Moel Hafod-Owen

[SH 7519 2646]

Introduction

Occupying a relatively high structural level above the Coed y Brenin porphyry copper deposit, the Moel Hafod-Owen site is another example of a mineralized breccia-zone formed during the waning stages of the Rhobell Fawr volcanism. What is of particular interest, however, is the evidence that this breccia represents the root zone of an ancient epithermal fumarolic system. This excellent exposure, forming a prominent boss on the northern side of a forest road, reveals strongly contrasting features between this and the Glasdir breccia (see Glasdir Mine GCR site report), situated farther to the south-west, in the Afon Wen valley and lying on the same line of structural weakness.

This site (Figure 5.11) has only been recognized relatively recently, and was not mentioned by Allen and Jackson (1985). Miller (1993) provided a first description of the site, although isotopic data concerning this style of mineralization were presented by Miller *et al.* (1991, 1992). Miller (1993) classified the mineralization, consisting of zones of intense pyritization and silicification enriched in Au, As and Sb, as epithermal in character.

The site is best approached from the west, along the upper forest road that leaves a minor tarmac road *c.* 1 km to the north-west of Capel Hermon. The first section along the road passes through the pyritized halo around the Coed y Brenin porphyry copper deposit, and pyritized sedimentary and intrusive rocks are exposed in frequent cuttings.

Description

The Moel Hafod-Owen breccia (Figure 5.15) is hosted by elastic shallow-water marine sedimentary rocks belonging to the Upper Cambrian Ffestiniog Flags Formation, which constitute the principal host to the Afon Wen Intrusive Complex (Allen *et al.,* 1976) and associated porphyry-style copper mineralization. The shape of the body is difficult to interpret in this exposure, but the breccia appears to form a lenticular pipe-like mass, with sharp, steeply dipping contacts, although the eastern contact is complicated by faulting. The site overlooks the Capel Hermon area, with a view down the markedly linear Afon Wen valley. It is along this lineament, termed the 'Afon Wen Fault' (Allen and Jackson, 1985), that both the Moel Hafod-Owen and the Glasdir mineralized breccia-zones occur.

Additionally, the view to the ESE, across the valley, shows the position of the base of the Rhobell Fawr volcanic succession, which lies unconformably upon the Ffestiniog Flags Formation. An obvious line of crags marks the outcrop of the volcanic rocks. The overall picture is complicated by the Bwlch Goriwared Fault, which has downthrown the volcanic rocks relative to Moel Hafod-Owen, the volcanic rocks therefore lying at a lower topographical level than the Moel Hafod-Owen GCR site.

The breccia consists of highly bleached, silicified and pyritized clasts of siltstone and mudstone, set in a mineralized matrix. The mineralization cementing the clasts comprises, in hand specimen, clear to white, locally drusy quartz carrying aggregates of cubic pyrite. In places, quartz and pyrite show rhythmic banding, the pyrite bands being 2–4 mm in thickness, in a crustiform arrangement about the clasts. Some of the quartz has a porous, clinkery appearance, although this is partly due to the dissolution of pyrite by weathering. In general, however, the pyrite is very fresh, and secondary limonite is limited in occurrence, although it is abundant along the eastern, fault-bounded margin. Elevated levels of arsenic, antimony and gold, detected by geochemical analysis, suggest the presence of other ore minerals.

To either side of the breccia, rocks belonging to the Ffestiniog Flags Formation are poorly exposed along the track. Although pyritic, as indeed this formation is in many exposures, they lack the pervasive pyritization seen along the earlier section of the track, being outside the pyrite-halo of the Coed y Brenin porphyry copper deposit. The contrast in hardness between the 'normal' rocks of the formation and the pyritized and silicified variety constituting the breccia is the reason for the relatively high relief of the breccia outcrop and for its boss-like shape.

Interpretation

The most important feature of the Moel Hafod-Owen deposit to be seen *in situ* is the locally developed sinter-like texture, with banded, porous quartz and pyrite formed about silicified and pyritized rock-clasts. Such a feature, combined with the epithermal geochemical signature of the mineralization obtained by Miller (1993), strongly suggests that the mineralization and alteration were developed within an active fumarolic system during the Rhobell Fawr volcanic episode. Sinter-like deposits also occur at the Parys Mountain GCR site (this chapter) and are strikingly similar to the Moel Hafod-Owen examples.

Hydrothermal fluids, driven by the convective heat engine of the intrusive complex emplaced beneath the Rhobell Fawr volcano, would, whether of igneous, sedimentary or meteoric origin, be driven upward through the sedimentary pile overlying the intrusive rocks, interacting *en route* with minerals contained within those rocks, and eventually, in some cases, escaping to surface as fumarolic geysers. Such features are common-place in modern-day volcanic terranes, such as in North Island, New Zealand; indeed, excellent exposures of explosion breccias and alteration assemblages at Ohakuri have been linked to hydrothermal activity which ceased only 42 000 years ago (Henneberger and Browne, 1988). Thus the Mod Hafod-Owen breccia is best interpreted as a site where such fumarolic waters have repeatedly pulsed up through an open fracture-system, causing pervasive silicification and pyritization of rock clasts, and depositing siliceous, banded, sulphidic sinter deposits within the open spaces between them.

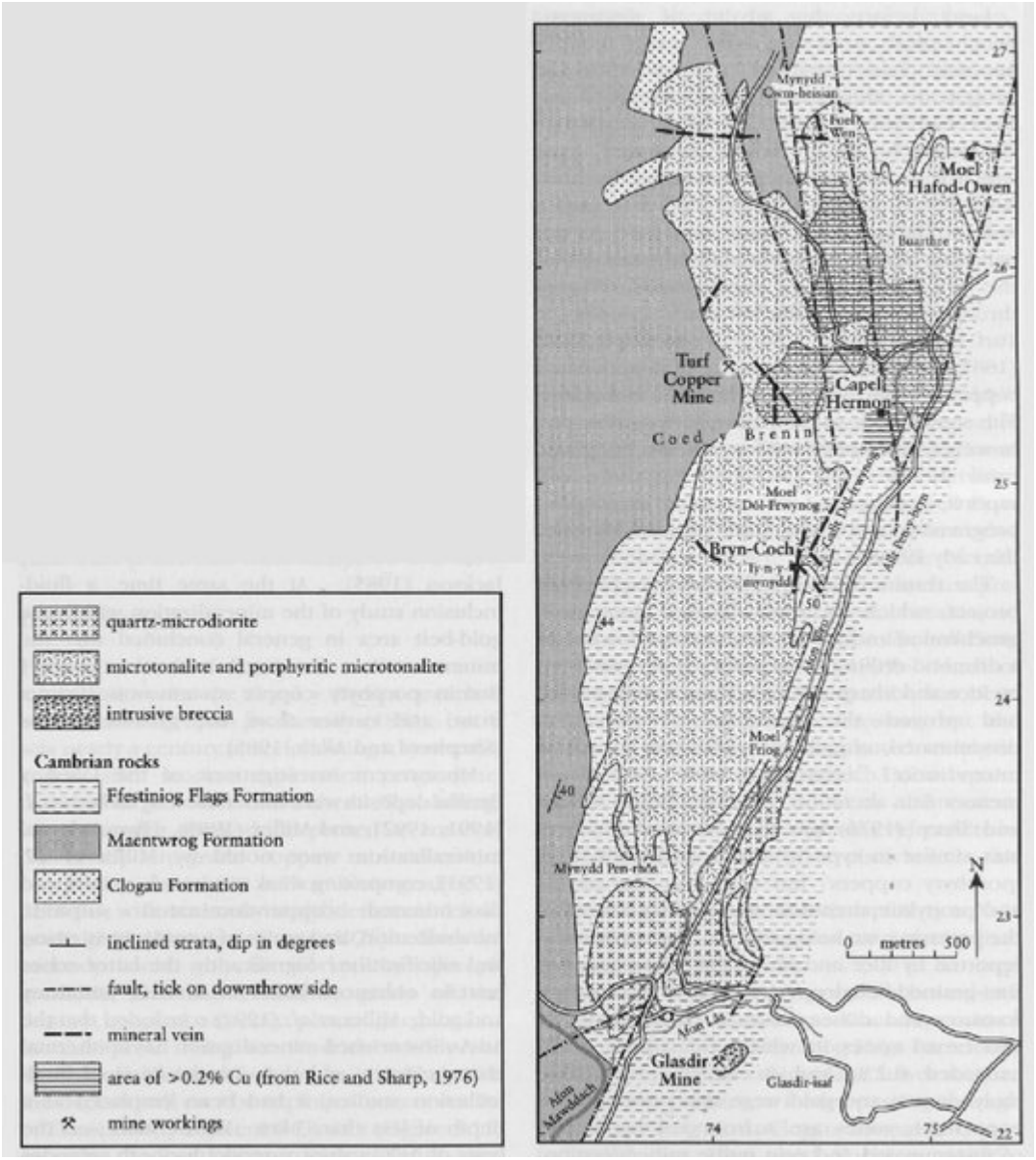
Miller *et al.* (1991) examined sulphur isotope ratios in pyrite from Moel Hafod-Owen and found them to contrast strongly with those.of the host rocks ($\delta^{34}S$ = –3.9‰ to –2.9‰ in pyrite, + 15‰ to +20‰ in whole-rock) and also with those of the porphyry copper sulphides (+1.1‰ to +9.75‰). The contrast was explained by Miller *et al.* (1991) to be due to the mixing of igneous-and meteoric-derived fluids; as with the Coed y Brenin porphyry copper deposit, this is perhaps to be expected in such a metallogenic environment, although the contrasting data obtained from the pyritic breccia and porphyry copper mineralization require further consideration.

The Moel Hafod-Owen breccia contrasts strongly with the Glasdir deposit; while Moel Hafod-Owen, with its more epithermal signature, is interpreted as a representative of the same overall system, it is thought to have been emplaced at a higher structural level. In common with Glasdir, however, the site is situated along the line of a major, NNE–SSW-trending structural weakness. This lineament, the Afon Wen Fault, marks the hinge of the tilting and folding which occurred immediately prior to Rhobell Fawr volcanism (Allen and Jackson, 1985) and appears to have been a deep-seated fracture that controlled and channelled much of the hydrothermal activity in Tremadoc times.

Conclusions

The Mod Hafod-Owen GCR site exposes a mineralized breccia-zone that is thought to represent the root zone of an ancient epithermal fumarolic system. This system may well have had a surface expression in the form of fumaroles and geysers, as seen today, for example, on North Island, New Zealand. The mineralization is dominated by pyritization and silicification, and is thought to have developed as part of the Rhobell Fawr volcanic episode in Tremadoc times.

References



(Figure 5.11) Map of the Coed y Brenin porphyry copper system, showing the localities of the Moe! Hafod-Owen, Thrf Copper Mine, Glasdir Mine, and Bryn-Coch and Cape Hermon GCR sites. After Allen et al. (1976).

(Figure 5.15) Photograph of the Moel Hafod-Owen GCR site. (Photo: S. Campbell.)