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REPORT ON THE ORE OF THE

WISCONSIN MINE

by

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The University of British Columbia

April - 1938.

October 21st, 1938.

To Whom it may concern:

I hereby grant the University of B. C. permission to use any information obtained in the research work on the ore from the Wisconsin property on the understanding that it is to be used for scientific purposes only.

Signed

A. C. Frost

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ACKNOWLEDGEMENTS.

The work was done under the supervision of Dr. Warren of the Department of Geology. The writer would like to thank Dr. Warren for his many suggestions, and criticisms, and D.R. Ferguson, for his invaluable aid and collaboration.

LOCATION OF PROPERTY.

The property is in the Nelson Mining division, two or three miles south-southwest from the forks of Midge Creek, which empties into the east side of Kootenay Lake, about twenty miles south-erly from Procter, B. C.

The property is reached from the railway at Midge Creek Station. A narrow road is practically completed for about two and a half miles up the creek; from there to the mine, there is a pack trail, which can be improved into a road. The total distance from the railway to the mine is fourteen miles. The elevation at the mine is about 6300 feet, which is about 4500 feet above the railway at Midge Creek.

Analysis of Ore.

Au	-	0.44 oz. / ton	SiO ₂	-	29.5 per cent
Ag	-	1.88 oz. / ton	Pb	-	0.33 " "
Fe	-	⁰ 29.7 per cent	Sb	-	Tr.
Cu	-	0.43 per cent	CaO	-	----
As	-	8.50 " "	MgO	-	----
S	-	30.5 " "	Zn	-	0.93 per cent

Arsenopyrite	18.5 %
Pyrite	48.9 %
Galena	0.35 %
Chalcopyrite	1.2 %
Sphalerite	1.5 %

SUMMARY.

The bulk of the ore was crystalline masses of pyrite and arsenopyrite, which were fractured and brecciated, with chalcopyrite forming veinlets along the fractures. In these veinlets were also sphalerite, galena, telluride mineral, tetrahedrite (?) and small particles of an unknown mineral.

Part of the gold occurs in finely disseminated particles fairly evenly distributed. The presence of a gold mineral is indicated by the super panning and infra-sizing results. Microchemical tests show the presence of atelluride, and fusion on a pyrex glass shows a telluride. (gold).

No free silver could be found, and as the galena could not account for all of the silver in the ore, the presence of a silver mineral is indicated. There are two possibilities; a mineral in the chalcopyrite which was tentatively identified as tetrahedrite, or a gold-silver telluride.

PARAGENESIS.

The paragenesis as determined from examination of the different sections is

Pyrite	_____
Arsenopyrite	_____
Sphalerite	_____
Galena	_____ ?
Chalcopyrite	_____
Tetrahedrite (?)	_____
Telluride	_____
Quartz.	_____

Pyrite.

The pyrite occurs in coarse crystalline masses mainly, and with the arsenopyrite constitutes the main portion of the ore. The mass is fractured and brecciated, the fractures forming veinlets for the deposition of the chalcopyrite and contemporaneous minerals. For sketch illustrating paragenesis see section 1.

Arsenopyrite.

The mass is fractured and brecciated in the same manner as the pyrite. The veinlets are similar in form and contain the sphalerite, chalcopyrite, galena, telluride, and tetrahedrite (?). It was noticed that the majority of the veinlets occurred in the arsenopyrite. For sketch illustrating paragenesis see section 2.

Sphalerite.

Small amounts of sphalerite were found in the veinlets, indicating that it was subsequent to the arsenopyrite. The

chalcopyrite was deposited later, as shown in section 3.

Galena.

The paragenesis could not be determined definitely, but two possible relationships were indicated.

(a) The chalcopyrite and galena were contemporaneous.

(b) The galena was earlier than the chalcopyrite and probably contemporaneous with the sphalerite.

The latter is possibly more correct, as in the majority of cases, the galena is surrounded, or nearly so, by the chalcopyrite.

Chalcopyrite.

The chalcopyrite occurs principally in veinlets in the arsenopyrite and pyrite. The remainder was present as comparatively large blebs in the arsenopyrite and pyrite. At first, it was believed to be a telluride, as the presence of tellurium was indicated by microchemical tests. It was noted later, however, that the KCN solution stained the surface of the chalcopyrite differentially, indicating that the mineral was not homogeneous, but rather contained some mineral that reacted with the cyanide.

The associated minerals in the veinlets were sphalerite, galena, telluride, tetrahedrite (?), and gold.

INFRA-SIZER AND SUPER-PANNER RESULTS.TABLE I.

Product	Size Mesh	Size μ	Wt. Gms.	% Wt.	Gold oz/ton	Rec. Gold
1	250	+ 56	77.3	19.8	0.38	25.1
2	250-400	56-40	84.5	21.7	0.20	14.4
3	400-560	40-28	73.7	18.9	0.28	17.3
4	560-850	28-20	47.75	12.3	0.48	19.5
5	850-1100	20-14	34.1	8.7	0.24	7.0
6	1100-1700	14-10	30.75	7.9	0.32	8.4
7	-1700	-10	40.85	10.5	0.24	8.3
			<u>388.95</u>	<u>100.0</u>		<u>100.0</u>

One thousand grams of ore at pulp density of 1:1 were ground twenty minutes in a ball mill, dried and screened. Four hundred grams of the -200 product were put in the infra-sizer for *two periods* two hours. The loss in weight in the product was almost three per cent.

The table shows that the gold is fairly uniformly distributed throughout the products, with the exceptions of #4 and #1. Seventy-five per cent of the gold is contained in the first four products, but this is due to the bulk of the products, which is also seventy-five per cent of the total. Eight per cent of the gold is contained in ten per cent of the bulk in the finest product.

TABLE 2.

Product	Size Mesh	Size <i>u</i>	Wt. Gms.	% Wt.	Gold oz/ton	Rec. Gold
1	250	+56	0.5	0.36	-----	-----
2	250-400	56-40	19.4	14.00	0.22	12.80
3	400-560	40-28	39.3	28.40	0.19	22.45
4	560-850	28-20	31.6	22.85	0.20	18.95
5	850-1100	20-14	20.8	15.04	0.26	16.22
6	1100-1700	14-10	9.8	7.08	0.28	8.23
7	-1700	-10	16.9	12.20	0.42	21.30
			138.3	100.00		100.00

Five hundred grams of ore at a pulp density of 1:1 were ground in a ball mill for twenty minutes. It was cyanided for forty-eight hours at a pulp density of 3:1, during which time fifty-nine per cent of the gold was extracted. The tailings, which assayed 0.18 ounces of gold, were dried and screened, and one hundred and forty grams of -200 product were infra-sized.

The results show that twenty-one per cent of the gold is in #7, which contains only twelve per cent of the bulk. There is a gradual increase in the gold assays as the product size decreases until #7, where there is a sharp increase in the gold assay.

TABLE 3.

Product	Size Mesh	Size <i>μ</i>	Wt. Gms.	% Wt.	Gold oz/ton	Rec. Gold
1	250	+56	0.1	0.07	-----	----
2	250-400	56-40	0.2	0.13	-----	----
3	400-560	40-28	0.5	0.33	-----	----
4	560-850	28-20	3.3	2.20	0.10	1.44
5	850-1100	20-14	21.8	14.54	0.18	16.92
6	1100-1700	14-10	40.1	26.75	0.18	31.02
7	-1700	-10	83.9	56.00	0.14	50.62
			149.9	100.00		100.00

A charge of two hundred grams of ore at 1:1 pulp density was ground for three hours in a ball mill. Then it was cyanided for forty-eight hours at a pulp density of 5:1, during which time seventy-three per cent of the gold was extracted. One hundred and fifty-five grams of -200 product were put through the infra-sizer. The tailings assayed 0.12 ounces of gold.

TABLE 4.

	Gold oz/ton	Gold oz/ton	Gold oz/ton	Gold oz/ton	Gold oz/ton
	-150+200	#1(+250)	#2(250-400)	#3(400-500)	#4(850-1100)
Arseno.	0.25	0.48	0.50	0.73	0.85
Pyr.	0.40	0.40	0.40	0.35	0.40

The table shows the gold value with the arsenopyrite and pyrite for the different sizes. The pyrite has a constant gold value while the arsenopyrite has an increasing gold value as the particle sizes decrease. The products which were used were those whose assays were recorded in Table II.^I

There are three possible reasons why all the gold is not extracted by cyanidation:-

1. The presence of fine gold that is not unlocked by grinding.
2. Some of the gold is coated.
3. The presence of some of the gold as a mineral.

The evidence on the whole points to the existence of a gold mineral. If the gold is finely divided, it should be uniformly distributed throughout the different infra-sized products, and their assays should be almost the same. Table 2 shows that the assays are not uniform; therefore the possibility that the cyanidation loss is due only to fine gold not being unlocked is ruled out. Table 2 also rules out the possibility that the gold might be coated. Gold is malleable and will not be broken up by grinding; therefore, if any of the coarser gold was coated, it would be caught in the coarser products of the infra-sizer, and their assays would be higher. The suggestion that gold is present as a soft, brittle mineral explains the results of Tables 2 and 4 nicely. The gold mineral is ground fine, being softer than the others, and consequently is caught in the finer products on the infra-sizer, whose assays will, therefore, be higher. When attempting to separate arsenopyrites on the super-panner, this gold mineral came up with and salted the arsenopyrite tip. This would give the arsenopyrite a higher gold content than it should have, and explain the graph of the results of Table IV.

DETERMINATION OF TELLURIDES.

The methods of determining the presence of a telluride were :-

- (1) Microchemical tests.
- (2) Qualitative Chemical Analysis.
- (3) Infra-sizer and super-panner experiments which indicated the presence of a gold mineral other than native gold.
- (4) Pyrex glass tests.

Microchemical Analysis.

The methods of microchemical analysis are very delicate. The tellurium, if present, forms tetragonal or pseudo-hexagonal crystals of a double chlorite salt of Tellurium upon the addition of Caesium Chloride to a weak hydrochloric acid solution. This test was made independently by three observers with positive results in each case.

Qualitative Chemical Analysis.

This analysis is not as sensitive as the microchemical. Several tests were made, both on the ore and on a pure telluride mineral (tetrady^mite, $(\text{Bi}_2(\text{TeS}_2))$. They were:-

1. Concentrated sulphuric acid on 1 milligram of tetrady^mite.
A deep pink color resulted-----successful.
2. Concentrated sulphuric acid on 0.005 mgs. tetrady^mite (0.002 mgs. Te.). A definite pink color resulted.-----successful.
3. Concentrated sulphuric acid on a mixture of pure arsenopyrite

and tetradymite (100:1). Evidently the arsenopyrite masked the action of the acid on the telluride. There was sufficient tetradymite to give the pink color, if no arsenopyrite had been present.----unsuccessful.

4. Concentrated sulphuric acid on the tip of the arsenopyrite concentrate from the super-panner (From product 2 table IV) -----unsuccessful.
5. Concentrated sulphuric acid on chalcopyrite taken from section by needle for microscope use.-----unsuccessful.
6. Taking same mixture as used in #3 and using the H₂S method of precipitation to eliminate the iron and impurities----unsuccessful.

It is evident from the above tests that tellurium can be detected even when present in amounts as small as 0.002 mgrms. The acid must be heated slowly as any color that may be obtained will be lost when the acid begins to fume.

While the results do not indicate the presence of tellurium, they cannot be regarded as conclusive, as it was clearly shown that arsenopyrite prevents the detection of the tellurium.

Infra-sizer and Super-panner Experiments.

These are reported and discussed elsewhere.

Pyrex Tests.

A portion of the tip from the super-panner used in the qualitative chemical analysis, part 4, was used here. It

was fused at a low red temperature range and examined under the Ultrapak. Various blue pools were noted, indicating the presence of a telluride. These pools usually surrounded a gold pool, or a particle of gold that was not fused. Several pools of native gold were also noted.

Note. For confirmation of blue pools indicating a telluride, a known slide was examined, also the color-plate illustrating tellurides at the Lake Shore Mine in the C.I.M.M.E. Bulletin for June, 1936.

MILLING METHODS.

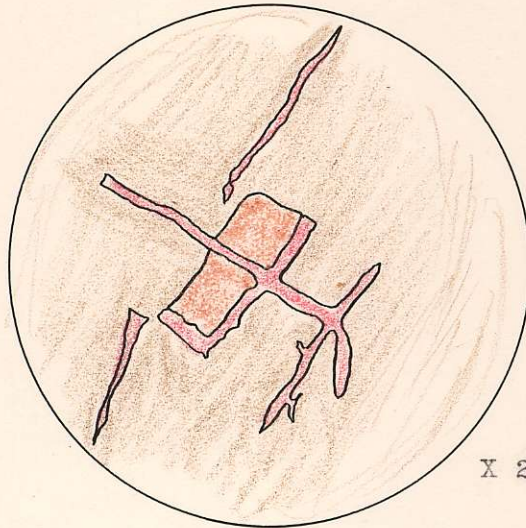
The microscopical examination of this ore, established the fact that the ordinary methods of milling cannot give a high recovery of gold.

Flotation is not practical, due to the small size of the gold particles and the difficulty of separating arsenopyrite and pyrite.

Straight cyanidation cannot give an extraction of more than 60 per cent of the gold. This is due to the locking of part of the remainder of the gold not attacked by the cyanide within the chalcopyrite and arsenopyrite in so fine a state of division that these minerals would have to be broken down by some means such as roasting in order to expose the gold to the action of the cyanide or any other solvent. The remaining part of the gold is in the form of a telluride, which is not very amenable to cyanidation.

It is evident that smelting is the most logical treatment, but as this is impossible in the existing circumstances, it is apparent that a satisfactory method of treatment has not yet been devised.

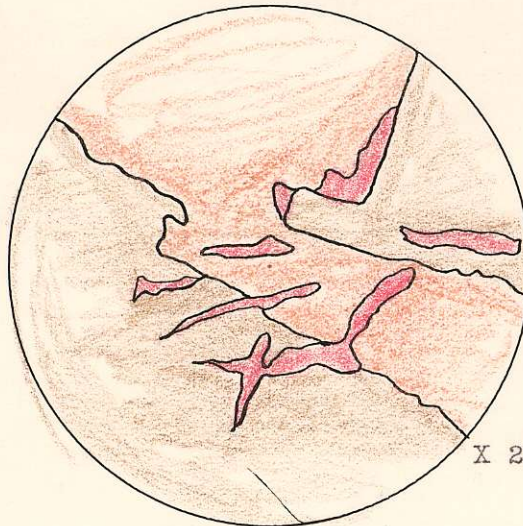
Section 1.



X 230




PARAGENESIS OF PYRITE, ARSENOPIRYTE, & CHALCOPYRITE.

Section 2.



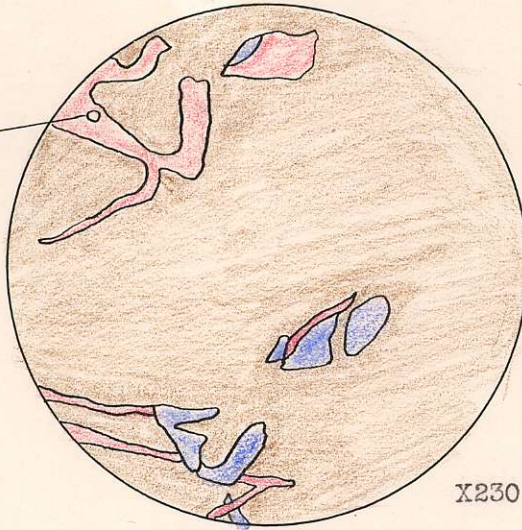
X 230

PARAGENESIS OF PYRITE, ARSENOPIRYTE & CHALCOPYRITE

Chalcopyrite	
Arsenopyrite	
Pyrite	

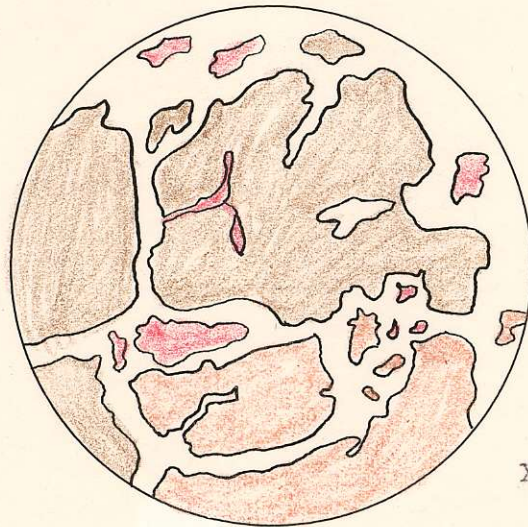
Section 3.

Tetrahedrite (?)








X230

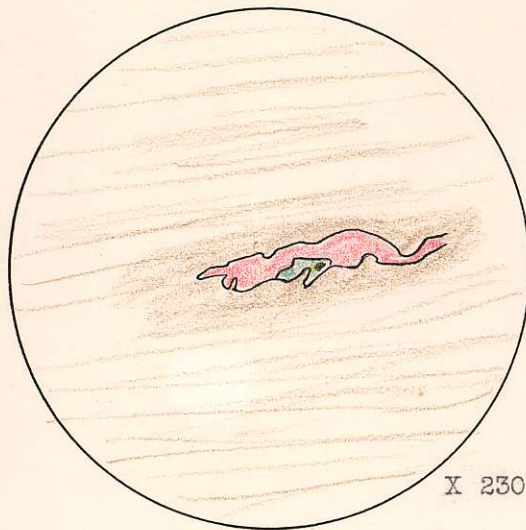
PARAGENESIS OF SPHALERITE & CHALCOPYRITE.







X 230

- Arsenopyrite 
- Pyrite 
- Quartz 
- Sphalerite 
- Chalcopyrite 

PARAGENESIS OF QUARTZ.



CHALCOPYRITE VEINLET CONTAINING TETRAHEDRITE(?) & GOLD.

Arsenopyrite	
Chalcopyrite	
Tetrahedrite(?)	
Gold	

GRAPH SHOWING RELATION BETWEEN
GOLD VALUE & PARTICLE SIZE
FOR

PURE ARSENOPYRITE & PYRITE CONCENTRATES
(See table 4, page 7)

