VERMICULITE

By Michael J. Potter

Domestic survey data and tables were prepared by Nicholas Muniz, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

Vermiculite is a hydrated magnesium-aluminum-iron silicate, with a suggested formula of $(Mg,Fe^{+2},Al)_3(Al,Si)_4O_{10}(OH)_2 \cdot 4H_2O$ (Fleisher and Mandarino, 1991, p. 211). 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 900º 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 upon expansion 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 canvasses—one for mine-mill (concentrator) operations and the other for exfoliation plants. Data were not available for the three mine-mill operations. 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. Output of exfoliated vermiculite sold or used in 2002 was an estimated 115,000 metric tons (t) (table 1). Domestic production of exfoliated vermiculite sold or used was by 14 companies operating 18 plants in 10 States (table 2). Of the 18 exfoliation plants, 9 responded, representing 44% of the estimated sold or used exfoliated vermiculite listed in tables 1 and 3. Data for the remaining operations were estimated from previous years' production levels and estimates. States that produced exfoliated vermiculite, in descending order of estimated output sold or used, were South Carolina, New Jersey, Ohio, Arizona, Pennsylvania, Florida, Arkansas, Illinois, Texas, and New Mexico.

Legislation and Government Programs

A study was undertaken by the USGS to analyze the mineralogy of vermiculite-rich samples collected from 62 U.S. vermiculite mines and deposits (Van Gosen and others, 2002§[1]). The purpose of the study was to determine if amphibole asbestos minerals similar to those found in the Libby, MT, vermiculite deposit were present in other U.S. vermiculite deposits. The results of this preliminary survey suggested that fibrous amphiboles, in more than trace amounts, may not be common in the ore zones of some types of vermiculite deposits. But initial results also suggest that vermiculite deposits that can contain fibrous amphiboles occur in geologic settings similar to the Libby vermiculite deposits—within zoned, alkalic/calcic, quartz-poor plutons, especially those plutons with characteristics of carbonatite intrusions. Additionally, vermiculite deposits found where masses of ultramafic rocks are cut by granite and (or) pegmatite can contain amphibole fibers. The results of this mineralogical survey were preliminary, and additional sampling was planned. These relations may help guide priorities for sampling, reclamation, permitting, and monitoring of active and inactive vermiculite mines.

Consumption

Vermiculite has a wide range of uses that take advantage of its various attributes of 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 lightweight aggregates as perlite. Special plasters include fire protection and acoustic products in which vermiculite is combined with a binder, such as gypsum or portland cement, and 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).

In horticulture, exfoliated vermiculite improves soil aeration and moisture retention. When vermiculite is mixed with peat or other

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

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 (containing clay) 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. Published prices for raw (unexpanded) U.S. vermiculite concentrate, bulk, ex-mill were unchanged from those of 2001—from about $143 per metric ton to $220 per ton, depending on particle size (Industrial Minerals, 2002b).

The average unit value of U.S. exfoliated vermiculite sold or used by producers was estimated to be $390 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. Total U.S. imports of vermiculite in 2002 were about 56,000 t (Port Import/Export Reporting Service, unpub. data, 2003). South Africa supplied about 67% of the tonnage, and China, about 29%.

World Review

Western Europe.—An estimated 55% of exfoliated vermiculite was used in proprietary products for the 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.—Imerys Minerals Australia Pty. Ltd. acquired Australian Vermiculite Industries Pty. Ltd. in February 2002 for about $2.5 million. The operation mines and processes vermiculite at Mud Tank, near Alice Springs in the Northern Territory. Production capacity was reported to be 12,000 metric tons per year (t/yr), capable of yielding a range of concentrates from medium to micron size (Industrial Minerals, 2002a).

Canada.—Hedman Resources Ltd. reportedly will hold worldwide distribution rights to sell vermiculite produced at Enviro Industrial Technologies' plant near North Bay, Ontario. The plant has a capacity of 15,000 t/yr of vermiculite for use as an additive, filler, absorbent, in fertilizer and soil applications, and in the friction industry (Hedman Industrial Resources, 2002§).

Perlite Canada Inc., a company specializing in the production of expanded perlite and exfoliated vermiculite, officially opened its plant in Lameque, New Brunswick. Combined with the production capacity of the company's other facility in Baie-du-Febvre, Quebec, total capacity was close to 3.5 million cubic feet per year of perlite and vermiculite (Atlantic Canada Opportunities Agency, 2002§; Perlite Canada, Inc., 2002§).

Uganda.—IBI Corp. was receiving orders for its medium-grade golden vermiculite ore. Through its wholly owned subsidiary Canmin Resources Ltd., IBI owns a 100% working interest in the Namekara vermiculite mine in southeast Uganda. Market areas targeted by IBI included Canada, Europe, the Middle East, and the United States (IBI Corp., 2002§).

Outlook

North American vermiculite consumption has shown a decrease in the past few years that may reflect concerns of asbestos presence in vermiculite from the former Libby, MT, mine (closed since 1990). In conjunction with various government agencies, The Vermiculite Association has tested currently produced and/or sold vermiculite in North America and found no risk of exposure to asbestos (Moeller, 2002). A return of public confidence in the mineral would help restore end-use markets to more normal levels.

A major market for vermiculite output in Brazil has been the domestic agricultural industry, where vermiculite is used to produce seedlings. An export market is being developed for vermiculite as an asbestos substitute. In China, although official statistics of vermiculite production are not available, two significant producing regions are Xinjuang Province in northwestern China and Hebei Province in northern China (Russell, 2002). Output in China probably will continue to increase at a significant rate in the next few years (Moeller, 2002). Vermiculite production in South Africa increased to about 210,000 t in 2002, after a significant drop in 2001. The recovery in 2002 was reportedly because of improved plant recoveries (Mineral Price Watch, 2003). Trends indicate that South Africa will continue to be the largest producing country of vermiculite. In Zimbabwe, output of 23,803 t of vermiculite in 2002 indicates a generally increasing production trend during the past few years (table 4).

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TABLE 1
SALIENT VERMICULITE STATISTICS[1]

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

		1998	1999	2000	2001	2002
United States:						
Production:[2]						
Concentrate		W	175 [e]	150 [e]	NA	NA
Exfoliated:[e]						
Quantity		170	175	165	140	115
Value[e]		53,300	55,300	53,200	48,000	44,900
Average value[e, 3]	dollars per metric ton	$313	$315	$322	$340	$390
Exports[e]		11	13	5	7	10
Imports for consumption		68	71	59	65	56
World, production[4]		328 [5]	541	513 [r]	300 [r, 5]	376 [e, 5]

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Sold or used by producers.
[3]Based on unrounded data.
[4]Excludes production by countries for which data were not available.
[5]Excludes U.S. data.

TABLE 2
ACTIVE VERMICULITE EXFOLIATION PLANTS IN THE UNITED STATES IN 2002

Company	County	State
Isolatek International	Sussex	New Jersey.
J.P. Austin Associates, Inc.	Beaver	Pennsylvania.
Palmetto Vermiculite Co., Inc.	Spartanburg	South Carolina.
P.V.P. Industries	Trumbull	Ohio.
Scotts Company, The	Greenville	South Carolina.
Southwest Vermiculite Co., Inc.	Bernalillo	New Mexico.
Sun Gro Horticulture, Inc.	Jefferson	Arkansas.
Do.	La Salle	Illinois.
Schundler Co., The	Middlesex	New Jersey.
Thermal Ceramics Inc.	Macoupin	South Carolina.
Thermo-O-Rock East, Inc.	Washington	Pennsylvania.
Thermo-O-Rock West, Inc.	Maricopa	Arizona.
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 OR USED IN THE UNITED STATES, BY END USE[1]

(Metric tons, unless otherwise specified)

	2001	2002
Aggregates[2]	31,000	30,900
Insulation[3]	W	W
Agricultural:		
Horticultural	20,600	17,400
Soil conditioning	32,800	28,500
Fertilizer carrier	W	W
Total	W	W
Other[4]	2,690	W
Grand total	140,000	115,000

W Withheld to avoid disclosing company proprietary data; included in "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	1998	1999	2000	2001	2002[e]
Argentina[e]	903	2,800	2,800	1,450 [r]	1,232 [p]
Australia[e]	10,000	12,000	12,000	12,000	12,000
Brazil, concentrate	24,300	23,400 [e]	24,074 [r]	21,464 [r]	21,500
China[e]	NA	40,000	40,000	40,000	50,000
Egypt[e]	12,376 [3]	12,000	12,000	12,000	12,000
India[e]	4,080 [3]	4,000	4,200	4,300	4,300
Japan[e]	15,000	15,000	15,000	15,000	15,000
Kenya	353	164 [4]	124 [4]	-- [r]	--
Malawi	--	--	--	1	100
Russia[e]	25,000	25,000	25,000	25,000	25,000
South Africa	221,300	217,800	208,835	156,632	210,297 [3]
Uganda	--	--	--	100 [r]	1,000 [3]
United States, concentrate, sold and used by producers	W	175,000 [e]	150,000 [e]	NA	NA
Zimbabwe	14,804	13,898	18,935	11,632	23,803 [3]
Total	328,000	541,000	513,000 [r]	300,000 [r]	376,000

[e]Estimated. [p]Preliminary. [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, 2003.

[3]Reported figure.

[4]Reported exports.