Red-a-Ven Mine, Meldon, Devon

[SX 570 917]

Introduction

The Red-a-Ven Mine GCR site exposes tin-bearing skarns in the stream section of the Red-a-Ven Brook. The site is important for the availability of specimens from the dumps associated with an old copper trial and mine in the Meldon Chert Formation of Carboniferous age. This sulphide-rich chert bed is some 0.75 m wide and contains pyrrhotite, arsenopyrite and chalcopyrite. The sulphides occur in masses associated with rocks containing garnet, actinolite and axinite, interbedded with siliceous shales and cherts. These are intimately associated with bands of wollastonite hornfels (skarns) containing tin-bearing garnets and the rare tin silicate mineral malayaite. Malayaite is a very rare mineral worldwide, whilst tin-bearing garnets are very unusual. The assemblage represents an overprinting skarn formation. The association of the ore mineralogy, the suite of borosilicate minerals, the skarn assemblage and tin mineralization are of significant petrological and mineralogical interest.

Red-a-Ven Mine is reached by walking up the Red-a-Ven Brook from the path cutting through the Meldon Aplite Quarries. Mineralized horizons can be seen in the banks of the brook at a point where a minor tributary meets the Red-a-Ven Brook, where a shaft was sunk. Most of the mine workings and in-situ rock sections are grown over, but a representative selection of the mineral assemblage, can be collected from several dumps associated with the site. Host lithologies are Lower Carboniferous calcareous metasedimentary rocks and cherts within the metamorphic aureole of the Dartmoor Granite.

Red-a-Ven Mine was also known as Weldon Mine' and is described as such by Dines (1956), along with other mines in the metamorphosed Lower Carboniferous succession of the area (Figure 7.14). De la Beche (1839) referred to the deposits as 'tin lodes', but the minerals present are mainly sulphides of copper, iron and arsenic. At Red-a-Ven there are no true lodes, mineralization occurring as impregnations in metamorphosed calcareous beds in the Carboniferous succession. The old dumps consist mainly of chert and limestone with alteration along cracks and joints to actinolite and some garnet. The mineralization 'bed' at Meldon is about 76 cm wide, consisting of reddish chert and limestone, highly impregnatedwith pyrite and arsenopyrite, while axinite is also present.

The mineralization at Red-a-Ven Mine is further described by Durrance and Laming (1997). Dines (1956) also described other mines in the same geological context and provided outputs for the nearby Belstone Consols [SX 632 945] and Ramsley [SX 651 930] mines. No outputs are given for Red-a-Ven Mine, and it is possible that the deposits were too irregular and sporadic to be of economic value. A series of papers important to the understanding of the geology and mineralization of the Meldon and Red-a-Ven area are those of Dearman (1959, 1966), Dearman and Butcher (1959), Dearman and El Sharkawi (1965), and El Sharkawi and Dearman (1966).

Description

In the contact zone of the north-west part of the Dartmoor Granite occur mineral deposits which were formerly worked for a variety of metals, including copper and arsenic. As can be seen from (Figure 7.14), a series of mines were established on these deposits.

Wheal Fanny Mine (see Dines, 1956), where chalcopyrite and arsenopyrite were reported from shales and cherts, occurs in the western part of the mineralized belt. Forest Mine (see Dines, 1956) was quoted by De la Beche (1839) as a tin working, although the dumps have revealed only arsenopyrite and sphalerite. It is possible that the tin mineral present here was malayaite. Forest Mine now lies beneath the waters of Meldon Resevoir. Ramsley Mine and Belstone Consols Mine occur at the eastern extremity of the belt (see (Figure 7.14)), and occur on either side of the Sticklepath–Lustleigh Fault, the ore horizons at Ramsley being displaced some 2 km south-east relative to Belstone. These two mines were the largest producers of the belt. At Belstone a garnet-rich rock contains actinolite, axinite and sulphides; chalcopyrite, arsenopyrite, löllingite and pyrrhotite are the main sulphide ore minerals. At Ramsley Mine, specimens of the assemblage are still available on the extensive dumps. Within the axinite-actinolite-bearing rocks chalcopyrite and pyrrhotite are the main sulphide minerals, while löllingite and Co-Ni arsenides have also been recorded. The mine is famous for abundant scheelite specimens, which often occur as quartz pseudomorphs after bipyramidal scheelite crystals (see Embrey and Symes, 1987).

The mineralized horizons are confined to the Lower Carboniferous outcrop and lie within or just below the Meldon Chert Formation. Host rocks are shales and cherts with some volcanic horizons. All carry disseminated pyrite, pyrrhotite and arsenopyrite, but mineralization also occurs as garnet-rich calc-silicate skarns. The Lower Carboniferous rocks are disposed in a tight, southerly-overturned anticline, with the Red-a-Ven and Forest mines occurring in the steeper-dipping overturned limb. The structure of the area has been discussed by Dearman and Butcher (1959), Edmonds *et al.* (1975), and Issac *et al.* (1982).

Geochemical prospecting, based on a programme of soil analysis, revealed a strong arsenic-copper-tin anomaly, lenticular in shape and elongated along the strike of the calcareous beds, on both sides of the valley of the Red-a-Ven Brook (Dearman, 1966). Cassiterite has not been found at the mine but instead a tin-bearing analogue of titanite, the mineral malayaite ($CaSnSiO_5$), is present in the wollastonite hornfels. Investigations of tin contents in other associated minerals present in the calc-silicate rocks show that both grossular and andraditc also carry significant tin values (El Sharkawi and Dearman, 1966).

The rare mineral malayaite was first collected from the Red-a-Ven Mine in 1948 by G.F. Claringbull, on a visit to the Meldon area by the International Geological Congress. The mineral was shown by Claringbull (pers. comm.) to be isostructural but not identical to titanite.

Further studies by Claringbull (unpublished) showed it to be malayaite with about 0.2 wt% TiO_2 and 0.7 wt% FeO. Malayaite is generally cream or yellowish-brown in hand specimen, and although it is often hard to identify a useful determinative property for identification is its white fluorescence in ultraviolet light.

Interpretation

An area of important mineralogical interest occurs in the Meldon area, on the north-west margin of the Dartmoor Granite, where a strip of folded Lower Carboniferous chert, shale and subordinate limestone country rocks border the granite contact. Contact metamorphism andmetasomatism have produced a calc-silicate mineral assemblage with garnet, vesuvianite, wollastonite and diopside. Some of the Mn-rich horizons contain a complex assemblage of Mn silicates including bustamite, spessartine, rhodonite and tephroite (Howie, 1965). A further phase of metasomatism led to the formation of Fe- and B-rich skarns, with an assemblage of hedenbergite, Fe-wollastonite, andradite, axinite and datolite, these phases tending to replace earlier-formed minerals. Finally, ore minerals were introduced after the silicates, leading to crystallization of sphalerite, pyrite, chalcopyrite, arsenopyrite, molybdenite and löllingite. Scheelite has been recorded from the area, especially at Ramsley Mine, as well as a little fluorite. Tin anomalies have been recorded (up to 3000 ppm) during soil surveys over some of the Red-a-Ven area. The tin appears to be localized in silicate minerals, such as malayaite, andradite and grossular.

The bedded mineral deposits at Meldon are at the same stratigraphical horizon as the magnetite deposits in the Haytor Iron Mine GCR site, near Ilsington on the south-east margin of the Dartmoor Granite. It is generally thought that this latter deposit was linked to emanations from the granite, although it could be that the deposit was formed from remobilization of bedded iron ores within the Lower Carboniferous country rocks. However the close parallel between hydrothermal activity resulting in recrystallization of cassiterite, hematite and tourmaline deposits in the granite and the metasomatic activity involving tin, iron, and boron in the calcareous sediments appears to show that some epigenetic agencies have been involved. Alderson (1993) showed that stable isotope analyses for the fluids responsible for the massive skarns of South-west England are indicative of an origin from magmatic waters.

In the mining region of South-west England, tin generally occurs as cassiterite in a gangue of tourmaline, chlorite and quartz in granite or 'Icillas' (normally slaty country rocks). On Dartmoor the paragenesis is cassiterite, tourmaline, specular hematite, quartz and a little pyrite. This ore assemblage is well typified by the mineralization at the Birch Tor and Vitifer Mine [SX 687 808] on Dartmoor.

Following the early phase of calcium metasomatism in the calc-flintas it is clear that tin was introduced, locally, with the calcium, aluminum and iron that caused the formation of grossular in the external reaction zones. The same applies to the andradite skarns and to the presence of malayaite in the wollastonite hornfels. Tin is concentrated in garnet or in malayaite. The presence of stanniferous garnet in the non-reactive datolite veins cutting through the deposit of the Red-a Ven Mine shows that tin was still available during the final phase of metasomatism.

The unusual tin occurrence at Red-a-Ven Mine may be indicative of an emanative centre and therefore suggests that part of the mineralization is granite-derived. This could be seen to be true for higher-temperature tin and perhaps tungsten phases; however there is a question over the origin of the sulphide mineralization. It is possible that some of the pyrrhotite was formed by the remobilization of original sedimentary pyrite (Beer and Fenning, 1976). The proximity of volcanic rocks in a condensed Lower Carboniferous shale sequence suggests perhaps that some of the copper, zinc and arsenic contents may have been derived from sedimentary rocks by thermal reworking during emplacement of the granite. Granitic volatiles seem to have been important, however, and led to formation of axinite, datolite, bustamite and fluorite in the skarns. Other components of the ore assemblage may have been introduced directly from the granite along with volatiles. Crosscutting veinlets of chalcopyrite indicate post-metasomatic deposition, which could indicate a hydrothermal phase which may be co-eval with normal main-stage lode development.

L. Haynes (pers. comm.) has suggested that the Red-a-Ven Mine mineralogy actually represents two skarn assemblages, which have been superimposed, namely:

1. copper-rich exoskarns which , resulted from the metamorphism of a volcanogenic sulphide mineralization in ferruginous cherts, (i.e. with little input from granites). Economic deposits where calcareous lithologles have been converted to skarns are exemplified by the Ramsley Mine deposit; and
2. a later Sn-W exoskarn has been superimposed on the copper skarn in the Meldon (Red-a-Ven) area. This skarn may be related to late Li-mica granite intrusions associated with the main megacrystic biotite Dartmoor Granite.

El Sharkawi and Dearman (1966) showed that although the lithologics at the nearby Meldon Aplite Quarries GCR site are similar to those at Red-a-Ven Mine, the garnets contain much less tin. In the Meldon Quarries andradite garnets are reported to carry 0.51 wt% SnO_2, while at Red-a Ven andradite garnet contains up to 1.15 wt% SnO_2. In addition, malayaite-bearing rocks at Red-a-Ven may contain up to 6.82 wt% SnO_2 (El Sharkawi and Dearman, 1966), the mineral not being present elsewhere. The richest tin-bearing lithologies all contain wollastonite, indicating that they are metamorphosed limestones rather than cherts. Tin therefore seems to be focused at Red-a-Ven, and although tungsten also occurs within the Red-a-Ven assemblage its occurrence is more widespread. Such observations led El Sharkawi and Dearman (1966) to propose the existence of an emanative centre at Red-a-Ven, possibly associated with a zonal scheme of mineralization. They also discussed the relationship of iron metasomatism to such a centre.

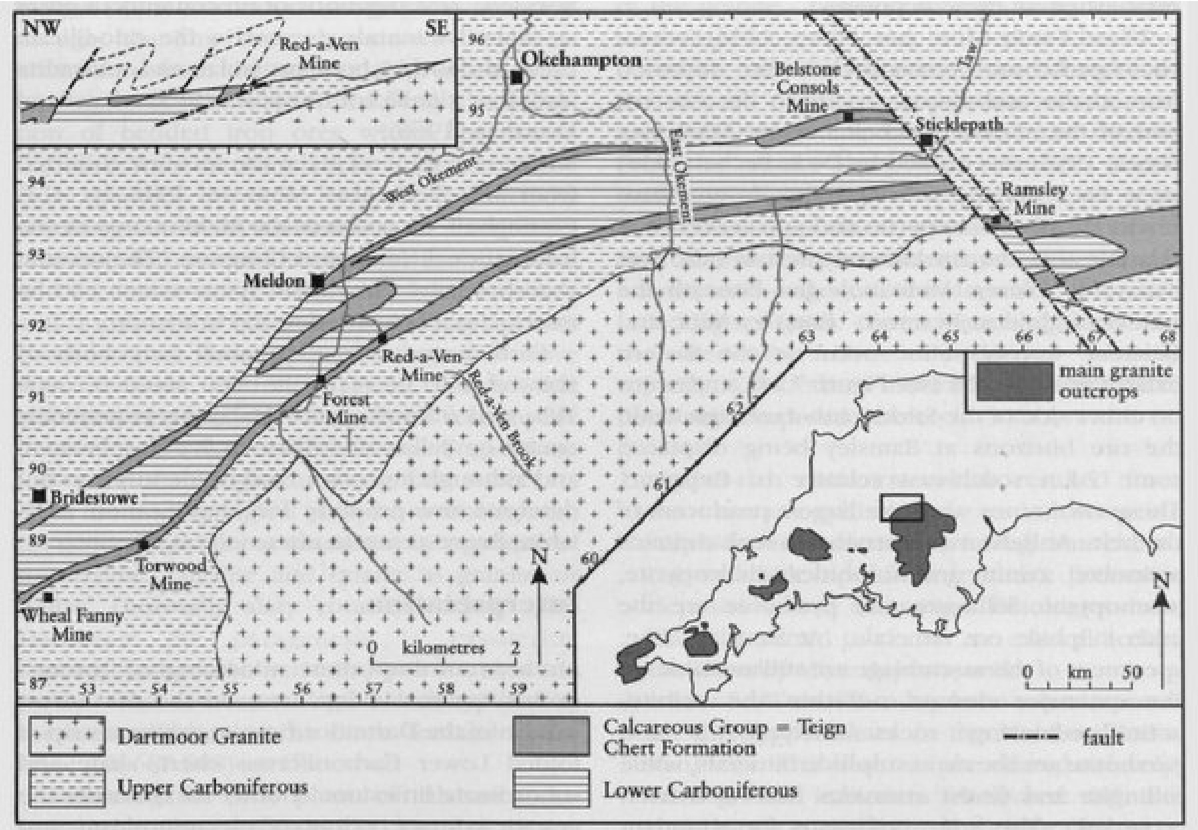
Conclusions

Lower Carboniferous cherts and limestones lie within the contact metamorphic aureole on the north-west margin of the Dartmoor Granite. Tin is concentrated in these rocks up to 6.82 wt% $Sn0_2$, centred on the Red-a-Ven Mine in the altered cherts, andraditic skarns and the rare tin silicate mineral malayaite.

At Red-a-Ven Mine a sulphide-rich chert bed contains abundant pyrrhotite, arsenopyrite and chalcopyrite. It is associated with narrow bands of wollastonite skarns. These contain tin-bearing garnets and malayaite. Other minerals of interest present are scheelite, axinite, datolite, danburite, Iiillingite, molybdenite, diopside, hedcnbcrgite and vesuvianite. However, Ryback *et al.* (2001) have demonstrated that the late A.W.G. Kingsbury falsified the localities of numerous rare mineral species. This deception affects a number of locations in the South-west England, including Red-a-Ven Mine, therefore care should be exercised when considering claims by Kingsbury which have not been substantiated or duplicated by subsequent collectors.

Fluids responsible for the formation of tin-bearing skarns and other tin-rich calcareous hornfelses in the rocks bordering the northwest part of the Dartmoor Granite are considered to be related to the granite itself. As such the site is of considerable petrological and mineralogical interest. Red-a-Ven Mine, with its high tin values, may be the focal point within a broad zone of iron-metasomatism. However, this appears to have been superimposed on an earlier sulphide skarn assemblage. The ore assemblage, borosilicate assemblage and tin-bearing silicates make this site of considerable international mineralogical importance.

References



(Figure 7.14) Geological map of part of the northern margin of Dartmoor, showing the location of the Red-a-Ven Mine GCR site. After El Sharkawi and Dearman (1966).