



2006 Minerals Yearbook

GARNET, INDUSTRIAL

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By Donald W. Olson

Domestic survey data and table were prepared by Maria Arguelles, statistical assistant.

In 2006, U.S. production of crude garnet concentrate for industrial use was estimated to be 34,100 metric tons (t) valued at about \$4.24 million. U.S. imports and exports of industrial garnet were estimated to be 50,800 t and 13,300 t, respectively. U.S. apparent consumption was estimated to be 71,600 t.

This report includes information on garnet produced in the United States that was used for industrial purposes. Current information on gem-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals chapter on gemstones. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data.

Garnet has been used as a gemstone for centuries. Garnet necklaces have been found in graves as far back as the Bronze Age, and garnet is found among the ornaments adorning the oldest Egyptian mummies. However, garnet's angular fractures, relatively high hardness and specific gravity, chemical inertness, nontoxicity, lack of crystalline silica, and its ability to be recycled make it ideal for many industrial applications.

Garnet is the general name given to a group of complex silicate minerals, all with isometric crystal structure and similar properties and chemical composition. The general chemical formula for the garnet minerals is $A_3B_2(SiO_4)_3$, where A can be calcium, ferrous iron, magnesium, or manganese, and B can be aluminum, chromium, ferric iron, or rarely, titanium. The most common garnet minerals are classified into three groups—the aluminum-garnet group, the chromium-garnet group, and the iron-garnet group. The most common minerals of the aluminum-garnet group are almandine or almandite, grossularite, pyrope, and spessartite. Andradite is the most common iron-garnet mineral, and uvarovite is the most common chromium garnet. Garnet occurs worldwide in many rock types, principally gneisses and schists; other sources include contact metamorphic rocks, metamorphosed 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 numerous; however, relatively few commercially viable garnet deposits have been discovered.

Production

The U.S. industrial garnet industry is dominated by a few major producers. The garnet industry has encountered higher production costs and tighter profit margins during recent years. These factors have resulted in the loss of noncompetitive producers. Because of the need to keep production costs at a minimum, the most competitive producers are those who produce garnet in combination with one or two other minerals, have reserves that can be mined at a low cost, and have the ability to react rapidly to changes in market demands. The value of industrial garnet 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 within the U.S. garnet industry is very competitive, and suppliers must provide a high level of customer service. The majority of industrial-grade garnet mined in the United States is almandine (iron aluminum silicate) and pyrope (magnesium aluminum silicate); some andradite (calcium iron silicate) also is mined domestically. Industrial garnet is produced from alluvial bar and beach deposits, like those in Idaho and Montana (also those in Australia and India), and it is produced from hard rock deposits, like those in New York (Moore, 2006).

Four U.S. companies accounted for all domestic production—one in Idaho, one in Montana, and two in New York. The USGS obtained the data in this report through a survey of U.S. industrial garnet producers. Three of the four domestic producers reported their output and sales to the USGS, and production amounts and values for the nonreporting company were estimated.

In 2006, U.S. production of crude garnet concentrate for industrial use was estimated to be 34,100 t valued at about \$4.24 million (table 1). This was a 15% decrease in production and an increase of about 10% in value compared with 40,100 t valued at \$3.84 million in 2005. Refined garnet material sold or used amounted to 16,800 t valued at \$5.33 million and a unit value of \$318 per ton, a 27% decrease in quantity, a decrease of about 14% in value, and an increase of almost 19% in unit value compared with the 2005 levels. The producers were Barton Mines Co. LLC in Warren County, NY; Emerald Creek Garnet Co. in Benewah County, ID; NYCO Minerals, Inc. in Essex County, NY; and Ruby Valley Garnet LLC in Madison County, MT. 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 2006.

Consumption

The United States continued to be one of the world's leading consumers of industrial garnet. In 2006, the estimated U.S. apparent consumption of industrial garnet was 71,600 t. The United States accounted for more than 22% of global industrial garnet use.

The end uses for garnet in the United States and their estimated market share in 2006 were waterjet cutting, 35%; abrasive blasting media, 30%; water filtration, 15%; abrasive powders, 10%; and other, 10%. Domestic industries that consume garnet include aircraft and motor vehicle manufacturers, ceramics and glass producers, electronic component manufacturers, filtration plants, glass polishing, the petroleum industry, shipbuilders, textile stonewashing, and wood-furniture-finishing operations (Moore, 2006).

Most industrial garnet is used as an abrasive because of its hardness, which ranges from 6 to 7.5 on the Mohs scale. High-quality, high-value garnet grain has been used principally 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 these applications. In recent years, industrial garnet powders have been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Garnet has replaced some silica sand in the blast cleaning market because garnet does not have the health risks associated with the inhalation of airborne crystalline silica dust. At present, however, silica sand and mineral slag continue to be the most widely used media in blasting (Harris, 2000). The U.S. petroleum industry is one of the leading garnet-consuming industries, using garnet for cleaning drill pipes and well casings. The shipbuilding and aluminum aircraft industries use garnet for blast cleaning and for finishing metal surfaces. Similar uses include the cleaning and conditioning of aluminum and other soft metals as well as metal cleaning by structural steel fabrication shops. Garnet entrained in high-pressure streams of water also is used to cut many different materials. Garnet powders generally are used for antiskid surfaces, antislip paints, and glass/ceramic polishes.

Low-quality industrial garnet, which has lower hardness and is more highly fractured, is used as a filtration medium in water purification systems because of its relative inertness and resistance to chemical degradation. Garnet is well suited for water filtration and treatment because it is relatively heavy and chemically stable. Mixed-media water filtration, which uses a mixture of anthracite, garnet, and silica sand, has displaced older filtration methods because it provides better water quality. Garnet competes with ilmenite, magnetite, plastics, and silica sand as a filtration medium.

Other applications include the manufacture of coated abrasives and the finishing of felt, hard rubber, leather, plastics, and wood. In the coated-abrasive market, garnet falls between low-cost quartz sand or staurolite and more costly manufactured abrasives, such as fused alumina and silicon carbide. Garnet is more efficient than quartz sand in most coated-abrasive applications. Owing to its friable nature and lower hardness, garnet cannot compete with manufactured abrasives in metalworking applications that require substantial metal removal.

Prices

Industrial garnet is priced at a wide range, depending on application, quality, quantity purchased, source, and type. During 2006, domestic values for crude concentrates for different applications ranged from about \$11 to \$204 per metric ton, with an average for the year of \$124 per ton. Domestic values for refined garnet for different applications sold during the year ranged from \$295 to \$441 per ton, with an average for the year of \$318 per ton.

The estimated values of garnet from other leading producers around the world are as follows: North America, \$125 to \$600 per ton; India, \$60 to \$120 per ton; and Australia, \$90 to \$145 per ton (Rapple, 2006).

Foreign Trade

Lower priced foreign imports slowly began displacing U.S. production in domestic markets during the 1990s. Since 2003, industrial garnet imports have exceeded domestic industrial garnet production.

The U.S. Census Bureau compiles trade data on exports and imports of industrial garnet mixed with other natural abrasive commodities, such as emery and corundum, so the data cannot be identified specifically as garnet. Based on reports from some producers and other industry sources, imports and exports of industrial garnet were estimated to be 50,800 t and 13,300 t, respectively, in 2006. The level of imports increased by about 22% compared with those of 2005, and exports decreased slightly by about 1% from those of 2005. Australia provided approximately 41%; India, almost 27%; China, almost 20%; Canada, approximately 11%; and other countries, 1% of industrial garnet imported into the United States for consumption. Australia, China, and India continued to increase their exports of garnet. Garnet exported by the United States was shipped to Asian, Canadian, Caribbean, Central American, European, and South American markets. More than one-half of exports of garnet from the United States went to Canada and Mexico.

World Review

The USGS estimated total world industrial garnet production to be about 325,000 t, but some industrial garnet consultants have estimated world production to be as high as 440,000 t (Gorrill, 2003). Australia, China, India, and the United States were the leading producers in 2006. The United States produced 10% of the industrial garnet mined worldwide. Production in both Australia and India exceeded production in the United States. Russia and Turkey have been mining garnet in recent years, primarily for domestic markets. Small garnet-mining operations also are located in Canada, Chile, the Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine. Production in most of these countries is for domestic use.

Australian industrial garnet production and exports have been increasing since 1998 and are expected to continue increasing. China and India also have increased garnet output in the past decade and have become significant garnet sources for other countries.

Worldwide end uses and their estimated market shares are abrasive blasting media, 60%; waterjet cutting, 20%; water filtration, 10%; and other end uses, 10%.

Outlook

Excess production capacity combined with stocks that vary in grain size, mineral type, and quality are expected to keep prices down for the short term. Garnet producers could benefit from the enforcement of existing regulations and tighter environmental and health controls on abrasive silica blasting media. The implementation of clean water regulations in the United States and the improvement of potable water supplies in developing countries also will benefit garnet suppliers.

The U.S. garnet industry has encountered higher production costs and tighter profit margins during recent years. The industry has also been competing with lower priced foreign imports that have displaced U.S. production in domestic markets, so much so that for the past 4 years, industrial garnet imports have exceeded domestic industrial garnet production. This has resulted in the loss of noncompetitive producers. Because of the need to keep production costs at a minimum, the most competitive producers are those who produce garnet in combination with one or two other minerals, have reserves that can be mined at a low cost, and have the ability to react rapidly to changes in market demand. An example of this type of mining operation is the mine being opened in Coos County, OR, by Oregon Resources Corp. The mine will begin production in March 2008 and be in full operation by late spring. The mine will produce 635,000 t of ore per year, yielding 54,400 t chromite and 16,300 to 18,100 t spessartite garnet each year. The garnet will marketed for waterjet cutting. Zircon will also be produced. Oregon Resources Corp. projects a 15-year mine life for the operation (James Dingman, director of marketing and sales, Oregon Resources Corp., written commun., February 28, 2007).

Worldwide industrial garnet demand is expected to continue growing during the next 5 years. Markets for waterjet cutting and blasting media are expected to exhibit the highest growth (Roskill Information Services, Ltd., 2000, p. 62, 66).

Demand for garnet polishing powders, which are used in polishing television and monitor screens, is declining with the emergence of flat screen systems that do not require garnet polishing during their manufacture. In coming years, as the affordability and popularity of flat screen technology increases, a further decrease in demand for garnet polishing powders is probable (Gorrill, 2003).

Recent worldwide increases in petroleum prices have stimulated an increase in exploration for petroleum resources.

This exploration increase should provide opportunities for increased use of garnet blasting media for cleaning drill pipe. Increased defense spending in the United States could lead to increased garnet demand, since the aircraft manufacturing and shipbuilding industries use significant amounts of garnet for blast cleaning and finishing of metal surfaces and for use in waterjet cutting.

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GENERAL SOURCES OF INFORMATION

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Other

- Industrial Minerals, monthly.
 Industrial Minerals Prices and Data, annual.

TABLE 1
 SALIENT U.S. INDUSTRIAL GARNET STATISTICS¹

		2002	2003	2004	2005	2006
United States:						
Crude production:						
Quantity	metric tons	38,500	29,200	28,400	40,100	34,100
Value	thousands	\$4,500	\$3,170	\$3,050	\$3,840	\$4,240
Sold or used: ²						
Quantity	metric tons	37,500	33,100	30,400	23,100	16,800
Value	thousands	\$11,100	\$10,900	\$10,000	\$6,200	\$5,330
Exports:						
Quantity	metric tons	10,400	11,000	10,900	13,400	13,300
Value	thousands	\$8,930	\$7,460	\$8,990	\$9,700	\$9,450
Imports for consumption:						
Quantity	metric tons	27,200	34,800	36,500	41,800	50,800
Value	thousands	\$3,610	\$3,710	\$4,260	\$5,910	\$8,340
Apparent consumption ³	metric tons	55,300	53,000	54,000	68,600	71,600
World, production ^c	do.	277,000	277,000	302,000	324,000	325,000 ^c

^cEstimated.

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

²May exclude some unreported exports.

³Domestic production plus imports minus exports.