

# Metalliferous and associated minerals, geology and man, Northern England

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[Jump to navigation](#) [Jump to search](#)

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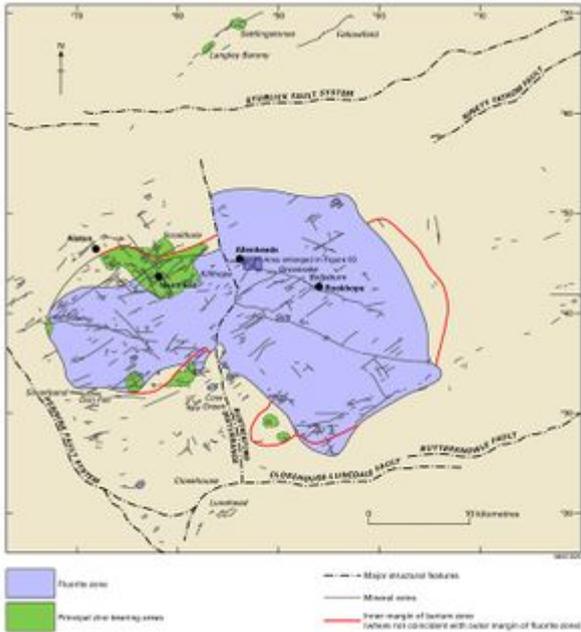
## Contents

- [1 Introduction](#)
- [2 Iron](#)
- [3 Copper](#)
- [4 Lead and zinc](#)
- [5 Silver](#)
- [6 Minor metal production](#)
- [7 Fluospar](#)
- [8 Barytes](#)
- [9 Witherite](#)
- [10 Future prospects](#)

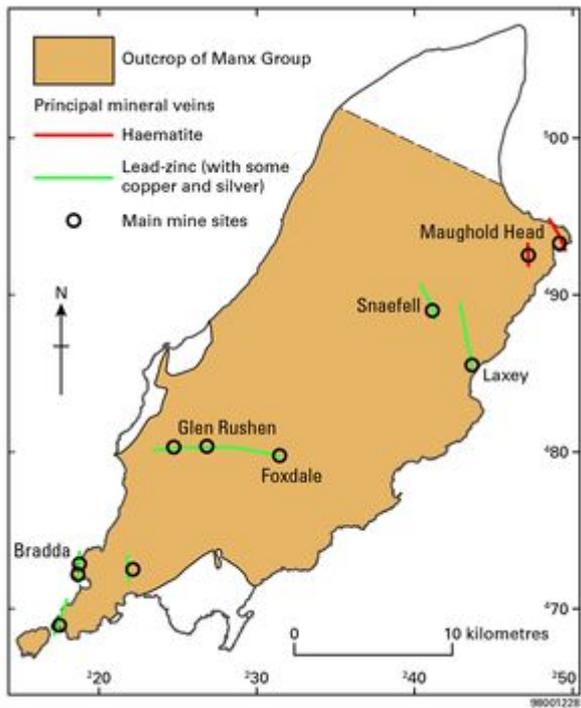
## Introduction



Queensberry ironstone workings at Cowhill, Weardale [NY 857 410](B Young, P548088). Supergene alteration has converted metasomatic replacement deposits of carbonate ores in the Great Limestone into workable deposits of limonitic ironstones. (P548088).



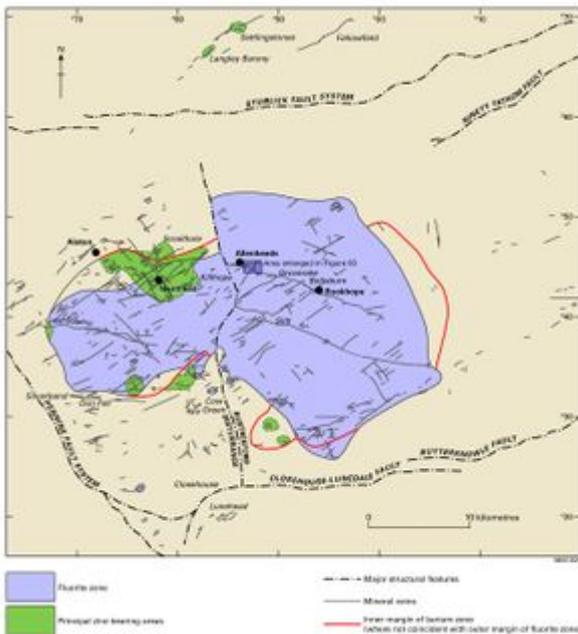
Principal geological features of the Northern Pennine Orefield. Named localities are those mentioned in the text (after Dunham, 1990. *Geology of the Northern Pennine Orefield* (1). BGS Memoir). P916091.



Principal mineral veins and mining sites in the Isle of Man. P916090.



Lady Isabella or Great Laxey Wheel erected in 1854 to pump water from the Laxey Mines, Isle of Man, and now restored as a tourist attraction [SC 432 852]. (P018718).



Principal geological features of the Northern Pennine Orefield. Named localities are those mentioned in the text (after Dunham, 1990. Geology of the Northern Pennine Orefield (1). BGS Memoir). P916091.

Numerous scattered sites show evidence for the early use of the region's varied range of ores, but the first documentary evidence for metal mining comes from the Norman period when, in the 12th century, iron, lead and silver were recorded as being produced from the northern Pennines.

With the establishment under Elizabeth I of the Company of Mines Royal, and the introduction of new mining and smelting technology, mainly from Germany, parts of the Lake District assumed world significance for copper production in the 16th century. By the 18th and on into the 19th centuries, mining and smelting in the northern Pennines, the Lake District and the Isle of Man, were at the forefront of the world lead industry. A collapse in metal prices towards the close of the 19th century brought about the closure of most of the region's mines, but an increasing economic interest in zinc ores (and the accompanying gangue minerals fluorspar, baryte and witherite) helped to offset the worst economic effects. The 19th century also witnessed the heyday of iron mining in south-west Cumbria, an industry that continued on a large scale until 1980.

# Iron

Sedimentary ironstones with typical iron content of around 25 per cent are locally common in parts of the Coal Measures. They were of greatest economic significance in north-east England, where prominent beds of clay ironstone were the basis for the establishment of ironworks at Consett, Bedlington, Tow Law, Witton Park and elsewhere. During the 19th century, their working was ended by the discovery of the much larger deposits of Jurassic ores in Cleveland, and the increased availability of high-grade haematite ore from Cumbria.

Clay ironstones are also present locally within the Visean succession. The most economically important were the Redesdale Ironstone Shales, which were worked in the Ridsdale and Bellingham areas of Northumberland in the mid 19th century. Iron from this source had the distinction of being used in the construction of Robert Stephenson's High Level Bridge over the Tyne at Newcastle.

Iron carbonate minerals, particularly siderite and ankerite are locally abundant within the Northern Pennine Orefield. Substantial deposits of goethite-rich ores, derived by supergene oxidation of primary iron carbonate minerals, occur both in vein outcrops and as large bodies replacing the limestone wall-rock of the veins. Although such ores were almost certainly worked in ancient times ([P548088](#)), their greatest exploitation came in the 19th century when large deposits such as those at the Rigg and West Rigg opencasts in Weardale supplied the iron works in Weardale and at Consett, Tow Law and Spennymoor. Iron content of the ores ranged up to 40 per cent Fe, and although this workable level was usually only attained as a result of supergene alteration, a number of deposits rich in primary siderite were also workable, for example at Carricks, Rowantree and Rispey mines in Weardale.

The region's largest, and richest iron ore deposits were the almost monomineralic, haematite orebodies of west and south Cumbria. Cumbrian haematite generally has an iron content of between 50 to 60 per cent, and a phosphorous content of less than 0.02 per cent making it ideally suited to the production of high-grade steel. Iron working in the area dates from the 12th century and mining is known to have been active in the 17th and 18th centuries. Large-scale mining dates from the 19th and first half of the 20th centuries but ended in the late 1970s with the closure of the combined Beckermet-Florence Mine at Egremont. Small-scale production continued until the late 2000s from shallow workings at Florence Mine, with the output employed in specialised steel making and in pigment manufacture. It has been estimated that about 250 million tonnes of haematite ore have been raised in Cumbria since the mid 19th century.

# Copper

The mining and smelting of copper ores from numerous veins, hosted in Borrowdale Volcanic and locally Skiddaw Group rocks in the Coniston, Ulpha and Newlands areas, and in Eycott Volcanic Group rocks in the Caldbeck Fells, placed the Lake District at the forefront of the world's copper industry during the 16th century. Much larger-scale copper mining, mainly in the 19th century and principally at Coniston, was an important part of the Cumbrian economy. A fall in world copper prices towards the close of the 19th century, combined with difficulties in processing the chalcopyrite-rich ores, led to the decline of the industry. Mining ended in the early 20th century after some years of intermittent and very small-scale activity.

Although chalcopyrite is widely present in the polymetallic veins of the Northern Pennine Orefield, small workable concentrations were only rarely found, mainly in the Garrigill and Tynehead areas. Likewise in the Isle of Man, small quantities of copper ores were worked from only a few of the metalliferous veins, though some waste tips were reprocessed for copper ore in the 1950s.

## Lead and zinc

Mineral veins carrying mainly lead and zinc mineralisation (galena and sphalerite are the principal ore minerals) are concentrated within the northern Pennines, the Lake District and the Isle of Man. They comprise the region's most abundant and widespread, non-ferrous metalliferous resource.

The Carboniferous rocks of the Alston Block and immediately adjoining parts of the Northumberland Trough are particularly important hosts for the mineral veins. In this area, the northern part of the Northern Pennine Orefield ([P916091](#)), unambiguous records of lead mining begin in the 12th century. Then, in addition, there was significant production of silver as a by-product of lead smelting. Galena was the sole lead ore mineral at all but a very few mines in the Alston area, where some cerussite was also worked from deposits affected by extensive supergene alteration. Most of the veins had been discovered by the mid 17th century and from then until the close of the 19th century, two major companies, the London Lead Company and the WB Company, dominated the industry. A collapse in world lead prices in the late 19th century meant that only a handful of mines survived into the first half of the 20th century. Thereafter, small amounts of lead ore continued to be produced as a by-product of the mining of zinc ore, and the spar minerals barytes, witherite and fluorspar, until mining for these finally ended in the closing years of the 20th century. That part of the Northern Pennine Orefield lying within the Northern England region produced at least 4 million tonnes of lead concentrates.

Although not as numerous as those in the Pennines, workable lead and zinc-bearing veins are also common in parts of the northern Lake District. Mining here can be traced back over many centuries, though the peak of production dates from the 19th century. The Lake District's last lead mine, at Greenside, near Ullswater, closed in 1962 with a total recorded output of approximately 250 000 tonnes of lead concentrates. Galena and small amounts of cerussite were the ore minerals, though Dry Gill Mine, in the Caldbeck Fells, also raised a few hundred tonnes of mimetite (a lead chloro-arsenate), for use in the glass industry.

A long history of mining in the Isle of Man ([P916090](#)) ended in 1919 with the closure of Laxey Mine ([P018718](#)). Galena and sphalerite in vein widths of up to 8 m were recorded there, and a parallel vein 3 km to the west was worked in the Snaefell area until 1898. Unsuccessful attempts to resume mining at Laxey were made in the first half of the 20th century and some lead ore was recovered by reprocessing spoil heaps during the 1950s. Elsewhere in the Isle of Man, the Foxdale and Glen Rushen group of mines worked a major vein structure, up to 5 km long, until 1911, whilst lead and some copper ores were raised from mines in the vicinity of Bradda Head prior to 1883.

Concentrations of supergene smithsonite, locally known as 'calamine', are common in parts of the northern Pennines and were worked from several mines in the Alston area from an early date, mainly for the making of brass. The primary zinc ore, sphalerite, was discarded as a waste product until the 19th century, when substantial tonnages began to be raised from orebodies previously worked for lead. The principal zinc mining centres were in the Nenthead area of the northern Pennines, at Force Crag in the Lake District and at Laxey in the Isle of Man. In the northern Pennines substantial tonnages of sphalerite were recovered from lead mine spoil heaps in the Nenthead and Haydon Bridge areas during World War II and in the 1950s. As recently as the 1980s some zinc ore was recovered as a by-product of fluorspar mining at Cambokeels Mine in Weardale. The total zinc production from the northern Pennines is around a third of a million tonnes.

## Silver

Most of the region's lead ores are silver bearing. Medieval references to the 'Carlisle silver mines'

may refer to deposits in either the northern Pennines or the Caldbeck Fells. Northern Pennine galena ore typically had silver contents ranging from 112 to 224 parts per million (ppm), though values as high as 2510 ppm Ag are recorded locally. At least 170 tons of silver were recovered from northern Pennine lead ores during the 18th and 19th centuries. Reported outputs of up to 4 tons of silver per year during the 12th century, if correct, suggest that much richer silver-bearing lead ores were then available than have been recorded in subsequent years. The lead ores of the Lake District had silver contents of around 800 ppm, which may have been the main reason for their 16th century exploitation. In the Isle of Man, silver values of around 420 ppm were commonly encountered with average values rising to around 1120 ppm Ag for the Laxey ore. Very high silver values exceeding 10 000 ppm were recorded locally at Foxdale, probably because the ore also contained silver-rich tetrahedrite.

## Minor metal production

The only British deposit of potentially workable tungsten ores outside of south-west England occurs within quartz veins associated with the Skiddaw Granite at Mosedale, in the northern Lake District. There have been several short-lived attempts at mining the wolfram and scheelite of this deposit at Carrock Fell Mine, the first in 1854, the most recent ending in 1981; some arsenic was recovered as a by-product. Elsewhere in the Lake District, during the 19th century, small quantities of the antimony sulphide, stibnite, were worked at Robin Hood, near Bassenthwaite, and a few tonnes of cobalt and nickel ores were produced from the Coniston copper mines. Manganese ores have been mined from the haematite deposits of west and south Cumbria, and from the upper parts of the Force Crag Mine, near Braithwaite.

## Fluospar

Fluospar is the commercial name for the mineral fluorite ( $\text{CaF}_2$ ), an extremely abundant gangue mineral in central parts of the Northern Pennine Orefield. Until late in the 19th century, huge quantities were separated during the processing of lead ores and either discarded on spoil heaps or backfilled into abandoned underground workings. Many fluorite-rich veins, regarded as too poor for lead mining, were left unworked. Towards the end of the 19th century, an increasing range of industrial uses, notably the introduction of open-hearth steel making, created a substantial demand for the mineral. Commercial production then began from a number of mines, either as a by-product of lead mining, or by re-working veins previously mined for lead. Substantial tonnages were also recovered by processing spoil heaps and extracting fluorite-rich fill from abandoned stopes. The rapidly rising demand for fluospar helped to offset the decline of lead mining during the closing years of the 19th century.

Fluospar mining was further developed, especially in Weardale and parts of Alston Moor, during the 20th century, with the product supplying a substantial domestic and export market. An unusual use of the mineral was the production of high quality transparent crystals from Boltsburn Mine, Rookhope, which were exported to Austria for the manufacture of specialised lenses. Increasing demand for acid-grade fluospar for the chemical industry encouraged exploration for further reserves and a reopening of several mines during the 1970s. However, the availability of cheaper fluospar from new producers eventually made the North Pennine mines uneconomic. The combined Groverake-Frazers Hush Mine, the region's last fluospar producer, finally closed in 1999 ([P548081](#)). The total recorded production of fluospar from the northern Pennines exceeds 2 million tonnes.

## Barytes

Baryte ( $\text{BaSO}_4$ ) is a common gangue mineral in the outer parts of the Northern Pennine Orefield ([P916091](#)) and in some of the lead-bearing veins of the northern Lake District. Like fluorite, this mineral was generally regarded as a waste product until industrial uses were found for it in the 19th century and led to its working as one of the region's major mineral products. For one of its most important early uses, as a white pigment in paint making, only top quality barytes was required and impure or discoloured material was ignored. As other uses emerged, such as heavy aggregate in concrete, for drilling fluids, and a variety of uses in the chemical industry, colour became less important, allowing previously uneconomic deposits to be mined.

Substantial tonnages of barytes have been obtained from several mines in the northern Lake District, notably from Force Crag, Potts Gill and Sandbeds, though the region's greatest production has come from the northern Pennines with major producers including Cow Green, Silverband, Dun Fell, Lunehead and Closehouse mines. In several of these mines, baryte occurred both in veins and in associated replacement flats in limestone. There was also significant barytes production from vein deposits in the Durham Coal Measures, which were worked alongside coal in mines such as New Brancepeth, Ushaw Moor and South Moor. Barytes mining finally ended in about 2002 with the abandonment of the large opencast working at Closehouse, in Lunedale, after several years of small-scale and intermittent production. The region's total recorded production of barytes is around 1.5 million tonnes.

## Witherite

A unique feature of the Alston Block portion of the Northern Pennine Orefield is the local abundance of the rare, barium carbonate mineral witherite ( $\text{BaCO}_3$ ) within the outer zone of the field. It is an important gangue in many veins and flats and is the major constituent of several large deposits. Witherite working, for the manufacture of a range of barium chemicals, began in the Alston area as early as 1850, and between 1860 and 1870 two lead mines in the Tyne valley, at Settlingstones and Fallowfield, changed over to witherite production. Over the next century, the region was to be the world's major commercial source of this mineral. Witherite was worked at several mines in the Alston and Tyne valley areas and also in the adjoining Durham Coalfield, notably at South Moor Colliery where a shaft was sunk in the 1930s specifically for witherite production. The leading producer was Settlingstones Mine, near Hexham, which at its closure in 1969 had accounted for almost two-thirds of the region's total output of around 1 million tonnes of witherite.

## Future prospects

Future commercial interest in the remaining haematite resources in west Cumbria, or in any of the region's other iron ore deposits, is very unlikely. Possibilities exist for locating further fluorite and lead-zinc mineralisation at depth within the northern Pennines, though investigation is likely to be triggered only by a significant rise in world commodity prices. There is some potential for stratabound base-metal mineralisation associated with the margins of the Northumberland- Solway and Stainmore troughs, but these would be difficult exploration targets.

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Category:

- [Northern England](#)

# Navigation menu

## Personal tools

- Not logged in
- [Talk](#)
- [Contributions](#)
- [Log in](#)
- [Request account](#)

## Namespaces

- [Page](#)
- [Discussion](#)

## Variants

## Views

- [Read](#)
- [Edit](#)
- [View history](#)
- [PDF Export](#)

## More

## Search

## Navigation

- [Main page](#)
- [Recent changes](#)
- [Random page](#)
- [Help about MediaWiki](#)

## Tools

- [What links here](#)
- [Related changes](#)
- [Special pages](#)
- [Permanent link](#)
- [Page information](#)

- [Cite this page](#)
- [Browse properties](#)

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