

## Introduction

Quarrying at the Penlee Quarry GCR site (see (Figure 7.60)), at Newlyn, commenced some 100 years ago, when it was formerly known as the 'Gwavas Quarry'. The crushed roadstone production was given as 120 000 tons in 1982, and at its peak the quarry is reported to have produced over 300 000 tons of roadstone annually. Work ceased in 1991 and although some areas of the quarry have recently seen restructuring of the levels, and therefore fresh exposures, there appear to be no plans for further development as a working quarry. The altered dolerite rock ('greenstone') from Penlee was noted for its high crushing strength, but a low polished stone value (PSV) precluded its use for most road surfaces in the UK.

The quarry provides a variety of mineralization types for study. A north–south vein is of considerable interest to mineralogists as it contains an unusual assemblage of minerals not common elsewhere in Cornwall. This assemblage consists of chalcopyrite, arsenopyrite, löllingite, molybdenite, pyrite, pyrrhotite, quartz and chalcedony. Both molybdenite and löllingite are rare in Southwest England.

Dependent on the state of the exposed faces at any time examples of early pegmatitic mineralization and pyrometasomatic mineralization in greenstones (the Gwavas 'metabasite' sill) can be studied. Further, an amethystine-chalcedonic vein has also been revealed in the northern faces of the quarry.

There is only a limited literature on the petrology and mineralization of Penlee Quarry. The geology of the country around the Penzance area was described by Goode and Taylor (1988) (see (Figure 7.61)). No details of mineralization were discussed by either Dines (1956), or Hosking (1964).

Quarried roadstone from Penlee was originally transported directly from the quarry by ship. The quarry is large, being in both a north–south and east–west direction close to 800 m. Some faces are old and unstable, and the nature of lode mineralization is often best studied from large loose blocks within the quarry.

## Description

Penlee Quarry exposes country rock ('killas') and greenstone located very close to the contact of the Land's End Granite. The Devonian Mylor Slate Formation metasedimentary rocks were intruded by a large dolerite intrusion, the 'Gwavas sill' during Devonian times. It was this greenstone intrusion that was the main component of the quarried stone. The intrusion of the nearby Land's End Granite (290–300 Ma) led to metamorphism of the greenstones, characterized by the formation of copious green acicular actinolite, which tends to overprint the original ophitic texture. Newly created quarry bench exposures to the south of the quarry, along with associated features in some of the old faces, display brecciated infill structures to the veins. These consist of comb-layered, sometimes vuggy, quartz, clasts of brecciated host-rocks, and chalcedonic cemented breccia. Some of the breccia textures are similar to those seen at the Nanjizal Cove GCR site, albeit on a smaller scale, and also those described from Wheal Remfry (Allman-Ward *et al.*, 1982). Such cockaded structures have been studied by C. Halls (pers. comm.), and are thought to illustrate the forceful fluid flow along the lode.

Pieces of the country rocks have been broken from the fissure walls and carried forcefully by the fluids. It would seem that fissure-filling was characterized by repeated opening and further deposition. Both within the lode structures and other disseminations, the distribution of mineralization tends to be patchy, but it can also be locally intense. It is dominantly of pyrometasomatic type, and largely restricted to the mafic lithologies. The common assemblage is of pyrite, chalcopyrite, marcasite, arsenopyrite and löllingite all associated with actinolite. A Sn-Cu lode is recorded as crossing the quarry, trending east-west, but is now poorly exposed or obscured completely, although when revealed, this roughly E–W-trending quartz lode carries some interesting mineralization.

The presence of molybdenite in the quarry is of considerable significance. It occurs as coarse crystals in hornfels adjacent to granite pegmatites and veins. It is usually most easily studied and collected in the south-west part of the

quarry.

In the north and south faces of the south-west part of the quarry, a prominent north–south lode is exposed, dipping 65° to the west. This structure is often highly ferruginous and brecciated, while some blocks or fresh quarry-face exposures show unaltered sulphides.

## Interpretation

Consolidation and subsequent volume contraction of the Land's End Granite (part of the Cornubian Batholith) caused opening of incipient planes of weakness in the killas host-rocks and greenstone units as well as joints in the granite. Circulation of various types of hydrothermal fluids led to the deposition of the identified mineralization assemblage.

The major cross-course structure in Penlee Quarry has the same overall trend as a similar structure at the Nanjizal Cove GCR site, and is typical of those seen in the Land's End area, and other areas of Cornwall.

Goode and Taylor (1980) described intrusive and pneumatolytic breccias in South-west England, and mention has been made of Wheal Remfrey by Allman-Ward *et al.* (1982). Halls (1987) described a mechanistic approach to lode infill. The nature of the metasedimentary rocks (killas) has been described in Goode and Taylor (1988), while Floyd (1983) described the composition and petrogenesis of pre-orogenic basaltic rocks in the region.

Of the mineral assemblage listed, it is molybdenite that may be the most significant, being a relatively rare mineral in South-west England. Hosking (1964) recorded molybdenite occurrences in early greisen-bordered, sheeted-vein complexes, and it has been further recorded associated with granite and granite pegmatites at several localities, including the Hingston Down Quarry and Hingston Down Consols GCR site. Bromley and Holl (1986) reported interstitial löllingite-arsenopyrite-molybdenite as being present in aplites and comb-layered pegmatites in the Li-mica granites of Tregonning and St Austell.

Further studies need to be made to interpret the paragenesis present in Penlee Quarry. It may be that in the Penlee Quarry there is a combination of a pegmatite paragenesis with that of a normal pyrometasomatic sulphide assemblage, produced by the metamorphism of sulphides in killas and greenstones. Alternatively, metasomatic replacement of the host lithologies by copper mineralization might explain the associated coarse molybdenite aggregates and the patchy distribution of high-temperature sulphides in the greenstone. However the presence of marcasite, abundant pyrrhotite and some iron silicates and carbonates would seem to favour the pyrometasomatic model.

## Conclusions

Penlee Quarry has been worked in a mixed sequence of metasedimentary and meta-igneous rocks close to the contact with the Land's End Granite. The exposures demonstrate a variety of mineralization types, namely;

1. early pegmatitic mineralization;
2. pyrometasomatic mineralization in greenstones;
3. a tin-copper lode;
4. essentially east-west quartz lodes; and 4. a late mineralized cross-course.

Penlee Quarry still exposes features relevant to the understanding of mineralizing processes within a variety of host rocks, especially related to the geochemical variation between the killas and greenstone intrusion. The quarry provides opportunities to study the effects of host-rock chemistry on mineralization over a wide temperature range so as to provide comparisons with other areas of the metamorphic aureole of the Land's End Granite.

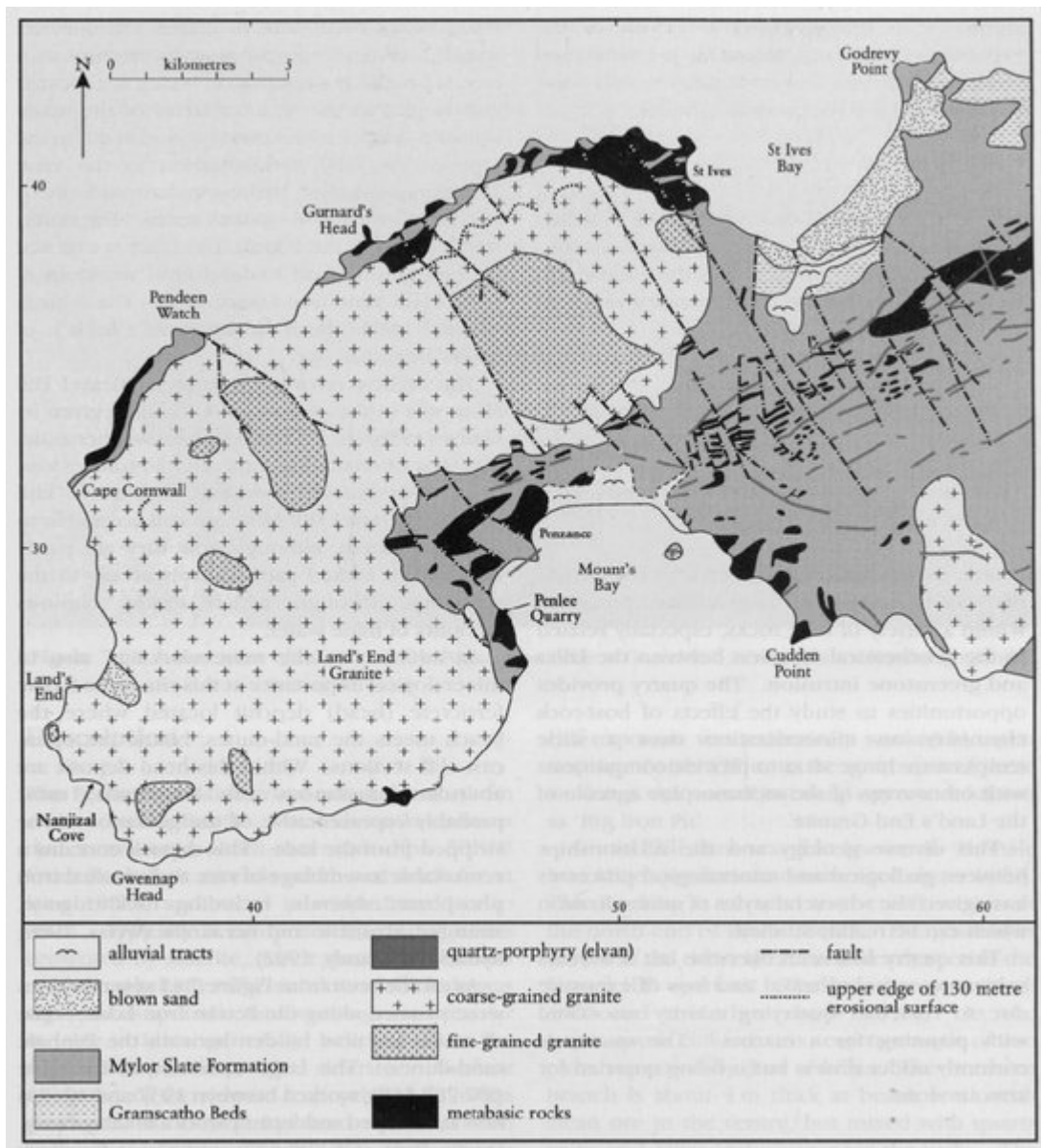
This diverse geology and the relationships between geological and mineralogical processes have given rise to several styles of mineralization which can be readily studied.

This quarry has been over the last few years subject to some upheaval and loss of exposure due to remedial quarrying activity associated with planning for a marina. The quarry is currently under review but is being quarried for armour stone.

### References



*(Figure 7.60) Penlee Quarry. (Photo: A. Tyson.)*



(Figure 7.61) The geology of the Penzance area, showing the extent of the Land's End Granite, and the locations of the Penlee Quarry and Nanjizal Cove GCR sites. After Goode and Taylor (1988).