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BUREAU OF MINES MINERALS YEARBOOK

Minor Nonmetals

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR • Stewart L. Udall, Secretary

BUREAU OF MINES • Earl T. Hayes, Acting Director

This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising *Volume I–II, Metals, Minerals, and Fuels; Volume III, Area Reports: Domestic; Volume IV, Area Reports: International.* Individual chapters from all volumes and the separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

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Minor Nonmetals

By Staff, Division of Mineral Studies

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GREENSAND [1]

Domestic production of greensand (glauconite) increased 5 percent in quantity and decreased 1 percent in value compared with that of 1966. The average annual production for 1963–67 was 3,298 short tons valued at $193,576. The material was marketed for use as a soil conditioner and a water softener.

Since only two firms, Kaylorite Corp. of Maryland and Iversand of New Jersey, produced greensand in 1967, statistics on production and sales for the year are withheld to avoid disclosing individual company confidential data.

IODINE [2]

Production of naturally occurring iodine in the United States decreased in 1967, because late in 1966 one of the country's two producing facilities, the operation near Seal Beach, Calif., was closed down. Michigan, the only producing State, reached a new high with an output slightly above that of 1966. Imports of iodine decreased substantially during 1967 owning to the reduction in deliveries under the barter program.

Legislation and Government Programs.—The Government strategic stockpile contained 2,955,693 pounds of iodine, the supplemental stockpile 4,149,923 pounds, and the Commodity Credit Corporation stockpile 251,928 pounds for a total of 7,357,544 pounds at the end of 1967. The stockpile objectives for iodine is 8 million pounds.

Under the barter program authorized by the Agricultural Trade Development and Assistance Act of 1954, as amended, (Public Law 480, 83d Congress) and the Commodity Credit Corporation Act, as amended, approximately 252,000 pounds of iodine was delivered to the Government stockpile in 1967.

Domestic Production.—Crude iodine production in the United States was 16 percent lower in volume and 13 lower in value than in 1966. The entire 1967 output was recovered from natural brines at Midland, Mich., by the Dow Chemical Co., and production from this source was slightly higher than in 1966. Operations of The Dow Chemical Co., near Seal Beach, Calif., were phased out in September 1966.

Consumption and Uses.—The consumption of crude iodine declined 5 percent compared with 1966 consumption. However. a large increase in the consumption of crude iodine for sanitizers, disinfectants, and intermediates resulted in a 44-percent increase in the consumption of iodine organic compounds compared with 1966 levels. Much of the iodine and its compounds was consumed in medicines and antiseptics and agriculture. New applications for iodine included use as a stabil-

[1] Prepared by Richard W. Lewis.
[2] Prepared by Timothy C. May.

izer and as a catalyst in chemical processes. Iodine is also becoming useful as a lubricant and cutting-oil additive for difficult to lubricate and hard to machine space-age materials.

Table 1.—Crude iodine consumed in the United States

Products	1966			1967		
	Number of plants	Crude iodine consumed		Number of plant	Crude iodine consumed	
		Thousand pounds	Percent of total		Thousand pounds	Percent of total
Resublimed iodine	7	194	5	6	120	3
Potassium iodide	12	1,505	40	11	1,301	36
Sodium iodide	2	W	W	5	W	W
Other inorganic compounds	20	1,121	30	19	790	22
Organic compounds	24	944	25	25	1,363	38
Total	[1] 44	3,764	100	[1] 42	3,574	[2] 100

W Withheld to avoid disclosing individual company confidential data; included with "Other inorganic compounds."
[1] Nonadditive total because some plants produce more than 1 product.
[2] Data do not add to total shown because of independent rounding.

Stocks.—Stocks held by firms that convert crude iodine into resublimed iodine and iodine compounds declined 15 percent in 1967. Yearend stocks were 725,937 pounds compared with 855,791 pounds on December 31, 1966.

Prices.—The price of iodine and its compounds remained constant throughout 1966 and 1967. Prices were as follows:

	Per pound
Crude iodine, drums	$1.18
Resublimed iodine, U.S.P., drums, f.o.b. works	$2.20–2.22
Calcium iodate, drums, delivered	1.45–1.60
Calcium iodide, 25-pound jars, f.o.b. works	4.27
Potassium iodide, U.S.P., crystals, drums, 500 pounds or more delivered	1.45
Potassium iodide, U.S.P., crystals, drums, smaller lots, delivered	1.47
Sodium iodide, U.S.P., 300-pound drums, freight equalized	2.13

Source: Oil, Paint and Drug Reporter.

Foreign Trade.—Imports of crude iodine in 1967 were substantially below those of 1966 because of the reduction in receipts for the Government stockpile under the barter program. Imports for consumption decreased 52 percent in volume and 56 percent in value compared with 1966 levels. Imports of resublimed iodine in 1967 were 9,000 pounds compared with 2,000 pounds in 1966. Beginning January 1, 1965, the exports and reexports of iodine were no longer separately classified.

Table 2.—U.S. imports for consumption of crude iodine, by countries

(Thousand pounds and thousand dollars)

Country	1965		1966		1967	
	Quantity	Value	Quantity	Value	Quantity	Value
Canada					30	$29
Chile	2,111	$1,689	4,404	$3,676	2,174	1,834
Hong Kong			11	13		
Japan	736	787	2,718	2,245	1,255	1,314
Sweden					(1)	(1)
Total	2,847	2,476	7,133	5,934	3,459	3,177

[1] Less than ½ unit.

World Review.—*Chile.*—In November 1966, the Anglo-Lautaro Nitrate Corp. informed the Chilean Government that increased competition from synthetic nitrates, unfavorable exchange rates on nitrate exports, and high production costs had combined to make continued production at the corporation's Maria Elena operation uneconomic. To avoid closing Maria Elena altogether, the corporation announced it would restructure the operation to produce 200,000 tons of potash nitrate, 189,000 tons of sodium sulfate, and 1,000 tons of iodine.[3]

According to the Servicio de Mines del Estado, Chilean iodine production during 1966 was 3,231 short tons. This was an increase of 23 percent over the 1965 output. With the change in the production schedule of its Maria Elena plant and the expansion of iodine production facilities at its Pedro de Valdivia plant, the Anglo Lautaro Nitrate Corp. expects to have facilities capable of producing 4,079 short tons of iodine annually.[4]

Japan.—Elemental iodine production in 1966 amounted to 2,895 short tons compared with 2,417 tons in 1965, an increase of approximately 20 percent.

Technology.—To determine if the violence of hurricanes can be lessened, such storms were seeded with silver iodide in a project conducted by the Department of Navy and the Environmental Science Services Administration, Department of Commerce.[5]

Iodine concentrates and products are now manufactured by a "cold process" in which a solution of iodine and iodide are added to unheated detergent. Products prepared by this process are extremely stable with respect to available iodine content and are unique in that essentially no organic carbon-iodine bonded fragments are formed. The addition of iodide has a profound effect on detergent-iodine complexing. Certain nonionic detergents intensify iodine color at concentrations below 10 parts per million, rivaling starch as an iodine indicator.[6]

LITHIUM[7]

Outputs of domestic lithium mineral source materials were the largest ever reported. Imports of lithium minerals, more than 90 percent of which came from Southern Rhodesia almost tripled those of 1966.

Legislation and Government Programs.—The Government-held stock of lithium hydroxide, monohydrate, remained at 6,497 short tons.

Domestic Production.—Outputs of spodumene flotation concentrate from pegmatite and lithium carbonate from brines were larger than ever reported. Foote Mineral Co. mined and milled spodumene from pegmatites at Kings Mountain, N.C., and also recovered lithium carbonate from brines at Silver Peak, Nev. American Potash & Chemical Corp. recovered lithium carbonate from brines at Trona, Calif. Keystone Chemical Corp., Keystone, S. Dak., produced a small quantity of amblygonite from the Ingersoll Mine and also shipped some lepidolite.

The processors of lithium raw materials to lithium primary products were Foote Mineral Co., Sunbright, Va., and Silver Peak, Nev.; American Potash & Chemical Corp., Trona, Calif.; and Lithium Corporation of America, at Bessemer City, N.C. Production data were not available for publication. Lithium Corporation of America, Inc., merged with Gulf Sulphur Corp. to form a new organization, Gulf Resources and Chemical Corp. Lithium Corporation of America thus became a subsidiary of the new organization.

Consumption and Uses.—Figures on consumption of lithium mineral raw materials and lithium primary products were not available for publication.

Domestic spodumene flotation concentrate and lithium carbonate from brines were processed into numerous chemicals for a wide variety of applications. The major uses were in ceramics, greases, air conditioning, polymers, alloying, and organic synthesis, and there was a growing use in aluminum metal production. Research for new lithium applications included the development of lightweight,

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[3] U.S. Embassy, Santiago, Chile. State Department Airgram A-498, Feb. 13, 1967, p. 11.

[4] U.S. Embassy, Santiago, Chile. State Department Airgram, A-183, Oct. 11, 1967, p. 40.

[5] Chemical Week. Hurricanes Seeded With Silver Iodide v. 101, No. 8, Aug. 19, 1967, p. 43.

[6] Schmidt, W., and M. Winicou. Detergent-Iodine Systems. Soap and Chemical Specialities, August 1967, pp. 61-64.

[7] Prepared by Donald E. Eilertsen.

high-energy batteries for driving automobiles electrically to reduce air pollution caused from gasoline-driven vehicles. Domestic spodumene and imported lithium minerals were used in the ceramic and glass industries.

Prices.—Lithium metal, 99.8 percent pure, was quoted at $9 to $11 per pound throughout 1967.[8]

Table 3.—Prices of selected lithium products in 1967

(Per pound)

Item	January to March 12, 1967	March 13 to yearend 1967
Lithium metal, 100-pound lots, delivered	$7.50	$7.50
Lithium carbonate:		
Drums, ton lots	.50	
Drums, carlots, truckloads, delivered		[1] 0.425– .45
Lithium chloride:		
Chemically pure, anhydrous, drums, ton lots	1.27	
Technical, anhydrous, drums, carlots, tuckloads, delivered or works, freight allowed	.87	
Anhydrous, carlots, truckloads, delivered		[2] .825– .875
Lithium fluoride:		
Barrels, ton lots and more, delivered	1.61	
10,000 pounds, minimum, delivered		[3] 1.56 – 1.65
Lithium hydride:		
Powder, drums, 500-pound lots or more, works	9.50	
Carlots, truckloads, delivered		7.10
Lithium hydroxide, monohydrate, drums, carlots, truckloads, delivered	.575	.535
Lithium nitrate, technical, drums, 100-pound lots	1.15– 1.25	[4] 1.15 – 1.55
Lithium stearate, drums, carlots, works	.475	[5] .475– .49
Lithium sulfate, drums, 100-pound lots	1.15– 1.25	[6] 1.15 – 1.30

[1] $0.45 until March 26; $0.425 until December 3; and then $0.425–$0.445.
[2] $0.825 until December 3; $0.852–$0.875 until December 17; and then $0.825–$0.85.
[3] $1.56 until March 26; $1.56–$1.61 until December 17; and then $1.56–$1.65.
[4] $1.15–$1.25 until March 26; and then $1.25–$1.55.
[5] $0.475 until March 19; and then $0.49.
[6] $1.15–$1.25 until March 26; and then $1.20–$1.30.
Source: Oil, Paint and Drug Reporter.

Foreign Trade.—Quantitative data were not available on the exports of lithium minerals and lithium metal, alloys, and compounds.

Imports of lithium minerals rose sharply in 1967 after a 2-year slump. As usual the largest supply, 91 percent in 1967, came from Southern Rhodesia. Imports of lithium materials, other than those shown in table 4, were as follows:

[8] Metals Week. v. 38, No. 1–52, January-December 1967.

Item	*Pounds*	*Value*	*Country*
Lithium (unspecified form)	1,650	$1,030	United Kingdom.
Lithium stearate	80,000	9,791	Netherlands.
Lithium compounds	290	6,225	Mostly from United Kingdom.
Lithium salts	61,240	95,469	Canada.

Table 4.—U.S. imports for consumption of lithium minerals, by country of origin and U.S. customs district

Country of origin and U.S. customs district	1966		1967	
	Short tons	Value	Short tons	Value
Brazil: Baltimore	-----	----------	45	$5,009
Canada: St. Albans	-----	----------	2,333	44,391
Rhodesia, Southern:				
Baltimore	7,856	$242,016	22,424	668,603
Charleston	-----	----------	1,131	48,065
South Africa, Republic of: New York	1,404	17,458	--------	---------
Total	9,260	259,474	25,933	766,068

World Review.—*Australia.*—The Government abolished restrictions on the export of lithium minerals to all Communist countries except mainland China in September. Lithium has been on the strategic list of materials for 16 years.

Brazil.—A large deposit of petalite was discovered near Aracuai, on the Piaui River in the Jequitinhonha Basin in Minas Gerais. The first 100 tons of petalite from the Nesinho mine was accumulated for shipment to a glass factory at Sao Paulo for use in glass for television tubes.

Canada.—Data on Canadian lithium deposits and occurrences were compiled, largely from publications, private reports, and personal communications with many geologists, engineers, and prospectors.[9]

Rhodesia, Southern.—Bikita Minerals (Private) Ltd. which experimented with froth flotation treatment of low-grade quartz-lepidolite ores, began to produce lepidolite concentrate continuously. The concentrate contained 4.5 percent Li_2O and was low in iron. The planned annual output was 2,500 tons.[10]

Tabe 5.—Free world production of lithium minerals, by countries [1]

(Short tons)

Country	Mineral produced	1963	1964	1965	1966	1967 [p]
North America: [2] Canada	Spodumene (Li_2O content)	322	528	507	127	283
South America:						
Argentina	Lithium minerals	1,583	799	686	287	NA
Brazil	Amblygonite	-----	------	[3] 28	-----	NA
	Spodumene [3]	28	------	7,512	[e] 100	NA
Surinam	Amblygonite	[3] 568	NA	NA	NA	NA
Africa:						
Mozambique	Lepidolite	115	------	83	-----	NA
Rhodesia, Southern	Eucryptite	[r] 1,142	806	[e] 705	NA	NA
	Amblygonite	52	------	------	NA	NA
	Lepidolite	16,157	22,943	[e] 17,700	NA	NA
	Petalite	29,946	36,449	[e] 29,900	NA	NA
	Spodumene	2,235	6,965	[e] 15,300	NA	NA
Rwanda	Amblygonite	406	325	------	-----	NA
South Africa, Republic of	Lithium minerals	417	179	958	337	[e] 400
South-West Africa, Territory of	Amblygonite	128	13	39	30	NA
	Lepidolite	86	407	298	365	NA
	Petalite	865	798	1,332	1,344	NA
Uganda	Amblygonite	53	22	22	-----	NA
Oceania: Australia	Petalite	437	233	347	1,112	NA
	Amblygonite	22	------			
	Spodumene	24	58	------	-----	----

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.
[1] Compiled mostly from data available April 1968.
[2] U.S. figure withheld to avoid disclosing individual company confidential data.
[3] Exports.

Table 6.—South-West Africa: Exports of lithium mineral concentrates

Year	Amblygonite		Lepidolite		Petalite	
	Short tons	Value	Short tons	Value	Short tons	Value
1964	------	----------	542	$12,211	1,151	$26,425
1965	669	NA	170	3,564	1,110	[r] 23,971
1966	13	$1,260	598	17,819	1,327	[r] 32,028

[r] Revised. NA Not available.

Technology.—Foote Mineral Co.'s large lithium brine operation at Silver Peak, Nev., which started in 1966, was described. The lithium-bearing sediments in the area extend about 8 miles in length and 4 miles in width and various reserve estimates range from 500,000 to 50 million tons of lithium chloride. The brine extracted from approximately 20 wells which are 300 to 800 feet deep, contains 6.2 percent Na, 0.8 percent K, 0.04 percent each of Mg and Li, 0.05 percent Ca, 0.71 percent SO_4, and 10.06 percent Cl. The brine is pumped to

[9] Mulligan, Robert. Geology of Canadian Lithium Deposits. Canada Geol. Survey, Econ. Geol. Rept. 21, 1965, 131 pp.
[10] Metal Bulletin (London). Bikita Producing Lepidolite. No. 5206, June 16, 1967, p. 23.

a series of evaporation ponds, where about 90 percent of annual evaporation occurs in 5 months. The concentrated brine, containing 3 to 4 percent lithium chloride, is pumped 2 miles to a processing plant in Silver Peak, where calcium and magnesium are first removed and the remaining solution then reacted with soda ash to produce crude lithium carbonate. This product is washed and dried and readied for shipment to customers.[11]

Widespread interest in reducing air pollution caused by gasoline-driven automobiles led to accelerated research on experimental lithium batteries for electric cars.

MEERSCHAUM[12]

Domestic consumers of meerschaum remained dependent on imports for their supplies. Turkey remained the primary world producer with an output of 148,000 pounds in 1967. Production statistics were not available for the other producing countries, Tanzania, Kenya, and the Somali Republic.

Imports of meerschaum for consumption declined 13 percent in quantity, to 11,707 pounds, and 18 percent in value, to $19,443, in 1967. Turkey supplied 88 percent of the imports. The remainder came from France and West Germany. The material continued to be used primarily for smokers' articles such as pipes and cigar and cigarette holders. Additional meerschaum is imported in the form of manufactured products for which no statistics are collected.

QUARTZ CRYSTAL

ELECTRONIC-GRADE[13]

The consumption of raw quartz crystal, both natural and manufactured, declined almost 9 percent from that of 1966. However, the consumption of manufactured quartz increased 29 percent. The production of finished units showed a substantial decrease.

Legislation and Government Programs.—The General Services Administration was authorized under Public Law 89–310 passed in October 1965 to dispose of quartz crystal from the Strategic and Critical Stockpile. Disposals during 1967 consisted of 65,236 pounds of specification-grade, and 50,814 pounds of non-specification-grade, material. At yearend the stockpile contained 5,441,479 pounds of specification and non-specification grade material. About 78 percent of this quantity was specification grade.

Domestic Production.—No domestic production of natural electronic-grade quartz crystal was reported to the Bureau of Mines in 1967. At yearend six companies reported the production of manufactured quartz for use by the electronic industry. These companies were P. R. Hoffman Co., Carlisle, Pa.; Quality Crystals, Inc., Cortland, Ohio; Sawyer Research Products, Inc., Eastlake, Ohio; Thermo Dynamics, Corp., Shawnee Mission, Kan.; Thermal Kinetic Corp., Tucson, Ariz.; and Western Electric Co., Inc., North Andover, Mass. The major domestic producers were Sawyer Research Products, Inc., and Western Electric Co., Inc. Sawyer reported sales of 87,000 pounds of manufactured quartz and Western Electric continued to produce quartz for its own and affiliated companies use.

Consumption and Uses.—Consumption of raw quartz crystal declined from 363,209 pounds in 1966 to 332,028 pounds in 1967. The consumption of manufactured quartz increased from 79,550 pounds in 1966 to 102,636 pounds in 1967. About 22.5 million finished quartz crystal units were produced from raw quartz crystal consumed during the year.

The data reported in table 7 are based on reports received in 1967 from 39 crystal cutters in 14 States. Finished piezoelectric units were produced by 37 of the cutters; the others produced only semifinished blanks. Of these cutters nine cut natural

[11] Shay, F. B. Low Cost Lithium From Brine at Silver Peak, Nevada. Pres. at 96th Annual AIME Meeting, Los Angeles, Calif., Feb. 21, 1967, 5 pp.
[12] Prepared by Benjamin Petkof.
[13] Prepared by Benjamin Petkof.

quartz only, 13 cut synthetic only, and 17 cut both natural and synthetic. Twenty consumers in four States used 77 percent of the total raw quartz crystal consumption. Pennsylvania was the leading quartz consumer with 51 percent of the total, followed by Kansas, Illinois, and Massachusetts.

Table 7.—Salient electronic- and optical-grade quartz crystal statistics

	1965	1966	1967
Imports of electronic- and optical-grade quartz crystal, thousand pounds	324	265	220
Value, thousands	$913	$596	$498
Consumption of raw electronic-grade quartz crystal, thousand pounds	315	363	332
Production, piezoelectric units, number, thousands	17,832	27,463	23,340

Piezoelectric units were manufactured by 54 producers in 19 States. Of these, 17, worked from partially processed quartz crystal blanks and did not consume raw material. Twenty plants in four States supplied 71 percent of the total output of finished crystal units. Oscillator plates comprised 83 percent of production. The remainder included filter plates, telephone resonator plates, transducer crystals, and miscellaneous items.

Prices.—The price ranges of electronic-grade quartz crystal, which remained essentially unchanged from those reported in the 1964 Minerals Yearbook.

Foreign Trade.—Imports of electronic- and optical-grade crystal decreased 17 percent in quantity, to 219,897 pounds, and 16 percent in value, to $498,257, from 1966 figures. The average value of imports was $2.27 per pound. Brazil maintained its status as the major world producer, supplying 75 percent of U.S. imports for consumption. Canada provided 24 percent and the remainder came from Argentina, France, and Japan. Quartz crystal imports, valued at less than $0.50 per pound, totaled 829,684 pounds valued at $232,245. This material, generally referred to as lasca, was used for the manufacture of fused quartz and as feed material for the production of manufactured quartz crystal.

Exports of raw quartz, both natural and manufactured, decreased from 145,562 pounds valued at $1,142,366 in 1966 to 112,935 pounds valued at $968,907 in 1967. About 75 percent of the material was shipped to Japan, India, the United Kingdom, Italy, and Israel.

World Review.—*Brazil*—Since 1963, exports of Brazilian quartz have been increasing and, in 1966, reached 7.17 million pounds valued at $2.43 million. However, 95 percent of exported material, in 1966, consisted of low-value lasca.[14]

Technology.—The production of man-made quartz with a Q-factor of up to 2 million, equivalent to that of natural quartz crystal has been reported. This will permit the replacement of natural quartz in high-frequency oscillators and other instruments requiring precise and stable frequencies. The addition of lithium nitrite to the sodium hydroxide growing solution increased the Q to 1 million. Additional improvement was made by special conditions of temperature, pressure and slower growth rates.[15]

STAUROLITE[16]

Staurolite, a complex silicate of iron and aluminum, is used as sand-blast abrasive and, to a lesser extent, as an ingredient in certain portland cement mixes. In some deposits, right-angle twinning of the crystals has created striking "fairy crosses" of this mineral that are valued as semiprecious stones for amulets. U.S. commercial production of abrasive-grade staurolite, in 1967, was confined to Florida, where the material was one of the products recovered from Clay County sand in the Highland and Trail Ridge plants of E. I. du Pont de Nemours & Co., Inc. Production declined 5 percent in 1967, while sales, even though substantially higher than in 1965, were about 8 percent less in both value and volume than in 1966.

[14] Bureau of Mines. Mineral Trade Notes. Quartz Crystal. Brazil. v. 65, No. 3, March 1968, p. 35.

[15] Frequency. Man-Made Quartz Crystal With Q of Two Million. v. 5, No. 2, March-April 1967, p. 8.

[16] Prepared by J. Robert Wells.

STRONTIUM[17]

Domestic Production.—There was no output of strontium minerals in the United States for the eighth consecutive year. Imports for consumption were the smallest in 13 years. Quantitive data were not available on the production of strontium metal, alloys, and compounds. Firms that consumed imported celestite and produced various strontium compounds included E. I. du Pont de Nemours & Co., Inc., Grasselli, N.J.; Foote Mineral Co., Exton, Pa.; and FMC Corp., Modesto, Calif.

Legislation and Government Programs.—The Government sold 2,263 short tons of stockpile-grade, and 287 tons of non-stockpile-grade, celestite during 1967, At yearend, Government stockpiles contained 17,179 tons of stockpile-grade, and 28,731 tons of non-stockpile-grade, celestite.

Consumption and Uses.—Strontium metal and its alloys were used as getters for removing traces of gas from vacuum tubes. Strontium compounds were used to produce the brilliant red color in tracer bullets, for distress-signal rockets and flares, and for fireworks. The compounds were also used in ceramics, medicines, greases, plastics, and in making high-purity zinc. Strontium ferrite magnets, new on the market, were developed for use in separators in beneficiation plants, in lifting devices, in direct current motors, and in speakers.[18] Strontium-silicon, a new inoculant, was used to improve the quality of gray-iron castings.[19]

Data were not available on the quantities of strontium minerals, metal, alloys, and compounds consumed.

Prices.—Oil, Paint and Drug Reporter quoted the following prices: Strontium sulfate, (celestite)—air floated, 90 percent, 325 mesh, bags, works, at $56.70 to $66.15 per ton; strontium carbonate—pure, drums, 5-ton lots or more, works, at 35 cents per pound; drums, 1-ton lots, works, at 37 cents per pound; and technical, drums, works, at 19 cents per pound; and strontium nitrate—bags, carlots, works, at $11 per 100 pounds; and bags, less carlots, works, at $12 per 100 pounds. These quoted prices have not changed since 1955.

The average value of imported strontium minerals at foreign ports was approximately $21 per ton.

Foreign Trade.—Imports of strontium minerals, practically all celestite, totaling 5,612 tons were the smallest since 1954.

Other imports for consumption follow: Strontium carbonate, precipitated—8 pounds, valued at $897, from the United Kingdom; other strontium compounds—502 pounds, valued at $1,371, from the United Kingdom, and 15,000 pounds, valued at $3,190, from West Germany.

World Review.—*Canada.*—Drilling and surface exploration of a celestite deposit discovered in 1963, at Enon Lake in Cape Breton County, Nova Scotia, indicated 0.8 to 1 million tons of 75 percent strontium sulfate (celestite) in a gently dipping bed. The deposit appears on the newly issued map of Nova Scotia that shows 32 minerals in their geological setting.[20]

[17] Prepared by Donald E. Eilertsen.
[18] Tatnall, R. Francis. Westinghouse Expands Strontium Ferrite Magnet Production. Ceramic Age, v. 82, No. 5, May 1966, pp. 35–39.
[19] American Metal Market. New Strontium-Silicon Inoculant Stops "Chill" In Gray Iron Castings. V. 73, No. 92, May 12, 1966, p. 18.
[20] Northern Miner. Largest Celestite Deposit Indicated in Nova Scotia. No. 15, July 6, 1967, p. 17.

Table 8.—U.S. imports for consumption of strontium minerals,[1] by countries

Country	1966		1967	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Canada	------	------	14	$5
Italy	11	$3	6	1
Mexico	6,434	117	3,148	37
United Kingdom	5,072	147	2,444	75
Total	11,517	267	5,612	118

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

Table 9.—Free world production of strontium minerals, by countries [1] [2]

(Short tons)

Country	1963	1964	1965	1966	1967
Argentina	595	33	659	NA	
Italy	721	504	705	659	
Mexico	r 6,918	r 6,020	r 2,888	r 6,267	NA
Pakistan	424	297	497	590	
United Kingdom	10,102	19,077	10,695	NA	
Total [3]	r 18,760	r 25,931	r 15,444	r 7,516	NA

r Revised. NA Not available.
[1] Strontium minerals are produced in Germany, Poland, and the U.S.S.R., but data on production are not available.
[2] Compiled mostly from data available May 1968.
[3] Total is of listed figures only; no undisclosed data included.

Technology.—Experiments were reported on the thermal reduction of zinc oxide with carbon monoxide in the presence of the strontium oxide. The addition of strontium oxide was found to hasten the reduction of zinc oxide to zinc.[21]

A method was developed for recovering strontium chloride from brine containing soluble chlorides of strontium, calcium, magnesium, potassium, and possibly sodium chloride and boron salts. The weigh ratios of the calcium to strontium chlorides ranged from 0.7 to 120 and the weight of calcium chloride did not exceed 47.5 percent. The brine was evaporated to remove sodium and most of the potassium and magnesium as carnallite, then cooled to form a solid product, which was leached with hot water to dissolve the strontium, boron, and remaining calcium, and again was then cooled to remove strontium chloride crystals.[22]

WOLLASTONITE [23]

Wollastonite sales in 1967, although less in volume and total value than in 1966, were higher in both respects than in any previous year. The Oxides Division of Cabot Corp., principal supplier in the United States, mined and processed paint- and ceramic-grade wollastonite in Essex County, N.Y. Two other firms produced smaller quantities of the mineral from sources in Riverside and Inyo Counties, Calif.

Nominal per-ton prices for wollastonite were recorded in Oil, Paint and Drug Reporter, unchanged from October 1960 through December 1967, as follows: Fine, paint-grade, bags, carlots, works, $41; less than carlots, ex warehouse, $51; medium, paint-grade bags, carlots, works, $29; less than carlots, ex warehouse $39. Ceramic Industry Magazine, January 1968, page 31, quoted $37 and $22.50 per ton as the respective high and low 1967 prices for wollastonite. As is customary for most industrial minerals, however, actual sales were concluded at prices agreed upon by buyers and sellers without public disclosure.

Technology.—A journal article described the advantages of a service by which a supplier of bulk ceramic materials would provide tile manufacturers with high-wollastonite bodies premixed according to their own formulations.[24] Tile made from high-wollastonite bodies, to which 2 percent of rasorite (similar to borax) has been added, would be amenable, according to published information, to single-layer, fast firing on wire mesh belts.[25]

Although the natural mineral is generally available in sufficient quantity throughout most of the world, the manufacture of synthetic wollastonite, in addition to providing a ceramic ingredient that is dependably uniform in composition, can furnish a use for materials otherwise likely to be wasted. An alumina-from-clay resi-

[21] Jones, T. S., and H. M. Davis. Reduction of Zinc Oxide by Carbon Monoxide in the Presence of Strontium Oxide. Trans. AIME, v. 239, 1967, pp. 244–248.
[22] Goodenough, Robert D. (assigned to The Dow Chemical Co., Midland, Mich.). Recovering Strontium Chloride From Brine. U.S. Pat. 3,329,318, Mar. 8, 1966.
[23] Prepared by J. Robert Wells.
[24] Burkley, Richard L. Preblended Tile Bodies. Ceram. Age, v. 82, No. 11, November 1966, pp. 28–30.
[25] Illing, Arno M. Floor and Wall Tile Research. Am. Ceram. Soc. Bull., v. 45, No. 1, January 1966, p. 22.

due, rich in lime and silica, was processed experimentally to yield a synthetic wollastonite suitable for the manufacture of ceramic tile.[26] A process was devised for treating a mixture of silica sand and limestone with superheated steam to form artificial wollastonite. In another application of the same principle, the unwanted calcite fraction of a wollastonite ore was reacted with silica sand at a high temperature to increase the wollastonite yield from subsequent flotation beneficiation.

[26] Fahrenberger, U., and D. Harkort, Synthetic Wollastonite—Conditions for Its Formation and Use in the Manufacture of Wall Tile. Keram. Z., v. 18, No. 4, 1966, pp. 228–230; abs. in J. Am. Ceram. Soc., v. 49, No. 8, August 1966, p. 219.

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