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2. Mineragraphy of the Spray Mine, Zeehan.

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Exploration by Tenneco Australia Inc., included dewatering the Spray Mine in 1971 and this opportunity was taken for sampling the underground workings for mineragraphic investigation of the ore. The writer gratefully acknowledges the assistance of R. Besley, Tenneco geologist, in underground sampling and in making drill core available.

The Spray Mine was first visited by Waller (1904) who made a detailed description of the workings. Six years later work had ceased at the mine (Twelvetrees; Ward, 1910). Since that time mining has been sporadic and of limited extent (Blissett, 1962). Production from the Spray and Brittania mines was 70,063 tonnes of ore for a recovery of 42,369 tonnes of lead and 200,825 kg of silver. The Brittania mine probably provided less than 400 tonnes of ore in this total and the Spray was the second largest producer of the Zeehan field (Blissett, 1962).

Mineragraphic investigations include a brief report by Stillwell (1947) and more extensive work by Both and Williams (1968) and Williams and Both (1972) which was part of a regional study of the Zeehan ores.

GEOLOGY

The ore bodies are fissure fillings in folded Oonah Quartzite and Slate of probable Upper Proterozoic age (Blissett, 1962). Two NNW-trending lodes have been mined: the No. 1 or Main Lode, and the No. 3 or Gurnie's Lode. The former lode is by far the more important and has been mined down to 6 level, 137 m below the main adit level.

The mine falls within the sidero-pyritic zone of Both and Williams (1968).

MINERAGRAPHY

The following minerals were identified in the present investigation of 42 polished sections: pyrite, arsenopyrite, quartz, sphalerite, siderite, pyrrhotite, marcasite, galena, boulangerite, bournonite, tetrahedrite and stannite. It should be noted that the 'jamesonite' referred to by the early writers was found to be boulangerite by Both and Williams (1968). In addition to the above assemblage the validity of a specimen of argentite from the Spray mine in the Petterd collection was confirmed by Williams and Both (1972).

Both and Williams (1968) recognised the following paragenetic sequence from the Zeehan ores. With reference to those minerals found at the Spray, the sequence is:

(1) *Early stage:*

pyrite, marcasite, arsenopyrite, pyrrhotite, quartz.

(2) *Intermediate stage:*

sphalerite, siderite, chalcopyrite, arsenopyrite, quartz.

(3) *Late stage:*

galena, tetrahedrite, stannite, boulangerite, bournonite, argentite, chalcopyrite, pyrrhotite, marcasite, arsenopyrite, quartz.

This sequence has largely been confirmed by the present work. A generalised description of the ore from dump material has been given by Williams and Both (1972) and only a brief resumé is given here.

Pyrite, arsenopyrite and, less commonly, marcasite occur as intergrowths of euhedral crystals up to 1 mm in diameter in quartz gangue, the intergrowths occurring in patches up to several centimetres across.

Sphalerite and siderite generally occur in mutual boundaries intergrowth and replace the earlier sulphides. Sphalerite exhibits a deep red internal reflection in some sections and is studded with fine blebs of chalcopyrite which occasionally coalesce into thin lamellae. Chalcopyrite inclusions are far more common than those of pyrrhotite.

Siderite and sphalerite are replaced by galena and the sulphosalts. Near the replacement boundaries the proportion of chalcopyrite inclusions in sphalerite increases, together with the appearance of seams and patches of galena and tetrahedrite, while on the galena side of the boundary fine inclusions of chalcopyrite, second generation pyrite and chalcopyrite are common.

Galena, boulangerite and bournonite are the most common minerals of the third generation, their relative proportions varying widely between polished sections. Galena, particularly from the upper levels is massive and normally contains fine needles of boulangerite. Isolated patches of intergrown boulangerite needles are common and in many sections boulangerite occurs to the virtual exclusion of galena. Bournonite is less common but in some specimens from 4 level and below occurs as massive patches of irregular equant crystals which display the characteristic 'parquet-type' twinning. Tetrahedrite is also a relatively minor constituent of the ore occurring as fine grains near galena-sphalerite grain boundaries and in the interstices of boulangerite-bournonite intergrowths. In one stope just above 6 level south of the main shaft massive tetrahedrite, bluish grey in hand specimen, occurs in contact with chalcopyrite. Fine rounded grains of stannite, possibly a reaction product are common at tetrahedrite-chalcopyrite contacts.

The later minerals were emplaced partly by replacement of earlier sulphides and siderite but brecciation of the earlier assemblages with fracture filling by galena and boulangerite, in particular, was also important. Curved trains of cleavage pits in galena provide evidence for mild post-ore deformation.

An interesting point is the identification of stannite which has only previously been reported in quantity from the Queen Hill area. Besley (1971) reported 0.12% Sn in two samples from 6 lode.

Another contentious point is zoning in the Main lode. Williams and Both (1972) from a study of dump specimens remarked on the unusual abundance of boulangerite in the Spray ore and the fact that galena was less abundant than this mineral. Hills (1947) thought that the antimonal (boulangerite-rich) ore was confined largely to 4 level and below and that galena with mineralisation occurred higher in the mine. Hills based this conclusion on private notes of the mine manager written prior to closure in 1909 although no systematic assaying for antimony was done at that time. Besley (1971) doubted Hill's conclusion although in the more recent study only one sample was analysed from 4 level, the remainder coming from the lower levels. Besley based his conclusion on Waller's (1904) statement that 'there is a good deal of antimony in the ore, especially in the upper levels'. This conclusion is irrelevant in the present context since the mine was only developed down to 4 level at the time of Waller's visit.

The present work lends support to Hill's theory although the cut-off between galena-rich ore above, and boulangerite-tetrahedrite-bournonite-rich ore below 4 level is not as sharp as envisaged by him and individual polished sections may show exceptions to this trend.

Because of limited access and unmined ore only 15 samples were sectioned from the Main lode in 2, 3 and 4 levels. Of these, only three sections were richer in sulphosalts than galena and of the remainder most had a galena: boulangerite ratio of at least 8:1. Of the 24 samples from 5 level and below only three had more galena than sulphosalt minerals.

Two polished sections are from a diamond drill core drilled by Tenneco which intersected the Main lode 85 m below 6 level. At the margin of the lode the earliest formed minerals are pyrite and arsenopyrite intergrown with quartz, all three minerals being extensively replaced by siderite which is studded with fine inclusions of boulangerite. The siderite is host to intimately intergrown tetrahedrite, boulangerite and minor bournonite.

In the body of the lode boulangerite, as a mass of intergrown needles 0.2 x 0.03 mm in section, is the dominant mineral. Irregular grains and patches of bournonite and tetrahedrite occur within the boulangerite. Galena occurs only in trace amounts. Chalcopyrite, sometimes intergrown with stannite occurs in small blebs averaging 0.1 mm in diameter in siderite and scattered pyrite euhedra are strongly corroded by the other minerals.

In conclusion, the study substantiates the view that the ore becomes rich in the antimonal minerals boulangerite, tetrahedrite and bournonite with depth and that the marked abundance of boulangerite occurs mainly below 4 level.

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