VERMICULITE

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Vermiculite is a hydrated magnesium-aluminum-iron silicate. Flakes of raw vermiculite concentrate are mica-like in appearance and contain water molecules within their internal structure. When the flakes are heated rapidly at a temperature of 900° C or higher, the water flashes into steam, and the flakes expand into accordion-like particles. The color, which can range from black and various shades of brown to yellow for the raw flakes, changes to gold or bronze. This expansion process is called exfoliation, and the resulting lightweight material is chemically inert, fire resistant, and odorless. In lightweight plaster and concrete, vermiculite provides good thermal insulation. Vermiculite can absorb such liquids as fertilizers, herbicides, and insecticides, which can then be transported as free-flowing solids (Harben and Kuzvart, 1996).

Production

Domestic production (sold or used) data for vermiculite were collected by the U.S. Geological Survey (USGS) from two voluntary surveys—one for mine-mill operations and the other for exfoliation plants. Of three mine-mill operations, partial data were obtained from one.

Because there have only been three U.S. mining operations (two companies) of vermiculite concentrate in recent years, any vermiculite production data collected by the USGS are proprietary and must be withheld. The two U.S. producers of vermiculite concentrate were Virginia Vermiculite Ltd., with operations near Woodruff, SC, and in Louisa County, VA, and W.R. Grace & Co., from its operation at Enoree, SC.

Vermiculite concentrate was shipped to exfoliating plants for conversion into lightweight material (table 2). Output of exfoliated vermiculite sold or used in 2001, using partly estimated data, was about 140,000 metric tons (t) (table 1). Domestic production of exfoliated vermiculite sold or used was by 14 companies operating 19 plants in 10 States (table 2). Of the 19 known exfoliation plants, 9 (47%) responded. The nine operations represented 42% of the sold or used vermiculite listed in tables 1 and 3. Data for the remaining operations were estimated from previous years' production levels. States that produced exfoliated vermiculite, in descending order of output sold and used, were South Carolina, New Jersey, Ohio, Arizona, Pennsylvania, Florida, Arkansas, Illinois, Texas, and New Mexico.

W.R. Grace & Co. voluntarily filed for reorganization under chapter 11 of the U. S. Bankruptcy Code in response to a sharply increasing number of asbestos claims against the company. Grace's asbestos liabilities largely stem from commercially purchased asbestos added to some of its fire protection products; the company ceased to add any asbestos to its products in 1973. The filing would enable the company to operate in the usual manner under court protection from its creditors and claimants while developing and implementing a plan for addressing the asbestos-related claims against it (W.R. Grace & Co., 2001b§[1]).

Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) continued to test for the presence of asbestos in and around a former vermiculite mine, the local environment, and homes in Libby, MT. The mine was shut down in 1990. The agency also was continuing to assess the risk posed by exposure to the Libby material. Reports on the epidemiological and monitoring activities were available on the website for EPA region 8 (U.S. Environmental Protection Agency, 2002§).

The EPA issued a report investigating whether any of the mineralogical and chemical characteristics of vermiculite products might serve as tracers to help regulators identify product sources. Interest in tracking sales of vermiculite products arose because of the presence of asbestos in some of the Libby, MT, vermiculite products that were sold in the past. The objective of the EPA report was to form the groundwork for additional studies on tracer components. Two of the more promising areas for future study were compositional variations in amphiboles and micas and trace element variations in the ores from different locations. The study recommended various methods of analysis for further study and a sampling protocol (Frank and Edmond, 2001).

Consumption

Vermiculite has a wide range of uses that take advantage of its attributes, such as low density, good insulating properties, inertness, fire resistance, and high liquid absorption capacity. Vermiculite is used in general building plasters either in its own formulations or combined with such other aggregates as perlite. Specialist plasters include fire protection and acoustic products in which vermiculite is combined with a binder, such as gypsum or portland cement, plus fillers and rheological aids (Roskill Information Services Ltd., 1999, p. 72-76).

Exfoliated vermiculite treated with a water repellent is used to fill pores and cavities in masonry construction (especially hollow blockwork) to enhance fire ratings, insulation, and acoustic performance. Exfoliated finer grades of vermiculite are used to produce insulation shapes. The manufacturing process is very similar to that used for the production of silicate-bound building boards (Roskill Information Services Ltd., 1999, p. 84). Vermiculite-based insulation shapes can be used in lower temperature metal-melting-processing industries; vermiculite can be used in contact with molten metal up to 1,200° C. Vermiculite shapes are used in the aluminum industry, in particular, because vermiculite is said to have a nonwetting characteristic with aluminum (Russell, 2000, p. 16).

Exfoliated vermiculite has been combined for many years

[1]References that include a section twist (§) are found in the Internet References Cited section.

with high alumina (also known as aluminous or calcium aluminate) cements and such aggregates as expanded shale, clay, and slate to produce refractory and/or insulation concretes and mortars. These are used in areas where strength and corrosion/abrasion resistance are of secondary importance; the most important factor is the insulation performance of the in-place refractory lining. These mixes are used in such industries as iron and steel, cement, and hydrocarbon processing (Roskill Information Services Ltd., 1999, p. 85).

In horticulture, exfoliated vermiculite improves soil aeration and moisture retention. When vermiculite is mixed with peat or other composted materials, such as pine bark, the resulting product provides a good growing medium for plant propagation. As a soil conditioner, exfoliated vermiculite can improve the aeration of "sticky" soils and the water holding characteristics of sandy soils. This allows for easier watering and reduces the likelihood of cracking, crusting, and compaction of the soil. Vermiculite is used in the fertilizer/pesticide market because of its ability as a carrier, bulking agent, and extender (Roskill Information Services Ltd., 1999, p. 81, 90-91).

Finer grades of exfoliated vermiculite are used to partially replace asbestos in brake linings primarily for the automotive market (Roskill Information Services Ltd., 1999, p. 84).

Prices

Published prices for vermiculite serve only as a general guide because of variations in source, quantity, application, and other factors. Prices for raw (unexpanded) U.S. vermiculite concentrate, bulk, ex-mill were unchanged from 2000—from about $143 per metric ton to $220 per ton, depending on particle size. For imported South African crude vermiculite, bulk, free on board barge, U.S. Gulf Coast, prices ranged from $187 per ton to $243 per ton (Industrial Minerals, 2001c).

The average value of U.S. exfoliated vermiculite sold or used by producers, using partly estimated data, was $340 per ton (table 1), which was a composite value including both U.S. and imported material.

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 basket category "vermiculite, perlite, and chlorite, unexpanded" under tariff code 2530.10.0000. According to Moeller (2002), U.S. exports of vermiculite concentrate in 2001 were about 7,000 t (table 1). Total U.S. imports of vermiculite in 2001 were about 65,000 t (Port Import/Export Reporting Service, unpub. data, 2002). South Africa supplied about 73% of the tonnage, and China, 25%.

World Review

In Western Europe, an estimated 55% of exfoliated vermiculite was going into proprietary products used in construction of commercial and industrial structures, including building boards, general construction plasters, and specialist fire protection/acoustic plasters (Roskill Information Services Ltd., 1999, p. 3).

Australia.—Imdex Ltd., based in Perth, Western Australia, was planning to sell its mining concern Australian Vermiculite Industries. The operation is the country's only vermiculite producer; the mine is located 160 kilometers northeast of Alice Springs in the Northern Territory. Output was about 10,000 to 12,000 metric tons per year (t/yr), which was supplying 80% of the domestic market as well as being exported to Europe, Japan, the Middle East, New Zealand, and Taiwan. Markets were fire protection, building products, and horticulture (Industrial Minerals, 2001a).

China.—Although data were not fully available, output of vermiculite was estimated to be at least 30,000 to 40,000 t/y from the four main producers in Xinjiang Province. An additional 15,000 t of output (not listed in table 4) was estimated to have been produced in Hebei Province (Moeller, 2002). Hebei Metals & Minerals Import and Export Corp. (Hebei Minmetals), which deals with metals, minerals, and other products in Hebei Province, classifies vermiculite into two types. Silver-white vermiculite contains 5% to 13% iron oxide (Fe_2O_3) and is for use in the construction industry. Golden yellow vermiculite, with 16% to 22% Fe_2O_3, is used in agriculture and horticulture. Export destinations for Chinese vermiculite included Japan, the Republic of Korea, and North America (Li, 2001).

South Africa.—Reported production of vermiculite in 2001 was 156,632 t, a 25% decrease from that of 2000. Production at Palabora Mining Co. Ltd., the world's largest vermiculite producer, was hampered by wet in-pit mining conditions and low availability of plant and heavy equipment (Profile Data, 2002§). New management, dryer weather conditions, and improvements at the mine and mill could allow increased production in 2002 (Moeller, 2002).

Uganda.—Canmin Resources Ltd. began mining and production at its Namekara vermiculite project in the Mbale District of southeast Uganda. Canmin is a wholly owned subsidiary of Canadian junior mining and investment company IBI Corp. Some 2,000 t of vermiculite was being mined for stockpiling, and processing equipment had been installed in a newly constructed processing building. Canmin's target output was around 40,000 t/yr of vermiculite for insulation and horticulture, which would be exported to Europe and the Middle East (Industrial Minerals, 2001b). Also, prospective customers in Canada and the United States were assessing the feasibility of using the large-flake, coarse-grade vermiculite for similar purposes (Mining Journal, 2001).

Zimbabwe.—Samrec Vermiculite (Zimbabwe) (Pvt.) Ltd. (the Imerys-owned operator of the Shawa mine) was doubling its vermiculite capacity to 40,000 t/yr. Also, the plant was being automated, which would reduce production costs. The basis for the plant expansion was demand for large-flake vermiculite, of which Samrec was one of only a few producers worldwide. Two-thirds of the current production from Shawa was being sold to Europe, with the remainder going to Asia and the Middle East. The increased production would be marketed worldwide; some of the product was being tested in North America (Industrial Minerals, 2001d).

Outlook

Besides traditional end uses, such as horticulture, including potting soils, soil amendments, and as a fertilizer carrier, vermiculite is being used increasingly in other areas. One use is as an intumescent (swelling) material used, for example, in fire-rated building products where its expansion qualities under fire prolong the products' structural integrity; another example is use in composites where its intumescent action provides an insulating thermal barrier (W.R. Grace & Co., 2001a§). Another application is in dispersions of vermiculite in water

produced by the chemical exfoliation of vermiculite for various coatings and film-forming applications (Hindman, 1994). These films improve the fire resistant properties of such industrial products as gaskets and automotive seals for catalytic converters (Roskill Information Services Ltd., 1999, p. 86).

In China, vermiculite production capacity is said to be increasing at a significant rate (not reflected in table 4); about 80% of the output is being exported. China appears to be emerging as a major supplier of vermiculite (Moeller, 2002).

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TABLE 1
SALIENT VERMICULITE STATISTICS 1/

(Thousand metric tons and thousand dollars, unless otherwise specified)

	1997	1998	1999	2000	2001
United States:					
Sold and used by producers:					
Concentrate	W	W	175 e/	150 e/	W
Exfoliated e/	155	170	175	165	140
Quantity					
Value e/	49,400	53,300	55,300	53,200	48,000
Average value e/ 2/ dollars per metric ton	$318	$313	$315	$322	$340
Exports e/	9	11	13	5	7
Imports for consumption	67	68	71	59	65
World, production 3/	301 4/	328 4/	541	512	305 e/ 4/

e/ Estimated. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to no more than three significant digits.
2/ Based on unrounded data.
3/ Excludes production by countries for which data were not available.
4/ Excludes U.S. data.

TABLE 2
ACTIVE VERMICULITE EXFOLIATION PLANTS IN THE UNITED STATES IN 2001

Company	County	State
Isolatek International	Sussex	New Jersey.
J.P. Austin Associates, Inc.	Beaver	Pennsylvania.
P.V.P. Industries	Trumbull	Ohio.
Palmetto Vermiculite Co., Inc.	Spartanburg	South Carolina.
Schundler Co., The	Middlesex	New Jersey.
Scotts Company, The	Union	Ohio.
Do.	Greenville	South Carolina.
Southwest Vermiculite Co., Inc.	Bernalillo	New Mexico.
Sun Gro Horticulture, Inc.	Jefferson	Arkansas.
Do.	La Salle	Illinois.
Thermal Ceramics Inc.	Macoupin	Do.
Thermo-O-Rock West, Inc.	Maricopa	Arizona.
Thermo-O-Rock East, Inc.	Washington	Pennsylvania.
Verlite Co.	Hillsborough	Florida.
Vermiculite Industrial Corp.	Allegheny	Pennsylvania.
Vermiculite Products, Inc.	Harris	Texas.
W.R. Grace & Co., Construction Products Division	Maricopa	Arizona.
Do.	Broward	Florida.
Do.	Greenville	South Carolina.

TABLE 3
ESTIMATED EXFOLIATED VERMICULITE SOLD AND USED IN THE UNITED STATES, BY END USE 1/

(Metric tons, unless otherwise specified)

	2000	2001
Aggregates 2/	25,000	31,000
Insulation 3/	W	W
Agricultural:		
Horticultural	33,800	20,600
Soil conditioning	31,300	32,800
Fertilizer carrier	W	W
Total	W	W
Other 4/	W	2,690
Grand total	165,000	140,000

W Withheld to avoid disclosing company proprietary data; included with "Grand total."
1/ Data rounded to no more than three significant digits; may not add to totals shown.
2/ Includes concrete, plaster, and premixes (acoustic insulation, fireproofing, and texturizing uses).
3/ Includes loose-fill, block, and other (high-temperature and packing insulation and sealants).
4/ Includes various industrial and other uses not specified.

TABLE 4
VERMICULITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1997	1998	1999	2000	2001 e/
Argentina e/	822 3/	903 r/	2,800	2,800	2,800
Australia e/	5,000	10,000	12,000	12,000	12,000
Brazil 4/	23,000	24,300	23,400 e/	23,400 r/ e/	23,400
China	NA	NA	40,000 e/	40,000 e/	40,000
Egypt	447	12,376	12,000 e/	12,000 e/	12,000
India	4,405	4,080	4,000 e/	4,200 e/	4,300
Japan e/	15,000	15,000	15,000	15,000	15,000
Kenya	1,418	353	164 5/	124 r/ 5/	125
Mexico	295	--	-- r/	-- r/	--
Russia e/	25,000	25,000	25,000	25,000	25,000
South Africa	211,001	221,300	217,800	208,835	156,632 3/
Uganda	--	--	--	--	2,000
United States, sold and used by producers 4/	W	W	175,000 e/	150,000 e/	W
Zimbabwe	14,841	14,804	13,898	18,935	11,632 3/
Total	301,000	328,000	541,000	512,000	305,000

e/ Estimated. r/ Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.
1/ World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes production by countries for which data are not available and for which general information is inadequate for formulation of reliable estimates. Table includes data available through July 22, 2002.
3/ Reported figure.
4/ Concentrate.
5/ Reported exports.