Bwlch Mine, Deganwy

[SH 787 794]

Introduction

Antimony mineralization is comparatively rare in Great Britain. Amongst the better known antimony deposits are those in the Padstow, Tintagel and Port Isaac areas of north Cornwall (Dines, 1956; Hobson, 1972; Clayton *et al.,* 1990; Selwood *et al.,* 1998); the Louisa Mine at Glendinning (Smith, 1919; Gallagher *et al.,* 1983; Duller *et al.,* 1997) and Hares Hill near Cumnock (Boast *et al.,* 1990), both in the Southern Uplands of Scotland; and Carrock Mine (Kingsbury and Hartley, 1956a), Wet Swine Gill (Tortey *et al.,* 1984), and Robin Hood Mine, Bassenthwaite (Postlethwaite, 1913), in the English Lake District.

A lesser-known antimony deposit occurs in North Wales, in the vicinity of Deganwy, Gwynedd, where a complex sulphantimonide assemblage has been identified recently (Bevins *et al.,* 1988), following the earlier record of stibnite and semseyite from this mine by Russell (1944), in samples he examined from the collections of the Museum of Practical Geology and of the Royal Geological Society of Cornwall.

The history of mining is uncertain, as is the amount of ore extracted. The occurrence is not even mentioned in the Geological Survey '*Special Reports on the Mineral Resources of Great Britain'* volume covering antimony (Dewey, 1920). Neither is the mine mentioned in the regional geological memoir (Warren *et al.,* 1984), although a disused shaft is marked on the most recent 1:50 000 geological sheet (British Geological Survey, 1989b). Perhaps the earliest reference to the mine is that on a geological map dated 1837, which refers to a 'Mine of Antimony' (see Bick, 1982). The deposit is almost certainly that referred to in the description of stibnite from 'Casten. Diganwy, near Conway' by Smyth *et al.* (1864).

Sulphantimonide mineralization at Bwlch Mine is hosted by extensively recrystallized acidic ash-flow tuffs of Ordovician age. This volcanic activity was related to the 1st Eruptive Cycle of volcanism in North Wales in Ordovician (Caradoc) times, associated with the subsequent development of a major caldera subsidence structure during the 2nd Eruptive Cycle (see Howells *et al.,* 1991). It has been proposed by Bevins *et al.* (1988) that the antimony mineralization was genetically linked to the magmatic activity associated with the 1st Eruptive Cycle.

The Bwlch Mine mineral deposit (Figure 5.33) is included in the Wales GCR mineralogy network because it contains a suite of rare lead sulphantimonide minerals (Bevins *et al.,* 1988), unique to Great Britain. The unusually complex assemblage is replicated at only a few deposits worldwide, such as at Vall de Ribes, in the Spanish Pyrenees (Ayora and Phillips, 1981).

Description

Bwlch Mine is a small site which is visible from a distance due to the yellow antimony-ochres which pervade the dumps. The mine was driven into a hillside, although there are no records of the mine layout. The shaft is now blocked, and the only source of specimens is from the small overgrown dumps near to the former mine entrance, which represent a strictly limited mineralogical resource.

The host rock comprises a highly silicified ash-flow tuff, considered to be of Caradoc age, belonging to the Capel Curig Volcanic Formation (British Geological Survey, 1989b), part of the Llewelyn Volcanic Group (the 1st Eruptive Cycle in Snowdonia). The ash-flow tuff is extensively silicified and more locally carbonatized. As a consequence, original textures are almost entirely overprinted and determination of the original character of the silicic volcanic rocks is difficult. The rock is nodular and shows a variety of spherulitic textures in thin-section. The most common spherulites are up to 1.5 mm across and are composed of radiating aggregates of fine-grained quartz; other spherulites have a structure more reminiscent of orbicules, with concentric layers of fine-grained quartz. A third type of spherulite is composed of coarse-grained aggregates of randomly orientated quartz crystals, some of which have a hollow core. These latter

spherulites may represent former lithophysae. The only primary textures which are recognizable are poorly preserved glass shards, now replaced by fine-grained, recrystallized quartz aggregates. It is thus most likely that the Bwlch siliceous volcanic rocks are in fact ash-flow tuffs, which are widely developed in the Ordovician sequences representative of the 1st and 2nd Eruptive Cycles across Snowdonia (Howells *et al.,* 1991).

The antimony-bearing minerals at Bwlch Mine, dominated by stibnite (Figure 5.34) occur in irregular patches and veinlets up to 2 cm (but more typically around 0.5 cm) wide. The sulphosalt minerals are usually associated with quartz and more rarely carbonate, while other sulphide minerals present include galena, sphalerite, pyrite and marcasite. Smyth *et al.* (1864) noted the presence of stibnite from 'Castell Diganwy', while Russell (1944) also identified semseyite and jamesonite from Bwlch Mine. The most detailed account of the Bwlch Mine sulphosalt assemblage, however, was by Bevins *et al.* (1988) who confirmed the previous identifications and additionally reported the presence of zinkenite, jamesonite, and plagionite, along with possible robinsonite and boulangerite. Recent unpublished studies (J. Cleverley and R.E. Bevins) have subsequently confirmed the presence of the latter two phases.

Various secondary minerals are also present, although their identification is mostly uncertain. Russell (1944) considered that a brownish-yellow crust on stibnite and other sulphosalt minerals was bindheimite, while Bevins *et al.* (1988) suggested that cherry-red coatings on stibnite were kermesite. Anglesite was also recorded by Russell (1944). Recently, Ryback and Francis (2001) have described rosiaite from Bwlch Mine, occurring as a very thin, light orange-brown crust on stibnite and buff-coloured bindheimite. Rosiaite itself was only recently described as a new species by Basso *et al.* (1996) from Cetine Mine, in Tuscany, Italy. Finally, as yet unpublished studies on secondary minerals from Bwlch Mine (J. Cleverley and R.E. Bevins) have identified a secondary Sb-Al-Zn oxide hydrate forming acicular crystals as overgrowths on boulangerite and as coatings on dolomite occurring as intergrowths with jamesonite. It is thought that this phase is the zinc analogue of cualstibite, described from the Clara Mine, Germany (Walenta, 1984).

Interpretation

Antimony mineralization at Bwlch Mine is directly associated with altered silicic volcanic rocks, contrasting with other occurrences of antimony mineralization in Great Britain. At Glendinning, the antimony mineralization is thought to be epigenetic, with three stages of mineralization, comprising an early pyrite-arsenopyrite assemblage, overprinted by stibnite-sphalerite-galena, followed by a late, minor galena-sphalerite-chalcopyrite-barite assemblage (Gallagher *et al.,* 1983; Duller *et al.,* 1997). At Wet Swine Gill, where the mineralization is located in the contact aureole of the Skiddaw Granite, the genesis of the antimony mineralization has been linked to the remobilization of primary antimony (Fortey *et al.,* 1984). In both cases described above, there was an early episode of arsenopyrite mineralization; in contrast, no such early arsenic-rich phase of mineralization has been recognized at Bwlch Mine.

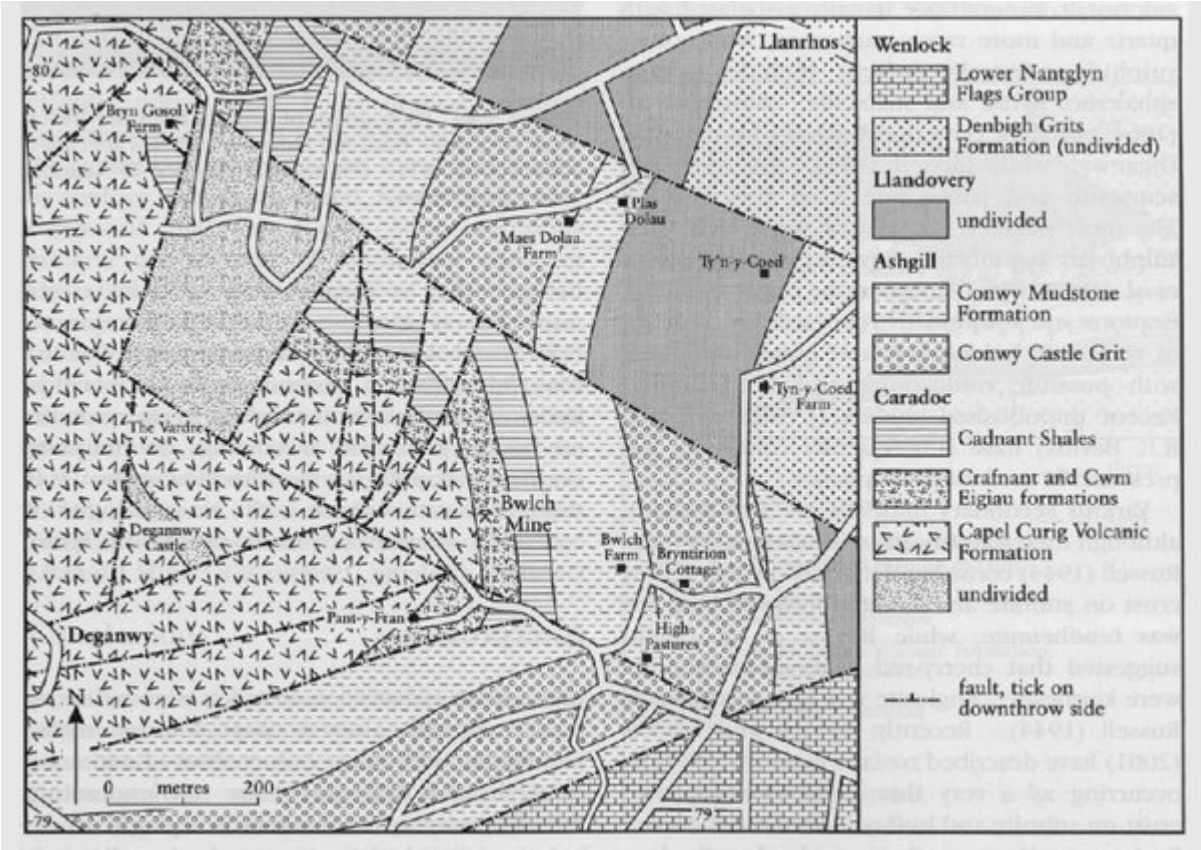
Potentially, a closer similarity is seen with the antimony mineralization in north Cornwall, which also occurs associated with volcanic rocks, although in this latter case they are of basic composition (Dines, 1956; Hobson, 1972; Clayton *et al.,* 1990; Selwood *et al.,* 1998). Accordingly, there appears to be no deposit in Great Britain which is directly analogous to the Bwlch Mine occurrence.

It is widely accepted that the Ordovician volcanic rocks of Snowdonia were erupted in an ensialic marginal basin setting, a basin which developed at the margin of Gondwanaland in relation to subduction of oceanic crust linked to closure of the Iapetus Ocean. Bevins *et al.* (1988) noted that hydrothermal systems commonly develop in such settings, leading to the generation of epithermal mineral deposits; by analogy with North Island, New Zealand they suggested that the Bwlch Mine antimony mineral deposit was of epithermal character also, linked to acidic ash-flow tuff eruption during the 1st Eruptive Cycle of Snowdon volcanism in Ordovician (Caradoc) times. Other episodes of mineralization in Snowdonia, for example the Cu-Pb-Zn-As and Fe-Sn-W oxide parageneses, have also been linked to the Ordovician volcanic activity (Reedman *et al.,* 1985), exposed, for example, at the Cwm Tregalan–Shadow Gully, Llanberis Mine and Lliwedd Mine GCR sites.

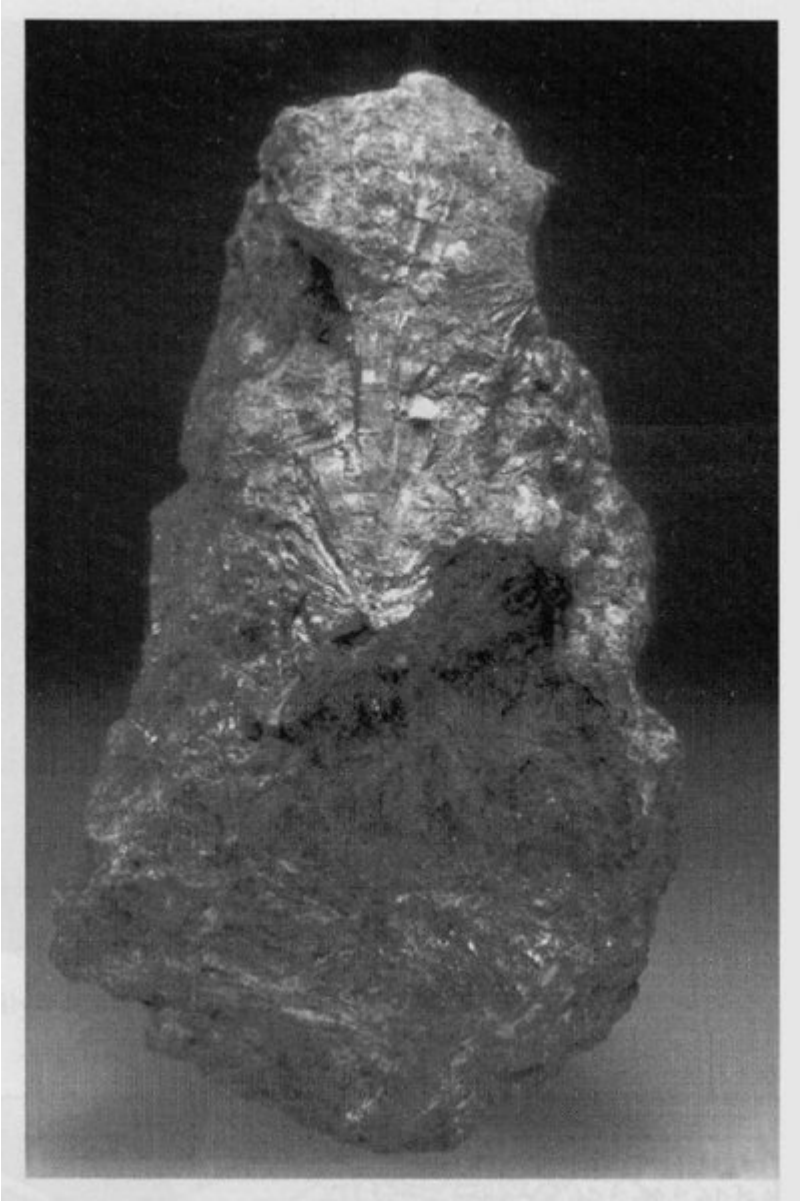
Conclusions

Antimony mineralization at Bwlch Mine, near Deganwy, is unique in Great Britain. It is associated with silicic ash-flow tuffs of Ordovician age and is thought to have been derived by hydrothermal activity associated with the contemporaneous eruption and alteration of the ash-flows. The site is also of importance for the rare primary and secondary minerals present, a number of the antimony-bearing minerals being the first, and in specific cases only, occurrence in Great Britain.

References



(Figure 5.33) Map of the Bwlch Mine GCR site. After British Geological Survey 1:50 000 Sheet 94, Llandudno (1989a).



(Figure 5.34) Photograph of stibnite from the Bwlch Mine GCR site. National Museum of Wales specimen NMW85.70G.M34. (Photo: M.P. Cooper, © National Museum of Wales.)