

INDUSTRIAL GARNET

By Donald W. Olson

Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant.

Garnet is mined as a gemstone and an industrial material, but it is valued primarily for its many industrial applications. Its angular fractures and high hardness, as well as its ability to be recycled, make industrial garnet desirable for a variety of abrasive and filtration purposes. The complex mineralogy of garnet determines its utility for a variety of uses ranging from water filtration to waterjet cutting.

Garnet is the general name for a group of complex silicate minerals with similar crystalline structures and diverse chemical compositions. The general chemical formula is $A_3B_2(SiO_4)_3$, where A can be calcium, magnesium, ferrous iron, or manganese and B can be aluminum, chromium, ferric iron, or rarely, titanium. Garnet occurs worldwide in many rock types, principally gneisses and schists; other sources include contact metamorphic rocks, crystalline limestones, pegmatites, and serpentinites. Alluvial garnet is associated with heavy mineral sand and gravel deposits in many parts of the world. Occurrences of garnet are large and numerous, however, relatively few commercially viable garnet deposits have been discovered.

Mine output of industrial garnet in the United States decreased in 1999 to a lower level than that of 1996, and the U.S. market demand declined. There were two mining operations in the United States that were offered for sale; of those one closed in 1999 and the other was sold in December.

Production

The U.S. industrial garnet industry is dominated by a few major producers. The industrial garnet market is influenced by the size and grade of reserves, the type and quality of garnet mined, the proximity of deposits to infrastructure and consumers, and the milling costs. Pricing is very competitive and suppliers must provide a high level of customer service (Kendall, 1997). Most industrial-grade garnet mined in the United States is almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), though andradite (calcium-iron silicate) is also a domestic source for industrial uses.

The United States produced approximately 25% to 30% of the industrial garnet mined worldwide in 1999; Australia was the only country that exceeds U.S. production. According to a survey conducted by the U.S. Geological Survey (USGS), five U.S. companies in Idaho, Montana, and New York accounted for all domestic output. Production decreased to 60,700 metric tons (t) valued at about \$6.2 million in 1999 (table 1). The producers were Barton Mines Corp. in Warren County, NY; Cominco American Inc. in Madison County, MT; Emerald Creek Garnet Co. in Benewah County, ID; NYCO Minerals,

Inc. in Essex County, NY; and Patterson Materials Corp. in Dutchess County, NY. All the producers reported their output and sales to the USGS. In addition to the producers cited above, International Garnet Abrasive Inc. in Clinton County, NY, processed and sold all the garnet mined by NYCO Minerals in 1999.

Sweetwater Garnet, Inc. shut down and continued to be offered for sale in 1999. The sale of the Cominco American Mine to Montana-Oregon Investment Group LLC took effect December 31, 1999, and the name was changed to the Ruby Garnet Mine.

Consumption

The United States is the world's largest consumer of industrial garnet, accounting for 20% to 25% of global consumption (Harris, 2000). Estimated U.S. consumption of industrial garnet was 46,000 t in 1999.

Major end uses in the United States and their estimated market share are abrasive air or water blasting media, 45%; abrasive powders, 15%; water filtration, 15%; waterjet cutting, 10%; and other miscellaneous abrasive uses, 15% (Kendall, 1997). U.S. users of industrial garnet in decreasing order of consumption share are the petroleum industry, electronic component manufacturers, water filtration plants, aircraft and motor vehicle manufacturers, shipbuilders, wood-furniture-finishing operations, and ceramics and glass producers (Kendall, 1997).

The majority of industrial garnet is used as a loose-grain abrasive because of its hardness, which ranges from 6.0 to 7.5 on the Mohs scale. Lower-quality industrial garnet is used as a filtration medium in water-purification systems because it is relatively inert and resists chemical degradation. High-quality, high-value garnet grain principally has been used for such applications as optical lens grinding and plate-glass grinding for more than a century; industrial diamond and fused aluminum oxide are competitors. In recent years, industrial garnet powders have been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Other industrial applications include the manufacture of coated abrasives; hydrocutting; and the finishing of wood, leather, hard rubber, felt, and plastics. Garnet is slowly replacing silica sand in the blast cleaning market. This market displacement is happening because of the health risks associated with the inhalation of airborne crystalline silica dust having curtailed its use, but silica sand and slag are still the most important media in blasting (Harris, 2000).

The U.S. petroleum industry is one of the largest garnet-consuming industries, using garnet for cleaning drill pipes and

well casings. Because of unreliable or insufficient sources of industrial garnet, however, some of the petroleum industry's drill pipe cleaning now uses fused aluminum oxide (Frank Alsobrook, Alsobrook and Company, Inc., oral commun., 2000).

The shipbuilding and aluminum aircraft industries use garnet for blast cleaning and finishing of metal surfaces. 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; ilmenite, magnetite, and plastics compete as filtration media. Garnet entrained in high-pressure streams of water also is used to cut many different materials. The garnet powders generally are used for glass/ceramic polishes, antislip paints, and antiskid surfaces.

In the coated-abrasive market, garnet has an intermediate place between low-cost quartz sand or staurolite and more costly manufactured abrasives (silicon carbide and fused alumina, for example); garnet reportedly is more efficient than quartz sand in most coated-abrasive applications. Because of garnet's friable nature and lower hardness, it cannot compete with manufactured abrasives in metalworking applications that require substantial metal removal.

Prices

Industrial garnet's wide price range depends on type, source, quantity purchased, quality, and application. Average values for crude concentrates ranged from about \$55 to \$120 per ton in 1999. Average values for refined garnet sold during the year ranged from \$55 to \$237 per ton. However, spot prices reached as high as \$413 per ton in 1999.

Foreign Trade

The U.S. Government no longer compiles trade data that can be used to identify garnet exports and imports specifically. On the basis of reports from some producers and other industry sources, however, exports and imports of industrial garnet were estimated to be about 10,000 t and 12,000 t, respectively, in 1999 (Frank Alsobrook, Alsobrook and Company, Inc., oral commun., 2000). Some of the imports, reportedly, were not consumed during the year. Most U.S. garnet exports go to Asian and European markets.

About 40% to 45% of the U.S. garnet imports are from Australia, 35% to 40% from India, and 15% from China (Frank Alsobrook, Alsobrook and Company, Inc., oral commun., 2000). Australia historically has accounted for most of the industrial garnet imported by the United States. Imports of garnet from China and India are increasing and have the potential to gain a significant share of the U.S. market (Frank Alsobrook, Alsobrook and Company, Inc., oral commun., 2000).

World Review

Total world production in 1999 was estimated to be 214,000 t. The most significant producers outside the United States are Australia, China, and India, all of which have growing markets. Other producers include the Czech Republic, Pakistan, Russia, Turkey, and Ukraine. Output in most of these countries is for their own domestic use.

Australian exports of garnet are expected to continue to increase. China and India also have increased garnet output and are likely to become a more significant sources of garnet for other countries.

Total global supply is roughly divided among markets as follows: blasting media, 45%; water filtration, 25%; abrasive powders, 10%; waterjet cutting, 10%; and other uses, 10% (Kendall, 1997).

Outlook

Although the United States will remain a major garnet consumer, imports are expected to supply a larger share of the U.S. garnet market in future years. The anticipated substitution of silica sand by garnet in abrasive blasting markets also will continue, but at a pace slower than expected by the most optimistic forecasts because silica sand has a price advantage and is more accessible to consumers. U.S. Air Force and Naval base closures are having and will continue to have a depressing effect on demand for garnet in the United States, since aircraft manufacturing and shipbuilding are industries that use significant amounts of garnet (Frank Alsobrook, Alsobrook and Company, Inc., oral commun., 2000).

The larger established garnet producers in the United States and elsewhere will continue to be the dominant garnet suppliers in the coming decade. Proposals in recent years for new mine openings and the expansion of existing operations appear to be sufficient to meet anticipated increases in demand. Worldwide capacity expansion would significantly restrain price increases as well as meet anticipated market needs. Most of the new capacity growth is expected in Australia, India, and China.

If U.S. production capacity does not increase sufficiently in the next several years, growing domestic markets will be more import dependent. Greater U.S. reliance on imports is not expected to become a major problem because leading domestic producers own key sources of garnet supply abroad. If industrial garnet is not available to meet growing demand, other natural and synthetic abrasives could serve as substitutes for major end uses. In many cases, though, the substitutes would entail greater production costs or sacrifices in quality.

References Cited

- Harris, Paul, 2000, At the cutting edge—Abrasives & their markets: *Industrial Minerals*, no. 388, January, p. 19-27.
Kendall, Tom, 1997, Garnet—Nice work if you can get it: *Industrial Minerals*, no. 354, March, p. 31-41.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Garnet. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Industrial garnet. Ch. in Mineral Commodity Summaries, annual.¹

¹ Prior to January 1996, published by the U.S. Bureau of Mines.

Other

Industrial Minerals (monthly).

Industrial Minerals Prices and Data (annual).

North American Minerals News (monthly).

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

Year	Crude production		Sold or used 2/	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1995	46,300	\$3,850	39,900	\$10,100
1996	60,900	5,630	46,200	11,200
1997	64,900	6,050	53,600	12,500
1998	74,000	7,070	51,900	12,600
1999	60,700	6,170	43,900	11,600

1/ Data are rounded to no more than three significant digits.

2/ May exclude some unreported exports.