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A REPORT ABOUT STANNITE
FROM
BRITISH COLUMBIA

by

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This report partially fulfils the
requirements of the course
of Geology 409

University of British Columbia

April 23rd., 1952.

ACKNOWLEDGMENTS

The writer offers his sincere thanks for the assistance which he received from Dr. R.M. Thompson and Mr. J. MacDougall.

Mr. MacDougall, besides his help in the laboratory, took the photomicrographs which are incorporated in this report.

Dr. Thompson, by his X-ray analysis, has identified two exsolution intergrowths which have not been reported previously.

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INTRODUCTION

LOCATION and ACCESS

The Snowflake group is situated on Clabon Creek, which is a southerly flowing tributary of Woolsey (Silver) Creek. Woolsey Creek flows into the Illecillewaet River about $1\frac{3}{4}$ miles below Albert Canyon. There is a flag-stop (Snowflake Siding) on the Canadian Pacific Railway, which is 21 miles east from Revelstoke and 6 miles south of the Snowflake property.

From the siding the location is now reached by a caterpillar road, the upper part of which is steep. At one time, a gasoline-drawn skip conveyed passengers over the most precipitous stretches to the mine workings.

TOPOGRAPHY

The topography is mountainous: the steep hillsides slope toward the bed of Clabon Creek with an average angle of 26 degrees. The mine tunnels are between 5500 and 6000 feet above sea level. Higher rock bluffs on the property are the starting points for winter snowslides.

HISTORY of the PROPERTY

The original stake was made in 1922 by Gus. Hedstrom and Ole Sandberg, and consisted of 9 claims. The property was sold by the original owners to the Snowflake Mining Company, Limited, of Vancouver. This was in 1927: in 1928 three more claims were added by the company.

Stannite was discovered in 1929 in the underground workings.

In 1930 extension of the main adit onto Regal Silver property was carried out by the Regal Silver Mines, Limited. The arrangement made between the two companies is not known: there is a paucity of information about the Snowflake property between the years 1929 and 1950.

The Stanntie Mines, Limited, of Vancouver, (9, p.158) was incorporated between the years 1940 and 1950. Its property consisted of the Snowflake group and the claims held by the Regal Silver Mines, Limited, this latter company having been struck off in August 1940 (12). During 1949 and 1950 some work was done, mainly on the old Regal grounds.

Columbia Base Metals, Limited, is the present owner and exploration is in progress.

Throughout the life of the Snowflake and the neighbouring Woolsey groups, the main minerals of value have been sphalerite and argentiferous galena. The discovery of stannite in the Snowflake workings created a new interest in the area. The mineral was subsequently identified from the bordering groups. Assays, however, have shown a low average tin content. Sphalerite and galena continue to be the two important minerals, and hand picked ore has periodically been shipped, and all the returns have been for silver, lead, and zinc.

GEOLOGY

GENERAL GEOLOGY

The geology of the area was mapped in 1928 (5, pp.140-151). The dominant rocks consist of a thick series of sediments interbedded with minor volcanic rocks, all of which have been metamorphosed. These rocks are part of a series of Precambrian age, known as the Shuswap complex. Mesozoic, probably post-Triassic intrusions of granitic and pegmatitic stocks, dykes and sills cut the earlier strata (figure 1).

The main structure is a broad synclinal trough, within which the rocks are complexly folded into a series of anticlines and synclines. The structure, which trends northeasterly, is overturned to the southwest (1, p.627) and plunges to the southeast. Faulting is on a minor scale.

LOCAL GEOLOGY

The veins of the Snowflake group occur in black, graphitic argillites. These are part of the quartzites, argillites, impure limestones, and greenstones of the Precambrian strata. The veins are parallel to the bedding.

The beds and veins strike northwesterly and dip to the northeast. The dips become progressively shallower from the upper Snowflake group, down the slope in a northeasterly direction, onto the lower Regal Silver property. The mine is therefore on the southwest limb of a syncline.

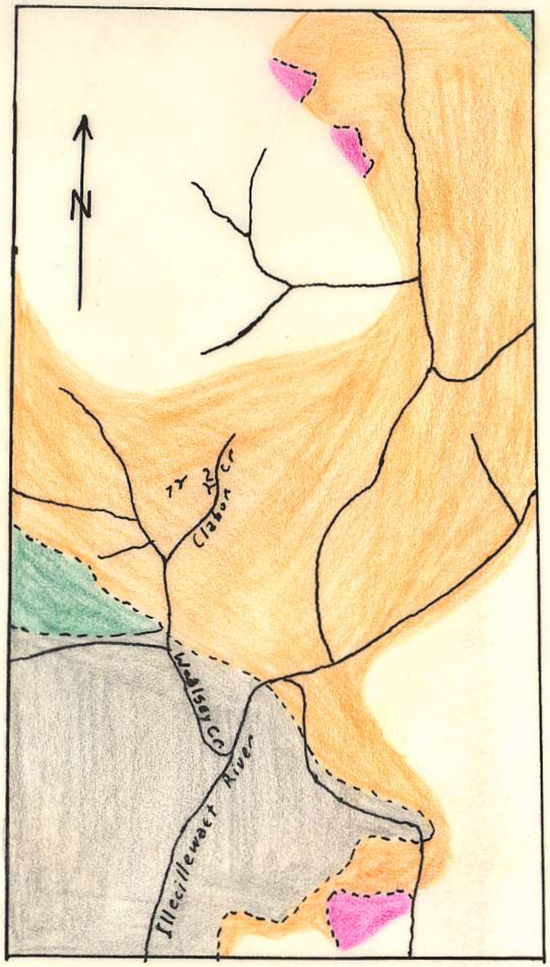


FIGURE 1

Taken from Map 237A of Can. Geol. Surv., Summ. Rpt., pt. A, 1928.

1 = Snowflake Adit

2 = Regal Silver (Woolsey) Adit

MESOZOIC

Post Triassic

Porphyritic granite, granite, porphyritic granodiorite, and quartz diorite

MESOZOIC and PRECAMBRIAN

Granite gneiss, sedimentary gneiss, quartzite, schist; all cut by granite and pegmatite

PRECAMBRIAN

crystalline limestone, argillite, quartzite, and schistose derivatives

mica schist, quartzite and greenstone, minor amounts of argillaceous schists and crystalline limestone

The veins are continuous along the strike over several hundred feet. Seven veins were uncovered on the Regal Silver property, filling fissures which are nearly parallel to the bedding. The larger veins vary in width from 2 to 20 feet, including the fragments from the crushed wall rock, and the vein quartz. There is a larger percentage of rock fragments in the wider parts of the veins.

There is a rather pronounced joint system which strikes northeast and dips steeply to the southwest.

Post vein faults are numerous (12, p.85). They are of two main types: (1) transverse, intervein faults, which strike east and dip steeply northward, and (2) parallel, intra-vein faults, that lie within the veins.

The transverse faults cut the veins at approximately 45 degrees and offset the veins across the strike of the fault. No major transverse fault has been observed in the Snowflake level, but there are several on the neighbouring property.

The intra-vein faults have moved the vein walls relative to one another, but this movement cannot be measured. This type of fault is present in the Snowflake level.

MINERALOGY

ORE DEPOSITS

The ore deposits are sulphides and sulphosalts in quartz veins which commonly pinch and swell along their strike. As previously mentioned, wall rock fragments are of frequent occurrence within the vein material. There are a few small subsidiary stringers cutting across the strike of the strata (5, p.182). In these, mineralization is sparse, and there is no lateral replacement of favourable rocks, such as the carbonate beds.

Mineralization on the main veins has occurred by the replacement of quartz, and the argillite fragments in places, by pyrite. Stannite is normally a replacement product of pyrite, but locally it fills open spaces in the vein, along with second generation quartz.

The ore is usually confined to shoots, but occasional lenses occur. The ore shoots are irregular and exhibit a crude banding, which thins and broadens with the pinch and swell of the veins. These shoots are most common on the foot-wall side of the veins.

Intra-vein faulting has occurred at various times throughout the period of deposition. The milky-white, first generation quartz exhibits a "bedding" or "tabular fracture", which has been caused by the shearing. In some cases, these fracture planes abut abruptly against pyrite or stannite: in other cases, the crack is continuous through the metallic mineral. Most of the crystals of second generation quartz, which fill or partly fill the vugs, have been fractured. Also, a lamina of argillite, polished and striated by fault movement, has contained crystals of pyrite which are likewise scratched. These features provide good evidence to prove more than one period of fault movement.

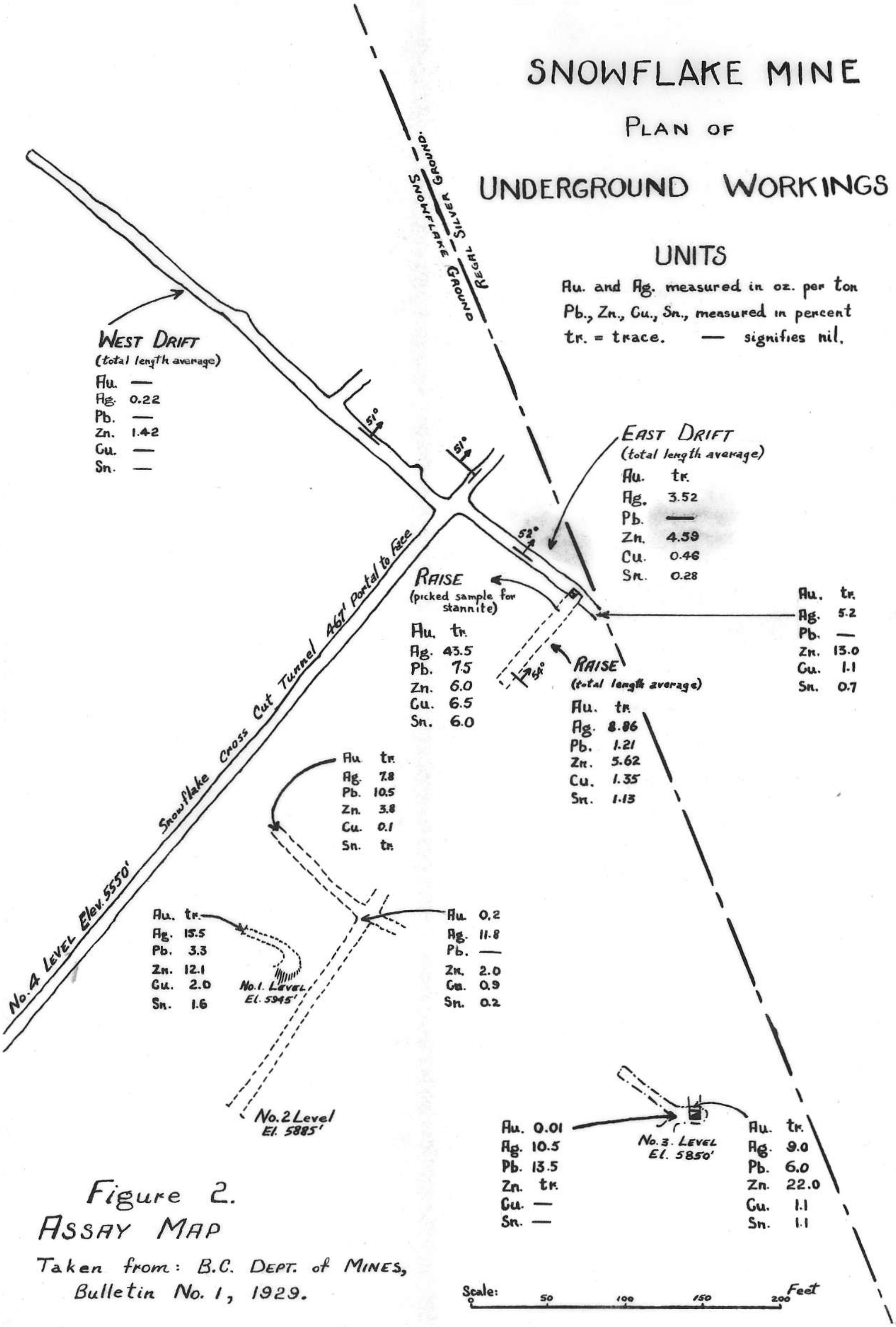


Figure 2.
ASSAY MAP

Taken from: B.C. DEPT. of MINES, Bulletin No. 1, 1929.

As a result of the faulting the ore was fractured and is now quite brittle.

In the hand specimens, quartz, pyrite, and stannite were seen. Quartz was the most abundant, comprising about 65 percent of the whole, with pyrite and stannite in equal amounts. Some assay results (4) are included on an assay map (figure 2) for further elucidation.

MINERALOGRAPHY

Six minerals, including the gangue quartz, were identified in polished surfaces under the microscope. In order of decreasing abundance they are: quartz, pyrite, stannite, sphalerite, galena, and chalcopyrite.

All polished sections contained pyrite; most contained stannite and chalcopyrite; and a few contained galena and sphalerite. An approximate percentage of the minerals from the seven sections would be: quartz, 45%; pyrite, 22%; stannite, 17%; sphalerite, 12%; galena, 3%; and chalcopyrite, 1%.

CHALCOPYRITE. Tetragonal scalenohedral: a 5.24, c 10.30, and a:c:1.9705. $CuFeS_2$

Chalcopyrite was identified by its brass yellow colour, hardness of C, smooth polished surface, and etch reactions. Rather weak anisotropism was noted from a few of the largest blebs. It appeared brass yellow against all minerals with which it had a common boundary. It had negative relief against sphalerite and had only slightly negative relief against stannite (see further under stannite).

The mineral occurred as an exsolution product from stannite and from sphalerite. This textural relationship was not immediately apparent because chalcopyrute was usually seen as disseminated specks from 10 to 160 microns in diameter within the sphalerite or stannite. However, in a few places the texture between the two pairs of minerals was diagnostic of exsolution.

Figure 3 shows chalcopyrite ribs and blebs in an oriented fashion within sphalerite. In one polished section, a chalcopyrite rib 330 microns long was noted. Figure 4 is a drawing of chalcopyrite in stannite.

The disseminated blebs are not plentiful enough to apply the term "mottled texture". In the opinion of the writer, the diagnostic mottled texture should not be used unless there is at least 3 percent of the dispersed phase present.

The temperature of unmixing of chalcopyrite from sphalerite (2, p.79) is between 350 and 400 degrees Centigrade. For chalcopyrite-stannite (2, p.72) the unmixing temperature is 500 degrees Centigrade.

<u>GALENA</u>. Isometric hexoctohedral: a 5.93 PbS

Galena was identified by its white colour, hardness of B, smooth polished surface, isotropism, and etch reations. It was the softest mineral encountered in the assemblage, and stood with negative relief against all others. It was white against all other minerals.

The mineral was seen as masses, varying in size from less than 10 microns to a mass 475 microns long by 200 microns wide. The average size was about 250 microns.

Two varieties of galena were present in the polished sections: one was galena with an intergrowth of stannite, identified by Dr. Thompson; the other was galena alone, here called ordinary galena.

The ordinary galena was found replacing sphalerite and stannite. The boundaries of the galena-sphalerite contacts displayed reverse caries texture (2, p.107), which seems to be typical of these two minerals. This situation was duplicated (figure 5) at ordinary galena-stannite boundaries. It may be that the textures of galena with stannite and with sphalerite are similar because of the nearly equal solubilities of sphalerite and stannite (see further under sphalerite).

The galena-stannite intergrowths (figure 6) were associated with stannite. Superficially, an intergrowth looked like ordinary galena, but on moving the microscope out of focus, by lowering the stage, darker ribs were seen to stand out from the main mass. These ribs were anisotropic while the groundmass was isotropic. Etch reactions (11, p.129, p.144) also proved the presence of two minerals.

Generally galena was in excess of stannite in the intergrowth, but in two or three places the two minerals were in about equal amounts.

In the deposition of stannite and galena there are only four possible combinations. If it is assumed that sphalerite, unless otherwise stated, is earlier than stannite, these four combinations are: (a) two generations of stannite and one of galena. In this case, sphalerite would be deposited first; then stannite; then galena, some with stannite in solid solution.

(b) two generations of galena and one of stannite. Here the order of deposition would be: sphalerite; then stannite, some with galena in solid solution; and finally galena.

(c) two generations of each mineral. This would result in the deposition of sphalerite; then stannite, some with galena in solid solution; and lastly galena, some with stannite in solid solution.

(d) one generation of each mineral. In this case sphalerite, stannite, and galena would be contemporaneous, and some galena would have stannite in solid solution.

The reverse caries texture, shown by galena with stannite (figure 6) and with sphalerite, indicates that galena is interstitial to, or replaces these minerals, and is therefore the last of the three to be deposited. On this fact possibility (d) is ruled out, and possibility (c) is rendered improbable. It was previously stated that in the stannite-galena intergrowth, the galena was generally in excess; that is, galena was the solvent. From this evidence, only one generation of galena is indicated, which makes possibility (b) improbable.

The most probable order of deposition was sphalerite; then stannite; then galena, some of which had stannite in

Have you considered replacement?

solid solution. The range of temperature of unmixing of stannite from galena has not been determined to date.

SPHALERITE. Isometric hextetrahedral. a 5.400 ZnS.

Sphalerite was identified by its grey colour, hardness of C+, rather smooth polish, orange internal reflection and powder, and its isotropism. It had negative relief against quartz and pyrite, and positive relief against all others, with which it was in contact.

The mineral ranged in size from blebs 65 microns in diameter to masses over one millimeter across. Grains of this size, which were not uncommon, should have been seen in hand specimens. Possibly the irridescent tarnish of the stannite masked the presence of sphalerite.

Sphalerite was deposited earlier than galena, and later than pyrite. Pyrite-sphalerite contacts displayed good caries texture (2, fig.122) in many places.

The relationship between sphalerite and stannite were more obscure. In the first place, the colour of stannite against sphalerite was not grey, but was cream yellow. In most places no definite conclusions could be rexched as to which of the two minerals was deposited first. Rarely (figure 7), the evidence seemed to indicate that stannite was later than sphalerite. The textures were not diagnostic enough to indicate whether stannite was exsolved from sphalerite, or replaced sphalerite.

Stannite-sphalerite solid solutions (2, p.73) are known to exist, and that either mineral can act as the solvent. Therefore, the possibility of exsolution is not precluded. Previous study (6) of Snowflake ore did not find any conclusive evidence that stannite was later than sphalerite. It was stated that the two minerals would be about contemporaneous.

Another factor to be considered is that, in some polished surfaces stannite was predominant, with practically no sphalerite; while in other sections, sphalerite was predominent, with only minor stannite. In no section were they in approximately equal amounts. Assay results (figure 2) show that sphalerite was generally in marked excess over stannite, except for one sample taken from the raise. This might explain the preponderance of stannite in some polished surfaces.

The present writer agrees with the conclusions reached in the former study; that is, stannite seems to be nearly contemporaneous, or slightly later than the sphalerite.

PYRITE. Isometric diploidal. a 5.405 FeS_2

Pyrite was identified by its pale brass yellow colour, hardness of F, poor polished surface, isotropism, and euhedral cubic crystals. It had positive relief against all other metallic minerals.

Remnants of pyrite as small as 25 microns in diameter were noted. Euhedral crystals were noted as small as 200 microns in polished sections and as large as 15 millimeters in hand specimens.

Pyrite was the earliest of the metallic minerals to be deposited. It was found replacing quartz and also the fragments of wall rock within the quartz. The mineral was replaced by sphalerite and by stannite. Fractures in pyrite were often the loci of replacement. More commonly however, caries texture was exhibited at pyrite-sphalerite, and pyrite-stannite boundaries. Occasionally, a bleb of stannite was found entirely within a crystal of pyrite.

There was no indication of more than one generation of pyrite.

The writer found that pyrite was weakly anisotropic in one rare instance.

STANNITE. Tetragonal scalenohedral: pseudo-octohedral
a 5.46, c 10.725, a:c::1:1.9666 $Cu_2(Zn,Fe)SnS_4$

Stannite from the Snowflake property differs in several respects from the stannite of better known localities. It was therefore studied in considerable detail so that these differences may be verified and incorporated in the pertinent literature.

In the hand specimens, both massive and disseminated stannite were observed, the former often having a bluish tarnish.

1 Ref.

Chemical analysis showed that zinc was present. The zinc occurred at the expense of iron, so that the formula for stannite from the Snowflake mine should be written $Cu_2(Zn,Fe)SnS_4$. The copper content was higher, and the tin content lower than in stannite from more famous mines other localities. Listed below, are the analyses of several samples of stannite, the first five (8, p.225) are from Bolivia, and the sixth (5, p.185) from the Snowflake mine.

	1	2	3	4	5	6
Copper	29.58	31.52	29.00	29.38	29.24	31.56
Iron	12.99	12.06	13.75	13.89	13.95	3.65
Tin	27.61	27.83	27.50	27.20	27.14	26.65
Zinc	---	---	0.75	0.02	0.08	7.72
Sulfur	29.82	28.59	29.00	28.77	28.88	29.76

Stannite in polished surfaces had a brownish grey colour, except when in contact with sphalerite, where the colour was cream yellow. The hardness (11, p.148) is given as D+. The present writer found that the Snowflake stannite was C+, and had a negative relief against sphalerite.

Etch reactions were negative to all reagents below nitric acid, which itself gave occasional negative tests.

The mineral is anisotropic, often markedly so. The polarization colours were rust brown and dark grey for the grey variety; and yellowish brown and violet for the cream yellow coloured stannite. It did not exhibit pleochroism or internal reflection. ?

Under crossed nicols, twinning (figure 8) was occasionally seen. The twin laminae were well defined, and in rare instances were 70 microns wide. Several curved twin lamellae were observed.

A fine, sub-graphic intergrowth (figure 9) was noted under crossed nicols. The intergrowth was more pronounced in places where stannite displayed strong anisotropism. Etch reactions gave similar tests for both stannite and the exsolved mineral. Physical properties were also alike, except for the colour difference under crossed nicols.

X-ray analyses, made by Dr. Thompson, gave good patterns of stannite and the intergrowth mineral. Unfortunately, the patterns did not fit any of the minerals which are known to exist in solid solution with stannite (10).

Stannite ranged in size from blebs 15 microns in diameter to the massive material of the hand specimens. The smaller blebs of it were usually associated with sphalerite.

The associations of stannite have been given with the preceding minerals. Blebs of chalcopyrite were few. The galena-stannite intergrowth was associated with the massive stannite, which was not usually in contact with sphalerite. Stannite replaced pyrite, displaying caries texture; or where it was associated with sphalerite it was contemporaneous or later than the sphalerite.

GANGUE MINERALS.

The gangue was quartz, with some argillaceous wall rock material. The quartz is rather coarsely crystalline. Most of it occurs early and is replaced by pyrite: some however, is later than the metallic mineralization.

The argillite is dense and black. It has been replaced by pyrite, in disseminated euhedral crystals. Argillite appeared to be unfavourable to the later metallic minerals because only rarely was stannite found replacing pyrite which was within the argillite. No other minerals were noted in the argillite.

PARAGENESIS

The writer concerned himself with the stannite mineralization from the Snowflake. Tungsten and silver minerals (6, p.223) do occur at the Snowflake mine but they will not be included in the present paragenetic sequence.

The paragenesis of the Snowflake tin ore is:

1. Fracturing and shearing to produce fissures.
2. Deposition of coarse, milkwhite quartz veins.
3. Intra-vein fault movement, causing crushing of the quartz.
4. Pyrite, as massive replacement of quartz and disseminated replacement of argillite fragments.

5.a. Sphalerite replaced pyrite. Exsolution of chalcopyrite between 350 degrees and 400 degrees Centigrade. Associated stannite deposited contemporaneously with, or slightly later than the sphalerite.

5.b. Stannite replaced pyrite where not in association with sphalerite. Chalcopyrite exsolved around 500 degrees Centigrade.

6. Galena replaced stannite and sphalerite.
7. Depostion of quartz, which filled, or partly filled vugs.
8. Intra-vein fault movement.

It is not certain whether the galena replacement preceded or succeeded the second generation quartz and the last fracturing.

The stannite deposition was probably hypothermal.

CONCLUSIONS

The stannite from the Snowflake mine is unique in several ways. The mineral is not associated with cassiterite; it is apparently softer than the usual stannite; it contains an intergrowth, which is unknown; and it occurs as an exsolution in galena.

The writer realizes that his recent study was quite limited, and that subsequent work will reveal new information, as well as mistakes in the present investigation.

When future examination is undertaken, several details should be given particular attention. These are:

1. The textural relationships between stannite and sphalerite, to establish whether stannite repalaced sphalerite, or whether they were exsolution intergrowths.

2. The two stannite intergrowths, as they have not been reported upon previously, are of especial interest.

3. The tungsten and silver minerals should be included in the investigation.

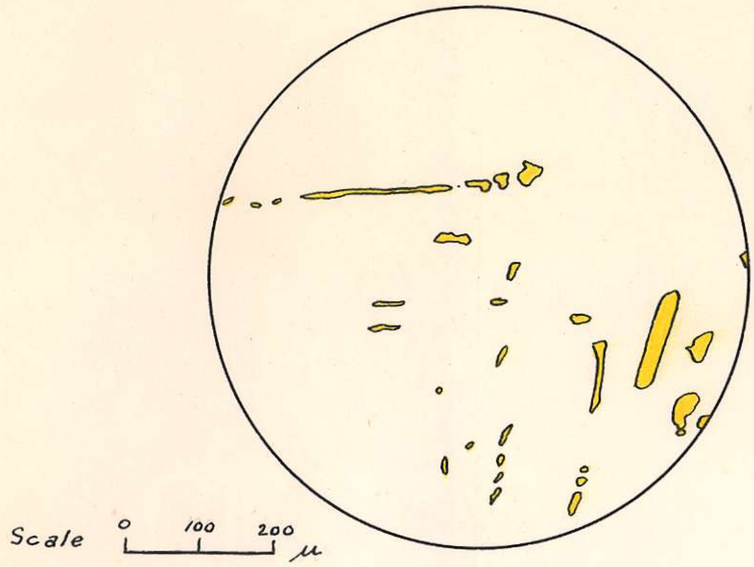


FIGURE 3

Exsolution of Chalcopyrite (yellow)
from Sphalerite (white)
(Polished Surface No. 7)

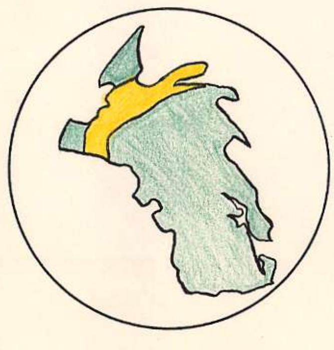


FIGURE 4

Scale 0 100 200 μ

Exsolution of chalcopyrite (yellow) from
stannite (green) in sphalerite (white)
(Polished Surface No. 7)

FIGURE 5

Scale 0 50 100 μ

Textural relationships between pyrite (orange), galena (blue) and stannite (green). Holes (white) (Polished Surface No. 4)

FIGURE 6

Scale 0 100 200 μ

Stannite-galena intergrowth (etched with HNO_3) within stannite
(Polished Surface No. 6)

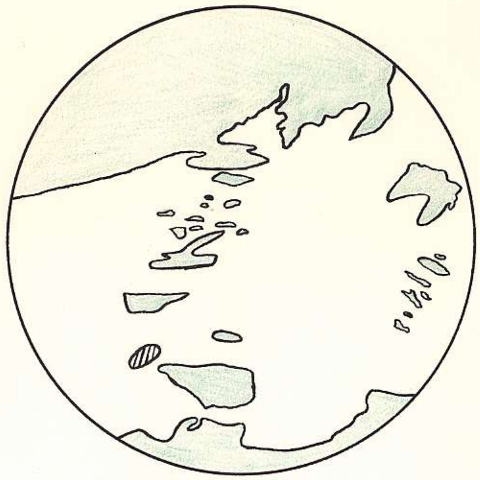
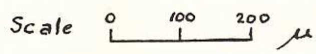


FIGURE 7



Texture of stannite (green) and
sphalerite (white). Hole (hatched).
(Polished Surface No. 3)

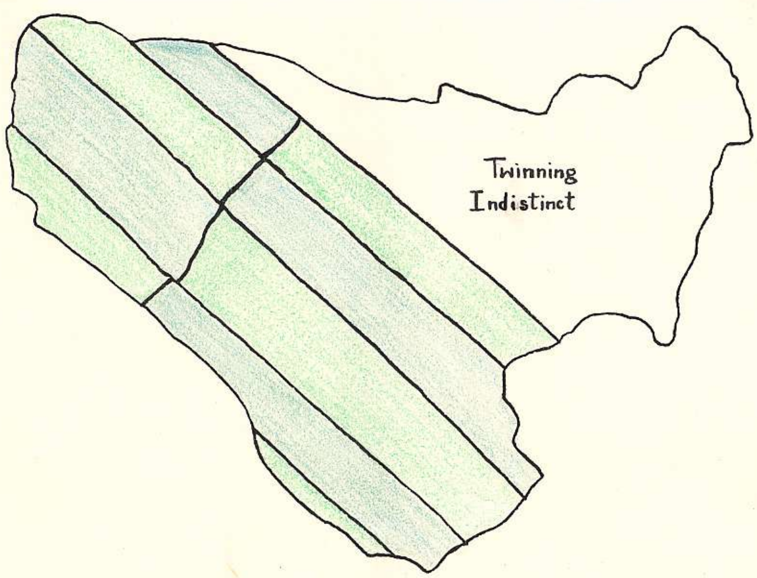
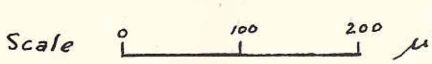


FIGURE 8



Twinning of stannite (crossed nicols).

FIGURE 9

Scale 0 100 200 μ

An unknown mineral

exsolved from stannite:

sub-graphic intergrowth.

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