Glasdir Mine

[SH 740 223]

Introduction

Glasdir Mine GCR site (Figure 5.13), comprising waste tips and a cavernous, part-flooded opencast (Figure 5.14), was at one time the most important copper mine in the Dolgellau Gold-belt, eventually producing over 7000 tons of copper ore concentrates, grading *c.* 10% Cu, with 0.5oz Au/ton and recoverable silver, prior to closure at the outbreak of the First World War in 1914 (Hall, 1990). The ore at Glasdir, consisting principally of fine-grained pyrite and chalcopyrite impregnating host-brecciated sedimentary rocks, was difficult to concentrate using the conventional 19th century technologies, and experiments with oil flotation were carried out as early as the 1890s. In the late 1890s, William Elmore and Sons continued with this experimentation, with the construction of the world's first practical flotation plant, inspired areas of the mill circuit where the ore pulp had reportedly by Frank Elmore's observation that been splashed (Hall, 1990). This new technology, sulphides were adhering to greasy hand prints in the Elmore Process, was to be rapidly adopted worldwide, and by 1916 had been so refined that in the United States over 25 million tons of ores per annum were being treated using this technique. While the process represented a major advance in ore beneficiation technology, an ironic consequence was that huge reserves of previously untreatable ores could now be cheaply concentrated. The treatment, by flotation, of previously worthless sphalerite-rhodonite ores at Broken Hill in Australia, was so cost effective that it led to the end of the zinc-mining industry in the very country in which the process was invented.

The Glasdir deposit was referred to as a 'lode' as recently as the late 1960s (Gilbey, 1968), and it was not until the 1970s that the true form of the deposit was recognized (Allen and Easterbrook, 1978). Together with a number of other breccia pipes in the Coed y Brenin district, the Glasdir deposit was classified by Allen and Jackson (1985) as an example of an explosion breccia, formed by the violent reaction between large quantities of meteoric waters and hot magma at a depth of less than 4 km. This interpretation clearly links the Glasdir mineralization to that of the Coed y Brenin porphyry copper deposit, and thereby with the Rhobell Fawr volcanic episode. Glasdir is therefore a further aspect of the sub-volcanic hydrothermal system that was developed during the early Ordovician magmatic episode in southern Snowdonia.

Description

The Glasdir breccia is hosted by arenaceous shallow-water marine sedimentary rocks of the Upper Cambrian Ffestiniog Flags Formation. Clasts within the breccia, which reach up to 30 cm in diameter, consist both of these sedimentary rocks and, more rarely, associated 'greenstone' intrusive rocks. The breccia body is oval in section (200 x 100 m), and has been proven during mining activities to persist to at least 210 m below surface (Allen and Jackson, 1985), where it is smaller in cross-section. The copper-bearing mineralization, which chiefly affects the margin of the breccia, occurs in a matrix of chlorite and very minor quartz, white mica and trace apatite, which cement the breccia clasts. Ore minerals comprise abundant pyrite, with subordinate but important marcasite and chalcopyrite, minor arsenopyrite and traces of gold. All minerals are fine- to medium-grained and appear in freshly broken samples as thin stringers, which rim breccia clasts and also form cross-cutting veinlets. Porphyroblastic pyrite and arsenopyrite also occur as scattered euhedra within breccia clasts (Allen and Easterbrook, 1978). Locally, later quartz-calcite veins, again carrying chalcopyrite, cut the stringer mineralization and locally reach up to 0.2 m in width (Bevins and Mason, 1998).

Secondary minerals are not particularly prevalent at Glasdir and are generally post-mining in origin, coating outer surfaces of rock fragments in the tips. Covellite and malachite are the chief alteration products of chalcopyrite and the basic copper sulphate wroewolfeite has been recorded as blue micro-crystals on mudstone associated with malachite (Bevins, 1994). The secondary aluminium-bearing minerals gibbsite and allophane, and the rare basic hydrated calcium silicate-carbonate-sulphate, thaumasite, have also been reported (Bevins, 1994) and are also believed to be of post-mining origin.

Interpretation

The formation of mineralized intrusive breccias, such as that at Glasdir, has been the subject of considerable debate. The Glasdir breccia was considered by Allen and Easterbrook (1978) to have formed during fumarolic activity in the waning stages of the Rhobell Fawr volcanic episode, although that model was modified by Allen and Jackson (1985), taking into account the work of Wolfe (1980). In the view of Wolfe (1980), such breccias result from phreato-magmatic explosions, caused by the interaction of hot magmas with meteoric waters, causing the upward ballistic intrusion of brecciated rock debris. Allen and Jackson (1985) suggested that this model might be applied to Glasdir, but invoked the role of later hydrothermal fluids percolating up through the breccia.

Ore mineralization at Glasdir has features in common with both the Coed y Brenin porphyry copper deposit and, to a lesser extent, the Dolgellau Gold-belt veins, with which Gilbey (1968) classified the deposit. Gilbey (1968) suggested that the lack of quartz, a most unusual feature given that the gold-belt veins are strongly quartz-dominated, was due to the fact that this particular fracture had opened up relatively late in the sequence of mineralizing events that formed the gold-belt veins.

There are a number of problems with the model of Gilbey (1968). Critically, the earliest phase of gold-belt vein development resulted in quartz-pyrite-arsenopyrite mineralization. Pyrite and arsenopyrite both occur at Glasdir, and the porphyroblast-like crystals of both phases, as described by Allen and Easterbrook (1978), are typical, very early features of most gold-belt veins (see the Cefn-Coch Mine and Foel-Ispri Mine GCR site reports, this chapter).

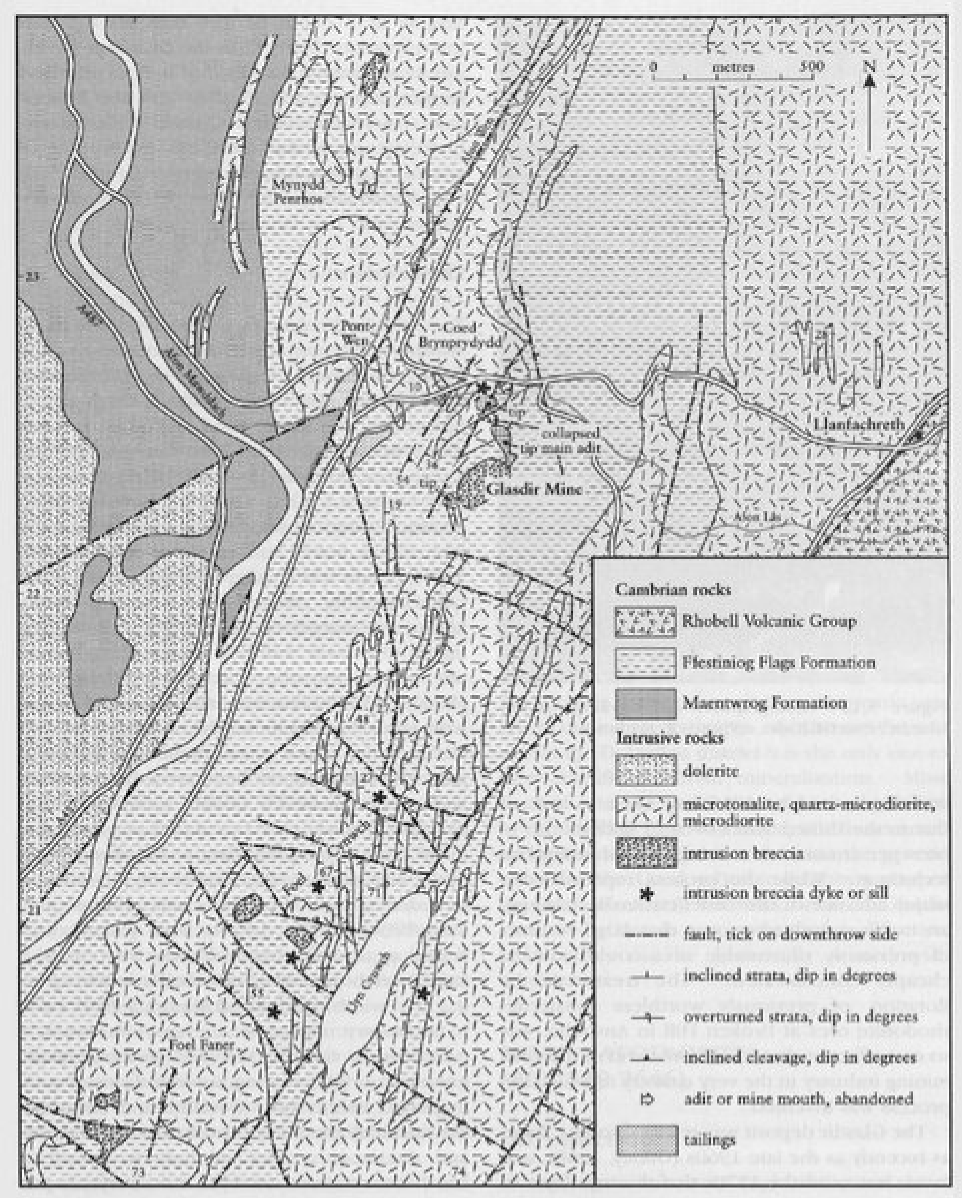
In addition, the most abundant associate of chalcopyrite in the gold-belt veins is pyrrhotite, a mineral which occurs, albeit in varying amounts, in all of the gold-belt veins, including those which cut the porphyry copper deposit, and were worked at Dolfrwynog mine, near Capel Hermon. Pyrrhotite has not been recorded, either from Glasdir or from the Coed y Brenin porphyry copper deposit. Whether it is genuinely absent, or whether once it was present but has since been altered to pyrite, remains to be determined.

These mineralogical disparities with the gold-belt veins, plus the limited fluid-inclusion data from Glasdir (Shepherd and Allen, 1985) which link the deposit more with the porphyry copper system than with the gold-belt veins, tend to preclude against a common genesis for the Glasdir deposit and the gold-belt veins; rather, Glasdir appears to represent a further facet of the complex hydrothermal system developed around the Rhobell Fawr volcano in Tremadoc times. In particular it reinforces the idea that this area is anomalous, on a regional scale, not only in Au (Shepherd and Bottrell, 1993) but also Cu and As, so that any localized centres of hydrothermal circulation might be expected to mobilize, transport and concentrate these elements in a variety of parageneses, although critically dependant on local conditions. Thus, the Coed y Brenin porphyry copper and Glasdir pipe mineralization may be genetically related to the same general system, but each with its own paragenetic features; for example As occurs in tennantite at Coed y Brenin but in arsenopyrite at Glasdir. However, further mineralogical work is required on both deposits in order to fully establish their genetic relationship.

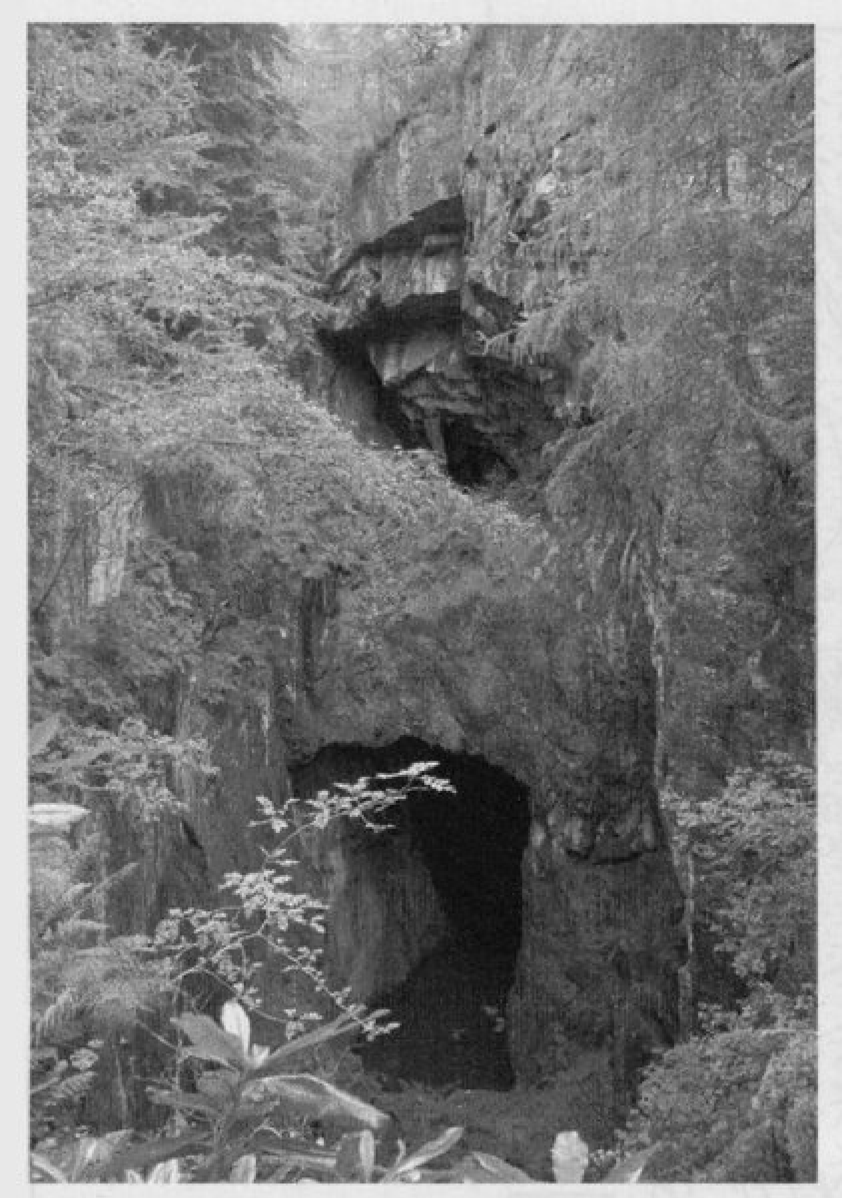
Conclusions

The Glasdir copper deposit is an enigmatic ore-body: out of several pipes of intrusive breccia within the Dolgellau district it is the only one to carry significant Cu-Au mineralization. Most lines of evidence point towards it being linked to the Rhobell Fawr volcanism, which occurred in Tremadoc times, and which was the genetic agent for the Coed y Brenin porphyry copper deposit. However, the links between Glasdir and Coed y Brenin require further qualification before they can be genetically related with confidence.

References



(Figure 5.13) Map of the Glasdir Mine GCR site and the locations of other intrusive breccias. After Allen and Easterbrook (1978).



(Figure 5.14) Photograph of old workings at the Glasdir Mine GCR site. (Photo: R. Mathews.)