Pikedaw Calamine and Copper Mines, North Yorkshire

[SD 8757 6400]

Potential GCR site

Introduction

Copper and zinc ores were worked from a number of small mines on the moorland west of Pikedaw Hill. Although comparatively small, the deposits are of considerable interest and include the unique deposit of supergene smithsonite, known locally as 'calamine', worked at the Pikedaw Calamine Mine. Copper working here is known to date back to at least the 17th century (Raistrick, 1938a,b), but no plans of the workings are known. The amount of copper ore recovered is not known, although it is likely to have been small. The smithsonite deposit was discovered during copper mining in 1788 and was worked until 1830. Here, as elsewhere in the Northern Pennines, the term 'calamine' was generally applied to the mineral now known to be smithsonite. Dunham and Wilson (1985) estimated the total production of smithsonite as 5000 tons. Raistrick (1954, 1983) gave comprehensive accounts of the deposit and the mine, and Arthurton *et al.* (1988) provided additional details, based on more-recent exploration of the workings.

Description

The Gayle, Lower Hawse and Gordale limestones (Dinantian) in the area between Grizedales [SD 872 646] and Pikedaw Hill [SD 883 638] are cut by a number of small faults which are mineralized with abundant quartz and dolomite, although in many instances without obvious ore minerals. However, rich concentrations of copper ores are also prominent locally, notably in the group of workings collectively known as 'Pikedaw Mine' (centred around [SD 876 639]), approximately 800 m west of Pikedaw Hill. Here a cluster of small to moderate-sized spoil-heaps marks the sites of several shafts and associated dressing floors (Figure 3.20). The workings lie on the outcrop of the Lower Hawes Limestone, and, although the pattern of old shafts suggests the presence of several mineralized veins, their precise positions are unknown and are not indicated on the most recent published British Geological Survey 1:10 000-scale map (SD86SE). Malachite and azurite are abundant on all of the spoil heaps; the former occurs mainly as cellular crystalline masses up to 20 mm across, the latter commonly as isolated rounded crystalline aggregates of a similar size. Green *et al.* (2006) have described beaverite from these, and several nearby, spoil-heaps. Although Arthurton *et al.* (1988) referred to the working of chalcopyrite from these deposits, copper sulphides are not presently to be found. The identity of the primary copper sulphide mineral or minerals cannot therefore be identified. Very small amounts of galena, commonly partially altered to cerussite and anglesite, together with a few fragments of 'dry bone' smithsonite, are also present. A little white barite and colourless quartz are the only gangue minerals observed. These deposits are unusual in the Northern Pennines in being dominated by copper rather than lead or zinc minerals.

The 'calamine' (smithsonite) deposits, which were discovered during copper mining in 1788, consist of geopetal fillings of a cavern system in the Goredale Limestone. Contemporary descriptions of the mine record that the mineral occurred mostly as a powdery sediment filling the bottom of three interconnected E–W-aligned solution caverns, referred to by the miners as the '104-yard', '44-yard' and '84-yard' caverns, according to their length (Dunham and Wilson, 1985) (Figure 3.21). The deposit was up to 1.8 m thick in places and in the 84-yard Cavern was locally covered by a layer of stalagmitic calcite (Arthurton *et al.,* 1988). Dunham and Wilson (1985) suggested that a total of 5000 tons of smithsonite may have been extracted during the mine's working life, and have proposed that the total tonnage of the mineral in the deposit may amount to 15 000 tons. Although originally extracted via the copper workings, a shaft, known as the 'New Shaft', was sunk in 1806 into the junction between the 104-yard and 44-yard caverns, in order to facilitate extraction. After being lost for over a century, the position of this shaft [SD 8757 6400], was re-discovered in 1944 (Gemmel and Myers, 1952).

No material remains on the surface today to indicate the nature or composition of the 'calamine' deposits. Underground access may be arranged via the 'New Shaft', which lies adjacent to the bridleway from Settle to Malham. Remnants of the deposit are still present between boulders on the floor of the caverns and as fillings to cavities adjacent to the main caverns. Samples of the mineral collected in 1979 varied in colour from creamy-white to pale-buff, and consisted of flakes and platelets ranging in size from 0.25 mm to 4 mm in diameter. X-ray diffraction analysis proved the mineral to be smithsonite (Dunham and Wilson, 1985; Arthurton *et al.,* 1988). Chemical analysis of one sample revealed 76.7% $ZnCO_3$, 19.6% FeO and 0.8% $CaCO_3.MgCO_3$ (Dunham and Wilson, 1985). Whereas smithsonite is locally a very common mineral in the supergene zone of many Northern Pennine zinc-rich orebodies, it is typically present as the crystalline cellular form known as 'dry bone', or locally as compact crystalline stalagmitic masses. The powdery form of the mineral found at Pikedaw, and its geological setting, appear to be unique to this locality.

Interpretation

The Pikedaw copper and 'calamine' deposits lie within Dinantian limestones in the ground beneath the Mid Craven and North Craven faults. These fractures are important components of the Craven Fault System which marks the southern margin of the Askrigg Block. This complex structural line acted as a major hinge line during Carboniferous times, separating the comparatively thin succession of the Askrigg Block from the much thicker, and deeper-water, succession of the Craven Basin. The widespread occurrence of significant, although generally uneconomic, mineralization in places along the Craven Fault System, including the copper and zinc mineralization at Pikedaw, has led to speculation, and some exploration interest, in the potential for so-called 'Irish Style' mineralization associated with the Mid Craven Fault (Dunham and Wilson, 1985; Arthurton *et al.,* 1988).

The origins, and possible significance, of the Pikedaw 'calamine' deposit is of particular interest. The occurrence of smithsonite as a powdery sediment within the filling of solution caverns is clear evidence of its supergene origin. It is well known that carbonate-rich phreatic waters are capable of transporting zinc in solution for considerable distances from a primary sphalerite source during oxidation (Loughlin, 1914). However, where deposition from such waters takes place in caverns or mine workings, it is normal for zinc to be deposited either as encrustations of 'dry bone' smithsonite or as hydrozincite. Dunham and Wilson (1985) suggested two possibilities to explain the formation of this extremely unusual form of smithsonite at Pikedaw. The first is that it results from deposition of smithsonite particles derived from erosion of a nearby, although unidentified, deposit of massive smithsonite. The second is that the mineral may be a direct chemical precipitate from carbonated water carrying zinc, perhaps as a result of a change in oxygen fugacity, although the authors admitted that it was difficult to explain why in such circumstances a solid crystalline deposit was not produced. Whatever process generated the deposit, it seems clear that a substantial body of sphalerite is, or was, present in the vicinity and was undergoing active oxidation, with export of the zinc and its subsequent deposition in solution caverns. Dunham and Wilson (1985) suggested that the smithsonite sediment is almost certainly of Quaternary age. In view of Raistrick's (1954) observation that parts of the smithsonite deposit were buried beneath a calcite stalagmite, Dunham and Wilson (1985) concluded that deposition of smithsonite was no longer active. The inferred presence of a substantial primary sphalerite orebody in the vicinity lends support to the hypothesis of hitherto unknown metalliferous mineralization, including possible 'Irish-Style' deposits in the neighbourhood.

Conclusions

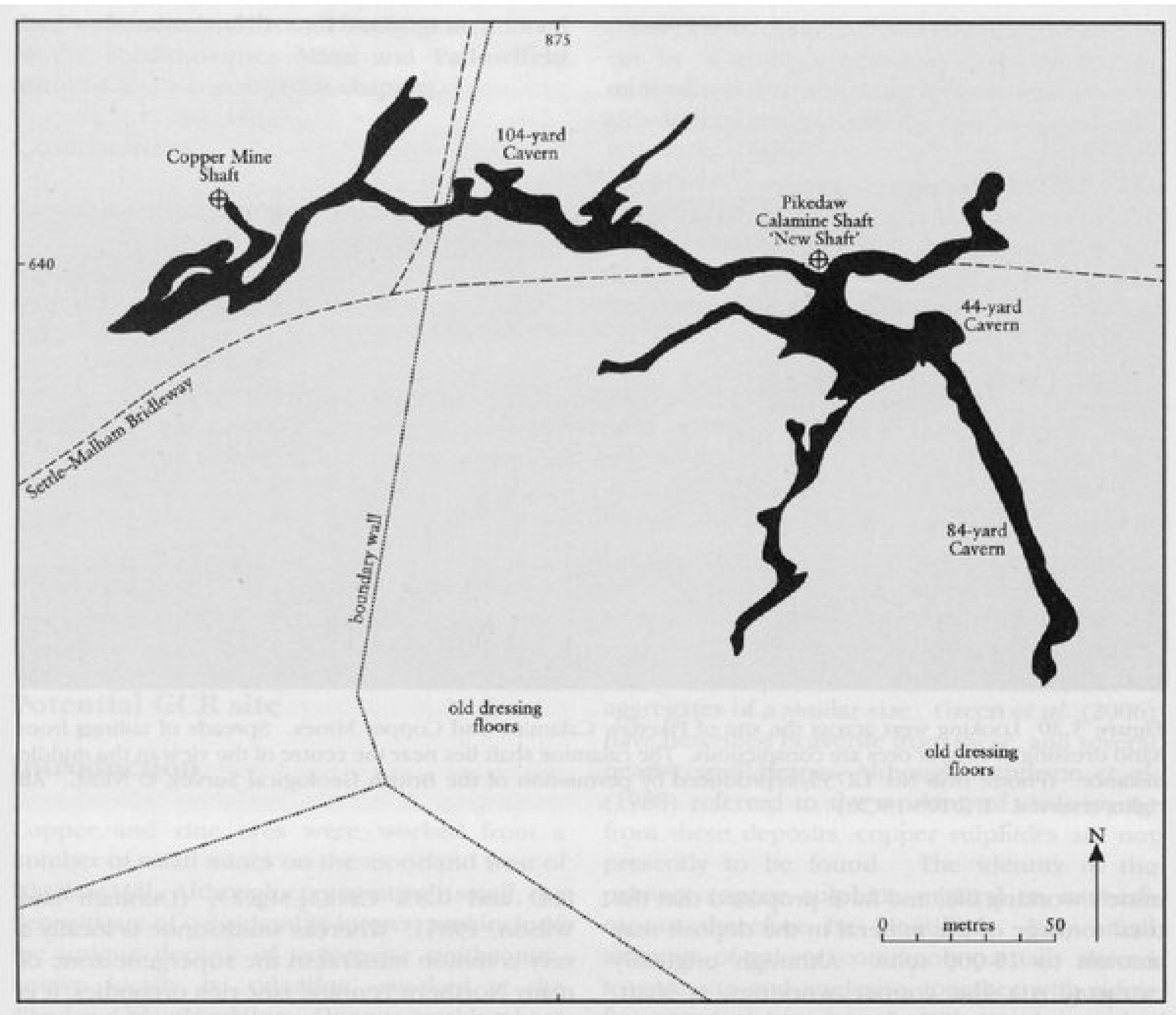
Unlike most parts of the Northern Pennines, several deposits here are dominated by abundant copper minerals. Although supergene malachite and azurite are abundant, the nature of the primary sulphide assemblage cannot be established.

The area includes the remarkable smithsonite deposit of the Pikedaw Calamine Mine. Although the precise mode of origin of this deposit is unclear, the presence of abundant smithsonite as a sediment in solution caverns appears to he without parallel in Great Britain. The remnants of the deposit offer important opportunities for further research into supergene processes in metalliferous orebodies.

The mineralization at Pikedaw may hold important clues to the area's potential for 'Irish-Style' deposits of base-metals adjacent to, or within, the Craven Fault System.

References

(Figure 3.20) Looking west across the site of Pikedaw Calamine and Copper Mines. Spreads of tailings from hand dressing of copper ores are conspicuous. The calamine shaft lies near the centre of the view in the middle distance. (Photo: BGS No. L2755, reproduced by permission of the British Geological Survey, © NERC. All rights reserved. IPR/105–15CX.)



(Figure 3.21) Sketch plan of Pikedaw Calamine and Copper Mines showing the extent of the calamine-bearing caverns. After Raistrick (1983).