BRITISH GEOLOGICAL SURVEY

MINERAL PROFILE

BARYTES

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Office of the Deputy Prime Minister
Creating sustainable communities

Contents

1: Definition, miner
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1.1 Composition and mineralogy

Barytes (synonyms barite: baryte) is a naturally occurring barium sulphate mineral ($BaSO_4$ in the proportion 66% BaO and 34% SO_3). Barytes can sometimes contain strontium, and forms a complete solid solution series to the mineral celestite ($SrSO_4$). The colour is usually white but can vary with the presence of impurities. A commercially important characteristic of barytes is its relatively high density of 4.5 g/cm^3 — hence the old name 'heavy spar'. Crystals of barytes are water-clear and have a distinctive tabular shape, but radiating or 'coxcomb' crystals also occur. A fibrous variety known as cawk (cauk or calk) is found in Derbyshire and Somerset. For more information the website www.webmineral.com/data/Barite.shtml contains useful data on the properties of barytes.

Photo: T Cullen BGS © NERC

Figure 1.1.1 Barytes specimen from Foss Mine, Perthshire, Scotland

Barytes is the main industrial source of barium. However, the use of barium metal is minor and barytes is usually used as an industrial mineral. It is relatively common and widely distributed, although the bulk of world production is supplied by only a few countries. It is known as barytes in Britain, but as barite in most other countries. The name barytes is also given to the commercially traded mineral.

The only other commercially available barium mineral is witherite (barium carbonate, $BaCO_3$). Witherite is much less common, but occurs in some barytes deposits. Witherite is sought after for use in the chemical industry as it is more easily dissolved than barytes. The largest witherite producer in the world is Bashan barium mine, Chengkou County, China with 50,000 t of witherite powder per year (Chinese Witherite Production).

1: Definition, mineralogy and deposits

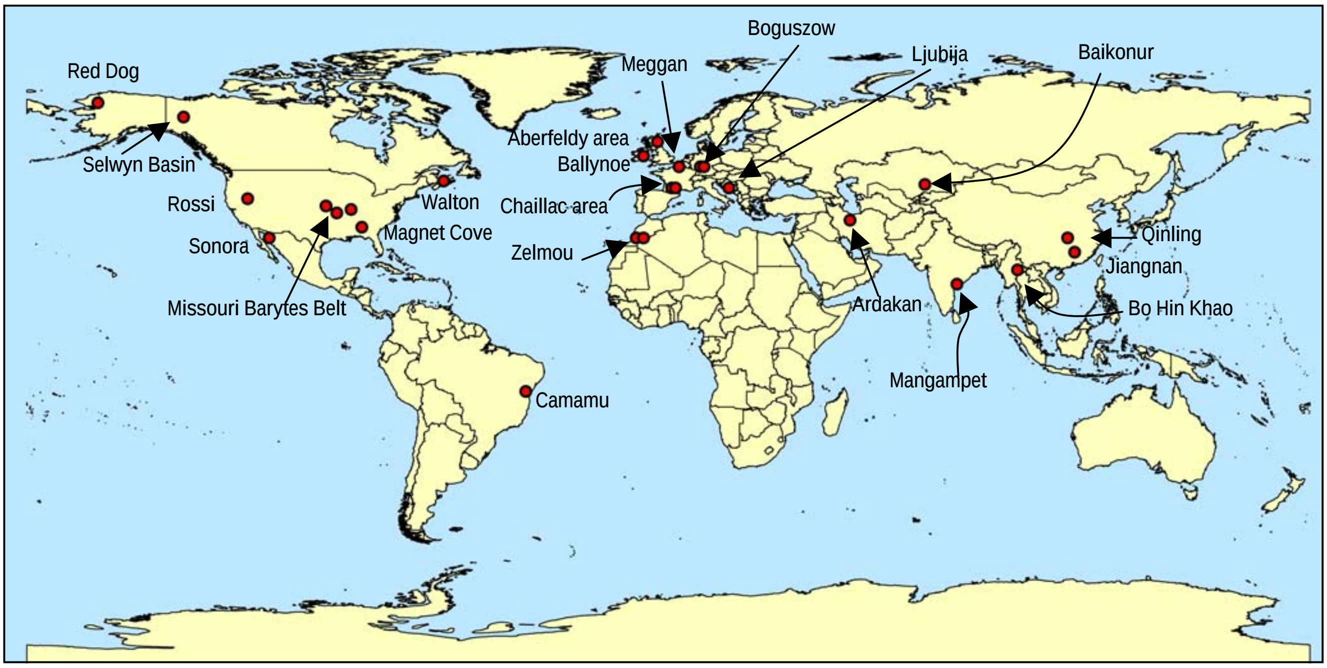


Figure 1.1.2 The distribution of major active and inactive barytes mines and significant deposits

1.2 Deposits

Barytes deposits are found throughout the world in a variety of geological environments (Figure 1.1.2). The three major types of barytes deposits are stratiform, vein and residual. The earliest workings were from veins, often associated with lead and zinc deposits, and from residual deposits, especially in the USA. Most barytes is now produced from stratiform deposits.

1.2.1 Stratiform deposits

The most important stratiform deposits are those formed by the precipitation of barytes at or near the seafloor of sedimentary basins (sedimentary exhalative or 'sedex' deposits). The brines are generated by migration of reduced, saline fluids and are concentrated by major basin-controlling faults. They are often associated with base metal sulphides (mainly zinc-lead). They occur in rocks varying in age from Precambrian to Cenozoic.

The largest single deposit is the Mangampet deposit in Andhra Pradesh, India where two stratiform lenses up to 1.2 km long and 20 m thick contain over 74 million tonnes of barytes. Annual production from the district is 700 000 tonnes and it contributes about 90% of barytes production in the state. The Andhra Pradesh Mineral Development Corporation is one of the major producers of the mineral
(see http://www.apmines.com/Geology/cuddapah.htm).

The most important producer from sedex deposits is China with almost 4 million tonnes per year. Major deposits occur in Cambrian black shales in the Jiangnan region of south China and the Qinling region in the Yangtze valley. The latter area contains some witherite and barytocalcite ($BaCa(CO_3)_2$) deposits associated with the barytes horizons.

Important stratiform barytes deposits occur in the western USA. The largest district is the Nevada barytes belt, which extends over 500 km from north to south and is about 125 km wide. It is estimated to contain around 90 million tonnes of barytes in hundreds of small lenses in siliceous sediments. A single bed of barytes 18 m thick in siliceous Carboniferous sediments in Arkansas was mined over a 40-year period from the 1940s, for a total production of 9 million tonnes. The major Red Dog Zn-Pb deposit in Alaska has associated barytes, but no details of barytes resources have been published and the barytes is not mined. There are also large unworked deposits in the Palaeozoic Selwyn Basin in western Canada, associated with the major stratiform Zn-Pb deposits of the MacMillan Pass and Anvil districts. Total barytes resources in the area have been estimated at 100 million tonnes.

Important stratiform deposits also occur in late Proterozoic meta-sedimentary rocks near Aberfeldy in Scotland. Other historically important stratiform deposits have been mined from Devonian shales in Germany and in Mesozoic carbonates in a belt from Pakistan through Iran. Until recently there were no recorded major barytes deposits in Russia, as supplies for the former Soviet Union were obtained from the Ansay, Bestube and Zhayrem barytes deposits in Kazakhstan. However, a recent report indicates that a barytes deposit in the Primorye region of far-eastern Russia, which had previously been regarded as too small to be commercially significant, has been re-evaluated and has a resource of 600 000 tonnes (Primorye Barytes Deposit).

1.2.2 Vein and replacement deposits

Small vein-style barytes deposits occur throughout the world, but very few are worked. Large vein-style deposits were mainly worked before the 1980s until large sedex deposits became more important. Vein-style deposits form by precipitation from hot barium-enriched fluids in faults and fractures as a result of fluid mixing or reduced pressure and/or temperature. Sometimes the fluids dissolve the surrounding host-rocks to form irregular replacement deposits. There are a number of vein and replacement deposits in Britain (see Section 8). Major veins have been worked in Morocco, USA, Germany and Slovakia. The Ballynoe deposit in Ireland produced over 5 million tonnes of direct-shipping barytes between 1963 and 1993. The barytes occurred as a single lens associated with replacement Zn-Pb mineralisation in Lower Carboniferous carbonates.

1.2.3 Residual deposits

Residual deposits are formed by the dissolution of the host rock of vein or bedded deposits, leaving irregular masses of barytes in a clay matrix. Deposits are extremely variable in size and shape, but can extend over several kilometres. In Missouri this form of barytes was known as ‘tiff’ and a substantial hand-mining industry grew up in the early 20th century, but is no longer active.

2: Extraction methods and processing

2.1 Mining

Mining methods vary with the type of deposit. Major stratiform deposits are worked by open pit where this is practicable. The ore is drilled and blasted and then trucked to the mill for processing. Conventional underground methods are used as appropriate to the shape and attitude of the deposit (these different mining methods are described at www.digistar.mb.ca/minsci/ug/undergm.htm). Vein deposits are worked by shafts and adits, as well as by shallow open-pits. Residual deposits are mainly worked by hand, due to the variable and irregular nature of the mineralisation.

2.2 Processing

Following initial crushing, some barytes is sold as 'direct shipping ore', if it is sufficiently pure, to be processed for addition to drilling fluids at plants adjacent to oil fields. If there are contaminants, such as waste rock or other minerals such as fluorite, quartz, galena or pyrite, these may be separated from the barytes by gravity separation[†], wet grinding and froth flotation. The barytes is then either dried and sold as a powder or processed further for particular applications.

[†] Normally jigging or using heavy liquids

3: Specification and uses

The main use of barytes (accounting for 88% of 2003 world production) is as a weighting agent in oil and gas well drilling fluids or 'mud' (Figure 3.1). Finely ground barytes is added to the drilling fluid (mainly water, but with other chemicals to enhance its performance) to increase the density of the column of fluid above the drill bit and thus assist in preventing a 'blowout'[‡]. Barytes can form up to 40% of the fluid by weight. Although there are alternatives, barytes is the favoured weighting agent as it is non-corrosive, non-abrasive, insoluble and non-toxic. It is also relatively cheap and easily available. The normal specifications are provided by the American Petroleum Institute ('API'). The density of pure barytes is about 4.5 g/cm^3, while the density for drilling fluid use must be greater than 4.2 g/cm^3 with at least 90% ground to less than -325 mesh (45µm). In offshore drilling in the USA the U.S. Environmental Protection Agency limits the content of mercury to 1 milligram per kilogram of barytes and that of cadmium to 3 milligrams per kilogram of barytes (U.S. Environmental Protection Agency, 1997).

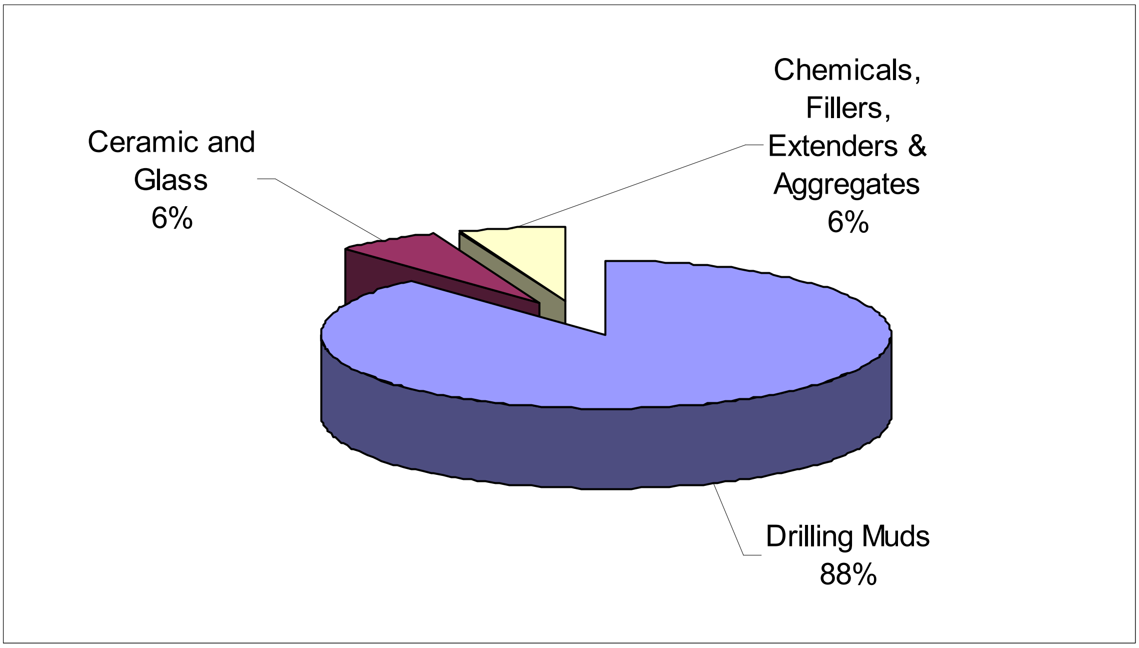
Barytes' particular qualities of high density, low solubility, high brightness and whiteness, chemical inertness, softness and relative cheapness also make it valuable in many other applications. These include:

- as a filler in paint and plastics
- as the main source of barium for the chemical industry
- the production of lithopone, which is a high performance white pigment composed of a mixture of chemically precipitated and calcined zinc sulphide and barium sulphate. Titanium dioxide has largely replaced barytes for this application, but there are still some specialised uses
- minor uses as an absorber of gamma and X-ray radiation, e.g. special concrete to shield nuclear and X-ray installations. In the construction industry barytes is sometimes added to concrete to increase its density for specialist application. In medicine, it is used to highlight problems within the human body
- in glass manufacture as a flux and to add brilliance and clarity.

The specifications for each of these applications place limits on the levels of contaminant minerals or elements in barytes. Natural barytes commonly contains fluorine, strontium, lead, zinc or iron in undesirable amounts that have to be reduced by blending or treatment.

[‡] The sudden uncontrolled release of pressurised gas or oil

3: Specification and uses



Source: *The Barytes Association*

Figure 3.1 The end-uses of barytes

4: World production

4.1 World reserves

Barytes is a common mineral. World identified resources are estimated at around 740 million tonnes, of which reserves total 200 million tonnes.

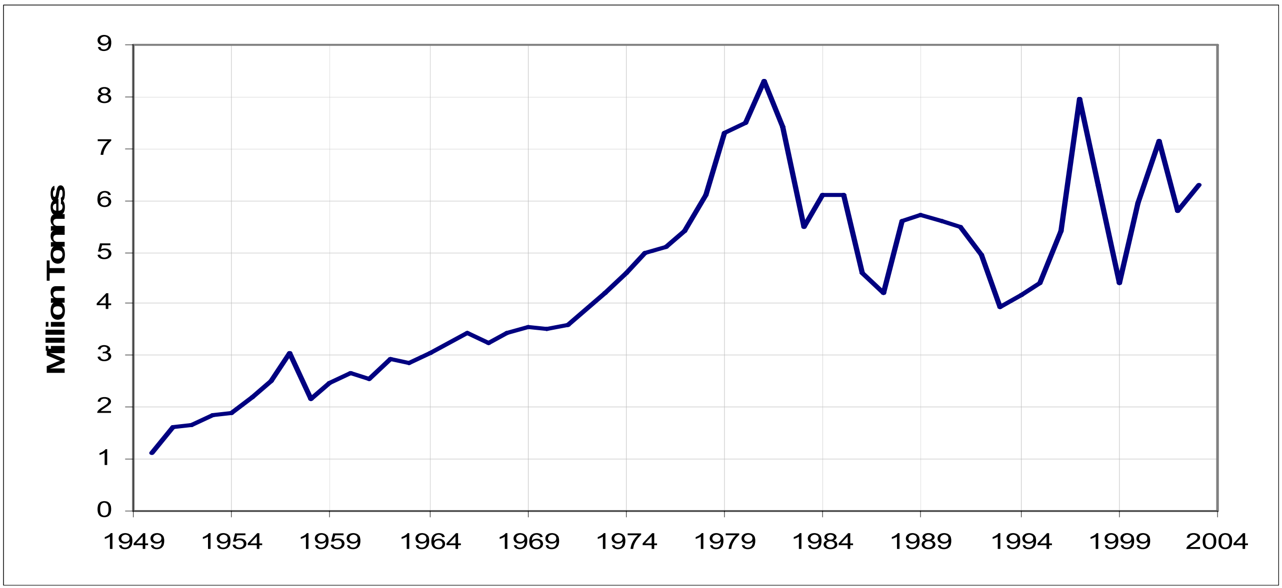
Table 4.1.1 World reserves of barytes, 2003

Country	Reserves (Million tonnes)	% Reserves
China	62	31.0
India	53	26.5
USA	26	13.0
Morocco	10	5.0
Bulgaria	10	5.0
Thailand	9	4.5
Algeria	9	4.5
Mexico	7	3.5
Turkey	4	2.0
Russia	2	1.0
France	2	1.0
Germany	1	0.5
UK	0.1	0.1
Others	12	6.0

Source: United States Geological Survey

4.2 World production

World production of barytes was about 6.3 million tonnes in 2004. Around 88% of this production is consumed by the oil and gas industry as an addition to drilling fluids. It follows therefore that the barytes market is very closely tied to activity in the oil and gas industry. Figure 4.2.1 presents the annual world production of barytes from 1951 to 2003.



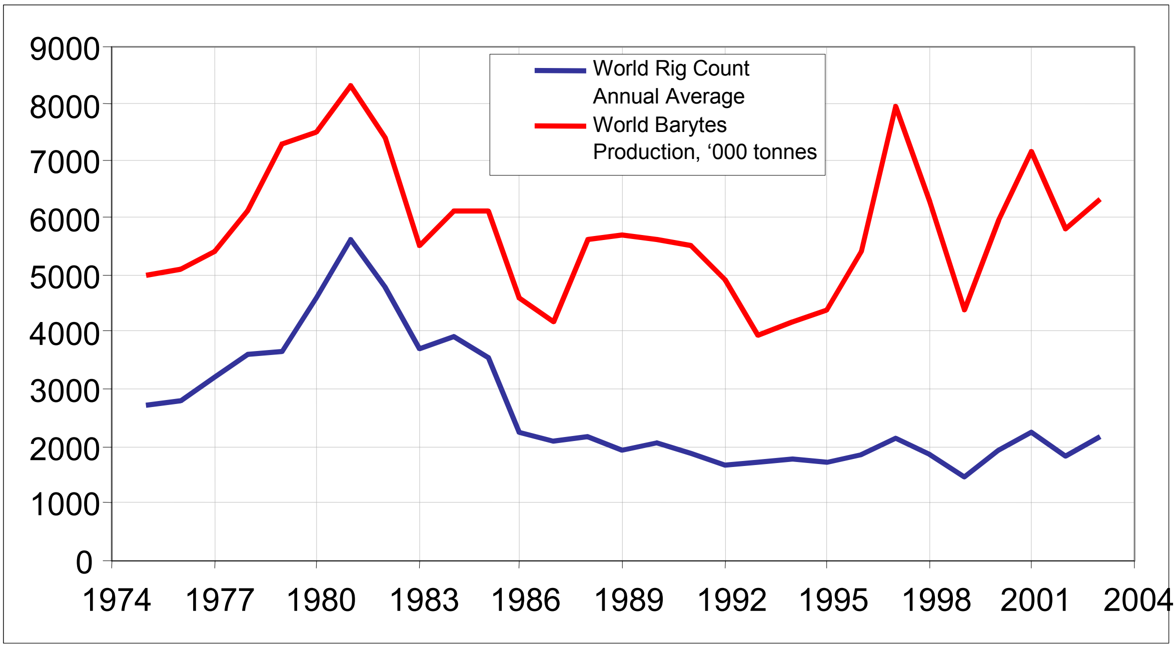
Source: World Mineral Statistics, British Geological Survey

Figure 4.2.1 World barytes production 1951 – 2003

The apparent increase in barytes production between 1951 and 1975 can, in part, be attributed to improved reporting by several countries that are significant producers. Some countries did not release data during the 1950s. Barytes production peaked at 8.1 million tonnes per year at the height of the oil exploration boom in 1981. A second peak of 8 million tonnes occurred in 1997 that was almost entirely due to stepping up production in response to improving oil prices. Oil price rises tend to lead to increases in drill rigs operating worldwide. Accordingly, the two largest (state-owned) barytes producers in China increased production in an effort to consolidate their influence on the world market. However these efforts were only partly successful: the rapid increase in production led to compromises in quality, to the extent that traders would not buy the product. This led, in 1999, to thousands of tonnes of low quality barytes being left in ports worldwide.

Throughout the 1970s in the build-up to the oil-boom in the early 1980s, barytes production increased directly in response to increasing worldwide oil and gas drilling exploration activity (Figure 4.2.2).

4: World production



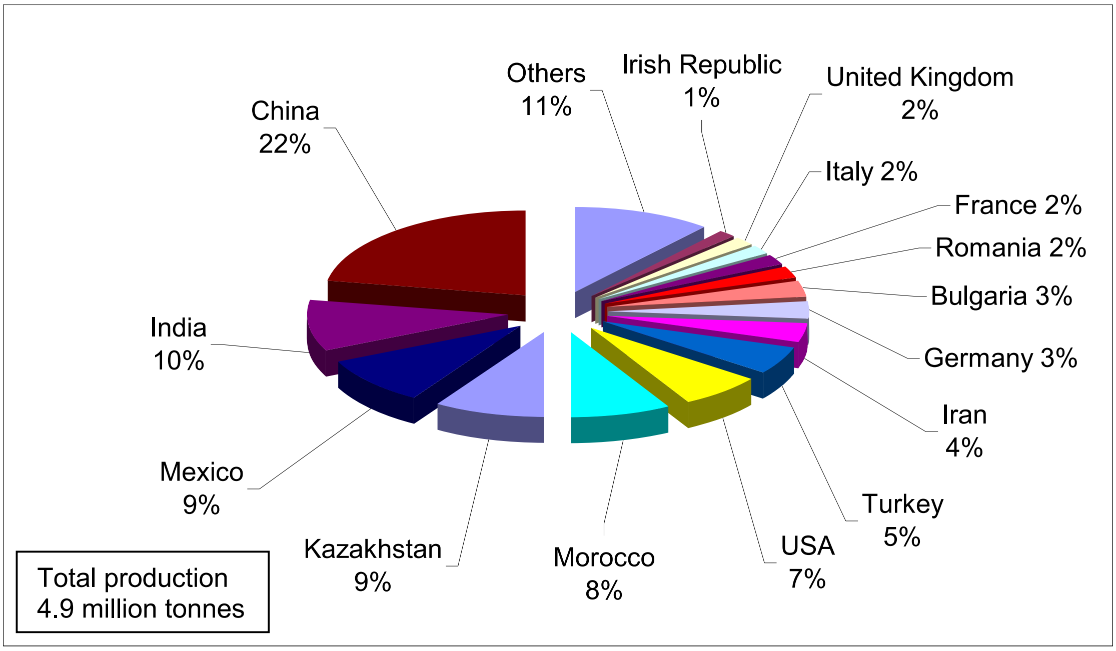
Sources: World Mineral Statistics, British Geological Survey (barytes production data) and Baker Hughes Inc (rig count data)

Figure 4.2.2 World barytes production compared with the annual average number of active exploration and producing oil and natural gas rigs, 1975 – 2003

A notable feature of Figure 4.2.2 is the increasing sensitivity of barytes production to variations in drill rig activity. Up to 1986 a change in rig activity was mirrored by an equivalent change in barytes production. After 1986, barytes production became much more sensitive to small changes in rig activity. For example, in 1988 there was a small rise in the number of active rigs but barytes production increased by one third. This led to a period of over-supply, led by excessive production in China, followed by a sharp drop in world production in 1993. Over-sensitivity to drilling requirements occurred again from 1996 onwards.

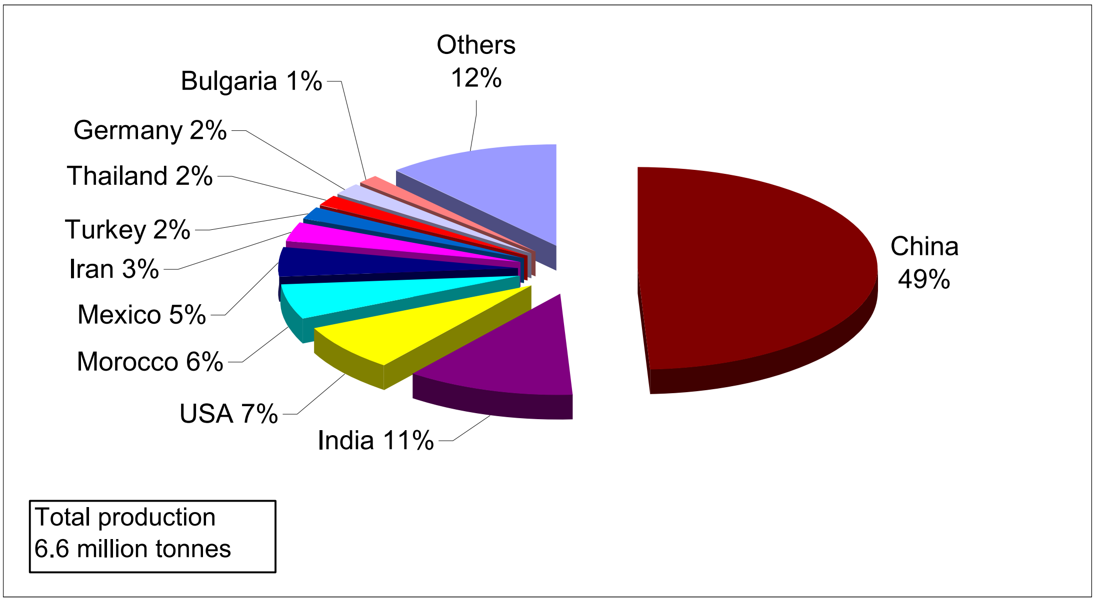
Over the last ten years there have been considerable changes in the countries that produce significant quantities of barytes. In 1992 (Figure 4.2.3) China, India, Mexico and Kazakhstan produced just over half of the world's barytes. By 2003, Chinese and Indian production accounts for over half of total world production, with China in effective control of the world market with 49% of all production (Figure 4.2.4).

4: World production



Source: [World Mineral Statistics](), British Geological Survey

Figure 4.2.3. World barytes production in 1992



Source: [World Mineral Statistics](), British Geological Survey

Figure 4.2.4 World barytes production in 2003

With 88% of production in 2003 used in drilling fluids, the quantity of barytes consumed for other uses is 12% or about 756,000 tonnes per year.

The future for barytes is unclear, and is closely associated with the future of oil and natural gas production. Oil has been extracted for over 100 years, with the discovery of over 41,000 oil fields. These fields vary enormously in size and distribution, as shown in Table 4.2.1.

4: World production

Table 4.2.1 1993 size distribution of worldwide oil fields

EUR[§] (million barrels)	Size	Quantity world-wide
50,000 +	Megagiant	2
5,000 – 50,000	Supergiant	40
500 – 5,000	Giant	328
100 – 500	Major	961
50 – 100	Large	895
25 – 50	Medium	1109
10 – 25	Small	2,128
1 – 10	Very small	7,112
0.1 – 1	Tiny	10,849
0 – 0.1	Insignificant	11,751
0 – 0.5	Other Tiny	5,989
Total		**41,164**

Source: Oil and Gas Journal, February 1993

There are several notable facts associated with Table 4.2.1:

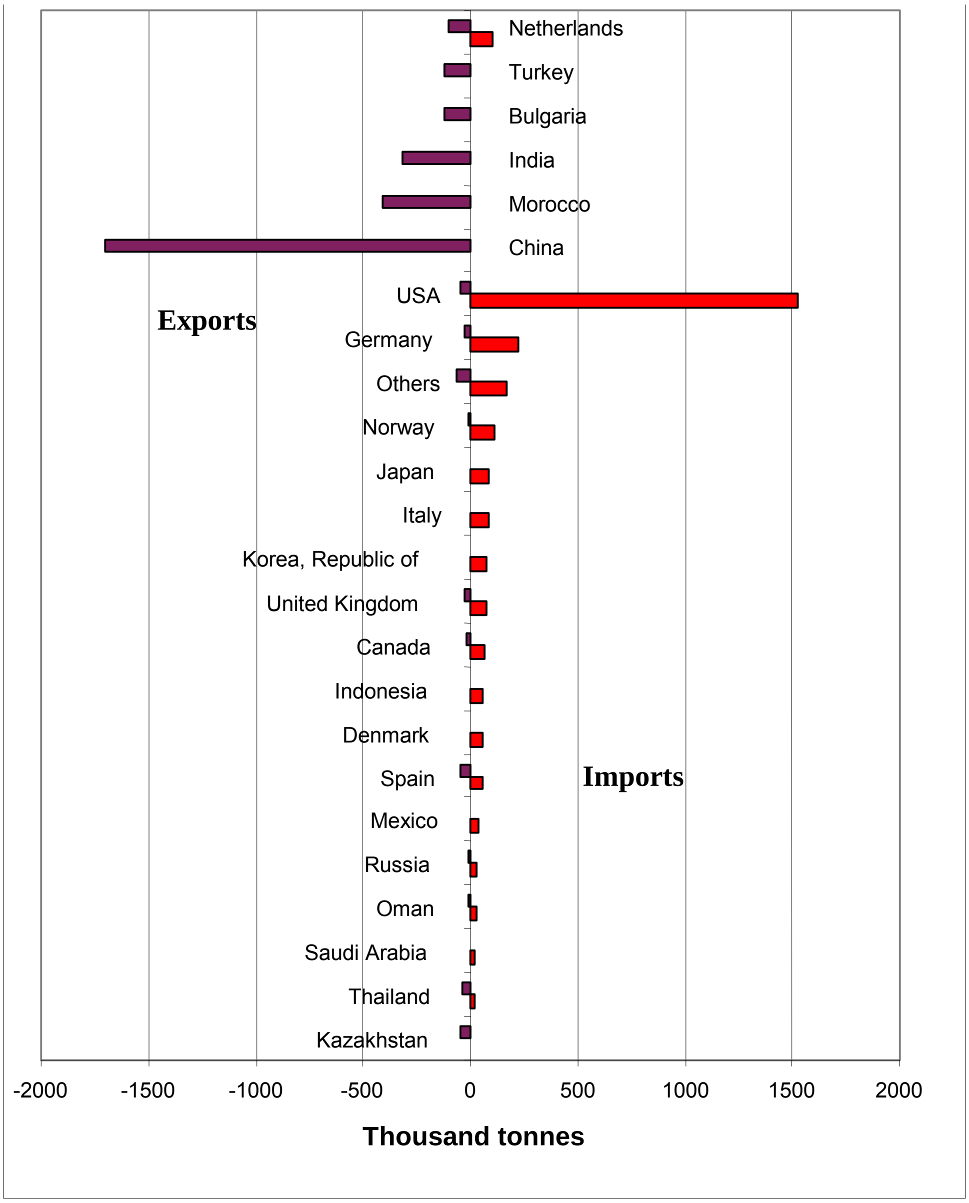
- three-quarters of the 41,164 known oil fields are in the USA, only 537 are in the Middle East
- both mega-giant fields are in the Middle East (Kuwait and Saudi Arabia)
- the 370 oil fields of Giant status and above account for 75% of world production, but only 1% of all the known oil fields
- the 1,331 oil fields of Major status or above represent 94% of all discovered oil, but only 3% of all discovered oil fields.

This skewed distribution has important consequences for barytes production. Some sources (World Resource Institute Report) suggest that all oil fields of major and above sizes have now been discovered. Exploration is now focussed on finding ever-smaller oil fields. This inevitably means that more drilling per unit of EUR oil is required and this will maintain, in the short term, a healthy demand for barytes.

[§] EUR : Estimated Ultimately Recoverable (crude oil)

5: World trade

The main barytes exporting countries in 2002 were China, Morocco and India. Together these three countries accounted for 80% of all exports (Figure 5.1).



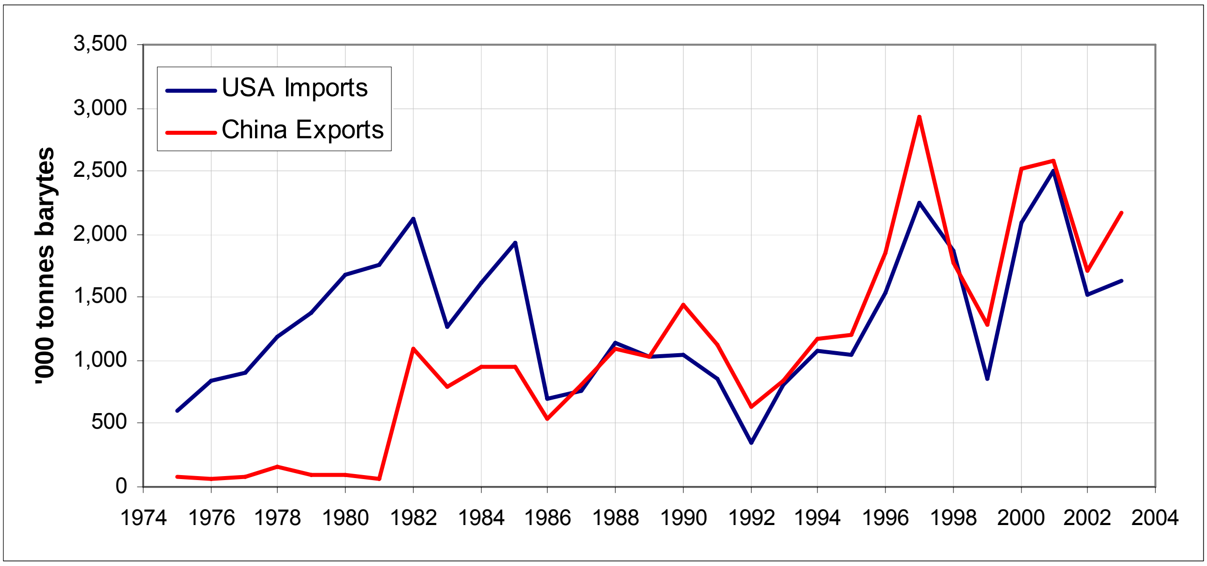
Source: World Mineral Statistics, British Geological Survey

Figure 5.1 Major barytes importing and exporting countries in 2002
('Combined countries' is the sum of 33 countries that have balanced or minor import/exports of barytes)

None of the main exporters of barytes are major oil-producing countries. This may change as China develops its own oil resources. Between 1995 and 2003 the pattern of Chinese barytes production and exports changed. Prior to 1995, almost all production was exported. However, in 1995 China began to explore and develop its own oil fields and exports dropped from almost 100% of domestic production in 1994 to only 63% in 2003.

5: World trade

Most of the barytes-importing countries also have domestic production (e.g. UK, USA and Canada) but are not self-sufficient. The USA is by far the largest importer, mostly from China (Figure 5.2). This is due to a small domestic production capacity and the fact that oil fields in the USA are small and difficult to find (i.e. more drilling is required to prove and extract oil). This contrasts with barytes consumption in the Middle East where, with the exception of Oman, most of the oil fields are 'Giant' or larger and consequently require relatively small amounts of drilling.

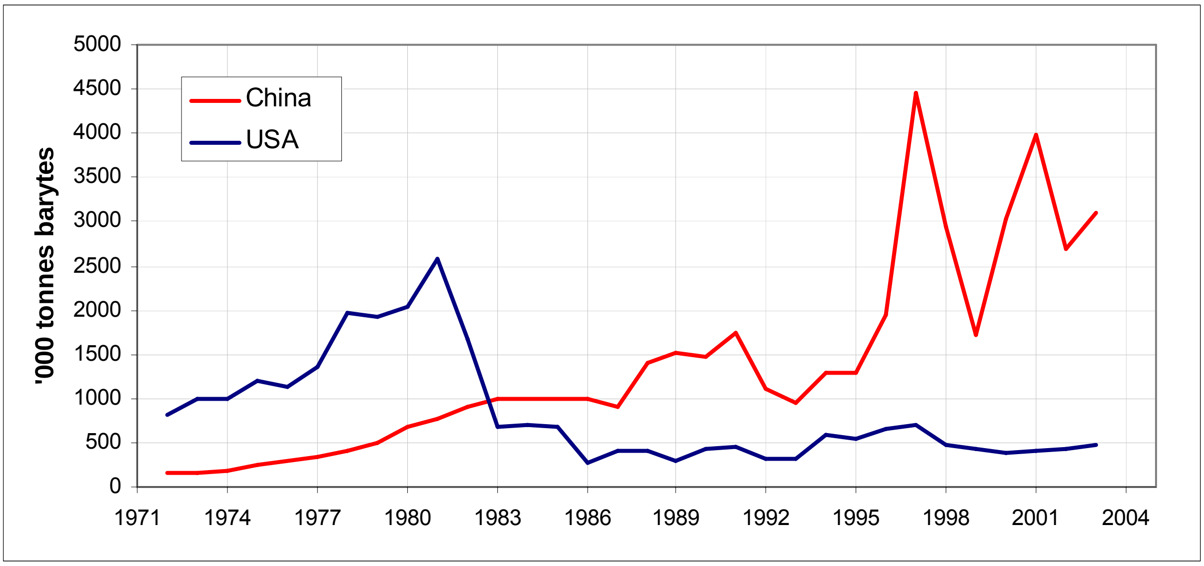


Source: World Mineral Statistics, British Geological Survey

Figure 5.2 Comparison of USA barytes imports and Chinese barytes exports 1975 – 2003

The dependence of the USA on barytes imported from China is clearly illustrated in Figure 5.2. Production of barytes in the USA has shrunk by 80% from a peak in 1981 of 2.5 million tonnes to just under 0.5 million tonnes in 2003 (Figure 5.3). This is despite the fact that annual consumption in 2003 was around 2.06 million tonnes, compared to 4.1 million tonnes in 1981.

6: Prices



Source: World Mineral Statistics

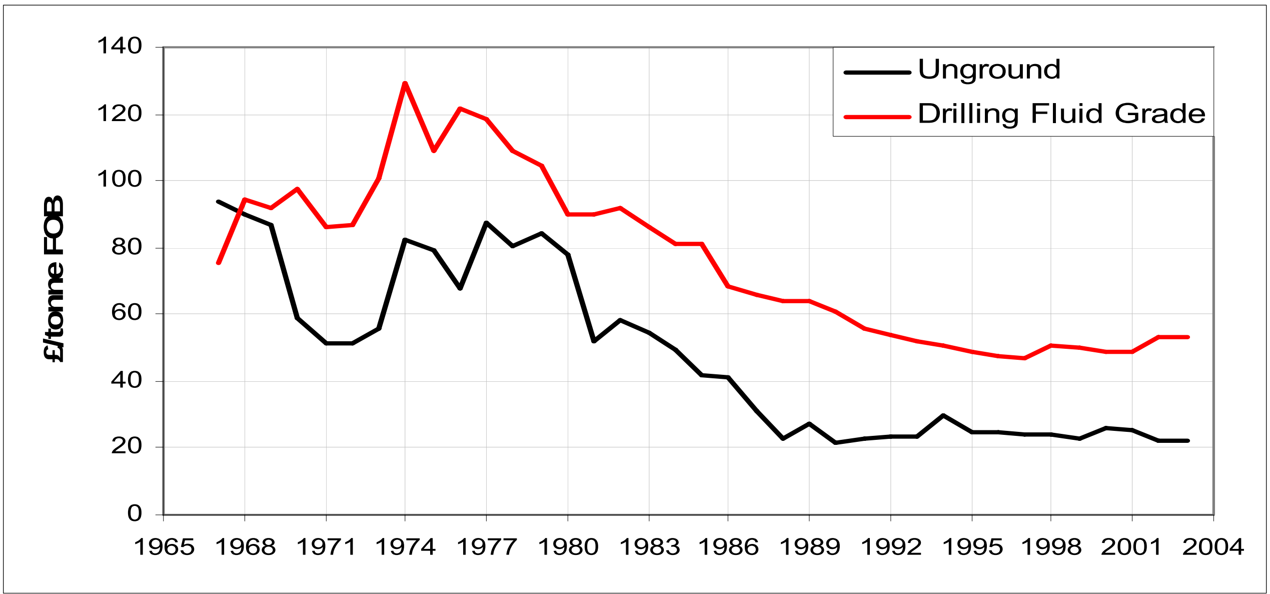
Figure 5.3 USA and China barytes production from 1972 to 2003

There are four barytes products for which price data are published. These are:

- ground white paint grade — finely ground barytes that is processed to remove discolouration
- micronised — ultra-fine ground barytes, almost entirely used by the chemical and medical industry
- drilling fluid grade
- unground barytes — broken ore transported directly from a mine to grinding plants supplying the oil and gas drilling industry. Also known as 'direct shipped'.

Price data for selected barytes products are presented in Figure 6.1. The coincident peak in prices around 1974 is a direct consequence of the oil and gas exploration boom that continued into the 1980s.

7: Alternative technologies



Source: Industrial Minerals Magazine

Figure 6.1 Historical price (nominal) variation of barytes 1967 – 2003. Drilling grade is based on the price for barytes, FOB, Aberdeen

The surge in the number of active oil and gas rigs in the mid-1970s generated a period of demand for drilling fluid that initially consumed much of the supply of all grades of barytes. This led to strongly elevated prices in paint and micronised grade barytes as supplies became harder to get, although the price for drilling fluid grade was less affected. World production quickly caught up, increasing from 4 million tonnes per year in 1973 to just over 8 million tonnes per year by 1980 (Figure 4.2.1). Subsequently, as supply expanded and exceeded demand, the price for barytes fell.

As a weighting agent in drilling fluids, barytes is very difficult to replace. There are several crucial factors that make barytes ideal as an additive for this application:

- high specific gravity
- low cost
- white colour (helps to keep the rig clean)
- relatively non-abrasive and soft as a powder suspension
- barytes powder mixes equally well in oil or water
- chemically inert and non-corrosive
- poses no known health threats through inhalation or contact
- environmental.

Other minerals that can substitute for barytes as a weighting agent in drilling fluid are celestite, galena, calcium carbonate, ilmenite and finely powdered iron ore. However, none of these alternatives meet all the criteria for barytes on price, technical performance, environmental and health and safety considerations. In Norway there is pressure to remove barytes from the ‘safe list’ of weighting agents because it can contain deleterious quantities of heavy metals.

Specialised applications for barytes offer little scope for significantly increased use. In these markets barytes tends to be chosen in preference to other possible minerals because it is low-cost and readily available. The ability of barytes to block X-rays (second only to lead) and the fact that it is the only X-ray-opaque material that is safe to use in the human body may lead to the development of new applications in medical science.

8: Barytes - focus on Britain

8.1 Resources

Although barytes is not uncommon in the UK, economic deposits are rare and the mineral has been extracted from only a few localities (Figure 8.1.1). In the past barytes production in the UK has been from small, steeply dipping, high-grade vein deposits in Paleozoic rocks in Wales, Shropshire, South Devon, the Pennines and Scotland. Vein and replacement deposits have been worked in Carboniferous rocks in the Northern and Southern Pennine Orefields. More recent production has been from stratiform deposits in Late Proterozoic rocks of central Scotland that contain world-class resources of barytes.

Currently only the Foss mine near Aberfeldy in Scotland extracts barytes as the primary mineral. Following the closure of small-scale workings in the Northern Pennines, barytes production in England is now limited to workings in the Southern Pennine Orefield, where it is produced as a by-product of fluorspar extraction and processing.

The Duntanlich deposit, located about 10 km north-east of the Foss mine in Perthshire, is a major barytes resource. The deposit has a simple structure and could be exploited by underground mining methods. The inferred resource is 13 million tonnes, with measured resources of high-quality barytes of 7 million tonnes. This would be sufficient to meet the UK's apparent consumption of 200,000 tonnes per year for the next 30 years, and would bring to an end the current need to import barytes. It is worth noting that the measured resources of barytes at Duntanlich are higher than the cumulative estimated 6.7 million tonnes that have been extracted from all UK sites since records began in 1876.

Mississippi Valley type (MVT) deposits occur in the Northern and Southern Pennine Orefields. MVT deposits are mostly bedded, stratabound, replacement sheets in dolomites or dolomitised limestones. The ore minerals are usually lead and zinc, but fluorspar and barytes can form a significant proportion of the mineral assemblage. The Variscan Front[**] in southern England is prospective for MVT deposits, and both Northern and Southern Pennine Orefields remain prospective for new discoveries.

There is significant untested potential for economic barytes deposits in other parts of the UK. The Devonian–Lower Carboniferous volcano-sedimentary belt affected by the Hercynian orogeny[††] in south-west England is prospective for both stratiform and vein style deposits. Barytes also occurs as a cement in Permo-Triassic sandstones throughout the English Midlands where locally barytes can form up to 10% of the rock. The Cheshire Basin is particularly prospective for sedimentary stratiform deposits.

[**] In the UK the line marking the northern limit of structures related to the Hercynian orogeny is known as the Variscan Front. This extends from southern Ireland, through South Wales and across southern England
[††] the Hercynian orogeny was a Europe-wide mountain-building event (oblique continental collision) that occurred in several phases between 400 and 260 million years ago

8: Barytes - focus on Britain

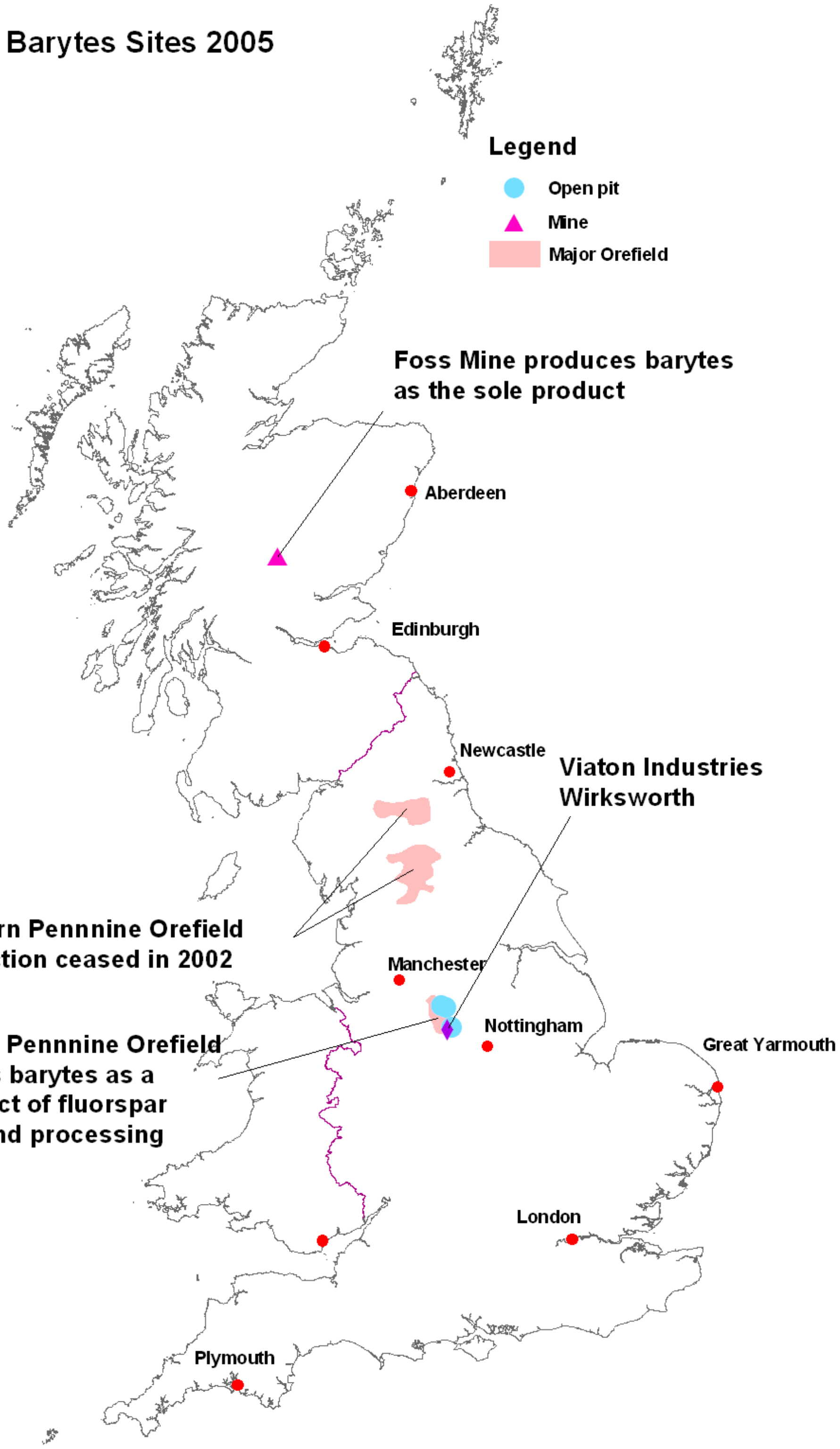


Figure 8.1.1 Major barytes mining areas in the UK (red filled outlines) and location of the main UK consumer of barytes for chemical and medical purposes (blue diamond). Most

barytes from the Foss mine is transported to Aberdeen and Great Yarmouth for processing and addition to drilling fluids

8.2 Reserves

Reserves are that part of a mineral resource that have been proven to be economically mineable after consideration of all technical, economic and legal factors. In the UK the term *permitted reserves* is in common use in land use planning to indicate that permission for mineral extraction has been granted. This term is not strictly necessary since a resource without permission cannot be legally worked and so cannot be classified as a reserve. Full definitions are at: http://www.imm.org.uk/reserves.htm.

Current permitted reserves are at the Foss mine in Perthshire and in the Southern Pennine Orefield in south Derbyshire. The Foss mine has three years of proven reserves remaining. As there are no published figures, it is not possible to be precise on the permitted reserves of barytes in the Southern Pennine Orefield. Cavendish Mill produces barytes as a by-product of processing fluorspar (Figure 8.2.1). Current permitted reserves of fluorspar ore are approximately 1 million tonnes with a typical barytes grade of 8 to 9%. This suggests that permitted reserves of barytes may be around 80 000 tonnes (assuming some losses during recovery). However, new resources are constantly being evaluated.

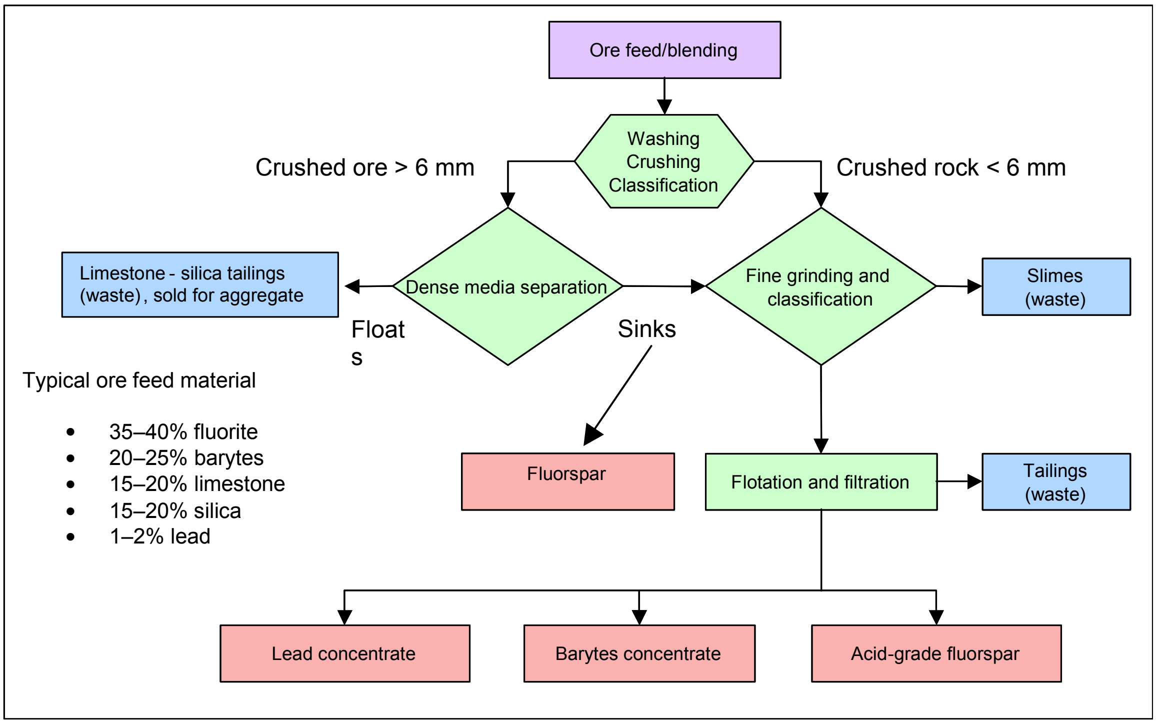


Figure 8.2.1 Simplified flowsheet for the production of by-product barytes during fluorspar beneficiation from an operation such as Cavendish Mill (Glebe Mines Ltd.).

8.3 Structure of the industry

The Foss mine is operated by MI Drilling Fluids UK Ltd, a subsidiary of the large American-based global drilling fluids manufacturer MI Drilling Fluids Co. Almost the entire production from Foss is processed in Aberdeen and used as a weighting addition to drilling fluids in the North Sea oilfields. Some production is also transported to Great Yarmouth.

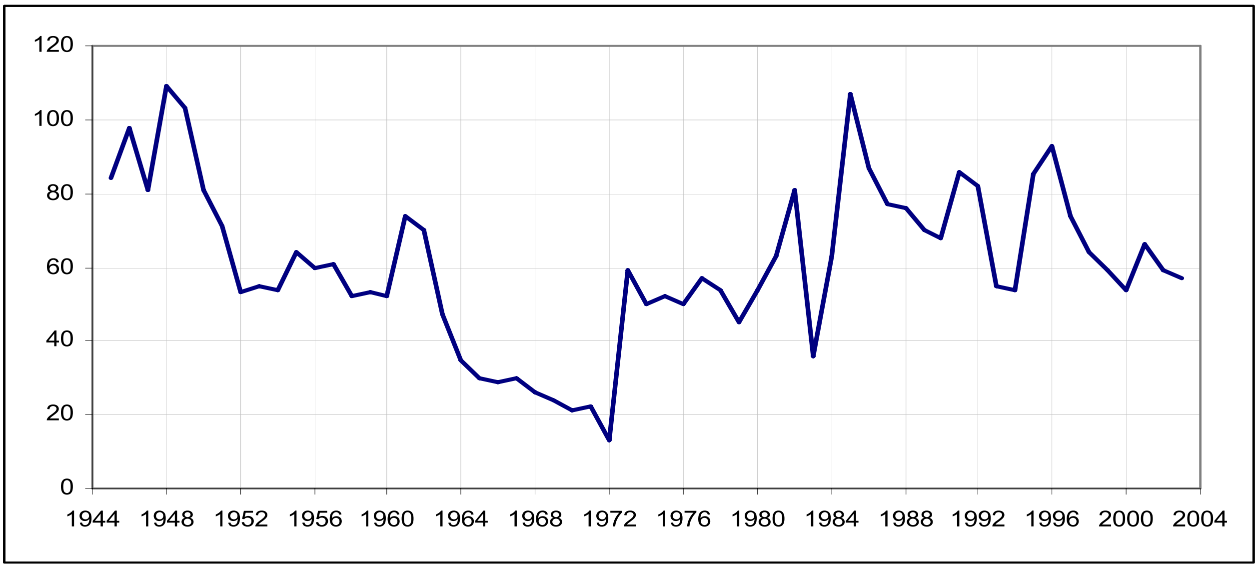
8: Barytes - focus on Britain

With CIF[‡‡] costs representing 80% of the cost of delivered drilling grade barytes (currently US$50 per tonne) the location of the deposit and relatively short transport distance to Aberdeen make Foss barytes locally competitive.

Glebe Mines Ltd, a privately-owned company, is now the only producer of a marketable barytes product in England following the closure of two small open-pit operations in the northern Pennines. The company was established in 1999 through the acquisition of most of the assets of Laporte Minerals former fluorspar mining and processing operations in the Peak District. The company operates the Cavendish Mill where barytes is a flotation concentrate by-product of processing fluorspar ore (Figure 8.2.1). Some of the barytes is sold into the drilling fluids market but most is sold to Viaton Industries, a Derbyshire-based company specialising in the fine grinding (micronising) of domestically produced and imported barytes for filler applications. Barytes destined for chemical or filler markets is more valuable per tonne than drilling grade (Figure 6.1). The Cavendish Mill supplies about half of Viaton Industries barytes requirements. The remainder is made up from imports.

8.4 Production

Since 1945 a total of 3.4 million tonnes of barytes have been produced in the UK. A further 4.4 million tonnes was imported over the same period. Over 80% of total barytes production in the UK of about 57,000 tonnes in 2003 was from the Foss mine. Following the recent closure of two small open-pit barytes workings in the Northern Pennine Orefield, at Closehouse in Durham and Silverband in Cumbria, production in England is now entirely confined to the Southern Pennine Orefield.



Source: World Mineral Statistics, British Geological Survey

Figure 8.4.1 UK production of barytes 1945 – 2003 (thousand tonnes)

[‡‡] Cost, Insurance, Freight — CIF is the term used to indicate total value of a shipment. This compares with Free On Board (FOB) where the sellers commitments end when the shipment is placed onto the transport carrier, thus FOB is usually the value of the commodity only.

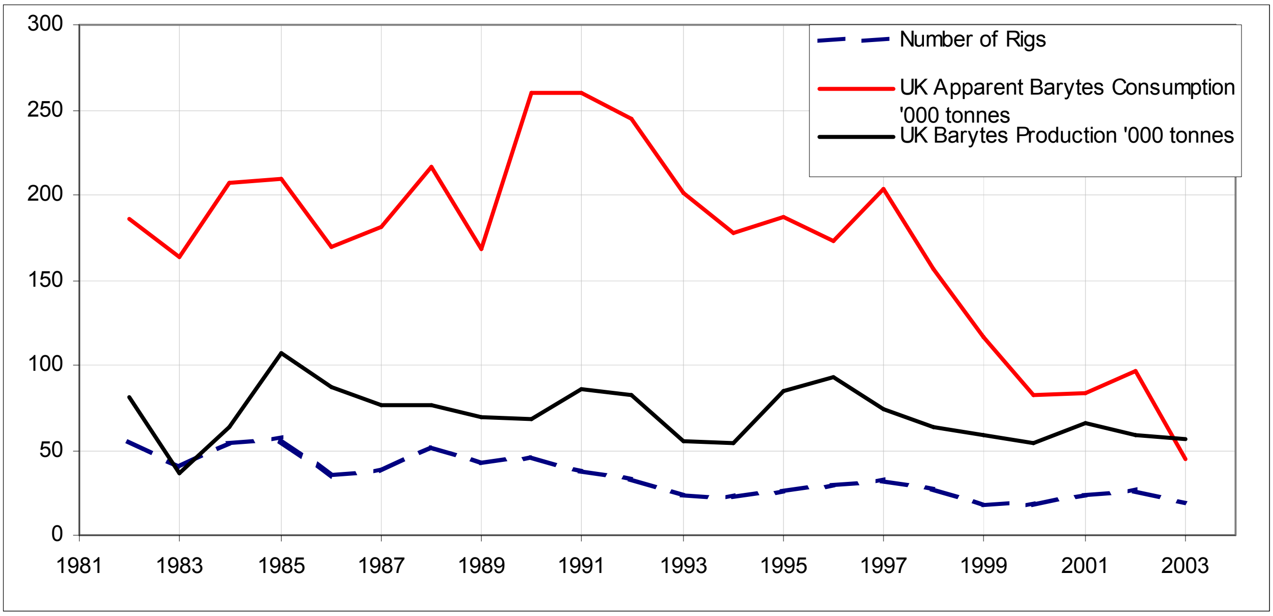
8: Barytes - focus on Britain

Post-war barytes production in the UK peaked in 1948 at 115,000 tonnes. Before 1950 over 90% of production was consumed in paint and lithopone manufacture as barytes was used to replace lead. However, production began to fall as titanium dioxide was increasingly used as a white pigment in paint. Domestic production reached its lowest point in 1972 at only 16,000 tonnes, whereupon the UK barytes industry was rescued by the surge in oil well drilling in the North Sea.

8.5 Consumption

Since 1972, demand for barytes in the UK has mainly reflected the level of oil exploration and production activity on the UK continental shelf. Following the discovery of hydrocarbons in the UK continental shelf in the early 1970s consumption of barytes increased to a peak of 260,000 tonnes in 1990-91, the major proportion of which consisted of imports. More recently consumption has been in the range 100,000 to 200,000 tonnes per year due to a decline in exploration activity.

The sensitivity of UK barytes consumption to the number of active exploration and production oil and gas rigs in the UK continental shelf is apparent from Figure 8.5.1. There has been a substantial decrease in exploration on the UK continental shelf since 1999 and this is reflected in the decline of apparent barytes consumption in the UK. It is notable that UK domestic barytes production has been little affected by the fall in consumption. Falling import levels have absorbed much of the decline in consumption.



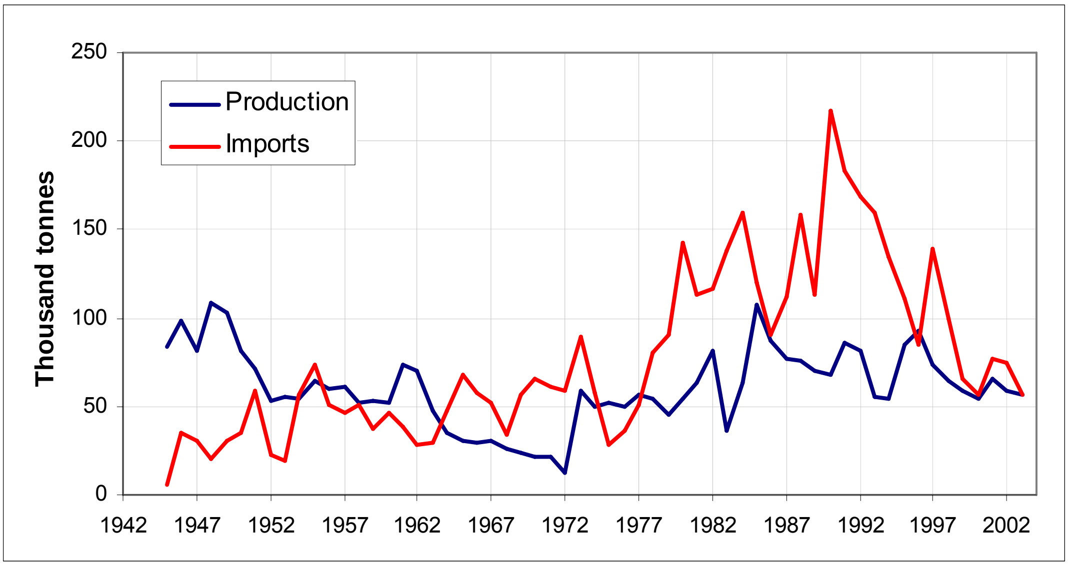
Sources: Baker Hughes Inc and World Mineral Statistics

Figure 8.5.1 Average annual number of active UK offshore oil and gas rigs compared to UK domestic barytes production and consumption 1982–2003 *(note: the difference between production and consumption reflects imports; however, it is believed that reported UK exports of barytes since 2000 are erroneously high).*

8.6 Trade

The UK has been a significant net importer of barytes since 1964 (Figure 8.6.1). Imports are mainly used in drilling fluid applications, although a small proportion is further processed for use as a filler. Imports between 1985 and 2005 have been in the range 100,000 to 200,000 t/y, with the level of imports essentially reflecting exploration activity on the UK continental shelf. However, in recent years imports have declined due to a general decrease in exploration activity and amounted to almost 57,000 tonnes in 2003. Exports are modest and have been between 5,000 and 10,000 tonnes in most years. Exports since

2000 have been much higher, up to approximately 69,000 tonnes in 2003, although these are difficult to account and are believed to be erroneous.



Source: World Mineral Statistics , United Kingdom Minerals Yearbook 2005

Figure 8.6.1 UK barytes production and imports 1945 – 2003

8.7 Issues

The future of barytes production in the UK remains uncertain. It is dependent on three main factors:

- the future of fluorspar extraction in the Southern Pennine Orefield
- the prospects for the proposed Duntanlich mine, near Aberfeldy, Perthshire
- competition with international suppliers of barytes.

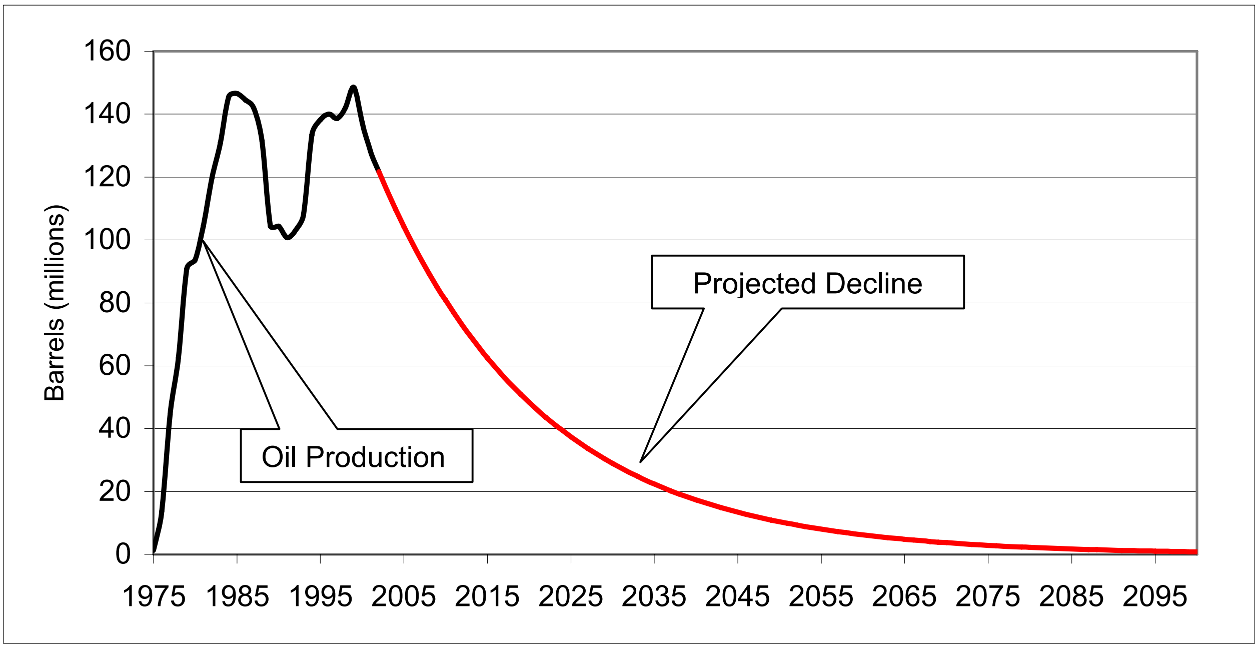
In the Southern Pennine Orefield continued supply of barytes is intimately related to the future of fluorspar production. This means identifying sufficient workable resources of fluorspar ore and progressing these through the planning system to permit extraction. As future sites are likely to occur within the Peak District National Park, planning issues within sensitive areas will be a major factor in the future.

The Foss mine, near Aberfeldy in Perthshire, is the most important source of barytes in the UK. The mine came into production in 1984 and its life has been considerably extended from original estimates. However, it is expected that reserves will be exhausted within the next two to three years. The nearby and much larger Duntanlich barytes deposit was intended to replace output from the Foss mine but planning permission to develop the deposit was denied in 1991. A public inquiry in 1993 upheld the decision (McCulloch 1993—Report of a public local inquiry) and this was further upheld by the Court of Session in Scotland in 1996. The key decision to deny permission mostly hinged on the following:

8: Barytes - focus on Britain

- the location of the deposit, and proposed development, in a National Scenic Area. Development would have a significantly deleterious effect on the intrinsic beauty of the area;
- with barytes being an abundant mineral and readily available on world markets there is no proven national need to produce barytes. The development is economically unjustified;
- the arterial A9 is a designated ‘fast track’ road and the creation of new junctions is not permitted.

MI may choose to submit a revised planning application, but there remains a possibility that this world-class deposit of barytes may never be worked. The hydrocarbon resources of the UK continental shelf are rapidly being depleted (see Hubbert Peak of Oil Production). An average decline of 5% per year is thought likely for current and future oil production in the North Sea (Figure 8.7.1). In addition, exploration within the UK continental shelf has continually declined since 1999. Although there is unlikely to be a fresh surge in activity (DTI - Consultation on declining oil and gas exploration in the North Sea), the 2005 surge in oil prices to over US$60 a barrel may lead to increased exploration in the North Sea.



Sources: DTI Energy Statistics (annual oil production figures) and The Impact of Declining Major North Sea Oil Fields upon Future North Sea Production (projected decline)

Figure 8.7.1 Historical and projected oil production from the North Sea 1975 – 2100

8: Barytes - focus on Britain

The consequences for the any future development of Duntanlich are uncertain. With the nearby North Sea drilling fluids market almost certain to decline over the next twenty years, the window of opportunity to supply the national need for barytes is passing. If, at some point in the future, Duntanlich was to receive permission to extract barytes there will almost certainly be a much smaller domestic market. Duntanlich will therefore have to compete with China, India and Morocco in the international drilling fluid market. It is notable that transport costs of barytes account for 80% of the shipment (CIF) value

(Industrial Minerals, May 2002). However, as production from world oil and gas fields declines, the price for oil and gas may be expected to rise. This would lead to sustained demand for barytes as it is consumed in the exploration for ever-smaller oil and gas fields. Duntanlich is a relatively simple ore-body, flat lying with very little structural complexity. Production costs should be relatively low and it may be able to compete successfully on the international market.

9: Further reading

BRITISH GEOLOGICAL SURVEY. 2005. *United Kingdom Minerals Yearbook 2004*. (Keyworth, Nottingham: British Geological Survey)

BRITISH GEOLOGICAL SURVEY. 2003. *World Mineral Statistics 1998–2002: production: exports: imports*. Minerals Programme Report No. 13. (Keyworth, Nottingham: British Geological Survey)

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MCCULLOCH J M. 1993. Report of a public inquiry into an appeal against the refusal of planning permission for the extraction of barytes by underground mine at Duntanlich, by Ballinuig, Perthshire; construction of an associated minehead yard; 6 km road to Fonab Forest; and formation of a new access to A827 road at Ballechin. Scottish Office

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