

# GARNET, INDUSTRIAL

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**Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant.**

Like diamond and only a few other minerals, garnet is significant as a widely used industrial material in addition to its value as a gemstone. Unlike diamond, however, garnet is valued primarily for its many industrial applications, principally as an abrasive and a filtration medium.

The complex mineralogy of garnet—a category of silicate minerals with a wide variety of chemical compositions—determines its utility for a variety of uses ranging from water filtration to waterjet cutting. The general chemical formula for garnet is  $A_3B_2(SiO_4)_3$ ; A can be calcium, magnesium, ferrous iron, or manganese and B usually is aluminum, chromium, or ferric iron.

Garnet occurs worldwide in many rock types, principally gneisses and schists; other sources include contact metamorphic rocks, crystalline limestones, pegmatites, and serpentinites. Additionally, garnet is found near veins formed at high temperatures. Alluvial garnet is associated with heavy mineral sand and gravel deposits in many parts of the world. Despite the large and numerous occurrences of garnet, however, comparatively few commercially viable garnet deposits have been discovered in the United States or abroad.

During 1998, the industrial garnet industry in the United States was distinguished by the following developments: Mine output increased to a record high, market demand remained firm, and two mining operations in the country were offered for sale. More information on these events and others are provided in the text and tables that follow.

## Production

The U.S. industrial garnet industry is dominated by a few major producers in markets principally influenced by several key factors: size and grade of reserves, type and quality of garnet mined, proximity of deposits to infrastructure and consumers, and milling costs. Pricing is very competitive and suppliers must provide a high level of customer service (Kendall, 1997). Most of the industrial grade garnet mined by U.S. producers is a solid solution of almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), but andradite (calcium-iron silicate) also is a domestic source for industrial uses.

Approximately 25% to 30% of world industrial garnet output is produced in the United States; Australia exceeds U.S. output and India may produce more as well. According to a survey conducted by the U.S. Geological Survey (USGS), five U.S. garnet companies, accounting for all domestic output, increased production to 74,000 metric tons (t) valued at about \$7.1 million in 1998 (table 1). The producers were Barton Mines Corp. in Warren County, NY; NYCO Minerals, Inc. in Essex County, NY; Patterson Materials Corp. in Dutchess County, NY; Emerald Creek Garnet Co. in Benewah County, ID; and

Cominco American Inc. in Madison County, MT. All the producers reported their output and sales to the USGS.

In addition to the producers cited above, International Garnet Abrasive Inc. in Clinton County, NY, prepared and sold all the garnet mined by NYCO Minerals in 1998. Also, Sweetwater Garnet Inc. in Madison County, MT, which ceased production in 1997, continued to sell stockpiled garnet in 1998. The Sweetwater Garnet and the Cominco American mines were offered for sale in 1998.

## Consumption

Sustained by a strong domestic economy, consumption of industrial garnet in the United States reached about 60,000 t in 1998. As the world's largest consumer of industrial garnet, the United States accounted for 20% to 25% of global consumption during the year. Industrial consumers in the United States and abroad primarily used garnet as an abrasive material (6.5 to 9.0 Mohs hardness range); garnet also was utilized as a filtration medium because it is inert and resists degradation.

Major end uses for garnet in the United States and their estimated market share in recent years have been as follows: air/water blasting media, 45%; water filtration, 15%; abrasive powders, 15%; and waterjet cutting, 7% (Gorrill, 1996; Kendall, 1997). The garnet powders generally are used for glass/ceramic polishes, antislip paints, and antiskid surfaces. Domestic consumption approximates world demand patterns, except that filtration uses abroad account for a larger market share. Industrial sectors that utilize garnet include the petroleum industry, the largest consumer of blasting-grade garnet (used to clean drilling pipe); filtration plants; aircraft and motor vehicle manufacturers; shipbuilding; wood furniture finishing operations; electronic component manufacturing; and ceramics and glass production.

Industrial garnet is used primarily as a loose-grain abrasive, especially for blast cleaning; lower quality industrial garnets are used as filtration media in water-purification systems. High-quality, high-value garnet grain principally has been used 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 recent years, industrial garnet powders have been used for high-quality, scratch-free lapping of semiconductor materials and other metals. Other industrial applications include the manufacture of coated abrasives; hydrocutting; and the finishing of wood, leather, hard rubber, felt, and plastics. In the blast cleaning market, garnet is replacing silica sand where health risks associated with the inhalation of airborne crystalline silica dust have curtailed its use in the United States and other countries.

Shipbuilding and aluminum aircraft industries use garnet for blast cleaning and finishing of metal surfaces. Similar uses

include the cleaning and conditioning of aluminum and other soft metals as well as metals 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 also is used to cut many different materials. The manufacturers of nonskid floor paint also use alluvial and other low-cost garnets in their products.

In the coated-abrasive field, garnet has an intermediate place between low-cost quartz sand or staurolite and more costly manufactured abrasives (silicon carbide and fused alumina, for example); garnet reportedly is more efficient than quartz sand in most coated-abrasive applications. Because of garnet's friable nature and lower hardness, especially the lower grades, however, it cannot compete with manufactured abrasives in metalworking applications that require substantial metal removal.

### Prices

Garnet has a very wide range of prices that are dependent on type, source, quantity purchased, quality, and application. Reported values for crude concentrates in 1998 ranged from about \$10 to \$110 per ton. Average values reported for refined garnet sold during the year by most producers ranged from \$55 to \$360 per ton, depending on quality, grain size, and quantities purchased. Prices as high as \$400 per ton, however, were reported (Kendall, 1998). Small quantities of the most highly processed garnet powders sold for prices that equated to more than \$1,000 per ton.

### Foreign Trade

The U.S. Government no longer compiles trade data that can be used to identify garnet exports and imports specifically. On the basis of reports from some producers and other industry sources, however, exports and imports of industrial garnet were estimated to be about 12,000 t and 20,000 t, respectively, in 1998; some of the imports reportedly were not consumed during the year. Most U.S. garnet exports go to Asian and European markets.

The United States imports garnet from Australia and India; some garnet reportedly is shipped from China (Kendall, 1997). Australia historically has accounted for most of the industrial garnet imported by the United States. Imports of garnet from India are increasing, however, and have the potential to gain a significant share of the U.S. market (Frank Alsobrook, Alsobrook & Company, Inc., oral commun., 1999).

### World Review

In addition to the United States, significant quantities of industrial grade garnet are mined in several countries abroad. Australia leads the world in garnet production, and mine operations in that country were expanded in 1998 to further increase output (O'Driscoll, 1998). Australian exports of garnet are expected to grow as well. India also has increased

garnet output and is likely to become a more significant source of garnet for other countries. If successful, several garnet mining projects in Canada may prove to be new sources for U.S. markets. Other garnet producers include China, the Czech Republic, Pakistan, Russia, Turkey, and the Ukraine; output in

most of these countries, however, is for domestic consumption.

Estimates of total worldwide garnet mine production have varied considerably in the past few years; some of the most recent assessments are as high as 300,000 t or more (Stephen Semeniuk, certified financial analyst, written commun., 1999). Total global supply is roughly divided among markets as follows: blasting media, 45%; water filtration, 25%; abrasive powders, 10%; waterjet cutting, 10%; and other uses, 10% (Kendall, 1997).

### Outlook

Although the United States will remain a major garnet consumer, imports are expected to supply a larger share of the U.S. garnet market in future years. The anticipated substitution of silica sand by garnet in abrasive blasting markets also will 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. In the more distant future, garnet may replace boiler slag in domestic abrasive markets as the industrial processes which generate the slag are eliminated to meet higher environmental standards (Frank Alsobrook, Alsobrook & Company, Inc., oral commun., 1999).

Although optimistic forecasts of garnet demand have attracted the attention of new entrepreneurs and potential investors, the larger established producers in the United States and elsewhere will continue to be the dominant garnet suppliers in the coming decade. Proposals in recent years for new mine openings and the expansion of existing operations appear to be sufficient to meet anticipated increases in demand. At least 120,000 t of new production capacity is under construction or is planned worldwide. Capacity expansion would significantly restrain price increases as well as meet anticipated market needs. Most of the new capacity growth is expected in Australia, India, and the United States.

If U.S. production capacity does not increase sufficiently in the next several years, growing domestic markets will be more import dependent. Nevertheless, greater U.S. reliance on imports is not expected to become a major problem because leading domestic producers own key sources of garnet supply abroad. Furthermore, if industrial garnet is not available to meet growing demand, other natural and synthetic abrasives (see the Consumption section above) could serve, to some extent, as substitutes for major end uses. In many cases, however, the substitutes would entail greater costs or sacrifices in quality.

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<sup>1</sup> Prior to January 1996, published by the U.S. Bureau of Mines.

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)
1994	44,700	\$3,430	41,100	\$10,700
1995	46,300	3,850	39,900	10,100
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

1/ Data are rounded to three significant digits.

2/ May exclude some unreported exports.