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REPORT ON A MINERALOGICAL EXAMINATION OF ORE

from

THE PROTECTION MINE (GOODENOUGH)

NELSON MINING DIVISION

YMIR, B. C.

for

GEOLOGY 409

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University of British Columbia
April 9th, 1948

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T A B L E   O F   I L L U S T R A T I O N S.

ABSTRACT

A mineralogical examination of a suite of ore from the Protection (Goodenough) Mine, Nelson Mining Division, B. C., is undertaken. The ore is found to be largely comprised of sphalerite, galena, and pyrite, with a quartz gangue. Minor amounts of chalcopyrite, pyrrhotite, and tetrahedrite? are found. A spectroscopic examination revealed silver in the galena and cadmium in the zinc. The order of deposition is concluded to be: pyrite; quartz; pyrite; sphalerite, chalcopyrite, pyrrhotite; tetrahedrite, galena, and quartz.

ACKNOWLEDGEMENTS

The author is indebted to Dr. H. W. Little of the Geological Survey of Canada for the time and permission to collect the samples, and also to Mr. G. Turk and his associates, for their assistance in selecting the samples. The author further would like to thank Mr. J. A. Donnan and Mr. R. Seriphim for making several polished sections. He wishes to express his appreciation for the assistance given by Drs. H. V. Warren and R. M. Thompson.

INTRODUCTION

The author collected this suite of ore in the summer of 1947. The location of the specimens is shown on (fig.3 in pocket). The numbers of the sections are the same as the specimens numbers. Where more than one section is cut from the same specimen the sections are designated by letters. The laboratory examination of the specimens was undertaken in the early part of the following year at the University of British Columbia.

The property is located in the Southeast part of the Province of British Columbia within the Nelson Mining Division of mineral survey district number five. More particularly it is in the Ymir Mining camp, located some eighteen miles South of Nelson (see fig. 1). The mine* is about four and a half miles East of Ymir on the North fork of Wild Horse Creek, at an

* See (fig. 4)

elevation of about 4,200'. It is connected with Ymir by a truck road, over which the ore is hauled to the Great Northern Railway siding at Ymir, for shipment to Trail.

In 1897 the Goodenough claim was crown-granted to C. H. Andrews, according to the Reports of the Minister of Mines of that year. Cockfield (1936) states that the property was optioned in 1899 by the Ymir Gold Mining Co. who sank a 60' shaft. Drysdale (1917) reports that a shipment of 20 tons of $22.00 ore was made in 1898. Not until 1923 was any further work on the reported. Then an attempt was made to pick up the extension of the Ymir vein. The adjoining Ymir claims are to the Northeast. Although the work done on the property has been largely of an exploratory nature, the mine has at times shown a sizeable profit.

The property has had a rather checkered career as a result of the lenticular and discontinuous character of its veins, and the loss of values at depth. In 1926 it was optioned to Porcupine Goldfields Development and Finance Co. Ltd.; in 1928, to Enterprise Consolidated Mining Co. Ltd., and in 1929 the owners, H. Jackson and associates resumed work on it. Shortly after this it was optioned to Ymir Consolidated Gold Mines Ltd. They operated it jointly with the adjoining Ymir Mine. They did considerable development work, but apparently lost interest when the values were found to terminate at depth. Since 1940 the property has been worked more or less continuously to the date of writing by leasers. The name of the mine was changed from the Goodenough to the Protection in 1945.

The production between 1926 and 1930 was 4660 tons, containing 3993 oz. of gold and 30,283 ozs. of silver and 431, 091 lbs. of lead. Since then rather sporadic shipments have been made. The ore commands a very favorable smelter rate because of its high silica content.

GEOLOGY (See fig. 2)

The country rock of the deposit is black to dark grey argillite (fig. 5). Drysdale was of the opinion that it belonged to the Pend-d'Oreille group of palaeozoic age. New evidence points to a latter age, probably triassic, but the question is still under discussion. This group is tentatively called the Ymir argillite. The rocks near the mine are highly sheared, the veins themselves occupying shear zones. There has apparently been some post ore movement. The author found some slickensided ore.

The Goodenough vein is a quartz filled fracture striking Northeast and dipping steeply Northwest. It splits into two branches a little over two-hundred feet from the adit of No. 1 level. The branches are separated by a sheared zone cut by a number of subsidiary veins. They unite again about 200 ft. farther along their strike. The better grade shoots generally are localized at or near the intersections of granodiorite dikes with the veins, according to Cockfield (1936). Several lamprophyre dikes also cut the veins. The veins are extremely lenticular pinching and swelling irregularly along their strike.

GENERAL MINERALOGY

Cockfield (1936) presumed the ore solutions to be related to the main mass of granodiorite to the East (See fig.2). Possible evidence pointing to this source is the mineralization of the Goodhope Mine, located several miles to the Northeast of the Protection, and almost on the contact. The mineral assemblage on the Goodhope property is similar to that of the Protection, yet appears to indicate a higher temperature of formation than the mineral group of the Protection Mine. The mineralization of the Goodhope is predominantly sphalerite, phyrrhotite, and pyrite. To the best of the author's knowledge no galena occurs on this property. This contrasts to the Protection where galena is abundantly developed and where pyrrhotite occurs only in very minor quantities.

The mineralogy of this mine is typical of all the Ymir Gold deposits, according to Cockfield. The principle minerals are quartz, sphalerite, pyrite, and galena, and the lesser ones are pyrrhotite, chalcopyrite, tetrahedrite? and gold. Some brown tourmaline, identified as dravite, was found in a small vein intersected by the road to the mine. (Marked with a T on fig. 2; see also fig. 5). The vein was of watery quartz and was marked with limonitic stains. The vein borders were sheared and marked by graphite. Whether this occurrence is related directly to the deposit at the mine is open to question. The gangue mineral is invariably milky to watery grey quartz. This may in places contain breeciated, bleached fragments of wall rock. These fragments are soft and do not react with hydrochloric acid, so they may be the unidentified white gangue mineral reported by McEachern (1941). Some of this material occurs in section (16). Stringers of white calcite commonly occur in the sheared argillites, but none was collected with the specimens.

The texture of the ore is generally quite coarse, although crystal outlines can't be seen, the cleavage indicates the coarse texture. The occasional euhedral grain of pyrite may be seen.

DETAILED MINERALOGY

The detailed mineralogical study was made on eight hand polished, and four super polished sections.

QUARTZ: Quartz, the only gangue mineral, occurred early in the sequence of deposition. This is readily ascertained from the relations to other minerals. It is replaced by all the sulphides which commonly occur along fractures in the quartz (fig.11). That replacement has taken place may be seen from the unmatched walls where the sulphides occur. At either end of such regions the fracture has decidedly matched walls. It is the most readily replaced mineral, other minerals replacing it preferentially to sulphides e.g.- (fig.14) where galena is advancing into quartz leaving pyrite behind; also (fig.11) where sphalerite replaces quartz along quartz-pyrite boundary. Quartz occurs commonly as remnants in other minerals. The quartz is apparently unable to replace other minerals to any extent. It fills highly comminuted pyrite with no appreciable replacement (fig.6). It may also be seen abutting cleavage faces of galena, without apparent replacement (fig.8). The relation was only seen in one place and the right angles may have been formed fortuitously. The evidence would seem to indicate two possible ages of quartz,- one after the pyrite, and one after the galena. The gangue quartz at no time shows crystal form, though specimens (89) (from a dump beside surface pits not shown on plan) exhibited vugy cavities lined with excellently developed crystals.

PYRITE

Pyrite is generally anhedral but there are a number of euhedral crystals occasionally occurring as unsupported nuclei in quartz (fig. 12 & 13). Pyrite also occurs along fractures in quartz where unmatched walls indicate that it is replacing quartz. Some fractures in quartz terminate against pyrite. Quartz fills fractured pyrite with only slight replacement of pyrite (fig.6). In hand specimen (16) two distinct textures of pyrite could be seen. This according to Basitin et al (1931) indicates different conditions, and hence an age disparity. Section (17) showed this relation also. Here the more lusterous form clearly cuts the dull one. This feature was inadvertently brought out by etching to heavily with dilute nitric acid in an attempt to outline the silver minerals in the galena. Subsequent through grinding and polishing, failed to entirely irradicate the etch stain from the dull form which apparently absorbed the acid more readily. The pyrite is often cut by sphalite and galena. It is difficult to establish any definite relations with the minor minerals. The above relations point to at least two pyrite ages. ~~One age of~~ pyrite, represented by the unsupported nuclei of pyrite in quartz, and the fractured pyrite filled with quartz, was the first mineral in the sequence of deposition. Then after the quartz is the pyrite occurring along the fractures in quartz and the pyrite against which fractures in the quartz terminate. The relations in (Sec. 17) also represent an age difference.

SPHALERITE

The mineral was determined by the usual methods. Sphalerite cuts both pyrite and quartz. In section (18) pyrite is fractured and filled with sphalerite. Here as opposed to filling by quartz replacement has taken place, indicated unmatched walls. It contains very few minute blebs of chalcopyrite. The chalcopyrite, however, is more abundantly developed near contacts with galena (Sec. 16).

It is commonly cut by tongues of galena. In one case galena appears to vein the sphalerite (fig.9). On the other hand short tongues of sphalerite extend into the galena. These are neither as long nor as pronounced as those from the galena into the sphalerite. Spectrographic examination revealed a content of cadmium though no greeockite was observed by the author in the section. The apparent relations of sphalerite place it it after the second pyrite; and at least some of it before the galena. No evidence was found by the author to indicate contemperaneous deposition with the galena as was suggested McEachern (1931), though it is entirely probable that there was an overlap in deposition.

GALENA

This mineral was distinguished by its triangular pits color and was confirmed by etch tests. Galena is apparently late in the sequence of deposition since it replaces quartz, pyrite, and sphalerite. (Figs. 10,13,14). It appears to favor quartz to the other minerals when replacing. It commonly advances into quartz leaving other minerals relatively unaffected. A spectrographic analysis indicated that galena carries the silver values. No individual silver minerals were found, though the sections were etched lightly with nitric acid to reveal their presence.

PYRRHOTITE

The mineral was determined by its color, anisotropism, and magnetic effect. It was found to occur only in section (87) and in hand specimen (16). The size of the blebs averaged about .2 mm. They ranged from around 1 mm. down to blebs hardly perceptible under high power. Its distribution was confined to galena and sphalerite. The evidence found permits at least two probable and one possible mode of occurrence for the mineral. Its occurrence in the galena may result from the inability of the galena to replace it while replacing the sphalerite. In (fig.10) galena may be seen apparently replacing sphalerite in preference to pyrrhotite. The origin in this case would be exsolution from only sphalerite. The round smooth bounded blebs are characteristic of exsolution accordingto Bastin (1931). The other probability is that it may have exsolved from both galena and sphalerite. A possible argument against this is the seeming tendency tongues of galena to replace phyrrhotite (fig.13). There is a possibility that the islands represent the ends of prongs of pyrrhotite, but if this is so, surely we could expect to see the mineral occurring as other than small islands. If indeed it were replacement it seems likely that the most easily replaced metasome would be selected, ie. quartz. The contention that the blebs represent remnants of a previous mineral is ruled out since they are not in optical orientation. There is no suggestion of these blebs being oriented with the crystal structure of the matrices. On the contrary they even cut across galena crystal boundaries.

CHALCOPYRITE

The chalcopyrite occurs as minute blebs in both sphalerite and galena. In sections other than (16) the grains of this mineral were very small, about .04 mm. In section 16 larger bodies are present (fig. 15). Needless to say these very small blebs were only found in the superpolished sections.. It is best developed in section no. 16 where it appears most abundantly at or near the galean - sphalerite contact. In several cases it forms a border between the two. Since sphalerite and chalcopyrite are chemically and crystalographically similar the sphalerite is able to hold the chalcopyrite in solution. This is not true of galena so possibly when the galena replaced the sphalerite the chalcopyrite was left as a separate mineral. The sphalerite was found spectroscopically to contain more copper than the galena. It is possible that the mineral was formed by replacement, but once again we may apply the argument that it should prefer the quartz. That such a replacement should be preferred seems likely since the more remote two minerals are in composition, the farther the chemical system will be out of equilibrium.

TETRAHEDRITE?

This mineral occurs in contact with sphalerite, galena, and quartz (fig.7). The grain was too small to remove for analysis (1/20x1/80 mm). It was tentatively identified as tetrahedrite on the basis of negative reactions to all the etch tests. Its hardness was placed at about C although it was rather difficult to tell on such small grain. The bright lines which move to softer mineral on raising the focal plane moved towards the "tetrahedrite" from the sphalerite and to the galena from the "tetrahedrite". This would place its hardness intermediate to sphalerite and galena. Its color was also intermediate to galena and sphalerite. A small tongue of the mineral extends into the adjacent sphalerite. Its relation to galena cannot be determined.

TOURMALINE

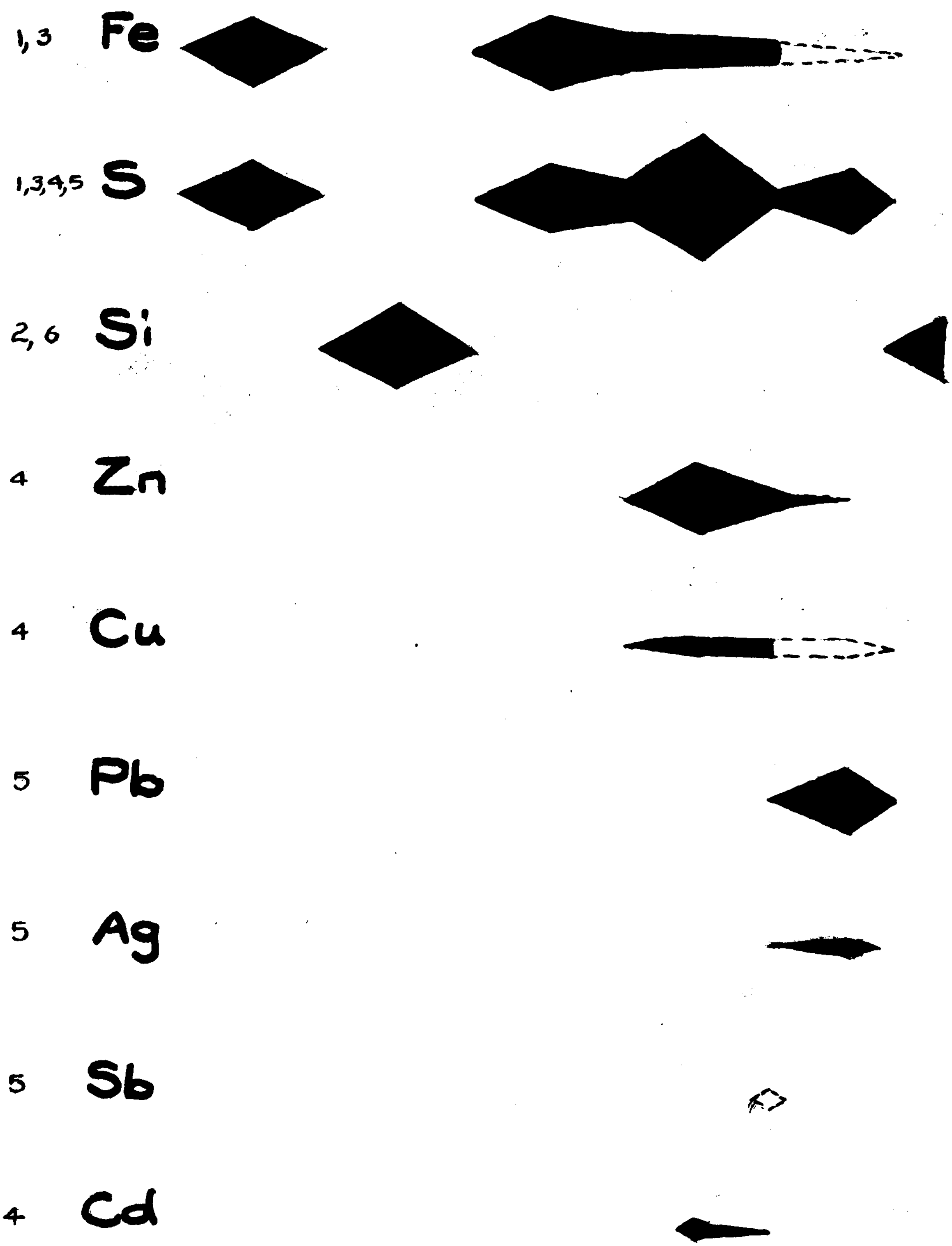
Whether this occurrence mentioned under general mineralogy is related to the ore deposit is open to question. If it were it would place the deposit at the high temperature end of the mesothermal. The macroscopic identification of the mineral was confirmed in the labratory by its optical characters. It was found to be strongly pleochroic with absorption of the O ray, uniaxial negative and to have moderate birefringence. It was determined as the variety, dravite ($NaMg_3Al_6B_3Si_6O_{27}(OH)_4$) on the basis of its indices of refraction.

GOLD

McEachern (1941) located gold in one specimen from the No. 3 level. He notes that the specimen has a banded structure of fine grained massive pyrite in quartz. Pyrite, he found more abundant in this section than in the others. The gold occurs near the quartz-sphalerite contact or near it, he reports. The largest piece of gold, he saw, was about .4mm long. The author traversed all the sections, using high power, and was unable to find any gold. The author assayed a number of the grab samples. The results were found to be at considerable variance with the statements made by the leasers. They are presented as follows:

SAMPLE NO.	GOLD oz./T	SILVER oz./T
12	.05	
16	.02	
28	.38	
28	.36	
87	1.12	
9	.56	9.98
11	-	6.00
12	.61	.80
16	-	-
87	.73	16.62
89	.260	9.45

Paragenisis



CONCLUSIONS:

The coarse texture and mineralization of the deposit would suggest a mesothermal character probably near the high temperature type. The deposition was almost entirely by replacement. The mineralization appears to be monotonously similar throughout the mine, except for the appearance of pyrrhotite and chalcopyrite on the No. 2 sub-level. The silver must be in solid solution with the galena and similarly the cadmium, with the sphalerite. In most of the ore the chalcopyrite is probably present in too small a quantity to have any effect upon milling. Since no gold was seen, the author is unable to draw any conclusions regarding it.

The character of the ore is apparently consistent with that of other mines in the area.

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	PAGE NO.			
1923	214 - 215	1935	-	E 28
1924	192 - 193	1938	-	E 37
1926	275 - 276	1939	-	A 82
1927	301 - 303	1941	-	A 65
1928	330 - 331	1942	-	A 62
1929	349 - 350	1943	-	A 64
1930	269 - 271	1944	-	A 60
1932	187	1945	-	A 43
1933	227	1946	-	A 144
1934	E 13			

I L L U S T R A T I O N S

FIGURE 1

Map of Ymir - Nelson area. (Traced from map by Cockfield (1936)).

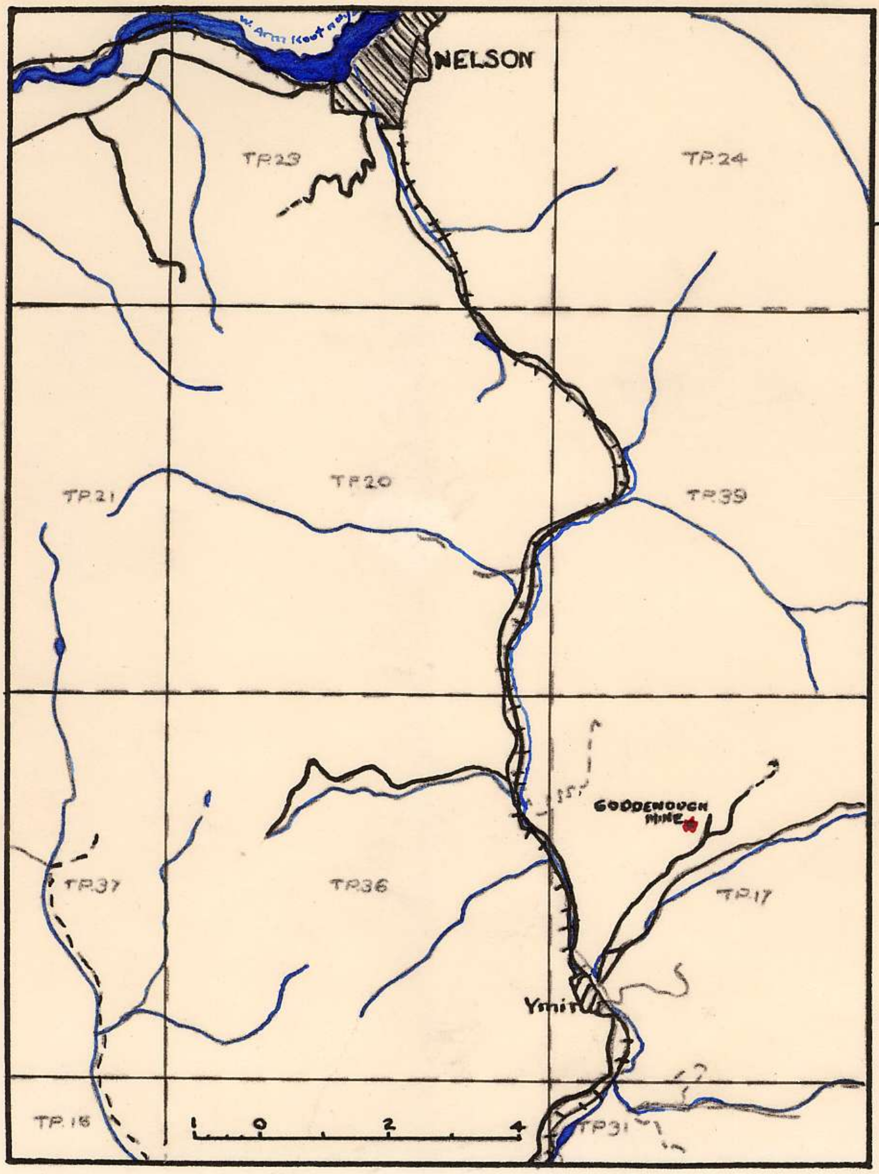
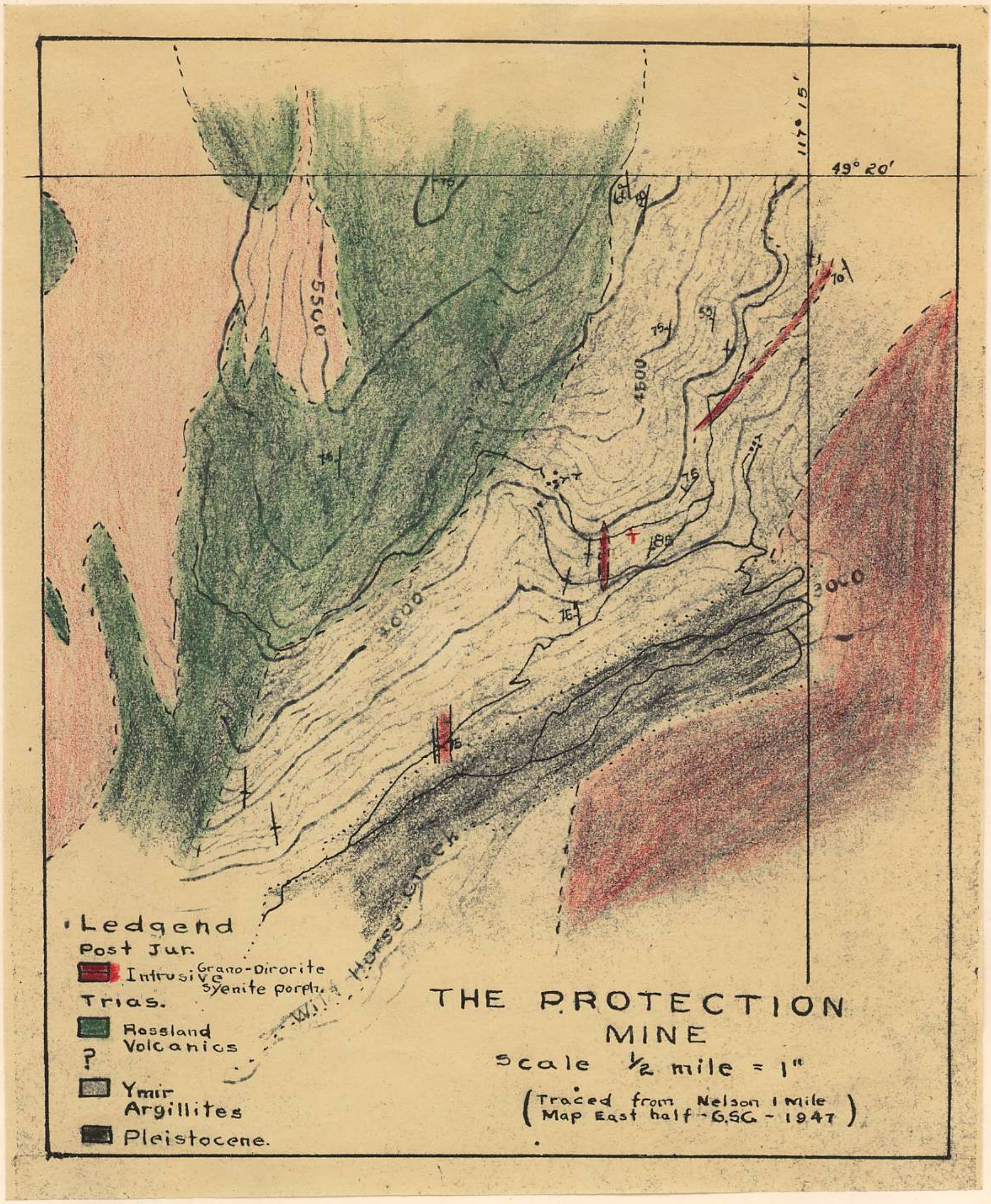

W. Arm Kootenay
NELSON
TP.23
TP.24
TP.21
TP.20
TP.39
GOODENOUGH MINE
TP.37
TP.36
TP.17
Ymir
TP.15
TP.31
1 0 2 4

FIGURE 2

Map showing the geology and topography in the neighborhood of the Protection Mine.



49° 20'
117° 15'
5500
4500
4000
3000
Wild Horse Creek
Ledgend
Post Jur.
Intrusive Grano-Diorite syenite porph.
Trias.
Rossland Volcanics
?
Ymir Argillites
Pleistocene.
THE PROTECTION MINE
Scale 1/2 mile = 1"
(Traced from Nelson 1 Mile Map East half - G.S.C. - 1947)

FIGURE 4

View (looking South-East) of the Protection Mine.

1/50 @ F 11 on Kodak verichrome.

FIGURE 5

Ymir argillites; the country rock of the Protection Mine. At the centre of the picture there is a small quartz vein containing tourmaline (Dravite). The picture was taken off the road to the Protection Mine.

1/50 @ F 8 on Kodak Verichrome
(Looking Northeast).

PHOTOMICROGRAPHS.

Notes

Leitz No. 305897.

Microscope was used for all the pictures. For high power a 1.215 mm. objective and 10X ocular were used, giving field width of .365 mm. For low power a 4.3 mm. objective and 10X ocular were used giving a field width of 3 mm. Kodak Wratten M plates were used.

Co-ordinates are referable to the corner of section marked X, in polished sections.

Legend

Q	-	Quartz
P	-	Pyrite
Pr	-	Pyrrhotite
S	-	Sphalerite
G	-	Galena
T	-	Tetrahedrite
C	-	Chalcopyrite

FIGURE 6

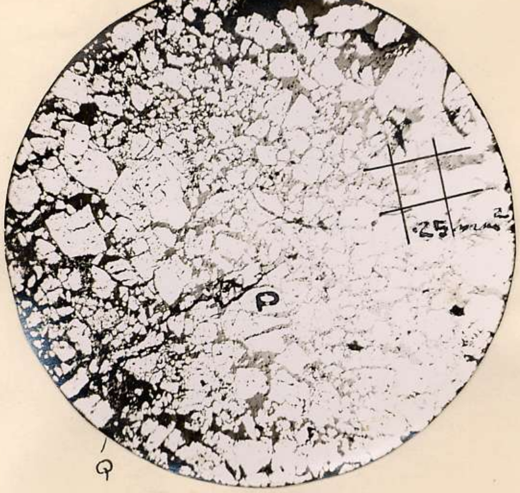
Section 28Y | X22.7 | Exposed 2 Seconds Blue Filter

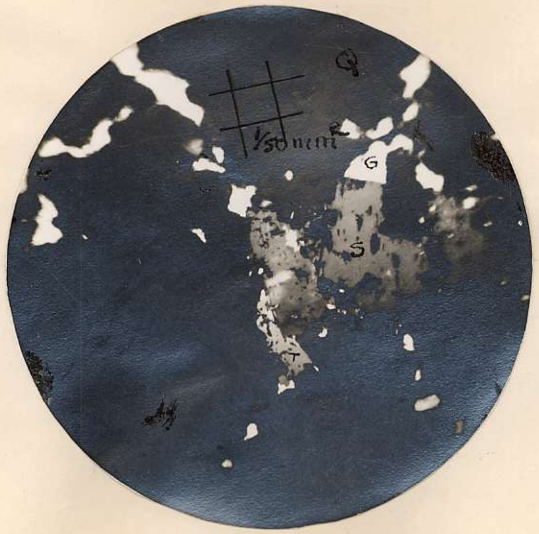
Comminuted pyrite filled with quartz, with only minor replacement.

FIGURE 7

Section 87 (13.0,53.3) | X211 | Exposed 3 Seconds Blue Filter

Tetrahedrite?


·25 mm
P
Q


Q
1/50 mm
G
S

Section 28X

FIGURE 9
23X

Exposed 2 Second
Blue Filter

Galena veining sphalerite

Section 87
(17.3,51)

FIGURE 8
X192

Exposed 12 Seconds
Blue Filter

Quartz filling along galena cleavage.

9

8

FIGURE 11

Section 87 (20.9,50.5) | X27 | Exposed 2.5 Seconds Blue Filter

This section shows both sphalerite and galena replacing quartz in preference to pyrite beside a pyrite crystal face.

FIGURE 10

Section 87 (19.3,49.8) | X214 | Exposed 5 Seconds Blue Filter

Galena replacing sphalerite apparently in preference to phyrrhotite. It is possible that this trans-boundary relation is the result of replacement. (See argument under sphalerite)

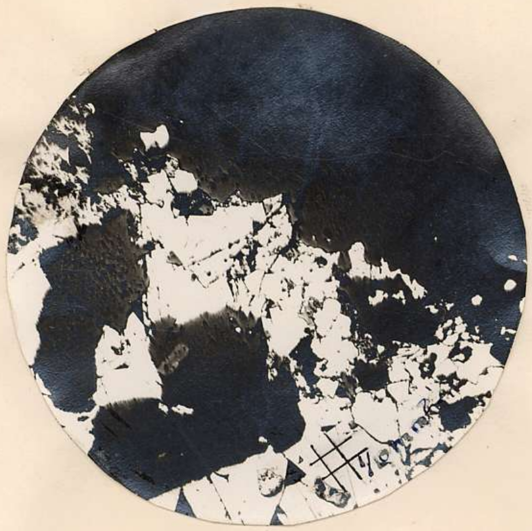


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FIGURE 12

Section 87 (17.0,48.2) | X37.5 | Exposed 2 Seconds Blue Filter

Unsupported nucleus of pyrite in quartz. Galena may be seen preferentially replacing quartz to pyrite. Tongues of galena extending into pyrrhotite indicate a possible tendency for galena to replace pyrrhotite.

FIGURE 13

Section 87 (12.5,56.7) | Approx. X25 | Exposed 2 Seconds Blue Filter

Euhedral pyrite crystal being replaced by galena. Note inclusions of galena within the pyrite replacing from the inside out.

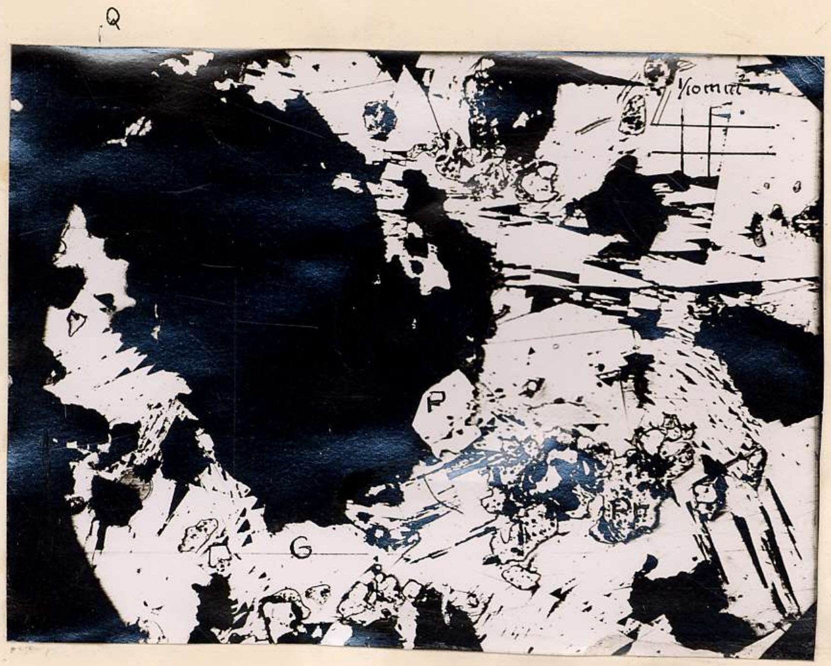

Q
1/10 mm^2
P
G

FIGURE 14

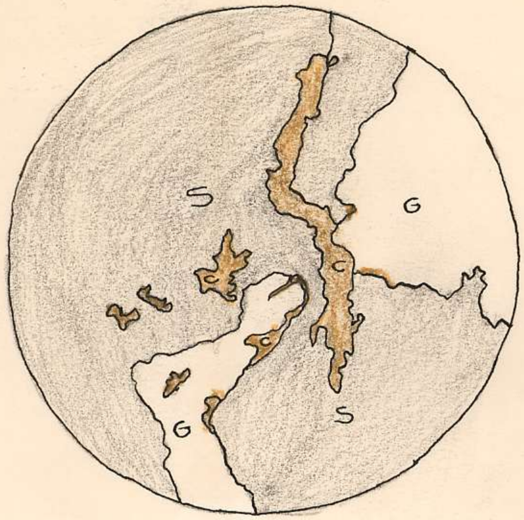
Section 16 X25

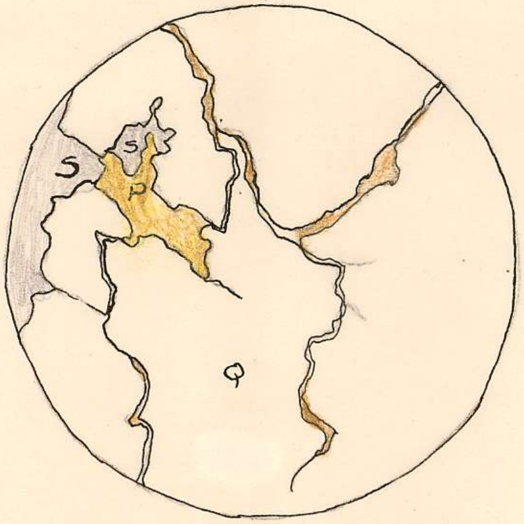
Chalcopyrite on and near galena-sphalerite contact.

FIGURE 15

Section 87 X25

Sulphides replacing quartz along fractures. (See also section 89) where galena is replacing along fractures.


S
G
S
G


S
s
p
Q

LIST OF SECTIONS.

12. Pyrite, quartz, and sphalerite.

16. Sphalerite, galena, quartz, chalcopyrite, pyrite, and wall rock.

17. Pyrite, quartz, and sphalerite.

18. Pyrite, quartz, sphalerite, and galena.

25. Pyrite, quartz, sphalerite, and galena.

28. a). Pyrite, quartz, sphalerite, galena, and chalcopyrite (Superpolished)

    x). " " " " "

    y). " " " " "

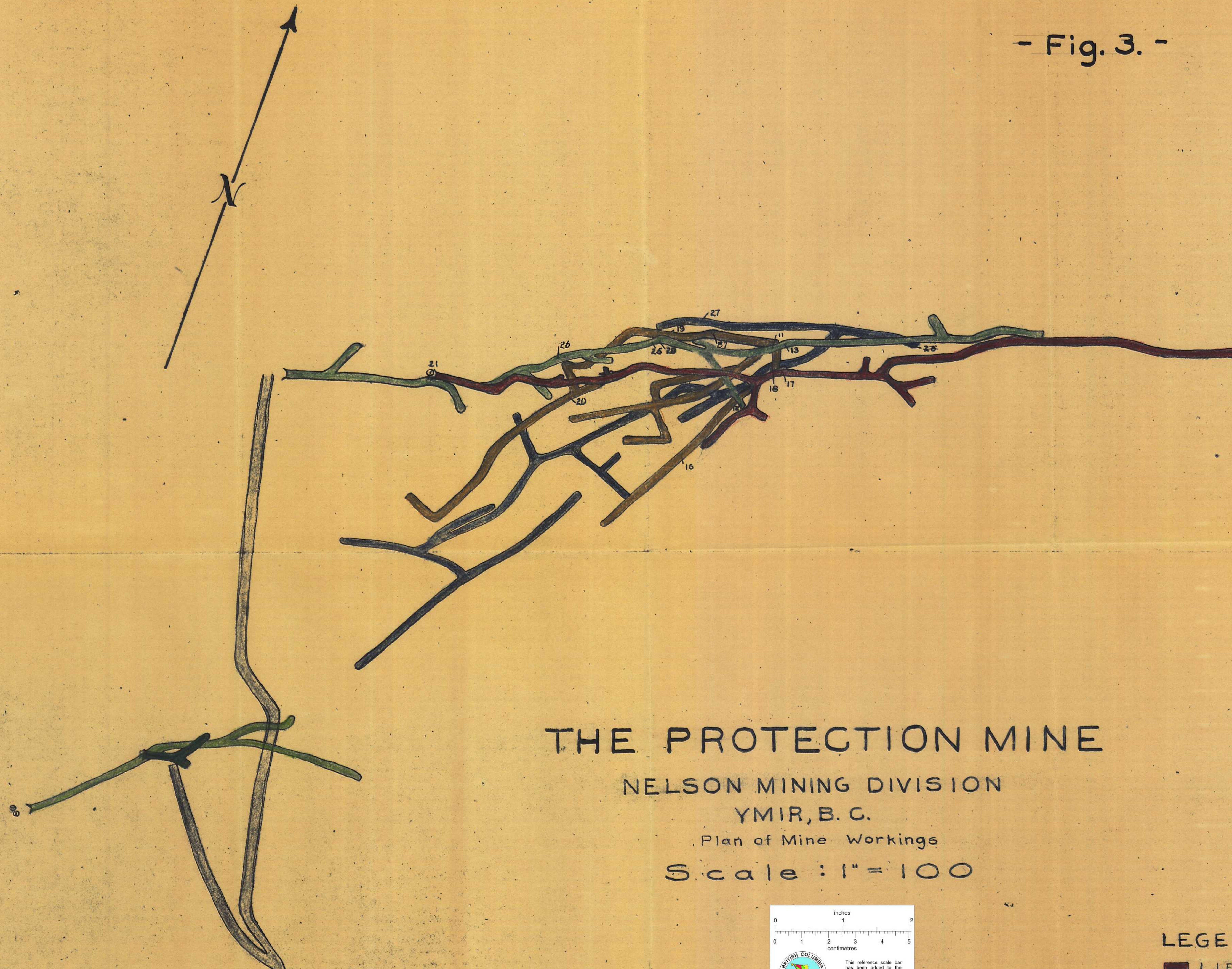
87. a). Sphalerite, quartz, pyrite, and galena.

    b). " plus chalcopyrite and tetrahedrite? (Superpolished)

88. Tourmaline (Index Test).

89. Galena, quartz, pyrite, sphalerite.

- Fig. 3. -



THE PROTECTION MINE

NELSON MINING DIVISION

YMIR, B. C.

Plan of Mine Workings

Scale : 1" = 100

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

LEGEND

1 LEVEL	El	4172'
2 LEVEL		4040'
SUB-LEVEL		3940'?
3 LEVEL		3840'?
4 LEVEL		3868'
5 LEVEL		3768'
21 SAMPLE No.		
ROAD		