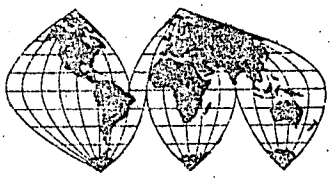


Talc today—the culmination of twenty years' growth

THE term talc refers ideally to a very pure hydrous magnesium silicate ($3MgO.4SiO_2.H_2O$) which has a theoretical chemical composition of 63.5% SiO_2, 31.7% MgO, 4.8% H_2O. In nature, however, 'true' talc is very rare and when it is found it is usually intimately associated with numerous other minerals such as serpentine, chlorite, tremolite, anthophyllite, diopside, quartz, calcite, dolomite, and magnesite. Thus 'talc' is loosely used as a term to describe various minerals akin to the ideal chemical composition and, to a lesser extent, to the physical properties. *Soapstone* is a massive, soft, greenish talcose rock which is a mixture of talc and various other magnesium silicates. *Steatite* (sometimes termed lava talc) is a compact, massive talcose rock with no visible grain and a maximum of 1.5% each of CaO and combined FeO and Fe_2O_3, and 4% Al_2O_3. *Pyrophyllite* is a hydrated aluminium silicate ($H_2Al_2(SiO_3)_4$) and is very similar to talc in its physical properties except in that it is somewhat harder and, unlike talc, does not flux when fired. This gives it great refractoriness which is useful in high-grade ceramics. *Asbestine* refers to a mixture of fibrous talc and tremolite asbestos which has an approximate composition of 85% hydrous magnesium silicate, 10% calcium silicate, and 2-3% calcium carbonate.

Mineral deposits containing talc

The mineral talc is formed in a variety of ways and in a number of geological environments. Some talc and soapstone deposits may form by the metamorphic alteration of ultrabasic igneous rocks, that is by the process of serpentinization or steatization in which water attacks the original rock which is usually peridotite (a mixture of magnesium-rich olivine and pyroxene). The mineral actinolite (a magnesia-rich metamorphic mineral which is a member of the amphibole group) is formed first, and then chlorite (a layer-lattice mineral consisting of talc units—$Mg_6Si_8O_{20}(OH,F)_4$—sandwiched between brucite layers—$Mg_6(OH)_{12}$). The chlorite in turn breaks down to form talc and a carbonate rock. An example of this occurs in Vermont in the USA where talc-bearing serpentine lenses are found within a sequence of schists, quartzites, and other metasedimentary rocks. The lenses are zoned with a core of serpentinite, surrounded by talc carbonate (termed 'grit'), and then almost pure mineral talc.

When talc deposits are in sedimentary terrains the host rock is usually dolomitic limestone, since it has a natural magnesia content and may also contain silica (originally as sandy or cherty layers). Other sources of the magnesia that is required to form talc have been postulated to be either magnesia-rich brines or circulating waters that have leached magnesia-rich ultrabasic rocks at depth. Minerals with a naturally high magnesia content formed during metamorphism, such as tremolite ($Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$), diopside ($CaMgSi_2O_6$), and forsterite ($Mg_2SiO_4$), may also be altered to talc. One of the best examples of talc deposits occurring in a sedimentary environment is in the Gouverneur District of New York State in the USA. Within the Pre-Cambrian Grenville series, composed of impure silicated metadolomite or 'marble', there is a tremolite-anthophyllite-serpentine-talc schist which hosts the talc deposits. The formation of the deposit is thought to have been by hydrothermal solutions replacing favourable beds of quartzite and metadolomite with various metasilicates, which in turn were later replaced by talc and serpentine. The high grade deposits of the Ariège area in France and the Cottian Alps west of Pinerolo in Italy were formed by the low grade metamorphic replacement of dolomite and dolomite-limestone.

Commercial production

The three majors—Japan, USSR, USA

The current world production of talc, soapstone, and pyrophyllite is over 5m. tpa and is increasing steadily. At least thirty countries are listed as talc producers, although at the beginning of the 1970s Japan, the USA, and the USSR accounted for 61% of the total figure. **Japan** is by far the world's leading producer of pyrophyllite and steatite with an annual output of over 2m. tons—the bulk being pyrophyllite. About half of this production comes from *Kunimine Koka Kogyo Co. Ltd.*; other producers include *Chugai Kogyo KK*, *Chemichi Kogyo KK*, and *Nippon Talc Co. Ltd.* Due to the enormous demand for talc by its domestic industries, Japan's output has increased by 50% over the last decade, and has also stimulated a large increase in South Korean production which is currently over 250,000 tpa (163,000 tons of pyrophyllite and 92,000 tons of talc in 1972). The *Ilshin Industrial Co.* produce over 50,000 tpa of talc at its Tongyang mine near Chungjoo City; other major South Korean talc mines are at Fougyang and at Shinbo.

Information regarding production in the **USSR** is very scanty, although the US Bureau of Mines estimates production to be around 500,000 tpa.

US talc production doubles

After Japan, the **USA** is the world's second largest talc producer, with production doubling over the last

twenty years to reach the present level of 1.2m. tpa (it should be noted that over 90% of Japan's output is pyrophyllite whereas the equivalent figure for the USA is only about 15%). Despite this increase in production imports still remain at about 20,000 tpa, although the source has moved from Europe (that is the cosmetic grade material from France and Italy) to Canada. There are two talc producing belts in the USA—in the east, stretching from Canada southwards through New York State, Vermont, North Carolina, Georgia, and Alabama; and in the west, taking in California, Montana, and Nevada. This partition is not only geographical: talc from the eastern states is mainly fibrous, whereas western talc is platey, very pure, and very soft.

Eastern talcs—Nytal, Asbestine, Emtal, Vertal

The main talc producer in New York State is *R. T. Vanderbilt Co.* through its wholly owned subsidiary, *Gouverneur Talc Co. Ltd.*, which mines a tremolitic talc deposit at Balmat in St. Lawrence County (this county is the most important talc producing area in the world). The talc has been mined and marketed for some time now under the trade name 'Nytal' which has become accepted in the local paper and paint industries. In May 1974, Vanderbilt increased its stake in New York talc production by taking over the interests of the *International Talc Co.*, a major producer in the state. The talc produced by this latter company is marketed under the trade name of 'Asbestine' and is mainly consumed in the paint industry.

To the south, Vermont talc, although not as bright as the New York material, is in great demand for the paper industry and for use in industrial paints. *Engelhard Minerals & Chemicals Corp.* operates an underground mine at Johnson in Vermont which it purchased from the Eastern Magnesia Talc Co. Inc. (part of the Johnson & Johnson Group) in 1967. After partial beneficiation on wet gravity tables, the talc is flotated, thickened, and filtered before it is dried and marketed under the trade name of 'Emtal'.

Vermont Talc Inc., a wholly owned subsidiary of the Vermont Marble Co. since its purchase in November 1969, was established in 1904. The company now operates a massive talc deposit at Windham in Vermont which is part of a serpentinite belt running from Massachusetts through the central part of Vermont, northwards into Canada. After extraction by underground mining methods, the talc material is trucked eleven miles to the recently modernised processing plant at Chester, which is also the location of the

World production of talc, steatite and pyrophyllite

(*metric tons*)

	1970	1971	1972	1973
Argentina	25,728	*31,000	35,000	n.a.
Australia: *talc*	47,518	41,280	43,849	56,000
pyrophyllite	7,707	6,596	12,299	
Brazil: *talc*	79,496	41,651	88,733	n.a.
pyrophyllite	8,908	6,356	33,136	n.a.
Bulgaria	n.a.	n.a.	21,000	23,000
Burma	213	215	220	n.a.
Canada	65,367	59,477	73,433	99,800
China*	150,000	150,000	150,000	150,000
Chile	639	1,758	2,615	2,462
Colombia	1,751	1,975	708	n.a.
Egypt	6,487	6,321	8,760	7,101
Finland	62,700	100,700	90,327	109,491
France	270,174	282,000	236,075	255,000
West Germany	33,806	29,658	30,348	28,191
Greece	2,744	1,855	5,441	2,465
Hungary	n.a.	n.a.	16,000	16,000
India: *talc*	159,314	176,845	210,619	190,901
pyrophyllite	13,922	11,780	15,086	14,063
Italy	154,825	143,571	147,046	146,546
Japan: *talc*	137,579	136,803	132,780	n.a.
pyrophyllite	1,538,769	1,434,286	1,365,131	n.a.
North Korea*	80,000	90,000	1,000	n.a.
South Korea: *talc,*	135,338	104,374	69,929	95,313‡
pyrophyllite	93,995	91,014	22,399	224,040‡
Mexico	1,918	1,714	3,130	2,108
Norway	75,886	64,463	66,564	n.a.
Pakistan	1,737	*3,527	3,042	3,942
Paraguay	120	160	220	n.a.
Peru: *pyrophyllite*	7,271	4,528	*4,500	n.a.
Philippines	1,590	1,317	1,007	1,634
Portugal	1,807	1,275	1,204	1,110
Rumania	57,000	57,000	57,000	n.a.
South Africa: *talc*	7,568	8,438	8,760	7,101
wonderstone	4,821	3,333	2,059	4,743
Spain	39,612	40,743	40,358	40,500
Swaziland	254	204	108	126
Sweden	32,300	24,045	26,405	28,029
Thailand		50	1,500	9,550
Taiwan	38,717	39,042	24,793	23,124
UK	10,953	12,127	16,107	20,333
Uruguay	150,000	150,000	150,000	n.a.
USA: *talc*	823,584	849,363	1,004,254	1,131,260
pyrophyllite	108,932	91,652		
USSR*	380,000	380,000	390,000	400,000
Zambia	n.a.	n.a.	2,323	713
Total	4,940,000	4,950,000	4,950,000	*5,159,000

n.a.—*not available* *USBM estimates †includes chlorite ‡In 1972 and 1973 production described as talc and agalmatolite respectively*
Source: in part 'Statistical Summary of the Mineral Industry', Institute of Geological Sciences, London

company's headquarters. The material is crushed and then ground by two Raymond five roller, high-side mills to three standard grades, the finest of which is a 98% minus 325 mesh product. The current production of around 15,000 tpa is sold under the trade name of 'Vertal', particularly to plastic, rubber, paint, and paper manufacturers in the local New England region. Reserves at Windham are estimated to be adequate for 50 years, even at an increased production rate.

Eastern pyrophyllite

In North Carolina the *Standard Mineral Co.* (another subsidiary of R. T. Vanderbilt Co.) mines pyrophillite at Robbins. The mine was converted from an underground operation to an open pit mine in the early 1940s and the original underground workings were completely closed in 1966. The pyrophyllite product is non-hygroscopic and is therefore used as a refractory, in addition to its role as a filler in paints, rubber, and in pesticides. It is marketed under the trade name of 'Pyrax'. Another Vermont producer is *General Minerals Co. Inc.*, a wholly owned subsidiary of the American Olean Tile Co., which operates an open pit pyrophyllite mine at Greensboro.

Of the less well documented deposits of talc, the low-grade talc deposit in Tallapoosa County in Alabama is the most important. Essentially this deposit consists of enstatite-anthophyllite-talc particles disseminated in a deeply weathered rock environment. Small scale mining was initiated by the *American Talc Co. Inc.* in 1969 and potential capacity was placed at about 5,000 tpa with reserves at 8m. tons. In Georgia, where the talc produced is of a greyish colour, *Pioneer Talc* (in which Whittaker, Clark & Daniels is thought to have an interest) produces most of the state's 50,000 tpa production.

Western talcs

Talc production in the western USA is dominated by two major companies—*Cyprus Industrial Minerals Co.* and *Pfizer Inc.*—both with a number of production sites in California, Nevada, Montana, and, on a smaller scale, in Texas and Nebraska. A number of other companies are involved in the talc industry in the west, notably *Johns-Manville* and *R. T. Vanderbilt.*

Cyprus Industrial Minerals Company

Cyprus Industrial Minerals Company, formerly the United Sierra Division of Cyprus Mines Corp., is one of the largest producers of talc in the world. Cyprus Mines is active in a number of US states, particularly California, Montana, Texas, Nebraska, and Nevada, as well as in Belgium, Mexico, and Japan. Production in Montana mainly comes from the operations at Beaverhead (opened in 1969) and Yellowstone, both of which are open pits. On the other hand, production in California and Nevada is mainly underground—talc from the north and east of Death Valley in California is a pure cosmetic-grade steatite, whereas the material from the south and east is of an inferior quality. *Southwestern Talc*, a Cyprus Mines subsidiary, mines talc in Texas. The product is black due to a high carbon content but this volatilises on heating to give a good, white product.

The company's Three Forks mill in Gallatin County, Montana produces 'Mistron Vapor', an ultra-fine product based on talc from the Yellowstone mine. 'Mistron Vapor' came on to the market in 1957 and has since proved very popular particularly for pitch control in the pulp and paper industry. It has been announced

recently that $3m. has been allocated to expand the production of 'Mistron Vapor' by 50% which will mean a corresponding increase in the output from the Yellowstone mine. Montana talc is also processed at a mill at Alder, and the company operates two mills in Owens valley, California (processing cosmetic-grade steatite from Death Valley) and at Los Angeles (processing poorer grade talcs used in the paper and paint industry).

The processing and handling facilities at Ghent in Belgium is fed by imported US and Australian raw material which is shipped in bulk prior to processing and redistribution. In Mexico City local talc production is processeed by a subsidiary, mainly for use in rubber and insecticides. Last summer (1974) Cyprus mines relocated its headquarters and laboratory facilities from Trenton, New Jersey, to Los Angeles in California.

Pfizer, Inc, in Montana and California

The Minerals, Pigments, Metals Division of Pfizer, Inc. operates two talc mines in the western USA, one at Barretts in Beaverhead County, Montana (formerly owned by the Tri-State Minerals Co.) and in Death Valley, San Bernardino County in California. At the Barretts mine the steatite variety of talc is extracted from the open pit and transported to the processing plant to be washed, sorted, crushed, ground and bagged. The main grade is marketed under the trade name of 'Cercron' (that is an amalgamation of ceramic and micron) and is mainly consumed in the ceramics industry—other grades include 'Microtalc' and 'Talcron' which are used in the paper, paint, and cosmetics industries as well as in ceramics. Pfizer's other industrial mineral interests include barytes, limestone, mineral pigments, and wollastonite.

Some other producers

As well as operating talc deposits in the eastern States, R. T. Vanderbilt also owns Western Talc Co. of Los Angeles, which operated a mine at Tecopa. This operation was placed on standby during 1974 awaiting results from further feasibility studies of the deposits. At the same time, the Dunn Siding Mill, which processed the Tecopa material, was sold. In mid 1972 the Celite Division of *Johns-Manville* (J-M) of Denver, Colorado took over the interests of the L. Grantham Corporation and so became the parent company of *Desert Minerals Inc.* which operated small talc mines in Death Valley, California. Thus J-M broadened its interests by adding talc to its range of industrial minerals, which includes asbestos, perlite, and diatomite. J-M are currently looking at the possibility of marketing their talc in Europe, particularly the very high-grade varieties, and is also examining a talc prospect in Canada. If the Canadian deposit proves economical it could be in production by the year end.

Canada—production and exports rise

Talc mining began in Canada in the late nineteenth century when deposits in Bolton Township, South Quebec and in Huntingdon Township in the Madoc district of Ontario started production. These areas are still productive with *Baker Talc Ltd.* producing some 10,000 tpa from its talc/soapstone underground mine at South Bolton (the material is processed at the Highwater mill by both wet and dry methods) and *Canadian Talc Industries Ltd.* producing high quality talc at its underground workings at Madoc. *Broughton Soapstone & Quarry Ltd.* produces low grade talc for use in sculpture and crayons from its mine at Broughton in eastern

Quebec. The only Canadian source of pyrophyllite is a mine at Manuels, 12 miles southwest of St. John's in Newfoundland, owned by *Newfoundland Minerals Ltd.*, a subsidiary of the American Olean Tile Co. Ltd. which in turn is a subsidiary of the National Gypsum Co. The production (which was 37,000 tons in 1972) is shipped to the parent company's factory at Landsdale in Pennsylvania where it is used in the manufacture of ceramic tiles.

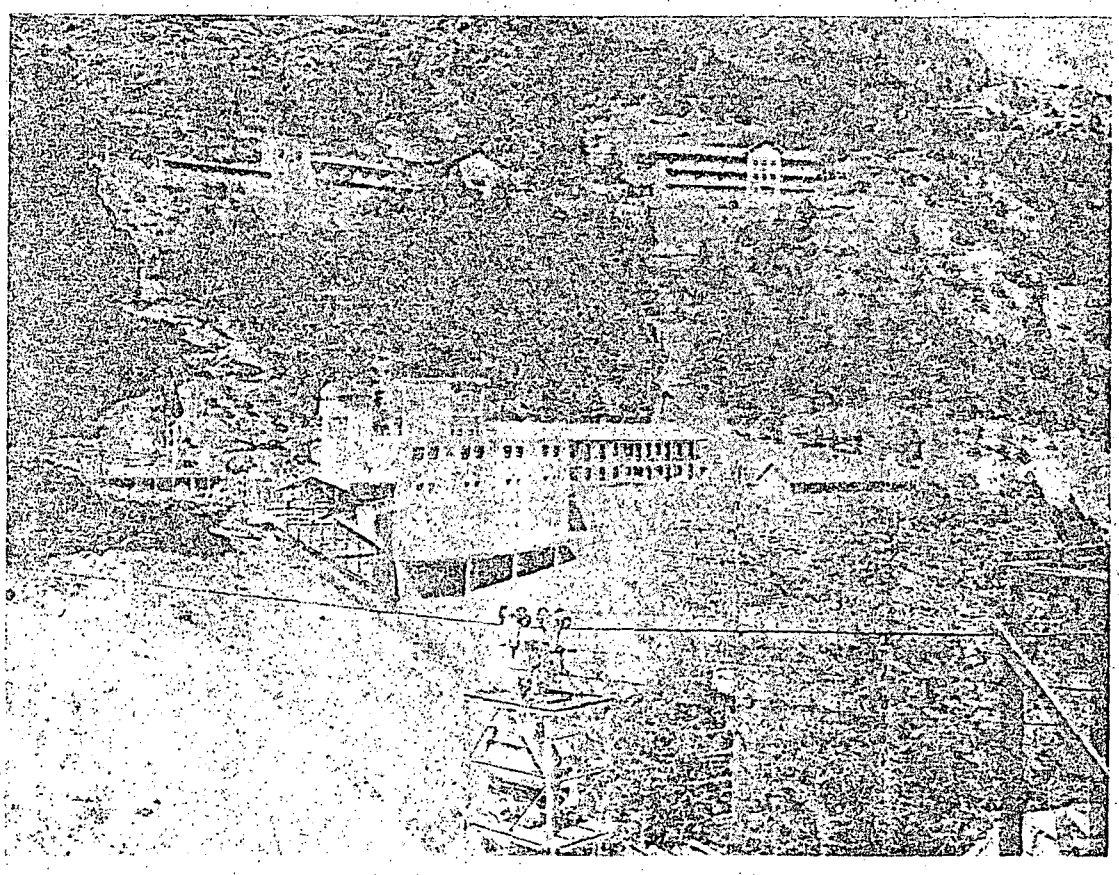
The Timmins area of Ontario has long been famed for its mining activity, particularly the early gold industry in the 'Porcupine Gold Belt' which included the legendary Hollinger Consolidated, McIntyre, Porcupine, Paymaster, and Dome mines among the 36 mines which have produced 30m. ounces of gold. In 1959 the geological and mining consultants, Watts, Griffis, and McOuat, recognised the area staked for gold as a potential source of magnesite and talc. Thus *Canadian Magnesite Mines Ltd.* was formed to exploit the deposit which is located in the Deloro and Adams Townships, near Timmins. Pilot tests on the deposit began in conjunction with Canadian Johns-Manville who held an option on the property with Canadian Magnesite up until October 1973. Since then Canadian Magnesite has carried on with the evaluation and has just completed bench scale and pilot plant testing. Sample evaluation to date indicates that it is a good quality talc with high brightness, a platy structure with no fibres, less than 2 ppm arsenic, and only trace amounts of lead and calcium. The material is thought to be suitable for ceramics, paper, and cosmetics, and the company is currently carrying out pilot plant evaluation which will be followed by a market survey. Canadian Magnesite are confident that the project will be financed to the production stage. (See IM April '71 for details of the deposit). It has been rumoured recently that Johns-Manville is evaluating another talc deposit in Canada and that a decision is expected soon. Details, however, are very scarce.

In Whitney Township, also near Timmins, a talc/magnesite deposit is in the advanced stages of exploration and a go/no-go decision is expected soon, possibly later this year. The deposit is free from quartz inclusions and contains 90% combined talc and magnesite. Reserves are around 100m. tons.

Production in Europe

France and Italy are Europe's leading talc producers with an average annual production of 250,000 and 150,000 tons respectively. Most of this talc is of a very high quality with little or no contamination, and so it is greatly coveted throughout the world, particularly for use in the cosmetic industry. Thus the talc produced commands a high price and is exported to various countries in relatively small lots. In **France**, the main producer is *SA des Talcs de Luzenac*, whose production from mines on the north slopes of the Pyrenees in Ariège, account for virtually all the talc produced in France (this is particularly true since it recently took over the operations of *SA Mines de Garrot*). In 1973 the company produced a total of 250,000 tons of talc (compared with 224,000 tons in 1972 and 217,000 tons in 1971) of which 184,000 tons was consumed in France (169,000 tons and 165,000 tons in 1972 and 1971 respectively), and 66,000 tons was exported (55,000 tons and 52,000 tons). The production is to be increased to 300,000 tons in the near future.

The major talc-producing area in **Italy** lies west of Pinerolo in the Cottian Alps where a 1,500 square kilometre area stretching from the Dora Riparia Valley in the north to the Torrente Maira Valley in the south has been known as a source of talc since the seventeenth century. The deposits were first operated by small family concerns which gradually dwindled in number so that in 1921 the two surviving operators merged to form the basis of Italy's leading talc producer, *Societa*



Societa Talco e Grafite val Chisone's talc mine in the central part of the Germanasca Valley in Italy. The building in the lower central part of the picture is the processing plant where the mined material is crushed, screened, dried, selected on the basis of hardness, and then milled. Part of the production is also micronised.

Talco e Grafite val Chisone. At one time the area boasted seven working mines—la Miniera Roussa, Maniglia, Fontane, le Miniere Envie, Sapatlè, Comba la Fracia, and Malzas—but today, because of depleted reserves, the area's sole productive mine is la Miniera Fontane, in the central part of the Germanasca Valley.

Like the French (and the Austrian) deposits, the genesis of the Italian talc is considered to be by hydrothermal and low-grade metamorphic replacement of local dolomite and dolomitic limestone. The commercial talc is totally unconnected with the serpentinites outcropping in the region. Thus the talc contains only trace amounts of silicates (such as chrysotile, tremolite, chlorite) and it is practically free from carbonate minerals (such as calcite, dolomite, siderite)

Production and sales for Soc. Talco e Graphite val Chisone

	1969	1970	1971	1972	1973
Proportion sold in Italy (%)	42.58	40.48	48.26	40.68	41.73
Proportion sold abroad (except USA) (%)	51.17	41.75	43.33	41.04	50.83
Proportion sold to USA (%)	6.25	17.77	8.41	18.28	7.44
Total production (metric tons)	69,994	79,825	71,787	82,112	71,802

Typical chemical analysis of la Miniera Fontane talc

SiO_2	61.80%	P_2O_5	0.06%
MgO	31.65%	S	0.03%
Fe_2O_3	0.59%	Pb	1–2ppm
Al_2O_3	0.60%	As	0.3ppm
CaO	0.20%	Cu	4ppm
H_2O+CO_2	5.16%	Ni	6ppm
TiO_2	0.05%	Mn	0.002%

Source: 'Il Talco del Pinerolese' by P. Sartoria

quartz, actinolite, sulphides, and iron oxides. This pure chemistry, allied to its lamellar rather than fibrous structure, has given Italian talc an international reputation for consistent high quality, and has made it ideal for use in the cosmetic and pharmaceutical industries (see table for chemical analysis).

In order to maintain this reputation, the beneficiation techniques employed at la Miniera Fontane are of the upmost importance. The mined material first undergoes primary crushing and screening through a 12mm. seive, drying in a cylindrical dryer, and selection by a Raymond selector to exclude particles above a set hardness, before a final milling in closed circuit to a 99.5% minus 200 mesh product. Some of this material is then micronised to sizes of 30, 20, and 10 microns. At each stage of the processing (and the underground mining) great care is taken not to introduce any contamination, either in the form of bacteria or as foreign mineral matter.

Despite the company's income from talc sales continuing to rise over the last few years, the actual tonnages produced and exported has decreased, probably due to domestic industrial disruptions and international trade problems. Over 60% of the company's production—which in 1973 was nearly 72,000 tons out of a total Italian talc production of 146,000 tons—is exported, and this percentage has remained constant over recent years. Sales to the USA, however, have dropped from over 18% of the company's exports in 1972 to only just over 7% in 1973; the deficit has been taken up by other non-Italian consumers (see accompanying table).

The main producer in **West Germany,** *Scheruhn Talkum-Bergbau,* works the talc deposits of the Schwarzenbach/Saale area of Northern Bavaria in south-east Germany. The talc is intermixed with outcropping serpentine and tremolite lenses, and this makes mining a relatively simple operation. After blasting, the material is transported by tipper-trucks to the plant where it is crushed and fed into hammer and ball mills. The very fine grades are separated by air classification. The various uses to which the material is put depends upon the composition of the material, and particularly the contents of serpentine and tremolite. Some of the production is fired to produce a temperature-stable product which is widely used as a raw material in high-class ceramic goods. Other material is used for fillers notably in plastics where the tremolitic-fibrous nature leads to good binding properties. The talc has been exploited since the beginning of the century and reserves are thought to be adequate for many years to come.

A view of the working face of Cantiere Crosetto in la Miniera Fontane, Italy. The 'plates' of talc are being prised away by the drill before it is transported to the processing plant for primary crushing.

Talkumwerke Naintsch, of Austria

Although *Talkumwerke Naintsch GmbH* had its beginnings as a pyrite producer, the company is today almost exclusively involved in the exploitation, processing, and marketing of talc. In **Austria,** the company now has an affiliated talc-producing company, *Osterreische Talkumindustrie GmbH,* as well as an affiliated company for marketing in Europe, *Naintsch Mineralwerke GmbH.* All the companies are owned by Erich von Kiwisch and his two sons.

Today the company's production is concentrated on three sites—Rabenwald, Lassing, and Weisskirchen. The Rabenwald deposit is exploited by both underground and openpit mining and the crude material is processed at plants at Anger, Oberfeistritz, and Stubenberg. In addition, some material is milled at the Weisskirchen micronising plant for use in specialised fields. The talc ore at Lassing, an intimate mixture of mag-

nesite and talc, is extracted by underground methods and is processed locally. Because of the product's exceptional whiteness, it is utilized as a filler in paint and sold as 'SE micro' or special extender. The raw material at Weisskirchen consists essentially of chlorite (a green hydrous magnesium-aluminium silicate), from which mica and quartz impurities must be removed. Specialised processing at the local plant yields 'Plastorit Naintsch' for use in the paint, varnish, and plastic industries where it serves to increase elasticity, adhesion, resistance to weathering, cohesion, and improves the efficiency of the binders. In 1973 the company's total talc production was 86,000 tons which constituted over 93% of the national output. 80% of this production was exported, mainly to West Germany, Italy and Switzerland.

Finland's only talc producer is *Suomen Talkki Oy* which operates the Lahnaslampi mine at Sotkamo in northern Finland. This operation was owned by Lohjan Kalkkitehdas Oy till *United Paper Mills Ltd.* took control of the company earlier this year. Since 1969 the talc/magnesite material has been treated by a flotation method and the production of this beneficiated material is currently about 130,000 tpa, although plans to increase this to 300,000 tpa are in hand. (See IM Dec. '74.) *A/S Norwegian Talc* is the largest **Norwegian** talc producer operating two mines—the larger is at Altemark near Mo i Rana (yielding 35,000-40,000 tons of micronised talc processed at the Knarrevik plant) and the other is at Framfjord in the Sognefjord region (producing 12,000 tons of coarse material). *Ostlandske Stenexport A/S* of Otta produces 35,000-40,000 tpa and *Smestad & Saetre A/S* of Kvam have an annual output of around 25,000 tons (see IM Jan. '75).

Sweden produced over 28,000 tons of talc in 1973, much of which was consumed in the large domestic paper and pulp industry. One producer of note is *Handöls Täljstens AB*, a subsidiary of the large refractory producer Höganäs AB, which produces talc as well as olivine at Handöl (in fact the company's name infers that it produces talc). The UK has recently begun to import talc from Sweden (see section on trade) and the statistics show that it rose to over 3,000 tons in 1974. However, Peter Skinner, the Sheffield-based minerals merchant, imports in the region of 5,000 tpa of talc from Handöls Täljstens AB and is their sole UK and European representative. The discrepancy in the figures can be explained by the fact that some Swedish talc is exported through a Norwegian port and so in the official statistics it is shown as of Norwegian origin. When the material enters the UK it is processed into four main grades—16-36, 36-70, minus 70, and minus 200 mesh—and is consumed mainly as a filler and in dusting roofing felts.

Shetland talc production doubles

Talc occurrences in the UK are almost exclusively confined to hydrothermally altered serpentinite bodies found in the Highlands and Islands of Scotland, in Cornwall, and Anglesey in North Wales. By far the most important source of talc in the UK—in fact the sole source except for minute amounts of talcose Polyphant stone produced by *Clarborough Products Ltd.* at Polyphant in Cornwall—is the talc-magnesite deposit near to Baltasound on Unst, the northernmost island in the Shetlands off the northeast coast of Scotland. Although the exploitation of these talc-bearing rocks is thought to have begun some time ago with the manufacture of pots, hearth-stones, etc., commercial production did not begin until after the 1939-45 war

when *Alexander Sandison & Sons Ltd.* began to exploit the Quayhouse or Quoys Quarry. This deposit is situated near the western edge of the serpentinite mass which covers the central section of the island and is sandwiched in between a gneiss complex on the west and greenstones on the east. Recent exploration in the area by Alexander Sandison and English China Clays has proved 400,000 tons of reserves both in the original quarry and in a number of nearby localities. An additional 500,000 tons of reserves is also known at an as yet unworked talc-magnesite deposit at Cunningsburgh on the Mainland of Shetland.

The Unst talc-magnesite is mined by open-pit methods such as blasting or ripping, and is transported by truck to the company's private wharf four miles away, from where it is shipped in bulk to Sharpness in the south-west of England. The milling and marketing of the Shetland talc is the resposibility of English China Clay Ltd. (ECC) who take over the crude talc at Sharpness harbour. The material is sent to the nearby Yate Mill where it is crushed, dried, and milled into three standard grades—100, 200, 300 mesh (intermediate grades are also available). About 5% of the Shetland talc is micronised by an ECC subsidiary, Rogers and Cooke (Salisbury) Ltd. at their Quidhampton mill near Salisbury. This mill also micronises imported Chinese talc, grinds marble, and custom grinds magnesite (see IM Sept. 74). The final products are marketed through ECC Sales Ltd.

The output of Shetland talc averaged between 9,000 and 10,000 tpa throughout most of the 1960s, but then expanded to 12,000 tpa in 1971, 16,000 tpa in 1972, and reached 20,000 tpa in 1973. Production last year is estimated to have exceeded the 1973 output. ECC says that the increase in production came about due to a decrease in the competitiveness of imported Norwegian talc which was brought about by the large increases in freight charges and the firming of Norwegian currency with respect to Sterling. A second mill has been installed at the Yate Mill to process the extra production. In this way the domestic source became economically attractive and thus increased its proportion of the UK market particularly for use in fertilizers (as an anti-cake material), in roofing felt, in insecticides, and in foundry requisites.

Others

Spain is another major talc producer with an average production of 40,000 tpa between 1970 and 1973 and its neighbour in the Iberian Peninsula, **Portugal**, has a modest output of just over 1,000 tpa. In the Eastern Bloc, **Bulgaria** had an output of 23,000 tons in 1974 and **Hungary** produced some 16,000 tons in 1973.

The rest of the world's producers

Australian production on the up

Production of talc (including steatite) in **Australia** has averaged just under 50,000 tpa over the last five years, with Western Australia contributing about 75% of this overall production. A major West Australian producer is *Three Springs Talc (Pty) Ltd.*, a company jointly owned by Western Mining Corporation Ltd. and Universal Milling Co. (Pty) Ltd., which operates an open-pit steatite/soapstone mine 13km. east of Three Springs and 340km. north of Perth. The talc is con-

tained in a 15 acre lenticular body and was formed by a replacement process during the metamorphism of local Proterozoic magnesium limestones. When the new company was formed in 1960, its first step was to discontinue underground mining and to introduce open pit methods. From the pit the material is moved to the processing plant (which was opened in 1968) where it is crushed, hand-sorted, and then sampled automatically according to colour. Sales for the financial year ending 18/6/1974 amounted to about 49,000 tons, most of which was exported to Japan and to Europe via Fremantle. All sales, excepting those in Australia and New Zealand, are handled by Cyprus Industrial Minerals of the USA which has processing and distribution facilities in Ghent, Belgium, to supply European customers.

Westside Talc, Western Australia

Westside Mines NL was formed about six years ago as an entirely public-owned company to exploit a talc deposit found at Mt. Seabrook, about 110 miles north of Meekatharra in Western Australia. After a number of trial shipments to potential customers, particularly in Japan, the company has now brought the mine into production with an output of 15,000 to 20,000 tpa and plans are in-hand to increase this to about 40,000 tpa over the next three or four years. The material is extracted by strip mining since the talc-bearing rock is very near to the surface. Processing of the material will initially be restricted to crushing the rock at the mine-site, screening through a grizzly, removing any iron oxide staining by water attrition, and then hand-sorting to remove any free quartz. It is probable that three grades will be available eventually, selected by colour (less than 88%, 88-90%, and over 90% whiteness at −325 mesh). The rated capacity of the plant is 30,000 tpa on the basis of an 8-hour shift, and therefore working on three shifts the theoretical capacity is nearly 100,000 tpa, although it is very unlikely this figure will be reached in practice. Current known reserves are adequate for about twenty years production on the above basis.

Amalgamet Australia Ltd., the Australian subsidiary of AMC, the international metals and minerals traders, are shareholders in Westside Talc NL and have sole control of world-wide marketing. The deposit consists of a white micaceous, foliated, tremolitic talc which is claimed to be asbestos-free, and has a very low lead (20 ppm) and arsenic (2 ppm) content. These properties, together with its good milling characteristics fulfil UK and USA health regulations, and make it ideal for use in cosmetics (see page 29). It also has potential as an industrial filler, particularly in the paint and paper trade. The interest by Japanese consumers in Westside lower grade talc stems not only from the now established mineral trade between Japan and Australia, but also from recent indications of irregularity in supplies from China. Amalgamet has also found interest in Europe, where it plans to build storage and processing facilities, to provide a direct customer service. The USA has also been earmarked as a future market. The talc will be shipped in 2,000 to 5,000 ton lots initially through Fremantle but, when the Allied Eneabba Pty Ltd.'s mineral sands project comes on stream later this year, shipping facilities built at Geraldton to handle the mineral sands production could also handle Westside Talc. Thus bulk shipment of talc from Australia to Europe would be able to compete with the traditional European sources, particularly if the current low level of freight rates continues.

South Australia and New South Wales

Production of talc and soapstone in South Australia averages about 11,000 tpa, most of which is produced at Mount Fitton, in the northern Flinders Ranges. The main company involved is the Minerals Division of *Steetley Australasia Pty Ltd.* and, to a lesser extent, *Industrial Rock Mines Pty Ltd.* Other South Australian talc producers are the *Ready-Mix Group* and *Torrens Mining Co. Ltd.* Talc production in New South Wales is less than a 1,000 tpa but pyrophyllite output increased from 6,596 tons in 1971 to 12,299 tons in 1972.

India—diversity of sources

In 1972, out of a total Indian steatite/talc production of some 189,342 tons, the state of Rajasthan produced 173,020 tons. Within Rajasthan the Udaipur district had an output of over 66,000 tons in the same year (that is about a third of the national output), mainly from mines operated by the *Associated Soapstone Distributing Co. (Pvt.) Ltd.* The main producing company in Jaipur, the second largest producing district with 37,000 tpa, is the *Jaipur Mineral Development Syndicate (Pvt.) Ltd.* operating a mine 17 miles from Dausa. The material is processed locally where the 2,500 tpm feed is milled to produce about 2,000 tpm of talc powder. Negotiations are presently in hand to install micronising facilities. The company exports high grade material to the UK, the USA, France, Yugoslavia, Japan, and Australia. The third district of Rajasthan is Bhilwara with a production of about 24,000 tpa, the major company being *Udaipur Mineral Development Syndicate (Pvt.) Ltd.* Other producing states include Andhra Pradesh, (6,072 tons in 1972), Madhya Pradesh (6,808 tons), Maharashtra (2,040 tons), and Uttar Pradesh

(1,014 tons). Since over 100 operators are active it is evident that the majority of these operations are on a very small scale indeed.

Thailand's talc production rose from 50 tons in 1971, to 1,550 tons in 1972, and then to 9,550 tons in 1973. Although there are no official production figures available from **Afghanistan**, Kabul radio reported on May 4, 1974, that "300,000 tons from the Mama Kheyl mine in Nangarhar were awaiting export" (source: Institute of Geological Sciences, London).

Talc production in Africa is very modest with a 1973 total of around 12,000 tons. The largest producers are **South Africa**, which has averaged about 8,000 tpa over the last seven years, and **Zambia**, with a production of 2,323 tons in 1972, 713 tons in 1973, and 4,521 tons in 1974. **Swaziland** has a production of less than a 1,000 tons of pyrophyllite. In North Africa, **Egypt's** 1967 production of 30,000 tons (a USBM estimate) has dropped to average 6,000 tpa over recent years.

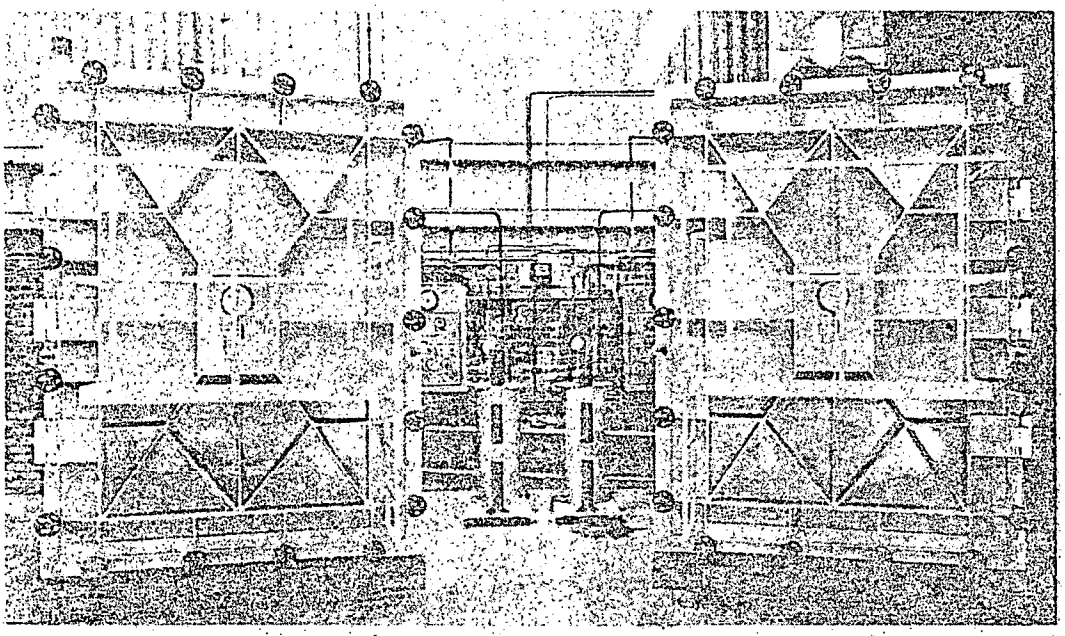
Grades and prices

The industrial utilisation of talc depends largely upon the chemical (see accompanying table) and physical properties of the mined material. Pure or 'true' talc is white-to-silvery white in colour, has a greasy feel, a specific gravity of 2.75, and a hardness of one on the Mohs scale (talc was arbitrarily chosen as the lower end of the Mohs scale of hardness and diamond as the upper limit). Some additional properties that make talc particularly useful in industry include: a high whiteness, softness, and smoothness; a good lustre; high slip or dry lubricating power; chemical inertness; a high fusion point, specific heat, and resistance to heat shock; low thermal and electrical conductivity and shrinkage; good oil and grease absorption; and a good retention as a filler.

Very few talcs can be used directly from the mine, and most have to be upgraded, treated, and cleaned before they are of any use. Italian and French materials have built up a reputation for natural purity, a quality particularly needed in the cosmetics industry. These talcs command a high market price which in turn means that the material can be traded economically in relatively small quantities (see trade section on page 30). The stranglehold these naturally pure talcs had on the market has been somewhat eroded in recent years through the application of sophisticated beneficiation

The average chemical composition of some commercial talcs

	France *Luzenac grade* 00S	*Italy* *Val Chisone* *MT 120*	*China* *Micronised* *MW4*	*Austria* *Best white* *(Mautern)*	*India* *'Finex'*	*UK* *Unst, Shetland*	*Norway* *Ground* *FWXO*	*USA* *Grey talc, Johnson Vt.*
Silica, SiO_2	57.52	60.52	59.40	61.54	62.2	34.8	39.8	42.73
Ferric oxide, Fe_2O_3	0.83	1.03	0.18	0.76	0.30	6.2	6.7	4.93
Alumina, Al_2O_3	3.08	1.27	0.68	1.74	0.30	1.3	0.6	1.17
Lime, CaO	0.53	0.53	0.66	1.81	0.10	0.4	0.6	0.10
Magnesia, MgO	31.60	31.75	31.40	30.09	32.20	34.5	33.1	33.16
Loss on ignition	6.48	5.51	7.10	3.65	4.90	23.6	19.7	17.69



The interior of AMC's sterilisation plant in the UK showing the chambers where the talc is treated with ethylene oxide under pressure to remove any bacteria.

techniques designed to upgrade the poor quality material. Originally, selective mining and hand-sorting were the only upgrading methods used, but later on processing by crushing, grinding, magnetic separation, and air-classification was introduced. The application of flotation methods to talc first began in the USA about a decade ago, and has had continued success ever since. In Europe, Suomen Talkki Oy of Finland process their talc/magnesite material in a three-stage flotation system which increases the percentage of talc from 56% to 93%, and also recovers the nickel values as a profitable co-product.

An added modern sophistication is the micronising of talc which effectively gives the talc a larger surface area and therefore improves certain properties such as opacity, dispersibility, and absorption. Micronising is a very specialised field, and the details of the process are jealously guarded by the companies involved. In the UK several millers including *Hopton Mining Co. Ltd., Colin Stewart Minerals Ltd., English China Clays Ltd., Microfine Minerals & Chemicals Ltd.,* and *Irwell Minerals & Chemicals Ltd.,* micronise talc (see IM Sept. 74). The feed material is all imported talc except for some Shetland material milled by ECC. Micronising facilities are currently being installed at Suomen Talkki Oy's plant in Finland, and Norwegian Talc micronise imported talc for re-export as well as their own product. Talc to be used in the cosmetic and pharmaceutical industries undergoes a final cleaning process when it is sterilised to remove bacteria and contamination. Details of the procedure are rare, but the general scheme is that ethylene oxide gas (or a similar substance) is pumped through a batch of talc for a pre-determined time. AMC has a sterilisation plant in the north of England, and the three major cosmetic companies working in the UK, Boots Pure Drug Co. Ltd., Cussons Sons & Co. Ltd., and Johnson & Johnson Ltd., all sterilise their own talc supplies.

Prices

Like other commodities recently, the price of talc has risen at such a rate that it is difficult to keep up to date, and forecasting future price movements is a thankless task. The talc price is particularly elusive because of the number of qualities, grades, and stages of processing, and an additional complication is that the country of origin influences the utilisation and so the price of the talc—a consideration that is not shared by many minerals. Cosmetic-grade talc from Italy requires very little additional beneficiation and therefore commands an extremely high price—currently the CIF (main European port) price is about £90-110 per metric ton, although very high quality talc sold in 1kg. lots fetch even higher prices. The French fine ground material, not as pure as the Italian cosmetic-grade, has a CIF price range of £40-90 per metric ton. The Chinese material, sold at the annual Canton Fair, is distributed by appointed agents. The current price is about £60-£70 per metric ton. Another major source of talc is Norway and, depending upon the purity and whether or not the material is micronised, the price varies from £30 per ton (ex-store) for ground material to £47-£70 per ton (ex-store) for the micronised material.

Patterns of consumption

Many characteristics of talc are duplicated by a number of other relatively cheap minerals—including which are feldspar, asbestos, kaolin, fuller's earth, and barytes—and so if talc is to be used in preference, there must be a low cost source available which can compete economically with any would-be substitute. The pattern of consumption in various industries is different from country to country and from continent to continent (see accompanying table). Recently, synthetic minerals have also substituted for talc, particularly in the ceramic and filler industries.

The most important talc-consuming industries are paper, paint, ceramics, cosmetics, refractories, insecticides, and rubber. The function of talc in the paper industry is to increase the brightness and opacity of the finished product, to control the pitch globules in the mix, and also to increase the retention of the fillers. The grade of the talc needs to be high since

Breakdown in the industrial use of talc [%]†

	UK	*W. Europe*	*USA*	*Canada*
Ceramics	3	2	35	22
Paint	30*	30*	18	19
Paper	1	17	6	10
Roofing	33	20	—	18
Rubber	13	10	4	5
Toilet prep.	15	15	14	2
Refractories	—	—	4	—
Construction materials	—	—	4	—
Fertilizers	4	5	—	—

**including plastics* †*All figures are for* 1970 *except USA which is* 1972

the process requires chemical inertness, softness, freedom from grit, a good ink acceptance, high brightness, and adequate dispersibility in water. Competitors include china clay, gypsum, barytes, and whiting. The use of talc in the **paint** industry is most notable in the field of exterior paints where its properties of durability, good viscosity, and uniform weathering are required. In addition it does not discolour and it reduces pigment settlement, thereby reducing the amount of titanium dioxide required. Talc of the quality to be used in the paint industry needs to be completely free from coloured material and 98.5% minus 325 mesh in order to give the paint a smooth finish. The main competitors are pyrophyllite, whiting, china clay, gypsum, and barytes, although added competition comes from the use of synthetic pigments and metals, ceramics, asbestos-cement, and gypsum facing materials which do not require painting. Poor-quality talc is also used as a filler and surface-coating for **roofing** paper and shingles since it provides a fireproof, weather-resistant, non-sticky product (this is the main use of talc in the UK). The demand for paint and roofing materials is closely linked with the level of building activity which in turn depends upon the state of the economy, and so demand tends to fluctuate considerably.

Talc is used in the manufacture of various **ceramics and refractories** in direct competition with wollastonite, kyanite, alumina, and clays. The final products range from very high quality electronic steatite components to floor or wall tiles and pottery. Refractory applications are restricted almost entirely to pyrophyllite. In Japan, the world's largest pyrophyllite producer, about 50% of the total prodution is used in refractories. The use of talc as a filler in the **rubber** industry is on the increase since apart from adding bulk it gives added electrical insulation and prevents sticking. Talc provides translucency at a low cost in the **plastics** industry, particularly for vinyl floor tiles, polyesters, epoxies, and polypropylene.

In the **textiles** industry finely ground talc is used for bleaching and packing; the material needs to be of good quality and of high whiteness. Talc is used as a carrier for **insecticides,** where requirements are chemical inertness, with respect to toxicants, a satisfactory bulk density, and a low abrasive level.

Talc is used in the **cosmetics** industry for a number of preparations including make-up creams, coloured make-up, dermopediatric preparations, and of course talcum powder. The chemical and physical specifications of cosmetic-grade talc are strictly controlled; for example, allowable limits in the USA are a maximum of 0.01% foreign substances soluble in acids, no trace iron, and a maximum of a 5% loss through calcining. More specifically, the inclusion of minerals such as dolomite, calcium silicates, tremolite, serpentine, chrysotile, anthophyllite, etc., in a particular talc, precludes its use in cosmetics because of their micro-abrasive action on the skin and the resulting loss of fluidity. Also, the talc must be neutral when in contact with water so as not to affect the acidity of the skin, which ideally should have a pH of between 5 and 5.5. Particle size is also strictly controlled, with recommended standards of 100% minus 100 mesh and 98% minus 200 mesh. In general, cosmetic talc must have good absorbing powers on the skin, a good water repelling action, good fluidity, and good adherence to the skin in very fine layers.

Health hazards—inhalation, ingestion, contact

Various health hazards have been spotlighted recently by the public questioning the safety of chemicals, medications, treatments, etc., and the lasting health effects of certain working environments. Many such questions have been asked in the cosmetics industry, including the risks involved when using talc on the skin. As outlined briefly above, both physical and chemical standards have to be rigidly enforced in an attempt to eliminate any harmful effects if certain elements and minerals are present (see above and tables). It has been known for some time that inhaling talc over a prolonged period causes 'talcosis', a lung complaint which, like silicosis and asbestosis, is in the pneumoconiosis family of diseases. Allegations that talc is a carcenogene have yet to be proved, since the causes of cancer in general are far from clear. Current thinking, however, maintains that the harmful effects of talc itself are limited, and that the real danger lies with its intimate association with asbestos ('asbestos' in the sense of a general term covering a number of complex, fibrous, magnesium silicates). The added danger is that asbestos, having roughly the same chemical formula as talc, can only be distinguished from talc by complex analytical methods such as the scanning electron microscope, and so often escapes detection.

There seems little chance of harmful effects caused by talc contacting the skin itself since most cosmetic talcs are sterilised (see page 28) to remove any harmful bacteria. Similarly danger from ingestion is rare since this can usually be avoided.

Trade is brisk

Although international trade in the industrial minerals fields is becoming increasingly common, it is usually carried out in large tonnages and the material is transported in bulk. In the case of talc, however, certain grades command very high prices—particularly those that require little additional beneficiation—and so can be shipped in small lots. The major European producers—Austria, France, Italy, Norway, and Finland—all export a large percentage of their output, particularly to their European neighbours. The UK's 1974 imports

UK talc imports (*metric tons*)

	1970	1971	1972	1973	1974
Belg-Luxembourg	2,409	2,408	2,415	2,567	2,679
China	9,649	9,647	11,332	11,570	10,052
France	13,971	12,960	11,056	14,152	11,829
W. Germany	564	580	988	585	247
India	3,638	1,911	1,499	2,804	3,884
Italy	8,341	7,753	7,737	9,040	3,050
Netherlands	944	640	1,231	2,517	508
Norway	16,403	18,725	17,973	16,501	14,231
Sweden	—	—	46	1,079	3,337
USA	1,027	1,281	1,000	1,895	340
Total	57,463	56,362	55,595	63,283	51,801

Only the major sources are shown

of talc which amounted to 51,801 tons, came from a great variety of sources, the major ones being Norway (14,231 tons), France (11,829 tons), China (10,052 tons), and Italy (3,050 tons) (see table). The level of Chinese exports is interesting; in 1973 Japan imported 72,163 tons of steatite and 101,070 tons of talc from China

(compared with 57,771 tons and 74,687 tons respectively in 1972) and West Germany imported 7,072 tons in the same year (5,571 tons the year before). These figures alone, however, seem to greatly exceed the USBM estimate of 150,000 tpa for Chinese talc production for each of the last five years. The Chinese minerals are distributed by the *China National Metals & Minerals Import & Export Corporation* through appointed agents.

Although Belgium itself is not a producer of talc, it imports around 30,000 tpa, half of which is exported after processing. Cyprus Industrial Minerals of the USA has set up a subsidiary company in Belgium which imports talc from the USA and also handles Three Springs Talc Co.'s material. Belgium is also used by other European producers to distribute and/or process material, for example, Austria, France, and Norway.

The high quality of the Italian mineral means that even the USA, a major producer and exporter of talc,

Italian talc exports (*metric tons*)

	1969	1970	1971	1972	*Jan.June* 1973
Belg.-Luxembourg	—	—	—	7,548	—
France	4,810	4,980	—	4,900	—
W. Germany	16,293	13,144	14,858	18,014	16,583
USA	4,636	13,206	6,224	15,169	—
UK	8,586	6,786	8,351	—	9,785
Venezuala	1,438	2,170	2,075	—	—
Total	48,630	54,308	48,074	59,006	32,231

imports large tonnages of Italian material, as does the UK, West Germany, and even France (see table). On the other hand, Australia's main customers are Japan

Australian talc exports (*metric tons*)

	1969	1970	1971	1972	1973*
Japan	9,818	16,185	20,426	14,953	16,003
Netherlands	21,885	12,584	9,889	14,992	11,165
New Zealand	1,451	1,542	1,713	—	—
UK	91	90	—	—	—
Others	350	146	118	2,107	1,495
Total	33,595	30,547	32,146	32,052	28,663

**to September only*

and the Netherlands who shared evenly about 90% of Australia's 1972 talc exports which amounted to 32,052 tons. New Zealand is the only other customer of note (see above). West Germany currently imports over

West German talc imports (*metric tons*)

	1970	1971	1972	1973	*Jan.-Oct.* 1974
Natural talc, crude or split					
India	659	1,077	680	433	459
China	3,792	1,564	1,302	846	2,580
Australia	9,175	6,436	2,772	5,036	3,874
Total	15,899	9,422	4,949	6,671	8,109
Other talc					
Australia	—	—	—	—	2,596
France	11,233	12,299	16,207	17,870	16,769
Belg.-Luxembourg	879	2,057	3,310	3,818	4,704
Italy	13,644	15,425	17,144	18,303	15,638
UK	1,049	758	376	403	—
Norway	9,071	10,688	11,447	13,064	8,465
Austria	35,466	36,003	32,169	33,454	29,563
USA	1,954	991	—	163	—
India	629	436	174	494	—
China	7,469	5,050	4,688	6,226	5,384
Total	81,709	84,047	85,445	95,027	—

100,000 tpa of talc, a third of which comes from neighbouring Austria (33,454 tons in 1973), and much of the rest from Italy (18,303 tons), France (17,870 tons), Norway (13,064 tons), and China (6,226 tons) (see table). Other major exporters are North and South Korea, and India.

Outlook for talc

World talc production over the last quarter century has shown a very regular growth, doubling from 1.2m. tons in 1950 to 2.4m. tons in 1960, and doubling again over the next decade to reach 4.9m. tons in 1970. Growth since 1970 has been more moderate, rising to only 5.16m. tons by 1973, which indicates a levelling-off of production following twenty years of rapid expansion. It is generally considered that demand will continue to climb, but that the rate depends upon a number of factors. A major influence is the ability of talc to compete successfully with many would-be substitutes, since it is one of more than a dozen minerals that, depending upon economics, can be used by the filler/extender consuming industries. In addition, the actual tonnage used depends upon the level of activity in the respective industries; for example, its utilisation in the ceramics industry depends upon the rate of production of low-cost ceramics, and the tonnage of talc consumed as a white filler—currently a booming market due to the high price of prime pigments, etc.—depends upon the level of production of plastics, paints, and roofing materials which in turn depends upon the activity in the construction industry—a well-known barometer of the prevailing economic climate. The success of pyrophyllite in making inroads into the refractory industry has been limited, although in Japan and the western USA, where pyrophyllite is relatively plentiful, the success is quite marked (in fact over half of Japan's pyrophyllite production is used in refractories). Talc has met with great success in the paper industry and this seems to be a major field for expansion in the future.

A further barrier to talc expanding its markets could be the current controversy over the dangers of talc from the point of view of health. The working environment when talc is mined, processed and manufactured into various products now has to be tightly controlled which will call for capital investment which in turn will increase the cost of production. However, a factor that may counteract this disadvantage may be the high price some talcs can command, particularly the micronised grades, so that the extra production costs could be absorbed by the overall price. The health hazard problem has far from been resolved although many of the accusations are said to be unfounded and emotive; a clearer picture of the situation will emerge in due course.

Reserves seem to be adequate for many years to come, even if the market grows appreciably—in fact with the introduction of new beneficiation techniques many previously non-economical deposits can now be mined successfully. The world's two largest producers—the USA (with reserves estimated at 150m. tons) and Japan (60m. tons)—hold well over half of the world's 360m. tons of reserves. The overall picture for the future of talc is unclear, although its uses in such a wide variety of industries gives it the advantage of flexibility.