GARNET

By Ronald F. Balazik

Garnets are a complex family of silicate minerals with similar crystalline structures and a wide range of chemical compositions and properties. The general chemical formula for garnet is $A_3B_2(SiO_4)$, where A can be calcium, magnesium, ferrous iron, or manganese; and B can be aluminum, chromium, ferric iron, or titanium. Much industrial-grade garnet from the United States is a solid solution of almandine (iron-aluminum garnet) and pyrope (magnesium-aluminum garnet) that breaks into sharp chisel-edged plates. Industry uses garnet as an abrasive material (6.5 to 9.0 Mohs hardness range). Low-quality industrial garnet primarily is utilized as airblasting or hydroblasting media and as filtration media.

Production

It is estimated that the United States accounts for more than one-third of world industrial garnet production. In 1996, six U.S. firms, including a new company, produced 68,200 tons of crude garnet concentrate valued at about $10.2 million. The firms were Barton Mines Corp., Warren County, NY; NYCO Minerals, Inc., Essex County, NY; Patterson Materials Corp., Wingdale, NY; International Garnet Abrasive Inc., Clinton County, NY; Emerald Creek Garnet Co., Benewah County, ID; and Cominco American Inc., Madison County, MT (a new producer). All six companies were surveyed by the U.S. Geological Survey to determine U.S. production and sales of industrial garnet. Five of the six companies responded to the survey; production at the remaining firm was estimated.

The new Cominco American mine cited above opened in early 1996. The facility reportedly will produce almandine garnet at a rate of about 9,000 tons annually, but eventually will expand to a capacity of 40,000 tons per year.

Also in 1996, Western Garnet International (owner of the Emerald Creek operation noted above) and NYCO Minerals signed an agreement under which Western has the right to purchase garnet from NYCO.

Consumption

The United States is the world's largest consumer of industrial garnet. It is estimated that U.S. consumption of industrial garnet was about 50,000 tons in 1996. According to various reports, domestic use of industrial garnet accounted for 25% to 40% of global consumption in the mid-1990's (Gorrill, 1996; Roskill, 1996). Major end uses in the United States and their estimated market share are as follows: Blasting media, 45%; water filtration, 15%; waterjet cutting, 10%; and abrasive powders, 10%. (Gorrill, 1996). Domestic industrial sectors that utilize garnet include the petroleum industry, filtration systems, aircraft and motor vehicle manufacturers, wood furniture finishing operations, electronic component manufacturing, and ceramics and glass production.

Industrial garnet is used primarily as a loose-grain abrasive; some lower quality industrial garnet also is used as filtration media. High-quality, high-value garnet primarily has been used as a loose-grain abrasive for applications such as optical lens grinding and plate-glass grinding for more than a century. In recent years, industrial garnet has been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Other industrial applications include the manufacture of coated abrasives; air/water blasting; hydrocutting; nonskid surfaces; and the finishing of wood, leather, hard rubber, felt, and plastics.

Shipbuilding and aluminum aircraft industries use lower quality garnet for sandblasting. Similar uses include the cleaning and conditioning of aluminum and other soft metals as well as metals cleaning by structural steel fabrication shops. Mixed-media water filtration, using a mixture of sand, anthracite, and garnet, has displaced older filtration methods because it is more reliable and provides better water quality. Garnet entrained in high-pressure streams of water also is used to cut many different materials. The manufacturers of nonskid floor paint also use alluvial and other lower cost garnets in their products.

Garnet has an intermediate place in the coated-abrasive field between lower cost quartz sand and more costly synthetic abrasives (silicon carbide and fused alumina). In addition, garnet reportedly is more efficient than quartz sand in similar applications. However, garnet, especially the lower grades, cannot compete with synthetic abrasives in most metalworking applications requiring substantial metal removal because of its friable nature and lower hardness.

Prices

Industrial garnet has a very wide range of prices that are dependent on type, source, quantity purchased, quality, and application. Reported values for crude concentrates in 1996 averaged $150 per ton, but ranged from about $20 to $190 per ton. Refined garnet values generally ranged from $160 to $350 per ton (Industrial Minerals, 1996). However, prices for small quantities of highly processed garnet (e.g., powders) that are more than double the upper limit of this range have been reported.

Foreign Trade

The U.S. Department of Commerce, which is the major government source of U.S. trade data, does not provide import or export statistics on industrial garnet. However, the U.S. Geological Survey estimates that U.S. industrial garnet imports and exports in 1996 were 8,000 tons and 13,000 tons, respectively. Australia has accounted for about 85% of U.S. industrial garnet imports since 1990; China and India have been the remaining import sources.

World Review

Garnet occurs worldwide in many metamorphic rocks, particularly gneisses and schists. Moreover, garnet occurs as contact-metamorphic deposits in crystalline limestones, pegmatites, and serpentinites, and in high-temperature intrusive contacts and vein deposits. Alluvial garnet also is a coproduct with many heavy mineral sand and gravel deposits throughout the world. In addition to the United States, major garnet deposits exist in Australia, China, and India, where they are mined for foreign and domestic markets; deposits in Russia and Turkey also have been mined in recent years, primarily for internal markets.

Estimates of world industrial garnet production range from 145,000 to more than 200,000 tons. In addition to the United States, leading producers in recent years have been Australia, China, and India. Estimates of Australian production in the mid-1990's have ranged from 30,000 tons to about 70,000 tons; estimates for India have been between 15,000 and 60,000 tons. Chinese output of industrial garnet during the same period reached at least 15,000 tons. At yearend 1996, significant new garnet operations were under development in southeastern India and in Ontario, Canada.

Outlook

Forecasts indicate significant growth in world demand for industrial garnet; one report projects an average annual increase of 7% during the next 10 years (Roskill, 1996). These forecasts predict that global markets for industrial garnet may increase by more than 160,000 tons within the next 5 years. Specifically, world markets for garnet blasting media and waterjet cutting conceivably could more than double by the year 2000 if economic conditions permit. Planned production worldwide to meet anticipated demand would add at least 160,000 tons of capacity if constructed. This new capacity would tend to restrain price increases.

According to industry plans, U.S. production capacity for garnet could increase significantly before the end of this decade. However, the domestic garnet industry may be operating near capacity already. If so, new domestic markets for industrial garnet in the remaining 1990's largely will depend on imports if economic conditions and/or resource restrictions delay additional capacity.

If industrial garnet is not available to meet growing demand, other natural and synthetic abrasives could serve as substitutes to some extent for all major end uses. In many cases, however, the substitutes would entail sacrifices in quality or cost. Fused alumina and staurolite compete with garnet as a sandblasting material in the transportation equipment industries. Ilmenite and plastics compete as filtration media. Diamond, corundum, and fused alumina compete for lens grinding and for many lapping operations. Finally, sand, silicon carbide, and fused alumina compete for grinding and finishing of plastics, wood furniture, and other products.

References Cited

Russell, Alison, 1996, Prices: Industrial Minerals, no. 342, p. 82.

Gorrill, Lindsay E., 1996, World garnet review - Supply and markets: 12th Industrial Minerals International Congress, Chicago, April 21-24, 1996, Proceedings p. 85-87.

Roskill Information Services Ltd, 1996, Soaring demand for garnet: London, Roskill News Release, June 20, 1996, 3p.

SOURCES OF INFORMATION

USGS Publications

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Industrial Garnet. Ch. in Mineral Commodity Summaries, annual.

Other

Industrial Minerals (monthly).

TABLE 1
SALIENT U.S. INDUSTRIAL GARNET STATISTICS 1/

	Crude production		Sold or used	
Year	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1992	54,100	$4,840	46,100	$13,000
1993	44,000	4,440	55,800	15,400
1994	51,000	6,100	51,100 r/	13,000 r/
1995	53,000	9,690 r/	46,100 r/	11,100 r/
1996	68,200	10,200	58,500	12,200

r/ Revised.
1/ Data are rounded to three significant digits.