Beryllium

By Benjamin Petkof[1]

During 1978 and 1979 low-grade bertrandite ore, mined in Utah, was the only commercial source of industrial quantities of domestic beryllium minerals and was a significant fraction of the world beryllium mineral supply. Only a minor quantity of beryl was produced domestically. Consumption and imports of beryllium ore increased, and exports of beryllium materials decreased.

Table 1.—Salient beryllium mineral statistics

		1975	1976	1977	1978	1979
United States:						
Beryllium mineral concentrates:						
Shipped from mines[1]	short tons	W	W	W	W	W
Imports	do.	1,479	1,058	746	1,031	1,037
Consumption[1]	do.	4,850	3,740	4,165	5,916	9,518
Price, approximate, per unit BeO, imported cobbed beryl at port of exportation		$32	$36	$40	$43	$47
Yearend stocks[1]	short tons	3,546	3,957	3,557	1,346	835
World production of beryl	do.	3,290	r2,553	r2,748	3,094	3,082

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Includes bertrandite ore, which was calculated as equivalent to beryl containing 11% BeO.

Legislation and Government Programs.—Strategic stockpile goals issued on October 1, 1976 by the Federal Preparedness Agency of the General Services Administration remained unchanged during 1978-79. No beryllium materials were released from the strategic stockpiles during both years.

The Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, did not finalize its proposed beryllium occupational and health standards, as published in the Federal Register, October 17, 1975.

DOMESTIC PRODUCTION

Brush Wellman, Inc. (Brush) was the only major commercial domestic producer of beryllium concentrates in 1978-79. Brush mined low-grade bertrandite ore at its Spor Mountain, Utah, operation for processing into beryllium hydroxide. Reported production of beryl was minor in both years.

Brush converted its ore to beryllium hydroxide at a facility north of Delta, Utah, and shipped the hydroxide to its Elmore, Ohio, facility and elsewhere for conversion into various beryllium products. Brush also had the capability to convert imported beryl to beryllium hydroxide at Delta, Utah. In October 1979, Brush announced plans to increase the capacity of its Delta, Utah, facility to process bertrandite ore.

Kawecki-Berylco Industries, Inc. (KBI) became a wholly owned subsidiary of the Cabot Corp. in May 1978. KBI produced beryllium metal, alloys, and oxide at its plants in Hazleton and Reading, Pa., from imported ore that was converted to beryllium hydroxide. In 1979, KBI announced that effective October 1, 1979, the company would produce only beryllium-copper alloy and cease the production of beryllium metal.

Domestic production of beryllium metal, beryllium oxide, and beryllium-copper master alloy in 1978-79 increased over that of 1977.

CONSUMPTION AND USES

In 1978-79 the domestic beryllium industry consumed beryllium ore equivalent to 5,916 and 9,518 tons of beryl, respectively, containing a nominal 11% BeO.

Products utilizing beryllium-copper alloys accounted for the greatest quantity of beryllium consumption. These alloys were used by the business machine, appliance, transportation, and communications industries. Beryllium-copper alloys were also widely used in electrical and electronic systems for connectors, sockets, switches, and temperature- and pressure-sensing devices to provide reliability and long service life.

Beryllium oxide (beryllia) ceramics were used in lasers, microwave tubes, and semiconductors, primarily for heat dissipation. Beryllia was used also as a substrate in various electronic devices and equipment.

Beryllium metal, with its high stiffness-to-weight ratio and excellent thermal properties, was used in items such as inertial navigation systems, satellite structures, space optics, nuclear devices, and military aircraft brakes.

STOCKS

Consumer stocks of beryllium minerals containing 11% BeO totaled 1,346 tons at yearend 1978, and 835 tons at yearend 1979. The drawdown of beryllium mineral yearend stocks reflected increased beryllium mineral consumption and the low quantity of beryllium mineral imports.

PRICES AND SPECIFICATIONS

From January 1978 to the end of August 1978, Metals Week quoted the price of imported beryl at $40 to $42 per short ton unit of contained BeO. For the remainder of 1978, imported beryl was quoted at $45 to $50 per short ton unit. At the beginning of 1979, beryl ore price went to $50 to $53 per short ton unit and remained at that level throughout 1979.

At yearend 1978, the American Metal Market quoted the following prices for beryllium materials: Vacuum-cast ingot, $120 per pound; metal beads (1,000-pound lots), $93 per pound; metal powder (5,000-pound lots), $103 per pound; beryllium-copper master alloy, $67 per pound of contained beryllium; beryllium-copper casting alloy, $2.75 to $3.40 per pound; beryllium-copper in rod, bar and wire, $4.79 per pound; beryllium-copper in strip, $4.77 per pound; beryllium-aluminum alloy ingot (100,000 pound lots), $83 per pound; and beryllium oxide powder, $26 per pound. All beryllium metal quotations were for 97%-purity metal.

At the end of 1979, the price quotations for vacuum-cast ingot, metal beads and powder, and oxide remained unchanged. Other beryllium categories were as follows: Beryllium-copper master alloy, $72.50 per pound of contained beryllium; beryllium-copper rod, bar and wire, $5.56 per pound; beryllium-copper strip, $5.54 per pound; beryllium-aluminum alloy, $98 per pound.

FOREIGN TRADE

Although the quantity of wrought and unwrought beryllium alloys and waste and scrap exports declined in 1978-79, the annual average value of exports increased, indicating that greater quantities of finished forms of beryllium metal and alloy were exported.

Beryl was the only beryllium mineral ore imported. The average value of the imported material rose from $399 per ton in 1977, to $404 per ton in 1978, and $471 per ton in 1979. In addition, 1,455 pounds of wrought, unwrought and waste and scrap beryllium metal valued at $11,226 was imported from Mexico and France in 1978, and 2,107 pounds valued at $9,182 from Canada and the United Kingdom in 1979.

Table 2.—U.S. exports of beryllium alloys, wrought or unwrought, and waste and scrap[1]

Country	1977		1978		1979	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Argentina	967	$21	2	$2	291	$3
Australia	797	3	2,271	2	--	--
Belgium-Luxembourg	549	5	88	1	112	66
Canada	44,472	28	3,400	245	10,698	211
Ecuador	--	--	800	1	--	--
El Salvador	--	--	33,534	6	--	--
French West Indies	--	--	400	1	--	--
Finland	5	5	4	3	86	19
France	13,414	571	5,471	590	17,370	1,635
Germany, Federal Republic of	855	65	8,013	169	1,022	195
Hong Kong	--	--	1,161	3	2,200	11
India	--	--	169	4	253	8
Israel	3	2	491	4	--	--
Italy	56	1	150	7	249	6
Jamaica	832	4	--	--	--	--
Japan	84,410	624	3,305	244	4,691	397
Mexico	4,000	9	3,128	19	326	21
Netherlands	1,356	38	207	56	1,057	40
New Zealand	--	--	--	--	65	1
Norway	--	--	--	--	192	2
Singapore	--	--	222	1	1,367	6
Switzerland	30	11	1,570	41	3,939	50
Taiwan	--	--	3,696	9	4,000	15
United Kingdom	7,912	521	13,597	577	23,915	999
Venezuela	--	--	--	--	319	1
Other	847	3	--	--	--	--
Total	160,505	1,911	81,679	1,985	72,152	3,686

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

Table 3.—U.S. imports for consumption of beryl, by customs district and country

Customs district and country	1977		1978		1979	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Philadelphia district:						
Argentina	66	$22	--	--	--	--
Australia	15	3	--	--	--	--
Brazil	370	162	237	$114	187	$94
China, People's Republic of	--	--	--	--	265	115
India	--	--	553	211	--	--
Rwanda	--	--	--	--	110	77
South Africa, Republic of	32	12	--	--	21	8
Spain	9	4	--	--	--	--
Total	492	203	790	325	583	294
Los Angeles district:						
Argentina	111	38	69	24	84	40
Brazil	99	42	144	58	331	141
Mozambique	22	6	--	--	22	6
Rwanda	22	9	--	--	--	--
South Africa, Republic of	--	--	28	10	17	7
Total	254	95	241	92	454	194
Grand total	746	298	1,031	417	1,037	488

WORLD REVIEW

World beryl production remained low in 1978-79 in response to limited industrial requirements for beryllium products. Argentina, Brazil, and the U.S.S.R. were the major world beryl producers. The United States retained its position as a significant producer of commercial beryllium minerals by mining and processing bertrandite ore in Utah. The U.S.S.R. and the United States were the major consumers of beryllium concentrates.

Table 4.—Beryl: World production, by country[1]

(Short tons)

Country	1976	1977	1978[p]	1979[p]
Argentina	123	182	219	200
Brazil	406	496	815	800
Madagascar	19	[e]15	12	11
Mozambique	([2])	NA	NA	--
Nepal[3]	[e]1	1	([2])	--
Rhodesia, Southern[e]	70	70	50	50
Rwanda	51	61	64	21
South Africa, Republic of	3	3	4	--
Uganda[e]	60	50	NA	--
U.S.S.R.[e]	1,820	1,870	1,930	2,000
United States[4]	W	W	W	W
Total	[r]2,553	[r]2,748	3,094	3,082

[e]Estimate. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]In addition to the countries listed, Bolivia and the Territory of South-West Africa (Namibia) may also have produced beryl, but available information is inadequate to formulate reliable estimates of output levels.

[2]Less than 1/2 unit.

[3]Fiscal year ending in July of year stated.

[4]Primarily bertrandite ore.

TECHNOLOGY

Hazards associated with milling, sawing, welding, and brazing of beryllium-copper alloys were evaluated experimentally. The study concluded that beryllium-copper alloys should be treated as toxic materials and air samples should be taken for each fabrication method to determine worker exposure and effectiveness of workplace controls.[2]

An experimental program was conducted to develop a material-process combination that would produce a high-quality beryllium-titanium composite. The resulting composite had a proportional limit equal to or greater than 40,000 pounds per square inch, an elastic modulus of 28 million pounds per square inch, and a density of 3.32 grams per cubic centimeter.[3]

Scientific literature was reviewed to assess the biological and environmental effects of beryllium. The review included a general summary and discussion of beryllium topics such as physical and chemical properties; occurrence, synthesis and use; analytical methodology; biological aspects in micro-organisms, plants, animals, and humans; distribution, mobility, and persistence in the environment; assessment of present and potential health and environmental hazards; and standards and governmental regulations. The review cited a large number of references.[4]

The beryllium standards proposed by OSHA and their impact on some end uses were discussed.[5]

The use of beryllium oxide and other substrates for mounting power components such as transistors and diodes was described.[6]

Beryllium-nickel alloy was considered for the fabrication of connectors that function above the range of 150°F to 300°F, the limit of conventional connectors, because of its high yield strength and high resistence to stress relaxation above 300°F.[7]

A brief article described the characteristics and uses of beryllium- nickel alloy.[8]

Specific uses for beryllium-copper alloys were discussed along with some description of the required alloy treatment.[9]

The toxic effect of beryllium on potatoes and oats was measured when grown in a beryllium-contained acid soil. The uptake of beryllium by the plants was also measured.[10]

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[2]Senn, T. J. Evaluation of the Hazard Associated with Fabricating Beryllium-Copper Alloys. Lawrence Livermore Lab., Univ. Calif., Livermore, Calif. UCRL-52258, May 5, 1977, 45 pp.

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[5]Wetmore, W. C. Proposed Standard Threatens Beryllium. Aviation Week and Space Technol., v. 108, No. 18, May 1, 1978, pp. 44-45.

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