



2014 Minerals Yearbook

GARNET, INDUSTRIAL [ADVANCE RELEASE]

GARNET, INDUSTRIAL

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In 2014, U.S. production of crude garnet concentrate for industrial use was estimated to be 44,200 metric tons (t) valued at about \$6.54 million, a decrease from 51,600 t valued at about \$7.5 million in 2013. U.S. exports and imports of industrial garnet were estimated to be 15,400 t and 213,000 t, respectively. U.S. apparent consumption was estimated to be 242,000 t. World production of crude garnet concentrate for industrial use was estimated to be 1.66 million metric tons (Mt) during 2014, essentially unchanged compared with that of 2013 (table 1).

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 calculated using unrounded data.

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. Uvarovite is the most common chromium-garnet mineral, and andradite is the most common iron-garnet mineral.

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 identified.

Production

The U.S. industrial garnet industry is dominated by a few major producers. The garnet industry has experienced progressively higher production costs and tighter profit margins during the past 20 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 production cost 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. 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, such as those in Idaho and Montana (also those in Australia and India), and it is produced from hard rock deposits, such as those in New York (Moore, 2006).

Four U.S. companies accounted for all domestic production in 2014—one in Idaho, one in Montana, and two in New York. The USGS obtained the data in this report through a survey of these industrial garnet producers. Production quantity and value for any nonreporting companies were estimated by using employment data provided by the Mine Safety and Health Administration.

In 2014, U.S. production of crude garnet concentrate for industrial use was estimated to be 44,200 t valued at about \$6.54 million (table 1). This was a 14% decrease in production quantity and a 13% decrease in value compared with 51,600 t valued at \$7.5 million in 2013. The United States accounted for about 3% of global industrial garnet production. Refined garnet material produced during 2014 was estimated to be 34,700 t valued at \$9.86 million with a unit value of \$284 per metric ton. Garnet producers in 2014 were Barton International in Warren County, NY; Emerald Creek Garnet Ltd. in Benewah County, ID; Garnet USA LLC in Madison County, MT; and NYCO Minerals, Inc. in Essex County, NY. In addition to these producers, Opta Minerals Inc. in Clinton County, NY, processed and sold all the crude garnet mined by NYCO Minerals as a byproduct of wollastonite production in 2014. Opta Minerals also operated Emerald Creek Garnet.

Burrell Western Resources, LLC announced the discovery of a large deposit of garnet between Alamogordo, NM, and El Paso, TX, just north of Oro Grande, NM, in the Jarilla Mountains Mineral District of Otero County. In November 2013, the company filed an exploratory drilling application with the U.S. Bureau of Land Management (BLM) stating that, based on preliminary drilling and testing, Burrell estimated that the deposit could contain as much as 2.5 Mt of minable material. Burrell planned to eventually mine the garnet and estimated a mine life of more than 25 years. The mined material likely would be processed for distribution in nearby Anthony, NM (Scott, 2013). Burrell has been working with local, New Mexico State, and BLM officials on a proposed economic incentive package to move the project forward, and the company expected initial mine production in about mid-2016. Burrell anticipated production of about 45,400 t of garnet during 2016, ramping up to full production of 90,700 tons per year for the first phase of the project (Devine, 2015).

Consumption

In 2014, the estimated U.S. apparent consumption of industrial garnet increased by 31% to 242,000 t (table 1). The

United States was estimated to account for about 15% of global industrial garnet use.

The end uses for garnet in the United States in 2014 were abrasive grains for water-jet cutting, abrasive blasting media, water filtration, abrasive powders, and other uses. 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.

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 is a good alternative to silica sand as a natural abrasive blasting media because it does not have the health risks associated with the inhalation of airborne crystalline silica dust, and it is a safer abrasive for the environment (Lismore, 2013). Garnet has replaced some silica sand in the abrasive blasting media market, but at present, silica sand and mineral slag continue to be the most widely used media in blasting. The U.S. oil and gas drilling industry is one of the leading garnet-consuming industries, using garnet for cleaning drill pipes and well casings.

The oil and gas drilling industry also uses garnet as reservoir-fracturing proppant, alone or mixed with other proppants. Preferred Sands, LLC, produced a nonphenolic resin-coated garnet proppant that does not require the use of an activator in low-temperature well environments for flowback control (PR Newswire, 2012; Dow Chemical Co., 2013).

The 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.

Water-jet cutting is the process of combining water under ultrahigh pressure with entrained garnet grains to cut a wide variety of materials. Materials cut using this process range from soft leather and fabric to hard steel, titanium, and other metals. Water-jet cutting makes it possible to carve extremely complex shapes with computer-assisted cutter control. Almandine-pyrope garnet is excellent for this application because it strikes the necessary balance between cutting productivity and equipment wear. The water-jet market began to develop slowly in the late 1980s and early 1990s, and it has grown at a faster rate in the past 20 years. Future growth is expected to remain steady as use of this technology expands in existing areas and enters new applications. Abrasive water-jet cutting provides a tool for manufacturers faced with the task of cutting new materials, such as composites and sandwiched materials that had been problematic to machine in the past. Water-jet cutting allows for

flexibility and eliminates the need for flame cutting. Cutting fragile materials or intricate patterns by abrasive water-jet cutting significantly decreases the amount of distortion and breakage (Rapple, 2006). Garnet materials most preferred for water-jet cutting applications remain in tight supply.

Low-quality industrial garnet, which has lower hardness and is more highly fractured, is used as a high-density medium in water filtration 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 for garnet 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.

Other natural and manufactured abrasives can substitute to some extent for all major end uses of garnet. In many cases, however, the substitutes would entail sacrifices in quality or cost. Fused aluminum oxide and staurolite compete with garnet as a sandblasting material. Diamond, corundum, emery, and fused aluminum oxide compete for grinding and for many lapping operations. Emery is a substitute in nonskid surfaces. Quartz sand, silicon carbide, and fused aluminum oxide compete for the finishing of plastics, wood furniture, and other products.

Prices

Industrial garnet pricing varies over a wide range, depending on application, quality, quantity purchased, source, and type. During 2015, domestic unit values for crude concentrates for different applications ranged from about \$100 to \$225 per metric ton, with an average for the year of \$156 per ton. Domestic unit values for refined garnet for different applications sold during the year ranged from \$100 to \$440 per ton, with an average for the year of \$268 per ton.

The estimated average unit values of crude garnet from other leading producers around the world based on the customs value of import shipments were as follows: China, \$442 per ton; Canada, \$250 per ton; Australia, \$215 per ton; India, \$214 per ton; and South Africa, \$128 per ton. During 2014, the average value of industrial garnet imported from all sources was \$209 per ton of crude garnet, which was a 9% decrease from \$230 per ton in 2013.

Foreign Trade

Lower priced foreign imports of garnet slowly began displacing U.S. production in domestic markets during the 1990s. For the past 5 years, industrial garnet imports have

provided between 69% and 82% of the total U.S. industrial garnet supply.

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. Exports and imports of industrial garnet for 2015 were estimated to be 15,400 t and 213,000 t, respectively. Exports increased by 7%, and imports increased by about 45% compared with those of 2013. In 2014, Australia, China, India, and South Africa supplied the majority of the U.S. garnet imports for consumption, with Australia providing 33%; India, 25%; South Africa, 22%; China, 6%; and other countries, 14%. About 65% of garnet exports from the United States went to Brazil, Canada, China, Germany, Japan, Malaysia, Mexico, and Switzerland.

World Review

The USGS estimated total 2014 world industrial garnet production to be about 1.66 Mt, a slight increase compared with that in 2013. In 2014, India, China, Australia, and the United States were, in decreasing order of tonnage, the leading producers. In 2014, India produced about 48% of total global output; China, about 31%; Australia, about 16%; the United States, about 3%; and other countries, about 3%. China and India are expected to continue as the leading world producers of industrial garnet. 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. China and India were expected to continue increasing garnet output for the next decade and have become significant garnet sources for other countries.

Outlook

The U.S. garnet industry has had higher production costs and tighter profit margins during recent years. The industry also has been competing with lower priced foreign imports that have displaced U.S. production in domestic markets, which has resulted in the closure of noncompetitive operations.

Garnet is likely to continue displacing silica sand for blasting as countries ban the use of silica sand blasting media owing to its associated occupational health risks. Garnet also is expected to continue displacing mineral slag abrasives for blasting because it is safer for the environment and less costly to dispose of after it has been recycled (Lismore, 2013).

Worldwide demand for industrial garnet is expected to continue to increase, especially within the markets for abrasive grains for water-jet cutting and for abrasive blasting media. Garnet demand also is expected to continue to expand for aircraft manufacturing and shipbuilding, where significant quantities of garnet are used for abrasive blast cleaning and finishing of metal surfaces and for water-jet cutting.

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GENERAL SOURCES OF INFORMATION

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TABLE 1
ESTIMATED SALIENT INDUSTRIAL GARNET STATISTICS¹

		2010	2011	2012	2013	2014
United States:						
Crude production:						
Quantity	metric tons	30,700 ^r	31,300 ^r	38,700 ^r	51,600 ^r	44,200
Value	thousands	\$4,320 ^r	\$4,670 ^r	\$5,920 ^r	\$7,500 ^r	\$6,540
Refined garnet production:						
Quantity	metric tons	23,700 ^r	23,300 ^r	29,100 ^r	40,200 ^r	34,700
Value	thousands	\$6,730 ^r	\$6,420 ^r	\$8,220 ^r	\$11,600 ^r	\$9,860
Exports:						
Quantity	metric tons	11,700	14,500	14,600	14,400	15,400
Value	thousands	\$14,400	\$14,100	\$14,700	\$16,000	\$12,800
Imports for consumption:						
Quantity	metric tons	79,700	116,000	166,000	148,000	213,000
Value	thousands	\$20,800	\$24,500	\$34,500	\$34,000	\$44,600
Apparent consumption²						
Quantity	metric tons	98,700 ^r	133,000 ^r	190,000 ^r	185,000 ^r	242,000
Value	thousands	\$10,800 ^r	\$15,000 ^r	\$25,800 ^r	\$25,500 ^r	\$38,400
World, production	metric tons	1,410,000	1,660,000	1,670,000	1,660,000	1,660,000

^rRevised.

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

²Domestic crude production plus imports minus exports.