Llanberis Mine

[SH 598 586]

Introduction

The rocky hillside overlooking the south-east shore of Llyn Peris is honeycombed with the old workings of the once important Llanberis Mine (Figure 5.27), which is one of a number of mines developed on veins carrying Snowdonia copper-type mineralization, but occurring outside of the Snowdon Caldera area (see Howells *et al.,* 1991). These deposits, in pre-Caradoc rocks, have a mineral assemblage with consistent differences from that within the caldera, possibly reflecting a hitherto unidentified zonation pattern to the Snowdon volcanic-related mineralization.

According to Bick (1982), the Llanberis Mine was commenced around the middle of the 18th century, and Vaynol Estate papers from 1760, described by Bick (1982), indicate that by then work had started in earnest. At this time, the ore was carted down to the valley floor and then conveyed by boat along Llyn Peris, as commemorated in a 1792 watercolour painting by John 'Warwick' Smith. Activity continued into the 19th century, with good results at times; in 1832 ore production amounted to 1169 tons, albeit at an apparently low grade (Bick, 1982). However, by the latter half of the 19th century, the mine was struggling, and in 1873 it fell victim to a share promotion venture, accompanied by glowing reports of the richness of the mine. Although the promotion raised a considerable sum of money, the company went into liquidation in 1885, having sold no ore whatsoever. This was not an unusual pattern in late 19th-century Welsh metal mining, and gave the industry a tarnished reputation from which it never really recovered.

Despite this inauspicious end, Llanberis Mine was one of the more productive of the Snowdonia copper mines, yielding, between 1804 and 1885, 7499 tons of copper ore, the vast majority of which was produced prior to 1847 (Bick, 1982). Production figures for the 18th century remain unknown.

Description

Llanberis Mine (Figure 5.28) lies beyond the north-west margin of the Snowdon Caldera, and the mineralization has been emplaced at a much lower stratigraphical level than that worked within the caldera area, described under the Lliwedd Mine GCR site. The mineralization at Llanberis Mine is hosted by W-dipping elastic marine sedimentary rocks, belonging to the Bronllwyd Grits Formation and the Marchlyn Formation, of Merioneth (Upper Cambrian) age (British Geological Survey, 1985a), and approximately equivalent to the Ffestiniog Flags and Maentwrog formations of southern Snowdonia and the Dolgellau Gold-belt. Quartzose grits are a feature of the sequence, and are intercalated with mudstones and siltstones. This sequence is the host to a series of quartz-chlorite-sulphide veins up to several metres in width. The steeply dipping veins generally trend WNW–ESE to north-west–south-east, and form an interconnecting network in which the geometry of the open workings suggests that rich sulphide deposits occurred as massive lensoid bodies within the vein structures.

The vein mineralization consists of quartz, accompanied by chlorite and massive sulphides. However, the paragenesis is somewhat different to the veins within the caldera area. Early mineralization comprises abundant rhombic arsenopyrite associated with pyrite. The arsenopyrite and pyrite occur both in vein quartz (which cements clasts of wall-rock) and also as porphyroblastic growths within a chloritized grit matrix. Arsenopyrite-pyrite deposition was followed by pyrrhotite, which is particularly abundant at the south-east margin of the site. Abundant chalcopyrite, associated with traces of sphalerite, occurs in veins in the pyrrhotite, and in addition forms peripheral rims to, and veinlets within, arsenopyrite. Chalcopyrite also occurs as massive aggregates in the quartz-chlorite matrix.

Deformation, which post-dated the vein emplacement, resulted in the development of cataclastic textures in arsenopyrite, while pyrrhotite often occurs with an equigranular mosaic-like texture, a feature suggestive of recrystallization. Secondary mineralization is of restricted occurrence at the surface and is of a superficial nature. Yellow scorodite forms thin coatings on corroded arsenopyrite while pyrrhotite is commonly altered to limonite. Thin, blue to green copper stains are not

uncommon on chalcopyrite-bearing veinstone.

Interpretation

The primary paragenesis at Llanberis Mine is representative of a group of pre-tectonic veins which occur around the margins of the Snowdon Caldera within Cambrian and Lower Ordovician strata. They are interpreted here as being connected to the mineralization associated with hydrothermal convection centred on the Snowdon Caldera. This means that they were emplaced at a much greater depth than the intra-caldera veins, occurring stratigraphically more than 500 m below the veins at the Lliwedd Mine GCR site.

The arsenopyrite-pyrrhotite-rich paragenesis at Llanberis Mine is characteristic of the veins occurring within these older strata. Other occurrences of the paragenesis occur in the Gwaith–Ceunant area, to the south-east of Bethesda, where arsenic was a mining product (Sick, 1982), in the Drws-y-Coed district, south of the Mynydd Mawr microgranite, at various mines in Cwm Pennant, and to the south-east of the caldera at Moel Fleiddiau (Bevins and Mason, 1998). Proportions of arsenopyrite and pyrrhotite vary: at Blaen-y-Pennant mine arsenopyrite occurs as inclusions in massive pyrrhotite, while at Drws-y-Coed coarse-grained arsenopyrite and massive pyrrhotite are common. Pyrite, chalcopyrite, sphalerite and galena are frequent associated minerals, although the quantities of these minerals vary from minor to major occurrences without any particularly obvious pattern, except that sphalerite and galena seem to be more abundant the further the site is from the caldera margin. As in the caldera area, native copper occurs as flakes within the wall-rock in places.

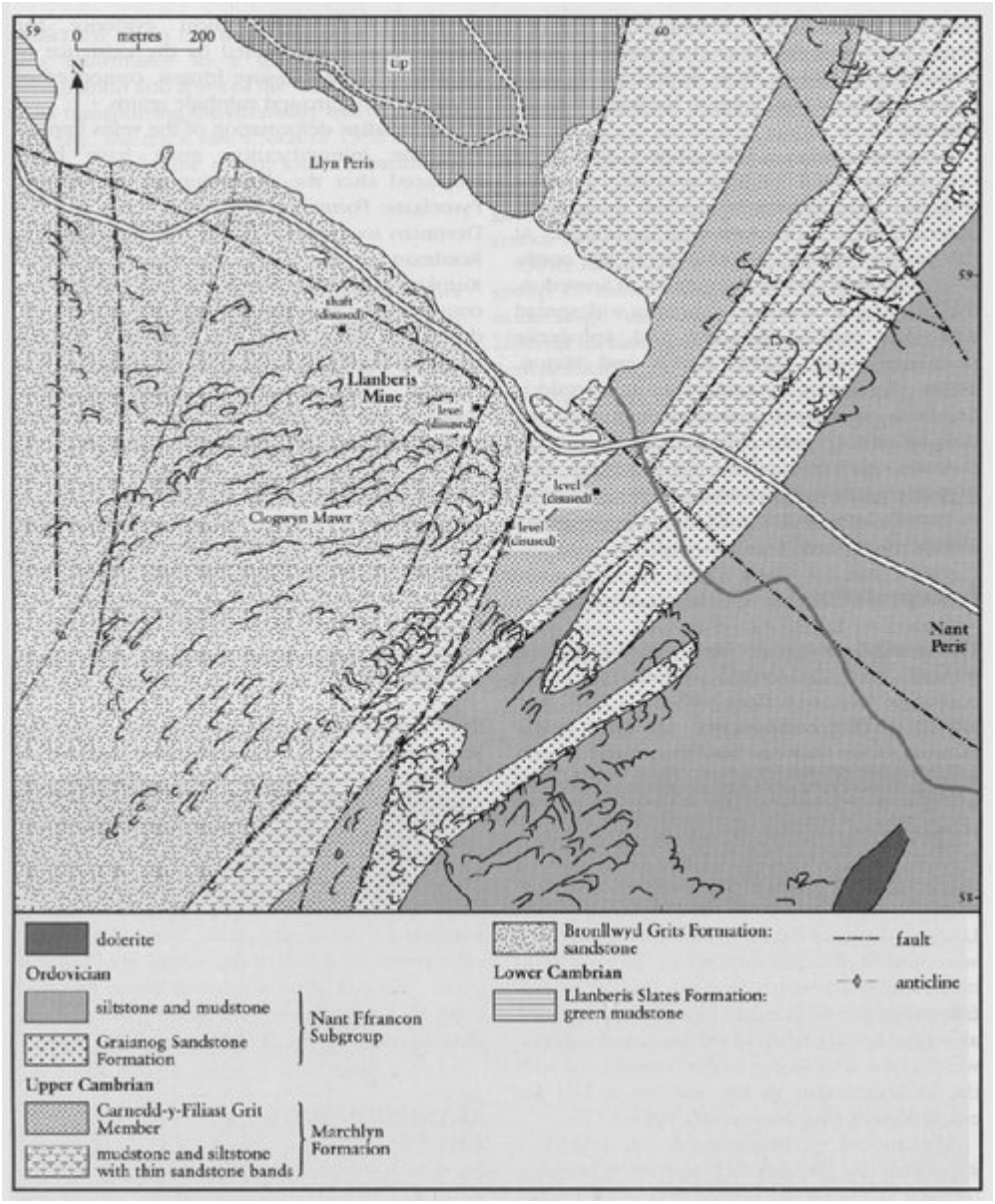
The distribution and stratigraphical position of this paragenesis strongly suggests that the mineralization in and around the Snowdon Caldera exhibits a pattern of depth, and perhaps lateral, zonation. In this zonation, the deepest-formed veins contain more arsenopyrite and pyrrhotite, while those closer to surface contain more galena and sphalerite, with chalcopyrite and pyrite occurring ubiquitously. However, further work is required to qualify this, in particular examination of crystallization temperatures of the various assemblages, as arsenopyrite-pyrrhotite mineralization passing up into galena-sphalerite-rich deposits is suggestive of a higher-temperature zone existing at depth. This is a reasonable expectation given the model of Reedman *et al.* (1985) for the caldera mineralization, in which the hydro-thermal fluids were driven around a convective cell by a magmatic heat source, which would have resulted in a steep geothermal gradient in the Snowdon Caldera and adjacent areas in Caradoc times.

The total extent of the Snowdon Caldera convective hydrothermal system is worthy of examination, for if the proposed model is correct, it extended well beyond the caldera rim, and was operative, as indeed hydrothermal cells tend to be, on a regional scale. Reedman *et al.* (1985) suggested that the Cae Coch massive sulphide deposit, almost 15 km to the north-east of the caldera (see Cae Coch Mine GCR site report, this chapter), might represent the same hydrothermal system exhaling onto the seabed. In addition, numerous veins carrying chalcopyrite but dominated by sphalerite and galena occur in Lower to Middle Ordovician strata in the Ffestiniog–Porthmadog belt (see Bevins and Mason, 1998); these are demonstrably pre-tectonic and cut the Tan y Grisiau Microgranite and related intrusions of Caradoc age, as at the Coed LIyn y Garnedd GCR site, 4 km to the south-east of the southern margin of the caldera. Clearly, further detailed research is required in order to fully classify the metalliferous vein mineralization of Snowdonia.

Conclusions

The mineralization worked at Llanberis Mine, and at a number of other localities peripheral to the margin of the Snowdon Caldera, was emplaced at a stratigraphically lower level than the caldera-fill mineralization as seen at the Lliwedd Mine GCR site. The mineralization is similar to that of the caldera-fill in many respects, but differs in that it contains abundant arsenopyrite, a greater abundance of pyrrhotite, and lesser quantities of Pb-Zn sulphides. These features, observed at many sites peripheral to the caldera, suggest that the mineralization exhibits a degree of depth, and possibly lateral, zonation.

References



(Figure 5.27) Map of the Llanberis Mine GCR site. After British Geological Survey 1:50 000 Sheet 106, Bangor (1985a).

(Figure 5.28) Photograph of the Llanberis Mine GCR site. (Photo: R.E. Bevins.)