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Office: Mission, Kansas
Date: November 26, 1975

SUBJECT

Article on Asbestos

Gentlemen:

The attached article on asbestos, which appeared in the June, 1975 issue of INDUSTRIAL MINERALS, was brought to my attention by Charlie Schane of GAF Corporation.

It is a very comprehensive article, and I think you will find it interesting.

Very sincerely yours,

LHL

Lyle H. Laughlin

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Asbestos— production losses prolong the shortage

IN COMMON with many other industrial minerals (and many other commodities), asbestos experienced extremely strong demand throughout 1974, which was reflected in higher prices, shortages in certain areas, and producers operating at capacity levels. This year's recession in Western industry appears to have taken the heat out of the majority of mineral markets, however, with significant falls in both demand and prices. Not so asbestos! Demand continues to exceed supply, and after price rises averaging over 50% between the end of 1973 and the beginning of 1975, yet another rise is expected shortly—and all this even though two of asbestos' major consuming areas—the construction and the motor manufacturing industries—are operating at low levels. This paradox cannot be explained simply. The continuing short supply has in fact been brought about by a combination of factors—producer problems, ranging from a fire and landslide to strikes and other political pressures; supply problems, such as shipping difficulties and the like; and continuing strong demand, particularly from the developing countries. In addition, the whole industry from mining to manufacturing, is undergoing extensive changes as new and wider controls are introduced to counter the much-publicised health hazards associated with asbestos usage. This article sets out to pinpoint the major factors leading up to today's situation and to assess some of the possible implications for the future of the industry.

World production nears 5m. tpa

Total world production of asbestos in 1974 was nearly 5m. tons, of which Canada and the USSR each produced about a third, and the remaining third was produced by a number of countries, notably South Africa, Rhodesia, the USA, Italy, and China. A more accurate breakdown for the year 1973 is presented in the accompanying table. Two sets of figures are shown: the first set was presented at an industry/government conference held by the Asbestos Information Association/North America in September 1974, and the second is based on preliminary data available to the United States Bureau of Mines. The chief discrepancy between the two figures lies in the estimates given for Russian production, and this arises mainly because the USSR produces large tonnages of by-product asbestos used for railway ballast, etc., which is not included in the USBM estimates. In terms of the quantity of asbestos available for world markets, however, the two sets of figures can be considered to be in fairly close agreement, since discrepancies chiefly occur over estimates of material that is consumed within the countries concerned. Certainly there is no disputing Canada's role as the

World asbestos production—1973 (metric tons)

	AIA/NA	USBM
Canada	1,791,000	1,791,000
USSR	1,995,000	1,280,000
South Africa	318,000	325,000
China	90,000	210,000
Italy	118,000	150,000
United States	118,000	136,000
Rhodesia	154,000	80,000
Brazil	27,000	40,000
Swaziland	41,000	37,000
Cyprus	25,000	26,000
Japan	18,000	14,000
India	3,000	11,300
Finland	11,000	11,000
Yugoslavia	14,000	9,000
Other countries	5,000	51,000
Total	4,728,000	4,171,000

N.B.—The figures in the left hand column were presented at an Industry-Government Conference held by the Asbestos Information Association/North America in September 1974. Those in the right hand column are the preliminary United States Bureau of Mines figures. The greater share (32,000 tons) of production from 'other countries' in the USBM figures came from Australia.

principal supplier to world markets. All but a small proportion of the country's output is exported, and figures for exports in the past few years have thus risen to the 1.6m./1.8m. ton level. After Canada the most important asbestos exporters are the USSR (about 450,000 tpa), South Africa (over 300,000 tpa), and the USA, Italy, and West Germany (each about 60,000 tpa). It is therefore evident that any review of world asbestos developments must begin with Canada.

Canada—landslides, fires, and strikes

Unfortunately, the most significant events of recent months are all of a depressing nature. The country's two largest producers have both received setbacks to production, one through a landslide in its open pit and the other through a fire which destroyed its main mill. At the present time further production is being lost as the result of a strike by miners in the principal producing region of Quebec. The landslide occurred in January this year, when 1m. tons of overburden moved, covering the southern section of the Jeffrey open-pit mine in Quebec. This mine, which is operated by Canadian Johns-Manville Co. Ltd. (a subsidiary of Johns-Manville Corp. of the USA), is the largest asbestos mine in the western world and extracts approximately 35m. tons of rock per annum to yield about 700,000 short tons of fibre. As a result of the landslide, output of fibre has been reduced by about 20% and normal production is not likely to be restored until October or November this year.

A month earlier, in December 1974, at the nearby

Thetford Mines in Quebec, the King-Beaver mill of Canada's second largest producer, *Asbestos Corp.*, was destroyed by fire. Although the company has tried to compensate by treating King-Beaver ore in its other mills (the British-Canadian and Normandie mills), an estimated 27% of output will be lost this year. A decision about a possible new mill is now being delayed by the strike. This strike is now over 10 weeks old and concerns the mines in the Thetford Mines area operated by *Asbestos Corp.*, *Lake Asbestos*, *Carey-Canadian*

Canadian asbestos exports (short tons)		1971	1972	1973	1974
Milled fibres [Gp. 3]					
United States ..	..	13 428	13 756	14,981	12,705
United Kingdom ..	..	6,001	5,239	6,243	5,333
Total ..	..	30,401	29,190	32,373	34,555
Milled fibres [Gps. 4 & 5]					
United States ..	..	194,526	197,344	208,501	205,172
Mexico ..	..	21,586	20,759	26,302	26,161
Brazil ..	..	12,180	9,443	7,096	15,806
Colombia ..	..	10,737	12,835	12,839	18,241
West Germany ..	..	53,770	67,520	103,726	105,362
United Kingdom ..	..	55,507	54,562	69,140	56,214
France ..	..	50,200	41,537	57,392	44,819
Belgium-Luxembourg ..	..	27,555	24,393	35,496	29,660
Netherlands ..	..	15,000	13,163	19,798	13,531
Spain ..	..	23,796	27,604	40,136	34,171
Italy ..	..	12,418	13,641	21,363	22,431
Austria ..	..	13,534	12,021	13,622	7,530
Denmark ..	..	10,023	5,490	9,204	6,450
Rumania ..	..	9,654	13,324	17,276	6,044
Japan ..	..	33,470	35,010	51,386	48,724
India ..	..	15,567	23,454	19,858	14,244
Malaysia ..	..	8,770	6,836	10,079	9,623
South Korea ..	..	12,266	13,583	5,729	5,989
Australia ..	..	41,345	43,209	35,741	37,726
Total ..	..	739,734	738,526	889,921	839,799
Shorts [Gps. 6-9]					
United States ..	..	455,479	503,552	548,412	517,273
Mexico ..	..	3,685	4,704	3,670	5,085
Argentina ..	..	8,565	8,844	6,626	6,755
Brazil ..	..	3,875	3,886	5,955	13,448
West Germany ..	..	31,692	28,639	37,164	33,277
United Kingdom ..	..	45,457	39,180	52,168	50,926
France ..	..	22,673	25,735	29,972	24,695
Belgium-Luxembourg ..	..	16,627	16,727	20,751	15,943
Netherlands ..	..	11,751	15,436	26,146	36,222
Spain ..	..	10,806	11,872	11,981	13,035
Denmark ..	..	7,155	3,478	5,994	5,232
Japan ..	..	73,853	75,138	105,366	92,916
South Korea ..	..	21,645	27,522	5,705	10,250
Australia ..	..	20,889	10,530	17,770	12,713
Total ..	..	785,313	830,885	932,458	898,454

United States asbestos exports (short tons)		1971	1972	1973	1974
[i] Milled fibres					
Mexico ..	..	2,954	2,151	8,040	
Canada ..	..	927	708	979	
India ..	..	5,476	4,177	—	
South Korea ..	..	1,450	—	18,709	
South Vietnam ..	..	4,719	6,361	6,715	
Thailand ..	..	3,520	—	—	
Malaysia ..	..	1,600	1,200	—	
Japan ..	..	2,085	853	2,187	
Belgium ..	..	286	1,814	2,445	
Total (i) ..	..	28,087	22,081	42,791	
[ii] Shorts					n.a.
Canada ..	..	1,645	1,083	1,468	
Brazil ..	..	2,683	1,890	2,721	
Colombia ..	..	—	—	1,403	
South Korea ..	..	5,629	15,990	3,005	
Thailand ..	..	1,977	—	—	
Japan ..	..	5,403	4,639	8,094	
Belgium ..	..	—	1,137	—	
Total (ii) ..	..	24,115	29,711	23,109	
Grand Total (i) & (ii)		52,202	51,792	65,900	61,723

Mines, and *Bell Asbestos* (but not Canadian *Johns-Manville*). The dispute has to do with both pay and conditions and has been forced into the political arena by the provincial government's alleged intransigence in introducing new safety regulations (see later section on health hazards) and the federal government's siding by implication with the miners. At the time of writing, the strike was continuing but signs of a settlement were becoming more apparent. Whatever the outcome, several thousand tons of production has been lost and a further price rise of 7% or more is expected to follow.

Production from Canada's western provinces has not been trouble-free either, and *Cassiar Asbestos Corp.* has experienced a number of mining problems. Extraction at the company's main mine at Cassiar in British Columbia was slowed by the necessity to deal with an overburden problem and fibre output was consequently lower than expected in 1974. The company's second operation at Clinton Creek in the Yukon has been running close to capacity but is now scheduled for closure by the end of 1977 due to the increasing difficulty of mining. Although the actual tonnage of reserves is adequate, the extra cost of mining a steeply dipping orebody will, it seems, make it uneconomic to continue.

Canada—closures, acquisitions, and new operations

Among the more normal (or at least less spectacular) developments in recent years, the following are worthy of mention. Closures include the Thetford Mines operation of *The Flintkote Co.* during 1971 and the more recent termination of operations at *Johns-Manville's* Reeves Mine in northern Ontario in February this year. The most significant acquisition concerns the takeover by *Lake Asbestos of Quebec Ltd.* (a subsidiary of *ASARCO* of the USA) of the Thetford Mines operation formerly owned by *National Gypsum Co.* of the USA. The only new operation to go on stream in recent years was the Asbestos Hill project in northern Quebec operated by *Asbestos Corp.* The operation has a production capacity of 300,000 tpa of asbestos concentrates, which are then shipped to the company's mill at Nordenham in West Germany for final processing into fibre. This year will see initial production from the new 100,000 tpa Midlothian operation in Ontario operated by *United Asbestos Inc.* The company expects to start production in July and a possible 30,000 tpa of fibre will be produced by the year end. The most promising future venture is the *Abitibi Asbestos Mining Co.* project at Amos, Quebec, where a 160,000 tpa plant has been proposed. Commercial production is unlikely to begin before mid-1978. The company is an RTZ associate.

The USA—problems too

In 1974, closures were announced for three of the country's largest asbestos operations, and during the course of the year two operations, both in California, duly closed. These were the plant of *Pacific Asbestos Corp.* (a subsidiary of *H. K. Porter Inc.*) at Copperopolis, and that of *Coalinga Asbestos Co.* (a subsidiary of *Johns-Manville Corp.*) at Coalinga. The third operation, at Lowell in Vermont, was reprieved, however. The operation, which was formerly owned by *GAF Corp.*, has been taken over by employees at the plant and will operate under the new name of *Vermont Asbestos Group Inc.* The remaining asbestos operators in the USA are *Union Carbide Corp.* and *Atlas Asbestos Co.* in California; *Jaquays Asbestos Corp.* in Arizona; and *Powhatan Mining Co.* in North Carolina.



An aerial view of Canadian Johns-Manville's Jeffrey mine in the Eastern Townships of Quebec, Canada. The mine has been in continuous operation since 1881 and today is the largest individual operation in the Western world. At the present time output has been reduced through a slide of overburden which covered one section of the mine. When operating at full capacity, however, about 35m. tons of rock is extracted per annum, from which 700,000 short tons of fibre is produced.

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Southern Africa

South Africa's importance in world asbestos markets is mainly derived from its position as the dominant producer and almost sole exporter of amphibole asbestos. The country's production is made up of about 150,000 tpa of crocidolite, 100,000 tpa of amosite, and 70,000 tpa of chrysotile. The bulk of production is controlled by three mining groups: the UK-owned *Cape Group* (amosite and crocidolite); the South African-owned *General Mining Group* (crocidolite and chrysotile); and the Belgo-Swiss-owned *Eternit Group* (crocidolite). Among the more interesting production developments of recent years are the rationalisation of amosite production by the Cape Group, which is centralising production to its Penge plant in the Transvaal, and the completion earlier this year of the Eternit Group's new mine and mill at Klipfontein in Cape Province. On the supply side, all producers were affected to varying degrees by the political upheavals in Mozambique which disrupted shipments through Lourenço Marques. Shipments from the Havelock chrysotile operation in Swaziland, operated by a subsidiary of the UK's *Turner & Newall Group*, were also affected.

Southern Africa's other asbestos producer—Rhodesia—has supply problems of a different sort, of course. The world, or at least the sanctions-observing part of it, has been deprived of the high quality Rhodesian chrysotile for almost a decade, and its reappearance would be of major significance to world markets. However, this event will not occur until a lasting solution is found to the country's political problem. Within the country itself, the most notable development appears to have been the opening in 1972 of the King Mill at Mashaba by the Turner & Newall subsidiary, *Rhodesian & General Asbestos Corp.*

South African asbestos exports (metric tons)

	1970	1971	1972	1973
Japan	63,488	65,277	63,452	
United Kingdom ..	51,591	46,847	55,080	
Italy	25,757	21,457	17,072	
United States	22,625	23,550	17,797	
Denmark	10,908	11,309	16,004	
France	15,102	13,555	12,874	
Belgium-Luxem. ..	8,336	10,366	11,925	n.a.
Spain	11,622	8,838	10,695	
Australia	9,341	8,719	7,529	
West Germany	6,960	7,176	5,473	
Rumania	486	5,250	5,274	
Mexico	5,295	4,497	5,461	
Canada	4,085	4,560	4,732	
Total	290,375	299,775	295,846	329,880

Developments elsewhere

Details of developments in the USSR are naturally difficult to obtain, but reports suggest that expansions are in progress at a number of locations (see page 40). In

Russian asbestos exports (metric tons)

	1970	1971	1972	1973
Austria	11,200	15,900	12,200	12,400
Belgium-Luxem. ..	11,100	11,600	11,600	11,000
Bulgaria	21,200	22,800	19,700	30,600
Cuba	9,500	10,800	12,300	12,000
Czechoslovakia ..	21,000	21,100	21,200	20,700
France	53,000	35,700	43,700	45,100
East Germany	43,100	43,700	48,700	44,000
West Germany	n.a.	34,700	26,000	33,800
Hungary	13,900	16,300	16,800	18,900
India	15,900	20,200	33,500	20,800
Italy	11,600	14,500	10,100	4,900
Japan	n.a.	56,100	41,200	45,500
Poland	31,500	43,300	55,200	63,000
Rumania	n.a.	20,200	19,700	22,200
Yugoslavia	20,600	21,800	26,700	27,400
Total	385,300	433,000	432,700	448,900

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general, production developments in the rest of the world are concerned mostly with domestic consumption and have only marginal implications on the world asbestos market as a whole. Some notable exceptions to this generalisation include the Woods Reef chrysotile project in Australia, the Kozani project in northern Greece, and the asbestos processing operations in West Germany.

The Woods Reef mine, near Barraba in New South Wales, Australia, started production in February 1972 and after a period of recurring losses has operated under receiver managership since November 1973. The principal difficulty was concerned with the ore itself, which is very difficult to mill, but the profitability of the operation was further undermined by the appreciation of the Australian dollar. However, it now appears that the milling problem is on the way to being solved, and a recent drilling programme has substantially increased reserves. Furthermore, the fibre product is being well received by consumers. These are all encouraging pointers to the future viability of the operation, which is owned by *Woodsreef Mines Ltd.*, a subsidiary of *Woodsreef Minerals Ltd.* of Canada.

The Kozani asbestos project in northern Greece is currently operating at pilot plant levels, but plans are in hand to begin commercial operations at a rate of 50,000 tpa, possibly during 1976. Further plans suggest an eventual doubling of capacity to the 100,000 tpa level. The operating company is *Asbestos Mining Co. of Northern Greece (MABEM)*, in which *Cerro Corp.* of the USA holds the majority share. Although not actually mining asbestos, West Germany is now a processor and supplier of asbestos fibre through the operations of *Asbestos Corp. GmbH* at Nordenham. The company's plant has a capacity to produce 100,000 tpa of fibre using raw material shipped from the parent company's Asbestos Hill mine in northern Quebec. Perhaps one other development, or non-development, worth noting is that Cyprus continues to produce and export asbestos despite last year's troubles on the island. The operation remains in the Greek Cypriot part of the country.

Cyprus asbestos exports (metric tons)

	1971	1972	1973	1974
United Kingdom ..	6,796	8,895	8,676	7,305
Denmark	4,093	8,483	6,713	8,533
Greece	1,638	1,366	2,710	5,814
Ireland	1,360	853	2,704	2,268
Sweden	1,360	1,497	2,269	2,040
Israel	1,000	1,011	1,272	1,907
Lebanon	430	1,942	1,135	1,669
Austria	813	1,327	1,419	1,002
Egypt	998	1,529	392	182
Total	22,612	27,988	28,999	32,679

Italian asbestos exports (metric tons)

	1971	1972	1973	1974
West Germany ..	22,191	21,691	28,031	25,421
France	9,873	13,075	13,055	14,515
Spain	—	5,776	4,775	—
Total	48,793	54,537	62,915	66,784

West German asbestos exports (metric tons)

	1971	1972	1973	1974
Belgium-Luxem. ..	—	544	10,844	3,783
Spain	—	—	5,513	11,907
Austria	610	276	2,839	4,290
Netherlands ..	—	—	1,263	2,922
France	—	—	1,071	11,925
Switzerland ..	—	—	672	248
Italy	—	—	—	6,393
Poland	—	—	—	2,850
Total	1,271	1,217	23,213	57,047

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Destinations

As one would expect, the largest consumers of asbestos are the industrialised countries of North America, Europe, and Japan. The largest individual countries (and their approximate annual consumptions) are as follows: the USSR (800,000 tpa of fibre plus 700,000 tpa of asbestos rock and sand); the USA (800,000 tpa); Japan (380,000 tpa); West Germany (220,000 tpa); the UK (180,000 tpa); France (160,000 tpa); Italy (150,000 tpa); and Spain (100,000 tpa). Except for about 80,000 tpa of US-produced material and imports of about 30,000 tpa of South African amphibole, the North American market is served almost totally by Canadian material. In the same way, the USSR and Eastern Europe are served almost totally by Russian production—although Rumania buys significant tonnages from Canada and South Africa. Although Canada and South Africa are the dominant suppliers to countries in Western Europe and Japan, a number of other sources are of comparable importance to certain countries. For instance, the USSR is an important supplier to Japan, France, West Germany, and Belgium. Italy obtains the major share of its requirements from its own production and also exports substantial tonnages to West Germany, France, and Spain. Cyprus is a major supplier to the UK, Denmark, and Greece. Swaziland is also an important source of material for the UK. Australia is emerging as an important supplier to Japan and other Far Eastern countries. West German chrysotile of Canadian origin is now being used not only for internal consumption but also for export to France, Spain, Belgium, Italy, and Austria. These, and more detailed movements, are presented in the various tables of imports and exports accompanying this section. Such

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Asbestos Industry

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Major asbestos importers (metric tons)

	1970	1971	1972	1973	1974
WEST GERMANY					
Canada	100,892	76,947	130,034	240,044	307,832
USSR	20,547	34,105	24,810	32,416	32,097
Italy	19,629	21,443	22,704	29,482	22,534
South Africa ..	26,588	28,973	22,435	19,435	20,251
Total	175,612	167,941	206,602	329,392	394,920
UNITED KINGDOM					
Canada	90,555	102,198	87,630	135,365	107,885
Swaziland	20,127	18,180	16,014	26,247	16,351
South Africa ..	27,396	26,535	30,224	26,036	15,673
Cyprus	6,793	6,854	8,937	7,767	6,761
Total	148,175	156,270	144,977	197,703	153,007
FRANCE					
Canada	73,526	70,810	71,600	80,482	
USSR	48,876	29,618	44,012	43,528	
South Africa ..	17,302	15,741	16,827	18,816	n.a.
Italy	10,589	11,260	14,651	14,535	
Total	151,848	128,890	148,298	158,549	
SPAIN					
South Africa ..	n.a.	32,049	34,370	50,697	
Canada	20,615	40,601	44,759	44,759	n.a.
Italy	n.a.	1,813	6,730	6,665	
Total	77,677	65,287	82,608	109,045	
BELGIUM					
Canada	30,627	40,443	62,348	45,365	
South Africa ..	7,544	12,698	9,050	12,395	
West Germany ..	—	—	—	10,084	n.a.
USSR	—	—	11,531	—	
Total	54,839	70,068	89,685	85,615	
ITALY					
South Africa ..	33,511	33,507	22,678	31,275	28,857
Canada	16,641	14,536	13,950	20,556	23,363
USSR	10,069	13,376	7,547	5,511	—
West Germany ..	—	—	—	—	6,438
Total	62,253	63,894	47,500	60,183	66,164
NETHERLANDS					
Canada	14,576	16,095	18,960	28,995	
USSR	2,107	2,803	2,000	2,976	n.a.
Total	22,063	23,537	26,226	37,684	
DENMARK					
Canada	15,694	13,946	10,892	13,812	
Cyprus	6,003	4,808	6,997	8,964	
South Africa ..	3,505	3,893	5,125	7,075	n.a.
Total	28,690	26,798	26,213	33,505	
AUSTRIA					
Canada	18,771	20,297	21,073	20,281	13,041
South Africa ..	5,724	7,745	7,223	7,125	4,902
USSR	5,832	7,700	6,904	6,835	8,828
Italy	1,212	2,012	1,992	3,417	3,663
Total	34,155	39,943	39,991	39,592	33,066
JAPAN					
Canada	154,349	110,903	118,037	144,000	136,678
South Africa ..	94,879	99,445	100,234	112,194	124,141
USSR	42,066	55,642	41,203	46,609	64,961
Australia	—	—	12,727	30,125	15,759
Total	298,253	273,757	278,582	341,540	352,110
UNITED STATES					
Canada		1971	1972	1973	1974
Chrysotile (spinning) ..	10,540	10,520	14,210		
Chrysotile (other) ..	575,950	634,000	670,480		
South Africa					n.a.
Amosite	13,225	6,463	7,114		
Crocidolite	6,307	4,875	11,386		
Total	618,100	667,240	718,900	695,050	

N.B.—Importing countries in capital letters. Only principal countries of origin shown.

MARDEP000423
Industrial Minerals June 1975

figures do not tell the whole story of production and consumption, of course, since total tonnage figures naturally obscure details of grades beneath. The asbestos market is particularly complex in this respect since there are not only a large variety of grades but also a variety of asbestos types. Hence before discussing the consumption side of the asbestos market it is worth taking a look at some of the more general background.

Chrysotile and the amphiboles

The term 'asbestos' refers to a range of natural mineral fibres. All are silicate minerals, but they may be conveniently divided into two groups—chrysotile and the amphiboles. *Chrysotile* is the sole species classified in the serpentine group of hydrous magnesium silicates, whereas the amphibole group contains five known varieties—namely *crocidolite*, *amosite*, *anthophyllite*, *tremolite*, and *actinolite*. The chemical formulae of these minerals are as follows:

Chrysotile (also known as white asbestos) $3\text{MgO} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$.

Crocidolite (or 'blue asbestos') $\text{Na}_2\text{O} \cdot \text{Fe}_2\text{O}_3 \cdot 3\text{FeO} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$.

Amosite $5\frac{1}{2}\text{FeO} \cdot 1\frac{1}{2}\text{MgO} \cdot 8\text{SiO}_2 \cdot \text{H}_2\text{O}$.

Anthophyllite $7\text{MgO} \cdot 8\text{SiO}_2 \cdot \text{H}_2\text{O}$.

Tremolite $2\text{CaO} \cdot 5\text{MgO} \cdot 8\text{SiO}_2 \cdot \text{H}_2\text{O}$.

Actinolite $2\text{CaO} \cdot 4\text{MgO} \cdot \text{FeO} \cdot 8\text{SiO}_2 \cdot \text{H}_2\text{O}$.

Chrysotile is by far the most abundant of these minerals and is responsible for about 95% of total world production. Of the amphiboles, only crocidolite and amosite are of significant commercial importance, partly because of the occurrence of large deposits in one particular region (South Africa) but more importantly because of

their properties. Although all six types of asbestos share the well-known properties of fire and heat resistance, to be of use commercially the properties of strength and flexibility become important. Anthophyllite, tremolite, and actinolite all have poor tensile strengths, and their commercial importance is therefore considerably limited (as is their occurrence). Chrysotile, amosite, and particularly crocidolite all have extremely high tensile strengths and are therefore used extensively for their reinforcing properties when combined with materials such as cement, resins, and plastics. The principal difference between them is that chrysotile is soft and flexible whereas both crocidolite and amosite are hard and brittle. Hence chrysotile is perhaps the most adaptable, but crocidolite and amosite are particularly useful for adding specific properties such as rigidity, often in conjunction with chrysotile.

Grades and classification

Apart from the differences of mineralogical type described above, there are naturally differences in the quality of different deposits of the same type of asbestos. For instance, Cassiar chrysotile is generally purer than Quebec chrysotile and is therefore particularly valuable for applications which require an absence of contaminants. However, such considerations are generally restricted to the more specialised applications, and the main system of grading asbestos is based on fibre length rather than on quality. For chrysotile the most widely used system of grading is the Canadian system developed under the auspices of the Quebec Asbestos Mining Association (QAMA). There are 9 groupings:

Groups 1 & 2 (or Crude No. 1 and Crude No. 2) refer

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to the longest fibres, with lengths of over $\frac{3}{4}$ -inch and between $\frac{1}{4}$ -inch and $\frac{3}{4}$ -inch respectively. These long-fibre grades are not separated into individual fibres at the mine-site but instead are shipped crude to the customer, who will separate the fibres himself for use in preparing asbestos textiles, etc.

Groups 3 to 7 consist of milled fibres classified by means of the Quebec Standard Testing Machine. This machine consists of three screens ($\frac{1}{2}$ -inch mesh, 4-mesh, and 10-mesh) and a box to catch the short material. Groups and sub-groups are classified according to the proportion by weight retained on each screen. Hence Group 3 material will have a very high proportion of long fibres retained on the larger aperture sieves, whereas Group 7 material ends up mostly or totally in the box. In terms of applications, Group 3 fibres are used almost exclusively in textiles (except for a small proportion used in specialised papers, gaskets, etc.); Groups 4-6 are used in asbestos cement products, insulating boards, asbestos paper, friction products, etc., where the choice of grade—or mixture of grades—depends on the required properties of the finished product; Group 7 fibres are used in what are essentially filler applications, such as in floor tiles, plastics, paints, adhesives, etc.

Groups 8 and 9 contain a preponderance of rock and sand and are sold as cheap fillers in construction-type applications.

Large chrysotile producers outside Quebec—in British Columbia, the USSR, the USA, South Africa, Swaziland, Rhodesia, etc.—operate their own grading systems, but for the most part grades are produced which are equivalent—or at least comparable—to the Canadian grades. Amosite and crocidolite are graded by somewhat similar methods although a greater variety of long fibres is offered.

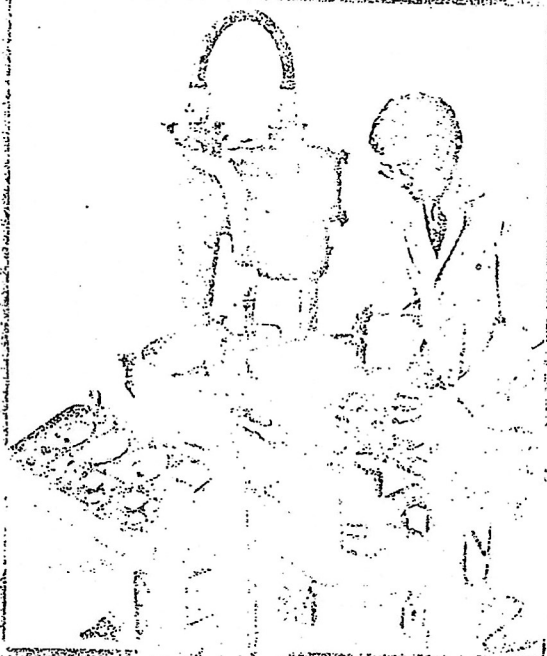
Production by grade

It is perhaps unnecessary to point out that output of long-fibre forms only a small proportion of total world production and that the bulk of fibres produced are in the QAMA group 4-7 range. Outside Quebec the only commercial producers of chrysotile equivalent to Groups 1-3 are in British Columbia (Canada), Arizona (USA), Swaziland, Rhodesia, China, and the USSR. Luckily, Canada is the one country that gives a breakdown of production by grade. In 1972 the quantities (in short tons) and the proportions (percentages) of Canadian shipments were as follows: Groups 1, 2 and 3: 38,609 tons (2%); Group 4: 499,234 tons (30%); Group 5: 271,585 tons (16%); Group 6: 236,105 tons (14%); Group 7: 642,625 tons (38%); and Group 8: 893 tons (negligible).

Consuming industries

One distinctive feature of the asbestos industry is the high degree of integration, whereby a large proportion of world fibre production is consumed by member or associate companies of the mining groups. This is no doubt a reflection of the specialist nature of working with asbestos—at all stages from mining and processing to incorporation into usable products. The reasons are also historical, however, and four companies in particular play major roles in both the mining and manufacturing ends of the market—namely Johns-Manville Corp. of the USA; the Belgo-Swiss Eternit group; and Turner & Newall Ltd. and Cape Industries Ltd. of the UK. Although JM now only operates two asbestos mines (two others were closed down recently) it is the largest asbestos miner in the Western world and is a

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major manufacturer of asbestos products at factories in the USA and throughout the world. The Eternit group is the world's largest consumer of raw asbestos through its subsidiaries and associates throughout the world. Eternit's principal mining interests are situated in Canada (Asbestos Corp. and Advocate Mines), Italy (Balangero), and southern Africa (operating subsidiaries of the Asbestos Investments group). Turner & Newall has mining interests in Canada (Bell and Cassiar), Rhodesia (Rhodesian & General), Swaziland (Havelock Mines), and South Africa (Dublin Consolidated), and manufacturing interests in the UK and abroad. Cape Industries (which is now part of Charter Consolidated Ltd.) operates a number of mines in South Africa and has manufacturing interests in the UK and abroad. Apart from these four companies, a number of other large asbestos product manufacturers hold monetary interests in mining operations. These include: Raybestos-Manhattan Inc. of the USA, Saint-Gobain-Pont-à-Mousson S.A. of France, and James Hardie Asbestos of Australia.

Uses of asbestos

Although the list of end-uses for asbestos is almost endless, the vast bulk of consumption in tonnage terms is used for constructional applications. Most important of all is its use in asbestos cement products, which range from pipes and ducts to flat and corrugated sheets. When wet a mixture of Portland cement and asbestos can be moulded without difficulty to a wide variety of shapes and sizes. After drying the finished products are not only strong, rigid, and durable but also resistant to fire and weather. A specialised sector within the asbestos cement category is the production of asbestos cement pressure pipe. Such pipe is ideally suited for heavy duty applications, e.g., for water supply and sewage disposal systems, irrigation projects, and for carrying chemical wastes. Asbestos cement products use fibre in Groups 4 to 6 but naturally Group 4 fibre is most desirable for the stringent pressure pipe applications. Although chrysotile forms the bulk of fibre consumed, most formulations contain smaller proportions of amphibole fibre wherever possible. This is because of the dewatering characteristics of crocidolite and amosite. Mixtures of cement and chrysotile drain very slowly and production rates are consequently slow. By using a blend of chrysotile and amphibole fibres (usually around 20% but sometimes as high as 40%) considerable improvements in the drainage rate have been achieved, plus the additional bonus of greater reinforcing strength.

Other important constructional applications include insulating products such as boards and roofing felts, and floor tiles. Lightweight fire resisting boards form an especially important market for amosite, which is used in conjunction with calcium silicate and diatomite formulations. Amosite gives high reinforcing properties for a relatively low density in boards that are fire-proof, incombustible, and both thermal and sound insulating. A large proportion of such boards are fitted to the bulkheads and inner wall linings of ships. Production of such products for use in buildings is more prevalent in Europe and Japan than in the USA—partly a result of more stringent fire regulations in these countries than in the USA. The use of asbestos in floor tiles is essentially a filler application and uses Group 7 material—partly for reinforcing and partly for insulation and fire retardant properties.

One of the most important areas of consumption outside the construction industry is the use of asbestos in

MARDEP000426

friction products such as brake linings and clutch facings, used in cars and trucks. Traditionally asbestos textiles formed the basis for such products but today it is more usual to use molded products combining asbestos with resins. The automotive industry also uses asbestos in a variety of other products such as gaskets, air cleaners, oil filters, etc. The use of asbestos friction products is now also growing in other transportation fields, particularly railways. Asbestos textiles are used in the manufacture of yarn and cloth which is used in safety clothing, packings, the above-mentioned brake linings, filters (see IM May '75), etc.

The two accompanying tables give a breakdown of asbestos consumption in the USA and the UK. These breakdowns cannot be taken as typical of other countries, however, since in both cases it will be seen that asbestos cement applications account for about 40% of total, whereas worldwide probably 70% of total consumption is used in cement-related products. In most developing countries over 90% of asbestos is used in cement products, and even for other industrialised countries the proportion often exceeds 70%. This is mainly because of the long history of the asbestos manufacturing industries of the USA and the UK in the development of non-cement applications. Both countries therefore maintain important export sales of asbestos-containing products.

Trends in consumption

The most significant feature of asbestos consumption in recent years is undoubtedly the growth of consumption in developing countries. It is this fact more than any other that helps to explain the paradox (highlighted

United States asbestos consumption—1973

	Short tons	Percentage
Asbestos cement pipe	141,000	17.0%
Asbestos Latex sheet	134,000	16.0%
Floor tiles	125,000	15.0%
Asbestos paper	84,000	10.0%
Friction materials	51,000	6.0%
Asbestos cement sheets, etc. ..	50,000	6.0%
Roof coatings	34,000	4.0%
Asbestos textiles	28,000	3.4%
Plastics	18,000	2.1%
Joint cements	13,000	1.6%
Miscellaneous	154,000	18.5%
Total	832,000	99.6%

United Kingdom

Breakdown of asbestos fibre consumption—1973 [estimated] (metric tons)

	Chrysotile	Amosite	Total	
Asbestos cement building products	55,600	—	55,600	(32.2%)
Asbestos cement pressure pipes	7,800	1,200	9,000	(5.2%)
Fire resistant insulation boards	3,000	19,500	22,500	(13.1%)
Insulation products (inc. spray)	1,300	2,700	4,000	(2.3%)
Jointings & packings ..	11,400	—	11,400	(6.6%)
Friction materials ..	17,000	—	17,000	(9.9%)
Textile products (excl. friction mat.)	8,300	—	8,300	(4.8%)
Floor tiles	16,200	—	16,200	(9.4%)
Moulded plastics	2,200	600	2,800	(1.6%)
Filler in felts, millboard, paper, underseals, mastics, etc.	25,300	—	25,700*	(14.9%)
Totals	148,100	24,000	172,500*	(100%)

*Includes 300 tons of anthophyllite

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in the introduction) of asbestos enjoying such strong demand when its biggest consuming industry—the construction industry—is in the doldrums in many Western countries. The opportunities for expanding asbestos cement usage in industrialised countries is now somewhat limited—it is in any case used now principally in industrial and agricultural buildings rather than domestic buildings (partly because of tradition and partly because of certain health hazard taboos). In the developing countries asbestos cement products are being used in all types of buildings as one of the simplest and cheapest basic building materials available. This cheapness factor may come as a surprise when one considers that asbestos cement grades cost between (Canadian currency) \$211 and \$674 per short ton, fob Quebec. However, only small fibre contents (8-12% of total for sheet and 15-20% for pipe) are required to give the desired properties. Despite the price rises of recent months, asbestos has improved its competitiveness on price grounds over a number of rival products incorporating iron, steel, and plastics, etc. (Fuel costs form a comparatively low proportion of total costs when compared to most other building materials.) The simplicity factor is also important, since once the right equipment has been installed, asbestos cement manufacture is an extremely easy process to control and is extremely adaptable. Add to this the properties of the finished products—strong, rigid, durable, resistant to fire and weather—and it is easy to see why the material is so attractive to developing countries.

Although some developing countries have increased their imports of asbestos products from industrialised countries, the most important trend has been the setting up of asbestos plants in the countries themselves. In the past few years asbestos cement plants have sprung

up at a number of locations throughout the Middle East, the Far East, Africa, and Latin America. Many of the plants are producing not only sheets and board but are also supplying pressure pipe for the large number of water supply, sewage disposal, and irrigation projects currently underway in many such areas. Most of these plants have been set up by the major companies—Johns-Manville, Eternit, Turner & Newall, etc.—in conjunction with the government or local interests in the countries concerned.

Trends in consumption in other fields are a little more difficult to assess—not least because of the current recession in Western industry. Sales of asbestos products to the motor manufacturing industry have naturally been running at much lower levels during the past year than in previous years and demand from other sectors such as plastics and floor tiles have also fallen off. This means that there has been an overall softening in demand for Group 7 fibres. Although the automotive industry is something of an unknown, it would appear that demand from other industries will pick up as soon as industry in general begins to move out of the recession.

Health hazards

A number of other changes in the pattern of the consumption for asbestos have been brought about by regulations concerning the health hazards associated with the material. This subject has received much airing in the mass media in recent years and has therefore had certain commercial effects—in helping to bring in new regulations but also in promoting psychological barriers against the use of asbestos in certain fields. The industry has come in for a lot of criticism—some justified but much of it unfair. Much of the publicity

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gave the impression that the general public were at risk by the widespread use of asbestos and obscured the fact that the dangers are associated with *working environments* where there is a high level of asbestos dust content in the air. In fact, exposure to asbestos dust has been recognised as a health hazard for over forty years and in the UK legislation was passed in 1931 to improve factory conditions. However, most precautions were ignored during the war years, and through a combination of negligence and lack of knowledge about the nature of the associated diseases, truly effective controls were not introduced until 1969. There are two, or possibly three, diseases associated with asbestos, one which shows itself as scarring of the lung (asbestosis), another particularly vicious disease in which tumours are formed in the chest wall (mesothelioma), and in the third case asbestos appears to be carcinogenic and its connection with lung cancer is therefore under investigation. All three take a long time to show themselves—the visible signs of asbestosis may not appear for between 15 and 40 years. Hence much of today's research is examining a disease contracted in another era. The 1969 regulations have been drawn up after a number of years' intensive medical research into the subject, however, and although their effectiveness will not be fully known for a further 10 to 20 years, most people would agree that they strike a balance between what is 'probably' safe and what is commercially feasible. Basically the regulations state that the maximum allowable dust level when working with chrysotile and amosite is 2 fibres per cubic centimetre of air. For crocidolite, which is heavily implicated with the incidence of mesothelioma, the standard has been set at 0.2 fibres per c.c. At the present time controls in other countries are generally more lenient but the trend is moving quickly towards making the UK levels universal. Under current US regulations 5 fibres per c.c. for all types of asbestos is permissible but legislation reducing the level to 2 fibres per c.c. will be introduced later this year. In Quebec, where standards have been somewhat arbitrary until now, the provincial government has announced plans to limit dust levels to 5 fibres per c.c. within 3 years. The trade union concerned sees this level only as an interim one, however, and is pressing for a 2 fibres per c.c. limit to be imposed within 2 years.

Measurements

One of the great drawbacks of legislation of this type is that although the standards are clear-cut on paper, the methods of measurement used are subject to wide margins of error. The most widely used method of testing at the present time is the membrane filter test, in which air is drawn through a filter (held near the worker's face) and the fibres are then counted using phase contrast microscopy. This method is accurate when counting more rounded particles such as coal dust, but large discrepancies occur when the method is applied to fibres which are often hard to distinguish. It therefore seems likely that more sophisticated techniques such as image analysing computers which can distinguish between fibres and other airborne dust will be used for counting wherever possible. Such equipment has the advantage not only of accuracy but also of speed; a reading can be made in a matter of minutes rather than hours, or even days, using present methods.

Effects on consumption

So what effects have the regulations and attendant publicity had on asbestos usage? Its effect on overall

demand is impossible to measure but if the strength of demand over the past year or so is anything to go by the answer is 'none'. However, within the industry itself there have naturally been a number of changes in practice to come into line with the laws. Notably there has been a decline in the number of processes which use asbestos in the dry state. A number of former applications in which asbestos was used for insulation and applied in the dry state have disappeared. There are in any case a number of **equally** suitable and less dangerous alternative materials available. It should be noted that insulation board, which is made by a wet process, has not been affected. Asbestos cement manufacture, too, is a wet process and the only real danger of exposure to dust is at the point when dry asbestos is added to the wet cement mix. Hence it is at this point that more stringent safety precautions must now be taken. The effects on crocidolite consumption have been more measurable than on chrysotile or amosite since the dangers of using crocidolite are also more apparent. It is no longer used in products that used a dry process—such as textiles. It is not used at all in the UK as the result of a trade union decision and its future re-introduction would appear most unlikely. However, its use in asbestos cement pressure pipes appears to have grown considerably in other countries as demand remains at a high level.

Alternatives

Naturally any discussion of the health hazards of asbestos begs the question—what alternative materials are available? Such discussion also highlights those areas of asbestos consumption for which asbestos can be easily replaced and those for which it is practically

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indispensable. In the field of insulation asbestos meets a number of rival materials—many of them mineral products such as mineral wool, kaolin wool, glass fibre, exfoliated vermiculite, expanded perlite, and calcined diatomite. Hence asbestos has lost and will continue to lose markets to such rival products, although in certain areas of the insulation field where further properties of strength and high temperature resistance are required the material more than holds its own (in ship insulation, etc.). Glass fibre is also a rival to asbestos in certain reinforcing applications and in plastics and resins in particular. Until recently this market was growing at a high enough rate to benefit both materials but the rivalry between asbestos and glass fibre could become more intense with the current slower growth rate. In asbestos's major markets, however, there have so far been no satisfactory replacements for asbestos. Alternative materials such as glass fibre do not have the required strength for cement reinforcement, too low a melting point for friction products (in addition to damaging wear characteristics), and a lack of the combination of properties (strength, fire-resistance, wear-resistance, and flexibility) that textiles made from asbestos possess.

The future

An analysis of developments on both the supply and demand sides of the picture suggests that the shortage of asbestos fibre in Group 4-6 (the asbestos cement grades), which has already lasted for about 18 months, will probably last for at least another 18 months. Demand has relaxed in certain industrialised countries,

such as the UK, but in other industrialised countries, such as France and West Germany, has not relaxed sufficiently to change the basic picture. Meanwhile, developing countries, in the throes of new asbestos cement projects, have been subjected to particularly acute shortages of supply. Since this situation prevailed before the present series of production difficulties arose in Canada, the supply/demand imbalance can only get worse in the short term. An estimated minimum of 250,000 tons of fibre in Groups 4-6 will be lost during 1975 as a result of the landslide, fire, and strike. This loss comes on top of reduced output from the USA and, less importantly, the finish of Finnish anthophyllite production. The only new capacity of significant scale from Western world producers would appear to be the Midlothian chrysotile operation in Canada, which will probably contribute about 30,000 tons of fibre (including Group 7 material) this year; and the Klipfontein crocidolite operation in South Africa. Increased production may also be forthcoming from other countries, particularly Australia, but altogether these extra quantities add up to less than 100,000 tpa. The USSR is a bit of an unknown quantity, of course. Certainly expansions are believed to be in progress, but if recent rumours are correct, Russia has been having a few supply difficulties of its own—in which case increased supplies may not be available until late 1975 or early 1976. The real key to future supply, however, could depend on the speed with which Canada deals with its production problems. The need for a rapid return to full operating levels will become more urgent if the predicted boom in Western industry takes place next year as some observers believe.



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World Asbestos Producers

North America

CANADA—chrysotile

(i) Quebec producers

Canadian Johns-Manville Co. Ltd. (wholly-owned subsidiary of Johns-Manville Corp. of the USA). Operates the Jeffrey mine and mill at Asbestos, Quebec. Mill has 720,000 stpa capacity (650,000 metric tpa) of QAMA grade 3-8 inclusive. The Reeves mine in northern Ontario (operated by a 100% subsidiary, Johns-Manville Mining & Trading Co.) was closed down in February 1975. CIM handles sales for Advocate Mines Ltd., with which it is associated.

Asbestos Corp. Ltd. (owned 54% by General Dynamics Corp. of the USA through its Canadian subsidiary, Canadair). Operates three mine/mill plants in southern Quebec (King-Beaver, British-Canadian, and Normandie). Total mill capacity is about 350,000 stpa (320,000 metric tpa) of QAMA grades 1-8 inclusive. Also operates the Asbestos Hill plant at Ungava in northern Quebec which produces about 300,000 tpa of asbestos concentrates which are shipped to the company's mill at Nordenham in West Germany.

Carey-Canadian Mines Ltd. (formerly owned by Philip Carey Corp. of the USA but now a wholly-owned subsidiary of

Jim Walter Corp. of the USA). Operates mine and mill at East Broughton, Quebec. Mill capacity is about 200,000 short tpa (180,000 metric tpa) of grades 3-8 inclusive.

Lake Asbestos of Quebec Ltd. (wholly-owned subsidiary of American Smelting and Refining Company—ASARCO). Controls two plants in southern Quebec (Black Lake and Thetford Mines). The Thetford Mines plant, which is operated by the National Division, was acquired from National Gypsum Co. of the USA during 1973. Mill capacities are: Black Lake 161,000 stpa (146,000 metric tons) and the National Division 70,000 stpa (63,000 mtpa), although the latter will be increased to 80,000 stpa (73,000 mtpa) during this year. Both mills produce QAMA groups 3-7 inclusive. Although Lake Asbestos is the sole operator of the Black Lake property, the mineral rights are owned by United Asbestos Inc., and this company shares in the profits. During 1973 and 1974 Lake Asbestos acquired from Asbestos Corp. two asbestos-bearing properties bordering the Black Lake mine.

Bell Asbestos Mines Ltd. (wholly-owned subsidiary of Turner & Newall Ltd. of the UK). Operates the Bell Mine in Thetford Mines, Quebec. Mill has annual capacity of 60,000 short tons (54,000 metric tons) of QAMA grades 1-7 inclusive. The company handles sales for Cassiar Asbestos Corp.

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N.B. Among possible new ventures in Quebec, probably the most promising is the Amos prospect of *Abitibi Asbestos Mining Co. Ltd.* (in which Brinco Ltd.—an RTZ associate—is a majority shareholder) where a 160,000 tpa mill has been proposed. However, a recent announcement states that no commercial mining is likely before mid-1978. Another potential operation is situated in the Chibougamau area of Quebec, on property owned by *McAdam Mining Corp.* *Riocanex* (an RTZ subsidiary) has conducted sampling and testing of the deposit but no firm decision has yet been made on developing the property.

(ii) Producers in other provinces

Cassiar Asbestos Corp. (shareholders include Turner & Newall of the UK, Conwest Exploration Co. of Canada, James Hardie Asbestos of Australia, and Raybestos-Manhattan Inc. of the USA). Operates the Cassiar Mine on McAdam Mountain in British Columbia and the Clinton Creek Mine in Yukon Territory. Both mills have a theoretical capacity of about 110,000 stpa (100,000 mtpa) although Cassiar should operate at 120,000 stpa in 1976. Company uses its own classification system but Cassiar operation yields long, medium, and short fibre qualities (roughly equivalent to QAMA grades 1-6) and Clinton Creek medium and short qualities (equivalent to QAMA 4-6). Clinton Creek is due to close down at the end of 1977.

United Asbestos Inc. (formed by the merger of United Asbestos Corp. and Allied Mining Corp. in 1973). Initial production from the company's new mine and mill at Midlothian, Ontario is scheduled to begin next month (July 1975). Mill capacity is 100,000 tpa and grades will probably be in QAMA 4-7 range.

Hedman Mines Ltd. (owned by Gulf & Western Industries Inc. of the USA). Operates a small mine and mill at Matheson, Ontario. Current production is about 7,000 stpa of QAMA group 7 only.

Advocate Mines Ltd. (owned by Johns-Manville Corp., Amet Corp., and Eternit S.A.). Mine and mill between Baie Verte and Notre Dame Bay in northern Newfoundland. Current capacity of the mill is 78,000 stpa (71,000 mtpa) of grades corresponding to QAMA grades 4 and 6.

MEXICO—chrysotile

No production at present. *Compañia Minera Pegaso S.A.* (a subsidiary of Industrias Peñoles) is developing a deposit in the Cuicatlan district of Oaxaca State. Production planned for 1978. Freeport Minerals Co. of the USA once held an interest in the project but sold out during 1972. Another company, *Cia. Nacional de Asbestos S.A.*, was set up by the Mexican government to exploit a deposit at Ciudad Victoria in Tamaulipas State but interest in the project appears to have waned.

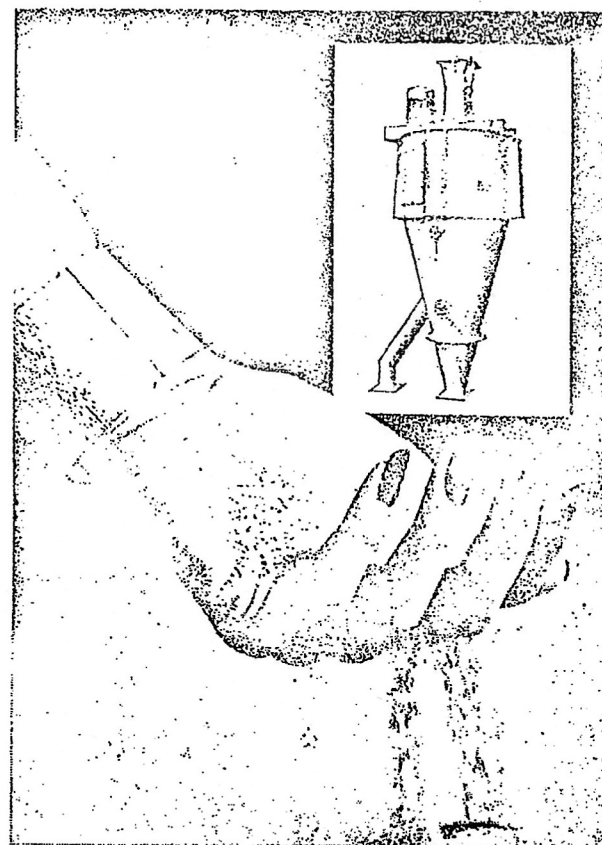
UNITED STATES

(i) Western states—chrysotile

Union Carbide Corp. (Mining and Metals Division). Mine in the San Benito County of California and mill situated at nearby King City. Mill capacity is thought to be in the region of 40,000 tpa of fibres similar to QAMA grade 7. In addition to conventional fibre, the company produces colloidal and modified asbestos products that are specially adapted for particular filler/reinforcing applications.

Atlas Asbestos Co. (wholly-owned by Wheeler Properties Inc. of Reno, Nevada). Mine and mill situated 32 miles north-west of Coalinga in California. Mill capacity is 30,000 tpa of QAMA grade 7R and shorts.

N.B. Two other Californian producers, *Pacific Asbestos Corp.* (a subsidiary of H. K. Porter Co. Inc.) and *Coalinga Asbestos Co.* (a subsidiary of Johns-Manville Corp.), ceased operating during 1974 and have subsequently been offered for sale. So far there has been no news of developments. The Pacific Asbestos mill at Copperopolis in Calaveras



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Barytes	90% minus 5 μ
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County had an annual capacity of about 50,000 stpa and produced grades equivalent to QAMA 4-7 inclusive. The Coalinga Asbestos Mill had a capacity of 15,000 stpa of QAMA grade 7 fibres.

Jaquays Asbestos Corp. operates one mine (The Chrysotile Mine) and holds two others (Regal Mine and Asbestos King Mine) on standby, all in Gila County, Arizona. The mill, which is situated at Globe, Arizona, has an annual capacity of 1,200 tpa of all grades (corresponding to QAMA 1 and 2 crudes, 3Z and 4T filter fibre, and 7F shorts).

(ii) Eastern states—chrysotile and anthophyllite
Vermont Asbestos Group Inc. (formerly operated by GAF Corp.). Mine and mill at Lowell, Vermont. Recent operating levels are thought to be in the region of 40,000 stpa of chrysotile fibre in the QAMA 4-7 range. Early in 1974 GAF Corp. announced that it would close the plant by March 1975 as the result of an order by the U.S. Environmental Protection Agency to install \$1m. worth of pollution control equipment. The employees at the operation then began a campaign to buy the plant and preserve their jobs. This transfer of ownership was concluded successfully in March this year, with the help of a \$1.5m. loan from the Vermont Industrial Development Authority, an extension on compliance with the EPA regulation, and an unusually low price (\$400,000) set to the operation by GAF Corp.

Powhatan Mining Co. is the USA's only producer of amphibole asbestos. The anthophyllite mine is situated at Newdale in North Carolina and the company's 700 tpa mill is situated in Baltimore, Maryland.

South America

BOLIVIA—crocidolite

Present production only at pilot plant levels. The Bolivian government has received continuing assistance from the United Nations Industrial Development Organisation with a view to setting up a commercial plant producing fibre from a crocidolite deposit near Cochabamba.

BRAZIL—chrysotile

S.A. Mineracao de Amianto (controlled by S.A. Tubos Brasilet, a Brazilian subsidiary of Saint-Gobain-Pont-à-Mousson of France). Operates a mine and mill at Cana Brava, near Uruaca in Goias State. Capacity of operation probably about 40,000 tpa.

COLOMBIA—chrysotile

No production at present. *Asbestos Colombianos S.A.* (owned by Eternit Colombiana (70%) and Compania Minera Emmo (30%)). Exploits the Las Brisas deposit near Camamento in the south of the country. The deposit was developed by Nicolet Industries of Canada, who sold its 70% share to Eternit during 1974 (see IM Nov. '74). Although early proposals suggested that a 50,000 tpa plant would be built to start operating by 1976, commercial production is now expected to begin during 1977 at a rate of 15,000 tpa. A high proportion of recovered fibre is likely to be of QAMA grades 4 and 5.

Africa

SOUTH AFRICA

(i) Amosite

Egnep (Pty.) Ltd. (a member of the Cape Group of the UK). Used to operate three mines, all in the Lydenburg district of Transvaal but in future production will be centred on just one operation—that at Penge. The Weltevreden plant has already closed and the mine and mill at Kromellenboog will be closed later this year. Output has been increased at Penge to keep total production at about 100,000 tpa. Eight grades ranging from long fibres over 18mm. to shorts of under 6mm. are produced.

(ii) Chrysotile

Msauli Asbes Ltd. (a member of the Federal Mynbou—General Mining Group). Chrysotile mine and mill in the

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Barberton district of Transvaal is operated by the Msauli subsidiary, African Chrysotile Asbestos Ltd. The operation yielded 68,720 metric tons of fibre in 1974, a figure that is very close to its full capacity. QAMA grades 4-7 inclusive are produced.

Consolidated African Mines Ltd. operates mines and a mill in the Barberton district of Transvaal. Approximate annual capacity is 8,000 tpa of QAMA grades 4-7 inclusive, although the company is to expand to 12,000 tpa. Principal sales agent is Commonwealth & Overseas Asbestos Corp. (Pty.) Ltd.

(iii) Crocidolite

Cape Blue Mines (Pty.) Ltd. (a member of the Cape Group of the UK). Operates two mine/mill plants in northern Cape Province—one at Pomfret and the other at Kogas/Westerberg. Combined production is of the order of 55,000 tpa and a full range of grades is produced with longest fibres over 35mm.

Asbestos Investments (Pty.) Ltd. (a member of the Eternit group). Has two operating subsidiaries—Kuruman Cape Blue Asbestos (Pty.) Ltd. and Danielskuil Cape Blue Asbestos (Pty.) Ltd. The larger of the two, Kuruman C.B.A., operates two milling plants on the farm Whitebank in northern Cape Province; combined capacity is about 30,000 tpa. Earlier this year, however, the company brought into production a new mine and mill on the farm Klipfontein. This modern mill has a capacity of 18,000 tpa. Danielskuil C.B.A. operates mines on the farm Ouplaas with an annual production capacity of 15,000 metric tons. Target production for the two companies is 60,000 tpa.

Griqualand Exploration & Finance Co. Ltd.—Gefco (a member of the Federal Mynbou—General Mining Group). Operates a number of mines in the Kuruman area of northern Cape Province through subsidiaries such as Coretsi Asbestos (Pty.) Ltd., Merencor Asbestos Mines (Pty.) Ltd., and

Griqualand Asbes (Pty.) Ltd. Some mines, such as Merencor, have their own mill but the main mill is the Elcor mill. Gefco's total fibre production in 1974 was 52,674 metric tons, which was very close to capacity. Sales are handled by the wholly-owned subsidiary, Central Asbestos Co. Ltd. of the UK.

Valley Asbestos (Pty.) Ltd. is essentially the sales organisation for three affiliated mining companies—Groenwater Asbestos Mining Co. (Pty.) Ltd., Postmasburg Cape Blue Asbestos (Pty.) Ltd., and Rooipoort Blue Asbestos (Pty.) Ltd.—all of which operate in the Postmasburg district of Cape Province. Total fibre production capacity for the group is about 10,000 metric tpa. A range of crocidolite fibres is produced.

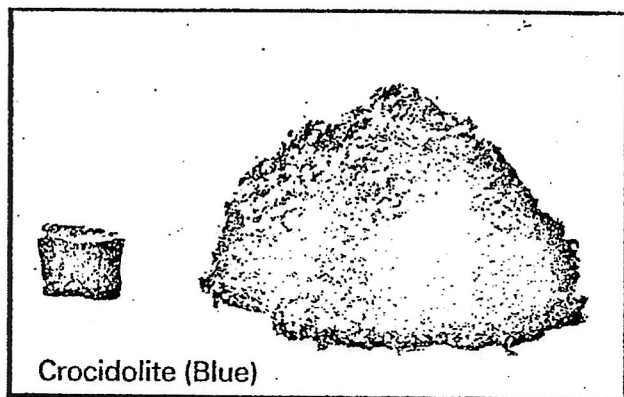
Wandrag Asbestos (Pty.) Ltd. operates mines on the farms England and Ettrick and a mill on the farm Depression in the Kuruman district of northern Cape Province. At the moment the company is engaged in opening a new mine in the Danielskuil area. Approximate capacity of the present mill is 11,000 metric tons per annum. The company produces three grades of fibre which are eventually blended with the fibres of its sales agents—namely Gefco.

N.B. Dublin Consolidated Asbestos Mines (Pty.) Ltd., a subsidiary of Turner & Newall of the UK, conducts small scale operations mining crocidolite in the Vryburg district of Cape Province, and amosite near Pietersburg, Transvaal. The company also processes the output of some small mine operators (as do a number of the other major South African producers).

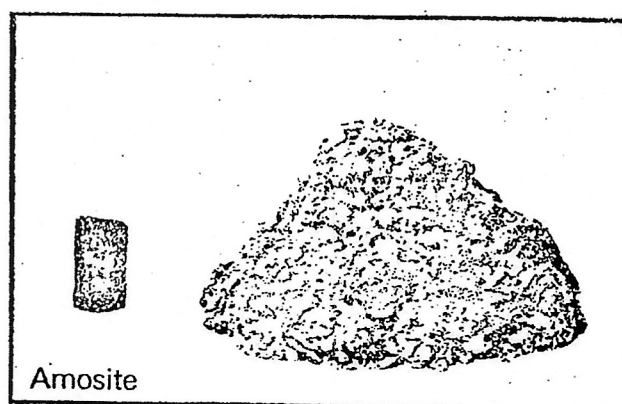
SWAZILAND—chrysotile

Havelock Asbestos Mines (Swaziland) Ltd. (owned by Turner & Newall of the UK (60%) and the Swaziland Government (40%)). Mine and mill at Havelock is currently operating at a rate of about 37,500 metric tons per annum. Produces high quality fibres of long and medium lengths.

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RHODESIA—chrysotile

Since UDI few details have been made available on developments in the Rhodesian asbestos industry. *Rhodesian and General Asbestos Corp.* (a subsidiary of Turner & Newall) continues to dominate the industry with production from three sites—Shabani, Gaths, and the new King mine—all in the Shabani area of south central Rhodesia. The only other producer of size is the *Asbestos Investments* group which controls the Pangani, Boss, Vanguard, and Rex mines, all in the Bulawayo/Shabani region. Total Rhodesian production in recent years has been variously estimated between 80,000 and 150,000 tpa. Production includes exceptionally high quality long-fibre types.

MOZAMBIQUE—anthophyllite

Minas Gerais de Mocambique Lda. has been operating a pilot plant for a number of years at a rate of 500/600 tpa of finished anthophyllite fibre. A commercial scale mill is currently being installed and is expected to start production by mid-1976. The operation is situated near Vila Pery, inland from the port of Beira.

Europe and Asia Minor

CYPRUS—chrysotile

Cyprus Asbestos Mines Ltd. (an associate of Tunnel Portland Cement of the UK and F. L. Smidth of Denmark) operates a mine and mill at Amianos in the Troodos mountains of Cyprus. Annual capacity of the mill is between 30,000 and 40,000 metric tons. 1973 production was 31,205 tons, about half of which was medium length fibre and the other half consisted of shorts. Despite last year's troubles (the operation remains under Greek Cypriot control), exports for 1974 reached a record 32,679 metric tons.

FINLAND—anthophyllite

Paraisten Kalkki Oy's anthophyllite mine between Kuopio and Joensuu in eastern Finland was closed down in January this year; the mill is expected to close this month (June

1975). In recent years the plant had operated at a level of 6/7,000 tpa of qualities approximating to QAMA grades 4-7.

GREECE—chrysotile

Asbestos Mining Co. of Northern Greece—MABEM (owned 51% by Cerro Corp. of the USA and 49% by the Hellenic Industrial Development Bank). Project at Kozani in western Macedonia is currently operating at pilot plant scale but plans are in hand to install a first stage 50,000 tpa plant, for probable start-up during 1976, and a second stage could take the total capacity to 100,000 tpa by 1980. Fibres will be in the QAMA 4-7 range.

ITALY—chrysotile and tremolite

Amiantifera di Balangero SpA (associated with the Eternit group). Chrysotile mine and mill at San Vittore, north-west of Turin. Current production is currently of the order of 130,000 metric tons per annum of fibres in the QAMA 4-7 range.

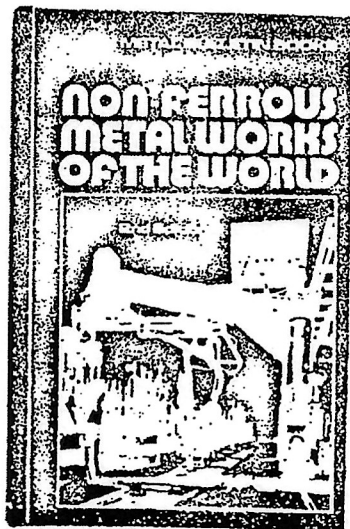
N.B. Small tonnages of tremolite are produced from two operations, at Sondrio and Aosta, in the Lake Como area. The products consist of long fibre material.

TURKEY—chrysotile

According to recent articles in 'Asbestos' magazine, six asbestos deposits in Turkey are being worked by asbestos product manufacturers for their own use, among them the *Adana Atermit* company at Adana in the south of the country. The sum total from all such operations is about 6,000 tpa. However, a larger scale operation has been proposed in the development of the deposit at Tatarcik, near Mihaliccik (east of Eskisehir). The company concerned, *Anyant Sanayii A.S.*, has made tentative plans to build a 10,000 tpa mill, possibly by 1977, and further plans cater for an expansion to 30,000 tpa.

USSR—chrysotile

Uralasbest Combine, at Asbest near Sverdlovsk in the Urals, is Russia's largest mine/mill operation with a total capacity of about 1m. tpa.

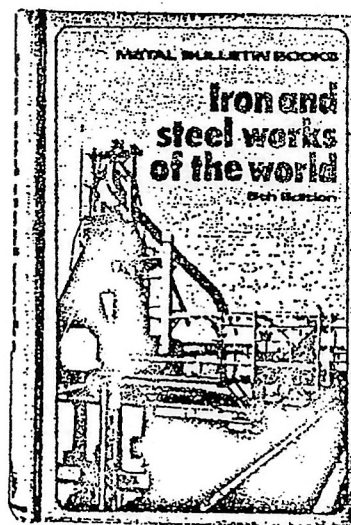


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Dzhetygara-Combine, at Dzhetygara in Kazakhstan (about 300 miles due south of Sverdlovsk) is the second largest with a total capacity of about 300,000 tpa. Expansion in progress.

Turaashest Combine, at Ak-Dovurak near Krasnoyarsk (in south central Siberia) has a current capacity of 35,000 tpa, which expansion in progress is expected to double.

Kiembay Combine, in Orenburg Oblast, is currently under construction, although first stage is thought to be operating. N.B. Other chrysotile deposits have been outlined at Molodezhnoye and Il'chinsk in Buryat A.S.S.R. and plans have been proposed for their development.

YUGOSLAVIA—chrysotile

The *Bosanko Petrovo Selo Mine* at Tuzla in Bosnia is Yugoslavia's principal asbestos operation with an annual capacity of about 10,000 metric tons of qualities similar to QAMA grades 4-7 inclusive. Smaller operations include the *Korlace Asbestos Mine* at Raska in Serbia, and the recently-opened *Piceky-Kosouska* deposits near Mitrovica.

Oceania and the Far East

AUSTRALIA—chrysotile

Woodsreef Mines Ltd. (majority owned by Woodsreef Minerals Ltd. of Canada—formerly Pacific Asbestos Ltd. of Canada). Woodsreef Mines in turn owns Chrysotile Corp. of Australia Pty. Ltd., the operating company which controls the chrysotile mine and mill at Woods Reef, near Barraba, in New South Wales. Capacity of the mill is between 60,000 and 75,000 short tons per annum, depending on the grades being produced. Principal grades correspond to QAMA grades 4-7 inclusive.

Asbestos Mines Ptd. Ltd. (a wholly-owned subsidiary of James Hardie Asbestos Ltd.) operates a mine and mill at Baryulgil, near Grafton, N.S.W. The mill produces up to 700 tpa of QAMA Group 4Z which is entirely consumed by the parent company.

N.B. Until 1966 Australia was a producer of crocidolite through the operations of Australian Blue Asbestos Ltd. at Wittenoom in Western Australia. After operating for many years at about 15,000 tpa the plant was eventually closed down for economic reasons.

CHINA—chrysotile

Estimates for China's total asbestos production vary from 90,000 tpa to as much as 200,000 tpa. Certainly the major producing area is at Shihmien in Szechuan Province, where long fibre chrysotile is produced. Smaller mines are worked at a large number of locations throughout the rest of China.

INDIA

Deposits of chrysotile and amphibole asbestos types have been located at numerous locations throughout India and several such deposits are mined on a small scale. Until now commercial interest has only found practical form in two deposits—one of chrysotile at Roro in the Singhbhum District of Bihar, which is exploited by *Hyderabad Asbestos Cement Products Ltd.* and the other an amphibole (amosite) deposit at Hole-Narsipur in the Baba Budan Hills of Mysore where feasibility studies for a possible 10,000 tpa plant are in progress. At present total Indian production is in the region of 11,000 tons.

JAPAN—chrysotile

Nozawa Asbestos Cement Co. operates a mine and mill at Furano city on the island of Hokkaido. The mill has a capacity of 20,000 tpa and a production of QAMA grade 7 shorts and tailings.

Yamabe Asbestos Co. also produces short chrysotile fibres in the Yamabe District of Hokkaido.

TAIWAN—actinolite

Seven small producers (mainly of actinolite) produced a total of 5,000 tons of fibre in 1973. All this output was short fibre and was consumed domestically.

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(See IM February, page 7, for preliminary details)

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