



2015 Minerals Yearbook

GARNET, INDUSTRIAL [ADVANCE RELEASE]

GARNET, INDUSTRIAL

By Christine L. Thomas

Domestic survey data and table were prepared by Chanda C. Williams, statistical assistant.

In 2015, U.S. production of crude garnet concentrate for industrial use was estimated to be 55,600 metric tons (t) valued at about \$8.45 million, a 26% increase in tonnage and a 29% increase in value from 44,200 t and \$6.54 million in 2014. U.S. production of refined garnet for 2015 was estimated to be 38,000 t valued at \$11 million, a 9.5% increase in tonnage and an 11% increase in value from 34,700 t and \$9.86 million in 2014. U.S. exports of industrial garnet were estimated to be 14,700 t, a 4% decrease compared with those in 2014. U.S. imports of industrial garnet were estimated to be 238,000 t, a 12% increase compared with those in 2014. U.S. apparent consumption was estimated to be 279,000 t. World production of crude garnet concentrate for industrial use was estimated to be 1.69 million metric tons (Mt) during 2015, a slight increase compared with 2014 (table 1).

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 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, grossular, pyrope, and spessartine. Uvarovite is the most common chromium garnet, 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, but relatively few commercially viable garnet deposits have been identified.

Garnet has many industrial applications because of its angular fractures, relatively high hardness and specific gravity, chemical inertness, nontoxicity, lack of crystalline silica, and ability to be recycled. The primary industrial applications include water-jet cutting, abrasive blasting media, water filtration, and abrasive powders.

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.

Production

A few major companies dominate the production of industrial garnet in the United States. The garnet industry has encountered progressively higher production costs and tighter profit margins during the past 20 years, resulting in the loss of noncompetitive

producers. Because of the need to keep costs at a minimum, the most competitive companies 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 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. The majority of industrial-grade garnet mined in the United States consists of almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), though 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 from hard rock deposits, such as those in New York (Moore, 2006).

Four U.S. companies accounted for all domestic production in 2015—one in Idaho, one in Montana, and two in New York. The USGS obtained the data in this report through a voluntary survey of U.S. industrial garnet producers. Production quantity and value for any nonreporting companies were estimated by using employment data (mining and milling hours) provided by the Mine Safety and Health Administration.

In 2015, U.S. production of crude garnet concentrate for industrial use was estimated to be 55,600 t valued at about \$8.45 million with a unit value of \$152 per metric ton (table 1). This was a 26% increase in production quantity and a 29% increase in value compared with 44,200 t valued at \$6.54 million in 2014. The United States accounted for about 3% of global industrial garnet production. Refined garnet material produced during 2015 was estimated to be 38,000 t valued at \$11 million with a unit value of \$288 per metric ton, which was a 9.5% increase in quantity and an 11% increase in value compared with 2014 levels. Garnet producers in 2015 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. 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 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 metric tons per year for the first phase of the project (Devine, 2015). In April 2015, the Otero County Commission approved a taxable industrial revenue bond to fund the project (Associated Press, The, 2015).

Consumption

In 2015, the estimated U.S. apparent consumption of industrial garnet increased by 15% to 279,000 t (table 1). The United States was estimated to account for about 17% of global industrial garnet use.

The end uses for garnet in the United States in 2015 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. Oil and gas producers also use 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). In 2015, Preferred Sands released results from a study that indicated wells using its garnet proppant had better performance compared to the majority of wells using conventional resin in the Permian Basin (Business Wire, 2015).

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, estimated domestic unit values for crude concentrates ranged from about \$100 to \$200 per metric ton, with an average for the year of \$152 per ton. Domestic unit values for refined garnet sold during the year ranged from \$100

to \$440 per ton, with an average for the year of \$288 per ton; this is a slight increase from the 2014 average of \$284 per ton.

The estimated average unit values of garnet from other leading producers around the world based on the customs value of import shipments were as follows: Australia, \$169 per ton; Canada, \$163 per ton; China, \$320 per ton; India, \$194 per ton; and South Africa, \$124 per ton. During 2015, the average value of industrial garnet imported from all sources was \$226 per ton of crude garnet, which was an 8% increase from \$209 per ton in 2014.

Foreign Trade

Lower priced foreign imports of garnet slowly began displacing U.S. production in domestic markets during the 1990s. For the past 6 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 14,700 t and 238,000 t, respectively. Exports decreased by 4% from those of 2014, and imports increased by about 12%. In 2015, Australia (41%), India (31%), South Africa (11%), and China (6%) supplied the majority of U.S. garnet imports for consumptions, with 50 other countries providing 11% of imports. About 80% of garnet exports from the United States went to Canada (27%), Mexico (23%), Trinidad and Tobago (12%), China (8%), Chile (4%), Taiwan (4%), and Switzerland (2%); 42 other countries received the remaining 20% of exports.

World Review

The USGS estimated total 2015 world industrial garnet production to be about 1.69 Mt, a slight increase compared with that in 2014. In 2015, the leading global producers were China (31%), India (27%), Australia (15%), United States (3%), and other countries (3%). China and India are expected to continue as the leading world producers of industrial garnet; these countries will likely continue increasing garnet production for the next decade and have become significant garnet sources for other countries. 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, but the available information is inadequate to make reliable estimates of output. Production in most of these countries is for domestic use.

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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TABLE 1
ESTIMATED SALIENT U.S. INDUSTRIAL GARNET STATISTICS¹

		2011	2012	2013	2014	2015
United States:						
Crude production:						
Quantity	metric tons	31,300	38,700	51,600	44,200	55,600
Value	thousands	\$4,670	\$5,920	\$7,500	\$6,540	\$8,450
Refined garnet production:						
Quantity	metric tons	23,300	29,100	40,200	34,700	38,000
Value	thousands	\$6,420	\$8,220	\$11,600	\$9,860	\$11,000
Exports:						
Quantity	metric tons	14,500	14,600	14,400	15,400	14,700
Value	thousands	\$14,100	\$14,700	\$16,000	\$12,800	\$11,000
Imports for consumption:						
Quantity	metric tons	116,000	166,000	148,000	213,000	238,000
Value	thousands	\$24,500	\$34,500	\$34,000	\$44,600	\$53,800
Apparent consumption. ²						
Quantity	metric tons	133,000	190,000	185,000	242,000	279,000
Value	thousands	\$15,000	\$25,800	\$25,500	\$38,400	\$51,200
World, production	metric tons	1,660,000	1,670,000	1,660,000	1,660,000	1,690,000

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

²Domestic production plus imports minus exports.