Beryllium

By Robert A. Whitman [1]

The consumption of beryl decreased in 1972. Production of domestic ore declined, and imports were less than those of 1971. Contracts were awarded for beryllium components of the Poseidon missile system to be delivered in 1973 and 1974.

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Table 1.—Salient beryllium mineral statistics

	1968	1969	1970	1971	1972 p
United States:					
Beryl, approximately 11% BeO:					
Shipped from mines---short tons	168	W	W	W	W
Imports---do	3,822	6,422	4,942	4,026	3,345
Consumption---do	9,244	[1] 8,483	[1] 9,496	[1] 10,373	[1] 7,781
Price, approximate, per unit BeO imported, cobbed beryl at port of exportation	$34	$37	$35	$33	$30
Bertrandite ore: Utah, low-grade, shipped from mines---short tons	--	W	W	W	W
World production of beryl---do	7,242	8,869	r 6,857	5,844	4,740

p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes some bertrandite ore that was calculated as equivalent to beryl containing 11% BeO.

Legislation and Government Programs.—Government yearend stocks of beryl, beryllium-copper master alloy, and beryllium metal are shown in table 2. Government inventories of beryl decreased 1,602 short tons during 1972 as a result of sales.

The Environmental Protection Agency held public hearings in New York City on January 10, 1972, and in Los Angeles on February 15 and 16, 1972, to obtain testimony concerning emission standards for the three air pollutants, asbestos, beryllium, and mercury. Final emission standards are due to be published in 1973.

Table 2.—Government yearend stocks of beryllium materials

(Short tons)

Material	National stockpile	Supplemental stockpile	All stocks
Beryl (11% BeO):			
Objective	12,433	2,782	15,215
Excess	3,841	59	3,900
Total	16,274	2,841	19,115
Beryllium-copper master alloy:			
Objective	--	4,750	4,750
Excess	1,075	1,562	2,637
Total	1,075	6,312	7,387
Beryllium metal:			
Objective	--	150	150
Excess	--	79	79
Total	--	229	229

Source: Office of Emergency Preparedness. Statistical Supplement, Stockpile Report to the Congress OEP-4, July–December 1972.

DOMESTIC PRODUCTION

Production of beryl ore was believed to be the lowest in several years. Some beryl was produced in Colorado and South Dakota, but most mines reported assessment work only. The largest domestic source of beryllium ore was the Spor Mountain bertrandite mine near Delta, Utah. Production of beryllium-copper alloy increased, but the production of metal declined from that in 1971.

Brush Wellman, Inc. (Brush), converted bertrandite from its Utah mine to beryllium hydroxide at Delta, Utah, and shipped the hydroxide to Elmore, Ohio, for further conversion to metal, alloys, and compounds. Brush also has beryl processing facilities at Elmore.

Kawecki Berylco Industries, Inc., (KBI) used beryl for its primary ore, most of which was imported. The beryl was processed at Hazelton, Pa. Further processing and fabricating was done at both the Hazelton and the Reading, Pa., plants.

CONSUMPTION AND USES

The beryllium industry consumed beryllium ore equivalent to 7,781 short tons of beryl containing 11% BeO. There was less beryllium metal and beryllium oxide ceramics shipped in 1972 than in 1971, but there was a substantial increase in the amount of beryllium-copper master alloy shipped in 1972. Beryllium-copper alloy products consumed the largest quantity of beryllium. These alloys combine the properties of good electrical and thermal conductivity, strength, hardness, and resistance to fatigue, corrosion, and wear. They are used in an ever-increasing variety of electrical and electronic systems. Beryllium-copper also is used increasingly as a tooling material for molding plastics.

Beryllium metal is being used where a high strength-to-weight ratio is needed, as in the aerospace industry. It was used for optical structures in space, for X-ray windows, and in missile parts and nuclear structures.

Beryl Ores, Arvada, Colo., bought beryl ore to process for the ceramics industry.

STOCKS

Consumer stocks of hand-sorted beryl at the end of 1972 totaled 6,913 short tons compared with 6,299 short tons at yearend 1971. Dealers' stocks of beryl are not reported. Stocks of bertrandite are company confidential data.

PRICES AND SPECIFICATIONS

Domestic beryl prices were negotiated between producers and buyers and were not quoted in the trade press. The price of imported beryl probably was negotiated. In February the quoted price range for imported beryl was reduced as a result of the weak market to a range of $30 to $35 per short ton unit from the $35 to $37 range in January. This price range was quoted until yearend.[2]

Prices for beryllium metal products remained steady throughout 1972. Beryllium billet was quoted at $70 per pound, 98% powder prices ranged from $54 to $66 per pound, and 5-inch diameter rod at $102 per pound.

Beryllium-copper master alloy started the year quoted at $54 per pound of contained beryllium and dropped June 1 to $53 per pound, the yearend price. Casting ingot containing 2% to 2.25% beryllium in copper started at $2.10 per pound, dropped on June 1 to $2.06 per pound, and stayed at that level the remainder of the year. The quoted price for Alloy 25 was $3.14 per pound until June 1 and dropped to $3.05 per pound through yearend.

[2] Metals Week. V. 43, Nos. 1–52, January-December 1972.

FOREIGN TRADE

Exports of beryllium alloys, waste, and scrap more than doubled, but the total value decreased by 20%.

Imports of beryl decreased for the third consecutive year and were down 17% from 1971. Value per ton was down by 10%. About 84% of the beryl came from Brazil, the Republic of South Africa, and Argentina, with Brazil furnishing over one-half of the imports. In addition to the imports of beryl, there were nearly 12 tons of beryllium products, wrought, unwrought, waste, scrap, and compounds imported with a value of $286, 922.

Table 3.—U.S. exports of beryllium alloys, wrought or unwrought and waste and scrap [1]

Country	1971		1972	
	Pounds	Value (thousands)	Pounds	Value (thousands)
Australia	87	(2)	1,270	$5
Belgium-Luxembourg	--	--	3,660	2
Brazil	--	--	1,208	4
Canada	495	$45	8,175	56
France	5,560	171	23,181	83
Germany, West	2,453	31	1,105	19
India	2,499	2	6	1
Israel	600	67	--	--
Italy	28	5	3	1
Japan	6,658	126	34,025	352
Mexico	--	--	271	1
Netherlands	244	2	185	2
Norway	12,000	12	14,141	20
Philippines	--	--	1,447	5
Spain	--	--	11	1
Switzerland	760	4	1,963	23
Taiwan	--	--	156	1
United Kingdom	9,730	586	4,685	263
Total	41,114	1,051	95,492	839

[1] Consisting of beryllium lumps, single crystals, powder, beryllium-base alloy powder; beryllium rods, sheets, and wire.
[2] Less than ½ unit.

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

Customs district and country	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Philadelphia district:				
Angola	--	--	56	$13
Argentina	248	$84	248	74
Australia	59	22	81	24
Brazil	2,342	889	1,755	576
Congo (Brazzaville)	23	7	23	7
Kenya	88	32	--	--
Malagasy Republic	16	5	40	13
Mozambique	163	55	--	--
Portugal	11	4	--	--
Rhodesia, Southern	--	--	65	20
Rwanda	120	36	88	23
South Africa, Republic of	593	222	798	298
Uganda	224	67	98	26
Total	3,887	1,423	3,252	1,074
New York City District:				
Angola	--	--	55	15
Australia	21	7	16	5
Brazil	23	10	--	--
Congo (Brazzaville)	23	7	--	--
South Africa, Republic of	--	--	22	7
Spain	4	1	--	--
Total	71	25	93	27
Baltimore district: Brazil	47	19	--	--
Detroit district: Canada	17	6	--	--
Norfolk district: Australia	4	2	--	--
Grand total	4,026	1,475	3,345	1,101

WORLD REVIEW

Australia.—A new beryl mine was opened near Perenjori, about 200 miles northeast of Perth. Seleka Mining and Investments, Ltd., initiated a drilling program in 1972 to determine the extent of beryl mineralization and was expected to produce beryl for export.

Brazil.—There were reports from the State of Minas Gerais of new beryl reserves to be developed with a Banco Nacional de Desenvolvimento Econômico loan of $15,000.

Japan.—The Japan Society of Newer Metals announced the capacity for production of a little more than 1 short ton annually of beryllium metal by electrolytic refining. The capacity for producing beryllium oxide was nearly 80 short tons per year, mostly by the silicofluoride process. The capacity for producing beryllium copper master alloy was about 800 tons per year. Production figures for 1972 were not available. Japan imports beryl principally from Africa, Brazil, and Australia.

Table 5.—Beryl: World production by country

(Short tons)

Country [1]	1970	1971	1972 [p]
Argentina	333	e 330	e 300
Australia	20	78	e 200
Brazil	[2] 3,674	2,756	e 2,000
Kenya	4	--	--
Malagasy Republic	57	66	e 50
Mozambique	36	14	e 30
Portugal	15	17	e 20
Rhodesia, Southern e	100	100	65
Rwanda	315	214	e 100
South Africa, Republic of	355	541	275
Uganda	405	244	e 120
U.S.S.R. e	1,400	1,400	1,500
United States	W	W	W
Zaire	143	84	e 80
Total	r 6,857	5,844	4,740

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] In addition to the countries listed, the Territory of South West Africa also may have produced beryl, but mineral production of this area has not been officially reported since 1966, and no reliable information is available as a basis for estimating output since that time. India, listed as a major producer in previous editions of this table (with output estimated in the order of 1,450 short tons annually) has been deleted from the producer list because information now available indicates that little if any beryl mining has been carried out in recent years.

[2] Exports.

TECHNOLOGY

The increasing concern with environmental pollution led to increased research to develop more selective analytical methods. A routine method of analysis for ultratrace concentrations of beryllium in particulate matter collected on air and water filters was described.[3]

A report on the hydrolytic behavior of toxic metals, prepared by the Oak Ridge National Laboratory,[4] should assist in determining methods to remove beryllium from water.

A process for making high strength beryllium by hot-pressing, extruding, and upset-forging, was described.[5] Isotropic compressive yield strengths of greater than 100,000 pounds-per-square-inch were achieved.

A way to bypass the traditional brittleness of beryllium by a technique of diffusion-bonding thin sheets into a laminated plate was reported. The resulting plate had better mechanical properties than the thin sheet from which it was made, and properties substantially superior to sheet

[3] Ross, William D., and Robert E. Sievers. Environmental Air Analysis for Ultratrace Concentrations of Beryllium by Gas Chromatography. Environmental Science and Technology, v. 6, No. 2, February 1972, pp. 155–178.

[4] Baes, C. F. Jr., and R. E. Mesmer. Ecology and Analysis of Trace Elements. Oak Ridge National Laboratory, ORNL-NSF-EATCI, March 1973, pp. 236–237.

[5] Floyd, Dennis R. Isotropic High Strength Beryllium. The Dow Chemical U.S.A., RFP 1816, July 6, 1972, 11 pp.

rolled directly from ingot to similar thickness.[6]

One paper reported efforts to improve ductility of beryllium by precipitation of about 1% iron from supersaturated solutions of iron in beryllium utilizing the Mössbauer effect.[7]

Further progress in reinforcing a titanium matrix with beryllium to improve rigidity and decrease weight of turbine fans and compressor blades resulted from work on Contract N00019–72–C–0247. This work was performed for the Department of the Navy, Naval Air Systems Command.

The need for substrates with high thermal conductivity for thin film electronic circuitry led to a study of the preparation of BeO by thermal decomposition of the sulfate phase.[8] A Brush scientist reported on the important aspects of heat-treating beryllium-copper alloys. KBI introduced a new alloy they designated Berylco 21C.

Five patents on the leaching of beryllium from its ores were noted, four from the United States and one from Canada.[9] Another U.S. patent dealt with the recovery of beryllium from low-grade ores by reacting the ore directly with anhydrous sulfur trioxide.[10]

The Bureau of Mines continued in-house research on the casting of beryllium alloys showing promise of ductility, fracture toughness, and weldability. Castings made with a beryllium alloy containing 10% combined nickel and aluminum were very porous and had the appearance of having a high gas content. A proprietary mold from a commercial casting company and a graphite mold coated with beryllium oxide were used. Some porosity seemed to be due to mold reaction. The work was to be continued.

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[6] Heiple, Clinton R. Mechanical Properties of Diffusion-Bonded Beryllium Ingot Sheet. Metal Trans., v. 3, No. 4, April 1972, pp. 807–812.

[7] Janot, Christian, and Huguette Gibert. Etude par Effet Mössbauer de la Précipitation du Fer dans le Beryllium (Study of the Precipitation of Iron in Beryllium by Means of the Mössbauer Effect). Materials Science and Engineering, v. 10, No. 1, July 1972, pp. 23–31.

[8] Johnson, D. W., Jr., and P. K. Gallagher. Kinetics of the Thermal Decomposition of $BeSO_4$. J. Amer. Ceram. Soc., v. 55, No. 5, May 1972, pp. 232–233.

[9] Grunig, J. K., W. B. Davis, and W. C. Aitkenhead (assigned to The Anaconda Company). Extraction of Beryllium. U.S. Pat. 3,704,091, Nov. 28, 1972; U.S. Pat. 3,685,961, Aug. 22, 1972; U.S. Pat. 3,699,208, Oct. 17, 1972; Canadian Pat. 907,286, Aug. 15, 1972.

Olson, R. S., and J. P. Surls, Jr. (assigned to The Dow Chemical Co.). Beryllium Extraction. U.S. Pat. 3,669,649, June 13, 1972.

[10] Habashi, F., R. Dugdale, and F. L. Holderreed (assigned to The Anaconda Company). Recovery of Beryllium From a Low-Grade Ore by Sulfur Trioxide. U.S. Pat. 3,650,679, Mar. 21, 1972.