

2017 Minerals Yearbook

VERMICULITE [ADVANCE RELEASE]

VERMICULITE

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In 2017, U.S. production of vermiculite concentrate increased slightly, although reportable production remained at an estimated 100,000 metric tons (t) because of rounding to one significant digit to avoid disclosing company proprietary data. Percentages in this report were calculated using unrounded data. Worldwide vermiculite production was 404,000 t in 2017, up by about 3% from that of 2016 (tables 1, 4). About 72,000 t of exfoliated vermiculite valued at \$63.5 million was sold or used in the United States in 2017, representing a nearly 6% increase in quantity with a 2% increase in value from that of 2016 (tables 1, 3). U.S. exports of vermiculite were estimated to be unchanged at about 2,000 t. Land imports were estimated to have increased by 15% to 53,000 t from that of 2016 and were 17% more than the average of imports for the previous 5 years (table 1).

Vermiculite is a hydrated magnesium-aluminum-iron silicate. Raw vermiculite is similar in appearance to mica, contains water molecules within its internal structure, and ranges in color from black to various shades of brown to yellow. When vermiculite flakes are heated rapidly to a temperature of 900 °C or higher, the intermolecular water flashes into steam, and the flakes expand into accordion-like particles, which are gold or bronze in color. This expansion process is called exfoliation, and the resulting lightweight material is chemically inert, fire resistant, and odorless.

Production

Domestic production (sold or used) data for vermiculite are collected annually by the U.S. Geological Survey by means of two voluntary canvasses—one is sent to mine-mill (concentrator) operations and the second to exfoliation plants. All individual company data from these canvasses were withheld from publication to avoid disclosing company proprietary data.

Production data for vermiculite concentrate were derived from responses from two U.S. producers, accounting for all domestic crude vermiculite mine production. In 2017, production of vermiculite concentrate increased slightly. Virginia Vermiculite LLC mined and processed vermiculite concentrate at its operation in Louisa County, VA, as did Specialty Vermiculite Corp. (a subsidiary of Dicalite Management Group, Inc.) at its operations at Enoree and Woodruff, SC. Both companies produced concentrates in finer grade sizes (less than 2 millimeters) from biotite mica ores (Moeller, 2018).

Virginia Vermiculite continued to mine crude vermiculite at its new mine site adjacent to its original vermiculite mine and to process vermiculite concentrate at its plant at the original site. Material processed from the new mine contains 20% to 25% vermiculite, and the waste will be used in the future reclamation of the property that was expected to include an 8-hectare (20-acre) lake (Gilbert, 2015).

Vermiculite concentrate was shipped to 14 companies operating 17 plants in 11 States for conversion into expanded lightweight products (table 2). In 2017, 72,000 t of exfoliated vermiculite sold or used by producers was valued at about \$63.5 million with a 3% decrease in average unit value (table 1). Of the 17 exfoliation plants, 4 responded to the canvass, representing 25% of the estimated sold or used exfoliated vermiculite tonnages listed in tables 1 and 3. Production data for nonrespondents were estimated on the basis of previous years' reported production levels. States that produced exfoliated vermiculite were, in descending order of tonnage, South Carolina, New Jersey, Arizona, Pennsylvania, Massachusetts, Illinois, Florida, Texas, Arkansas, Ohio, and New Mexico.

Consumption

Vermiculite has a wide range of uses, particularly in the agricultural and construction industries, because of its attributes, including fire resistance, high liquid-absorption capacity, inertness, low density, and low thermal conductivity. In horticulture, vermiculite mixed with peat or other composted materials, such as pine bark, produces a soil-like material well suited as a growing medium for plants. To condition soil, vermiculite can improve the aeration of “sticky” (clay-rich) soils and the water-retention characteristics of sandy soils, reducing the likelihood of compaction, cracking, and crusting of the soil. Use in horticulture and soil conditioning accounted for 46% of the exfoliated vermiculite sold or used in the United States in 2017 (table 3). Vermiculite also is used in the fertilizer and pesticide markets because of its ability to act as a bulking agent, carrier, and extender while providing some potassium, magnesium, and minor elements to plants. Vermiculite can absorb liquids, such as fertilizers, herbicides, and insecticides, which can then be transported as free-flowing solids.

Other major uses of vermiculite include insulation products and lightweight aggregate applications, such as general building plasters and concrete products, for its lightweight and thermal insulation properties. These uses accounted for 27% of the exfoliated vermiculite sold or used in the United States in 2017 (table 3). Special plasters, including those used for fire protection and soundproofing, may use vermiculite combined with a binder, such as gypsum or portland cement, fillers, and other specialized additives. As insulation, exfoliated vermiculite, in some applications treated with a water repellent, is used to fill pores and cavities in hollow blockwork and masonry construction to enhance acoustic properties, fire rating, and insulation performance. Finer grades of exfoliated vermiculite, combined with potassium or sodium silicate, are used to produce insulation shapes. The ability of vermiculite-base insulation shapes to resist attack by molten aluminum makes them especially useful as secondary insulation in the aluminum

production process. Other uses include refractory-insulation gunning and castable mixes and vermiculite dispersions. Finer grades of exfoliated vermiculite are used to partially replace asbestos in brake linings, primarily for the automotive market.

Prices

Published prices for vermiculite serve only as a general guide because of variations in application, quantity, source, and other factors. U.S. domestic prices for vermiculite concentrate, ex-plant, largely dependent on grade sizing, ranged from \$140 to \$575 per metric ton in 2017, unchanged since 2015. The value of imports into the United States in 2017, mostly coarser grades, bulk, free on board (f.o.b.) at barge gulf coast port, ranged from \$280 to \$1,100 per ton, unchanged from 2015 (Moeller, 2018). Coarser grained vermiculite with greater thermal expansion commands a higher price, but virtually none is produced in the United States.

The average unit value of U.S. exfoliated vermiculite sold or used by producers, using actual and estimated data, was about \$885 per ton in 2017, down 3% from \$910 per ton in 2016. These data were composite values of exfoliated vermiculite produced from domestic and imported concentrate (table 1).

Foreign Trade

Trade data for vermiculite concentrate are not collected as a separate category by the U.S. Census Bureau but are included within the category “vermiculite, perlite, and chlorites, unexpanded” under Harmonized Tariff Schedule of the United States code 2530.10.0000. Export trade data for 2013–15 are from PIERs, a U.S. trade database compiled by the Journal of Commerce (JOC Group Inc., 2016). Import data are from Trade Mining: Import Trade Data, a U.S. trade database compiled by Trade Mining, Inc. Total United States imports of vermiculite—crude and concentrate—(excluding any material from Canada and Mexico) were estimated to be 53,000 t, up from an estimated 46,000 t in 2016, with the majority in 2017 coming from South Africa, 38%; China, 32%; Brazil, 24%; and Zimbabwe, 1% (Trade Mining Inc., 2017). Concentrates of coarser-than-medium particle size from high-yielding deposits, which have been increasingly less available in recent years, were imported mostly from China and South Africa.

World Review

Global vermiculite production increased by about 3% in 2017 to an estimated 404,000 t (table 4), mostly owing to an increase in production from the world’s leading producer, Palabora Mining Co. Ltd. [a subsidiary of Palabora Copper (Pty) Ltd.] in South Africa (table 4; Ghilotti, 2016). Data for vermiculite production in China, which may have produced significant quantities of vermiculite, were largely unavailable. Although mines and prospects in Brazil, Peru, and South Africa had the potential to increase the production of medium to coarse grades, expected production increases in 2016 and 2017, especially of coarser grades, had yet to significantly materialize. Coarser and more expensive grades, increasingly in higher demand in recent years, continued to be in short supply, and there was excess capacity for very fine sizes (Moeller, 2017, 2018).

Brazil.—Brasil Minérios Ltd. was by far the leading vermiculite producer in Brazil. The company’s largest mine, in terms of production quantity, was the São Luís De Montes Belos Mine near Goiania in the State of Goiás in central Brazil, and its main processing plant was in São Luis. The mine had an estimated production capacity of 60,000 metric tons per year (t/yr) of vermiculite ore with estimated reserves of 1.2 million metric tons (Mt) of vermiculite ore (Brasil Minérios Ltd., 2018). With expansion of its mining operations continuing, Brasil Minérios produced about 51,600 t of vermiculite concentrate in 2016 (Departamento Nacional de Produção Mineral, 2017, p. 237). About 60% of Brazil’s vermiculite products were exported, with sales in North America (50%), Europe (35%), and Asia (15%) (Torrise and Patel, 2014). In 2017, Brasil Minérios exported about 12,000 t of vermiculite to the United States, up by about 60% from that of 2016 (Trade Mining Inc., 2017).

Near Brasília in Catalao, Goiás State, Brasil Minérios owned the mining rights to vermiculite deposits containing estimated vermiculite ore reserves of 2 Mt (Elliott, 2011). Brasil Minérios’ total production capacity is expected to increase to 200,000 t/yr when the Catalão Mine is fully brought on line in the next several years (Torrise and Patel, 2014; Moeller, 2018). Brasil Minérios expected to meet Brazil’s domestic demand for vermiculite for 50 years while continuing to be a significant exporter of the mineral. The company also operated two exfoliation plants—one in Sanclerlandia, Goiás State, and another in Cosmopolis, São Paulo State—with combined installed capacity of 15,000 cubic meters per month (Brasil Minérios Ltd., 2013).

Bulgaria.—In 2016, Wolff & Müller Minerals Bulgaria OOD, a German-Bulgarian joint-venture company, mined vermiculite ore from its Belitza opencast mine and had limited production at, and continued development of, the nearby Verona vermiculite deposit in southwestern Bulgaria near the capital of Sofia. The company processed the crude vermiculite ore into a concentrate in superfine- and micron-sized products at its modern vermiculite concentration plant that was capable of producing 20,000 t/yr (Moeller, 2017; Wolff & Müller Minerals Bulgaria OOD, 2017).

China.—Production levels of vermiculite in China were not available, but based on an estimate made by the Vermiculite Association that China annually exports 110,000 t of vermiculite, the country’s annual production likely is greater (Ghilotti, 2016). In 2017, about 16,800 t of vermiculite concentrate was exported from China to the United States, an increase of slightly more than 50% from that of 2016 (Trade Mining Inc., 2017).

Xinjiang Yuli Xinlong Vermiculite Co., Ltd. mined vermiculite ore from its 14.8-Mt deposit at its Xinlong Mine in the No. 2 sector of the Qeganbulake ring complex in the Bazhou area of Xinjiang Uyghur Autonomous Region. The Xinlong Mine was the top-producing vermiculite mine in China, from which the company’s production capacity of vermiculite concentrate and exfoliated vermiculite was 120,000 t/yr and 30,000 cubic meters per year, respectively. The company’s leading product was a flake vermiculite concentrate ranging in size from 0.3 to 8.0 millimeters. The company exported most

of its products, typically to developed countries and regions such as Australia, Europe, Hong Kong, Japan, the Republic of Korea, Russia, Taiwan, and the United States but also sold products domestically (Xinjiang Yuli Xinlong Vermiculite Co., Ltd., 2017).

South Africa.—In 2017, South Africa continued to be the world's leading producer and exporter of vermiculite, accounting for about 44% of estimated world production (table 4). From 2000 through 2016, on average, nearly 90% of the vermiculite produced in South Africa was exported (Ghilotti, 2016). In 2017, nearly 176,000 t were produced, most of which was mined by Palabora Mining Co. Ltd. (table 4). Palabora Mining exported about 20,000 t of vermiculite to the United States, a 27% decrease from that of 2016 (Trade Mining Inc., 2017).

Under the ownership of a consortium consisting of South African and Chinese entities led by the Industrial Development Corporation of South Africa Ltd. and China's Hebei Iron & Steel Group, the Palabora Mining Co. Ltd. increased production in 2017 by more than 5% from that of 2016 from its mine in Limpopo Province (table 4). In nearby areas, the company was preparing for the opencast mining of ore that was equally rich in high-purity vermiculite. The new mine would have a production capacity of 1.5 million metric tons per year of ore and yield 170,000 t/yr of vermiculite concentrate, extending the company's total mine life through 2033 (Industrial Minerals, 2016). Because of grade constraints and lower recovery rates from portions of the vermiculite ore body, the vermiculite product has continued to shift toward fine and superfine grades. Palabora Mining continued to face increased competition in the global vermiculite market, including that from Brazil and Uganda, but it regained some of its market share lost in the past few years, in part through competitive pricing (Palabora Mining Co. Ltd., 2014, p. 12, 38).

Palabora Mining marketed its vermiculite products through the company's Singapore office to its three international subsidiaries in Australia, Europe, and North America (Palabora America Ltd. Vermiculite Division in Kennesaw, GA) (Palabora Mining Co. Ltd., 2014, p. 38).

Turkey.—Organik Madencilik A.Ş., a 50–50 joint venture of Turkey's Yildirim Group and the Greek mining group S&B [a subsidiary of Imerys SA (Paris, France)] proceeded with plans to develop the country's first vermiculite mine at the Karakoc vermiculite deposit in Sivas in central Turkey. The deposit, discovered by Turkey's Government Exploration Co. in the 1990s, is thought to hold resources of about 2.8 Mt of high-quality vermiculite and 2.5 Mt of lower-quality vermiculite (Organik Madencilik A.Ş., 2017b). The mine had a capacity of 10,000 t/yr of vermiculite concentrate, a significant quantity, which consisted of coarse and medium grades. An unspecified portion of production was further processed by exfoliation (Organik Madencilik A.Ş., 2017a). Sales of vermiculite concentrate and exfoliated vermiculite were planned to go through Imerys' established network (Industrial Minerals, 2015).

Uganda.—Australian developer Black Mountain Resources Ltd., which in 2016 purchased the Namekara Vermiculite Mine in the Manafwa district of eastern Uganda, reported an increased estimate of nearly 62 Mt of inferred resources with a grade of 18.2% vermiculite and containing 11 Mt of vermiculite. The

vermiculite resource includes significant quantities of coarse and medium grades. The mine has sufficient resources to operate for more than 50 years at previously announced rates of production (Swanepoel, 2016). The Namekara Mine has an estimated production capacity of 20,000 t/yr of vermiculite concentrate. After having intermittent operations in 2016, the Namekara Mining Co. Ltd., which operated the mine, increased mining operations in 2017, in part in response to increasing orders for its vermiculite products (Nyasha Makoni, General Manager, Namekara Mining Co., Ltd., written commun., May 10, 2018).

Zimbabwe.—Samrec Vermiculite (Pvt.) Ltd. [a subsidiary of Imerys SA (Paris, France)], the leading vermiculite producer in the country, conducted intermittent mining at the Shawa Mine (Moeller, 2018). Samrec operated the Shawa Mine, which is about 300 kilometers southeast of the capital of Harare. The surface mining operation with ore to a depth of 40 meters had a capacity of 40,000 t/yr of vermiculite concentrate and an expected mine life of more than 30 years in one of the largest vermiculite deposits in the world. The ore, which included a significant portion of large flake vermiculite, was processed into concentrates, the majority of which was exported to Europe, the Middle East, Japan, and the United States (Lismore-Scott, 2014; Source, The, 2014).

The Minerals Marketing Corp. of Zimbabwe, which was responsible for marketing and selling the country's industrial minerals, reported exports of 29,300 t of vermiculite concentrate at a value of \$3.43 million in 2016 (most recent year available), representing a 5% decrease from about 30,900 t at a value of \$4.15 million in 2015. The company cited that the firming U.S. dollar and increased inland costs to sea ports had made the local product prices uncompetitive on the international market. Also, increased transportation costs related to the country's failing rail infrastructure and lower prices for the small grades of vermiculite had a negative impact on sales and exports the past several years (Minerals Marketing Corp. of Zimbabwe, 2017, p. 7, 12, 16, 19). In 2017, 730 t of vermiculite concentrate was imported into the United States from Zimbabwe, a 63% decrease from 1,950 t in 2016 (Trade Mining Inc., 2017).

On a smaller scale, Zimbabwe-based Wickbury Investments (Pvt.) Ltd. mined vermiculite at the Dinhidza Mine in Buhera for transport to its beneficiation facilities in the capital city of Harare. Wickbury marketed its product mainly to Zimbabwe's farming industry as a soil amendment to slow the leaching of fertilizers from soil after excessive rainfall while also promoting the mineral's slow release of fertilizer to the soils. In drier areas, farmers would benefit from the mineral's ability to swell and store water, increase soil aeration, and transport and store nutrients. In both instances, use of vermiculite would improve the long-term fertility of soils (Dickson, 2015).

Outlook

Exploration and development of vermiculite deposits containing medium, large, and premium (coarser) grades (mostly in China and South Africa) are likely to continue because of the higher demand for these larger grades. During the next several years, operations in Brazil and the United States are expected to help maintain regional and global supplies of fine, superfine, and

micron grades. The anticipated return to sustained production at the Namekara Vermiculite Mine in Uganda and a continuance of production from the Shawa Mine in Zimbabwe, which has been affected by political instability in recent years, may provide some of the needed supplies of coarser grades in the market.

With supplies of finer grades in excess capacity and far exceeding those of coarse grades for several decades, producers will continue to investigate more ways to increase the use of the finer grades in higher value markets and in existing products, such as functional filler in coatings, fireproofing, friction brake applications, and insulation. To increase fire resistance in coatings and binders that form high-tensile-strength films, finer grades of vermiculite concentrate may be used as intumescent, the concentrate swelling (expanding) and promoting a less dense, passive barrier upon exposure to heat. Product lines may be developed for new uses, such as fine-sized to micron-sized grades of vermiculite to control air pollution and absorb water in mines, replace zeolites in ion-exchange columns, purify wastewater, or serve to contain or remove nuclear waste. More innovation for new and increased uses in the construction industry was suggested by a major producer to have the potential to lower the carbon footprint and increase energy efficiency in constructing new buildings (Pengelly, 2017, p. 37). A company in the United Kingdom was marketing vermiculite dispersion products it had developed to suppress fires in lithium-ion batteries. In research and development activities, work included flexible polyamide composite foams for thermal and fire suppression and catalysts for syngas conversion to synthetic natural gas (Moeller, 2018).

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TABLE 1
SALIENT VERMICULITE STATISTICS¹

(Thousand metric tons and thousand dollars unless otherwise specified)

	2013	2014	2015	2016	2017
United States:					
Production, concentrate ^{e, 2}	100	100	100	100	100
Exfoliated:					
Quantity	64	63	65	68	72
Value	50,000	52,000	60,800	62,300	63,500
Average value dollars per metric ton	780	800	930	910 ^r	885
Exports ³	2	3	2	2 ^e	2
Imports for consumption ⁴	39 ^r	52 ^r	33 ^r	46	53
World, production	359	384	368 ^r	394 ^r	404

^eEstimated. ^rRevised.

¹Table includes data available through October 5, 2018. Data are rounded to no more than three significant digits unless otherwise specified.

²Sold or used by producers. Rounded to one significant digit to avoid disclosing company proprietary data.

³Source: JOC Group Inc., 2016, PIERS: Newark, NJ, JOC Group Inc. (a division of IHS Inc.). (Accessed November 8, 2016, via <http://i.piers.com/Login.aspx?ReturnUrl=/app/Default.aspx>.)

⁴Source: Trade Mining Inc., 2017, Trade Mining—Import trade data: Dearborn, MI, Trade Mining Inc. (Accessed February 20, 2018, via <https://portal.trademining.com/Account/LogIn>.)

TABLE 2
ACTIVE VERMICULITE EXFOLIATION PLANTS IN THE UNITED STATES IN 2017

Company	County	State
Fireproofing Products, Inc.	Bernalillo	New Mexico.
Isolatek International Inc.	Sussex	New Jersey.
J.P. Austin Associates Inc.	Beaver	Pennsylvania.
Palmetto Vermiculite Co. Inc.	Spartanburg	South Carolina.
P.V.P. Industries, Inc.	Trumbull	Ohio.
Schundler Co., The	Middlesex	New Jersey.
Specialty Vermiculite Corp.	Maricopa	Arizona.
Do.	Broward	Florida.
Do.	Laurens	South Carolina.
Sun Gro Horticulture Canada Ltd.	Jefferson	Arkansas.
Do.	LaSalle	Illinois.
Thermal Ceramics Inc.	Macoupin	Do.
Therm-O-Rock East, Inc.	Washington	Pennsylvania.
Therm-O-Rock West, Inc.	Maricopa	Arizona.
Vermiculite Industrial Corp.	Allegheny	Pennsylvania.
Vermiculite Products Inc.	Harris	Texas.
Whittemore Co., Inc.	Essex	Massachusetts.
Do. Ditto.		

TABLE 3
ESTIMATED EXFOLIATED VERMICULITE SOLD OR
USED IN THE UNITED STATES, BY END USE¹

(Metric tons)

	2016	2017
Aggregates ²	13,100	13,800
Insulation ³	5,130	5,960
Agricultural:		
Horticultural	22,100	27,100
Soil conditioning	7,070	5,990
Fertilizer carrier	W	W
Total	W	W
Other ⁴	W	W
Grand total ⁵	68,000	72,000

W Withheld to avoid disclosing company proprietary data; included in "Grand total."

¹Table includes data available through October 5, 2018. Data rounded to no more than three significant digits; may not add to totals shown.

²Includes concrete, plaster, and premixes (acoustic insulation, fireproofing, and texturizing uses).

³Includes loose-fill, block, and other (high-temperature and packing insulation and sealants).

⁴Includes various industrial and other uses not specified.

⁵Rounded to two significant digits because of estimated data.

TABLE 4
VERMICULITE: WORLD PRODUCTION, BY COUNTRY OR LOCALITY¹

(Metric tons)

Country or locality ²	2013	2014	2015	2016	2017
Argentina	120	90	90	60 ^r	50
Brazil, concentrate	60,379	56,444	56,000	55,000 ^e	55,000 ^e
Bulgaria, concentrate ^e	8,000	10,000	10,000	10,000	10,000
Egypt	3,000 ^e	3,000 ^e	8,190	8,000 ^{r, e}	8,000 ^e
India	7,460	16,384	13,250	8,058 ^r	5,315
Iran	1,200	1,200	1,000	1,000 ^r	1,000 ^e
Kenya	400	440	410 ^r	-- ^r	400 ^e
Mexico	425	226	299 ^r	310 ^r	300 ^e
Russia	20,931	21,000 ^e	8,282 ^r	12,363 ^r	13,000 ^e
South Africa	127,658	143,007	138,290	166,483	175,869
Uganda	243	2,620	1,118	3,294 ^r	5,000 ^e
United States, concentrate ³	100,000	100,000	100,000	100,000	100,000
Zimbabwe	28,808 ^r	29,767 ^r	30,868 ^r	29,316 ^r	30,000 ^e
Total	359,000	384,000	368,000 ^r	394,000 ^r	404,000

^eEstimated. ^rRevised. -- Zero.

¹Table includes data available through June 29, 2018. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²In addition to the countries and (or) localities listed, Australia, China, and Japan may have produced vermiculite, but available information was inadequate to make reliable estimates of output.

³Sold and used by producers. Rounded to one significant digit to avoid disclosing company proprietary data.