

GARNET, INDUSTRIAL

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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 chapter on gemstones. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using the unrounded data.

In 2004, U.S. production of crude garnet concentrate for industrial use was estimated to be 28,400 metric tons (t) valued at about \$3.05 million. U.S. imports and exports of industrial garnet were estimated to be 36,500 t and 10,900 t, respectively. U.S. apparent consumption was estimated to be 58,600 t.

Garnet has been used as a gemstone for centuries. Garnet necklaces dating from the Bronze Age have been found in graves, 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 garnet 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 six 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, 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 industrial garnet values are 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. Most 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.

Three U.S. companies accounted for all domestic production—one in Idaho 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 three domestic producers reported their output and sales to the USGS, and production amounts and values for the nonreporting company were estimated.

In 2004, U.S. production of crude garnet concentrate for industrial use was estimated to be 28,400 t valued at about \$3.05 million (table 1). This was a 3% decrease in production and a decrease of about 4% in value compared with 29,200 t valued at \$3.17 million in 2003. Refined garnet material sold or used was 30,400 t valued at \$10.0 million, an 8% decrease in quantity and a decrease of almost 8% in value compared with the 2003 levels. The producers were Barton Mines Co. LLC in Warren County, NY; Emerald Creek Garnet Co. in Benewah County, ID; and NYCO Minerals, Inc. in Essex County, NY. Sweetwater Garnet Inc. in Madison County, MT, reported no production for the year and was in foreclosure during the entire year. 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 2003.

Consumption

The United States is the world's leading consumer of industrial garnet (Harris, 2000). In 2004, the estimated U.S. apparent consumption of industrial garnet was 58,600 t. The United States accounted for more than 35% of global industrial garnet use.

The major end uses for garnet in the United States and their estimated market share in 2004 were abrasive blasting media, 35%; waterjet cutting, 30%; water filtration, 15%; abrasive powders, 10%; and other, 10%. The domestic industries that consume garnet include aircraft and motor vehicle manufacturers, ceramics and glass producers, electronic component manufacturers, filtration plants, the petroleum industry, shipbuilders, 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 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's wide price range depends on application, quality, quantity purchased, source, and type. During 2004, domestic values for crude concentrates for different applications ranged from about \$53 to \$120 per metric ton, with an average for the year of \$107 per ton. The domestic values for refined garnet for different applications sold during the year ranged from \$61 to \$298 per ton, with an average for the year of \$255 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, imports and exports of industrial garnet were estimated to be 36,500 t and 10,900 t, respectively, in 2004. The level of imports increased by about 19% over that of 2003, and exports decreased less than 1% from those of 2003. Australia provided almost 42%, China about 28%, India approximately 16%, Canada approximately 13%, and other countries 1% of U.S. industrial garnet imports

for consumption. Australia, China, and India continued to gain importance as garnet exporters. Most U.S. exports of garnet were shipped to Asian, Canadian, Caribbean, and European markets.

World Review

Total world industrial garnet production was estimated to be 440,000 t (Gorrill, 2003). Australia, China, India, and the United States were the leading producers in 2003. The United States produced about 6% of the industrial garnet mined worldwide. Production in both Australia and India exceeded U.S. production. Russia and Turkey have been mining garnet in recent years, primarily for domestic markets. Small 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

For the short term, excess production capacity combined with stocks that vary in grain size, mineral type, and quality will keep prices down. 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 garnet industry has encountered higher production costs and tighter profit margins during recent years. 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 demands.

Worldwide industrial garnet demand is expected to grow at a rate of 3% to 5% per year 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.

References Cited

- Gorrill, Lindsay, 2003, Global garnet market review: Mineral Price Watch, no. 97, January, p. 7-10.
 Harris, Paul, 2000, At the cutting edge—Abrasives & their markets: Industrial Minerals, no. 388, January, p. 19-27.
 Roskill Information Services, Ltd., 2000, The economics of garnet (3d ed.): London, United Kingdom, Roskill Information Services, Ltd., 88 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Abrasives. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
 Garnet (Industrial). Ch. in Mineral Commodity Summaries, annual.

Other

- Industrial Minerals, monthly.
 Industrial Minerals Prices and Data, annual.
 North American Minerals News, monthly.

TABLE 1
 SALIENT U.S. INDUSTRIAL GARNET STATISTICS¹

Year	Crude production		Sold or used ²	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2000	60,200	\$7,060	51,300	\$14,000
2001	52,700	6,430	46,200	13,500
2002	38,500	4,500	37,500	11,100
2003	29,200	3,170	33,100	10,900
2004	28,400	3,050	30,400	10,000

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

²May exclude some unreported exports.