Wheal Alfred, Cornwall

[SW 580 370]

Introduction

The area to the east of Hayle and the St Erth river contained a number of significant copper mines. Collins (1897) stated that in 1800 Alfred Consols was second only to Dolcoath as a copper producer. The Wheal Alfred GCR site is situated about 1.6 km due east of Hayle and consists of a sett of east-west lodes. Several mines were worked in this specific area, namely Alfred, Alfred Consols, North Alfred, South Alfred, West Alfred Consols, Mellanear and West Alfred (see (Figure 7.49)). Although a major copper producer, the mine is known internationally for the complex Sn-Cu-Zn-Pb mineralization associated with an important suite of secondary minerals, including pyromorphite-mimetite and agardite.

At Wheal Alfred several dumps of considerable size are present (see (Figure 7.50)), but it is the large dumps north of Lower Treglissan Farm that have yielded the most important specimens of pyromorphite-mimetite and associated agardite. The dumps still yield a range of ore and secondary minerals, although of small and poor quality compared to earlier times. However, the minerals found, often associated with the sugary quartz veinstone, are pertinent to the origin of the deposit.

Believed to be on the site of a much older tin mine, Wheal Alfred was prosperous as a copper mine in the early part of the 19th century. A description and sketch plan by Phillips (1814) show that several veins intersected and mineralization is therefore complex. Output records show that lead and tin were also produced. The mine was operated again from 1851 to 1862 as Great Wheal Alfred, but was unsuccessful in producing major ore.

The port of Hayle grew considerably at the start of the 19th century partly due to the servicing of ores from the Wheal Alfred area. Although the fortunes of Wheal Alfred plummeted, Hayle continued as a most important centre of the Cornish engineering industry. The Harvey foundry was famous for the exporting of pumping engines worldwide. The last of the Cornish copper smelters, at Copperhouse, Phillack, ceased work in 1819, shortly after the (first) closure of Wheal Alfred.

Many of the mines had commenced before the 19th century, most had ceased operation soon after the 1850s, and all finished before the 20th century. Dines (1956) described in detail the various mines of the sett, their general geology and recorded outputs. Surprisingly there is only a limited research literature. Specimens from Wheal Alfred were described and illustrated in Embrey and Symes (1987), and some mining details are described by Hamilton Jenkin (1959).

Description

The country rocks of the Wheal Alfred sett are mainly 'killas' with some altered basic igneous rocks ('greenstones') east of St Erth. Old mine plans show that several quartz-feldspar porphyry ('elvan') dykes also occur in the area, trending ENE–WSW. Dines (1956) gave a full detailed description of the structures of the mines in the Wheal Alfred sett. At Wheal Alfred the main east-west lode (Main Lode) has been worked over a distance of nearly 1 km and to a depth of over 450 m. It is crossed by four other lodes, Middle Lode (trending about N40°E), South Lode (which courses E35°N), and North Lode (where it courses E10° to 40°N), Branch and Weekses Lode (which courses E20°N), and finally the western extension of Alfred Consols Lode. Main Lode was worked from Copper House or Taylors Engine Shaft.

Main Lode is crossed at Cherry Garden Shaft by a 18 m-wide elvan that trends E 40°N and dips 45°NW. Main Lode is intersected by a fluccan (clay-filled fault), coursing N5°W and by a cross-course trending N15°W. The fluccan does not appear to throw the lode, but the cross-course heaves it about 5 fathoms. The interesting variety of differing mineral structures within the mines of the Wheal Alfred sett gives rise to the complex record of primary ore minerals and derived secondary minerals. Minerals present were various copper ores, arsenopyrite, siderite, cerussite, smithsonite, argentite, cerargyrite and pyromorphite-mimetite.

Between 1801 and 1864, more than 170 000 tons of copper ore averaging about 7% were produced, but the mine was in operation before this time, and Collins (1897) stated that in 1800 it was the second largest copper producer in Cornwall. Considerable quantities of galena and cerussite ($PbCO_3$) were raised before 1814, and 245 tons of sphalerite were also mined.

Wheal Alfred has long been known as the locality for exceptional specimens of pyromorphite (see (Figure 7.51)). These are seldom of the usual bright-green colour and are often almost colourless or earthy, perhaps indicating that calcium is present. The finest specimens are often found as tapering, yellowish-green crystals, sometimes hollow and' up to 5 mm across, and which occasionally form barrel-shaped crystals. They are normally found on iron-stained sugary quartz. Pyromorphites from this locality are the finest found in Cornwall but it is still not known from which part of the mine they were derived. The best locality for pyromorphite at surface is the large dump north of Lower Treglisson Farm marked by a telegraph pole. Extensive vein quartz still occurs in this dump.

Small pale-green sprays of the rare REE arsenate mineral agardite are sometimes found with the pyromorphite-mimetite. EDX analysis of various specimens of agardite collected from Wheal Alfred shows cerium to be the dominant rare-earth-element (REE) present, but lanthanum, neodynium and calcium were all also shown to be present. In terms of Levinson's rule for nomenclature of REE minerals these should be seen as the cerium variety of agardite, according to Nickel and Mandarino (1988), namely agardite-(Ce).

Dines (1956) recorded that the lodes in Alfred Consols Mine (the eastern extension of Wheal Alfred) contained considerable amounts of lead mineralization, and therefore the mixed mineral assemblage may be very similar to that at the Penberthy Croft Mine GCR site and Wheal Gorland. The eastern part of the mine contains cobalt and nickel in north–south structures, giving rise to secondary minerals including annabergite, erythrite and bieberite. It is believed that the secondary bismuth, nickel and cobalt minerals may have formed at the intersections of lodes with cross-courses.

Interestingly, the important Mellanear Mine [SW 561 362], a significant copper producer, worked the same Main Lode as West Alfred, and according to Collins (1897) output was second only to Devon Great Consols between 1879 and 1888. The mineral assemblage at Mellanear Mine (Dines, 1956) appears to have included some cassiterite, sphalerite, arsenopyrite and pyrite. West Alfred Consols records show lesser outputs of copper, zinc ore and small amounts of silver.

Alfred Consols lay just east of Wheal Alfred (see (Figure 7.50)), and here the lodes of the sett are traversed by the 'Great Fluccan' cross-course, which trends N30°W and underlies 10°W in killas, although most of the country rock is greenstone. Both of these are cut by elvan dykes. The Main Lode here was developed from Daveys Shaft, and the outcrop of the cross-course is recorded as passing through Daveys Shaft. The lodes developed in Alfred Consols were said to average 76 cm wide, but have been recorded up to 7 m. The recorded mineral assemblage is chalcopyrite, chalcocite, bornite, tetrahedrite, cuprite, galena, cerussite, pyromorphite-mimetite, sphalerite and cerargyrite. The two mines were large copper producers; for instance output between 1857 and 1864 was 18 500 tons of copper ore (at Alfred Consols), and between 1852 and 1863 21 510 tons of copper ore for Wheal Alfred. About 1.6 km farther east (and east of the Great Fluccan) Wheal Herland again worked part of the Main Lode. This mine is famous mineralogically for a remarkably rich pocket of native silver found at a cross-course intersection.

Interpretation

The area of mineralization worked at Wheal Alfred and associated mines appears to be a mixture of main-stage mineralization and a later cross-course assemblage. Very little is available in the literature for a full interpretation of the mineralogy at this important mining sett. From old records and the detailed description of Dines (1956) it would appear that primary, essentially east-west copper lodes of main-stage hydrothermal mineralization are crossed by later lead-zinc-bearing cross-courses. Silver was probably carried as argentiferous galena. In areas of the lodes a mixed mineral assemblage has therefore formed which is further complicated by the introduction of nickel and cobalt.

It would appear that the assemblage encompasses zones 4–5a and 5b of Hosking (1964). The presence of tin in the western parts of the sett would indicate higher hydrothermal temperatures of between 300°C and 500°C. However,

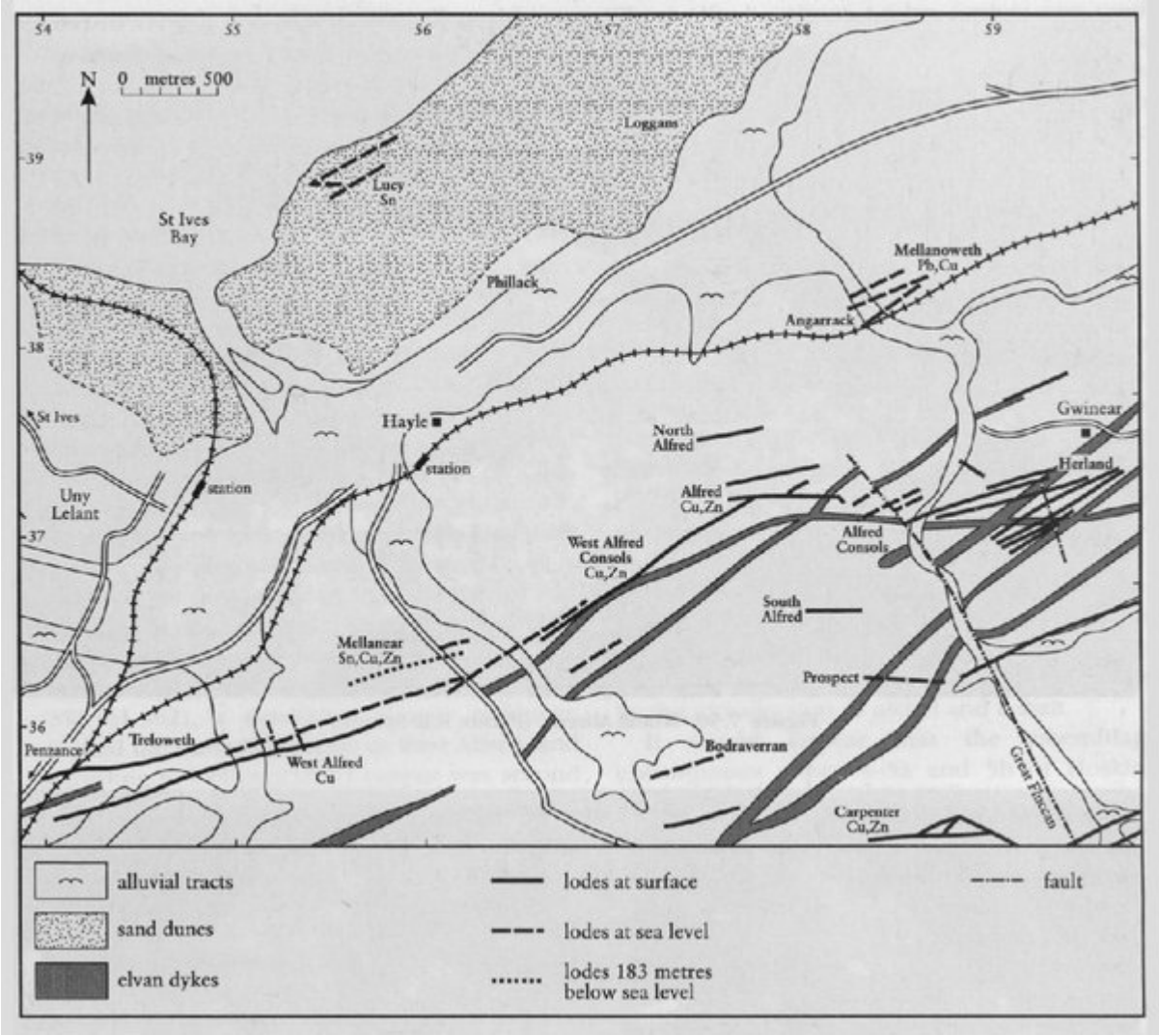
several cross-courses are present in the workings, including the 'Great Fluccan', and these have added even more variety to the ores, particularly in the eastern part of the mine. The importance to the mineralizing process of elvan dykes more-or-less parallel to the trend of main veins is not fully understood.

Supergene enrichment has been important at this site, especially on the lead mineralization areas, where carbonate, phosphate and arsenate species have formed. Accordingly, considerable amounts of cerussite, pyromorphite-mimetite and cerargyrite are recorded.

Conclusions

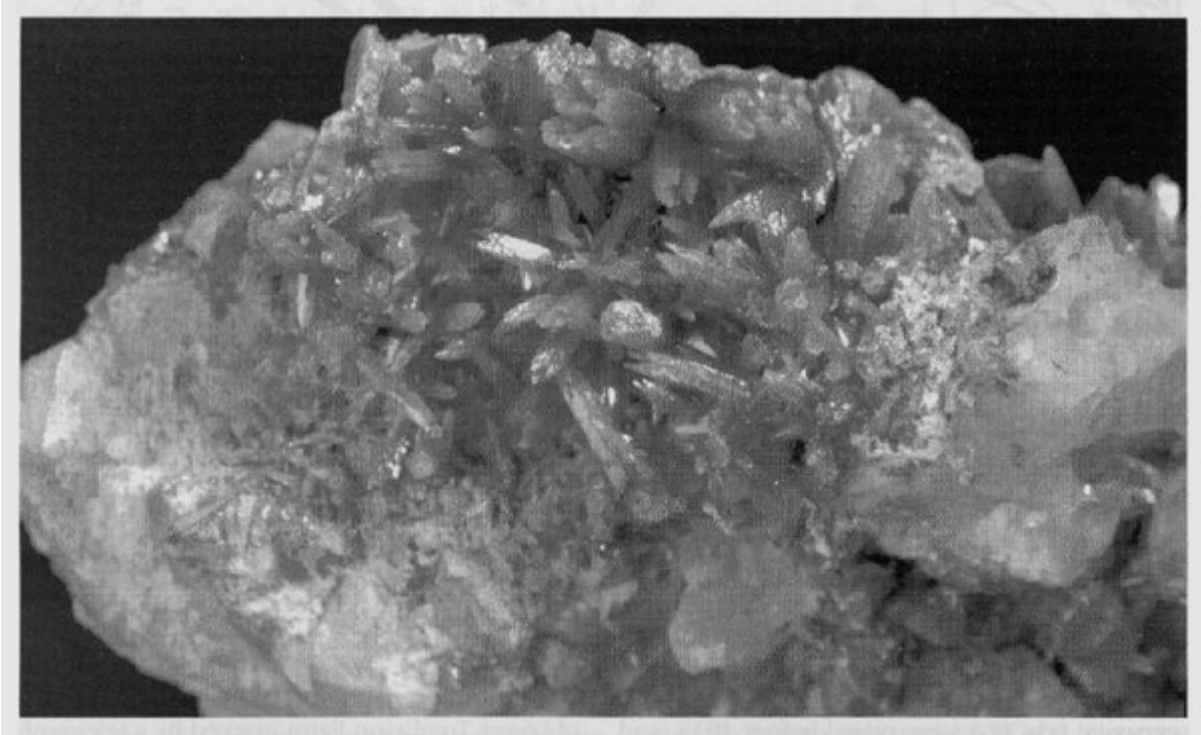
Wheal Alfred and associated mines show a complex assemblage of primary ore minerals and related secondary minerals which indicate the occurrence of both main-stage and later cross-course veins. Wheal Alfred has yielded the finest examples of pyromorphite in Cornwall, which sometimes is associated with agardite-(Ce).

References



(Figure 7.49) Sketch map of the Wheal Alfred setts. After Dines (1956).

(Figure 7.50) Wheal Alfred. (Photo: R.F. Symes.)



(Figure 7.51) Pyromorphite from Wheal Alfred, Phillack, Cornwall. Tapering crystals, some hollow and up to 4 mm across, on iron-stained quartz. Pyromorphite specimens from this locality are the finest found in Cornwall, but it is not known from which part of the mine they came. (Photo: © The Natural History Museum, London.)