Dale Head North and South Veins, Cumbria

[NY 223 155], [NY 222 156], [NY 22 71]

Introduction

The Vale of Newlands, south-west of Keswick, contains a number of metalliferous veins, two of which, the Dale Head North Vein and the Dale Head South Vein, belong to the widespread chalcopyrite-pyrite-arsenopyrite suite of Lake District veins.

Mining at Dale Head, as at a number of sites in the Vale of Newlands, may be traced back with certainty to Elizabethan times, although earlier working is possible. Working is known to have been active during the 17th century, and it is said that significant amounts of copper ore were raised here at various times during the 19th century. The history of mining in the Vale of Newlands and at Dale Head has been outlined by Postlethwaite (1913), and Donald (1994). Shaw (1970), and Stanley and Vaughan (1980) commented on more-recent proposals to attempt to re-open the mines.

The geology and mineralization of the Dale Head veins has been described by Dewey and Eastwood (1925), Rastall (1942), Strens (1962), Stanley (1979), and Stanley and Vaughan (1980).

Description

At Dale Head, mudstones belonging to the Buttermere Formation of the Ordovician Skiddaw Group are overlain by andesitic lavas and volcaniclastic rocks of the Birker Fell Formation at the base of the Ordovician Borrowdale Volcanic Group. The site includes exposures and spoil heaps from two separate, but almost certainly related, veins, namely the Dale Head North Vein and the Dale Head South Vein. The Dale Head North Vein is mineralized within Skiddaw Group rocks: the Dale Head South Vein occurs entirely within Borrowdale Volcanic Group rocks (Figure 2.10). These veins are described separately but their interpretation and genetic significance are considered together.

The Dale Head North Vein (also known as the 'Long Work') occupies an approximately E–W-trending fault. The vein is exposed in Newlands Beck where it dips south at about 70°, and is 0.5 m wide and composed mainly of quartz. Mineralization can be traced along strike for almost 0.75 km westwards onto the lower slopes of Hindscarth. It has been worked in surface trenches and stoped out to surface from shallow underground workings at several points (Figure 2.11). In these workings the vein is up to 1 m wide and comprises ribs and veins of quartz with bands rich in pyrite, chalcopyrite and arsenopyrite. Veinlets of quartz which carry these sulphide minerals penetrate the wall-rocks locally. Millward *et al.* (1999) described a strong cleavage fabric in the wall-rocks passing through and refracted by the vein and its included wall-rock clasts. Stanley and Vaughan (1980) described extensive chloritization of slate wall-rock with the development of zircon, rutile and graphite.

Sulphide-rich veinstone is abundant in small spoil-heaps adjoining most of these workings. Larger quantities of veinstone occur on the spoil heap from a level driven into the vein from the west bank of Newlands Beck. Stanley (1979), and Stanley and Vaughan (1980) presented detailed descriptions of the mineralogy and paragenesis of veinstone from this working. The most abundant and conspicuous minerals are quartz, pyrite, arsenopyrite and chalcopyrite. The vein differs from most Lake District copper veins in the abundance of pyrrhotite. In most veins of this type pyrrhotite occurs as minute inclusions usually enclosed within pyrite or arsenopyrite. The pyrrhotite at Dale Head is the monoclinic form. Other metalliferous minerals identified within the Dale Head North Vein by Stanley and Vaughan (1980) include cobaltite, cobaltiferous pyrite, native bismuth, bismuthinite, sphalerite, marcasite, tennantite and galena. A few inclusions of gold were recorded in one specimen. In addition to quartz, non-metalliferous minerals include rutile, muscovite and chlorite.

Dale Head South Vein occupies a NE–SW-trending fault which cuts the andesites and volcaniclastic rocks of the Birker Fell Formation at the base of the Borrowdale Volcanic Group on Dale Head Crags. The vein exposure in the crags is inaccessible. However, its course may be followed as a cleft in the crags adjacent to at least two levels which have been

driven on it. The underground workings are inaccessible. The mineralogy of the vein is most easily studied in the abundant mineralized spoil from these levels and on the site of an old, perhaps Elizabethan, dressing floor. Veinstone remaining here shows abundant quartz in which occur concentrations of djurleite (Stanley, 1979). It is likely that much, if not all, of the 'copper glance' described from here by Dewey and Eastwood (1925) may be djurleite. Bornite is also comparatively common. Stanley (1979) observed the alteration of bomite to chalcopyrite in some specimens and the presence of covellite along late fractures. He also commented on the fractured nature of many of the sulphides intimately mixed with finely brecciated country rock. Other sulphide minerals present in small amounts in the Dale Head South Vein include pyrite, arsenopyrite, galena and sphalerite. Most conspicuous of the copper minerals in the Dale Head South Vein are brightly coloured supergene species, the most abundant of which are malachite and chrysocolla. Ward (1876b) noted that the vein contained an abundance of 'green carbonate' (malachite) but very little 'yellow copper' (chalcopyrite). Dark-brown goethite is also common in most samples of veinstone.

Interpretation

The mineralogy of the Dale Head North Vein is generally characteristic of the assemblages present within the widespread suite of chalcopyrite-pyrite-arsenopyrite veins found throughout much of the Lake District (Stanley and Vaughan, 1982a). In their detailed studies of this vein, Stanley and Vaughan (1980) demonstrated that deposition of quartz,muscovite, chlorite and rutile was followed by pyrite, some of which contains cobaltiferous zones, at temperatures of 300°–350°C; arseno-pyrite was deposited at 295°–275°C; bismuthinite, monoclinic pyrrhotite , chalcopyrite and sphalerite followed at 240°–250°C, with late marcasite, pyrite and galena at about 235°C. The Dale Head North Vein thus exhibits some broad similarities to the copper-bearing veins of the Coniston Copper Mines (see GCR site report, this chapter). Stanley and Vaughan (1982a) proposed a Lower Devonian age for these veins, based in part on K-Ar isotopic dating of veinstone samples by Ineson and Mitchell (1974). However, the discovery by Millward *et al.* (1999) of cleavage within the Dale Head and Coniston copper veins indicates that mineralization, at least in part, pre-dates the Acadian cleavage-forming event and may be genetically related to the final phases of Ordovician magmatism.

Borrowdale Volcanic Group rocks have been suggested as a source of the introduced metals in these deposits (Firman, 1978a; Stanley and Vaughan, 1982a). More recently Lowry *et al.* (1991) demonstrated from sulphur isotope studies that Skiddaw Group rocks were the most likely source of sulphur. These and other authors have suggested that the underlying granitic batholith may have provided the heat source for the mineralization, and have also suggested that the distribution of copper mineralization within the Lake District is related to features in the batholith.

The relationship between the Dale Head South Vein and the majority of Lake District copper veins is not clear. A striking feature of this vein is the abundance within it of copper sulphides such as djurleite and bornite which are commonly found in zones of enrichment. Stanley (1979) described a number of replacement textures in sulphide minerals within this vein, although a detailed paragenetic sequence has not been established. He suggested that the South Vein was probably originally a chalcopyrite-pyrite-arsenopyrite vein similar to others in the Newlands Valley, including the North Vein, which has undergone considerable supergene alteration resulting from the circulation of oxidizing fluids through brecciated veinstone. The date of this brecciation and alteration is not known. The occurrence of abundant bornite in the uppermost exposed sections of the Birk Fell Hawse Vein, near Coniston, may be a similar example of supergene alteration within the upper levels of a copper vein (see Birk Fell Hawse Mine GCR site report, this chapter).

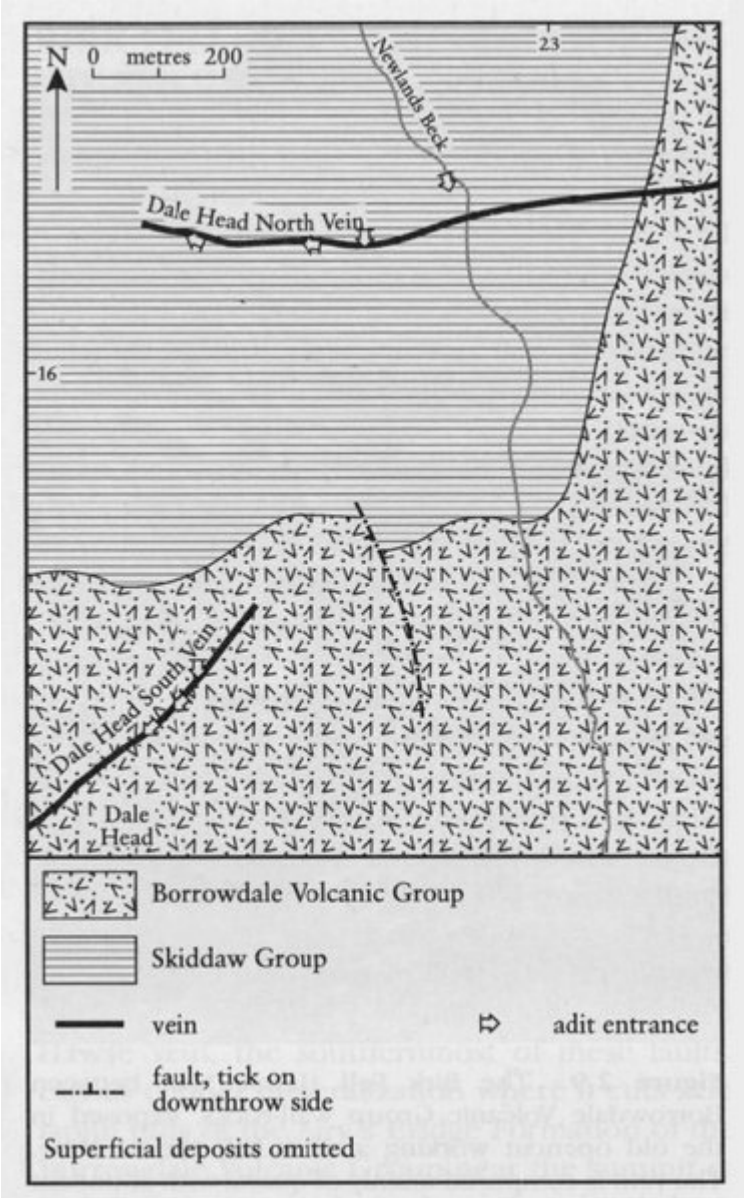
The presence of large quantities of minerals such as malachite and chrysocolla in the South Vein clearly results from supergene oxidation, although the timing of this alteration has not been established.

Conclusions

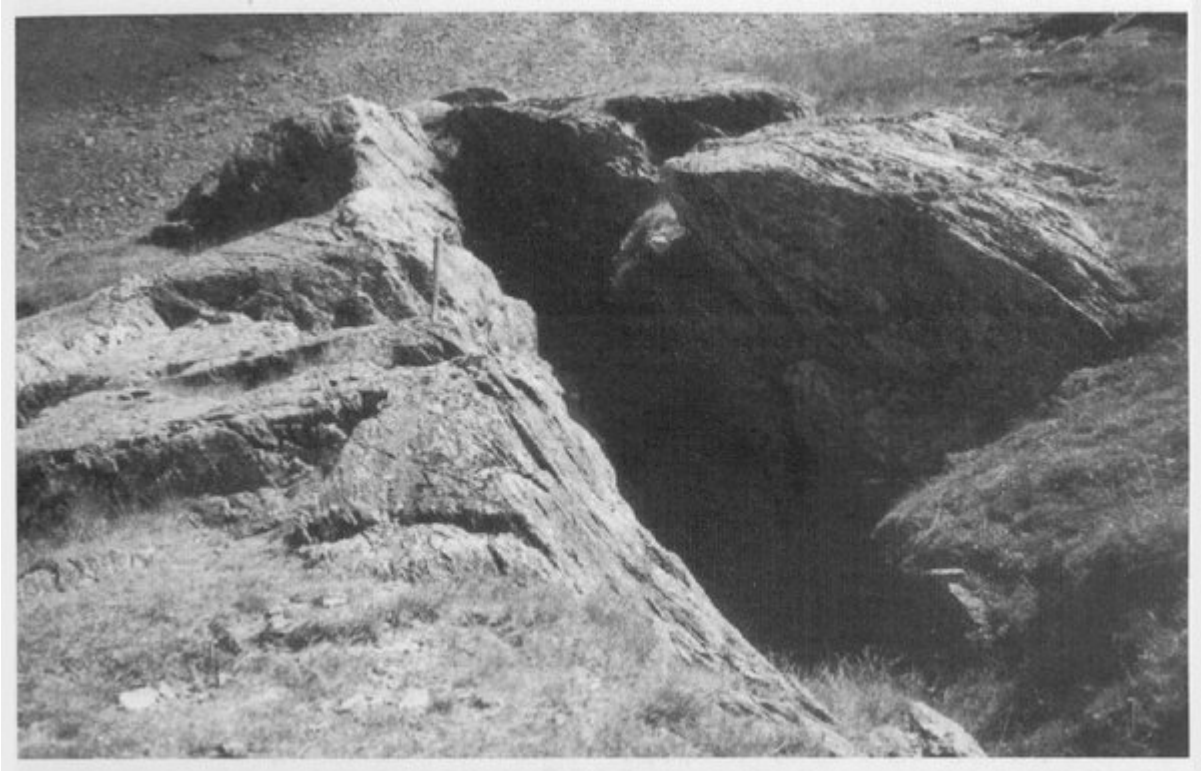
The Dale Head North Vein is an example of the widespread suite of chalcopyrite-pyrite-arsenopyrite veins within the Lake District, for which a Lower Devonian age has been proposed, although recent work by Millward *et al.* (1999) indicates that mineralization pre-dates the Acadian cleavage. This vein is hosted by Skiddaw Group rocks in which wall-rock alteration may be studied. Exposures of the vein *in situ* are supplemented by an abundance of mineralized veinstone in spoil heaps.

The mineral assemblage seen today in the Dale Head South Vein, which is hosted by Borrowdale Volcanic Group rocks, is believed to be the result of supergene alteration of an original chalcopyrite-pyrite-arsenopyrite vein.

References



(Figure 2.10) Geological sketch map of the Dale Head North and South Veins GCR site.



(Figure 2.11) Dale Head North and South Veins. Old opencast working in the North Vein, here between strongly cleaved Skiddaw Group wall-rocks. (Photo: B. Young.)