THE CONFORMABLE TIN BEARING PYRRHOTITE-PYRITE 'SILLS' AT RENISON BELL, TASMANIA: MINERALOGY, RELATIONSHIPS, GENESIS[1]

By

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The pyrrhotite-pyrite lodes and sills of Renison Bell have been described by Gilfillan (1965) and Solomon (1965), and the regional geology by Blisset (1962). In 1961 Hill collected fifty drill-core samples, spaced at 2 to 10-foot intervals, from DDHs 48 and 60 (for localities see Gilfillan, 1965). These samples have now been studied in detail (drill logs in Hill and Green, 1962). This account is based on the information obtained from these samples.

DDH 48 cuts one 25-ft sill of pyrrhotite. DDH 60 cuts two: the upper 57 ft thick, the lower 5 ft thick. The upper has a 7-ft layer of pyrite near the base, the lower a 1.5-ft layer of pyrite.

The percentages of the 'economic' minerals were estimated optically, sample by sample. Grain sizes were measured with a micrometer eyepiece calibrated against a graduated graticule.

The economic minerals consist of cassiterite, pyrite, pyrrhotite, arsenopyrite, sphalerite, galena, and chalcopyrite. Galena and sphalerite increase in amount with depth but chalcopyrite decreases. Arsenopyrite is sporadically distributed. It is restricted to the upper parts of the sills and is minor in DDH 48 and more dominant in DDH 60. Wolframite, stannite, and magnetite are minor constituents.

The cassiterite is erratically distributed. Most of it is fine-grained and embedded in quartz, pyrrhotite, or carbonate. The crystals tend to be euhedral in massive carbonate and in quartz but subhedral in vein carbonate and in pyrrhotite. High assay values for tin are usually indicative of large crystals, rather than any increase in the number of crystals.

The paragenesis of the sills is:

Stage 1 Pre-existing magnetite, pyrite and carbonate

Stage 2 Quartz - apatite - tourmaline - wolframite - cassiterite - carbonate

Stage 3A Arsenopyrite
        B Pyrite - carbonate

Stage 4 Pyrrhotite - chalcopyrite - sphalerite - stannite - carbonate

Stage 5 Veins of quartz - cassiterite - wolframite - carbonate

Stage 6 Veinlets of quartz - pyrrhotite - chalcopyrite - sphalerite - carbonate

Stage 7 Veins and boxworks of carbonate - chlorite - chalcopyrite - pyrite - marcasite?

Stage 8 Supergene marcasite.

The vertical distribution of monoclinic and hexagonal pyrrhotite was determined by etching thirty-six polished sections with a saturated solution of chromic acid (Arnold, 1966). The alternative method (Cowan, 1968) using ammonium dichromate in 15% HCl was found to be unreliable.

From the pyrrhotite intergrowths that appeared, fifteen scratch samples were removed and X-rayed in a powder camera. Using the split and single 102 reflections both the monoclinic and the lower temperature hexagonal pyrrhotite were distinguishable. With one exception, the dark etched areas were found to be monoclinic, the light, hexagonal. Only three of the hexagonal patterns were clear enough to be matched with the 2A 5c hexagonal pyrrhotites of Carpenter and Desborough (1964).

The intergrowths revealed by the etching and confirmed by X-rays, consist of patches and lamellae. In general, monoclinic pyrrhotites contain patches of hexagonal whereas hexagonal pyrrhotites contain only discrete lamellae of monoclinic. Where hexagonal and monoclinic patches occur together they appear to be replacing one another. Both the monoclinic and the hexagonal lamellae appear to be crystallographically oriented within their host pyrrhotes.

In DDH 48, monoclinic pyrrhotite is dominant in the stringers above the main sill. (The possibility that some of the magnetite in the pyroclastics above the sill may have been formed by the oxidation of pyrrhotite cannot be completely eliminated.) Monoclinic pyrrhotite is also concentrated at the top and bottom of the sill, intergrown with lamellae and patches of hexagonal pyrrhotite. In the centre of the sill, monoclinic pyrrhotite is only slightly more abundant than hexagonal and the intergrowths consist solely of hexagonal lamellae.

In DDH 60, the monoclinic phase increases with depth. It is dominant (80%-100%) in the lower sill. It is dominant also in the upper sill below the

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[1] The title of an unpublished M.Sc. thesis by Simon John Haynes (Carleton University, Ottawa, Canada, 1969, 143 pp.) from which thesis this paper has been abstracted.

pyrite band (100%) and in the pyrite band itself (50%-95%). Above the pyrite band, the hexagonal phase becomes dominant, reaching 60%-80% at the top of the sill. A direct relationship thus exists in this drillhole between monoclinic pyrrhotite and pyrite.

The distribution of the two phases of pyrrhotite must be considered fully in any future geophysical interpretation of Renison Bell for monoclinic pyrrhotite is ferromagnetic, hexagonal, para-magnetic. The difference in magnetic suscepti-bility could lead to a more effective recovery of the cassiterite if it could be shown that the cassiterite was concentrated more in one phase than in the other.

To check the percentages of hexagonal pyrrhotite as determined in etched sections, fourteen 'bulk' samples of pyrrhotite were X-rayed by the diffractometer method of Graham (1966). Except for two samples (434, 436) midway up the upper sill of DDH 60, the percentages of hexagonal pyrrhotite could be correlated to within ±15%. Both Arnold (1966) and Graham (1966) have shown that bulk samples from the same hand specimen can vary greatly in their monoclinic to hexagonal ratios.

The distribution of the pyrrhotite phases relative to the pyrite band in DDH 60 suggests that the bulk composition of pyrrhotite of Paragenetic Stage 4 approached equilibrium with the pyrite of Stages 1 and 3. The distribution of the pyrrhotite phases can be explained by a cooling history which started either above or below the β transformation of pyrrhotite (about 310° C) and which later was modified by low temperature reactions, and by variations in the sulphur fugacity. As the late pyrrhotite (Stage 6) which cuts earlier massive pyrrhotite (Stage 4) is richer in monoclinic pyrrhotite, and therefore in sulphur, a late S-rich 'front' may have advanced laterally along the sills.

To determine the temperature of formation six geothermometers were considered. Serious con-sideration could however be given to only three: the quartz decrepitation, the system Fe-As-S, and the system Cu-Fe-S.

The decrepitation of the quartz indicates a temperature of 350°±50° C for the formation of the cassiterite, a temperature which is question-able because of the unknown amounts of CO_2 present at the time. Of the Fe-As-S, the arseno-pyrite and pyrite texturally (Stage 3) appear to have formed a stable assemblage and were thus probably emplaced below 491° C. However as the quartz inclusions are unruptured the arsenopyrite-pyrite was probably deposited below 350°±50° C.

Of the system Cu-Fe-S, the main phase of sulphide metallisation (pyrrhotite-chalcopyrite-sphalerite of Stage 4) probably took place below 334° C although it is not known whether the pyrrhotite had reached a full equilibrium with the earlier pyrite.

As to origin, no evidence *exists in the samples studied* that the sills might be syngenetic. The decrepitation of the quartz; the ratios of the sulphur isotopes; the similarity of the Co:Ni ratios of the pyrites with those at Mt Bischoff (Groves and Solomon, 1964); and the high content of manganese in the sphalerites suggest that the sills had, at least in the latter part of their history, a predominantly hydrothermal-magmatic origin and were derived from gases or fluids rising up the fissure lodes, spreading out laterally, and selec-tively and effectively replacing the carbonate horizons, preserving in the pyrrhotite the original stylolites. The pre-existing ankeritic carbonates were remobilised, locally enriched in manganese and iron, and redeposited in veins and masses.

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