Vermiculite

By Oliver S. North [1] and Nan C. Jensen [2]

THE RECORD of industry activity presented in this chapter is more complete than was previously possible, because, for the first time, the Bureau of Mines has conducted a statistical survey of exfoliated-vermiculite production. In 1954 the output of screened and cleaned vermiculite was maintained at a high level—only 6 percent below the record established in 1951.

The start of full-scale operation of a new mill in Montana and the beginning of construction of another new plant in South Carolina, both designed to beneficiate low-grade ores, greatly improved the domestic vermiculite reserves situation.

DOMESTIC PRODUCTION

Crude Vermiculite.—Seven firms and individuals operating 8 vermiculite properties in 5 States reported output of crude vermiculite in 1954. Of these, 3 produced crude vermiculite only for sale, 3 only for use in their own experimental mills or exfoliating plants, and 1 both for its own furnaces and for sale to other exfoliators. The bulk of the crude vermiculite was produced by the Zonolite Co. from its properties near Libby, Mont., and Lanford, S. C. The second largest producer was American Vermiculite Co. from a mine near Woodruff, S. C. Other producers were Alabama Vermiculite Co. from a mine near Lanford, S. C.; Phillip S. Hoyt from a mine near Aguila, Ariz. (for milling research only); Variegate Vermiculite Mines from a mine near Green Mountain, N. C.; National Vermiculite Co., Inc., from a mine near Lanford, S. C.; and R. C. Quaintance from a mine near Iola, Colo.

Table 1 shows output of crude vermiculite in 1945–54.

TABLE 1.—Screened and cleaned vermiculite sold or used by producers in the United States, 1945–49 (average) and 1950–54

Year	Short tons	Value	Year	Short tons	Value
1945–49 (average)	118,007	$1,185,655	1952	208,906	$2,657,826
1950	208,096	2,122,427	1953	189,535	2,445,381
1951	209,008	2,679,148	1954	195,538	2,537,577

Exfoliated Vermiculite.—In 1954, for the first time, the Bureau of Mines canvassed the output of vermiculite exfoliating plants. Production was reported by 27 companies operating 50 plants in 32 States and Hawaii. Of these 50 plants, 3 each were in Florida,

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Illinois, New Jersey, North Carolina, and Texas. According to reports from producers, 144,994 short tons of exfoliated vermiculite was produced in 1954, and 144,964 short tons, valued at $10,807,023, was sold or used.

In the light of the new canvass, it now appears that production estimates of exfoliated material made in previous years have been somewhat higher than was actually attained.

Mine and Plant Developments.—Zonolite Co. began constructing a new mill just south of Enoree, S. C. When completed the plant will concentrate and size vermiculite mined from open pits in the immediate vicinity. This mill, which is designed to treat low-grade vermiculite ores, will be near the company's present sources of raw ore in this area, and will supplement or replace the older mill at Travelers Rest, S. C. The company estimated that the new mill will cost $313,000.

Zonolite Co.'s new concentrating plant near Libby, Mont., went into operation. Technological changes have made it possible for this facility to utilize the large tonnage of low-grade ore available in the Libby deposit.

It was reported that sizable deposits of vermiculite in Carriso Gorge, near Jacumba, San Diego County, Calif., were leased by the Chemical Plant Food Corp. That company disclosed plans to mine and mill the material for sale to exfoliators in the Southwestern States.[3]

Mikolite Products, Inc., Rawlins, Wyo., was incorporated during the year for the purpose of mining vermiculite and other minerals.

Western Mining Corp., Boise, Idaho, purchased vermiculite claims near Bozeman, Mont., and announced plans to process and expand vermiculite from those properties and crude perlite from Owyhee County, Idaho, in a plant to be built at Nampa, Idaho.

Early in 1954 Zonolite Co. acquired an exfoliating plant at North Billerica, Mass., and replaced its Sharpsburg, Pa., exfoliating plant with new facilities at Ellwood City, Pa. In June the same firm took over operation of plants in St. Louis and Kansas City, Mo., and the Kenilworth, Md., plant of Vermiculite Products Corp. was acquired by Carolina Vermiculite Co., High Point, N. C., a subsidiary of Zonolite Co.

CONSUMPTION AND USES

Crude Vermiculite.—Nearly all of the crude vermiculite used in the United States was exfoliated by heat before it was utilized. Relatively small quantities were used in unexfoliated form for special fire-retardant structural purposes, as a filler in certain paints and plastics, and for metallurgical purposes. Other limited quantities were treated with acids to produce a pure silica or silica-alumina material that was used as a catalyst in preparing organic compounds, and in the chemical industry to absorb water vapor.

Exfoliated Vermiculite.—No official figures on the use pattern of exfoliated vermiculite were available. Zonolite Co. listed the uses of the mineral under three major headings as follows:

[3] Mining and Industrial News, Jacumba Vermiculite Mine to be Opened: Vol. 22, No. 6, June 1954, p. 6.

Construction industries: Fireproofing gypsum plaster; fireproofing portland cement; loose fill insulation; concrete insulation; sound conditioning; roof decks and floors; underground pipe insulation; cold storage insulation; preformed concrete roof tiles; refractory Lumnite cement; and insulating bricks.

Agricultural industries: Fertilizer conditioners; hatchery litter; carriers of insecticides, herbicides, fungicides, and fumigants; soil conditioners; cutting beds; and propagation of seed.

General: Packaging; transportation of hot ingots; insulation of liquid air storage vessels; insulation of household appliances; and high temperature insulating cements.

Other applications of exfoliated vermiculite frequently came to light. Additional information on such uses will be found in the Technology section of this chapter.

PRICES

The mill value of screened and cleaned crude vermiculite sold or used by producers averaged $12.98 per short ton in 1954, compared with $12.90 in 1953. The average value of the Montana-mined vermiculite in 1954 was $13.02 per short ton, while the average of the crude mined in South Carolina was $13.05 per short ton.

The average value of exfoliated vermiculite in bags at the plant was $74.55 per short ton in 1954. Comparable data for earlier years are not available.

FOREIGN TRADE

As in the previous several years, nearly all imports of crude vermiculite during 1954 came from the Palabora district, Transvaal, Union of South Africa, and were used by exfoliating plants on the eastern seaboard of the United States. According to reports published by the Union of South Africa Mines Department, exports of crude vermiculite, values f. o. b. port of shipment, from South Africa to the United States since 1950 are shown in table 2.

TABLE 2.—Crude vermiculite exported from South Africa to the United States, 1950–54

Year	Short tons	Value	
		Total	Average per ton
1950	16,531	US $256,152	US $15.50
1951	9,920	142,184	14.33
1952	7,998	113,084	14.14
1953	6,930	101,646	14.67
1954	7,553	117,426	15.55

Crude vermiculite is imported into the United States duty free under paragraph 1719 of the Tariff Act of 1930 as material not specifically provided for.

Vermiculite is not produced commercially in Canada, as that country's requirements are supplied by imports from the United States and the Union of South Africa. According to the Canadian Department of Mines and Technical Services, the value of crude-vermiculite imports since 1951, in Canadian dollars, was as follows:

Country of origin	1951	1952	1953	1954
Union of South Africa	Can $35,472	Can $45,700	Can $34,337	Can $73,117
United States	269,867	274,638	294,680	275,041
Total	305,339	320,338	329,017	348,158

Through 1951 the Canadian dollar was worth, on the average, 95 cents in American money. During 1952–54 the Canadian dollar was worth about $1.02 in American money.

From the above figures it was estimated that the Canadian production of exfoliated vermiculite in 1954 was approximately 25,000 short tons.

TECHNOLOGY

Patents.—The use of small percentages of exfoliated vermiculite to prevent caking of bulk and bagged fertilizers was patented. Numerous materials, most of which are objectionable in one way or another, have been used for this purpose. It was claimed that the addition of exfoliated vermiculite, a material free of fire hazard and relatively inexpensive to use, makes fertilizer free-flowing and improves its nutrient character by adding acid-soluble magnesium to the composition. Magnesium is an essential component of chlorophyll.[4]

A method for manufacturing heat-insulating molded panels from any of several lightweight minerals, including exfoliated vermiculite, was patented. The lightweight of the product is maintained principally by foaming the mixture; the dry, absorbent aggregates are added mainly to take up the excess moisture therein.[5]

Another patent described the conversion of several siliceous materials, including exfoliated vermiculite, to more chemically reactive forms having properties that make them suitable for manufacturing lightweight heat-insulating materials having good strength. This object is accomplished by reacting the silica-containing material with an alkaline-earth silicate-producing compound, such as lime, and acidifying the resulting composition.[6]

A method of using exfoliated vermiculite in a preplastered gypsum wallboard was set forth in a patent. Conventional plasterboard is coated at the factory with a regular base-coat gypsum-vermiculite plaster, which in turn is sprayed with a sodium silicate solution and sprinkled with a mixture of Keene's cement and hydrated finishing lime. The latter coating constitutes a water-setting, unset layer. After the board is in place on the job, the unset layer is wetted and worked with a brush or trowel like job-placed plaster, subsequently setting in the same way as standard gypsum wall plaster. The principal reason for using vermiculite is to make a thick, and consequently rather heavy, unit as light as possible for handling convenience. It was claimed that this plasterboard and method of application will be of particular value to amateur plasterers and builders.[7]

[4] Dresser, H. A. (assigned to Zonolite Co., Chicago, Ill.), Fertilizer Conditioner: U. S. Patent 2,669,510, Feb. 16, 1954.
[5] Willson, C. D., Making Molded Panels: U. S. Patent 2,674,775, Apr. 13, 1954.
[6] Shea, F. L., Jr., and Hsu, H. L. (assigned to Great Lakes Carbon Corp., Morton Grove, Ill.), Siliceous Composition and Method for Manufacturing the Same: U. S. Patent 2,698,256, Dec. 28, 1954.
[7] Cleary, D. E., Plasterboard: U. S. Patent 2,687,359, Aug. 24, 1954.

A patent disclosed the use of various types of mica flakes, including unexfoliated vermiculite, to hasten the maturity and improve the yield and size uniformity of fruits or berries borne on trees, bushes, or leguminous plants. This object is accomplished by covering the ground surface throughout the orchard, berry patch, or garden with a layer of sunlight-reflecting mica particles.[8]

Geology and Occurrences.—The geology and geochemistry of the Day Book dunite deposit near Burnsville, Yancey County, N. C., were discussed in a technical article. This deposit is a well-exposed ultramafic body intruded by pegmatites. Veins of vermiculite formed by the weathering of phlogopite in a magnesium-rich environment occur irregularly along the pegmatite intrusion on the north side of the deposit and at the intersections of major fracture systems. The considerable amount of development work done for vermiculite on this property has indicated that reserves of the mineral are limited to the depth of the zone of weathering, below which the vermiculite grades into unaltered phlogopite.[9]

The origin of vermiculite deposits lying within a 1-mile-square area in the Gold Butte mining district, Nev., was investigated. It was concluded that all vermiculites present are varieties of hydrobiotite and resulted from vermiculitization of biotite by hydrothermal and meteoric solutions. The mineral is distributed widely in the ultramafic rocks in veins, stringers, and pockets and as scattered flakes.[10]

Investigations of Physical and Chemical Properties.—A study was made of cation exchange in such micaceous minerals as vermiculite, biotite, and montmorillonite in soils. It was concluded that the replaceability of interlayer ammonium and potassium is strongly affected by the magnitude of the interlayer crystal lattice charge, particle size, presence of difficulty replaceable hydrogen, nature of the replacing cation, and the nature of the potassium.[11]

The effect of heat on both natural and barium-exchanged vermiculites was examined. Results of the investigation were published in an article in the technical press.[12]

An investigation of the molecular structure of vermiculites indicated that the vermiculite minerals can be classed as montmorillonoids.[13]

An X-ray investigation of the structure of vermiculites was made in Sweden, and the results were published in bulletin form in English. Structure determinations made previously by Hendricks and Jefferson and reported in the American Mineralogist were in the main confirmed by this investigation. However, at some points modifications of lat-

[8] Cohen, H. (one-half assigned to Imperial Talc Co., Inc., Hoboken, N. J.), Method of Improving Plant Yields: U. S. Patent 2,669,804, Feb. 23, 1954.

[9] Kulp, J. L., and Brobst, D. A., Notes on the Dunite and the Geochemistry of Vermiculite at the Day Book Dunite Deposit, Yancey County, N. C.: Economic Geol., vol. 49, No. 2, March–April 1954, pp. 211–220.

[10] Leighton, F. B., Origin of Vermiculite Deposits, Southern Virgin Mountains, Nevada (abs.): Econ. Geol., vol. 49, No. 7, November 1954, p. 809.

[11] Barshad, I., Cation Exchange in Micaceous Minerals. I. Replaceability of the Interlayer Cations of Vermiculite with Ammonium and Potassium Ions: Soil Science, vol. 77, No. 6, June 1954, pp. 463–472; II. Replaceability of Ammonium and Potassium from Vermiculite, Biotite, and Montmorillonite: Vol. 78, No. 1, July 1954, pp. 57–76.

[12] Gregg, S. J., and Packer, R. K., The Production of Active Solids by Thermal Decomposition. Part IV. Vermiculite: Jour. Chem. Soc. (London), November 1954, pp. 3887–3893.

[13] Chemical and Engineering News, Should Vermiculites Be Classed as Montmorillonoids?: Vol. 32, No. 49, Dec. 6, 1954, p. 4842.

tice symmetry and developments of structural details were introduced.[14]

The crystal structure of a magnesium-vermiculite from Kenya was investigated by single-crystal X-ray methods.[15] Magnesium-vermiculite is formed by hydrothermal alteration of biotite and phlogopite.

Utilization.—Articles published in agricultural periodicals described the results of using exfoliated vermiculite for rooting flower cuttings,[16] preparing seed beds for iris,[17] mulching vegetable seedrows,[18] and as a carrier for liquid fumigants[19] and potato-scab inoculation solutions.[20]

The many uses of exfoliated vermiculite in the construction industries were listed and its advantages for each type of application discussed in an article.[21] The list included its utilization in: Hardwall, fireproofing, and finish plasters; acoustical plastic; poured concrete and concrete units of many types; loose-fill insulation; and asphalt roof fill. Other articles described its use in exterior portland-cement plasters,[22] gypsum plasters,[23] and acoustical plastics.[24]

An article discussed methods of preparing a good lightweight plaster for gun application. A rich mix (one containing a maximum quantity of gypsum) was recommended, except when the plaster is to be applied against a high-suction background.[25]

A building material made with exfoliated vermiculite, slag, oil, and water has been developed for exterior residence walls and office and factory partitions. The material is formed into 8 by 16-foot panels in various thicknesses.[26]

A 2-inch-thick slab of vermiculite insulating concrete poured on 1-inch-thick rigid insulation board was used as part of the roof deck of a large factory. The deck weighed only 7.7 lb. per sq. ft., had a "U" value of 0.15, and was economical compared with other roofing systems.[27]

A concrete-block firm began manufacturing an 8-inch hollow-core modular unit of vermiculite insulating concrete. Using a mix of 1 part portland cement to 5 parts vermiculite stabilized concrete aggregate, by volume, the company obtained a 15-pound block with a "K" factor of 0.69 and a "U" factor of 0.13. This unit is especially

[14] Grudemo, A., An X-Ray Examination of the Structure of Vermiculites: Swedish Cement and Concrete Research Inst., Royal Inst. Technol., Stockholm, Proc. NR 22, 1954, 56 pp. (in English).
[15] Mathieson, A. McL., and Walker, G. F., Crystal Structure of Magnesium-Vermiculite: Am. Mineral., vol. 39, Nos. 3–4, March–April 1954, pp. 231–255.
[16] Mullard, S. R., Rooting Cuttings in Vermiculite (Acid Grades): Jour. Royal Horticultural Soc. (London), vol. 79, pt. 8, August 1954, pp. 367–368.
[17] Douglas, G., New Tools for Old: Bull. Am. Iris Soc., No. 132, January 1954, pp. 58–60.
[18] Market Growers Journal, Field-Seeded Vegetables Respond to Vermiculite Mulch: Vol. 83, No. 9, September 1954, pp. 26, 31.
[19] Sasser, J. N., and Nusbaum, C. J., The Use of Vermiculite as a Carrier for Volatile, Liquid Fumigants to Control Nematodes: Plant Disease Reporter, vol. 38, No. 2, Feb. 15, 1954, pp. 65–67.
[20] Houghland, G. V. C., and Cash, L. C., The Use of Vermiculite in Providing Scab Inoculation for Potatoes: Plant Disease Reporter, vol. 38, No. 7, July 15, 1954, pp. 460–461.
[21] Construction Methods and Equipment, Expanded Vermiculite Has a Lot to Offer: Vol. 36, No. 10, October 1954, pp. 74, 76, 78, 82, 84, 88, 90.
[22] Plastering Industries, Must "Roll With the Punch" for Best Portland Cement (Stucco): Vol. 33, No. 1, February 1954, pp. 10–11.
[23] Plastering Industries, Lightweight Plaster Celebrates 21st Anniversary This Year: Vol. 34, No. 5, December 1954, pp. 43–44.
[24] Plastering Industries, Vermiculite Plastic Direct Gets 4-hour Fire Rating: Vol. 34, No. 2, September 1954, pp. 46–47.
[25] Hobson, L. H., You May Be Spending More to Give Weaker Plaster: Plastering Ind., vol. 34, No. 1. August 1954, pp. 13–14.
[26] Rock Products, Vermiculite Wall Panels: Vol. 57, No. 3, March 1954, p. 65.
[27] Civil Engineering, Roof of Vermiculite Concrete Poured on Insulation Board: Vol. 24, No. 6, June 1954, pp. 67–68.

suited for metal-faced spandrel wall construction in multiple-story buildings.[28]

Many uses for vermiculite in the chemicals field were discussed in an article.[29] These uses included: Carrier for chemicals, such as iron chelates, phenyl mercuric acetate, and chlordane; conditioner in fertilizer; resilient packing material; filler in plastics, liquid sulfur mortar, and etching powder; lubricants; and insulation of process equipment. When iron chelates are used as a spray (for example on citrus trees), the leaves and fruit may be burned. Vermiculite is used to absorb and hold the solution for gradual release of the metal to the trees.[30]

RESERVES

Montana's reserves of vermiculite are extensive, especially since recent mill improvements have made usable large quantities of low-grade ore. Near Enoree, S. C., Zonolite Co. has outlined ore bodies large enough to justify erection of a modern mill. Medium-size deposits, several of which have been mined commercially in the past, are known in Colorado, Georgia, North Carolina, Pennsylvania, Texas, and Wyoming, and the mineral has been identified in many other States. Exact data are not available on the overall tonnage of reserves, but they are considered adequate to take care of domestic and export requirements for many years.

WORLD REVIEW

NORTH AMERICA

Canada.—Siscoe Vermiculite Mines, subsidiary of Siscoe Gold Mines, began operating an exfoliating plant in Etobicoke Township west of Toronto. The firm also exfoliated vermiculite at a plant in Cornwall, Ontario. Crude ore from South Africa was used at both locations. The company reportedly was continuing exploration for a domestic source of crude vermiculite. At its property at Stanleyville, near Perth, Ontario, the vermiculite is of good quality but too disseminated in the host rock to be economic.[31]

SOUTH AMERICA

Brazil.—The Government of Brazil granted a license to prospect for vermiculite in the municipality of Uba, Minas Gerais. This action was interpreted to indicate a discovery of mineral in that area.

[28] Pit and Quarry, Minnesota Firm Markets Vermiculite Units for Metal-Faced Spandrel Walls: Vol. 46, No. 8, February 1954, pp. 162–164.
[29] Chemical Engineering, Chemical Processors Put Vermiculite to Work: Vol. 61, No. 11, November 1954, pp. 136, 138, 140.
[30] Farm Chemicals, Vermiculite-Carried Chelates: Vol. 117, No. 7, July 1954, p. 36.
[31] Northern Miner (Toronto), Toronto Plant for Siscoe: Vol. 61, No. 27, Sept. 23, 1954, pp. 17, 24.

TABLE 3.—World production of vermiculite, by countries,[1] 1945–49 (average) and 1950–54, in short tons

(Compiled by Helen L. Hunt)

Country[1]	1945–49 (average)	1950	1951	1952	1953	1954
Australia	148	134	62	69	32	(2)
Egypt			702	66	[3] 100	
India		58	260	24		(2)
Japan						882
Kenya	3	4	3		82	403
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[4] 539	784	553			
Tanganyika	[5] 14					
Union of South Africa	12,250	46,763	27,014	39,918	33,844	45,633
United States (sold or used by producers)	118,007	208,096	209,008	208,906	189,535	195,538
Total[1]	130,961	255,839	237,602	248,983	[3] 223,600	[3] 242,500

[1] In addition to countries listed, vermiculite is produced in Brazil and U. S. S. R., but data are not available, and no estimates are included in the total.
[2] Data not available; estimate by senior author of chapter included in total.
[3] Estimate.
[4] Average for 1948–49.
[5] Average for 1946–49.

EUROPE

Finland.—Potentially commercial deposits of vermiculite were reported to have been found near Posio, northern Finland. The vermiculite was said to be stratified with amblygonite and to occur in an area 1 or more miles long and 500 to 1,000 feet wide.[32]

United Kingdom.—A new trade association, called the Association of Vermiculite Exfoliators, was formed by several British companies. Most British exfoliators used crude ore from Union of South Africa.

ASIA

India.—Vermiculite occurs in bands up to 3 or 4 feet thick in a series of highly folded peridotites and schists intruded by quartz veins and pegmatites, in the Ajmer-Merwara area, Kishengarh State, India.[33] It also is found in a number of localities in Mysore State.

AFRICA

Egypt.—Vermiculite and anthophyllite occur in close association with serpentine lenses and feldspar dikes in Wadi Hafafit, in the Central Eastern Desert. The vermiculite is strictly confined to the walls of feldspar dikes within serpentine masses; vermiculite does not occur where the dikes extend into granitic gneiss. These deposits have been worked for some time on a small scale for feldspar and vermiculite.[34]

Southern Rhodesia.—Exports of vermiculite from Southern Rhodesia in 1953 totaled 163 short tons. Of that quantity, 159 tons went to Northern Rhodesia and 4 tons to Mozambique. Vermiculite occurs in the vicinity of apatite-mineralized carbonate "pipes" in

[32] Chemical Trade Journal and Chemical Engineer (London), Finnish Vermiculite Discovery: Vol. 134, No. 3476, Jan. 15, 1954, p. 165.
[33] Roy, B. C., Vermiculite Deposits in Ajmer-Merwara (India): Indian Minerals (Calcutta), vol. 7, No. 3, July 1953, (Pub. 1954), pp. 117-124 (in English).
[34] Amin, M. S., and Afia, M. S., Anthophyllite-Vermiculite Deposit of Hafafit, Eastern Desert, Egypt: Econ. Geol., vol. 49, No. 3, May 1954, pp. 317-327.

an area 70 miles southeast of Umtali, near the Mozambique border.[35]

Uganda.—Extensive deposits of vermiculite of varying quality were reported to occur in the low hills surrounding Bukusu Hill, a volcanic center in the Eastern Province, near the Kenya border, about 15 miles from Mbale and 7 miles from Magodes, a station on the Tororo-Soroti railway line. The mineral usually underlies a gravel or rubble containing magnetite and knopite (a gray calcium-cerium-titanium silicate). Pits dug to prospect for titanium mineralization showed that the magnetite-knopite cover grades into vermiculite at a depth of 8 to 20 feet, below which vermiculite predominates. A small quantity of vermiculite from one of these deposits has been used commercially. It was estimated that one of the hills in this area contains at least 9 million cubic yards of vermiculite-bearing material of workable quality.[36]

Union of South Africa.—Production of vermiculite totaled 45,600 short tons in 1954 compared with 33,800 short tons in 1953. Local sales totaled 3,100 short tons valued at $52,500 (ave., $17.02) f. o. r. in 1954, compared with 3,300 short tons valued at $51,300 (ave., $15.76) f. o. r. in 1953. Exports totaled 40,900 short tons valued at $704,800 f. o. b. in 1954, compared with 34,300 short tons valued at $561,700 f. o. b. in 1953. Details of the 1953–54 exports from Union of South Africa appear in table 4.

TABLE 4.—Exports of crude vermiculite from Union of South Africa, 1953–54 [1]

Country of destination	1953			1954		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
United Kingdom	9,901	$161,913	$16.35	8,363	$151,155	$18.07
United States	6,930	101,646	14.67	7,553	117,426	15.55
France	3,158	57,434	18.19	5,209	97,443	18.71
Canada	2,821	40,827	14.47	5,160	79,811	15.47
Italy	3,655	61,818	16.91	5,036	88,455	17.56
Germany	1,392	24,626	17.69	2,668	46,953	17.60
Denmark	2,453	40,967	16.70	2,491	45,021	18.07
Netherlands	1,499	27,628	18.43	1,163	19,659	16.90
Sweden	284	5,121	18.03	1,097	19,541	17.81
Australia	505	9,033	17.89	578	10,158	17.57
Belgium	274	4,880	17.81	391	6,812	17.42
Japan	293	5,127	17.50	186	3,186	17.13
New Zealand	54	801	14.83	170	3,217	18.92
Venezuela				130	2,248	17.29
Rhodesia	251	4,091	16.30	116	2,167	18.68
Switzerland				116	2,075	17.89
Morocco	160	3,290	20.56	114	2,355	20.66
Lebanon	60	966	16.10	101	1,823	18.05
Egypt				70	1,263	18.04
Malaya	29	557	19.21	56	1,092	19.50
French West Africa	91	1,952	21.45	54	1,204	22.30
Arabia	55	1,005	18.27	52	874	16.81
Chile				48	890	18.54
Norway	214	3,738	17.47			
Uruguay	120	2,044	17.03			
Ireland	100	1,770	17.70			
Persian Gulf	25	454	18.16			
Total	34,324	561,688	16.36	40,922	704,828	17.22

[1] Source: Union of South Africa Mines Department Quarterly Reports.
[2] Converted to U. S. currency at the rate of SA£ 1=US$2.80.

[35] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 2, August 1954, p. 64.
[36] Taylor, R., The Magnetite-Vermiculite Occurrences of Bukusu, Mbale District (Uganda): Geol. Survey Uganda Records (Entebbe), 1953 (pub. 1955), pp. 59–64.

The Transvaal Ore Co., operating in the Palabora district, produced virtually all of the South African vermiculite output. The company planned early renovation of machinery and reorganization of its mining methods.[37]

OCEANIA

Australia.—Vermiculitized biotite occurs in schists and gneisses 10 miles south of Home Hill, Queensland. Lenses and veins containing vermiculite, biotite, quartz, and feldspar are numerous and large, but the limited prospecting had not uncovered by early 1954 any section of clean vermiculite large enough to warrant commercial development. However, the examining engineer recommended further sampling, mapping, and testing in this area.[38]

[37] Mining Journal (London), Vermiculite Production: Vol. 242, No. 6195, May 14, 1954, p. 577.
[38] Carruthers, D. S., Vermiculite and Asbestos Occurrences, Home Hill District (Queensland, Australia): Queensland Govt. Min. Jour. (Brisbane), vol. 55, No. 627, Jan. 20, 1954, pp. 64–65.