# Fall Hill Quarry, Derbyshire

[SK 355 624]

## Introduction

Fall Hill is situated on the crest of a small Visean inlier within the Namurian Bowland Shale Formation (formerly 'Edale Shales') and Ashover Grit (see (Figure 4.18) for location and geological map). The inlier is composed of the Eyam Limestone Formation (formerly the 'Cawdor Limestone') and the Fallgate Volcanic Formation, with the latter in the core of an anticlinal feature. Most of the mineralization is located in the Eyam Limestone Formation (Ewbank, 1992). A mineralized fault, the Ashover Old Vein, has been worked for fluorite in Fall Hill Quarry, and contains minerals such as greenockite (CdS) and its cubic dimorph hawleyite (only known in Great Britain from this locality; see Smith, 1982). The Ashover Anticline has long been known as a classic teaching area of British geology (Himus and Sweeting, 1951). At its north-west end, the vein known as 'New Butts' has been worked for fluorite, but the wall-rock is highly silicified (Kanaris-Sotiriou *et al.,* 1986) and the high silica content of the ore caused extraction difficulties (Ford and Ineson, 1971). At the Fall Hill end, a large opencast along the vein was worked for fluorite during the 1960s and early 1970s. The opencast has been partly backfilled, and the area between the backfill and the eastern end is now flooded to some depth. At the western end, a backfill of limestone boulders extends down a ramp to water level. Many of these boulders contain fluorite, calcite and sulphide mineralization. A large proportion of the wall-rock surfaces are stained green due to the oxidation of sulphide mineralization. A large fluorite-lined vug is present on the north-east face, but is now submerged. On the opposite face at this point calcite veining is evident in the toadstone, and the primary calcite vein was mined for nickel minerals. The adits in the north-west of the quarry represent the remains of the former underground workings on the vein. The area has much dump material, and the best remnants of mineralization are in the dumps between the quarry and the road at the top of the backfill (see (Figure 4.19)).

## Description

The Ashover Old Vein is a mineralized reverse fault, downthrown and dipping at 80° to the north-east. Smith (1982) described the geology of Fall Hill Quarry. The mineralized fault trends north-west–south-east along the crest of the Ashover Anticline. This fault has been worked at Fall Hill Quarry where the footwall is in basaltic pyroclastics (toadstone) and the hangingwall in limestone. The vein is mineralized with fluorite, galena and sphalerite. Calcite veinlets running into the pyroclastics also contain pyrite ($FeS_2$), millerite (NiS) and chalcopyrite ($CuFeS_2$). The vein runs the length of the anticline from Butts in the north-west to Fall Hill in the south-east. Fluorite cubes, from vugs in the vein, attain dimensions of up to 75 mm. These were coated with the iron oxyhydroxides limonite and goethite in the upper levels and carry inclusions of zoned marcasite near the quarry bottom (Smith, 1982).

Smithsonite ($ZnCO_3$) encrusts fluorite, while galena from higher parts of the quarry is encrusted with cerussite ($PbCO_3$) and pyromorphite ($Pb_5(PO_4)_3Cl$). Barite ($BaSO_4$) occurs as cockscomb rosettes associated with fluorite, and at times encloses small pyrite crystals. Most of the pyrite present is associated with toadstone, through which it is disseminated, particularly near calcite veining. This calcite encloses bright brassy metallic filaments of millerite, associated with small granules of chalcopyrite. A green staining of these minerals may represent both nickel and copper secondary minerals, although specific mineral species have not been identified. These nickel and copper minerals are not seen in the main vein. Quartz occurs as euhedral crystals in vugs in the limestones and in the central part of the main vein, where pyrite is also present. Hydrocarbons are usually associated with fluorite (Ewbank *et al.,* 1993, 1995) and in one instance were enclosed by marcasite (Smith, 1982).

In the southern section of the inlier lies the E–W-trending Gregory Rake. This is a major rake vein up to 6.5 m wide, relatively high in fluorite but worked only for galena underground, which splits up into a number of 'scrins' in the southwest. In contrast to the main Ashover Old Vein there is an elevated concentration of nickel in this vein, chiefly associated with marcasite (Ixer and Townley, 1979).

## Interpretation

Fall Hill Quarry demonstrates the control of lithology on mineral chemistry in the South Pennine Orefield. The Fallgate Volcanic Formation in the centre of the anticline was thought to be laterally equivalent to the Upper Matlock Lava Member. However, British Geological Survey boreholes in the anticline centre proved over 100 m of pyroclastic rocks and lavas, on the site of what is interpreted as a vent complex (Kelman, 1980). It is not known whether limestone-hosted mineralization continues at depth within the anticline (beneath the volcanic sequence), although the Gregory Rake was worked down to toadstone in the area to the south-west.

Smith (1982) described the ore mineral assemblage, but no detailed paragenesis has been determined. A sequence across the Ashover Old Vein from both walls to the centre, of calcite-sphalerite-smithsonite-calcite-galena-quartz, was established by Smith (1982). The Ni content of the marcasite has not been determined, although this mineral from the Gregory Rake was nickeliferous (Ixer and Townley, 1979). The formation of greenockite and hawleyite is likely to be a result of the alteration of cadmium-rich sphalerite to smithsonite. Sphalerite in the adjacent Milltown Quarry [SK 354 622] does not contain unusual amounts of cadmium, and greenockite and hawleyite are absent. This quarry is more renowned for the presence of the three poly-morphs of $Zn(OH)_2$, ashoverite, sweetite, and willfingite, being the type locality for the first two listed species. Canary-yellow greenockite coatings at Fall Hill Quarry, along with its cubic dimorph hawleyite, on both sphalerite and fluorite indicate oxidation of the upper part of the orebody. The close association at the adjacent Fallgate Quarry [SK 355 623] of sphalerite with fluorite is similar to that observed at Fall Hill.

The nickel-copper mineralization in the toadstones is distinct from the fluorite-barite-sphalerite-galena mineralization in the main vein. It reflects remobilization of nickel and copper as a consequence of hydrothermal alteration (which may or may not be associated with the South Pennine Orefield mineralization activity) of the volcanic rocks.

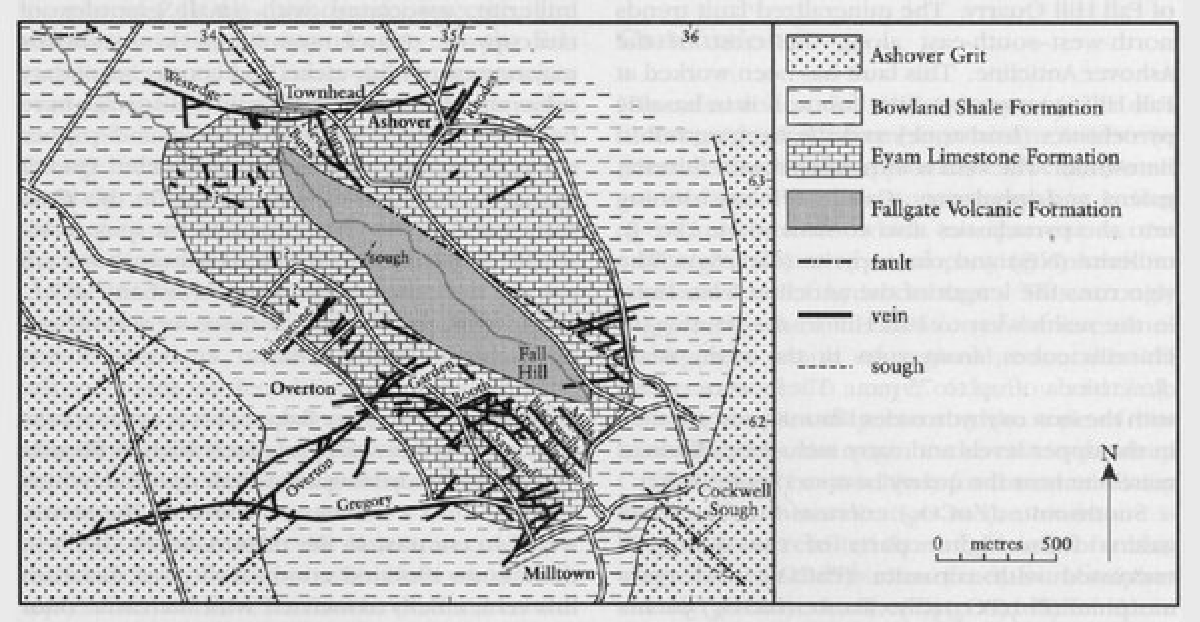
Thick shales overlie the limestones, while a thick volcanic pile underlies it. Both would have represented effective barriers to ore-fluid vertical migration. If the major Ashover–Crich fold is pre-Zechstein in age, it would have formed a physical barrier to the westward progress up-dip of laterally migrating mineralizing solutions. As a result, a local concentration of mineralization in the crest of the anticline beneath the shales might have occurred. In such circumstances, hydrocarbon accumulations would also have been likely to occur. Dolomitization is absent at Fall Hill, suggesting that the shale cover was intact during mineralization. The presence of a central quartz area in the vein is unusual and may be the result of silica transport from the underlying volcanic rocks. As at the Odin Mine and the Windy Knoll GCR site, both near Castleton (Derbyshire), hydrocarbons are evident just below the Bowland Shale Formation unconformity.

The main concentration of mineralization at Ashover occurs in the south-western section of the Carboniferous limestones, where the large east–west Gregory Rake splits up into a number of scrins. This is where mineralization would be expected if solutions had broken through the volcanic rocks below, along a deep major structure. The Gregory Rake in this area does contain nickeliferous marcasite. If Gregory Rake continues across the crest of the Ashover Anticline to the east, it can be suggested that mineralization has migrated laterally up-dip into this area from an easterly direction. Alternatively, it would have had to break through volcanic rocks below the Gregory Rake before moving laterally through the limestone in the crest of the anticline.

## Conclusions

Mineralization at Fall Hill Quarry consists of a limestone-hosted assemblage and a toadstone (basaltic lavas and pyroclastic rocks)-hosted assemblage. The limestone assemblage is free of nickel minerals which are present in the toadstone, absent of accompanying dolomitization and carries hydrocarbons. This strongly suggests that the mineralization of the limestones is largely a result of regional mineralization processes, and that a cover of the Bowland Shale Formation was still present at the time of this mineralization. An origin to the east in the deep Carboniferous basin is likely for the mineralizing fluids. The mineralization in the toadstone is likely to have resulted from the result of a low-temperature re-distribution of metals and sulphur already present in the lava and tuff. More intense mineralization along the Gregory Rake to the south-west may have resulted from the lateral migration of ore fluids from an E-orientated feeder vein or may have originated by vertical migration of higher-temperature ore-fluids from depth through the basaltic lavas and pyroclastics.

[References](#)



(Figure 4.18) Location and geological map of Fall Hill Quarry. After Ford and Ineson (1971).


(Figure 4.19) Fall Hill Quarry. (Photo: M.L. White.)