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GARNET, INDUSTRIAL

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Garnet, Industrial

By Donald W. Olson

Domestic survey data and table were prepared by Nicholas A. Muniz, statistical assistant.

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 the unrounded data.

In 2005, U.S. production of crude garnet concentrate for industrial use was estimated to be 40,100 metric tons (t) valued at about $3.84 million. U.S. imports and exports of industrial garnet were estimated to be 41,800 t and 13,400 t, respectively. U.S. apparent consumption was estimated to be 68,600 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 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. 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 2005, U.S. production of crude garnet concentrate for industrial use was estimated to be 40,100 t valued at about $3.84 million (table 1). This was a 41% increase in production and an increase of about 26% in value compared with 28,400 t valued at $3.05 million in 2004. Refined garnet material sold or used amounted to 23,100 t valued at $6.20 million and a unit value of $268 per ton, a 24% decrease in quantity, a decrease of about 38% in value, and a decrease of almost 19% in unit value compared with the 2004 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 2005.

Consumption

The United States continued to be one of the world's leading consumers of industrial garnet. In 2005, the estimated U.S. apparent consumption of industrial garnet was 68,600 t. The United States accounted for more than 35% of global industrial garnet use.

The end uses for garnet in the United States and their estimated market share in 2004 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 2005, domestic values for crude concentrates for different applications ranged from about $58 to $120 per metric ton, with an average for the year of $96 per ton. 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 $268 per ton.

The estimated per ton values of garnet from other leading producers around the world are as follows: North America, $125 to $600; India, $60 to $120; and Australia, $90 to $145 (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 41,800 t and 13,400 t, respectively, in 2005. The level of imports increased by about 14% compared with that of 2004, and exports increased by about 22% from those of 2004. Australia provided approximately 33%, India almost 28%, China almost 26%, Canada approximately 12%, 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 324,000 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 2005. The United States produced about 12% 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 will 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.

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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TABLE 1
SALIENT U.S. INDUSTRIAL GARNET STATISTICS[1]

		2001	2002	2003	2004	2005
United States:						
Crude production:						
Quantity	metric tons	52,700	38,500	29,200	28,400	40,100
Value	thousands	$6,430	$4,500	$3,170	$3,050	$3,840
Sold or used:[2]						
Quantity	metric tons	46,200	37,500	33,100	30,400	23,100
Value	thousands	$13,500	$11,100	$10,900	$10,000	$6,200
Exports:						
Quantity	metric tons	10,000	10,400	11,000	10,900	13,400
Value	thousands	$8,270	$8,930	$7,460	$8,990	$9,700
Imports for consumption:						
Quantity	metric tons	29,600 r	27,200 r	34,800 r	36,500	41,800
Value	thousands	$3,700	$3,610	$3,710	$4,260	$5,910
Apparent consumption[3]	metric tons	72,300 r	55,300 r	53,000 r	54,000 r	68,600
World, production[e]	do.	283,000	277,000	277,000	302,000	324,000

[e]Estimated. [r]Revised.

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

[2]May exclude some unreported exports.

[3]Domestic production plus imports minus exports.