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MINERGRAPHIC INVESTIGATIONS

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MINERAL COMPOSITION OF THE TIN ORES OF RENISON BELL, TASMANIA.

Renison Bell is on the Emu Bay Railway, midway between Zeehan and Rosebery on the West Coast of Tasmania. The tin deposits in this area have been discribed by G.A. Waller (1902), L.K. Ward (1909), and Hartwell Conder (1918) for the Tasmanian Geological Survey.

The ore bodies occur in the slates, grits, altered lava flows and tuffs of the Dundas Series, and consist of fine grained cassiterite disseminated through massive sulphides (chiefly pyrrhotite or pyrite) or through bodies of quartz and sulphides. Some of these bodies show a N.W. S.E. strike, parallel to the strike of the tin belt, but others strike N.E.-S.W. or E.-W.

The ore bodies are of two types:

1. steeply dipping fissure veins, spoken of locally as "feeders", and
2. flatter-lying bodies more or less conformable with the bedding planes of the slates (bedded veins), spoken of locally as "floors".

The feeders range from 5-12 ft. in width, with occasional bulges as great as 45 ft. Their lengths vary from 100ft. to several hundred yards, and they are known to continue to considerable depths. They dip steeply, generally at angles of 45 degrees to 60 degrees to the east or south.

The floors, where they occur, are directly connected with the feeders, and are sheet-like bodies of sulphide ore. The composite ore bodies thus have the shape of an inverted L, or a T, according to whether the floor extends out from one side or both sides of the feeder. Most of the floors extend from the hanging wall side of the feeder. Where erosion has removed the connection, they appear as separate bodies.

The feeders as a rule carry more quartz and arsenopyrite than the floors, and are richer in tin. In addition, the cassiterite tends to be coarser-grained in the feeders than in the floors. The floors, on the other hand, carry a greater proportion of sulphides, chiefly pyrrhotite, and the grade of ore and grain size of the cassiterite tend to decrease as the floor is followed down the dip away from the feeder, so that the outer and lower extremities of the floors may be too low-grade to work economically. The average grade of the ore worked at present is 0.9% Tin.

The slates forming the roofs of the floors are commonly much contorted and silicified, so that they form hard rocks in which the contortion and shattering of the original slates are well preserved. Joints extending upwards, more or less at right angles to the roof of the floor are occasionally filled with finely-crystalline quartz, similar to that in the ore bodies, ~~and~~ are often rich in tin, so much so that the slate as a whole may average 0.4% Tin.

Some carbonate gangue is present in all the ore bodies, commonly on the footwall side, and in places it becomes an important constituent of the ore. This is usually accompanied by a decrease in the grade of the ore.

The chief ore bodies of the field are:

1. Renison Bell Lode, comprising the N.W.-S.E. Lead Lode feeder with a N.E. dip of 60 with a pyritic floor, and the "Black Face" pyrrhotite floor dipping N.E. 30 degrees.
2. Blow Lode, a NW.-S.E. lode, east of the Renison Bell Lode.
3. Dalcoath Creek (Reid's Lode) - a pyrrhotite - arsenopyrite lode, striking N.E.-S.W. and dipping S.E. about 60 degrees.
4. Dalcoath Workings - probably a feeder lode with a N.-S. strike on the contact of the slates with a gabbro dyke.
5. Cable Workings - an E.-W. feeder, dipping N. and associated with a floor on the hanging wall side.
6. Luck's Lode - an unimportant pyritic lode, south of the Cable Lode striking E.-W.
7. Battery Lode - a N.W.-S.E. feeder in conjunction with a pyrrhotite floor dipping 25-30 degrees S.W.
8. Dreadnought Lode - a N.W.-S.E. feeder, dipping N.E. 65 degrees.
9. Montana Lode - a combination of a N.W.-S.E. feeder and a floor.

Mineral Composition

The Chief minerals in the ore bodies are cassiterite, arsenopyrite, pyrite, and pyrrhotite, with quartz as the chief gangue mineral accompanied by smaller amounts of tourmaline and topaz. These chief pyritic sulphides are accompanied or followed by small quantities of chalcopyrite and stannite. The progress of this mineralisation continued with a marked change in the composition of the mineralising solutions, resulting in a limited, more or less localised development of sphalerite and galena. This late crystallisation follows continuously upon the first without anytime break as the pyritic bodies gradually merge into the sphalerite galena segregations. Much of the gangue mineral in the late stages is an iron magnesium carbonate (pistomesite), known locally as dolomite.

Miner and rare constituents of the lodes are wolfram, marcasite, magnetite, stannite, tetrahedrite, jamesonite, canfieldite, native bismuth and gold.

Microscopic obersvations of polished sections reveal that over the whole field wolfram and cassiterite have been deposited before the sulphides. The main sequence of crystallisation of the sulphides appears to be arsenopyrite, pyrite, pyrrhotite, chalcopyrite, native bismuth, sphalerite, stannite, tetrahedrite, jamesonite, galena. This sequence, however, is subject to exceptions, arising from the instability of some of the earlier pyrrhotite and from the changing composition of the mineral solutions. Thus a considerable amount of pyrite has been derived by the alteration of pyrrhotite and a second minor development of arsenopyrite, and pyrrhotite proceeds or accompanies the development of sphalerite and galena.

Wolfram

Wolfram is present in rare prismatic crystals about 0.030 x .005 mm. in quartz, in specimens from Reid's lode and the Black Face floor of the Lead Lode. It has also been observed in the Dreadnought Lode, the Cable Lode, and in Reid's Lode as forming the central core of crystals of cassiterite. It can be recognised by its greyish-white colour, anisotropism, inertness to etching reagents and its tendency towards slight marginal alteration.

Analyses of the final tin concentrates show 0.4% WO_3, which is equivalent to about 0.5% wolfram. This, however, does not represent all the wolfram in the lode as a little wolfram is removed from the final concentrates in the Rejected Kieve Tub Float.

Cassiterite

The ore as mined averages about 0.9 per cent tin though in places, as in the Battery Lode feeder, the grade is as high as 5%. Most of the tin is present as fine-grained cassiterite, embedded in either grains of quartz, or in the various sulphides, so that it appears to have been the earliest of the minerals to crystallise. Generally, where the cassiterite is enclosed in sulphides (Fig. 1), it retains its crystal shape, but occasionally it appears to have undergone slight errosion. Ore showing an abundance of quartz intermixed with sulphides is generally richer in tin than the more massive sulphide ore.

In hand specimen, the coarser cassiterite crystals appear black, but in thin sections they are colourless, or more frequently brownish-violet at the margins, and slightly yellow at the core. The larger crystals commonly show repeated zoning.

The largest crystals of cassiterite observed measured as much as 4 mm. in diameter, but these were exceptional, and came from a thin vertical seam of cassiterite and oxidised pyrite, a few centimetres thick, in altered slates exposed in the southern wall of the shaft in the Dalcoath workings, close to the surface. Elsewhere in the ore bodies, crystals as large as 1 mm. diameter are unusually coarse.

Crystals visible to the unaided eye, or with the hand lens, were found in a number of specimens of rich ore from the quartz-arsenopyrite body forming the Battery "feeder", which is reported to average 5 per cent Sn. over much of its length. Most of these crystals were less than 0.5 mm. diameter. They occured chiefly as short strings, short seams, or small lens-like clusters, from 1 to 5 cm. long. Thin sections of such ore show abundant cassiterite, sometimes in groups of crystals scattered through quartz, and sometimes in clusters of as many as a hundred crystals, in which the quartz was excluded. The grain size ranged from 0.843 x 0.562 mm. down to 0.034 x 0.028 mm. In the clusters most of the grains were of more or less uniform size, averaging about 0.34 x 0.340mm.

In the pyrrhotite ores, generally, the grain size of the cassiterite is much reduced, and the crystals tend to occur isolated, or in strings, but rarely in the large clusters in quartz-rich ore.

Mine assays show that in the sulphide floors the grade of the ore decreases as the distance from the junction of the floor with the feeder increases, and it is the experience of the management that the grain size of the cassiterite diminishes as the grade falls. To test this, several specimens were selected at intervals down the dip of the Battery floor. At the actual contact of the floor, with the feeder, the cassiterite is as coarse as that in the feeder, but about 20 ft. from the feeder, measurements on typical ore showed a grain size distinctly smaller, the range of measurements being from 0.220 x 0.165 mm. to 0.030 x 0.030 mm., the average grain size being about 0.100 x 0.100 mm. Still further down the dip, at about 50 ft. from the feeder the range in crystal size was from about 0.065 x 0.030 mm. down to 0.003 x 0.005 mm., the average being about 0.015 x 0.015 mm.

In the Lead Lode feeder, the sizes range from 0.150 x 0.120 to 0,010 x 0,015 mm., whereas in the Black Face floor, which is pyrrhotite-rich, and appears to be connected with the Lead Lode Feeder at a higher level than the pyritic floor exposed in the Emu Bay Railway cutting, the grain size of the cassiterite is considerably smaller, the average being about 0.030 x 0.030 mm.

In Reid's Lode, the observed size of the cassiterite in the quartz-arsenopyrite ore varied from 0.280 x 0.240 mm. to 0.010 x 0.010 mm. with a number of grains approximating to 0,075 x 0,075 mm. In the pyrrhotite patches, the measured range was from 0.075 x 0.075 mm. to 0.015 x 0.015 mm., with an average about 0.030 x 0.030 mm.

In the Dreadnought Lode, the grain size of the cassiterite in typical quartz-pyrrhotite ore ranges from about 0.100 x 0.100 mm. to 0.003 x 0.003 mm., the average being about 0.050 x 0.050 mm., regardless of whether the cassiterite grains are enclosed in quartz or pyrrhotite. The smaller grains tend to occur in segregations in the quartz.

Cassiterite occurs also in numerous thin stringers or veins of quartz, penetrating joints and fractures in the silicified slates that form the hanging walls of the floors. These veins may contain a little pyrite, but generally they consist only of quartz and cassiterite. The quartz is hemimorphic and forms crystals about the same size as those in the quartz-sulphide ore. The cassiterite occurs as small crystals 0.1 to 0.5 mm in diameter, often in well marked bands. The veins are often vughy, the central parts consisting of interlacing quartz prisms, while the cassiterite occurs close to the walls. Where these veins are numerous the silicified slates as a whole may assay as high as 0.4% tin.

Arsenopyrite

Arsenopyrite has been observed in all the ore bodies, but it is especially abundant in Reid's Lode, where it is the dominant sulphide in many hand specimens.

In the Battery Lode, it is restricted to the feeder, where it is often the dominent sulphide, but it occurs only in slight amount in the floor. In the Dalcoath workings, oxidised ore rich in arsenopyrite was observed closely associated with seams of coarse cassiterite near the old shaft, and occasional patches rich in arsenopyrite were noted in the Cable workings, but in other ore bodies it has been found only as a minor constituent.

Arsenopyrite, in the massive areas, occurs in crystals 2 to 3 mm. long by 1 to 2 mm. wide, with occasional larger crystals up to 5 mm. long, intergrown with quartz. Where less abundant, it occurs as smaller isolated crystals in massive pyrite or pyrrhotite. Arsenopyrite is the earliest sulphide to crystalise, and it is sometimes minutely fractured by narrow veins (Fig. 2.) containing pyrrhotite, chalcopyrite, stannite and more rarely sphalerite and galena. Isolated crystals in pyrrhotite sometimes show corroded margins, though many retain a perfect crystal outline. Arsenopyrite was formed after the cassiterite, because it enclosed grains of cassiterite and is sometimes moulded on cassiterite crystals which are isolated in quartz. Occasionally the marginal zone of crystals is crowded with inclusions of very small irregular particles of quartz and other transparent gangue minerals; it is a structure which presumably arises from replacement of quartz along its grain boundaries since it is also shown by adjacent pyrrhotite and chalcopyrite

A second minor development of arsenopyrite occurs in the form of minute idiomorphic crystals, assocaited with tetrahedrite in galena-rich seams in the Battery Lode and the Lead Lode. They occur with clusters of small particles of tetrahedrite in galena around the margins of unreplaced remnants of pyrrhotite, but they are never abundant. It is possible that this marginal development arises from the combination of iron from replaced pyrrhotite with arsenic from tetrahedrite replaced by jamesonite. Sometimes these minute crystals of arsenopyrite appear in the carbonate gangue or on the margin of gangue and carbonate.

<u>Pyrite</u>

Pyrite occurs in every ore body, but in the Lead Lode (Renison Bell Lode) it is the preponderant sulphide in both the feeder and the floor that outcrops on the northern slope of the Renison Bell hill and in the Emu Bay Railway cutting.

The main development of pyrite occurs as coarse-grained, idiomorphic crystals, commonly one or two millimetres across. In ore bodies other than the Lead Lode, this pyrite occurs as blebs ranging up to the size of a man's hand, scattered through pyrrhotite, and occasionally forms a band along the walls of the ore body. It encloses coarse crystals of both cassiterite and arsenopyrite, but appears to have crystallised prior to all the other sulphide minerals in the ore, since they are found filling fractures in the pyrite, or invading, or corroding isloated pyrite crystals.

The second development of pyrite is uniformly fine-grained and is derived from the alteration and replacement of pyrrhotite. Many of these crystals are less than 0.010 mm. in diameter and are sometimes intergrown with carbonate gangue and sometimes aligned along a vein of carbonate, which may also be a product of the same alteration. The fine grained pyrite occurs along the marginal edges of pyrrhotite or extends into it as bays or traverses it as seams or veins (Fig. 3). Occasionally it occurs in veins a centimetre or so wide in large masses of pyrrhotite, and in these, as in the narrower fractures, the pyrite tneds to be concentrated along the walls of the vein, while carbonates with lesser amounts of fluroite and quartz fills the centre of the vein. In this case the pyrite tends to show a banded structure arising from minute inter-leavings of carbonate more or less parallel to the wall.

In specimens from Reid's Lode, this fine pyrite is intimately associated with marcasite giving rise to in places to a form suggestive of "lamellar marcasite". The presence of corroded areas of pyrrhotite within the pyrite-marcasite areas is clear evidence of their residual character. It is an alteration that occurs during the development of the lodes and is not related to weathering.

Pyrrhotite

Pyrrhotite is the most abundant sulphide mineral in all the floors and feeders examined, with the exception of the Lead Lode feeder, and the floor from it that is exposed along the northern slope of Renison Bell Hill and in the Emu Bay Railway cutting.

The grain size of the pyrrhotite varies considerably from place to place, depending largely on the grain size of the associated quartz and arsenopyrite. It tends to be coarser in the feeders than in the floors, though this is not always so, and because finer as the individual floors are followed down the dip away from the feeders. It also shows some tendency to be finer-grained close to the walls of the ore bodies.

Pyrrhotite encloses crystals of arsenopyrite and pyrite, and commonly forms veinlets and threads ramifying the former mineral, but rarely the latter. It also encloses cassiterite and quartz crystals, and frequently forms irregular areas filling the grain boundaries and intersices between clusters of cassiterite crystals. Sometimes it fills fractures through cassiterite crystals and, more frequently, through quartz grains.

Pyrrhotite itself is fractured and invaded by the later-formed sulphides. In places it has been considerably altered to pyrite. In some specimens from the Dreadnought Lode it is ramified by carbonate gangue.

Microscopic amounts of pyrrhotite also occur as parallel strings of ex-solution bodies in sphalerite. This association has developed with the deposition of sphalerite and is thus subsequent to the main masses of pyrrhotite in the ore bodies.

Chalcopyrite

Chalcopyrite is present only in very small amounts, but it is more abundant in Reid's Lode than in other ore bodies. In specimens rich in chalcopyrite it occurs in such intimate intergrowth with pyrrhotite as to leave little doubt that they were deposited more or less simultaneously.

Sometimes chalcopyrite appears in the secondary veins of pyrite and carbonate derived from the alteration of pyrrhotite in Reid's Lode; but it is possible that such chalcopyrite was present in the pyrrhotite prior to alteration.

Chalcopyrite occurs also as minute ex-solution bodies both in sphalerite and stannite. In the sphalerite, the ex-solution bodies of chalcopyrite occur in parallel strings, and it is clear that they have tended to segregate and coalesce, but that this trend has been arrested before they could dffuse completely into the grain boundaries of the sphalerite. The reverse association, feathery ex-solution bodies of sphalerite in chalcopyrite, was noted in one or two specimens. In the stannite, the chalcopyrite bodies are so minute that most of them can barely be distinguished under high magnifications.

Stannite

Stannite in the Renison Bell ore bodies was first demonstrated by Hartwell Conder (Bull. Geo. Surv. Tas., No. 26, 1918, p. 63) from chemical analyses of ore from Robertson's workings near the south end of the Montana Lode.

Small amounts of stannite have been observed in the majority of the ore bodies. In the polished section it resembles tetrahedrite in appearance, but is slightly darker grey in colour and distinctly whiter than sphalerite. It is distinguished from both these minerals by its anisotropism and by the fact that it can be etched by 1 : 1 HNO_3. The relative proportion of stannite to cassiterite in the ore at present being mined is small and is shown by the following assays of a stannite-rich specimen from Reid's Lode:

Soluble Tin	0.04%
Insoluble Tin	1.71%

which is equivalent to 0.14% of stannite and 2.18% of cassiterite.

Stannite mostly occurs in association with chalcopyrite. It appears with chalcopyrite in veinlets penetrating quartz, arsenopyrite or pyrrhotite in Reid's Lode, the Battery Lode and the Dreadnought Lode. It occurs in small plates in areas of chalcopyrite associated with pyrrhotite (Fig. 4), and frequently, when included in pyrrhotite or gangue, it is still surrounded by a thin rim of chalcopyrite. The largest area of stannite observed in these cases measured .086 x .052mm., but mostly they are very much smaller.

It has also been observed in the pyritic-quartz ore from the Lead Lode feeder where the stannite, accompanied by a trace of chalcopyrite, occurs as inclusions and stringers in coarse pyritic crystals and quartz and is sometimes associated with sphalerite. It also occurs in the massive pyrrhotite from the Black Face floor of the Lead Lode associated with traces of sphalerite. Sometimes it surrounds the sphalerite and sometimes intersects the sphalerite as a vein.

Stannite also occurs in a galena-rich specimen from the footwall of the Lead Lode feeder. Here it is associated with unreplaced residuals of gangue which are studded with pyrite and arsenopyrite. Stannite is associated with sphalerite, sometimes moulded on pyrite and arsenopyrite and sometimes in isolated irregular areas in the gangue. In areas of more advanced replacement by galena, residual particles of gangue, pyrite and stannite appear in the marginal galena, sometimes with tetrahedrite moulded on the stannite.

Native Bismuth

A number of small areas of native bismuth were observed in specimens from Reid's Lode. The largest of them measured 0.030 x 0.015 mm., and the smallest 0.003 x 0.003 mm. The bismuth was identified by its pinkish colour, its strong power of reflection, its softness, and its anisotropism. It was blackened immediately by 1 : 1 HNO_3, and the resulting solution gave a strong test for bismuth when treated with caesium chloride and potasium iodide. The majority of the bismuth particles occured in the interstices of pyrrhotite grains, close to areas of chalcopyrite. One relatively large area of bismuth occured at the junction of the two, and was moulded on the chalcopyrite. In another section, the native bismuth was moulded about a cassiterite crystal enclosed in pyrrhotite, and associated with veinlets of chlacopyrite through quartz and through arsenopyrite.

Native bismuth was also present in specimens from the Battery Lode feeder, accompanying veinlets of chalcopyrite and pyrrhotite through quartz. In one section three particles measuring 0.090 x 0.060 mm., 0.060 x 0.045 mm., and 0.045 x 0.015 mm. occured at the contact of chalcopyrite and pyrrhotite, while in another section three further particles were observed in quartz, close to a chalcopyrite veinlet.

Sphalerite

Sphalerite is a minor constituent of the ore. It occurs in scattered crystals in coarse pyritic ore and in massive pyrrhotite. Small insignificant areas may be associated with the larger areas of chalcopyrite, but it is mostly developed in the galena-rich patches of the ore bodies, particularly along the footwall of the Lead Lode feeder. The coarsest grained sphalerite observed occurs in a specimen from the Dreadnought Lode, and from its dark colour and abundant ex-solution inclusions of pyrrhotite and chalcopyrite it is probably an iron-rich marmatite. Sphalerite-rich patches have also been observed in the Battery Lode and the Montana Lode.

Tetrahedrite

Tetrahedrite is restricted to those patches of ore rich in galena. It occurs either as small irregular-shaped blabs in coarse galena crystals or a small elongated particles dispersed along the cleavage planes or between crystals of galena. In addition to its distribution throughout the crystals of galena, it also occurs in the Battery Lode in clusters in galena frequently near the margin of remnants of partially replaced pyrrhotite. Most of these clusters are associated with jamesonite and appear to be larger plates of tetrahedrite which have partly altered to jamesonite.

Tetrahedrite sometimes accompanies areas of sphalerite either as inclusions and veins, as in the Montana Lode, or areas of chalcopyrite, as in a specimen from the Dreadnought Lode. In the footwall of the Lead Lode it appears at times in contact with canfieldite.

Tetrahedrite is probably the most important silver-bearing mineral of the ore, and the Rejected Sulphide Float with insignificant quantities of galena has an assay value of 23.15 dwt. per ton.

Jamesonite

The observed occurrence of jamesonite is restricted to the occurrence of galena in the Battery Lode. It occurs as fine prisms and small plates in galena and, as these are very similar in colour to galena, it is distinguished from galena on well polished surfaces by its pleochroism and anisotropism. It can be etched with HNO_3 and KOH and belongs to the group of lead antimony sulphides and is probably jamesonite. It is constantly associated with clusters of tetrahedrite particles in a manner suggesting that plates of tetrahedrite have been partially altered to jamesonite.

Galena

Galena occurs in small quantities sporadically throughout the several ore bodies as inclusions and replacing veins in arsenopyrite, pyrite, pyrrhotite. Locally it becomes a more abundant mineral, and it is best developed in the Lead Lode, which takes its name from the occurrence of a persistent band of galena, two or three feet wide, along the footwall.

Galena appears to have been the last of the sulphide minerals to crystalise since it can be observed corroding and veining them all, including the sphalerite that is generally associated with it.

Canfieldite (Stanniferous Argyrodite)

Associated with the galena in the Lead Lode are few particles of a silver mineral which appears to be related to argyrodite ($4Ag_2S, GeS_2$) and canfieldite ($4Ag_2S, (SnGe)S_2$). It occurs as minute rounded inclusions in galena, sometimes as part of composite inclusions with tetrahedrite and sometimes in larger areas with quartz and tetrahedrite. The colour of this mineral on the polished surface is a greyish-white with a tint of violet. It is darker and greyer than tetrahedrite, with which it is frequently in contact. It is also darker and greyer than stannite. When exposed under high powers to an unscreened electric light, it rapidly develops black spots, the so-called light etching, which conclusively establishes it as a silver mineral. Its hardness can be observed to be greater than that of galena and softer than tetrahedrite. It has no internal reflections and it is either isotropic or very weakly anisotropic. Etching tests appear to be negative with HNO_3, HCl, $FeCl_3$, and KOH. It appears to darken and develop scratches with KCN, while it is immediately etched with $HgCl_2$ producing an iridescent tarnish. These etching tests conform with argyrodite, and no other silver mineral except canfieldite presents the above combination of reflectivity, colour, hardness and isotropism. Canfieldite is reported to react with HNO_3 and KOH, but as canfieldite and argyrodite are believed to form mixed crystals, the difference in etching will vary between the extremes with the composition of the mixed crystal. The mineral association in this case makes it appear probable that the Renison Bell mineral is tin bearing, and that it is stanniferous argyrodite or canfieldite. On this view, the slight differences in etching are discounted because the difference between a negative etching test and a weakly positive test is very slight. The particles have been regarded as too minute to secure uncontaminated material for microchemical tests.

An unidentified material adjoins the largest area of stanniferous argyrodite and in places the argyrodite appears as corroded residuals in an undetermined base which is also silver-bearing. Aggregates of minute prisms are present in this base which are suggestive of rare lead-tin minerals. For this reason, and for the teasion that germanium minerals are extremely rare, the investigation of further material is warranted as opportunity offers.

Gold

A particle of gold, measuring 0.042 x 0.075 mm., was observed associated with carbonate at the contact of a crystal of cassiterite and pyrite in quartz-arsenopyrite ore from the feeder of the Battery Lode.

The amount of gold in the ore is very little, however, and no further particles of gold could be found even by treating the sized concentrates and reject products of the Renison Associated Tin Mines mill on the Haultain superpanner. An assay of the Rejected Sulphide Float was 0.25 dwt. of gold per ton. An assay of the final tin concentrates was 0.05 dwt. per ton.

Magnetite

Magnetite was not observed in situ, but occasional grains of magnetite, showing incipient alteration to hematite along octahedral planes were observed in various mill products of the Renison Associated Tin Mines.

Non-Sulphide Gangue Minerals

Quartz is the most abundant of the non-sulphide gangue minerals. It shows a pronounced tendency to occur as small idiomorphic prisms, of uniform size and very irregular orientations. Individual crystals are rarely more than 5 mm. long by 1 mm. thick. The grain size varies somewhat from place to place and, in so far as the sulphide minerals tend to fill the intersectices in this meshwork of quartz prisms, it controls the grain size of the sulphide minerals. In the oxidised ore from the sulphides are largely leached, the meshwork structure is strikingly displayed.

Tourmaline invariably accompanies the quartz and is inter-grown with it. It occurs, like quartz, as prisms, though much smaller ones, their length only occasionally exceeding 0.10 mm. They constitute a very much smaller bulk of the gangue minerals.

Fine-grained topaz was observed in sections from Reid's Lode, in bands through the quartz-tourmaline gangue. It presumably occurs in all the lodes at present being worked, since a considerable amount of topaz occurs in some of the mill products of the Renison Associated Tin Mines.

The chief non-sulphide gangue other than quartz is an iron-magnesium carbonate which is known locally as dolomite. A partial analysis of a sample of the massive carbonate from the Cable Lode shows that it has a composition between siderite and magnesite.

$FeCO_3$	69.3%
$MgCO_3$	27.8%
$CaCO_3$	2.9%

Cabonates of this composition have been called pistomesite. It appears to be more important as a gangue constituent in the final stages of the crystallisation of the lodes.

Fluorite commonly accompanies the carbonate gangue in crystals of varying size. It appears as one of the diluents of the table concentrates of cassiterite.

Frank [illegible]. Stillwell.