Erglodd Mine

[SN 657 903]

Introduction

Erglodd Mine (Figure 5.59) is one of a small number of key sites in the interpretation of the early (A1) phase of the Central Wales Orefield primary paragenesis, as identified by Mason (1994, 1997). The site exhibits an important development of the early polymetallic (A1-c) assemblage, here containing an exceptional quantity of Co-Ni minerals, principally siegenite. A number of samples of veinstone have assayed in excess of 3 wt% combined Co + Ni; in these samples the pale-pink to white siegenite is clearly visible in hand specimen. Additionally, the assemblage contains cobalt pentlandite, millerite, ullmannite, and pyrrhotite (not reported elsewhere from the A1-c assemblage), and is auriferous; minute gold grains have been identified in polished section and gold grades locally exceed 0.5 g/t.

Description

Erglodd Mine (Figure 5.60) worked an ENE–WSW-trending vein of mineralized breccia cutting grey mudstones and sandstones of the Devil's Bridge Formation of Llandovery age. It is undoubtedly an old working and the abundance of stone hammers amongst the debris from outcrop workings may even point to it being one of a number of Early Bronze-Age copper workings in the area (S. Timberlake, pers. comm.). The Roman road, Sam Helen, runs nearby, and in 1976 a Roman fortlet was discovered nearby, while in 2004–2005 an extensive Roman smelting site was discovered during archaeological excavations close to the edge of Borth Bog, at the foot of the slope below the mine. However, the recorded history commences in the late 18th century (Hughes, 1981a). The mine was in the hands of John Taylor and Sons in the 1840s, when a deep adit cross-cut was driven to drain the old workings. However, when this holed through it was still well above the lowest workings: the assumption that ancient miners were unable to work to any great depth was disproved in Central Wales many times in the 19th century, at some considerable expense to the then operators.

The mine fell into disuse in about 1883, by which time a recorded total of 16 tons of lead and 12 tons of zinc sulphide concentrates had been sold. Production prior to the advent of statistical collation in 1845 is unknown but is unlikely to have been very large. The current site layout is partly the result of much dump removal for hardcore in the 1970s; above the remnant tips lies a deep and dangerous opencast working. The deep adit portal is situated at the top of the area of disturbed tips, but is now collapsed.

The sulphide mineralogy of Erglodd Mine is of particular interest and as such it was selected as one of the key sites in the Central Wales Orefield by Mason (1994). Although ore microscopy is required to fully investigate the assemblages, the presence of cobalt and nickel minerals, in highly elevated levels compared to other Central Wales Orefield sites, may be appreciated in hand specimens of veinstone. Most of the cobalt and nickel occurs in the rare mineral siegenite, one of the thiospinel group of minerals with the formula $(Co,Ni,Fe)_3S_4$.

Early (A1) mineralization, which consistently gives a Lower Devonian isotopic age (Fletcher *et al.,* 1993), dominates the vein worked at Erglodd Mine. Initial mineralization resulted in the formation of breccia cements of quartz, with abundant dark-brown sphalerite accompanied by minor pyrite, ferroan dolomite and chlorite (A1-b assemblage). However, the majority of this material occurs as clasts, brecciated and cemented by later mineralization of the subsequent A1-c assemblage. This, the most polymetallic assemblage of the Central Wales Orefield, has here developed in two sub-stages with brecciation in between, a feature not recognized elsewhere in the orefield. The first sub-stage consists of quartz and fine-grained sulphides, which give the quartz a bluish colour. The fine grain-size makes paragenetic determinations impossible without resorting to ore microscopy. The depositional sequence of sulphides in this quartz is trace pyrite, trace marcasite, siegenite, cobalt pentlandite, chalcopyrite, trace pyrrhotite and galena. Brecciated fragments of enclosed A1-b sphalerite have been spectacularly affected by chalcopyrite disease, particularly where in proximity to later deposits of chalcopyrite.

The second A1-c sub-stage has a cyclic paragenetic sequence, with repetition of several minerals being observed in layered overgrowths around clasts. It comprises, in order of crystallization, chalcopyrite, minor ullmannite, minor bournonite, galena, quartz, trace gold, siegenite, cobalt pentlandite, trace millerite, chalcopyrite and trace galena. Tetrahedrite, although not noted in the samples studied to date, occurs in minor amounts in this assemblage at several neighbouring mines, the inference being that it can be expected to be found at Erglodd Mine with further study.

Although many phases can only be observed under the microscope, siegenite is conspicuous in hand specimen, forming euhedral crystals typically up to 1 mm across, aggregated into pale-pink to white, metallic patches dispersed throughout the quartz matrix. Indeed, Jones (1922) noted its presence on the dumps, but misidentified it, stating that '...some pyritous lode-matter occurs on the tip.'. Pyrite is, in fact, much less conspicuous at Erglodd Mine. Cobalt pentlandite can be seen under the hand lens as trellis-like patterns on the crystal faces of siegenite, although in polished section the networks of yellow cobalt pentlandite lamellae set against the pinkish siegenite are more distinct. Apart from galena, chalcopyrite and millerite, all other sulphide phases occur as microscopic inclusions in galena, with ullmannite being the most frequently observed. Gold occurs as minute (10 kiln) crystals associated with siegenite, and assays performed on samples from this mine (Mason, 1998) show a close positive correlation between levels of gold, cobalt and nickel.

Later cavity filling, a common feature of the A1 mineralization in the Central Wales Orefield, involved the crystallization of minor, typically yellow to orange, translucent sphalerite ('honey-blende') overgrown by minor calcite. Polished sections reveal that this sphalerite generation has locally replaced A1-c galena, with the development of caries texture along sphalerite-galena contacts. Curiously, inclusions of ullmannite within the galena have remained unaffected by this process.

Late (A2) mineralization, which in the Central Wales Orefield is often found along re-activated A1 fractures, occurs in only trace quantities at Erglodd Mine. Accompanied by a minor fracturing episode, with local brecciation, it comprises quartz, as crustiform layers of stumpy colourless crystals, associated in places with granular-textured, reddish-brown sphalerite and later intergrown pyrite and marcasite.

Secondary mineralization is limited at Erglodd Mine to thin brochantite and linarite, occurring as thin, dump-formed coatings on chalcopyrite fragments. Covellite often replaces chalcopyrite superficially. Cerussite and pyromorphite occur as insipid, filmy coatings on quartz. Siegenite often shows alteration to oxides, via an intermediate phase petrologically resembling violarite. The alteration of siegenite-cobalt pentlandite composite crystals always commences along the cobalt pentlandite lamellae.

Interpretation

Erglodd Mine is one of three GCR sites in the Central Wales Orefield selected, amongst other factors, for the diversity of the early A1-c assemblage that they portray. The A1-c assemblage, economically by far the most important aspect of the A1 Central Wales Orefield mineralization, is also the most interesting in mineralogical terms. In all of its occurrences it is characterized by abundant galena and chalcopyrite, yet it is the distribution of the minor, often inclusion-forming ore minerals, that is the chief focus of interest. Certain of these phases, particularly tetrahedrite, siegenite, millerite and tucekite, occur more abundantly in some areas than in others, and it is the clustered nature of these occurrences that is of note. Thus, there is the concentration of siegenite-rich mineralization in the area north of Talybont, typified by the Erglodd Mine GCR site, the concentration of tucekite occurrences in the area to the north-west of Plynlimon, represented by the Eaglebrook Mine GCR site, and the cluster of particularly tetrahedrite-rich deposits of the Darren–Goginan area, as seen at the Darren Mine GCR site.

Siegenite is in fact widespread throughout the Central Wales Orefield, but outside of the area immediately to the north of Talybont it occurs only as a trace phase, detected only by ore microscopy. Cobalt and nickel levels are likewise lower outside of this one area. The nickel sulphantimonide mineral ullmannite is present at widely scattered localities as a component of the much later A2-b assemblage, where it occurs as macroscopic crystals in a crustiform layered assemblage, as occasionally seen at the Frongoch Mine GCR site.

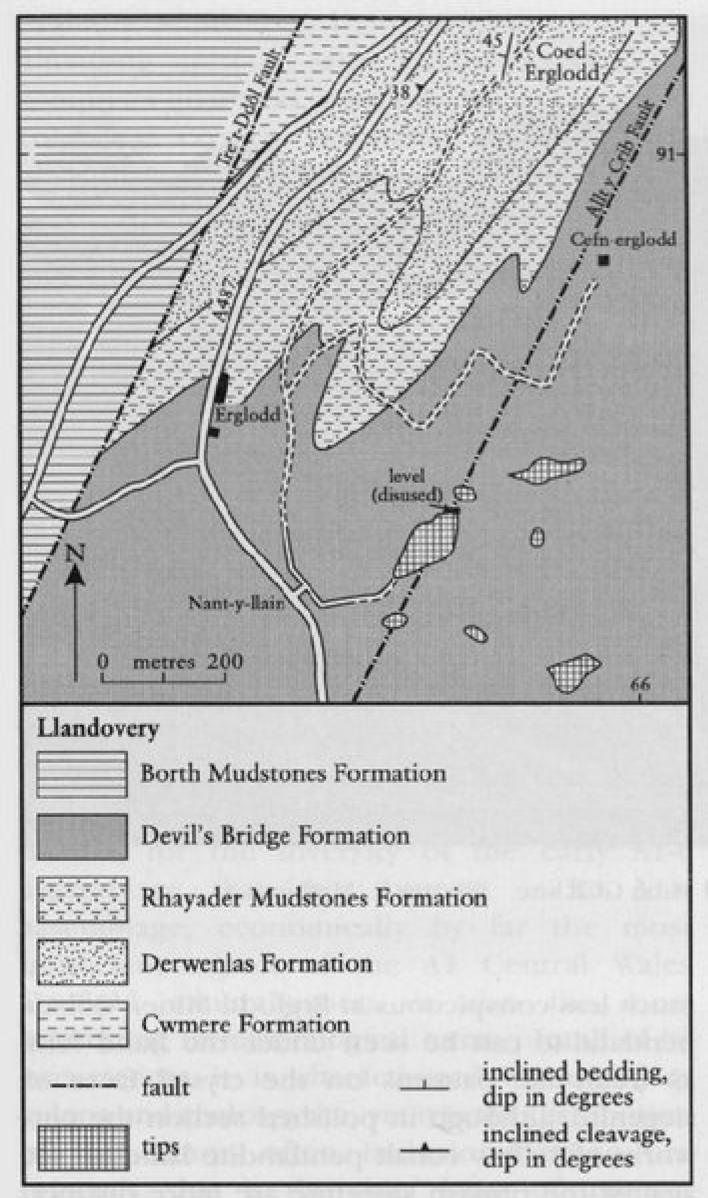
Marked, well-constrained variations in the mineralogy of a single assemblage, hosted by similar strata across the Central Wales Orefield, tend to suggest that there were variations in the geochemistry of ore-forming fluids from place to place within the area as a whole. The isotopic model proposed for the Central Wales Orefield mineralization (Fletcher *et al.,* 1993) involves a single crustal source of lead (and other metals), repeatedly tapped as successive phases of mineralization took place. In this context, it is likely that the spatial variations in the mineralogy and geochemistry of a single assemblage reflect a source terrain within which key geological horizons have influenced the geochemistry of the fluids derived as a result of their leaching.

It is therefore possible, as suggested by Mason (1994, 1997), that the A1-c assemblage was formed by the action of a series of co-existing hydrothermal cells, each leaching metals from broadly similar crustal levels, but each encountering a variety of strata acting as metal reservoirs. Within the Lower Palaeozoic sequences of the Welsh Basin, even if the Cambrian sequences are discounted, there remains a wide range of sedimentary rocks from pyritic shales through sedimentary ironstones to greywackes, and notably in the Ordovician sequences both acid and basic volcanic and intrusive rocks. These all outcrop just to the north of the Central Wales Orefield, in the area between Machynlleth and Dolgellau (Pratt *et al.,* 1995), and it is quite likely that similar sequences underlie the orefield itself, thereby providing a geochemically diverse source terrain, particularly in terms of minor element variations. In the case of the Erglodd Mine area, a source terrain relatively rich in ro and Ni is required to explain the abundance of siegenite if the overall model of Fletcher *et al.* (1993) is appropriate.

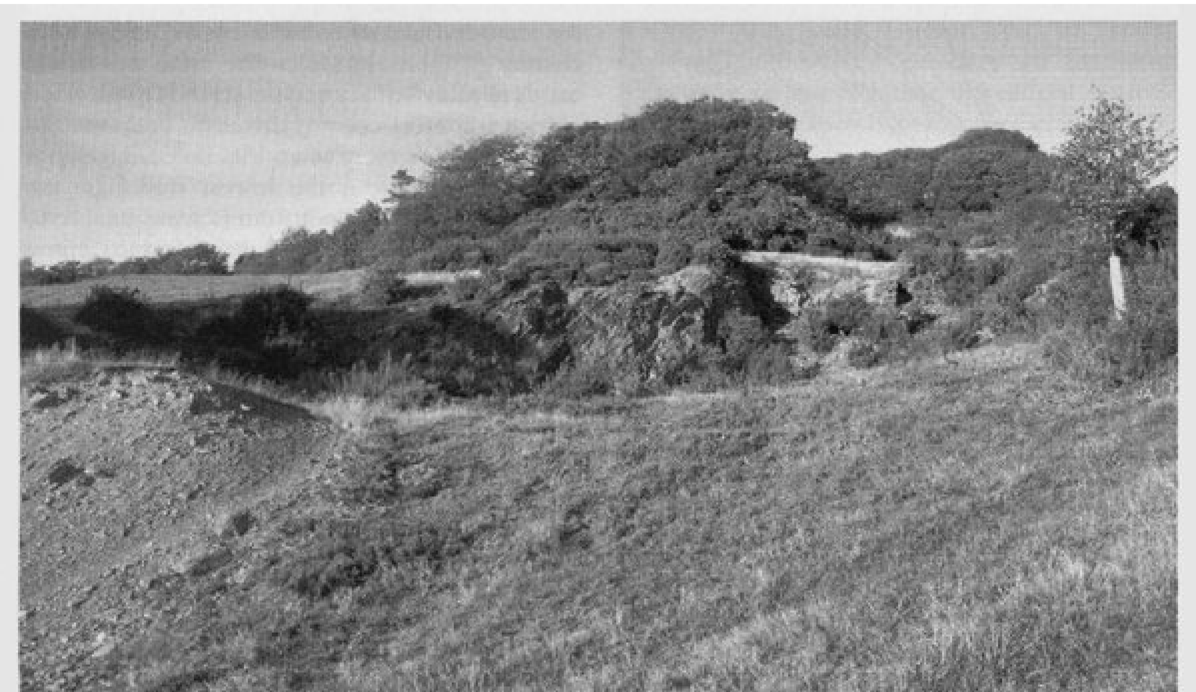
Conclusions

Erglodd Mine is the most significant example of one of a number of localities to the north of Talybont where the early, A1-c polymetallic assemblage (see (Table 5.1)) is particularly rich in cobalt and nickel minerals, to the extent that they may be observed in hand specimen. This clustering together of localities, where particular minerals or metals are unusually abundant, is characteristic of the A1-c assemblage, the most widely developed facet of the early mineralizing episode. The occurrence of such clusters suggests that the A1-c mineralization was emplaced across the Central Wales Orefield by a series of co-existing convective hydrothermal cells, each tapping similar, but subtly different, source rocks at depth.

References



(Figure 5.59) Map of the Erglodd Mine GCR site. After British Geological Survey 1:50 000 Sheet 163, Aberystwyth (1984).



(Figure 5.60) Photograph of the Erglodd Mine GCR site. (Photo: R. Mathews.)

A1 ('Early Complex') assemblages	A2 ('Late Simple') assemblages
Early Devonian isotopic age Post-Caledonian relaxation?	Early Carboniferous to Permian isotopic ages Mainly Variscan extension?
WEAK BRECCIATION	MAJOR BRECCIATION
A1-a Minor early Cu qtz + chalcopyrite + ferroan dolomite	**A2-a Pb-Zn assemblage** qtz + sphalerite + chalcopyrite + galena
BRECCIATION	MAJOR BRECCIATION
A1-b Early sphalerite assemblage qtz + pyrite + sphalerite (with chalcopyrite disease) + ferroan dolomite + chlorite	**A2-b Ullmannite-bearing Pb-Cu assemblage** qtz + chalcopyrite + ullmannite + galena
MAJOR BRECCIATION	CRUSTIFORM OVERGROWTH
A1-c Polymetallic assemblage qtz + pyrite + siegenite + cobalt pentlandite + millerite + chalcopyrite + *pyrrhotite* + tucekite + ullmannite + *gersdorffite* + *electrum* + tetrahedrite + bournonite + *boulangerite* + galena	**A2-c Calcite-dominated assemblage** qtz + galena + sphalerite + calcite + *chalcopyrite* + *pyrite*
SHEARING OF SULPHIDES	CRUSTIFORM OVERGROWTH
A1-d Minor late veining chalcopyrite + galena + "honey-blende" sphalerite	**A2-d Coarsely crystalline quartz** qtz + *chalcopyrite* + *pyrite*
LOCALLY MAJOR BRECCIATION	RELATIONSHIP UNKNOWN
A1-e Ferroan dolomite influx qtz + ferroan dolomite	**A2-e Barium minerals assemblage** *qtz* + sphalerite + galena + calcite + barite + witherite
LOCAL FRACTURING	MAJOR BRECCIATION AND TECTONISM
A1-f Late cavity-filling qtz + *siegenite* + *cobalt pentlandite* + millerite + chalcopyrite + galena	**A2-f Iron sulphides assemblage** qtz + sphalerite + pyrite + marcasite
Important economic assemblages: A1-b (moderate Zn); A1-c (major Pb-Ag, moderate Cu); A1-f (minor Pb-Cu)	**Important economic assemblages: A2-a (major Pb-Zn, minor Ag); A2-b (moderate Pb, Ag, Cu); A2-c (locally major Pb-Zn); A2-e (locally major Pb, barite)**

(Table 5.1) Classification of Central Wales Orefield mineralization into the 'Early Complex' A1 and 'Late Simple' A2 groups. Minor/trace species are in italics; major phases are underlined. After Mason (1994, 1997).