

# Potash

*This factsheet provides an overview of potash supply in the UK. It forms part of a series on economically important minerals that are extracted in Britain and is primarily intended to inform the land use planning process. It is not a statement of planning policy or guidance; nor does it imply Government approval of any existing or potential planning application in the UK administration.*

April 2011

**Boulby Mine,  
North York Moors  
National Park.**

**P**otash is a generic term for a variety of potassium-bearing minerals and refined products. There are many potassium-bearing minerals but only those that are water-soluble are of significant commercial interest. **Sylvine** (potassium chloride, KCl) is by far the most important source of potash worldwide, because of its solubility and high potassium content, and accounts for all the potash produced in the UK to date. Potassium minerals rarely occur in pure form and the mined material is invariably a physical mixture of salts. **Sylvinite** is a mixture of **sylvine** and **halite** (salt, NaCl) in varying proportions and this is the material that is mined in the UK.  $K_2O$ , a compound not found in nature, is the basis for comparing all potassium compounds. Marketable potassium chloride contains about 60%  $K_2O$ .

Sylvine is a relatively scarce mineral, which occurs in the UK in beds up to a few metres thick. It occurs in evaporite deposits, which were formed by precipitation from brines resulting from the extreme evaporation of seawater. Other potassium-bearing evaporite minerals found associated with sylvine are carnallite (hydrated potassium, magnesium

chloride) and polyhalite (hydrated potassium, magnesium, calcium sulphate).

These minerals have much lower  $K_2O$  contents. Potash does not crop out at the surface and in the UK, deposits only occur at depths in excess of 800 m. Resources are confined to England and offshore areas.

## Demand

Potassium is one of the three primary nutrients essential for plant growth (the others being nitrogen and phosphorus). These nutrients form the basis of fertiliser production in the UK and throughout the world. Potassium is involved in the production, transport and accumulation of sugars in plants, assists their hardiness and resistance to water stress, pests and diseases. Potash applied as fertiliser replaces potassium removed from the soil through plant harvesting and animal grazing.

About 90% of UK potash production is consumed in the manufacture of fertilisers. Of this, some 95% is used as a blend or compounded with other nutrients, principally nitrogen and phosphorus. Small quantities of potash are also used by the chemical and pharmaceutical industries for the manufacture of a wide range of goods, ranging from soaps, the production of glass for television screens, drilling fluid additives, and as a flux in secondary aluminium smelting.

Since most potash is used as a fertiliser, demand is primarily linked to agricultural productivity.

## Supply

Potash is produced in only a few countries. Canada, Russia, Belarus and Israel are the main producers, followed by China, Germany, Jordan and the USA. In Europe, Spain and the UK are small producers, but production in France ceased in 2003. World production of potassium chloride has been decreasing in recent years and was about 21 million tonnes  $K_2O$  in 2009, the lowest global output since 1993. A high proportion of this (18.7 million tonnes  $K_2O$ ) entered world trade because there are so few producers.

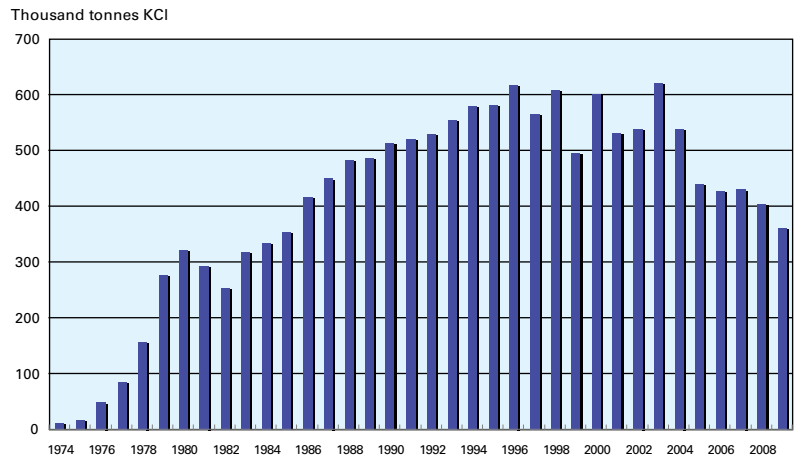


# Mineral Planning Factsheet

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The UK has emerged as an important world producer of potash in the last 30 years with the development of the Boulby Mine near Loftus in the North York Moors National Park. Shaft sinking for the Boulby Mine began in 1968 and was completed for production in 1976, although some production was possible from a single shaft from 1973. Output increased steadily until 2003 but has been in decline since then with 600 000 tonnes refined KCl produced in 2009. This reduction in output is partly due to the collapse of global demand for potash in 2009 as well as the mine having to ramp up production of gritting salt in response to the severe weather. Peak production was in 2003 with an output of 1 040 000 tonnes and cumulative output has been 24.6 million tonnes. The Boulby Mine is the UK's only potash mining operation.

Two other proposals to extract potash in North Yorkshire, one of which involved solution mining, were permitted in the late 1960s, but were never implemented. York Potash Ltd, recently acquired by Sirius Minerals Plc, has been analysing the potential to develop a potash project in an area to the south of the current mine. The



**Figure 1 UK sales of refined potassium chloride, 1974–2009.** Source: UK Minerals Yearbook, BGS.

company has stated that it has various agreements relating to mineral rights covering an area of more than 600km<sup>2</sup> both onshore and offshore between Whitby and Scarborough.

### Trade

The UK is a net exporter of potassium chloride, the main potassium fertiliser material. Official figures for exports of potassium chloride have been withheld for a number of years for commercial reasons, but exports figures have been estimated by BGS (Table 1).

Potash from Boulby is exported through Tees Dock which is linked to the mine via a dedicated rail line. Exports are mainly to Western Europe, with France being the largest single market. Imports of potassium chloride are mainly from Germany and the Netherlands. The Boulby Mine is operating in a world market and has to remain competitive by optimising mining costs to achieve lower costs per tonne of final product.

### Consumption

Apparent consumption of potash in the UK has declined from 834 000 tonnes KCl in 2004 to about 535 000 tonnes in 2009. This is partly due to the collapse of global demand for potash in 2009. The general fall in consumption over the

	Exports		Imports	
	Tonnes	£000	Tonnes	£000
<b>2003</b>	630 000	N/A	424 000	22 447
	e			
<b>2004</b>	510 000	N/A	342 000	20 615
	e			
<b>2005</b>	340 000	N/A	336 000	22 281
	e			
<b>2006</b>	430 000	N/A	286 000	19 905
	e			
<b>2007</b>	350 000	N/A	336 000	24 969
	e			
<b>2008</b>	283 000	N/A	277 000	47 095
	e			
<b>2009</b>	200 000	N/A	135 000	33 226
	e			

e=BGS estimate. N/A not available

**Table 1 UK: Imports and exports of potassium-chloride, 2003–2009.** Source: HM Revenue & Customs and BGS.

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last few years is believed to be partly an effect of a decline in agricultural production, but also to an overall loss in potassium levels in soils. This deficiency in application will presumably have to be made good at some stage.

### Economic importance

The Boulby Mine is the single most important non-hydrocarbon mineral operation in Britain generating total sales of an estimated £170 million in 2009, including by-product rock salt.

The mine employs around 1000 people, over half working underground and it is the largest employer in the North York Moors National Park, with over 90% of employees living within 30 km. Exports are valued at about £50 million.

Sirius Minerals Plc have stated that the York Potash project has the potential to create several thousand jobs, both directly and indirectly, in the local and regional economy.

### Structure of the industry

The Boulby Mine is operated by Cleveland Potash Ltd, a wholly-owned subsidiary of Israel Chemicals Ltd following the acquisition of the company from Anglo American plc in April 2002. With a total output of some 4.1 Mt/y, Israel Chemicals Ltd is now Europe's second

largest potash producer and the sixth largest in the world. The potash supply chain is summarised in Figure 2.

### Resources

Potash resources were first discovered in England at depth near Whitby in North Yorkshire during exploration for oil in 1939. Further exploration was undertaken in 1948 and later in the early 1960s. The potash is of late Permian age and occurs at two main horizons; the Boulby Potash, which is the most extensive, and a higher horizon, the Sneaton Potash. In both these beds sylvine is the main potassium mineral present. Potash in the form of carnallite ( $KCl \cdot MgCl_2 \cdot 6H_2O$ ) and polyhalite ( $K_2SO_4 \cdot MgSO_4 \cdot 2CaSO_4 \cdot 2H_2O$ ) also occurs.

The sub-surface extent of the Boulby Potash and its conjectured western limit is shown on Figure 3. The bed underlies extensive parts of east Yorkshire but is only worked at the Boulby Mine. Mining is confined to a single bed, the Boulby Potash Member, which occurs at the top of the Boulby Halite Formation at depths

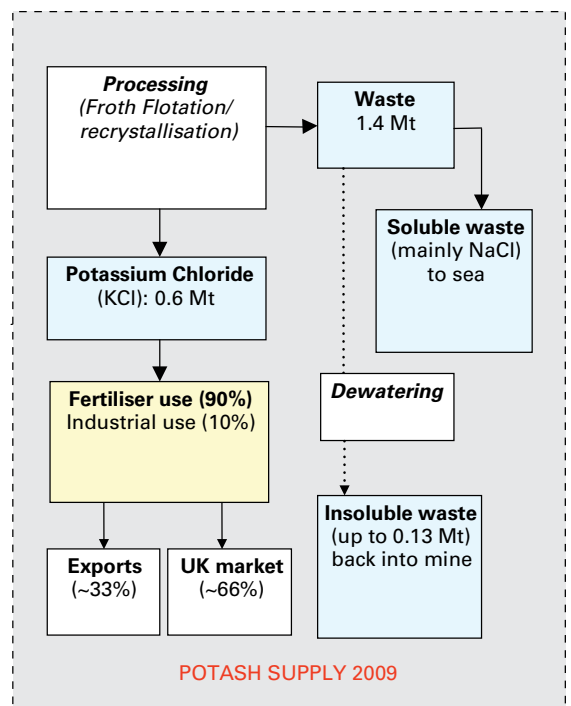
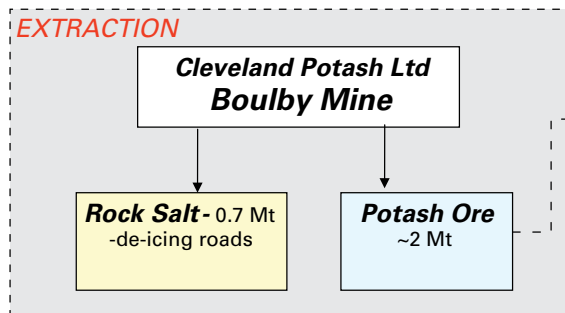


Figure 2 Potash supply chain 2009.

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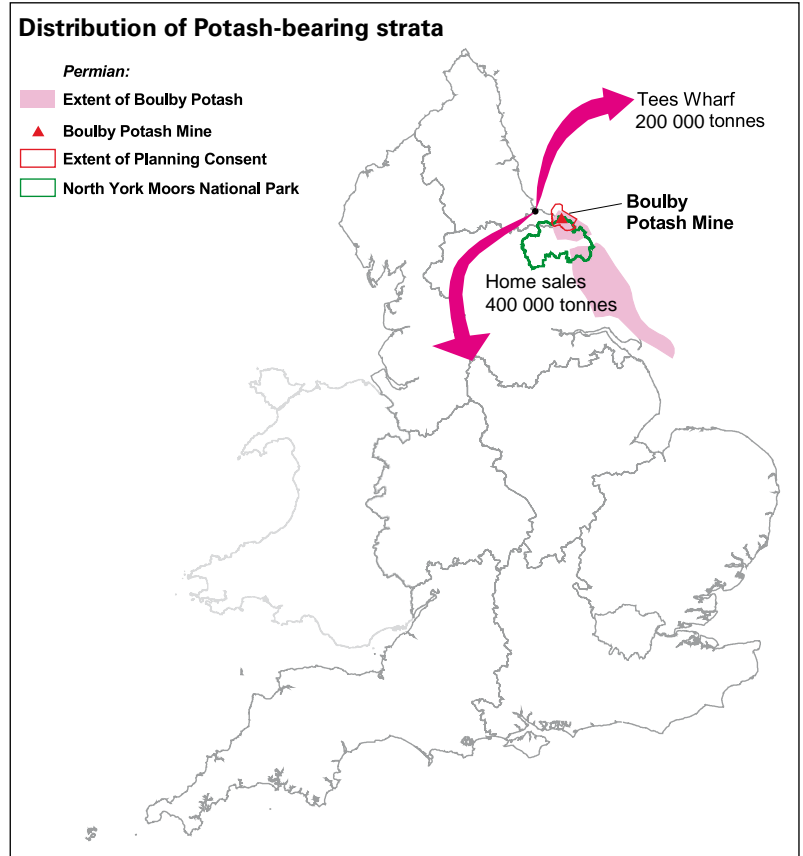
of over 1200 m in onshore areas. The bed dips at a shallow angle from north-west to south-east. Mining operations currently extend about 11 km offshore to the north where they are approximately 800 m below the seabed. In the south a combination of seam dip and topography leaves the workings almost 1300 m below the land surface.

The Boulby Potash averages 7 m in thickness but ranges from nil to over 20 m. The bed consists of sylvinitic with minor clay minerals and anhydrite, and traces of other minerals. The material mined is of high grade by international standards with a mean KCl content of 34% (21% K<sub>2</sub>O). However, grade varies both vertically and laterally. The potash bed has a sharp basal contact with the underlying rock salt and a sharp, but undulating upper contact with the overlying Carnallitic Marl. Plastic deformation can have a marked effect on potash grade and thickness, which ranges from a complete absence in some areas to grades of 60% KCl in others. The Carnallitic Marl is a weak rock and 1.5 metres of potash are left in the roof for safety reasons.

The Boulby Halite beneath the potash bed achieves a total thickness of about 40 m. About 8–10 m below the potash bed is a bed of pure and strong halite through which the mine's arterial roadways are driven to access current mining areas and to explore and develop new areas for potash production. Resources are also evaluated by drilling long horizontal boreholes to intersect the potash bed.

Another potential potassium resource in the area is polyhalite. In addition to sylvinitic, the Boulby Mine also hosts high grade polyhalite (K<sub>2</sub>Ca<sub>2</sub>Mg(SO<sub>4</sub>)<sub>4</sub>·2(H<sub>2</sub>O)). The feasibility of extraction of polyhalite is currently under active investigation at Boulby. Sirius Minerals' York Potash project is proposing exploration for both potash and polyhalite.

A stratigraphically higher, but less extensive evaporite succession in north-east England, the Sneaton Halite Formation, also includes the Sneaton Potash Member. These deposits are not currently of economic interest.



**Figure 3** Distribution of potash bearing strata, England.

## Reserves

Figures for reserves are not in the public domain.

## Relationship to environmental designations

The Boulby mineshaft and associated facilities, together with the southern mining area, are located in the North York Moors National Park, which is the Mineral Planning Authority. The northern mining area extends into Redcar and Cleveland outwith the Park and the eastern and parts of the northern mining area also extend out under the sea (Figure 3). The Crown Estate is responsible for potash occurring beneath the seabed.

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### Extraction and processing

Potash is worked by underground mining methods. The potash bed is accessed by two 5.5 m diameter concrete and cast-iron lined shafts, which are each about 1150 m deep. One shaft is for raising the potash ore and rock salt and the other is for men and materials. Remotely controlled continuous mining machines are used to extract both the potash ore and rock salt. Potash is mined during the week and rock salt at the weekends. Potash mining areas are subsequently abandoned because of the roof stability considerations. The ore is loaded into shuttle cars to feed an underground primary crusher which reduces the potash to less than 150 mm. This material is then conveyed to the shaft bottom for raising to the surface in 22.8 tonne skips. The surface plant is capable of treating about 3 Mt/y of ore.

The potash bed is a mixture of sodium and potassium chloride crystals with inclusions of insoluble material, usually clays. Composition is typically 38% KCl, 52% NaCl and 10% insoluble matter. A small proportion of the sylvinite ore is sold directly as a fertiliser for sugar beet. However, the vast majority is crushed and ground and potassium chloride is recovered from the salt and other constituents by froth flotation. The product is then de-watered, dried and screened. A granular product is made by the compaction of standard grade material. A high-grade soluble product for both industrial and agricultural use is produced by preferentially dissolving potassium chloride for subsequent re-crystallisation. Four potash products are thus produced; soluble (95–98% KCl), standard (95% KCl), granular (95% KCl) and sylvinite (30% KCl). The most important products are standard and granular.

The waste from the extraction process, comprising insoluble clay minerals, calcium sulphate and sodium chloride, are formed into a slurry with brine and pumped out to sea from an outfall 1.8 km from the cliffs. Virtually all the components dissolve except the clays. However, the clays contain traces of heavy metals, including cadmium and mercury. These discharges, which currently amount to about 180 000 t/y, have to be substantially

reduced. Returning the insoluble waste into disused mine workings was started in 2003 thereby reducing discharges into the North Sea. Infrastructure and development work for the project was part funded by a European Commission grant.

The company use natural gas for drying and operates the largest Combined Heat and Power plant on a single site in the UK. It was installed to reduce dependence on heavy fuel oil and reduce carbon dioxide emissions.

The ground surface in the vicinity of the mine has been monitored since mining began. This shows that some minor subsidence (0.5 m) does occur in a uniform and gentle manner in areas where potash has been mined. This is because of the depth of the workings, the geological conditions and the mining method used. Damage to building and structures are unlikely to be caused, because damaging strains are not developed by the uniform subsidence. Similarly, natural land drainage is unlikely to be affected.

### By-products

Rock salt is produced through driving roadways in the Boulby Halite, which lies beneath the potash bed. The salt is suitable for de-icing roads and substantial quantities are produced for this purpose. Output of rock salt was about 700 000 tonnes in 2009. The Boulby Mine is one of only two mines producing rock salt in England (see Factsheet on Salt).

### Alternative/recycling

Potassium fertilisers are essential for healthy plant growth and there are no substitutes and the mineral cannot be recycled. Unconventional sources of potassium, such as glauconitic sands, potassium feldspars and some slags, have been examined in the past but without success. In the north-west Highlands of Scotland a bed of mudstone, which has an unusually high potassium content in the form of a very fine-grained feldspar, has been considered as a direct application fertiliser for organic farming. However, there is no current production.

## Transport issues

The railway track between Boulby and Skinningrove was reinstated when the mine was developed so that the environmental impact of road transport could be minimised. A large proportion of the refined potash is transferred by rail from the Boulby Mine to Tees Dock for export by sea or onward distribution to fertiliser manufacturers in the UK. Nearly 100% of the rock salt is similarly transferred by rail to Middlesbrough for distribution.

## Planning issues

**Location within a national park** Boulby Mine is located in the North York Moors National Park. The Park Authority adopted in 2003 a supportive Local Plan policy for the Boulby Mine which is: 'Proposals for the extraction of potash at Boulby will be permitted provided that any detrimental effect on the environment or landscape, or residential or visitor amenity can be moderated to a level considered acceptable in a National Park in the context of and overriding need for the development.'

**Proximity to sensitive coastline** The proximity of underground workings to the sensitive coastline of the National Park has become an issue. This is because of concern amongst some parties that minor subsidence at the surface associated with extraction might exacerbate rates of coastal erosion. If mining is not permitted beneath the coastal zone, then considerable reserves of potash will be sterilised. Cleveland Potash has entered into a collabora-

tive research and development project with the University of Durham to gain a better understanding of the natural and anthropogenic influences on the coast.

## Authorship and Acknowledgements

This factsheet was produced by the British Geological Survey for the Department of Communities and Local Government as part of the research project 'DCLG- BGS Joint Minerals Programme.'

It was updated by Abigail Walters and Andrew Bloodworth from an original compiled by David Highley with the assistance of Don Cameron and Deborah Rayner.

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