2018 Minerals Yearbook

GARNET, INDUSTRIAL [ADVANCE RELEASE]

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Garnet, Industrial

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In 2018, U.S. production of crude garnet concentrate for industrial use was 101,000 metric tons (t) valued at about $22.1 million, a 9% increase in tonnage and a 17% increase in value from the revised 92,900 t valued at $18.9 million in 2017. U.S. production of refined garnet in 2018 was 166,000 t valued at $68.9 million, almost double the tonnage and a 77% increase in value from the revised 84,100 t valued at $38.9 million in 2017. U.S. exports of industrial garnet in 2018 were 14,200 t, a 20% decrease from 17,700 t in 2017. Imports of garnet in 2018 were 254,000 t, more than triple the tonnage of 54,200 t in 2017. These imports accounted for about 74% of U.S. apparent consumption of 341,000 t. World production was estimated to be 1.25 million metric tons (Mt) in 2018, a 30% increase from 0.96 Mt in 2017 (table 1).

Garnet is the general name given to a group of complex silicate minerals, all with 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 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, 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 of garnet were, in decreasing percentage of consumption, for abrasive blasting, water-jet cutting, water filtration media, and abrasive powders.

This chapter 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 that produce garnet in combination with one or two other minerals, have reserves that can be mined at a low cost, and can react rapidly to changes in market demand. The 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. Most industrial-grade garnet mined in the United States consists of almandine (iron-aluminum silicate) and pyrope (magnesium-aluminum silicate), although 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).

In the United States, four companies mined garnet in three States during 2018. Three were vertically integrated garnet mining and processing companies—Barton International in Warren County, NY; Emerald Creek Garnet Ltd. in Benewah County, ID; and Garnet USA LLC in Madison County, MT. The fourth producer, NYCO Minerals Inc. (a subsidiary of Imerys, S.A., France) in Essex County, NY, produced garnet as a byproduct of wollastonite mining and sold the material to processors. The USGS obtained the data in this report through a voluntary survey of the four U.S. industrial garnet producers; responses were received from three companies. The USGS estimated the production quantities and values of nonreporting company on the basis of industry sources, industry production trends, and past reports from producers adjusted using employment data from the Mine Safety and Health Administration.

In 2018, U.S. production of crude garnet concentrate for industrial use increased to 101,000 t from 92,900 t in 2017, and the value increased to $22.1 million from $18.9 million. The United States accounted for about 9% of global industrial garnet production. In 2018, refined garnet production was 166,000 t valued at $68.9 million compared with 84,100 t valued at $38.9 million in 2017. The increase in refined production was attributed to increased production at existing plants and a full year of production in 2018 for a processing plant that opened in 2017 in Pennsylvania. Refined garnet was processed from domestic mine production and imported crude garnet. Industrial garnet's retail value is dependent on type, source, quality, and degree of processing.

Emerald Creek Garnet (a subsidiary of Opta Minerals Inc.) mined alluvial almandine garnet in Idaho by excavating floodplain sediments and using a specialized shaker and jig system to sort the garnet. Garnet USA (a subsidiary of GMA Garnet Pty. Ltd.) mined almandine garnet at its quarry in southwestern Montana and processed garnet at its southeastern Pennsylvania facility. In New York, Barton mined an almandine-pyrope mixture from a quarry at Ruby Mountain. NYCO

Minerals produced andradite garnet as a byproduct from its wollastonite mining operation at Oak Hill; some of the material was sold to a cement producer and some was processed by International Garnet (an Opta Minerals company) in Keeseville, NY.

In 2018, Garnet USA announced a new garnet-processing plant was being constructed in Coos Bay, OR. This facility was expected to have a maximum refined garnet production capacity of more than 100,000 metric tons per year (Gobby, 2018).

Consumption

U.S. apparent consumption, defined as crude production plus imports minus exports, more than doubled to 341,000 t in 2018 from 129,000 t in 2017 owing to a large increase in imports (table 1). The major end uses for garnet in the United States in 2018 remained the same as those of 2017 and were estimated to be abrasive blasting (50%), water-jet cutting (35%), and water filtration media (10%); the remainder was used as abrasive powders, as an additive in nonslip coatings, in sandpaper, or other uses. Domestic industries that consume garnet include aircraft and motor vehicle manufacturers, ceramics and glass producers, electronic component manufacturers, glass polishing, natural gas and petroleum producers, shipbuilding and maintenance, structural steel fabrication and maintenance, textile stonewashing, water filtration plants, 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, making it 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. During 2018, the number of drill rigs operating in the United States was 924 rigs at the beginning of the year, increasing steadily through the year to reach 1,083 rigs at the end of December. The average weekly drill rig count for 2018 was 1,032 operating rigs, compared with an average of 876 in 2017, indicating that more garnet likely was consumed in well drilling (Baker Hughes Inc., 2019).

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 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 abrasive grit 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 use of abrasives for water-jet cutting began to develop slowly in the late 1980s and early 1990s and 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. Two-dimensional water-jet tables have been produced in larger standard sizes in recent years, up to 4 by 14 meters, and the ability to cut three-dimensional shapes using accessories and special software has become available for some models (Olsen, 2012a, b). 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 remained 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 coal, 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.

Prices

Industrial garnet pricing varies over a wide range, depending on application, quality, quantity purchased, source, and type. During 2018, estimated domestic unit values for crude garnet concentrates ranged from about $175 to $275 per metric ton, with an average for the year of $218 per ton; this was an 7% increase from the 2017 average of $204 per ton. Domestic unit values for refined garnet sold during the year ranged from $240 to $520 per ton, with an average for the year of $416 per ton; this was a 10% decrease from the 2017 average of $463 per ton. The decreases in average values were due to an influx of cheaper imports compared with more expensive domestically refined garnet.

The estimated average unit values of garnet from other leading producer countries based on the customs value of import shipments were as follows: Australia, $320 per ton; India, $310 per ton; China, $280 per ton; and South Africa, $150 per ton. During 2018, the average unit value of industrial garnet imported from all sources was $215 per ton of crude garnet, a

30% decrease from $306 per ton in 2017. This decrease in price was the result of increased imports of lower valued garnet from South Africa into the Philadelphia district to supply the Fairless Hills, PA, processing plant.

Foreign Trade

Exports of industrial garnet in 2018 were 14,200 t, and imports were estimated to be 254,000 t. Exports decreased by 20% and imports more than quadrupled from those in 2017. The large increase in imports was the result of an increase of imports from South Africa to supply the Fairless Hills, PA, processing plant and the easing of supply restrictions on mineral sands and increased production in India. In 2018, South Africa (59%), India (19%), and China (13%), supplied the majority of United States garnet imports for consumption, with Australia and 10 other countries supplying the remaining 9% of imports. Garnet exports from the United States were primarily shipped to Canada (27%), Mexico (19%), Brazil (9%), Trinidad and Tobago (7%), China (6%), and South Africa (4%), with the remainder going to many other countries.

World Review

Total world industrial garnet production was about 1.25 Mt in 2018, a 30% increase from that in 2017. The leading global producers were Australia, 360,000 t; China, 290,000 t; South Africa, 278,000 t; India, 162,000 t; the United States, 101,000 t; and other countries, 60,000 t.

Russia and Turkey have been mining garnet in recent years, and small garnet-mining operations also were located in Canada, Chile, Czechia, Pakistan, Spain, Thailand, and Ukraine, but the available information was insufficient to make reliable estimates of output. Production in most of these countries was for domestic use.

Outlook

Garnet is likely to continue displacing silica sand for blasting as countries ban the use of silica sand-blasting media owing to concerns about potential occupational health risks. Garnet also is expected to continue to displace 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

SALIENT U.S. INDUSTRIAL GARNET STATISTICS [1]

		2014	2015	2016	2017	2018
United States:						
Crude production:						
Quantity	metric tons	59,900	77,200	81,300	92,900 r	101,000
Value	thousands	$11,700	$15,700	$16,300	$18,900 r	$22,100
Refined garnet production:						
Quantity	metric tons	35,900	47,200	46,600	84,100 r	166,000
Value	thousands	$17,200	$24,500	$24,000	$38,900 r	$68,900
Exports:[2]						
Quantity	metric tons	11,500 r	11,000 r	10,100 r	17,700 r	14,200
Value	thousands	$9,600 r	$8,260 r	$8,120 r	$11,900 r	$9,220
Imports for consumption:[3]						
Quantity	metric tons	162,000	212,000	156,000	54,200	254,000
Value	thousands	$33,900	$47,900	$31,500	$16,500	$54,600
Apparent consumption:[4]						
Quantity	metric tons	210,000 r	278,000 r	227,000 r	129,000 r	341,000
Value	thousands	$36,000 r	$55,400 r	$39,600 r	$23,600 r	$67,500
World, production	metric tons	1,100,000	1,010,000	1,130,000	960,000 r	1,250,000

[r]Revised.

[1]Table includes data available through August 2, 2019. Data are rounded to no more than three significant digits.

[2]Source: U.S. Census Bureau; adjusted by U.S. Geological Survey.

[3]Sources: U.S. Census Bureau and Trade Mining, LLC; adjusted by U.S. Geological Survey.

[4]Domestic production plus imports minus exports.