Penberthy Croft Mine, Cornwall

[SW 553 324]

Introduction

Penberthy Croft Mine is situated approximately 1.5 km from the village of Goldsithney, in the parish of St Hilary, Cornwall (see (Figure 7.52)). The importance of the site at the present day is purely mineralogical, being a prolific source of unusual and rare secondary minerals, of which the Cu-Pb-Fe arsenates are the best known. 'Virtually all of these have been collected from the extensive dumps which cover a large area of open ground at the site (see (Figure 7.53)). However, five main areas on these dumps have been identified as containing the richest and most diverse assemblages of mineral species: Dukes Shaft (the richest area at Penberthy Croft Mine) has 52 confirmed species; Daws Shaft has 51 confirmed species; Ducketts Shaft has 48 confirmed species; the pharma-cosiderite dumps have 41 confirmed species; and the birnessite dumps have 39 confirmed species (Betterton, pers. comm., 2010).

Copper- and tin-mining took place at Penberthy Croft Mine to a maximum depth of 53 fathoms below adit; small amounts of lead ore were also raised. In recent times, when tin prices were at a high, the dumps were sampled to evaluate their tin content.

Penberthy Croft Mine was noted as a locality for pyromorphite and mimetite in the mid-19th century. The copper lead asenate mineral bayldonite is ubiquitous at Penberthy Croft Mine and although originally described as from the St Day area, Kingsbury (1964) and others have stated that the original material came from Penberthy Croft Mine, which is considered to be its type locality. Recent studies have shown Penberthy Croft Mine to be the first recorded site in the British Isles for segnitite (Betterton, 2000), and the joint first recorded site for jeanbandyite and natanite (the other being Hingston Down Quarry) (see Betterton *et al.,* 1998).

Other rare minerals recorded from the dumps are carminite, pharmacosiderite, plumbogummite, wroewolfeite, monazite-(La) and mansfieldite. Altogether some 96 authenticated species have been reported from the locality, and Betterton (2000) has recently made a comprehensive review of the species present (see (Table 7.3)).

Description

Penberthy Croft Mine is believed to be very old, although historical records of output are sparse. Dines (1956) gave recorded outputs of 8700 tons of 7% copper ore, 60 tons of 'black tin' (unrefined ore) and 1.25 tons of 60% lead ore during the years 1818, 1824 and between 1881 and 1883. The mine was said to be producing very little in 1840, and was believed to be have been closed in the late 1840s. Dines (1956) provided details of the mining sett, while the detailed history of the mine has been recorded by Hamilton Jenkin (1965).

The Main Lode courses east–west, parallel to a quartz-feldspar porphyry ('elvan') dyke which lies some 140 m to the south of the lode. The outcrop crosses Long Lanes 530 m south of Penberthy Cross, and the lode has been worked for about 280 m east and 830 m west of the lane. Various other important lodes course away from the Main Lode, for example Longdose Lode courses E28°N and leaves the footwall on Main Lode 600 m west of Long Lanes. Canant Lode strikes W35°S and leaves the hangingwall of Main Lode 120 m west of Long Lanes. The total worked distance is around 3 km.

The Main Lode is either a double lode or the mineralization is telescoped, because tin, copper and lead minerals are all present within the dump material. However, the lead mineralization may be carried by small-scale cross-courses.

(Table 7.3) List of minerals recorded at the Penberthy Croft Mine GCR site. Mineral species in bold (96 species) have been confirmed; those in *italics* are fradulent, suspected or cases of analytical errors. 'UKPC2' and 'UKPC3' refer to 'Unknown Penberthy Croft' 2 and 3 — further research on these minerals is required. After Betterton (2010).

Adamite

Agardite-(Ce)

Agardite-(La)

Alloclasite

Anatase

Anglesite

Ankerite

Annabergite

Apatite-(CaF)

Aragonite

Arseniosiderite

Arsenolite

Arsenopyrite

Atacamite

Aurichalcite

Azurite

Bayldonite

Beaverite

Beraunite

Beudantite

Bieberite

Birnessite

Bismuthinite

Bismutite

Bornite

Brochantite

Calcite

Caledonite

Carminite

Cassiterite

Ceruleite

Cerussite

Chalcoalumite

Chalcocite

Chakophyllite

Chalcopyrite

Chlorargyrite

Chrysocolla

Clinochlore

Connellite

Copper (native)

Corkite

Cornubite

Cornwallite

Covellite

Cuprite

Cyanotrichite

Devilline

Dolomite

Duftite

Erythrite

Galena

Goethite

Gypsum

Halite

Halloysite

Hidalgoite

Hornblende

Jarosite

Jeanbandyite

Jordanite

Langite

Laurionite

Leadhillite

Libethenite

Linarite

Liskeardite

Malachite

Mansfieldite

Mattheddleite

Millerite

Mimetite

Mixite

Monazite-(La)

Mottramite

Muscovite

Natanite

Olivenite

Orthoclase

Paratacamite

Parnauite

Pharmacosiderite

Philipsburgite

Phosgenite

Pitticite

Plumbogummite

Plumbojarosite

Pseudomalachite

Pyrite

Pyromorphite

Quartz

Redgillite (UK PC1)

Rosasite

Scheelite

Schulenbergite

Scorodite

Segnitite

Serpierite

Siderite

Silver (native)

Smithsonite

Sphalerite

Stannite

Stilpnomelane

Stolzite

Sulphur (native)

Tenorite

Tyrolite

UK PC2

UK PC3

Varlamoffite

Woodwardite

Wroewolfeite

Zincolivenite

The mining sett is in Devonian metasedimentary rocks consisting of low-grade greenschist-facies killas, mostly slates, and is situated between the Land's End and Carnmenellis granite masses. The slates belong to the Mylor Slate Formation, usually a series of siltstones and mudstones with occasional impersistent sandstone layers (Goode and Taylor, 1988). Some interbedded metabasites strike east-west through the sett.

The primary mineralization is multi-stage, polymetallic and hydrothermal in character. The deposit appears to consist (from evidence of material collected mostly at surface) of several but distinct overlapping assemblages. The early main-stage mineralization is of high-temperature hydrothermal Sn–Cu–W–As veins, followed by a later-stage lower-temperature mesothermal to epithermal Pb-Zn mineralization, and a final late-stage Fe-Mn mineralization. As with all hydrothermal mineralization, fracturing, brecciation, silicification and chloritization of the vein material is common.

Supergene weathering and oxidation processes led to the formation of complex gossans with oxide and supergene enrichment zones. These processes led to the formation of a prolific suite of secondary minerals, such as pyromorphite and many secondary copper minerals. However, a further phase of mineral formation dates from post-mining times, both underground and certainly on the dumps, resulting in increased mineral species representation, including for example, birnessite. The abundance of the various species groups present is roughly in the decreasing order arsenates, arsenates-sulphates and phosphates.

Most of the supergene minerals are found in cavities associated with strongly oxidized gossan in vein quartz, or as small crystalline crusts on the slates. Today most specimens occur as euhedral to subhedral micro-crystals.

Interpretation

Other than the description by Dines (1956), little is known of the mineralization and structure of the underground workings, and any paragenetic sequence has to be derived from past-collected samples in museum or private collections and the evidence of species in the dumps.

The origin of the primary mineralization of the Penberthy Croft area is directly associated with the main-stage hydrothermal mineralization of South-west England, of a late Carboniferous to Permian age and formed under similar conditions to the granite-driven models of convective mineralizing fluids (Simpson *et al.,* 1979). In such models mineralization is phased both in space and time. Early tin mineralization may be associated with the pink propylitic alteration of feldspars in the granites; however at Penberthy Croft the main-stage high-temperature vein mineralization seems to be the most important. At upper levels a chalcopyrite-dominated assemblage is found with arsenopyrite and associated sphalerite, while at depth arsenopyrite dominates, with cassiterite and minor scheelite and stannite present. It could be that rich tin mineralization occurs at some depth below Penberthy Croft.

In addition, minor, burial-related quartz-albite-anatase-monazite veins of a pre-tectonic, metamorphic origin can be found. This phase of mineralization is very minor, but has also been found at other Cornish mines (Betterton, pers. comm.).

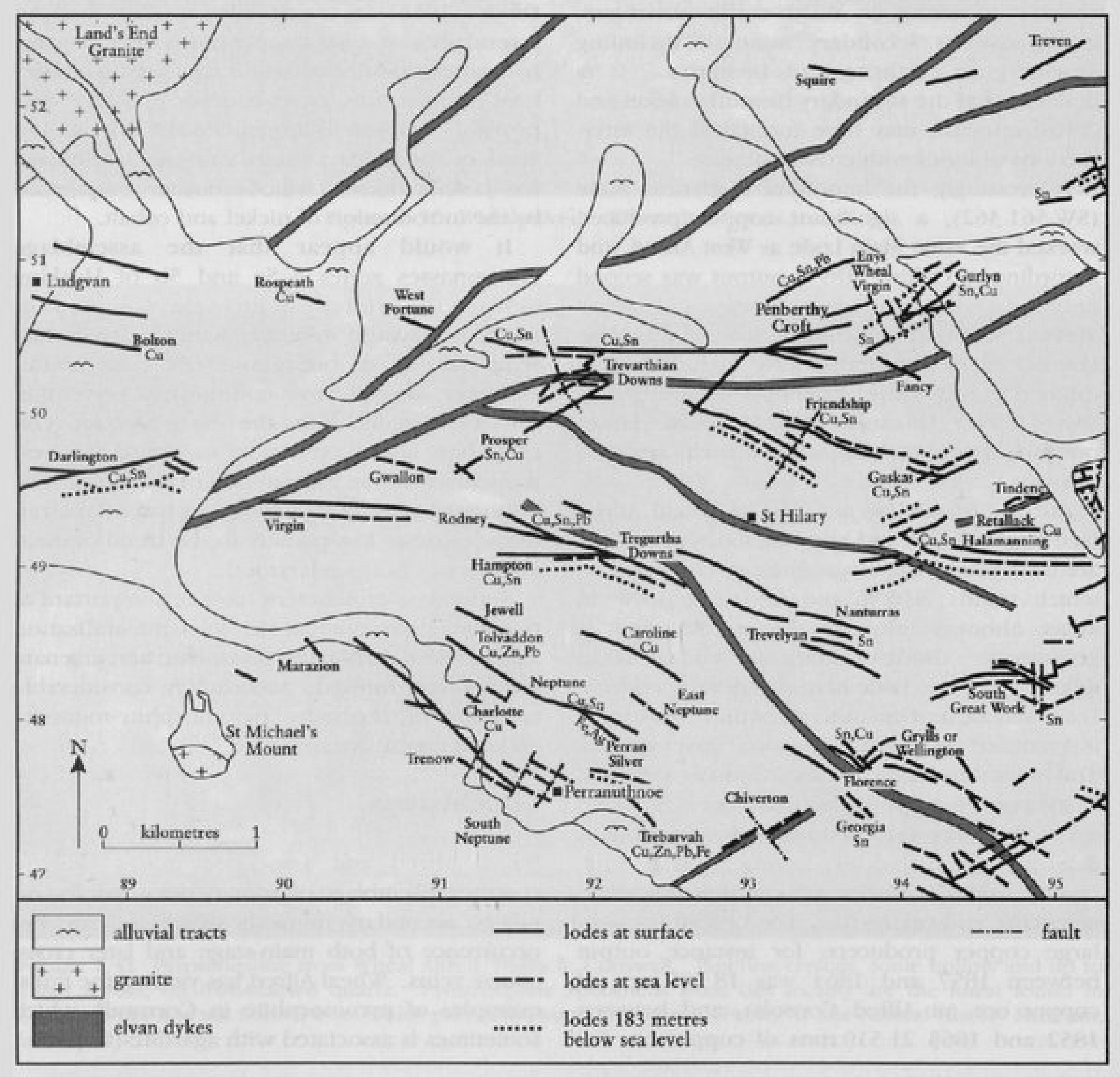
A later stage of mineralization associated with lead-bearing hydrothermal fluids is found in the cross-course lodes. This led to an assemblage of galena, sphalerite, pyrite and minor chalcopyrite. Some nickel, bismuth and cobalt minerals have been found at Penberthy Croft, indicating a possible later phase of nickel mineralization associated with the cross-course assemblage. A phase of low-temperature mineralization (siderite) led to an assemblage of iron mineralization.

The diversity of the supergene minerals arises from the range of primary sulphides present and the prolonged and complex history of weathering and erosion under a variety of climates. Modification of the water-table over time has also played an important part in this process. The presence of 'boxwork' supergene specimens, with goethite, emphasizes the episodic nature of supergene and oxidation processes.

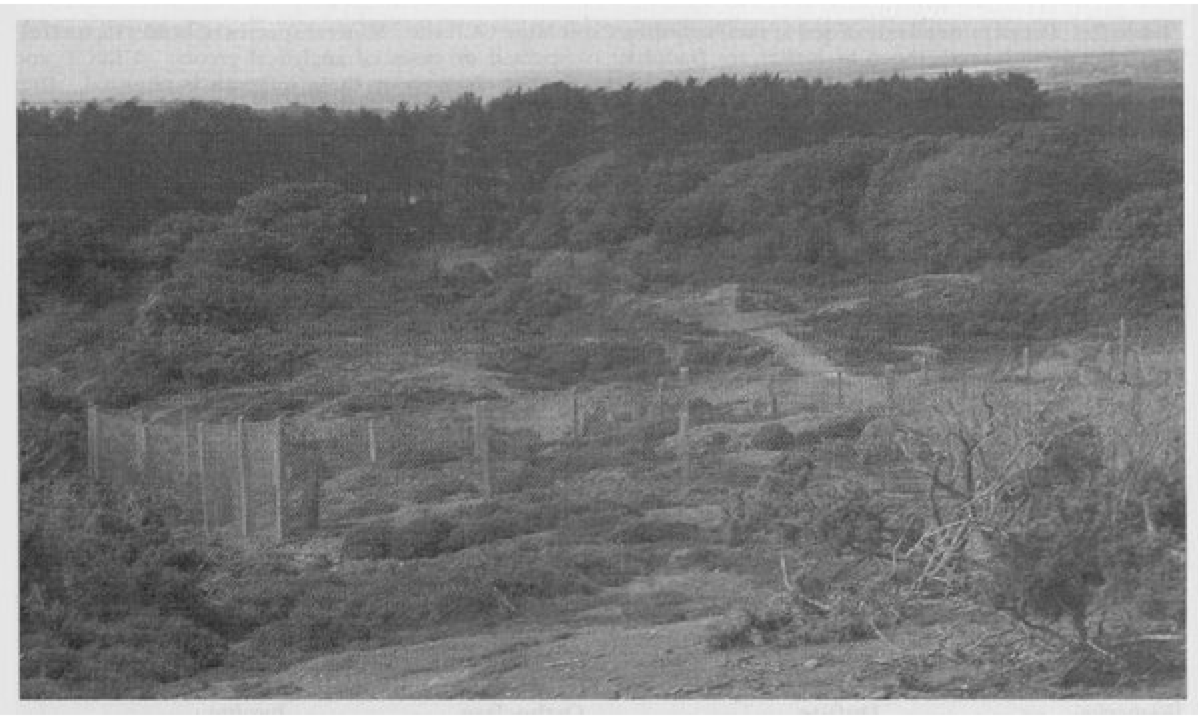
Conclusions

The Penberthy Croft mining area worked a number of metalliferous epigenetic veins hosted by 'killas' of Upper Devonian age. The mine is an important mineralogical site for the variety of primary, secondary and tertiary mineral species that occur on the dumps. Especially noteworthy are the secondary copper and lead minerals, present as arsenates, sulphates and phosphates.

References



(Figure 7.52) The Mount's Bay District, showing the location of Penberthy Croft Mine. After Dines (1956.)



(Figure 7.53) View across the main area of spoil heaps, Penberthy Croft Mine. The fenced area is Daws Shaft, the type locality for bayldonite. (Photo: H. Townley, Natural England.)

Adamite	**Cassiterite**	**Jarosite**	**Pseudomalachite**
Agardite-(Ce)	*Ceruleite*	**Jeanbandyite**	**Pyrite**
Agardite-(La)	**Cerussite**	*Jordanite*	**Pyromorphite**
Alloclasite	**Chalcoalumite**	**Langite**	**Quartz**
Anatase	*Chalcocite*	**Laurionite**	**Redgillite (UK PC1)**
Anglesite	**Chalcophyllite**	**Leadhillite**	*Rosasite*
Ankerite	**Chalcopyrite**	**Libethenite**	**Scheelite**
Annabergite	*Chlorargyrite*	**Linarite**	**Schulenbergite**
Apatite-(CaF)	**Chrysocolla**	**Liskeardite**	**Scorodite**
Aragonite	**Clinochlore**	**Malachite**	**Segnitite**
Arseniosiderite	**Connellite**	**Mansfieldite**	*Serpierite*
Arsenolite	**Copper (native)**	**Mattheddleite**	**Siderite**
Arsenopyrite	**Corkite**	**Millerite**	**Silver (native)**
Atacamite	**Cornubite**	**Mimetite**	**Smithsonite**
Aurichalcite	**Cornwallite**	**Mixite**	**Sphalerite**
Azurite	**Covellite**	**Monazite-(La)**	**Stannite**
Bayldonite	**Cuprite**	*Mottramite*	**Stilpnomelane**
Beaverite	**Cyanotrichite**	**Muscovite**	**Stolzite**
Beraunite	**Devilline**	**Natanite**	**Sulphur (native)**
Beudantite	**Dolomite**	**Olivenite**	**Tenorite**
Bieberite	**Duftite**	**Orthoclase**	*Tyrolite*
Birnessite	**Erythrite**	*Paratacamite*	**UK PC2**
Bismuthinite	**Galena**	**Parnauite**	**UK PC3**
Bismutite	**Goethite**	**Pharmacosiderite**	**Varlamoffite**
Bornite	**Gypsum**	**Philipsburgite**	**Woodwardite**
Brochantite	**Halite**	**Phosgenite**	**Wroewolfeite**
Calcite	**Halloysite**	*Pitticite*	**Zincolivenite**
Caledonite	**Hidalgoite**	**Plumbogummite**	
Carminite	*Hornblende*	*Plumbojarosite*	

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