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4. Mineragraphy of the Rex Hill cassiterite-sulphide ores

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INTRODUCTION

This report provides additional information on the composition and sequence of deposition in the Rex Hill ores, and is intended as an appendix to the report by Urquhart (1967). A total of six polished sections were examined in the latter report: the examination of many more sections has resulted in the identification of additional sulphide minerals, and has shown that the position of pyrite in the depositional sequence envisaged by Urquhart (1967) is incorrect.

The primary minerals present in approximate order of abundance are: quartz, sphalerite, galena, pyrite, chalcopyrite, cassiterite, arsenopyrite, fluorite, wolframite, marcasite, pyrrhotite, canfieldite, tetrahedrite, boulangerite, cubanite, hematite and native bismuth (?). Some secondary covellite and chalcocite also occur.

The probable sequence of deposition of the major components is: quartz and fluorite, cassiterite and wolframite, arsenopyrite, sphalerite, chalcopyrite and galena, pyrite, second generation pyrite and marcasite, second generation cassiterite (?), and second generation quartz and fluorite.

SYSTEMATIC MINERAL DESCRIPTIONS

Quartz

Quartz occurs as large euhedral crystals, up to 20 cm in length and 4 cm in diameter, surrounded by cassiterite and sulphides, or as equi-grained anhedral crystals in quartz-cassiterite veinlets. It is also present in later veins and veinlets cutting both cassiterite and sulphides.

Fluorite

Fluorite occurs rarely as large cubic crystals with a side-length of up to 10 cm, rimmed by sulphides. It occurs more commonly as small discrete veinlets or in the centre of the late quartz veinlets.

Hematite

Hematite occurs only in one section (68-229)*, as small blade-like inclusions in cassiterite.

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* Specimen numbers prefixed 68- or 69- refer to specimens housed in the collection of the Department of Mines, Hobart. Other specimen numbers refer to specimens housed in the collection at the Department of Geology, University of Tasmania.

Cassiterite

Cassiterite occurs in at least two and possibly three generations. Cassiterite of the first generation is present as small granular aggregates of subhedral to euhedral crystals in relatively widely spaced quartz-healed fractures that contain no sulphides. Cassiterite of the second generation occurs in a closely spaced fracture foliation that cuts the earlier quarz-cassiterite veins, and is the locus for sulphide mineralisation. The cassiterite occurs in clusters of subhedral, zoned or twinned crystals. Individual crystals rarely exceed 3 mm in diameter, but clusters up to 15 mm in diameter are common (e.g., 68-232). The cassiterite contains rare inclusions of hematite and chalcopyrite but no other sulphides. The cassiterite is in contact with all sulphides and exerts its crystal outlines against them, but no reaction between minerals was observed. A feature of the cassiterite is that it is not strongly cracked (c.f. cassiterite-sulphide ores in western Tasmania (Groves, 1968)), and this feature may be related to the lack of reaction between sulphides and cassiterite. A third and late generation of cassiterite was described by Urquhart (1967) as forming a ' dusty ' coating on the surface of sulphide minerals. This type of occurrence was not verified by the present study.

Wolframite

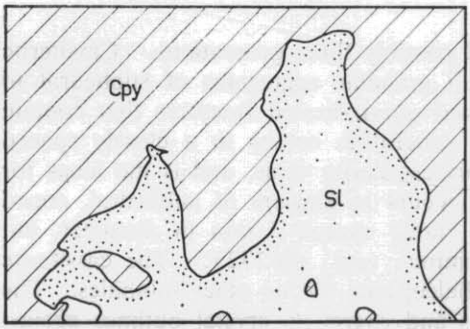
Wolframite occurs generally as blade-like crystals that are partially replaced by sulphides. In one section (101164) it is abundant as massive crystals with strong cleavages that are filled with dilational veinlets of quartz and marcasite. In this section the wolframite is separated from sulphides by narrow rims of quartz. It also occurs sporadically as small inclusions in arsenopyrite. Wolframite and cassiterite were not seen in contact, and hence no age relationships could be established between the two minerals.

Arsenopyrite

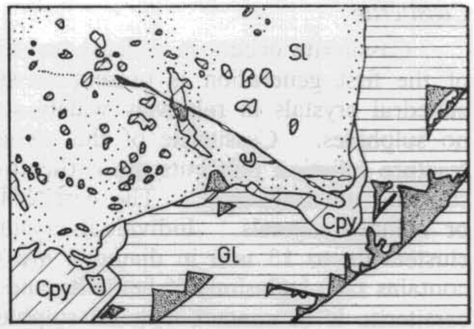
Arsenopyrite occurs as large euhedral crystals, up to 20 mm in side length, and as minute euhedral crystals in galena. The larger arsenopyrite crystals contain inclusions of cassiterite and wolframite but no sulphides. The arsenopyrite is commonly embayed by chalcopyrite and galena which transect zonal structures in the arsenopyrite that are revealed by etching with 1:1HNO_3 (fig. 8C). Arsenopyrite is not embayed by sphalerite or pyrite, the latter commonly rimming euhedral arsenopyrite crystals (e.g., 101167). The arsenopyrite is also cut by dilational veinlets of chalcopyrite and galena, which in places contain isolated fracture-bound blocks of the arsenopyrite adjacent to arsenopyrite crystal edges (e.g., 69-75A). The arsenopyrites have 131 spacings which vary from 1.6289 and 1.6332±0.003A° and are indicative of S-rich compositions between 37.5 and 33.6 atomic % S (Morimoto and Clark, 1961). The idiomorphic form of arsenopyrite and its apparent replacement, particularly the disruption of zonal structures by other sulphides, suggest that it may be the earliest sulphide to be deposited. The dilational veinlets of other sulphides could be related to minor post-ore deformation.

Sphalerite

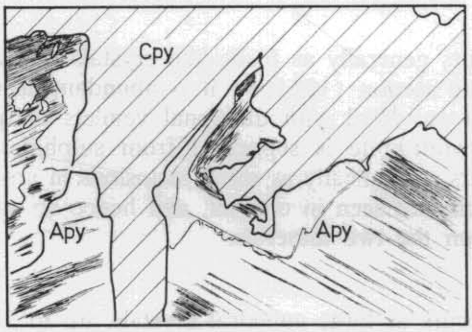
Sphalerite is common as anhedral crystals that form large patches intimately associated with other sulphides throughout the ore. Sphalerite contains abundant segregated circular, ovoid, rectangular or skeletal exsolution bodies of chalcopyrite with an average diameter of approximately 0.04 mm. Some elongate



A: Typical chalcopyrite-sphalerite interface with abundant sub-microscopic chalcopyrite exsolution bodies in sphalerite at the interface. Specimen No. 101129.

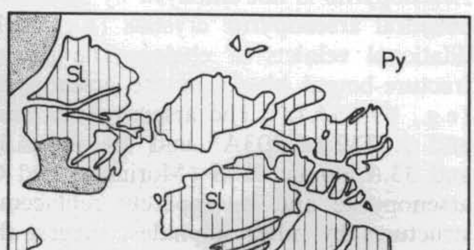


B: Typical galena-sphalerite interface with disconnected chalcopyrite grains and abundant segregated and exsolution bodies of chalcopyrite in the sphalerite. Specimen No. 101092.



C: Zoned arsenopyrite crystals (etched with 1 :1 HNO_3) replaced by chalcopyrite. Specimen No. 101167.

D: Star-shaped bodies of sphalerite in pyrite and chalcopyrite. Note common orientation in both hosts. Specimen No. 101167.



E: Replacement of sphalerite within a pyrite crystal. Specimen No. 101079.

FIGURE 8. Textures in sulphides, Rex Hill mine.

blebs form discontinuous trails through the sphalerite host. The chalcopyrite blebs are generally surrounded by irregular areas of fine dusty sub-microscopic chalcopyrite exsolution bodies with intervening chalcopyrite-free areas of sphalerite. There are also definite zones that are enriched in these sub-microscopic particles in some sphalerite grains that contain no segregated chalcopyrite bodies (e.g., 101089). Analysis of separated sphalerite grains by X-ray spectrography indicates that between 5 and 28 wt % chalcopyrite is bound up in the sphalerite in one of these forms. Pyrrhotite occurs in most sections as sub-circular bodies in composite grains with segregated chalcopyrite blebs. Discrete pyrrhotite bodies are rare, and the proportion of pyrrhotite present in the sphalerite host varies considerably between sections. Both chalcopyrite and pyrrhotite bodies are commonly most abundant at mineral interfaces, particularly galena-sphalerite and chalcopyrite-sphalerite boundaries (fig. 8A, 8B). Similar relationships have been observed elsewhere (e.g., Lawrence, 1967; Both and Williams, 1968). It is possible that the concentrations of chalcopyrite exsolution bodies adjacent to galena and chalcopyrite boundaries have resulted from annealing effects during replacement of the sphalerite (e.g., Both and Williams, 1968).

Sphalerite is intimately mixed with galena and chalcopyrite in most sections. Configuration of mineral interfaces is complex, with many sphalerite-galena and sphalerite-chalcopyrite interfaces exhibiting mutual boundaries texture although concentration of chalcopyrite in sphalerite at these interfaces is anomalous (fig. 8A, 8B). However, in some sections galena and chalcopyrite appear to replace sphalerite, which occurs as isolated fragments in these minerals adjacent to the interfaces. Chalcopyrite and galena also occur as veinlets in sphalerite, but the reverse situation is extremely rare. This textural evidence indicates that deposition of sphalerite was possibly synchronous with, or prior to, deposition of chalcopyrite and galena. The composition of the sphalerite varies between 2.3 and 17.4 wt% FeS and 0.15 and 0.64 wt% MnS (electron-probe microanalysis; Williams, 1967). An average of 0.35 wt% CdS in sphalerite is indicated by bulk ore analyses from Urquhart (1967).

Pyrrhotite

Pyrrhotite occurs exclusively as compound or discrete segregated exsolution bodies in sphalerite. The composition and structural state are unknown.

Chalcopyrite

Chalcopyrite is more restricted in occurrence that sphalerite, but is abundant in places as anhedral grains that form irregular patches up to 4 cm in diameter. The chalcopyrite contains abundant star-shaped or skeletal bodies of sphalerite that rarely exceed 0.01 mm in length. The orientation of these sphalerite bodies is controlled by the (111) planes in the chalcopyrite host, and is constant over areas up to 5 mm in diameter. Larger blebs of sphalerite are included in chalcopyrite in places, and commonly contain minute exsolution bodies of chalcopyrite, indicating possible progressive unmixing. A high proportion of euhedral pyrite present in the sections is included within chalcopyrite. In section 68-239 elongate lamellae or veinlets of cubanite occur within the chalcopyrite, but no bornite (Urquhart, 1967) was observed. The chalcopyrite and included sphalerite grains are commonly cut by covellite and chalcocite veinlets.

The chalcopyrite exhibits mutual boundaries texture with sphalerite and galena, but also occurs as veinlets in both these minerals. Galena veinlets commonly traverse chalcopyrite, but sphalerite veinlets are rare. Small chalcopyrite grains occur discontinuously along galena-sphalerite interfaces (fig. 8B). These textural relationships indicate synchronous deposition of chalcopyrite and galena following deposition of sphalerite, with at least some chalcopyrite being post-galena.

Cubanite

Cubanite occurs in section 68-239 as lamellae or veinlets in chalcopyrite.

Galena

Galena occurs as strongly cleaved cubic crystals forming irregular areas, up to 4 cm in diameter, that rarely include other sulphides. Inclusions of a grey-brown isotropic mineral with moderately low reflectivity occur in the galena to a maximum size of 0.02 x 0.01 mm. The concentration of this mineral in galena within one section is erratic, and its concentration in galena varies considerably between sections. Chemical analyses by the Department of Mines Laboratories, Launceston, of galena containing blebs of this mineral together with minor chalcopyrite indicate 0.307% Ag, 0.02% Cu, 0.04% Sn and nil Sb. The lack of Sb indicates that the mineral is not tetrahedrite and the proportions of Ag and Sn are consistent with that of canfieldite which has similar optical properties. Canfieldite has also been reported from Renison Bell (e.g., Stillwell and Edwards, 1943). In section 101143 lamellae intergrowths of probable boulangerite, only 0.005 to 0.01 mm in width, occur in galena and in section 68-228 minute inclusions of probable native bismuth occur.

Ore textures described previously indicate that galena was deposited penecontemporaneously with chalcopyrite and was at least in part post-sphalerite.

Boulangerite

Boulangerite was only observed in one section (101143) where it occurred as lamellar intergrowths with galena.

Tetrahedrite

Tetrahedrite occurs as rare compound veinlets with chalcopyrite that traverse sphalerite grains (e.g., 68-230).

Native Bismuth

A mineral tentatively identified as native bismuth occurs as a series of small inclusions in galena in section 68-228.

Pyrite

Pyrite occurs predominantly as euhedral, cubic crystals, with a side length varying from 0.01 to 8.0 mm, that commonly occur in small clusters, particularly in chalcopyrite. The pyrite shows anomalous anisotropism. Pyrite-chalcopyrite and pyrite-galena interfaces are generally linear or slightly curved and represent pyrite crystal faces that are rarely embayed (fig. 8D). However pyrite-sphalerite interfaces are far more complex, with sphalerite commonly occurring as embayments in pyrite crystals faces (apparent caries texture) or as inclusion in pyrite. Pyrite which occurs in a compound chalcopyrite-sphalerite host commonly has linear margins against chalcopyrite, but patches of sphalerite are shared by pyrite and chalcopyrite. In some sections (e.g., 101079) subhedral to euhedral pyrite crystals contain up to 50% included sphalerite (fig. 8E). Euhedral pyrite crystals commonly contain star-shaped bodies of sphalerite that are orientated parallel to identical exsolution bodies in the adjacent chalcopyrite host (fig. 1D).

It is apparent from the textural relationship described above that the pyrite was deposited after sphalerite, chalcopyrite and galena, but that complete replacement of these minerals was inhibited by the presence of sphalerite. The idiomorphism of pyrite is therefore probably related to its structural properties (e.g., Stanton, 1964) rather than its early formation (c.f. arsenopyrite). Rare dilational veinlets of chalcopyrite in pyrite may be related to mild post-pyrite deformation.

Pyrite-Marcasite

Pyrite-marcasite intergrowths occur rarely as clusters of anhedral grains in chalcopyrite and also as rims around galena, pyrite and arsenopyrite grains (e.g., 101167). Their occurrence is not related to the present topographic surfaces and they are probably hypogene and deposited after the bulk of the pyrite.

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REFERENCES

BOTH, R. A.; WILLIAMS, K. L. 1968. Mineralogical zoning in the lead-zinc ores of the Zeehan field, Tasmania. Part II: Paragenetic and zonal relationships. *J. geol. Soc. Aust.* 15: 217-244.

GROVES, D. I. 1968. *The cassiterite-sulphide deposits of western Tasmania.* Ph.D. Thesis. University of Tasmania: Hobart.

LAWRENCE, L. J. 1967. Mineralogy and textures of Thackaringa sulphide ore. *Proc. australas Inst. Min. Metall.* 222: 85-94.

MORIMOTO, N.; CLARK, L. A. 1961. Arsenopyrite crystal-chemical relations. *Am. Miner.* 46: 1448-1469.

STANTON, R. L. 1964. Mineral interfaces in stratiform ores. *Trans. Instn Min. Metall.* 74: 45-79.

STILLWELL, F. L.; EDWARDS, A. B. 1943. Mineral composition of the tin ores at Renison Bell, Tasmania. *Proc. australas. Inst. Min. Metall.* 131-132: 173-186.

URQUHART, G. 1967. The Rex Hill mine. *Rep. geol. surv. Tasm.* 9.

WILLIAMS, K. L. 1967. Electron probe microanalysis of sphalerite. *Am. Miner.* 52: 475-492.