Mineral Resources
Consultative Committee

**Mineral Dossier No 10**

# Talc

Compiled by
D E Highley, BSc, MIMM, C Eng.
Mineral Resources Division
Institute of Geological Sciences

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*Titles in the series*

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## Preface

The Mineral Resources Consultative Committee consists of representatives of interested Government Departments, and specialist advisers. It was set up in 1967 to keep present and future requirements for minerals under review and to identify problems associated with the availability, exploitation and use of mineral resources, both inland and offshore, having regard to competing demands on land use and other relevant factors.

Widespread and increasing interest in the mineral resources of the United Kingdom has led the Committee to undertake the collation of the factual information at present available about those minerals (other than fossil fuels) which are now being worked or which might be worked in this country. The Committee has produced a series of dossiers, each of which was circulated in draft to the relevant sectors of the minerals industry. They bring together in a convenient form, in respect of each of the minerals, data which had previously been scattered and not always readily available. These dossiers are now being published for general information.

## Acknowledgements

This mineral dossier has been compiled with the assistance of the Department of the Environment and the Department of Industry. The compiler would also like to thank his colleagues at the Institute of Geological Sciences for their helpful advice and contributions, in particular Mr D Horne and Mr M C Harrison of the Mineral Statistics and Economics Unit, Mineral Resources Division, and Mr J A Bain of the Mineralogy Unit, Geochemical Division. Thanks are also due to Alexander Sandison and Sons Limited, English China Clays Limited and Clarborough Products Limited, as well as numerous other United Kingdom suppliers and consumers of talc for their assistance.

Metric units are employed throughout this document except where otherwise stated. In most cases this has necessitated the conversion of originally non-metric data. The units and conversion factors used are as follows:

| | | |
|---|---|---|
| millimetres | (mm) | = inches x 25.4 |
| metres | (m) | = feet x 0.3048 |
| kilometres | (km) | = miles x 1.609344 |
| hectares | (ha) | = acres x 0.404686 |
| grammes | (g) | = troy ounces x 31.1035 |
| kilogrammes | (kg) | = pounds x 0.45359237 |
| tonnes (1000 kg) | | = long tons x 1.01605 |

## Contents



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**Summary**

Talc is a hydrated magnesium silicate with the formula $Mg_3 Si_4 O_{10}(OH)_2$. The mineral is extremely soft (it is the standard for hardness 1 on Mohs' scale) and has a characteristic soapy feel. Commercial grades of talc range in colour from white to grey and may contain varying proportions of associated minerals, the most common of which are magnesite and chlorite.

Talc deposits occur in a metamorphic environment associated with either ultrabasic rocks or dolomitic limestones. In the United Kingdom, talc is almost entirely confined to metamorphosed ultrabasic rocks which have undergone hydrothermal alteration; its occurrence, therefore, is largely restricted to the Highlands and Islands of Scotland, although it also occurs in Cornwall and Anglesey. Deposits of talc are found mainly in the Shetland Islands, in particular on the island of Unst, where the only talc producer of any significance in the United Kingdom is situated. A talc-magnesite deposit occurs at Cunningsburgh on the Mainland of Shetland and other talc deposits are known at Portsoy, Banffshire; Corrycharmaig, Perthshire; Glenelg, Rossshire and in the Innellan and Toward district of Argyllshire, some of which have been worked in the past. At Polyphant near Launceston, Cornwall an altered ultrabasic rock, known as 'Polyphant Stone', consisting mainly of talc and chlorite, is worked from time to time. Dereliction caused by talc exploitation in the United Kingdom is negligible because of the small size of the operations.

Industrially, talc is valued for its softness, smoothness, dry lubricating properties, whiteness, chemical inertness and foliated structure, among other properties. Its most important and best known applications are in the cosmetics and pharmaceutical industries although its use as a filler and extender in paints is also important. The mineral is also used in the manufacture of certain ceramics, as a filler and dusting agent in the roofing felt, rubber and plastics industries and in the manufacture of fertilizers and insecticides, as well as in numerous other applications. Commercial grades of talc range in quality from the high purity, white, cosmetic grades to grey-coloured, low-grade talcs often containing in excess of 50 per cent impurities. Prices generally range between £12 and £55 per tonne depending on grade.

The United Kingdom is, by world standards, a very minor producer of talc, production in recent years being only about 10,000 to 12,000 tonnes, although in 1973 production increased to 20,333 tonnes. The United Kingdom is a significant importer of talc, Norway, France, Italy, and China being the main sources of supply; in 1973 imports amounted to 63,283 tonnes valued at £2,266,690. Exports, consisting of imported material further processed, are small and amounted to 2,044 tonnes in 1973.

Almost all the United Kingdom output of talc is produced by Alexander Sandison and Sons Limited, from operations near Baltasound on Unst in the Shetlands. The mineral, which is produced by opencast quarrying, is relatively low-grade, containing only about 45 per cent talc, the main accessory mineral being magnesite. The whole of the production is sold to Yate Mills Limited, a member of the English China Clays Group, for milling at their works at Yate near Bristol. Small quantities of the talcose Polyphant Stone are produced at Polyphant in Cornwall by Clarborough Products Limited.

## Definition and mode of occurrence

Talc is a hydrated magnesium silicate which, when pure, has the formula $Mg_3Si_4O_{10}(OH)_2$ corresponding to a theoretical composition of 31.7 per cent MgO, 63.5 per cent $SiO_2$ and 4.8 per cent $H_2O$. Substitution within the talc lattice is not common, although minor amounts of iron may replace magnesium and very small amounts of aluminium may substitute for magnesium and silicon. However, commercial grades of talc rarely approach the theoretical composition of the pure mineral (see Table 1) because of the presence of other minerals intimately associated.

Structurally, talc is a layer-lattice mineral in which each layer is composed of a brucite sheet (in which Mg is linked octahedrally to O and OH) sandwiched between two sheets of silica tetrahedra (in which Si is linked tetrahedrally to O). Each layer is electrically neutral so that no additional cations are required between the layers to satisfy an electrical imbalance (as in the micas) and there is no residual electric charge of the sort that gives rise to the cation-exchange capacity of clay minerals. This neutrality and chemical inertness are properties of considerable industrial importance. As in all layer-lattice minerals, the individual layers are held together by weak Van der Waals' forces and not by ionic bonding. This weak bonding accounts for the excellent basal cleavage of talc, producing platey or foliated particles of high surface area which is the reason for its high covering power when used in paints; it also leads to other properties such as marked anti-settling behaviour in suspension. As in the case of graphite, the weak bonding allows a certain amount of slippage between the layers when a shearing force is applied and gives the extremely smooth and unctuous feel of talc which is of value when it is used as a dry lubricant in pharmaceutical and toilet preparations.

Talc, which occurs as massive foliated aggregates, is usually white, silvery white, pale green or yellowish in colour, has a greasy feel and pearly lustre and is used as the standard for hardness 1 on Mohs' scale. Commercial grades may be slightly harder because of the presence of impurities. *Steatite* is the term used to describe the massive, fine-grained (cryptocrystalline) variety of talc. (This term has also a specialised meaning in the ceramics industry, see p.6.) The term *soapstone* (and occasionally *potstone*) is loosely applied to impure talcose rocks containing variable proportions of talc and associated minerals. *Polyphant Stone* is an altered ultrabasic rock occurring at Polyphant, near Launceston in Cornwall which consists of talc and chlorite, with smaller amounts of dolomite and other minerals. *Pyrophyllite*, a hydrous aluminium silicate with the theoretical formula $Al_2Si_4O_{10}(OH)_2$, is the aluminium analogue of talc and has similar physical properties, although it is slightly harder and does not flux as easily when fired (pyrophyllite has a melting point of 1,700° C, talc 1,490°C). Commercial grades of pyrophyllite have been marketed as talc for some purposes in the past.

**Table 1 Typical chemical analyses of some commercial grades of talc**

*Weight per cent*

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
|---|---|---|---|---|---|---|---|
| $SiO_2$ | 59.40 | 60.47 | 57.52 | 47.50 | 39.8 | 34.8 | 63.5 |
| $Al_2O_3$ | 0.68 | 1.55 | 3.08 | 13.25 | 0.6 | 1.3 | |
| $Fe_2O_3$ | 0.18 | 1.32 | 0.83 | 2.50 | 6.7 | 6.2 | |
| CaO | 0.66 | 0.65 | 0.53 | 1.05 | 0.6 | 0.4 | |
| MgO | 31.40 | 30.75 | 31.60 | 26.05 | 33.1 | 34.5 | 31.7 |
| Loss on ignition | 7.10 | 5.69 | 6.48 | 9.00 | 19.7 | 23.6 | 4.8 |

*1* Chinese micronised talc MW4; Rogers and Cooke Limited.
*2* Italian (Pinerolo) talc Extra A; Zach Cartwright Limited.
*3* Luzenac talc grade 00S; Luzenac Talc Sales Limited.
*4* Luzenac talc grade 2S; Luzenac Talc Sales Limited.
*5* Norwegian ground talc FWXO; Norwegian Talc (UK) Limited.
*6* Unst talc (Queyhouse quarry); English China Clays Limited.
*7* Theoretical composition of the pure mineral.

*Sources:* Published commercial data.

Talc deposits usually occur associated with either altered ultrabasic rocks or metamorphosed dolomitic limestones, the formation of talc probably being due to the action of hydrothermal solutions on these magnesium-bearing rocks. In the United Kingdom, talc is almost entirely confined to metamorphosed ultrabasic rocks, where it occurs as an alteration product of magnesium-rich silicates, such as olivine, diopside and enstatite, and is commonly found along shear and fracture zones through which the hydrothermal solutions permeated. Generally speaking the first stage in the hydrothermal alteration of an ultrabasic rock is the formation of serpentine [$Mg_3Si_2O_5(OH)_4$] which may be followed by the formation of talc during low-grade greenschist facies metamorphism. Talc may also be formed by the low-grade thermal metamorphism of dolomitic limestones, the silica having been present in the original sediment or introduced by hydrothermal solutions, and at a late retrogressive stage in metamorphism when it may replace a variety of silicates produced under conditions of higher temperature and pressure. Talc, therefore, occurs associated with a wide variety of minerals including the serpentines, chlorites, tremolite – actinolite, anthophyllite, magnesite, dolomite, calcite and quartz. Such remnant magnesium silicate minerals as olivine, enstatite and diopside, together with residual chromite, picotite and magnetite, may also be present. High purity white talcs are commonly derived from the metamorphism of siliceous dolomites, whereas impure varieties, with higher iron contents, are generally associated with ultrabasic rocks.

In industry the term 'talc' is rather loosely applied to a wide range of commercial grades containing varying proportions of talc and other minerals which are used for many different purposes. Cosmetic grade talcs contain a high proportion of the pure mineral, whilst lower quality industrial filler and dusting grades may contain as little as 45 per cent talc, the most common accessory minerals present being magnesite and chlorite. Table 2 shows typical mineralogical analyses of some commercial grades of talc.

**Table 2 Typical mineralogical compositions of some commercial grades of talc**

| | *Weight per cent* | | | | | |
|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* |
| Talc | 95 | 90 | 89 | 50 | 49 | 45 |
| Chlorite | 3 | 4 | 8 | 49 | 15 | 12 |
| Magnesite | - | 0.6 | - | - | 31 | 37 |
| Dolomite | 1 | 0.8 | - | trace | - | 4 |
| Tremolite | - | - | - | - | trace | - |
| Serpentine | - | - | - | - | * | - |
| Quartz | - | trace | trace | trace | - | - |
| Opaques | - | - | - | trace | trace | trace |
| Percentage reflectance | 94 | 89 | 84 | 70 | 70 | 64 |

* Serpentine identified by X-ray diffraction but included by thermogravimetry in chlorite figure.

Mineralogical compositions obtained by X-ray diffractometry; weight percentages derived from thermogravimetric data. Percentage reflectance gives an indication of whiteness.

*1* Chinese talc – cosmetic grade.
*2* Italian (Pinerolo) talc – cosmetic grade.
*3* French (Luzenac) talc – high quality.
*4* French (Luzenac) talc – industrial grade.
*5* Norwegian talc – industrial grade.
*6* Unst talc (Queyhouse quarry) – industrial grade.

*Source:* Institute of Geological Sciences. *Rep. No.* 132, *Mineralogy Unit.* 1973. [Unpublished]

Some grades of 'talc' contain only minor amounts of the pure mineral but a high proportion of fibrous minerals, mainly tremolite [$Ca_2(Mg,Fe)_5 Si_8O_{22}(OH)_2$] but also anthophyllite [$(Mg,Fe)_7 Si_8O_{22}(OH)_2$]. Tremolite imparts desirable properties to the talc for certain applications, for example in paints the fibrous particles act as a suspension aid and the chemical composition is ideally suited for certain ceramic bodies such as wall tiles. The famous tremolitic talcs of New York State, USA, may contain 50 per cent or more of tremolite and less than 25 per cent talc; indeed some grades contain virtually no talc at all. The term *asbestine* is rather loosely applied to grades of talc used in paint manufacture which contain substantial but varying amounts of fibrous minerals. However, it seems that the term *asbestine* is also being used in the United Kingdom for some grades of talc used in paint manufacture, but which do not, apparently, contain fibrous minerals. Talc itself is often referred to as occurring in fibrous form and this may be due, in part, to pseudomorphing after other fibrous minerals, but most so-called 'fibrous talcs' consist largely of other minerals, usually tremolite and anthophyllite.

In recent years, concern has been expressed at the potential dangers to health occasioned by the presence of fibrous minerals in some commercial grades of talc. However, although a great deal of further detailed mineralogical work is required to establish the non-talc components of the numerous commercial grades on the market, it seems likely that in the majority, fibrous minerals are present only in very minor amounts, if at all.

*Talcum powder* is a familiar commodity and *French Chalk* or powdered talc, used for a variety of dusting purposes, is equally well known, but the term is also used for sticks or lumps of the mineral used for marking steel or cloth (tailor's chalk). In the ceramics industry, the term *steatite* refers to fired ceramic bodies, i.e. steatite ceramics, which are produced from mixes containing a major proportion of talc. *Wonderstone* is the name given to a massive block pyrophyllite produced in South Africa.

**Resources**

The occurrence of talc in the United Kingdom is almost entirely confined to serpentinite bodies which have undergone hydrothermal alteration, usually, although not always, in association with dynamic metamorphism. Talc is, therefore, largely restricted to the Highlands and Islands of Scotland (see Fig. 1 page 7), although it is also found in Cornwall and Anglesey.

Talc occurrences are widely distributed in Scotland but the most important deposits are found in the Shetland Islands, particularly on Unst and the Mainland of Shetland. The Unst serpentinite stretches across the eastern part of the island from the south coast, north-north-eastwards to Clibberswick, north of Harold's Wick (see Fig. 2 page 8). The western portion of the serpentinite consists largely of antigorite but along its western margin, where thrusting has taken place, irregular bands of talc-schist and talc-magnesite rock have been formed extending from the Wick of Belmont in the south, northwards to Queyhouse, and also along the western edge of the Clibberswick serpentinite further east, from Cross Geo in the south, northwards to Nor Wick. (The word 'Klebber', and its varieties Cleber and Clibber, is a local name for talcose rock in Shetland and is incorporated in many place names.) Talcose rock also occurs in narrow belts and lenses up to a few hundred metres in length along fault zones within the serpentinite running both parallel and perpendicular to its western margin. The talcose rock consists essentially of talc and magnesite, with smaller quantities of chlorite, antigorite, chromite and magnetite. Often, however, lenticles of almost pure talc, up to a metre or so thick, occur within the talc-magnesite rock. At the Queyhouse or Quoys quarry, near Baltasound, talc has been successfully worked since 1945, although initial operations started in 1940; production in 1973 amounted to 20,333 tonnes of talcose rock. More recently planning permission has been given for a further talc quarrying operation at Cross Geo.

At Cunningsburgh in the southern part of the Mainland of Shetland a belt of metamorphosed ultrabasic rocks some 550m wide consists of small masses of serpentinite enclosed in talc-magnesite schists. The talc-schists are extensive and appear to be homogeneous over an area of about 5.5 hectares. Other extensive outcrops also occur. The deposit is relatively low-grade, the bulk rock containing about 45 per cent talc and 45 per cent magnesite, the remainder consisting of magnetite/chromite and chlorite. Talc is also found in association with serpentinite at the northernmost point of the Mainland of Shetland, on the Isle of Fethaland, and at Cleber Geo soapstone was once worked on a small scale.

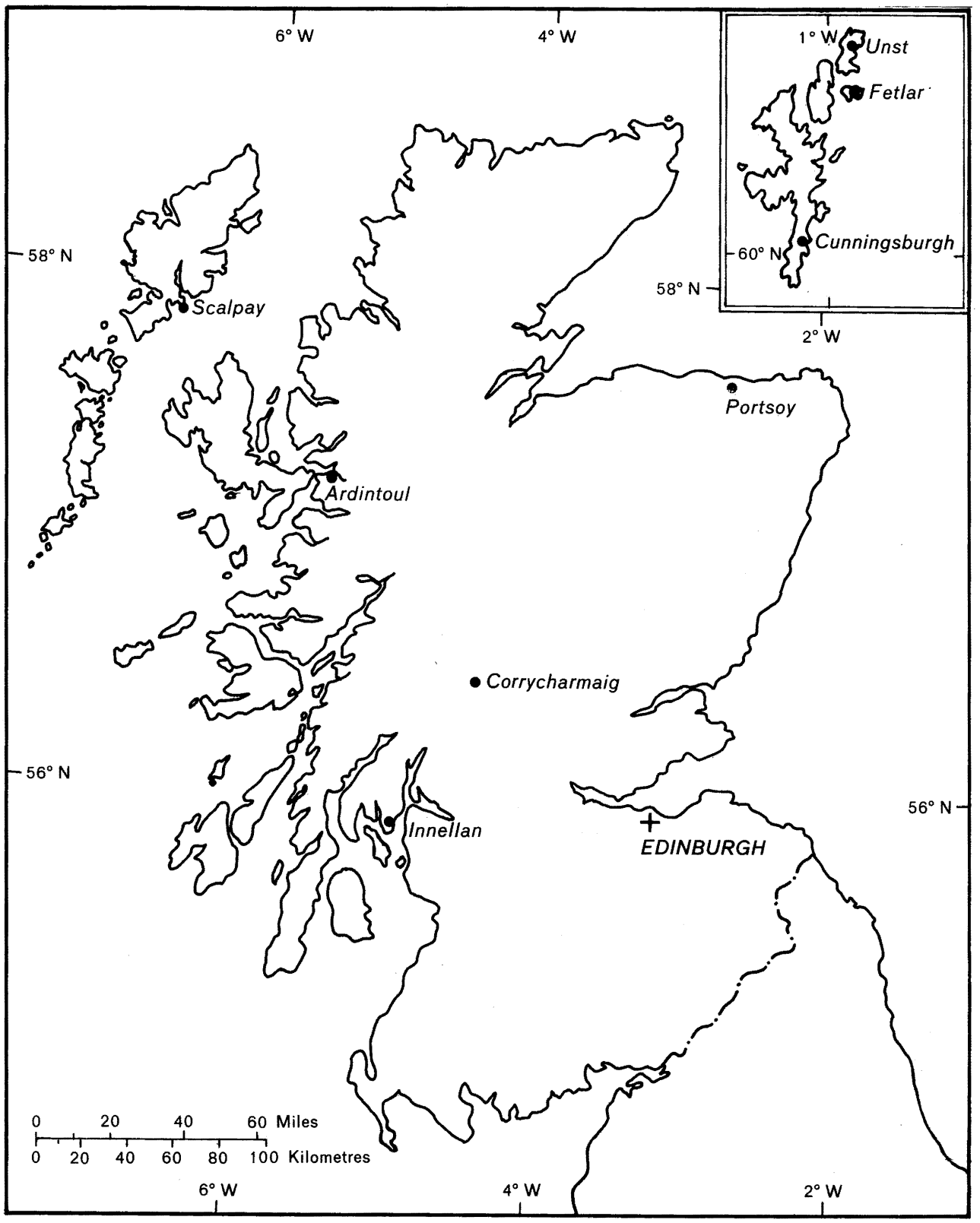


**Fig 1** Talc localities in Scotland

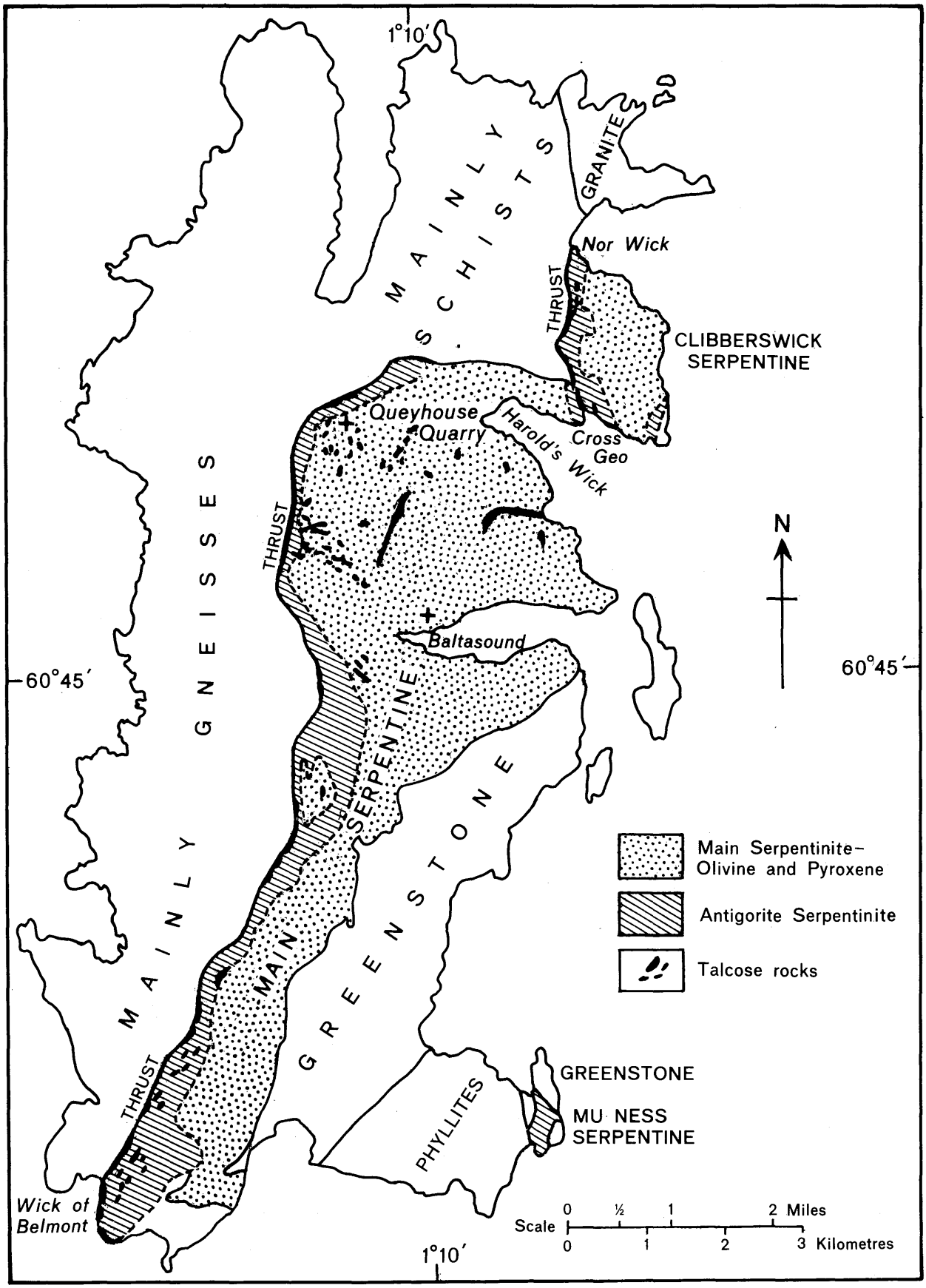


**Fig 2** Distribution of talcose rocks on the island of Unst in the Shetlands. (After H H Read. *Q. Jnl geol. Soc. Lond.*, 1934, Vol. 90, Pt.4, No. 360, figs 7 and 9, pp. 663 and 670.)

On Fetlar, an island south of Unst, talc is found in serpentinite along thrust planes a few metres wide at a number of localities. The most important is at Hesta Ness in the north-east of the island, where talc was quarried on a small scale between 1914 and 1924, some 400 tonnes having been produced between 1920 and 1923. Talc-schist also occurs at Stackaberg and Leagarth, and soapstone at Robis Geo.

On the mainland of Scotland talc occurs at a number of localities, usually as veins or crush zones in serpentinite, and has been worked sporadically in the past. At Portsoy in Banffshire a belt of serpentinite up to 400m wide extends in a south-south-westerly direction from the coast, 0.8 km west of Portsoy, for a distance of some 9.5 km inland to the Mains of Badenyouchers. Talc occurs within the serpentinite at the Damheads quarry, some 2.5 km inland, as veins or lenses in crush zones distributed en echelon parallel to the strike of the serpentinite mass. The lenticular bodies rarely exceed more than 0.3m or so in width and seldom more than 7m in height although they are reported to broaden in depth; locally some lenses contain considerable masses of pure talc, although sometimes contaminated with antigorite. The Damheads quarry was worked fairly extensively for talc, mainly for use as a coating material in roofing felt, in the nineteen-forties and early fifties, but the intimate association of the talc and serpentinite, the irregular occurrence and size of the talc veins and lenses and the large quantities of serpentinite that had to be removed to extract small amounts of talc made quarrying operations uneconomic.

North of Glenelg, Ross-shire, a 2m band of talc-schist and soapstone is exposed in a stream section about 0.8 km south-east of Ardintoul. The talcose rock occurs along a thrust plane between the Lewisian Gneiss and Moinian granulites and was worked on a small scale in the late twenties and early thirties, first by quarrying and later by mining, total production being between 600 and 1,000 tonnes. The deposit terminated abruptly against a fault to the north-east and appeared to thin out in other directions. In 1933-34 it was considered that further exploratory work would not be profitable and the operation was abandoned. The deposit is unusual in that it is not associated with any observed ultrabasic rocks, although serpentinite bodies are known in the area, some of which contain talc in small quantities.

In the Innellan and Toward district of Argyllshire, on the western shore of the Firth of Clyde, lenticular veins of talc are present in a belt of serpentinite lying between two faults belonging to the Highland Boundary Fault Zone. The belt, which is inclined to the south-east at an angle of 60° to 70°, is about 5 km long but for most of its length the serpentinite lies beneath heavy overburden or built-up areas. The serpentinite varies in width of outcrop from 18m to 24m in the north, near Innellan Pier, to 45m further to the south-west near Toward Taynuilt. To the west of Toward Point the serpentinite outcrops on the shore, where it is largely altered to dolomite fault-rock with little talc present. To the north of Toward Taynuilt talc is exposed in stream sections as veins 0.3m and 0.6m thick lying along faults or shear planes in the serpentinite. The talc is of fairly good quality, although it contains irregular grains of picotite and magnetite, and was mined on a small scale in the past, some 183 tonnes having been produced in 1928-29.

At Corrycharmaig, 5.5 km north-west of Killin, Perthshire, the western portion of an antigorite-serpentinite body measuring approximately 550m by 230m has been altered to a talc-carbonate rock consisting mainly of talc and breunnerite [$(Mg,Fe)CO_3$] with small amounts of antigorite, dolomite and chromite, within which thin impersistent veins of pure talc are present at a number of places. The talc-carbonate rock contains about 40 to 50 per cent talc and is described as being highly talcose in places. Although there appear to be substantial quantities of talcose rock, no attempt has been made to work the deposit, apart from trial workings in the mid-19th century for chromite, which occurs disseminated in small amounts in the eastern portion of the serpentinite.

Talc has been recognised at a number of other localities in Scotland mainly associated with serpentinite bodies. Most of these occurrences are small and of academic interest only, although a few have been examined in the past, such as the deposit on Scalpay, Harris, where talc associated with a sill-like body of serpentinite exposed at the entrance of East Loch Tarbert was formerly worked on a small scale. Talcose epidiorite was formerly quarried at Creagan on the west side of Loch Fyne, Argyllshire and at Bolfracks Hill, near Aberfeldy, Perthshire for building purposes.

In Cornwall, small discontinuous veins of steatite and soapstone are not uncommon in the Lizard serpentinite and are found around Kennack, Mullion, the Black Head, Pentreath and to the west of Kynance. The mineral was worked between 1750 and 1820 at Predannack and at Gew Graze along the coast north-west of Lizard Point for the manufacture of porcelain, but the total quantities involved were small. At Polyphant, near Launceston, Cornwall, part of an intrusive ultrabasic mass, described as a picrite (although perhaps more accurately defined as a peridotite) has been extensively altered to talc and chlorite with minor amounts of dolomite and magnesite. The altered rock, known as 'Polyphant Stone' is extremely soft and easily carved, and has been worked since the 11th century for ornamental purposes; small quantities are still produced from time to time. A mineralogical analysis (by the Mineralogy Unit of the Institute of Geological Sciences) gave the following results: Talc, minimum of 41 per cent; chlorite, 30 per cent; dolomite, 11 per cent; magnesite, 3 per cent; magnetite, several per cent and other minerals one or two per cent. Chemical analyses of two samples of Polyphant Stone are shown in Table 3.

**Table 3 Chemical analyses of Polyphant Stone**

| | *Weight per cent* | |
|---|---|---|
| | *Brown Polyphant Stone* | *Grey Polyphant Stone* |
| $SiO_2$ | 42.59 | 36.53 |
| $Al_2O_3$ | 8.25 | 6.28 |
| $Fe_2O_3$ | 15.72 | 14.04 |
| $TiO_2$ | 0.56 | 0.54 |
| CaO | Trace | 4.62 |
| MgO | 23.20 | 25.72 |
| Loss on ignition | 9.34 | 12.42 |
| TOTAL: | 99.66 | 100.15 |

*Analyst:* Miss R C Groves, Mineral Resources Division, Imperial Institute, 1940.

On Anglesey, serpentinite occurs in the south-east of Holy Isle and on the east side of the strait of Holy Isle, and talc occurs as a constituent mineral of the carbonated serpentinite near Llanfwrog. A band of talc-schist, 0.5m to 1m thick, occurs in a quarry near Bronddel on Holy Isle but it is reported to be of poor quality and highly contaminated by chlorite.

In Northern Ireland, the only recorded occurrence of talc is at Oritor, near Cookstown in County Tyrone, where bands of hornblendic schists have been altered to a soft grey talcose rock. Known occurrences of pyrophyllite in the United Kingdom are of academic interest only.

Resources of talc and steatite in Great Britain were briefly described during the First World War and the results appeared in the series of Special Reports on the Mineral Resources of Great Britain. During the Second World War a much more detailed account of the country's talc resources appeared in the Wartime Pamphlet series in 1941, with a revised edition published in 1946. A supplement to this report, published in 1949, dealt in some detail with the economic possibilities of the Corrycharmaig serpentinite intrusion near Killin, Perthshire. In 1954 the Mineral Resources Panel, set up by the Scottish Council (Development and Industry), produced a report describing the main occurrences of talc in Scotland, but, as in all the previous investigations, no drilling or exploratory work outside normal field mapping was undertaken.

The occurrence of talc in the United Kingdom is well documented and the regional distribution of serpentinites, the main talc-bearing rocks, well known. However, the characteristic mode of occurence of talc as narrow lenses, which tend to thin out both laterally and vertically, makes it extremely difficult to form any reliable estimate of the local distribution and extent of these deposits. New deposits and extensions to known deposits may be revealed by diamond drilling in areas where talc is already known to occur in reasonable quantities.

Many of the talc occurrences in Scotland are too small for commercial exploitation but Unst, the Mainland of Shetland and Corrycharmaig would appear to be the most favourable areas for further exploratory work, as the talcose zones are generally larger than elsewhere and more amenable to open-cast quarrying. Because of the close association of talc and serpentinite, however, any new deposit will almost certainly be contaminated with a variety of other alteration products, mainly carbonates, chlorite, serpentine minerals and heavy minerals such as chromite and magnetite, so that the ground product would command only a relatively low price. Beneficiation by flotation is of dubious value, as although a relatively high-grade talc product could be recovered the technique would probably incur high reject losses.

High purity white talcs are usually formed by the thermal metamorphism of siliceous dolomites. In Scotland, regionally metamorphosed limestones and dolomites, many of which are siliceous, occur in the Lewisian, Moinian and Dalradian but apart from a minor occurrence in Moinian limestone at Shinness in Sutherland, talc is not recorded. The Cambrian Durness Limestone, although predominantly dolomitic and thermally altered by granitic intrusions to brucite [$Mg(OH)_2$] marbles in Skye and the Assynt area of Sutherland, is generally not sufficiently siliceous to have favoured the formation of talc.

The presence of silica as chert nodules in the Kilchrist district of Skye favours the formation of talc at their contact with the dolomite, but this occurrence is of academic interest only.

In general, little exploratory work appears to have been carried out by industry, although over the years the Institute of Geological Sciences has received a number of inquiries relating to United Kingdom resources of talc, particularly from the consumer industries. However, Alexander Sandison and Sons Limited, the main United Kingdom producer, has carried out a considerable amount of exploratory work over a number of years, mainly on Unst but also at Cunningsburgh, in conjunction with English China Clays Limited. This has indicated that reserves of talc are substantial: about 400,000 tonnes has been outlined in two deposits on Unst and at least 500,000 tonnes at Cunningsburgh. In 1964 a drilling programme at the Corrycharmaig serpentinite instrusion in Perthshire located only minor quantities of talc. It was considered that the most favourable area for further exploratory work is at the schist-serpentinite contact, where talc-carbonate rock was present in one borehole, but no further drilling was carried out. Extensive drilling at Polyphant in 1969 failed to reveal any high-grade talc although it indicated that large reserves of low-grade talcose rock were present. The rock contained up to 50 per cent talc but was heavily contaminated with chlorite and iron oxides.

The Institute of Geological Sciences made a brief examination of the talc-magnesite deposit at Cunningsburgh on the Mainland of Shetland in 1970 and samples were collected for laboratory appraisal. The work was principally undertaken to test the feasibility of separating a talc product from the talc-magnesite rock and assessing the quality of the product (see Technology).

## Uses

Talc is valued industrially for its softness, smoothness,whiteness, high slip or lubricating power, foliated or lamellar structure, high surface area, chemical inertness, oil absorption properties, low electrical and heat conductivity, high refractoriness and low thermal expansion, properties all related to its crystal structure and composition.

The cosmetics and pharmaceutical industries are thought to be the leading users in the United Kingdom with an annual consumption of about 20,000 tonnes. High quality talc is used in various toilet preparations, the more important being toilet (talcum), baby and face powders, and as a dusting powder for various pharmaceutical purposes and for polishing tablets.

The paint industry is also an important consumer of talc, chiefly as an inert extender or filler in paints. Talc is valued because of its excellent white colour (although this is not so important where talc is used in primers and undercoats), easy dispersibility in water and oil systems, and foliated structure which gives good flatting and suspending properties. Asbestine increases the mechanical strength of certain types of paint film and the presence of fibrous minerals also gives it good suspending powers, thus reducing undesirable pigment settling in the can. The most important use of talc in the paint industry is in primers and fillers. It is also used in emulsion paints to improve brushing properties and to a limited extent in exterior undercoats and primers

for house-painting, giving good spreading power and increased durability of the paint film. Talc also confers good mechanical properties to industrial primers which are applied prior to mechanical forming processes and can be used to adjust the gloss of semi-glossy and matt stoving finishes.

In the ceramics industry talc is a major constituent in steatite and cordierite technical ceramics which are mainly used as insulators for the electrical industry. Normal steatite, which usually consists of talc, clay and feldspar, may replace porcelain for low tension pressings and extrusions and some high tension insulators.

Low-loss steatite electroceramics, which are usually fairly small, are produced by dry-pressing or extruding a finely ground mix of talc (70 to 90 per cent with an average of about 85 per cent), ball clay and a flux about 10 per cent, usually barium carbonate, followed by firing at temperatures within the range 1,200°C to 1,350°C. Generally, calcined talc is included in the mix as a high proportion of raw talc may cause lamination. The fired body consists mainly of meso- or proto-enstatite crystals embedded in a glassy phase. Steatite is the most widely used ceramic in electronic applications, for use as coil formers, stand-off insulators, condenser end plates, panel bushes, valve electrode spacers and valve holder bases.

Talc mixed with clay and alumina and fired at 1,250°C to 1,400°C produces a cordierite body, which has a very low thermal expansion, high thermal shock resistance and good electrical properties. Cordierite bodies are used for coil formers, electric water-boiler insulators, arc chutes, fire-bars, fuse cores, oil burner ignition insulators, rheostat blocks and resistor bobbins and spools. The low thermal expansion and high thermal shock resistance properties of cordierite are also of value in the manufacture of saggars and other items of kiln furniture. In the manufacture of cordierite bodies, minerals with a higher MgO and lower $SiO_2$ content, such as serpentine, are sometimes preferred. Forsterite bodies for low-loss electronic use may be produced by firing mixes of talc (40 to 60 per cent), magnesium hydroxide, clay and alkaline earth compounds. Small amounts of block steatite are used for some purposes, the natural steatite being machined to the required shape and then fired at about 1,000°C. More recently, however, it has become the practice to fabricate block steatite by bonding talc powder with orthophosphoric acid. Talc is also used in the manufacture of steatite ceramic grinding balls. Talc consumption by the United Kingdom ceramics industry is probably not more than a few thousand tonnes. In the United States, however, large quantities of talc are used to partially or entirely replace feldspar in the manufacture of earthenware bodies, such as wall tiles, a rare application in the United Kingdom.

Low grade talc is used as a surface coating for roofing felt and damp courses to prevent the rolls from sticking together and to render the felt more weather resistant. The roofing industry is a major consumer of talc from Unst.

In the rubber industry talc is chiefly used as a dusting agent to lubricate the moulds and to prevent surfaces sticking together during manufacture. Talc is also used as an inert filler, chiefly in cable compounds, giving smooth extrusions and good insulating properties. This use is, however, declining and only small quantities are involved. Where rubber articles are still vulcanised in

steam autoclaves, talc is used to support the articles in the pans. However, this method of vulcanisation is being superseded by continuous processes which do not require talc.

Relatively small amounts of talc are used as a filler in the plastic polypropylene, commonly with loadings of 20 per cent and 40 per cent, to improve the rigidity of injection mouldings and to give them increased stability at elevated temperatures. It is also used as a filler in polyvinyl chloride and in polyester resin-based sealing compounds; perhaps one of its best known applications in this field is in car body patching compounds.

Small quantities of talc are sometimes substituted for china clay and whiting as a filler in paper, because of its excellent colour, good retention and chemical inertness, although this is rarely the practice in the United Kingdom. Talc may also be used as a pitch-control agent in pulp and paper manufacture. Low-grade talc is used as a refractory filler in a wide variety of core and mould coatings for both non-ferrous and ferrous foundry castings. However talc cannot be used for steel castings since even the most refractory grades would fuse or melt at the high casting temperature of steel. Significant quantities of low-grade talc are also used in the manufacture of fertilizers, in the preparation of insecticides and seed dressings, and as a filler in wall jointing plasters. Lump steatite is used in the form of crayons or sticks for marking purposes in steel works and foundries and also for marking cloth ('tailor's chalk'). Talc has also a wide variety or minor miscellaneous uses, such as a dusting agent for confectionery.

Polyphant stone is easily carved and sculptured and has been used for centuries for interior ornamental work; indeed, small quantities of roughly squared blocks are still sold for sculpture work. Polyphant Stone has also been used in the past for laboratory bench tops, for lining alkali furnaces and in marking steel. However, apart from the small quantities used by the ceramic industry, most of the Polyphant Stone at present produced is consumed by the roofing felt industry. Powdered Polyphant Stone is extremely soft and could perhaps be used more extensively as a dusting powder and low-grade filler.

Pyrophyllite (Wonderstone) imported from South Africa is used in the electrical, electronic and chemical industries for insulating purposes, but the demand is very small in the United Kingdom.

Serpentine was quarried until recently on Unst and at Pentreath, on the Lizard, Cornwall, for stabilising dolomite refractories, but is now no longer used because of changes in techniques. Peak production was some 30,000 tonnes a year, mainly on the Lizard. Serpentinites usually have a high iron content, which restricts their use for refractory purposes, and unfortunately the pure olivine rock, dunite, is rare in the United Kingdom. Serpentinites typically exhibit a rich variety of colours and as they are soft and easily cut and polished they are used in the production of a variety of ornamental objects. The Lizard is the best known British locality, although other serpentinites, particularly Portsoy, have been quarried in the past.

## Specifications

For the many industrial applications of talc a wide variety of qualities are required, ranging from pure white talcs amost completely free of all impurities to grey coloured talcs perhaps containing as much as 50 per cent impurities. The highest grades, for cosmetics, should be an excellent white colour, fine grained (98 per cent passing 200 mesh), free from gritty, granular and fibrous particles, but rich in foliated particles, and have a high slip. The Toilet Preparations Federation Specification No.12 states that carbonates and sulphides should be absent, lead should not be present in excess of 20 ppm and arsenic in excess of 2 ppm. Maximum lime content should be 1.5 per cent and maximum acid soluble matter 10 per cent. Talc must also be free of bacteria and it is general practice to sterilize talc for cosmetic purposes.

High grades of foliated white talc and fibrous asbestine are used by the paint industry. The talc must be a good white colour and must not contain any hard particles. A small latitude in the colour may be tolerated, but off-white grades will be restricted mainly to use in primers and undercoats. Particle sizes should be small, 98.5-99.95 per cent passing through 325 mesh and micronised grades usually have particle sizes ranging from 0.2 to 40 microns, the average being 5-10 microns. The oil absorption of high grade flake talc lies between 25 and 45 (grammes of oil per 100 grammes of talc) and that for asbestine between 20 and 35. Specifications for both talc and asbestine as extenders in paints appear in British Standard 1795: 1965.

Specifications for talc for the ceramics industry vary considerably and depend on their particular application. For low-loss electroceramics, CaO, $Fe_2O_3$ and $Al_2O_3$ should be low, maximum CaO content ranging from 0.1 to 1.0 per cent, $Fe_2O_3$ content from 0.1 to 1.5 per cent and $Al_2O_3$ from 0.1 to 2.5 per cent. The talc should fire to a white product: generally speaking iron and manganese are undesirable as they cause discoloration. Uniformity in the quality of supplies is also important. The desired composition of powdered talc for electrical insulating purposes is: $SiO_2$ not less than 60 per cent; MgO not less than 30 per cent; $Al_2O_3$ not more than 2.5 per cent; CaO not more than 1.0 per cent; $Fe_2O_3$ not more than 1.5 per cent; $Na_2O + K_2O$ not more than 0.4 per cent; loss on ignition not more than 6.0 per cent; acid soluble lime not more than 1.0 per cent. For cordierite ceramics, talcs may have a more variable composition and higher impurity levels are tolerated. Non-flaky types of talc are required to prevent lamination and to give a uniform bulk density, so that pressed articles have the right size and shape when fired.

The rubber industry uses lower grades of talc, a good white colour not being important. Talc used for dusting should be free of gritty particles leaving not more than 0.5 per cent residue on 200 mesh. Manganese and copper must also be low, hence Unst talc is only used for dusting, not in compounding. High quality white talcs are used as fillers in plastics and the mineral should show a residue of less than 0.5 per cent on a 300-mesh sieve. Official specifications for talc used in the rubber industry are given in Defence Specifications DEF-98-B and DEF-179, 'Steatite, Powdered, for Rubber' and 'Powder, Dusting for Rubber', respectively (both London: H.M.S.O., 1969).

A typical chemical analysis of talc used in foundry coatings is: $SiO_2$ 57 per cent, MgO 32 per cent, $Al_2O_3$ 3 per cent, the balance consisting of $Fe_2O_3$, CaO and ignition loss. Chemical composition is not, however, critical unless it causes a significant reduction in refractoriness. This may have little effect when used on most non-ferrous metals but its effect will be more marked when used in mould coatings for use in iron foundries. Talc for foundry use must pass a 200-mesh sieve.

For most of the other dusting and filler uses of talc, for example in roofing felt, fertilizers, insecticides and seed dressings, finely ground, off-white talc is generally suitable, although the presence of any abrasive constituents is objectionable.

## Price and cost

The price of talc varies considerably depending on its quality and particle size; in general, however, prices range between £12 and £55 per tonne, although some micronised grades may be considerably more expensive.

The average price of ground and bagged Shetland talc is £12 to £14.5 per tonne, depending on particle size, ex-works (Yate). Nominal prices for imported talc (c.i.f.) are published in the journal *Industrial Minerals.* Quotations for February, 1974, were as follows:

| | |
|---|---|
| Norwegian, ground | £11.5 – £13 per tonne |
| Norwegian, micronised | £20.5 – £35 per tonne |
| French, fine ground | £19 – £40 per tonne |
| Italian, cosmetic grade | £32 – £46 per tonne |
| Chinese | £24 – £29 per tonne |

Calculated average c.i.f. values for imported talcs in 1973 are shown in Table 7. Grades of tremolitic talc range in price from £50 to £100 per tonne delivered. Micronised Chinese talc packed in 12.5 kg bags in lots of over 4 tonnes is sold ex-United Kingdom works at about £55 per tonne. About 25 per cent of the ex-works price of Unst talc is due to transport costs from the Shetlands to Yate Mills near Bristol. Some reduction in transport costs could be achieved if larger ships were used, but this would be practicable only if the operations in the Shetlands were expanded and suitable quay facilities available.

## Technology

Talc is won by both opencast and underground mining methods but extraction in the United Kingdom is entirely confined to opencast workings, although small mining operations have been carried out in the past. The amount of land affected by present workings is negligible because of the small size of the operations and the virtual absence of waste.

At the Queyhouse quarry on Unst, worked by Alexander Sandison and Sons Limited, talc is exposed beneath an overburden of some 2m to 3m. The talc is broken up by rippers, followed by selection of the higher quality material to maintain the grade. The broken ore is transported by lorry to the quayside

at Baltasound where it is stockpiled prior to shipping to Avonmouth. The whole of the Unst production is processed by Yate Mills Limited at their plant at Yate, Gloucestershire, which is designed for drying, grinding and air classifying only, no other form of beneficiation being undertaken. The milling process consists of primary jaw crushing, drying by rotary oil-fired furnace, grinding by Raymond roller mill with associated air classification equipment and final bagging for delivery by road. The talc is usually ground to 300-mesh although for some purposes, such as the roofing felt industry, only 150-mesh is required. The final product contains less than 50 per cent talc, the main accessory mineral being magnesite.

At the Polyphant quarry, near Launceston, Cornwall, small quantities of talcose rocks are produced, but no processing is undertaken on site. Apart from small quantities of roughly trimmed blocks sold for sculpture work, most is milled by Yate Mills Limited at Yate and smaller quantities are sent to the Potteries for grinding, by J G Gregory and Son Limited, for use in the ceramics industry.

The steadily increasing demand for finer grades of high quality talc, particularly for the paint industry, has led to the production of micronised grades of talc from imported material by a number of companies, notably Rogers and Cooke (Salisbury) Limited, a member of the English China Clays Group, and the Hopton Mining Company Limited. In fluid energy or micronising mills, talc is subjected to high pressure jets of steam or air and the extremely fine grinding is brought about partly by self-attrition of the particles and partly by their impact with the walls of the mill. Particle sizes of 20 microns to less than one micron are obtained. Talc for cosmetic and pharmaceutical purposes is sterilized generally by passing ethylene oxide through batches of talc in a sealed chamber for a predetermined period. Cosmetic talc is perfumed before packaging.

The mineral as mined rarely undergoes any beneficiation other than grinding and air classification. Talc has a high native floatability but the occurrence of sufficiently high-grade deposits for most industrial applications has generally discouraged flotation as a beneficiation technique, although it is used in some countries. For example, in the United States at Johnson in Vermont, talc-magnesite rock, apparently rather similar to the Shetland material, is successfully beneficiated by flotation to produce a concentrate containing 91-92 per cent talc. Magnetic separation may also be used to remove iron-bearing minerals. The Institute of Geological Sciences has carried out laboratory work to examine the possibility of separating a talc product from the talc-magnesite rock occurring at Cunningsburgh on the Mainland of Shetland. The rock consists of equal proportions (about 45 per cent) of talc and magnesite with accessory chlorite and magnetite/chromite. Preliminary work showed that after grinding, air-classification would produce a concentrate containing 70 per cent talc, but recovery was below 50 per cent. Froth-flotation produced a concentrate containing 90 to 93 per cent talc but recovery was only 50 to 60 per cent. The product was relatively free from any abrasive constituents, although it had an inferior whiteness to most industrial grades of talc and turns a pale orange to pale reddish brown colour on firing as it contains appreciable iron in the mineral lattice. A high iron content is a characteristic feature of British talcs and is the result of their formation from the ferro-magnesian minerals in ultrabasic rocks. Consideration was also given to the

recovery of magnesite as a by-product and a final product containing 92 to 93 per cent magnesite was obtained by using a wet magnetic separator to remove magnetite/chromite.

## Production

Talc is widely distributed throughout the world and many countries produce for domestic consumption: generally only the high quality white talcs enter into world trade. The United Kingdom is a minor producer. Table 4 includes the production of a selection of the major producing countries, particularly those supplying the United Kingdom. Australia, Canada, North and South Korea and Japan are also large producers, Japan being also by far the world's largest producer of pyrophyllite with about 90 per cent of a combined talc and pyrophyllite production of 1,507,000 tonnes in 1972 consisting of pyrophyllite.

**Table 4 World production of talc 1969 - 1972, by selected producing countries**

| | *Tonnes* | | | |
|---|---|---|---|---|
| *Producing Country* | *1969* | *1970* | *1971* | *1972* |
| USA | 839,008 | 823,584 | 955,622 *(a)* | 1,004,000 |
| USSR *(b)* | 380,000 | 380,000 | 380,000 | 390,000 |
| France | 247,075 | 270,174 | 282,000 | 236,075 |
| India | 176,572 | 159,314 | 176,845 | 173,562 |
| China *(b)* | 150,000 | 150,000 | 150,000 | 150,000 |
| Italy | 136,495 | 154,818 | 138,000 | 148,000 |
| Finland | 28,740 | 62,700 | 100,700 | 90,327 |
| Austria | 94,133 | 100,159 | 91,621 | 83,212 |
| Norway | 67,664 | 75,886 | 64,463 | 70,000 |
| United Kingdom | 10,261 | 10,953 | 12,127 | 16,107 |
| World Total *(a)* (estimated) | 4,500,000 | 4,940,000 | 4,950,000 | 4,900,000 |

(*a*) including pyrophyllite
(*b*) United States Bureau of Mines estimate

*Source:* 'Statistical Summary of the Mineral Industry'. Institute of Geological Sciences.

A total of about 225,000 tonnes of talc has been produced in the United Kingdom since 1930 prior to which only minor quantities were mined. The Queyhouse quarry on the island of Unst has probably accounted for 95 per cent of this production, the remainder being produced at Portsoy and Polyphant in Cornwall. Between 1930 and 1933 there was a total United Kingdom production of 769 tonnes and in 1939 only 45 tonnes: no figures were shown in official returns from 1934 to 1938. Production on a significant scale began in 1940 when an indigenous source of supply was of great importance because of restrictions on overseas supplies. Annual production statistics for the period 1940 - 1973 are shown in Table 5.

**Table 5 United Kingdom: Production of talc, 1940 - 1973**

| *Year* | *Tonnes* | *Year* | *Tonnes* |
|---|---|---|---|
| 1940 | 1,074 | 1957 | 3,861 |
| 1941 | 4,552 | 1958 | 4,214 |
| 1942 | 2,231 | 1959 | 5,876 |
| 1943 | 2,815 | 1960 | 6,572 |
| 1944 | 2,829 | 1961 | 7,041 |
| 1945 | 2,170 | 1962 | 7,475 |
| 1946 | 3,437 | 1963 | 8,104 |
| 1947 | 3,379 | 1964 | 10,318 |
| 1948 | 4,000 | 1965 | 10,137 |
| 1949 | 3,000 | 1966 | 9,122 |
| 1950 | 1,727 | 1967 | 9,112 |
| 1951 | 2,540 | 1968 | 11,527 |
| 1952 | 2,627 | 1969 | 10,261 |
| 1953 | 4,003 | 1970 | 10,953 |
| 1954 | 4,034 | 1971 | 12,127 |
| 1955 | 5,117 | 1972 | 16,107 |
| 1956 | 3,874 | 1973 | 20,333 |

*Sources:* 1940 - 47 'Ministry of Power Statistical Digest'.
1948 - 71 'Statistical Summary of the Mineral Industry'. Institute of Geological Sciences.
1972 - 73 'United Kingdom Mineral Statistics'. Institute of Geological Sciences.

The figures relate to impure talc containing perhaps less than 50 per cent of the pure mineral. Production of Polyphant Stone is not included but over the period is thought to amount only to a few hundred tonnes in most years.

Until 1972 production had risen only gradually since 1940 but there was a sharp increase in both 1972 and 1973. The small size of the British talc industry is due mainly to the absence of high-grade deposits, the relatively small size and remoteness of known deposits and strong competition from a number of long-established European producers. However, the recent increase in production is probably due to the fact that more extensive reserves have been outlined in the Shetlands and that Unst talc is becoming increasingly competitive with Norwegian talc, which is mineralogically rather similar (Table 2).

## Overseas trade and consumption

The United Kingdom is not self-sufficient in talc and considerable quantities, particularly of the higher quality grades, are imported. Imports have doubled during the last twenty years and amounted to 63,283 tonnes in 1973 (Table 6). Domestically produced talc is not exported as far as is known, but small quantities of imported talc are re-exported. United Kingdom trade in talc has a small detrimental effect on the balance of payments, the difference between imports and exports amounting to about £2.2 million in 1973, although this is more than balanced by the favourable trade account for manufactured articles in which talc is an important constituent.

*Exports*

Between 1949 and 1969 no provision was made in the United Kingdom trade returns for recording exports of talc separately and it is believed that none was in fact exported. Re-exports of imported material, however, were recorded and amounted to 200 to 300 tonnes in most years. Since 1970 re-exports have no longer been separately distinguished and exports (and imports) of talc have been recorded under the heading 'Steatite, natural, including natural steatite not further worked than roughly split, roughly squared or squared by sawing; talc,' code number 2527 0007 in the United Kingdom Tariff and Overseas Trade Classification. In 1973 exports, totalling 2,044 tonnes and valued at £118,238, were believed to consist of imported talc further processed before shipment abroad, as it is unlikely that domestically produced talc is exported.

*Imports*

United Kingdom imports of talc for the period 1954 to 1973 have followed a fairly steady upward trend with an average annual growth rate of about 3.7 per cent and amounted to 63,283 tonnes in 1973 (Table 6).

**Table 6 United Kingdom: Imports of talc, 1954 - 1973**

| | *Quantity tonnes* | *C.i.f. value* | | *Quantity tonnes* | *C.i.f. value* |
|---|---|---|---|---|---|
| 1954 | 34,689 | £534,719 | 1964 | 48,968 | £902,143 |
| 1955 | 39,717 | £616,687 | 1965 | 46,451 | £933,576 |
| 1956 | 39,075 | £609,687 | 1966 | 49,196 | £948,315 |
| 1957 | 38,899 | £638,536 | 1967 | 51,162 | £1,002,321 |
| 1958 | 39,102 | £637,760 | 1968 | 50,793 | £1,242,249 |
| 1959 | 40,395 | £651,420 | 1969 | 52,051 | £1,278,995 |
| 1960 | 43,687 | £716,759 | 1970 | 58,378 | £1,503,071 |
| 1961 | 41,407 | £752,081 | 1971 | 57,297 | £1,567,872 |
| 1962 | 44,285 | £781,894 | 1972 | 55,595 | £1,702,276 |
| 1963 | 45,193 | £844,098 | 1973*(p)* | 63,283 | £2,266,690 |

*(p)* provisional

*Source:* HM Customs and Excise

The chief and traditional sources of supply have been Norway, France and Italy, although in recent years Chinese talc has become increasingly important because of its high quality and relative cheapness (Table 7).

**Table 7 United Kingdom: Imports of talc by countries, 1970 - 1973**

| | *Tonnes* | | | | *£ per tonne* |
|---|---|---|---|---|---|
| | *1970* | *1971* | *1972* | *1973 (p)* | *Average cif value in 1973* |
| Norway | 16,666 | 19,025 | 17,973 | 16,501 | 26.5 |
| France | 14,195 | 13,168 | 11,056 | 14,151 | 29.5 |
| China | 9,804 | 9,802 | 11,332 | 11,570 | 28.8 |
| Italy | 8,475 | 7,877 | 7,737 | 9,040 | 57.3 |
| India | 3,696 | 1,943 | 1,499 | 2,804 | 42.4 |
| Belgium | 2,448 | 2,448 | 2,415 | 2,567 | 62.3 |
| USA | 1,043 | 1,301 | 1,000 | 1,895 | 64.3 |
| Netherlands | 959 | 650 | 1,231 | 2,517 | 28.6 |
| West Germany | 566 | 589 | 988 | 585 | 49.6 |
| Sweden | - | - | 46 | 1,079 | 15.3 |
| Other countries | 526 | 494 | 318 | 574 | |
| TOTAL: | 58,378 | 57,297 | 55,595 | 63,283 | |

*(p)* provisional

*Source:* HM Customs and Excise.

Since April 1970 United Kingdom imports of 'tremolitic talc' have been separately recorded under the following heading; 'Mineral substances containing not less than 20 per cent by weight of talc, and not less than 25 per cent by weight and not more than 65 per cent by weight of tremolite' (code number 2532 0588). Imports for the period 1970 - 1973 are as follows:

**Table 8 United Kingdom: Imports of 'tremolitic talc' 1970 - 1973**

| | *tonnes* | | | |
|---|---|---|---|---|
| | *1970 (a)* | *1971* | *1972* | *1973 (p)* |
| USA | 840 | 1,054 | 1,184 | 562 |
| Other countries | 352 | 19 | | 16 |
| TOTAL: | 1,192 | 1,073 | 1,184 | 578 |
| cif value (£) | 33,814 | 45,137 | 36,897 | 19,422 |

*(a)* year from 1 April to 31 December 1970 only.
*(p)* provisional.
*Source:* HM Customs and Excise.

*Consumption*

There are no official statistics relating to United Kingdom consumption of talc. However, apparent consumption may be roughly calculated as production plus imports, ignoring exports, re-exports and changes in stocks, which have probably been comparatively small. Apparent consumption has shown a fairly steady average annual growth rate of about 4.3 per cent from 30,000 tonnes in 1950 to about 80,000 tonnes in 1973.

The pattern of consumption in the United Kingdom differs quite significantly from other countries. For example, the ceramics industry consumes no more than 5 or 6 per cent, compared with about 25 per cent in the cosmetics and pharmaceutical industries, whereas in the USA the ceramics industry is the largest consumer. In the United Kingdom, talc has never competed to any great extent with china clay and whiting (both of which are produced domestically on a large scale) for use as fillers in the paint, paper and plastics industries, mainly on the grounds of price. Where talc is used as a filler in paint, plastics and rubber, it is generally for specialised applications. Nonetheless, the paint industry probably has an annual consumption of talc approaching that of the cosmetics and pharmaceutical industries. Much of the remaining talc is of low quality and the major proportion is used in dusting rubber and roofing felt, in the preparation of insecticides and fertilizers, and in foundry facings.

Other minerals may compete for the lower-grade dusting and filler applications of talc. Powdered slate, for example, consisting essentially of chlorite, illite and quartz, is produced on a substantial scale in the United Kingdom and is used as a mineral filler, carrier and surface dusting agent in a variety of products such as various bituminous mixes, fertilizers, paints, pigmented powders, plastics and adhesives, and it seems likely that powdered slate may have replaced talc for some applications, particularly in view of its relative cheapness.

## Industry

Two companies are involved in the mining of talc in the United Kingdom. Alexander Sandison and Sons Limited produce almost the whole of United Kingdom output from workings near Baltasound on Unst in the Shetlands, all the talc being sold to Yate Mills Limited (a member of the English China Clays Group). Minor quantities of talcose rock are produced at Polyphant in Cornwall by Clarborough Products Limited.

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