



2010 Minerals Yearbook

GARNET, INDUSTRIAL

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In 2010, U.S. production of crude garnet concentrate for industrial use was estimated to be 52,600 metric tons (t) valued at about \$7.91 million (table 1). U.S. imports and exports of industrial garnet were estimated to be 42,500 t and 11,700 t, respectively. U.S. apparent consumption was estimated to be 83,500 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.

The name “garnet” comes from either the Middle English word “gernet,” meaning dark red, or the Latin word “granatus,” meaning grain, possibly a reference to the pomegranate (*Punica granatum*), a fruit plant with red seeds similar in shape, size, and color to some garnet crystals. Garnet has been used as a gemstone for centuries. Garnet necklaces have been found in burial sites as far back as the Bronze Age, and garnet is found among the ornaments adorning the oldest Egyptian mummies. Garnet also is ideal for many industrial applications because of its angular fractures, relatively high hardness and specific gravity, chemical inertness, nontoxicity, lack of crystalline silica, and its ability to be recycled.

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 progressively higher production costs and tighter profit margins

since the mid-1990s. 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 demand. 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. Two of the four domestic producers reported their output and sales to the USGS, and production amounts and values for the nonreporting companies were estimated.

In 2010, U.S. production of crude garnet concentrate for industrial use was estimated to be 52,600 t valued at about \$7.91 million (table 1). This was a 15% increase in production and an increase of 15% in value compared with 45,600 t valued at \$6.85 million in 2009. The United States accounted for about 4% of global industrial garnet production. Refined garnet material sold or used during 2010 was 28,900 t valued at \$7.43 million, a unit value of \$257 per ton, which was a 31% increase in quantity, an increase of about 22% in value, and a 7% decrease in unit value compared with the 2009 levels. Garnet producers in 2010 were Barton Mines Co., LLC in Warren County, NY; Emerald Creek Garnet Ltd. 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 as a byproduct of wollastonite production in 2010.

Consumption

In 2010, the estimated U.S. apparent consumption of industrial garnet was 83,500 t. The United States accounted for about 6% of global industrial garnet use.

The end uses for garnet in the United States and their estimated market share in 2010 were abrasive grains for waterjet

cutting, 35%; abrasive blasting media, 30%; water filtration, 20%; abrasive powders, 10%; and other, 5%. 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.

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 abrasive blasting media 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. The U.S. petroleum industry is one of the leading garnet-consuming industries, using garnet for cleaning drill pipes and well casings. The aluminum aircraft manufacturing and shipbuilding 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 and ceramic polishes.

Waterjet cutting is the process of combining water under ultrahigh pressure with entrained garnet grains to cut a wide variety of materials. Materials cut using this process range from soft leather and fabric to hard steel, titanium, and other metals. Waterjet cutting makes it possible to carve extremely complex shapes with computer-assisted cutter control. Water is first focused into a narrow, restricted stream (usually about 0.25 millimeter in diameter) by passing it through a ruby or diamond orifice. The water stream then passes through a mixing chamber and focusing tube. Garnet is introduced in the mixing chamber, where it begins to mix with the water stream and continues mixing in the focusing tube. The garnet-water mixture exits the tube at very high velocity and is directed at the item to be cut. Almandine-pyrope garnet is excellent for this application as it strikes the necessary balance between cutting productivity and equipment wear. The waterjet market began to develop slowly in the late 1980s and early 1990s, and it has increased at a faster rate in the past 20 years. Future growth is expected to remain steady as use of this technology expands in existing areas and enters new applications that require an entrained flow of abrasive garnet in a water stream to cut metal, plastics, and glass. Abrasive waterjet cutting provides a tool for manufacturers faced with the task of cutting new materials, such as composites and sandwiched materials that had been problematic to machine in the past. Waterjet cutting allows for flexibility and eliminates the need for flame cutting. Cutting fragile materials or intricate patterns in a work piece by abrasive

waterjet cutting significantly decreases the amount of distortion or breakage (Rapple, 2006).

Low-quality industrial garnet, which has lower hardness and is more highly fractured, is used as a high-density medium in water filtration 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 for garnet 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 2010, domestic values for crude concentrates for different applications ranged from about \$83 to \$226 per metric ton, with an average for the year of \$150 per ton. Domestic values for refined garnet for different applications sold during the year ranged from \$83 to \$287 per ton, with an average for the year of \$257 per ton.

The estimated average values of garnet from other leading producers around the world based on the value of import shipments are as follows: Australia, \$344 per ton; Canada, \$304 per ton; China, \$384 per ton; and India, \$182 per ton. During 2010, the average value of industrial garnet imported from all sources was \$261 per ton, which was a 12% increase from \$234 per ton in 2009.

Foreign Trade

Lower priced foreign imports of garnet slowly began displacing U.S. production in domestic markets during the 1990s. For the past 6 years, industrial garnet imports have provided between 44% and 60% of the U.S. total industrial garnet supply.

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, exports and imports of industrial garnet were estimated to be 11,700 t and 42,500 t, respectively, in 2010. Exports decreased by about 11% from those of 2009, and imports increased by about 12% compared with those of 2009. In 2010, Australia, Canada, China, and India continued to supply the majority of the U.S. garnet imports, with

India providing 56%; Australia, 23%; China, 17%; Canada, 2%; and other countries, 2% of industrial garnet imported into the United States for consumption. Garnet exported by the United States was shipped to Asian, Canadian, Caribbean, Central American, European, and South American markets. About 63% of garnet exports from the United States went to Brazil, Canada, China, Germany, Mexico, and Taiwan.

During 2010, GMA Garnet Corp., based in Western Australia, took a 5-year lease on a port facility in Fairless Hills, PA. The facility is located on a former U.S. Steel mill site along the Delaware River and is accessible to major highways, rail lines, and a deepwater port. GMA will use the facility to establish a Northeastern United States location to receive 10,000-ton parcels of Australian garnet in loose bulk for storage. From there, GMA will test the quality of the garnet and package it for distribution throughout North America. GMA also intends to construct a large-scale garnet recycling plant at the facility in Fairless Hills, PA (NAI Global, 2010).

World Review

The USGS estimated total world industrial garnet production to be about 1.41 million metric tons. In 2010, India, China, Australia, and the United States were, in decreasing tonnage order, the leading producers. In 2010, India produced about 50% of total global production; China, about 33%; Australia, 11%; the United States, about 4%; and other countries, about 2%. China and India are expected to continue as leading world producers of industrial garnet. 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 increased from 1998 until 2006, and have remained approximately the same each year since. In 2010, Australian industrial garnet production and exports decreased by about 6% from those of the previous year. China and India also have steadily 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, 50%; abrasive grains for waterjet cutting, 30%; water filtration, 15%; and other end uses, 5%.

Outlook

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 2 of the past 6 years, industrial garnet imports have exceeded domestic industrial garnet production.

This has resulted in the closure of noncompetitive operations. 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 a new mining operation that will produce more than one mineral is the mine being developed in Coos County, OR, by Oregon Resources Corp. The mine was expected to begin production during May 2011 and be in full operation by yearend 2011. Oregon Resources estimated that the mine will produce 635,000 t of ore per year, yielding 54,400 t of chromite and 16,300 to 18,100 t of spessartite garnet each year. The garnet is intended for waterjet cutting markets. Zircon will also be produced. Oregon Resources projected a 15-year mine life for the operation (James Dingman, director of marketing and sales, Oregon Resources Corp., written commun., February 28, 2007; oral commun., December 17, 2010, and May 5, 2011).

Worldwide demand for industrial garnet is expected to continue, especially within the markets for abrasive grains for waterjet cutting and for abrasive blasting media. Garnet demand also is expected to continue for aircraft manufacturing and shipbuilding, where significant quantities of garnet are used for abrasive blast cleaning and finishing of metal surfaces and for waterjet cutting. The use of garnet in waterjet cutting is expected to increase at a higher rate than the use of garnet as an abrasive blasting media.

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GENERAL SOURCES OF INFORMATION

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

		2006	2007	2008	2009	2010
United States:						
Crude production:						
Quantity	metric tons	34,100	61,400	62,900	45,600	52,600
Value	thousands	\$4,240	\$11,300	\$13,600	\$6,850	\$7,910
Sold or used: ²						
Quantity	metric tons	16,800	20,700	49,800	22,100	28,900
Value	thousands	\$5,330	\$5,830	\$13,500	\$6,100	\$7,430
Exports:						
Quantity	metric tons	13,300	12,000	12,500	13,200	11,700
Value	thousands	\$9,450	\$9,620	\$9,050	\$10,700	\$14,400
Imports for consumption:						
Quantity	metric tons	50,800	52,300	49,200	37,900	42,500
Value	thousands	\$8,340	\$8,010	\$11,500	\$8,890	\$11,100
Apparent consumption ³	metric tons	71,600	102,000	99,700	70,300	83,500
World, production	do.	1,370,000	1,380,000	1,310,000	1,390,000	1,410,000

do. Ditto.

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

²May exclude some unreported exports.

³Domestic production plus imports minus exports.