

GARNET, INDUSTRIAL

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The angular fractures and high hardness of garnet and its ability to be recycled make it desirable for a variety of abrasive purposes. The complex mineralogy of garnet determines its utility for a variety of uses ranging from a filtration medium to a waterjet abrasive.

Garnet is the general name for a group of complex silicate minerals with similar crystalline structures and diverse chemical compositions. The general chemical formula is $A_3B_2(SiO_4)_3$, where “A” can be calcium, magnesium, ferrous iron, or manganese, and “B” can be aluminum, chromium, ferric iron, or rarely, titanium. 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 large and numerous; however, relatively few commercially viable garnet deposits have been discovered.

Mine output of industrial garnet in the United States decreased slightly in 2000 compared with that of 1999, while the value of U.S. industrial garnet production increased by about 14% over that of 1999. The one mining operation in the United States that had closed down in 1999 was purchased during 2000 and began producing from stocks.

Production

The U.S. industrial garnet industry is dominated by a few major producers. The industrial garnet market 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. Most industrial-grade garnet mined in the United States is almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), although andradite (calcium-iron silicate) is also a domestic source for industrial uses.

The United States produced approximately 20% of the industrial garnet mined worldwide in 2000. According to a survey conducted by the U.S. Geological Survey (USGS), five U.S. companies in Idaho, Montana, and New York accounted for all domestic output. Production decreased slightly to 60,200 metric tons (t), whereas the value of annual production grew by 14% to about \$7.1 million in 2000 (table 1). The producers were Barton Mines Co. LLC in Warren County, NY; Emerald Creek Garnet Co. in Benewah County, ID; Montana-Oregon Investment Group LLC in Madison County, MT; NYCO Minerals, Inc. in Essex County, NY; Patterson Materials Corp.

Industrial Garnet in the 20th Century

Garnet is mined as a gemstone and an industrial material, but it is valued primarily for its many industrial applications. The United States developed substantial garnet abrasive technology and applications earlier than other countries mainly because of the large deposits of high-quality abrasive garnet in New York. The deposits were first commercially developed in 1878. In 1900, annual production of industrial garnet in the United States was about 2,890 metric tons valued at about \$123,000. Production was primarily in Maine, New York, North Carolina, Pennsylvania, and Virginia. There are no data to indicate that the United States had any foreign trade in industrial garnet in 1900. The price at the mine varied from \$25 to \$60 per ton. The main use for industrial garnet was in the sandpaper industry. At the end of World War II in 1945, U.S. industrial garnet production and consumption began a steady rise that roughly paralleled the rise in new home starts. The most significant jump in U.S. garnet production and consumption began in 1987, when health risks were first associated with the inhalation of airborne crystalline silica dust, and garnet began to replace crystalline silica as a sand blasting medium.

In 2000, domestic crude garnet production was estimated to be 60,200 tons, with an estimated value of more than \$7 million; the value of refined garnet material was estimated to be \$14 million. Garnet for industrial use was mined in 2000 by five firms: three in New York, one in Idaho, and one in Montana. In 2000, U.S. imports and exports of industrial garnet were about 23,000 tons and 10,000 tons, respectively. Imports were mostly from Australia, India, and China. Domestic consumption of garnet was estimated to be about 25,000 tons. Values for crude concentrates ranged from about \$53 to \$254 per ton, and values for refined garnet ranged from \$61 to \$441 per ton. By the end of the 20th century, major end uses for industrial garnet in the United States were abrasive sand blasting media, filtration media, precision abrasive powders, waterjet abrasives, and other miscellaneous abrasive uses, ranging from nonskid surfaces to finishing of plastic and wood products. In 2000, industrial garnet was still gradually displacing crystalline silica sand in the blast cleaning market, due to the health risks associated with the use of crystalline silica and due to garnet’s ability to be recycled for reuse several times.

in Dutchess County, NY; and Sweetwater Garnet Inc. in Madison County, MT. All but one of the producers reported their output and sales to the USGS, and production and values for the nonreporting company were estimated. In addition to the producers cited above, International Garnet Abrasive Inc. in Clinton County, NY, processed and sold all of the garnet mined by NYCO Minerals in 2000.

Sweetwater Garnet, which had shut down in 1999, was sold in July 2000 to Stansbury Holdings Corporation. In the fall of 2000, Stansbury resumed operations at Sweetwater after upgrading the mill and was producing from stocks.

Consumption

The United States was the world's largest consumer of industrial garnet, accounting for 20% to 25% of global consumption (Harris, 2000). In 2000, the U.S. apparent consumption of industrial garnet was estimated to be 25,400 t, which was a 45% decrease from the 1999 apparent consumption. This apparent consumption decrease was due to a 75% increase in U.S. producer stocks. Most of these stocks were concentrated in two of the U.S. industry's five producers.

Major end uses in the United States and their estimated market share were abrasive blasting media, 45%; water filtration, 15%; abrasive powders, 10%; waterjet cutting, 10%; and other miscellaneous abrasive uses, 20%. Domestic consumption approximated world demand patterns, except that filtration uses abroad accounted for a greater market share. U.S. industries that consumed industrial garnet included aircraft manufacturers, ceramics and glass producers, electronic component manufacturers, motor vehicle manufacturers, the petroleum industry, shipbuilders, water filtration plants, and wood-furniture-finishing operations.

The majority of industrial garnet is used as a loose-grain abrasive because of its hardness, which ranges from 6 to 7.5 on the Mohs scale. Lower-quality industrial garnet is used as a filtration medium in water-purification systems because of its relative inertness and chemical degradation resistance. 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 this application. In recent years, industrial garnet powders have been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Other applications include the manufacture of coated abrasives; hydrocutting; and the finishing of wood, leather, hard rubber, felt, and plastics. Garnet has been slowly replacing silica sand in the blast cleaning market. This market displacement is happening because of the health risks associated with the inhalation of airborne crystalline silica dust having curtailed its use, but silica sand and slag are still the most widely used media in blasting (Harris, 2000).

The U.S. petroleum industry is one of the largest garnet-consuming industries, using garnet for cleaning drill pipes and well casings. Huge crude oil price increases during 2000 allowed for the performance of previously deferred equipment maintenance activities and increased the petroleum industry's use of industrial garnet (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

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. Mixed-media water filtration, using a mixture of sand, anthracite, and garnet, has displaced older filtration methods because it is more reliable and provides better water quality; ilmenite, magnetite, and plastics compete as filtration media. Garnet entrained in high-pressure streams of water is also used to cut many different materials. The garnet powders generally are used for glass/ceramic polishes, antislip paints, and antiskid surfaces.

In the coated-abrasive market, garnet has an intermediate place between low-cost quartz sand or staurolite and such more costly manufactured abrasives as silicon carbide and fused alumina; garnet is more efficient than quartz sand in most coated-abrasive applications. Because of its friable nature and lower hardness, garnet cannot compete with manufactured abrasives in metalworking applications that require substantial metal removal.

Prices

The wide price range of industrial garnet was based on the type, source, quantity purchased, quality, and application. In 2000, average values for crude concentrates ranged from about \$53 to \$254 per ton, and average values for refined garnet sold during the year ranged from \$61 to \$265 per ton. However, spot prices reached as high as \$441 per ton. Quantities sold by U.S. producers increased by approximately 17%, and the value of sales increased by about 21% during 2000.

Foreign Trade

The U.S. Government no longer compiles trade data that can be used to identify garnet exports and imports specifically. Based on reports from some producers and other industry sources, however, exports and imports of industrial garnet were estimated to be about 10,000 t and 23,000 t, respectively, in 2000. Some of the imports were not consumed during the year. Most U.S. garnet exports went to Asian and European markets.

About 40% to 45% of the U.S. garnet imports were from Australia, 35% to 40% from India, and 15% from China (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000). Australia historically has accounted for most of the industrial garnet imported by the United States. Imports of garnet from India are increasing, and both China and India have the potential to gain a significant share of the U.S. market (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

World Review

Total world industrial garnet production was estimated to be 335,000 t (Roskill Information Services Ltd., 2000). Australia, China, India, and the United States were the most significant producers in 2000. The United States produced approximately 20% of the industrial garnet mined worldwide. Australia and India exceeded U.S. production. Russia and Turkey have been

mining garnet in recent years, primarily for domestic markets. Additional garnet resources with small mining operations are located in Canada, Chile, the Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine. Output in most of these countries is for domestic use (Frank Alsobrook, President, Alsobrook and Company, Inc., oral commun., November 8, 2000).

Australian exports of garnet are expected to continue to increase. China and India also have increased garnet output and are likely to become more significant garnet sources for other countries.

Outlook

Industrial garnet sold by U.S. producers increased by about 17% during 2000, and some forecasts indicate that domestic markets for industrial garnet may continue to grow in the next several years. Worldwide industrial garnet demand is expected to grow over the next 5 years at a rate of 3% to 5% per year. Markets for waterjet cutting and blasting media are expected to exhibit the highest growth (Roskill Information Services Ltd., 2000). With recent worldwide increases in petroleum prices, there has been an increase in petroleum exploration and in the use of garnet blasting media for cleaning drill pipe by the oil and gas industry. Increased defense spending in the United States could lead to increased garnet demand, since the aircraft manufacturing and shipbuilding industries use significant amounts for blast cleaning and finishing of metal surfaces. Substitution for silica sand by garnet in abrasive blasting markets will also continue but at a pace slower than expected by the most optimistic forecasts because silica sand has a price advantage and is more accessible to consumers. Growing

world demand encourages new companies to enter the garnet industry, but the current major producers will continue to be the dominant suppliers in the first decade of the 21st century.

Increased producer stocks are being reported in the United States, and significant stocks of industrial garnet are held in Australia and India. These excess production stocks coupled with possible future expansions will not only meet anticipated market needs, but may also result in widespread garnet price decreases until supply and demand come into balance.

References Cited

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Roskill Information Services Ltd., 2000, *The economics of garnet* (3d ed.): London, Roskill Information Services Ltd., 88 p.

GENERAL SOURCES OF INFORMATION

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Other

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Industrial Minerals Prices and Data (annual).
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TABLE 1
SALIENT U.S. INDUSTRIAL GARNET STATISTICS 1/

Year	Crude production		Sold or used 2/	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1996	60,900	\$5,630	46,200	\$11,200
1997	64,900	6,050	53,600	12,500
1998	74,000	7,070	51,900	12,600
1999	60,700	6,170	43,900	11,600
2000	60,200	7,060	51,300	14,000

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

2/ May exclude some unreported exports.