Nantiago Mine

[SN 826 863]

Introduction

The extensive tips at Nantiago Mine (Figure 5.65) provide the finest demonstration in the Central Wales Orefield of the resemblance of certain late (A2) mineralization to that of the 'Pennine-type' orefields. Textures at Nantiago show clearly that the mineralization developed as crustiform, banded fissure-fillings deposited on the walls of open fractures. The result is that the ore worked at Nantiago consists of repeated layers of galena and sphalerite, with late cubic pyrite, all in a very coarsely crystalline calcite gangue.

The site has suffered much less damage than most Central Wales Orefield mines and is still of great interest also to the industrial archaeologist (Figure 5.66). A Pelton-wheel still remains on site, a reminder that this mine was one of the last Central Wales operations to close, operating up to and through the First World War. Indeed, a major factor in its closure was the fall in metal prices brought about by the sale of Government stocks after the Armistice (Bick, 1990), coupled as it was with the fact that Nantiago is a remote site, with consequent high costs for haulage to and from the mine. Nevertheless, the mine was eventually sunk to a depth of 70 fathoms (128 m) below adit-level. Between 1846, when mining in earnest was commenced at the site, and 1917, the mine produced a recorded output of 1709 tons of galena (from which desilvering, only in certain years, yielded 1651 oz Ag) and 1929 tons of sphalerite concentrates (Jones, 1922). In more-recent years, the property was considered as a potential source of white calcite, but was rejected because of the calcite's sulphide content (S.J.S. Hughes, pers. comm.).

Description

The vein worked at Nantiago Mine varies from a vertical to steep, S-dipping mineralized fissure. It trends virtually east-west and is hosted by dark-grey mudstones of the Bryn-glâs Formation and, at depth, by sandstones of the Drosgol Formation, both of Ashgill age. These outcrop in the core of an anticline of Caledonoid trend; hence both to the east and west of the mine the vein at surface runs into the pyritic shales of the Cwmere Formation of Lower Llandovery age. According to Jones (1922), the vein varied between 1–2 m in width, with a tendency to split into branches at the western end of the mine. Jones (1922) also commented upon the frequent vugs, lined with elaborately branched masses of calcite rhombs, which were encountered underground. Economic quantities of ore were said to be largely restricted to the Bryn-glâs Formation mudstones; the sandstones proved to be a poor host-rock, so that the orebody, following the favoured mudstone beds over the crest of the anticline, took the form of a broad arch (Jones, 1922).

The mineralization has been assigned to the A2-c assemblage of Mason (1994, 1997), and this is its strongest development in the Central Wales Orefield, although it is actually of widespread occurrence. The mineralization comprises abundant octahedral galena (with minute chalcopyrite inclusions) and chocolate to dark-brown sphalerite, which occur in multiple, repeated bands in a calcite matrix. Some attractive galena specimens, consisting of crusts of octahedral crystals 1–1.5 cm across, have been collected from the site in the past. Quartz is minor and early in the sequence, forming thin coatings to rock clasts. Large, unfortunately bruised and weathered calcite crystal groups on the tips show low rhombohedral crystals aggregated together into sub-parallel, often stalactitic masses up to approximately 15 cm in length. Minor, late pyrite occurs both as a dark dust included in the outer layers of calcite crystals, as well as cubic crystals up to 5 mm scattered 'over calcite crystal faces.

Secondary mineralization is of little significance at Nantiago Mine, being limited to traces of malachite, cerussite and hydrozincite, occurring in thin, probably post-mining, coatings on weathered sulphides.

Interpretation

Although the minerals occurring at Nantiago Mine are all common species, the site is nevertheless important in metallogenic terms as it demonstrates textural features which can be linked to a specific type of mineralizing event, namely the filling of an open-space fissure. While much of the Central Wales Orefield mineralization occurs as cements to breccias formed by hydraulic fracturing, some assemblages belonging to the later or A2 group frequently, and in some cases predominantly, occur as banded fissure-fills. Typically an open-space fissure-fill consists of ribs of clean, relatively (and often entirely) clast-free gangue (in this case calcite) containing sulphides and other primary minerals in repeated, often continuous layers, thus demonstrating that the vein was built up through time as repeated injections of hydrothermal fluid passed through an open fracture system.

Such vein textures are more typical of the 'Pennine-type' orefields of Britain, but in fact occur throughout the Welsh Caledonides. The Llanrwst Orefield, in northern Snowdonia, is another example, where the Parc Mine was a rich source of banded veinstuff, until the site was largely reclaimed (Bevins and Mason, 1998). Late calcite-marcasite veins are also of frequent occurrence throughout the Snowdonia copper- mining district and are widespread in the Dolgellau Gold-belt, where particularly attractive banded sphalerite-marcasite-galena-calcite ore occurs at the West Cwmheisian Mine, although at this site representative material is now much more sparse at surface than at Nantiago Mine. Similar textures are commonly also seen in the mineralization of the West Shropshire Orefield, and, to the south of the Central Wales Orefield, at the Llanfyrnach Mine, in Pembrokeshire. The fact that such crustiform-banded veins, with a simple calcite-galena-sphalerite-iron sulphides-dominated mineralogy, are a regional feature of the Welsh Caledonides in turn suggests that they may represent the products of a metallogenic process operating on a regional scale.

Because of the resemblance of the mineralization at Nantiago Mine to that of the 'Pennine-type' orefields, the mine was one of a number of sites selected for Pb-Pb isotopic studies by Swainbank *et al.* (1992). Pb-Pb isotopic ratios of galena from Nantiago Mine plot outside the main cluster of A2-a galenas, which give a Lower Carboniferous model age, but fall within a wide field populated by A2-b and other A2-c galenas, all of which are relatively radiogenic and imply deposition in Permian times (270–240 Ma).

The high ^{206}Pb component of these galenas led Swainbank *et al.* (1992) to conclude that a metamorphic fluid source from the Welsh Basin could be eliminated. Given that the isotopic characteristics of these galenas falls within the field of galenas from the 'Pennine-type' orefields of central and northern Britain, it is not unreasonable to infer that these late-stage veins in Central Wales are the products of the same, regionally extensive, mineralizing episode, albeit in older strata than those which host the typical 'Pennine-type' mineralization. However, it is not unknown for 'Pennine-type' veins to be traced through their usual Dinantian carbonate host-rocks and into underlying Lower Palaeozoic strata. This was indeed the case at some mines in the North-east Wales Orefield (see Pool Park and South Minera Mines and Pennant Mine GCR site reports, this chapter). The ability for Mississippi Valley-type (MVI) fluids to migrate, not just into Carboniferous carbonate sequences, but also into uplifted blocks of older strata, should not be underestimated (J.S. Mason, unpublished data).

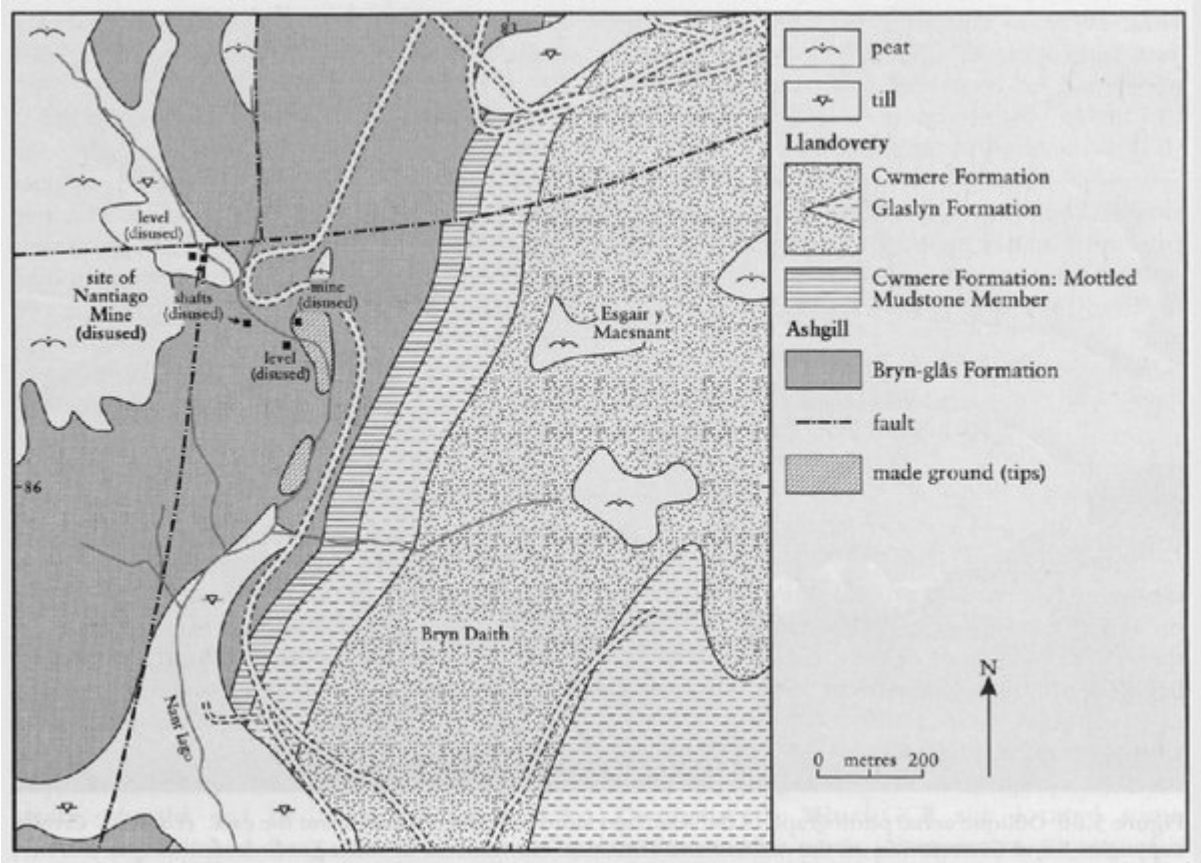
Several features, therefore, combine to suggest that the later (A2-b and A2-c) vein assemblages of the Central Wales Orefield were deposited during the same broad episode of mineralization that was responsible for the development of the 'Pennine-type' orefields. In terms of fluid sources, the 'Pennine-type' orefields are believed to have been formed from evolved brines expelled from adjacent Permian to Jurassic sedimentary basins (Ixer and Vaughan, 1993). The current hypothesis for the evolution of such brines is contentious (Ixer and Vaughan, 1993), but their ability to transport metals in solution over distances of hundreds of kilometres (Garven and Freeze, 1984) is accepted widely. It was therefore advocated by Mason (1994) that the fluid source for the late veins of the Central Wales Orefield could feasibly be the Upper Palaeozoic to Mesozoic sequences of the Cardigan Bay Basin, less than 40 km to the west of Nantiago Mine.

Conclusions

In the Central Wales Orefield, the later stages of mineralization are probably related to the metallogenic episode responsible for the development of the British MVT 'Pennine-type' orefields. This is supported on geological, mineralogical and textural grounds, and is backed up further by the results of a lead isotope study. Therefore, the crustiform-banded, calcite-dominated Pb-Zn-bearing mineralization at Nantiago Mine was probably deposited from

modified basinal brines expelled in Permian times from the Cardigan Bay Basin, lying approximately 40 km to the west of the area.

References



(Figure 5.65) Map of the Nantiago Mine GCR site. Based on unpublished British Geological Survey 1:25 000 Sheet SN88, and Jones et al. (2004).

(Figure 5.66) Oblique aerial photograph of the Nantiago Mine GCR site, looking from the east. (Photo: Crown copyright: Royal Commission on the Ancient and Historical Monuments of Wales.)