologic Occurrence. Pyrophyllite $[Al_2Si_4O_{10}(OH)_2]$ has physical and optical properties similar to those of talc; but contains aluminum instead of magnesium. In California, as elsewhere, the geological occurrences of the two minerals are dissimilar. Most of the commercial deposits of pyrophyllite have formed by alteration of acidic volcanic rocks. But pyrophyllite also has been noted in metamorphosed sedimentary rocks and in or along gold-quartz veins.

Localities. The commercial production of pyrophyllite in California was recorded for the first time in 1945. Four properties, two in Mono County and one each in Inyo and San Diego Counties, are currently active.

The two pyrophyllite properties in Mono County are in the belt of highly metamorphosed rock which contains the White Mountain