



2008 Minerals Yearbook

GARNET

GARNET, INDUSTRIAL

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In 2008, U.S. production of crude garnet concentrate for industrial use was estimated to be 62,900 metric tons (t) valued at about \$13.6 million (table 1). U.S. imports and exports of industrial garnet were estimated to be 49,200 t and 12,500 t, respectively. U.S. apparent consumption was estimated to be 99,700 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 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 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. 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 2008, U.S. production of crude garnet concentrate for industrial use was estimated to be 62,900 t valued at about \$13.6 million (table 1). This was a slight increase in production and an increase of 20% in value compared with 61,400 t valued at \$11.3 million in 2007. The United States accounted for about 18% of global industrial garnet production. Refined garnet material sold or used during 2008 was 49,800 t valued at \$13.5 million, a unit value of \$272 per ton, which was a 141% increase in quantity, an increase of about 132% in value, and a decrease of almost 4% in unit value compared with the 2007 levels. These large increases in refined garnet sales quantity and value were because the Ruby Valley Garnet Mine, which had been closed during most of 2006, went back into full production during 2007 under new owners, and whose sales came back online in late 2007. Garnet producers in 2008 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 2008.

Consumption

In 2008, the estimated U.S. apparent consumption of industrial garnet was 99,700 t. The United States accounted for about 8% of global industrial garnet use.

The end uses for garnet in the United States and their estimated market share in 2008 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 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.

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 2008, domestic values for crude concentrates for different applications ranged from about \$56 to \$226 per metric ton, with an average for the year of \$215 per ton. Domestic

values for refined garnet for different applications sold during the year ranged from \$260 to \$441 per ton, with an average for the year of \$272 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, \$220 per ton; Canada, \$185 per ton; China, \$328 per ton; and India, \$208 per ton.

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, exports and imports of industrial garnet were estimated to be 12,500 t and 49,200 t, respectively, in 2008. Exports increased by about 4% from those of 2007, and imports decreased by about 6% compared with those of 2007. India provided 39%; Australia, 35%; China, 17%; Canada, 8%; 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. About 47% of garnet exports from the United States went to Canada and Mexico.

World Review

The USGS estimated total world industrial garnet production to be about 1,310,000 t. Australia, China, India, and the United States were the leading producers in 2008. The United States produced about 5% of the industrial garnet mined worldwide. Production in 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% (Rapple, 2006).

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 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 is expected to begin production during 2010 and be in full operation by fall 2010. Oregon Resources estimated that 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 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., July 9, 2009).

Worldwide demand for industrial garnet is expected to continue, especially within the markets for abrasive grains for waterjet cutting and for abrasive blasting media. Demand for garnet polishing powders, which are used in polishing television and monitor screens, is declining with the emergence of flat screen systems, which 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). Garnet demand also is expected to continue as it is in aircraft manufacturing and shipbuilding industries where significant amounts of garnet are used for blast cleaning and finishing of metal surfaces and for waterjet cutting.

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GENERAL SOURCES OF INFORMATION

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TABLE 1
 SALIENT U.S. INDUSTRIAL GARNET STATISTICS¹

		2004	2005	2006	2007	2008
United States:						
Crude production:						
Quantity	metric tons	28,400	40,100	34,100	61,400	62,900
Value	thousands	\$3,050	\$3,840	\$4,240	\$11,300	\$13,600
Sold or used: ²						
Quantity	metric tons	30,400	23,100	16,800	20,700	49,800
Value	thousands	\$10,000	\$6,200	\$5,330	\$5,830	\$13,500
Exports:						
Quantity	metric tons	10,900	13,400	13,300	12,000	12,500
Value	thousands	\$8,990	\$9,700	\$9,450	\$9,620	\$9,050
Imports for consumption:						
Quantity	metric tons	36,500	41,800	50,800	52,300	49,200
Value	thousands	\$4,260	\$5,910	\$8,340	\$8,010	\$11,500
Apparent consumption ³	metric tons	54,000	68,600	71,600	102,000	99,700
World, production ^e	do.	1,080,000 ^r	1,190,000 ^r	1,370,000 ^r	1,380,000 ^r	1,310,000

^eEstimated. do. Ditto. ^rRevised.

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

²May exclude some unreported exports.

³Domestic production plus imports minus exports.