Mineral veins and minerals

Mineral veins are sheet-like bodies of mineral which occupy more-or-less vertical fissures or cracks in the surrounding rocks. The fissures are commonly faults. Veins may vary from less than a millimetre to tens of metres in width and comprise concentrations of minerals that may otherwise be extremely rare or widely scattered throughout the rocks. Some mineral veins are composed almost exclusively of one introduced mineral, though more usually a number of different minerals are present, commonly forming bands parallel to the vein sides. The minerals include metalliferous ore minerals generally accompanied by a variety of non-metallic minerals, known as ‘gangue’ minerals. Veins are commonly concentrated in groups in particular areas or geological environments and the term ‘orefield’ is often applied to such areas that have yielded commercially workable concentrations of ore minerals.

Vein minerals commonly occupy all available vein space and do not form well-shaped crystals. However, small cavities within the vein, known as ‘vugs’, may be lined with beautifully crystallised examples of the constituent minerals.

Mineral veins and minerals in Great Britain

Mineral veins of many different types, and with a wide range of constituent minerals, are found in many parts of Great Britain. Many of these have been important sources of metal ores and other associated economic minerals.

Mineral veins provide clear evidence of the circulation of large volumes of warm mineral-rich waters deep beneath the Earth’s surface. By studying their form, distribution, mineral content and chemical composition it is possible to deduce much about their geological evolution and the environments in which they formed. Such studies not only contribute to interpreting the deposits of any one area, but are vital to understanding the nature and origins of comparable deposits elsewhere, thus helping to inform and guide exploration for similar deposits worldwide.

Mineral veins and minerals in the district

In common with most parts of Great Britain, no comprehensive inventory of minerals exists for Northumberland. However, a substantial number of minerals are reliably reported in the scientific literature from the district’s mineral veins, as components of the rocks, and in a handful of rather specialised environments related to recent weathering processes.

Geological SSSIs

Mineralogy of the Pennines:

Fallowfield Mine [NY 936 675]

Settlingstones Mine [NY 849 688]

Stonecroft Mine [NY 854 688]

NWT Reserve

Beltingham Shingle [NY 783 641]

Minerals in metalliferous veins

The veins found in the southern part of the district, generally to the south of Hadrian’s Wall, occur within the outer zones of the Northern Pennine Orefield. Deposits within the central zone of the orefield, on the Alston Block, are characterised by an abundance of fluorite. In the outer zone, fluorite is typically absent, its place being taken by barium minerals, the most common of which are baryte (barium sulphate) and witherite (a barium carbonate). Elsewhere in the world, witherite is a very rare mineral, but for reasons which are not yet fully understood it occurs in remarkable abundance in the North

Pennines, and in particular in several veins in the Haydon Bridge area of the district.

Veins within the orefield mostly occupy normal faults, typically with a maximum displacement of only a few metres. Veins may be up to 10 metres wide, though most of those worked have been less than 5 metres. Non-metallic, gangue minerals such as baryte or witherite usually comprise most of the vein with ore minerals such as galena (lead sulphide) and sphalerite (zinc iron sulphide) forming a much smaller proportion of the filling. An important aspect of the deposits is the close relationship between the veins and the adjacent rocks. In hard rocks such as limestones, hard sandstones or the Whin Sill dolerite, veins may be comparatively wide and commonly stand almost vertically. Such areas of vein have generally been the most economically productive. In weak rocks such as mudstones, siltstones and soft sandstones, veins are typically narrow and inclined at a lower angle. Such lengths of vein are commonly barren and worthless. The interbedded nature of hard and soft rocks within the district, combined with the effects of this on faulting, have been conducive to the formation of mineral veins.

Although galena was the main metal ore extracted, few noteworthy specimens of this mineral are known from the district. However, the veins have long been celebrated for beautifully crystallised specimens of several minerals found lining vugs. Prominent amongst these are specimens of witherite. The Settlingstones and Fallowfield veins have provided some of the finest examples of witherite known and spectacular specimens are to be seen in most of the world's major mineralogical collections. In addition to witherite, Settlingtones Mine was a notable source of beautifully crystallised examples of baryte, together with much smaller amounts of strontianite (strontium carbonate) and niccolite (nickel arsenide), accompanied by small amounts of galena and ullmanite (nickel antimony sulphide). The Fallowfield Vein also has the distinction of being the source of some of the original, and finest, specimens of the rare double- carbonate of barium and calcium known as alstonite.

Sphalerite is locally abundant, particularly at Stonecroft and Langley Barony mines, where it is commonly found in the rather unusual pale brown banded variety known as 'schalenblende'.

The south of the district includes several other small veins which appear quite unrelated to those of the Northern Pennine Orefield. These include numerous bitumen-bearing calcite veins in the area of Ryal and Mootlaw quarries, galena-bearing veinlets associated with the contact of the Whin Sill at Divethill Quarry, and many narrow veins in the Whin Sill containing quartz.

North of Hadrian's Wall, the district includes very few mineral veins. Those which are known are generally of small size and, although locally tried as sources of economic minerals, have nowhere proved workable. They are widely scattered and cannot be regarded as forming part of an orefield. The main veins are those at Whittondean, on the northern slopes of the Simonside Hills, near Rothbury, and near Redpath in the Fallowlees Burn in Harwood Forest. Although it is known that 19th century trials were made in these for lead ore, no workable ore was discovered. Although descriptions of the veins are rather meagre, they appear to have been very narrow and to have contained only small amounts of galena, mainly in a matrix of baryte. This latter mineral is locally present coating joints or forming very narrow veins in the Fell Sandstone in a few places in the Rothbury area.

Very limited and incomplete reports of galena-bearing veins from other parts of the district exist but little or nothing is known of their precise location or mineral content.

Hydrocarbon veins

A distinctive feature of the Great Limestone of the Ryal area is the local abundance of calcite veins in which occur conspicuous concentrations of solid, black, brittle hydrocarbons. Very good examples are exposed from time to time in Mootlaw Quarry. Other examples may be seen in old quarries in the Great Limestone at Capheaton, Kirkheaton and Ryal. Solid hydrocarbons have been reported in very small amounts from the veins at Settlingstones and Fallowfield mines.

Minerals from the Cheviot volcanic rocks

The lavas of the Cheviot Volcanic Formation locally contain quartz-rich amygdales. Most commonly the quartz is in the form of beautifully banded agate, though in places more coarsely crystalline colourless rock crystal, purple amethyst and smoky varieties are also present, commonly in the central parts of agate amygdales.

Such weathered-out amygdales, commonly known as ‘agates’, may be found loose in any of the many rivers and streams which radiate from the hills, as well as in the fields that surround the lower slopes of the Cheviots. Numerous spectacular examples of agate have been recovered from the shingle banks of the River Coquet as well as from the river gravels worked at Caistron Quarry.

Minerals associated with the Whin Sills

The metamorphosed limestones in contact with the Whin Sill at Barrasford Quarry locally contain concentrations of well-crystallised garnet and vesuvianite (a silicate of calcium, aluminium, iron and magnesium).

Although beautifully crystallised pectolite (hydrous silicate of calcium and sodium) is a characteristic mineral found lining joints in the Whin Sill of the Northern Pennines, its occurrence in the district is much more restricted. Pectolite has been found coating joints and as amygdales (filling gas holes or vesicles) at Cawfields and Barrasford quarries. At the latter site it is locally altered to the rather uncommon mineral stevensite: a silicate of calcium, sodium, and magnesium.

Other amygdale-filling minerals at Barrasford include datolite (calcium borosilicate), calcite and quartz, both as brown ‘smoky’ quartz and purple quartz (amethyst).

The Haydon Bridge Dyke at East Mills Quarry, east of Haydon Bridge, was formerly known as a source of fine examples of amethyst found in cavities and veins in the dolerite. The quarry was filled several years ago and the site landscaped.

The iron sulphides pyrite and pyrrhotite, along with galena and sphalerite, are locally common as thin coatings on joints in the Whin Sill at Barrasford Quarry. Pyrrhotite is also common in contact-altered ironstone nodules at this locality. A few well-crystallised examples of galena have also been recovered from a veinlet adjacent to the contact of the Whin Sill with lower Carboniferous rocks at Divethill Quarry.

Authigenic minerals

An authigenic mineral is one formed in place in a sediment or rock either by replacing or displacing an earlier mineral. Impure siderite (iron carbonate), in the form of ‘clay ironstone’ is abundant as nodules scattered through the Redesdale Ironstone Shales (p. 38). These were extensively worked for iron ore during the 19th century in the Ridsdale and Bellingham areas.

A large specimen of haematite (an ore of iron) labelled as being obtained from the Bellingham area, Northumberland, is displayed in the Natural History Museum, London. However, its form is characteristic of west Cumbrian haematite and no reliable records of haematite are known from the district. It is probable that this specimen is labelled in error.

Fine examples of coarsely crystalline celestite (strontium sulphate) of diagenetic origin have been found recently in some of the impure dolomitic limestones within the Ballagan Formation, exposed in the River Coquet at Barrow Scar. This is the first record of this mineral from Northumberland.

Holocene deposits

Certain Holocene deposits at Vindolanda have, over many years, yielded a remarkably rich variety of Roman artefacts. The same waterlogged, anaerobic conditions which have allowed the preservation of archaeological objects have favoured the formation of an abundance of the unusual iron phosphate mineral vivianite. This striking blue mineral encrusts many of the objects recovered from these deposits.

The oxidation of pyrite-rich rocks in colliery spoil heaps, in old workings and in natural exposures of the Coal Measures commonly results in the formation bright yellow crusts of minerals such jarosite (potassium iron sulphate). Acidic

groundwater, produced by the same processes, may precipitate deposits of hydrated iron oxides, especially adjoining old mine entrances and in streams. Such deposits occur adjoining colliery spoil near Crindledykes.

An unusual deposit of well-crystallised gypsum (calcium sulphate) is today forming on the face of one of the Crindledykes quarries where water rich in sulphuric acid is reacting with the Great Limestone exposed in the quarry face.

Impact on the landscape

Unlike their counterparts further south in the main parts of the Northern Pennine Orefield, the vein outcrops of the present district have relatively little direct impact upon the landscape. Although there is little doubt that they were first discovered where exposed in streams or from the weathered soil content they produce, the veins themselves do not form recognisable topographical features. However, several veins have been worked on a significant scale, leaving a conspicuous legacy of spoil heaps and, in places, buildings.

The most notable spoil heaps are those associated with the Langley Barony [NY 82938 61485], Stonecroft [NY 85480 68768] and Fallowfield [NY 93887 67649] mines.

Most of the spoil heaps at the former Settlingstones Mine have been landscaped and although parts of the remaining coarse rock dumps are protected as an SSSI, they are becoming inconspicuous through increasing vegetation cover.

The fine brick-built Cornish pumping engine house at Stonecroft Mine is a prominent landmark and a row of miners' cottages, together with some of the ancilliary mine buildings, converted for modern uses, remain at Settlingstones. A pipe to vent gas from the main underground workings is all that remains at Frederick Shaft, the main working shaft at Settlingstones, and the winding wheel from Ellen Shaft of the same mine has been erected recently at Fourstones as a monument to this industry. Meagre remains of mine buildings and ore-dressing facilities also remain at Langley Barony and Fallowfield.

Impact on biodiversity

As the vein outcrops within the district have little direct impact on the landscape, they similarly have a limited impact on the biodiversity. Several mine spoil heaps, especially those which include accumulations of fine- grained tailings from ore-dressing processes, support plants that can grow in higher than normal concentrations of heavy metals; these plants are called metallophytes. In addition, such plants are found in some abundance growing on areas of Holocene river sediments at several locations adjoining the South Tyne. It is believed that waste from the main metal-mining and processing areas further south in the North Pennines, contaminated with lead, zinc, cadmium and sometimes barium, was released into the River Tyne and deposited downstream as fines, trapped amongst the river cobbles. Contamination levels vary according to which minerals were being mined and whether older contaminated deposits upstream have been reworked by the river. The most contaminated sites are sparsely vegetated with only the most metal-tolerant vascular plants present, but lichens, mosses and liverworts are abundant and may be highly diverse with as many as 30 lichen species per square metre. Many of the plants, including most of the mosses, leafy liverworts and larger lichens are present because they can tolerate the metals and periodic drought and therefore do well in the absence of competition from vigorous grasses. Plant species such as spring sandwort (otherwise known as leadwort), alpine pennycress, Pyrenean scurvy grass, thrift, mountain pansy, Young's heleborine and moonwort occur on sites in the district.

Economic use

The galena-bearing veins of the district have been worked for lead ore at several places, mainly within the Haydon Bridge area of the Wall country. Some veins were certainly known, and probably being exploited, in the 17th century and perhaps at earlier dates, although there is no evidence of workings that date from Roman times. The main period of lead mining was during the 19th century. A general worldwide collapse in lead prices towards the close of that century resulted in the closure of most of the lead mines in northern England. Unlike the galena found in many of the lead veins of the main North Pennine Orefield, that found in the Haydon Bridge area typically had a very low silver content, and did not yield significant quantities of this lucrative by-product. Future working from any of the known lead deposits or other

small veins in the district is very unlikely.

The discovery of substantial deposits of witherite as a gangue mineral in the Settlingstones and Fallowfield veins during the 19th century, together with demand for this mineral for the making of a range of barium chemicals, to some extent compensated for the worst effects of the collapse in lead mining. Witherite mining began at Settlingstones in 1873. From then until its closure in 1968 the mine became one of the world's main commercial sources of this mineral, and for long periods, including its final years, was the world's sole producer of this unusual raw material. The closure of Settlingstones Mine brought an end to witherite production worldwide.

Attempts to locate extensions to the Settlingstones and nearby deposits in the 1980s proved fruitless. Although proposals have been made within the past 20 years to recover baryte from the spoil heaps at Langley Barony, and witherite from those at Settlingstones, no extraction has taken place. In view of the toxic nature of the mineral, any resumption of witherite mining is unlikely, even if further reserves were to be identified.

Although sphalerite is abundant in parts of the veins worked at Langley Barony and Stonecroft (Greyside Mines), it was never recovered during lead mining. However, the spoil heaps at these sites were re-processed during the 1950s to recover the mineral.

Various attempts have been made to mine baryte or to recover it from spoil heaps, but little or none has ever been raised commercially. Further working of barytes within the district is very unlikely.

Clay ironstone nodules were extracted for iron on a substantial scale during the 19th century from quarries and underground mines in the Ridsdale and Bellingham areas.

Very small amounts of agate, collected from river shingles, have been employed as semi-precious stones in craft jewellery.

There are grounds for supposing that the lower Carboniferous rocks adjacent to the Stublick Fault System, at depth beneath the southern part of the district, could host metalliferous deposits analogous to some of those in central Ireland. Given the depth to the most promising horizons, and the difficulty in identifying exploration targets, exploration for such deposits must be considered unlikely.

The abundance of bitumen-rich veins in the Great Limestone of the Ryal area indicates that some of the Carboniferous rocks of the district may be source rocks for hydrocarbons and invites speculation on the potential for economic concentrations of oil and gas within central and southern Northumberland. Test drilling has taken place in several locations, most recently close to the A68 at Errington, although without discovering economically viable accumulations.

Conservation and environmental issues

No surface exposures remain in the district of any of the major metalliferous veins associated with the Northern Pennine mineralisation. The spoil heaps at Langley Barony, Stonecroft, Settlingstones and Fallowfield, provide the only remaining significant evidence of the worked veins and, in view of the very unusual nature of the mineral assemblages present, must be regarded as especially significant resources. They constitute important, and in some instances unique, resources of geological and mineralogical material and information. Fine examples of several minerals, notably witherite and alstonite, have long attracted collectors: excessive collecting is known to have been a problem at parts of the latter site. Encroaching vegetation threatens the accessibility of both sites and may require attention in the near future.

Landscaping or removal of spoil heaps, either as sources of low-grade aggregate, or as part of programmes of land reclamation, may pose serious threats to these resources.

Surface evidence of mineral veins elsewhere within the district is very meagre. Only very small amounts of spoil remain at Whittondean, though the site appears to be under no imminent threat. The site of the workings in Fallowlees Burn is heavily overgrown within the forestry plantation. Attempts should be made to locate and record any evidence of the workings when the timber is harvested.

Exposures of mineral veins in workings quarries are normally destroyed during the course of working. Where significant mineralisation is so exposed it is clearly desirable to see appropriate records made of the exposure together with collection of representative specimens. It is also important to ensure that such records and specimens are curated in a suitable permanent archive.

The small areas of mineral-related calaminarian grassland that are still in good condition are at risk of gorse colonisation from reduced grazing pressure, whether due to changes in agricultural practices or to a reduction of rabbit populations by culling or disease.

Environmental issues

Significant amounts of witherite which remain in the spoil heaps at both Fallowfield and Settlingstones may be regarded as significant contaminants which could be injurious, particularly to farm stock.

The attempts at Langley Barony and Stonecroft mines to re-process the spoil to recover the sphalerite have left substantial quantities of fine tailings. Like the spoil from lead working, these may be regarded as sources of heavy metal contamination.

Although surface subsidence over underground lead workings is generally uncommon, a striking example of this phenomenon occurs at Greyside Farm, near Newbrough. A number of farm buildings have here collapsed into a crown hole developed above extensive stopes in Greyside Sun Vein.

Wider significance

The veins of the Northern Pennine Orefield comprise one of the world's finest examples of a zoned Mississippi valley type orefield. Accordingly, they have figured prominently in the evolution of ideas on the origins of such deposits. One of the many particularly important aspects of this orefield is the remarkable abundance of witherite and alstonite, which makes the area unique in the world. Although the orefield has long been a focus for research, very substantial opportunities remain for further important research. The spoil heaps from Settlingstones Vein remain an important, though increasingly meagre, source of representative material from this remarkable witherite deposit.

Fallowfield Mine shares, with Brownley Hill Mine near Alston, the distinction of being an original, or 'type', locality for alstonite, first recognised as a new variety of mineral in 1835. From the numerous specimens preserved in mineralogical collections it seems that alstonite was present in some abundance at Fallowfield which has yielded some of the finest known examples. Fallowfield remains one of the few localities known in the world at which this mineral may still be found. Parts of the spoil heaps, which are designated as an SSSI, include substantial amounts of the mineral.

The minor veins associated with the Whin Sills, although never likely to attract commercial interest, offer important research opportunities for furthering understanding of the emplacement of this major intrusion.

The excavations at Vindolanda provide one of the best recorded occurrences of vivianite in British Holocene deposits.

Figures

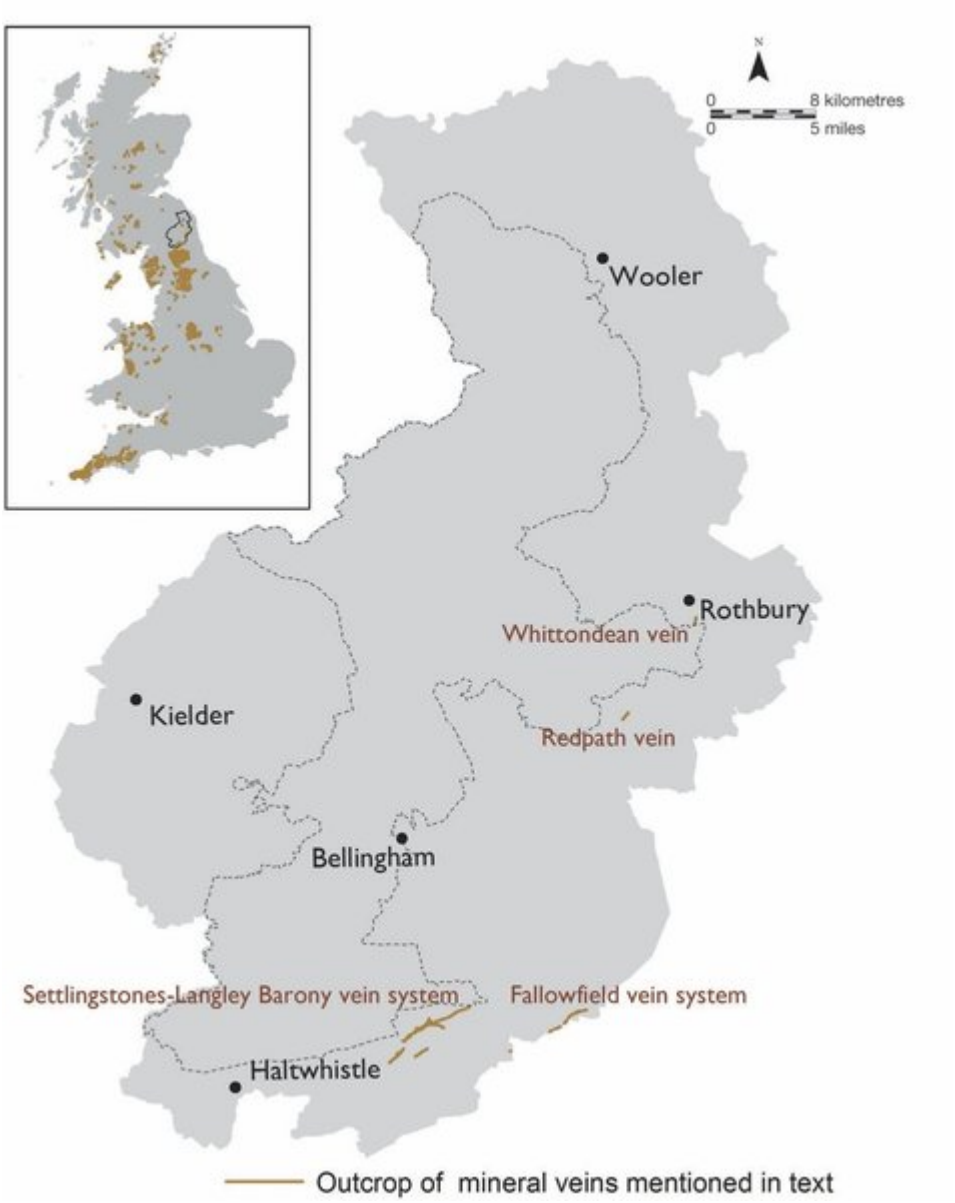
(Figure 58) The distribution of mineral veins in the district; the inset map shows, highly simplified, the main areas in Great Britain where mineral veins occur.

(Figure 59) Witherite crystals from Fallowfield Mine.

(Figure 60) Alstonite crystals from Fallowfield Mine.

(Figure 61) Cut and polished surfaces of agates, from amygdales in Devonian age lavas of Cheviot volcanic rocks, found as pebbles in river shingle. The upper photo is of a red 'fortification' agate with centre of crystalline amethystine quartz.

(Figure 62) Top left: Sign at entrance to Beltingham Nature Reserve; Top right: Spring sandwort; Bottom left, Alpine pennycress; Bottom right: Thrift.



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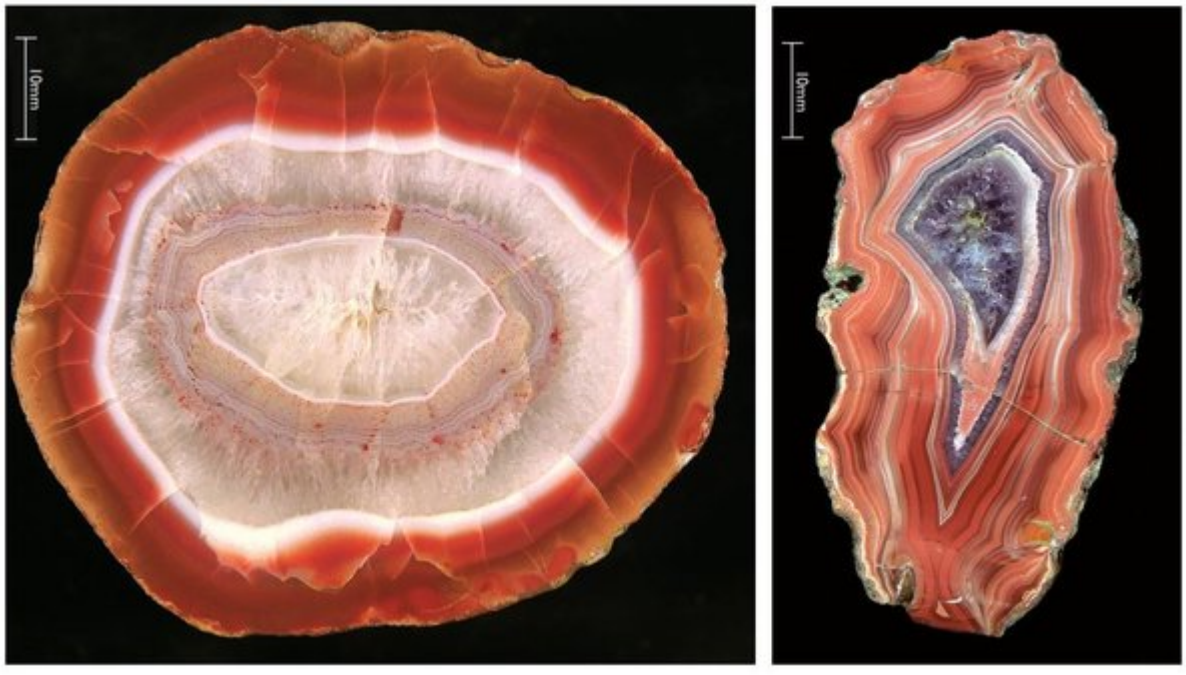

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