STANNITE ORE FROM OONAH MINE, ZEEHAN

Ore from the "Stannite" lode in the Oonah Mine, Zeehan, has a complex composition and contains an exceptional number of elements. Its chemical composition is indicated by the following figures published in Bulletin No. 8 of the Geological Survey of Tasmania (p.53)

Silver	22 ozs per ton
Copper	5.5 per cent
Tin	4.5 " "
Bismuth	0.4-0.45 per cent
Iron	26-27 " "
Sulphur	29 " "
Silica	22-27 " "
Alumina	4.5 " "

An analysis of apparently pure stannite was made by J.H. Levings with the following result (Ann. Report of Sec. for Mines Tas. 1907, p.32)

Silver	0.298	97.3 ozs. per ton.
Tin	23.27	as sulphide
	.64	as oxide
Copper	26.77	
Iron	12.11	
Bismuth	2.27	
Antimony	0.505	
Arsenic		
Zinc	0.475	
Sulphur	32.10	
Silica	1.40	
Oxygen	0.14	
	100.278	

These figures indicate the proportions of the main elements in the ore and show that even apparently pure stannite is contaminated by a number of minerals. The mineralogical composition and the relationships of the minerals to each other are therefore an important basis for any experimental work upon the metallurgical treatment of the ore.

Mineral Composition. The metallic minerals that have been observed in a sample of the ore are — pyrite, arsenopyrite, cassiterite, stannite, chalcopyrite, tetrahedrite, bisumthinite and galena. The gangue minerals are chiefly quartz, with some siderite and occasional fluorite.

Twelvetrees and Ward (Bull.8.p.53) also record wolfram and antimonial lead.

The examination of polished sections of the ore shows clearly the existence of two generations of minerals. Pyrite, arsenopyrite and cassiterite belong to the earlier generation with quartz. Stannite and chalcopyrite with the smaller included amounts of tetrahedrite, bismuthinite and galena belong to a later generation. The earlier generation shows considerable replacement by the later generation, and the varying degrees of replacement partly account for the wide variations in mineral content in different specimens of ore. Wolfram is a common associate of cassiterite and, though not detected, in the polished sections, would undoubtedly belong to the earlier generation.

Pyrite Pyrite occurs in seams and bunches of crystals which are generally associated with the siliceous portions of ore. Isolated crystals in quartz are often idiomorphic but isolated crystals in stannite are generally corroded and often represent shapeless, unreplaced residuals. The edge of a mass of pyrite in contact with an area of the stannite group of minerals is often corroded and, in places, is transgressed by numerous veins of chalcopyrite, stannite, galena and bismuthinite. Of these the replacement by chalcopyrite is the most prominent.

Arsenopyrite. Arsenopyrite is much less abundant than pyrite, though in limited areas crystals of arsenopyrite may be more numerous. The crystals are often comparatively large and easily visible to the naked eye on the polished surface. They are generally idiomorphic in contact with quartz or pyrite but are extensively corroded and veined by the invading areas of the stannite group of minerals. Fig.2 illustrates a crystal of arsenopyrite which is for the most part embedded in quartz but is corroded where it comes into contact with stannite.

Cassiterite. Crystals of cassiterite occur within the main areas of pyrite, arsenopyrite and quartz. They appear more abundantly as bunches along the margin of quartz and stannite and in areas of chalcopyrite. They also occur embedded in stannite as illustrated in fig.6 where the outline of the crystal is much corroded. Large bunches of crystals may measure .87mm. x 1.15 mm. but many individuals in the residual groups in stannite may be as small as .002mm. in width. Inclusions of cassiterite in stannite tend to be more abundant in areas rich in chalcopyrite and they are often surrounded by a thin sheath of chalcopyrite. The average amount of cassiterite is greater than that indicated in Levings' analysis of stannite and approximates to his estimate that as much as 15% of the total tin occurs as oxide.

Cassiterite in polished sections is recognised by its hardness, grey colour in comparison with dark quartz and by its resistance to all etching agents. Though recognisable in the polished sections it is only identified with certainty by the preparation of a thin section and by examination in transmitted light. The cassiterite is then recognised by its high refractive index, high double refraction, straight extinction, uniaxial and positive character. These optical properties combined with its hardness which is similar to that of quartz and sometimes a little higher, establish the mineral as cassiterite beyond doubt.

Chalcopyrite. Chalcopyrite is an abundant constituent of all sections containing stannite and is readily recognised by its yellow colour. It is unevenly dispersed throughout the stannite as small inclusions of irregular shape and size. While these are numerous they are not comparable in abundance with the myriads of minute particles of chalcopyrite that are a feature of many stannites from other localities. It may perhaps be that the excess copper in the stannite solutions of the Oonah deposit has been largely utilised in the replacement of pyrite and its conversion into chalcopyrite.

Some areas of stannite are comparatively free from inclusions of chalcopyrite, but there are other fields such as fig.1 where the amount of chalcopyrite approximates to that of stannite. Others again are more accurately described as large areas of chalcopyrite honey-combed with irregular inclusions of stannite. These larger areas of chalcopyrite are often studded with cassiterite particles. Moreover as many particles of cassiterite in stannite are surrounded with a thin coating of chalcopyrite would appear that cassiterite, belonging to the earlier generation of minerals, has been more stable in contact with chalcopyrite of the later generation than in contact with stannite. Chalcopyrite also contains inclusions of tetrahedrite, galena and bismuthinite.

Stannite. Stannite is the most abundant mineral in the specimens of ore and is readily recognised in a polished section by its brownish-white colour. It is a very brittle mineral and the polished surfaces show pittings which appear as dark spots in the photographs. It is anisotropic and frequently shows traces of an imperfet lamellae twinning. It is attacked by HNO_3 with the development of an etched structure, showing the irregular outlines of the crystals and also at times the intermittent and impersistent twin lamellae.

Like chalcopyrite, it frequently shows evidence of the replacement and veining of pyrite, arsenopyrite, cassiterite and quartz. Residuals of these minerals appear as common inclusions in stannite. In addition stannite contains numerous small inclusions of chalcopyrite, tetrahedrite (fig. 5) bismuthinite (fig.3) and galena.

Tetrahedrite. Tetrahedrite is the important silver mineral in the ore. It is also probably the source of all the antimony in Levings' analysis of stannite. Its greyish-white colour on the polished surface enables it to be distinguished from the brownish-white stannite of similar hardness. It is unattacked by the standard etching agents and only affected by a mixture of HCl and CrO_3.

An elongated area of tetrahedrite in stannite is illustrated in fig.5 when the contrast with stannite has been increased by etching the stannite with HNO_3. Many particles are more irregular in shape than that in fig.5 and also much smaller. Sometimes inclusions of tetrahedrite occur in chalcopyrite while minute particles are often associated with the inclusions of bismuthinite and galena.

Bismuthinite. Bismuthinite occurs as irregular veinings and replacements in quartz, pyrite and arsenopyrite and also as minute inclusions dispersed throughout the stannite. Isolated crystals are generally prismatic in shape (fig.3) and some are as small as .001 mm. in width.

Bismuthinite in a polished section has a galena-white colour and is etched slowly by HNO_3 with the development of its prismatic structure. It resembles stibnite in being strongly anisotropic and pleochroic but is distinguished from stibnite by its resistance to KOH. Its identification has been confirmed from areas surrounded by quartz from which it can be dissolved by concentrated HNO_3 without contamination. The drop of solution so obtained is transferred to a glass slide and tested for bismuth by microchemical methods.

Many of the areas of bismuthinite in both quartz and stannite are composed of several crystals associated with particles of tetrahedrite and galena. Some of the individual crystals may also contain thin films of stannite along the cleavage planes of bismuthinite and at times a very intimate association of bismuthinite and stannite is presented.

Galena. Minute quantities of galena occur in the ore as inclusions in chalcopyrite and stannite. It is often associated with the inclusions of bismuthinite and is indistinguishable from bismuthinite in an untreated section. It is however readily distinguished by etching with HCl or $FeCl_3$ when the galena is rapidly tarnished. Galena is then seen in some cases to fill interstices between the prisms of bismuthinite and extends in other cases to amounts equivalent to or greater than the area of bismuthinite. Fig.4 illustrates a composite area of bismuthinite and galena in which the galena has been tarnished with HCI and the white prisms of bismuthinite are clearly revealed. The tarnished surface of galena in this field of view is visually quite distinct from the neighbouring yellow chalcopyrite though unfortunately the contrast is not well marked in the photograph.

The minute inclusions in stannite may therefore be composed of galena, bismuthinite, tetrahedrite or chalcopyrite and many are minute composite aggregates of two or more of these four minerals. Galena is perhaps not so constant an associate of bismuthinite as tetrahedrite. It tends to be more frequently associated with chalcopyrite and appears to find its greatest development in areas of chalcopyrite.

Composition of Stannite Ore.

The comparison of the mineral constitution of the ore with Levings' analysis of stannite indicates that the tin content is derived from cassiterite as well as stannite. The proportion derived from cassiterite is less in apparently pure stannite than in the average ore sample.

The copper content is derived from stannite, chalcopyrite and tetrahedrite. In the apparently pure stannite possibly as much as 90% is derived from the stannite, perhaps 8% from chalcopyrite and the remaining 2% from tetrahedrite. In the average ore the percentage of copper derived from chalcopyrite meterially increases.

Bismuth is wholly derived from bismuthinite and the silver and antimony come from tetrahedrite.

Iron is derived from pyrite, chalcopyrite, arsenopyrite and stannite. The presence of arsenopyrite indicates that the average mine ore contains a small percentage of arsenic. Small quantities of lead are also present, being derived from the galena. Zinc blende has not been detected in the stannite and it is probable that the zinc in Levings' analysis of stannite replaces part of the iron in the theoretical composition of stannite (Cu_2S, FeS, SnS_2). Zinc is sometimes present in the composition of tetrahedrite but the proportions of tetrahedrite are insufficient to account for the estimated amount of zinc in the stannite analysis.

signed
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September, 6th, 1930.