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THE MINERALOGRAPHIC STUDY OF THE MINTO MINE ORE

by

Noel W. Hendry

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Location

The Minto Mine is situated in the Bridge River section of the Lillooet Mining Division on the north bank of the Bridge River, about two miles below the mouth of Gun Creek.

Communication

The mine is 25 miles from Shalalth, a station on the Pacific Great Eastern and is reached from there by a motor road. This road is passable throughout the year, except after very heavy falls of snow. A regular service of trucks and stages operates along the road from Bridge River and Shalalth to the Pioneer Mine, 55 miles away.

History

The property was originally known as the Alpha Group and owned by W. Davidson. During 1929 the Consolidated Co. took an option and financed all development work. Values obtained in the development work were low, though occasional high values were obtained. Development work was discontinued in 1931 and the property lay idle until June, 1933, when Minto Gold Mines Ltd. was incorporated and took over the property.

Since the new Company took over development work has proceeded at a rapid rate and the Company reported during 1934 that 100,000 tons of positive ore had been blocked out, the average values being above common grade.

A small mill was assembled in 1934 and a process of treating arsenic and antimony in the ore has been worked out so that milling costs are only 87 cents per ton for removal of arsenic. The concentrates are at present shipped to Tacoma.

The recovery at this dat is only 84%, and the main problem is to increase this recovery.

General Geology

The country rock on the property is mainly Bridge River series and consists of altered sediments with inter-beds of greenstone and serpentine. The chief member of the sedimentary series is a blue grey chert grading into a cherty quartzite often much contorted. The beds are separated by thin bands of argillite.

The greenstones are of especial interest, since the Pioneer vein is enclosed in these rocks for over 2000'. There seems little doubt that they were formed from submarine lava flows; they consist almost entirely of dense, black altered basalts. Their general conformity in altitude with the sediments, the presence of thin layers of interbedded argillite and the almost invariable presence of pillow structure, flow breccia and amygdules all lend proof of their volcanic origin. In certain localities, these volcanics are altered to chlorite schists and serpentine. Calcite occurs irregularly as veinlets in the sheared mass.

The minerals found in the resulting metamorphosed rocks are calcite, kaolin, chlorite, serpentine, zoisite, sericite and iron oxide.

Economic Geology

The commercial minerals of the mine, consisting of various sulfides with a gangue of quartz and calcite occur in fissure veins and are thus epigenetic.

The main metallic minerals are: gold, arsenopyrite, pyrite, chalcopyrite, galena, sphalerite, stibnite and tetrahedrite (which was not determined).

The gangue consists of quartz and calcite.

Description of Sections

Megascopic Examination

Sec. 1 No. 5 face: the minerals that can be seen in this section are pyrite, chalcopyrite and quartz. Pyrite occupies about 90% of the section with quartz about 9%.

Sec. 2 #4 level: the minerals in this section are arsenopyrite, pyrite, sphalerite, calcite, stibnite and quartz. The arsenopyrite occupies about 50%, pyrite 5%, calcite 35%, sphalerite 5%, quartz 5%.

Sec. 3 #4 level: from the first examination it appears that the section is 100% arsenopyrite, but on closer examination a vein of pyrite can be seen cutting across the section. This pyrite, however, occupies only about 2% of the section.

Sec. 4 high grade (A): Minerals contained in this section are pyrite, stibnite and calcite. The pyrite occupies 50%, calcite 45% and stibnite 5%.

Sec. 5 201 stope: the minerals contained in this section are pyrite, galena, stibnite, calcite and quartz. The galena appears to occupy a very narrow vein across the section and does not occur in the section except in this vein. The relative percentages of minerals are:pyrite 45% , galena 30%, calcite 15% and quartz 10%. The stibnite cannot be seen megascopically.

Sec. 6 201 stope: the minerals in this section are the same as No. 5 with the exception of galena which is absent.

Sec. 7 No. 5 face: supposedly low grade ore this section contains arsenopyrite and calcite. Megascopically this section does not differ in any way from sections No. 2 and No. 3. That is, the stibnite is too fine to be seen in the arsenopyrite and in the calcite.

Microscopic Examination (referring to drawings made)

Sec. 1 - Stibnite and Arsenopyrite

This section c ntains high gold values and, since the gold was of late deposition as was the stibnite, it is apparent that the gold is associated with stibnite: - ore dressing tests have shown this to be true. Megascopically this section would a pear as pure arsenopyrite, but under the microscope stibnite can be seen veining it in a complicated way. Some of the particles of stibnite are very fine, being about 5 microns, while the maximum size is about 40 microns.

The fact that the stibnite everywhere cuts the arsenopyrite proves that the stibnite is younger in age than the arsenopyrite.

Sec. 2 Stibnite, Arsenopyrite, Calcite and Pyrite

This section contains high gold values. The stibnite occurs as in the above section in very fine veins and bl ebs, but here it also cuts across the pyrite vein as well. The veins of stibnite may or may not have calcite present.

The fact that the pyrite cuts across the arsenopyrite in the form of a vein shows that the pyrite is younger than the arsenopyrite. However, in other sections it is apparent that the pyrite was one of the first minerals to come in, so this vein represents a second generation of pyrite. The calcite at the contacts of the pyrite and arsenopyrite came in either at the same time or later than the pyrite.

The pyrite appears to contain as much stibnite in fine disseminations as does the arsenopyrite.

Sec. 3 - Sphalerite, Arsenopyrite, Calcite, Stibnite, Chalcopyrite and Pyrite.

In this section the sphalerite, arsenopyrite and pyrite are all fractured in a very complicated manner; the fractures are filled with calcite and stibnite. The pyrite and arsenopyrite are intergrown and the contacts are smooth, which would apparently denote contemporaneous deposition. The sphalerite on the other hand appears to have come in somewhat later than these two minerals as it occupies complicated bays both in the pyrite and arsenopyrite; that is, it appears as though the sphalerite has in part replaced these two minerals.

Small, regular particles of chalcopyrite are everywhere contained by the sphalerite. This would point to contemporaneous deposition of the sphalerite and chalcopyrite

This could be explained as follows: - the solution containing the sphalerite and chalcopyrite came in and the chalcopyrite crystallized out first in a viscous material. The sphalerite then crystallized around these inclusions of chalcopyrite. The particles of chalcopyrite have not been replaced by the sphalerite because they are not corroded around the edges.

The calcite and stibnite are obviously the youngest minerals in this section.

Sec. 4 Pyrite, Stibnite, Calcite and Quartz

This section shows the sphalerite definitely cutting the pyrite and therefore definitely being younger than the pyrite. The stibnite and calcite again cut the pyrite. The quartz in this section must be of a second generation and younger than the calcite because it does not occupy any fractures in the pyrite nor is it fractured. It has evidently replaced the calcite to a large degree.

Sec. 5 Pyrite, Calcite, Stibnite and Quartz

Again in this section the quartz is of the second generation having replaced the calcite. This conclusion is reached after noting that the quartz is not fractured to the slightest degree. The fractures in the pyrite are again filled with calcite. The bleb of stibnite probably was first surrounded by calcite, with which it came in, and the calcite was later replaced by quartz.

Sec. 6 - Quartz, Pyrite, Calcite and Stibnite

The fact that the stibnite occurs in the calcite as blebs as shown in this section points to deposition of nearly the same age, with the stibnite being slightly older than the calcite. This may be explained in the same way as the sphalerite-chalcopyrite in Sec. 3. The quartz is not fractured and belongs to a second generation of deposition.

Quartz of the first generation that same in just before or at the same time as the pyrite and arsenopyrite exists and is not shown by a drawing only because of its very complicated nature. Fractures in the quartz were seen containing stibnite and calcite.

Sec. 8 - Quartz, Stibnite, Galena and Calcite

This section shows the galena which is fractured in a manner similar to the pyrite, arsenopyrite and sphalerite with the fractures being filled with calcite. The galena is probably of the same age as the sphalerite and chalcopyrite.

Distribution of Gold

Assays conducted by Dr. H.V. Warren of the University of British Columbia have revealed that the gold occurs chiefly at the contacts between the sulfides. This is indicated by the very high assay of gold in table No. 2 for sulphide contacts. However, another series of assays run by the author and Dr. Warren give a much lower value for sulphide contacts. These lower values in no way detract from the idea that some of the gold occurs at the contacts, but might indicate that the concentration was erratic.

It is apparent though that the deposition of gold has some relation to contacts from the assay results in the following tables. The assays of sulfides taken at the contacts with quartz in nearly every case are higher than when the pure mineral is taken.

Apparently, then, the sulfide contacts had some influence in the concentration of the gold, whether this was some electrical influence is not known and can only be found out by further experimentation.

In the sections submitted with this paper it is shown that the sphalerite, pyrite and arsenopyrite are very intricately disseminated with stibnite and it is the opinion of this writer that some of this stibnite was included in the assay samples thought to be pure minerals. Some of the disseminations of stibnite are less than 5 microns in size and could easily be included in a grain of pyrite, say, ground even to 325 mesh. Since the stibnite is disseminated throughout the arsenopyrite and sphalerite as well, then this would apply also to assay samples of them. Thus, whereas it was previously thought that pure sphalerite, arsenopyrite and pyrite were giving values in gold, in reality the gold was associated with the stibnite in them.

The greater part of the gold in this ore is associated with the stibnite, as from ore dressing tests it was found that the higher the recovery of stibnite from flotation, the higher the percentage of gold was obtained.

Table 1

Test	Product	Gold		Silver		Stibnite	
		Assay Oz/T	Recovery %	Assay Oz/T	Recovery %	Assay Oz/T	Recovery %
1	Conc.	.96	33.1	9.84	106.0	.64	48.3
	Tails						
2	Conc	.98	28.6	10.14	62.4	.28	18.8
	Tails	.40		1.00		.21	
3	Conc	1.46	23.2	18.2	53.6	.59	19.4
	Tails	.36		1.2		.21	
4	Conc	.96	8.4	25.5	43.3	.53	9.8
	Tails	.42		1.34		.21	
5	Conc (a)	1.06	19.7	19.1	87.8	1.07	
	Conc (b)	1.06	14.75	1.46	5.03	.28	8.8
	Tails	.36		.16		.11	
6	Conc	.88	35.1	9.38	80.7	.69	59.2
	Tails	.36		.50		.11	
7	Conc (a)	1.20	17.5	18.1	45.7	.53	16.4
	Conc (b)	.62	9.0	5.3	13.5	.42	12.7
	Tails	.38		1.16		.16	

Table 2

Mineral		Oz.Gold/Ton
Arsenopyrite	- pure	1.60
	with qtz	1.80
Pyrite	- pure	3.50
	with qtz.	2.50) sample was mostly quartz.
Sulfide Contacts		28.60

Table 3

Mineral		Oz.Gold/Ton
Arsenopyrite	- pure	1.1
	with qtz.	1.4
Pyrite	- pure	.15 ? /
	with qtz.	2.4
Mixed sulfides		3.0

Paragenesis - as determined by the preceding sections.

1. Pyrite, Arsenopyrite, Quartz.
2. Sphalerite, Chalcopyrite, Galena
3. Pyrite, Stibnite, Calcite, Quartz, Gold

Summary and Conclusions

1. The silver present in the ore is not alloyed with the gold as might be supposed, but is present in the form of Tetrahedrite. This mineral was not identified in the sections prepared, due, probably, to its occurrence as very fine particles. This conclusion is reached after ore dressing tests have shown that the gold recovery has no relation to the silver recovery and also that the silver is quite easily floated off.

2. Particles of gold ? seen under very high power of magnification were all under 2 microns in size.

3. These particles were seen either in the stibnite or scattered irregularly in the calcite. There is absolutely no regularity in their arrangement; they are present in clusters in some places and in others they are entirely absent.

4. The gold is hypogene and should continue to depth.

5. The deposit is of the mesothermal type. The minerals being typical of those formed at temperatures of 175^{o}-$300^{o}C$.

6. The predominant metallic minerals are arsenopyrite and pyrite, while the important gangue mineral is quartz.

Milling Method

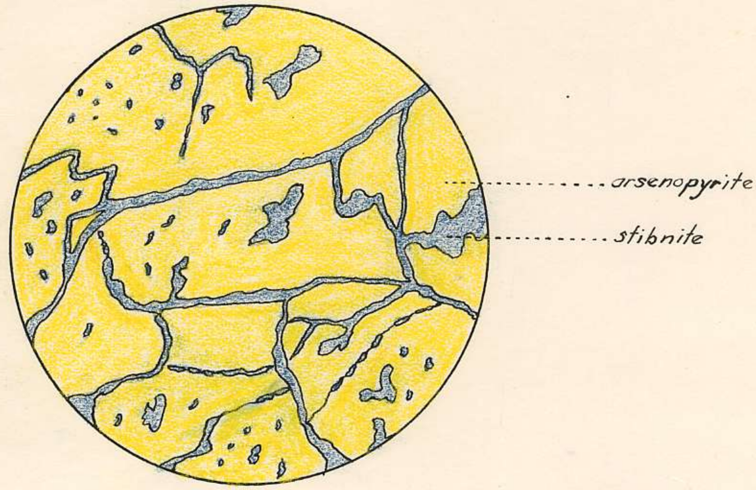
The ore is amenable to flotation, but special reagents must be added to coagulate the gangue.

The gold appears to be definitely associated with the stibnite for when the antimony recovery rises the gold recovery also rises.

The arsenopyrite has no relation to the precious metals, its recovery rises and falls without affecting the recovery of the precious metals.

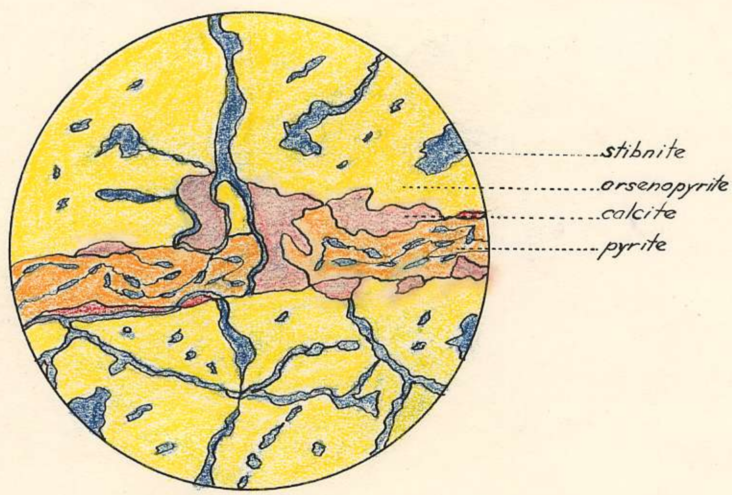
From tests carried out in the ore dressing laboratory it was found that only about 60% of the stibnite could be floated using depressors to hold back the other minerals. Thus, if this recovery can not be increased, then certainly the tails can not be cyanided because still too much antimony is present. However, this process should not be condemned because more experimental work might increase the stibnite recovery to such a point that the tails could be commercially cyanided. Also, the antimony concentrate could be sold.

Until this process has been improved, it appears as though the present milling practice will have to be continued at the mine. A recommendation which might prove of value is that the ore be ground finer than at present if at all possible. This recommendation is made because of the very fine nature of the gold and to release this gold the ore has to be ground extremely fine.



X 30

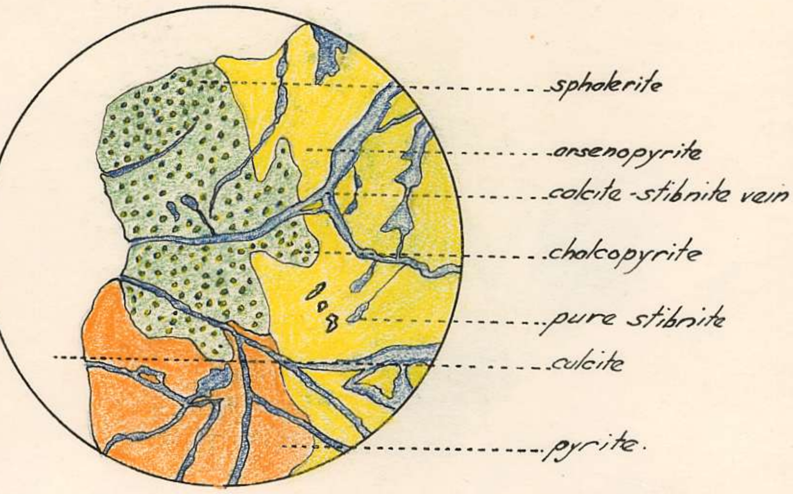
Sec. 1



X 30

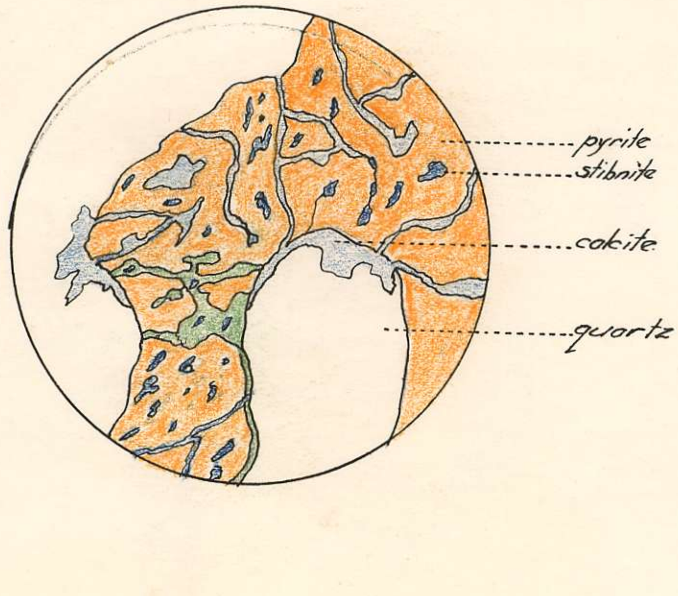
Sec. 2.

12



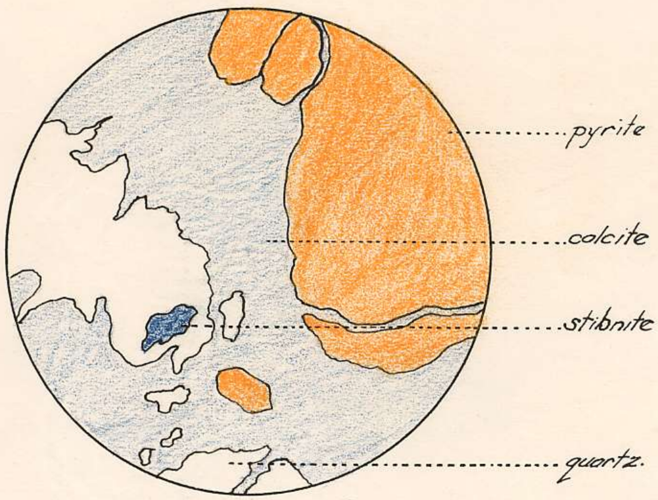
X 30

Sec. 3



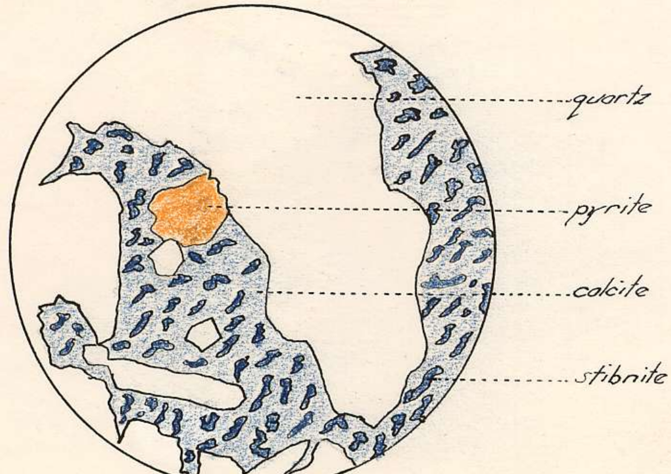
X 30

Sec. 4



X 30

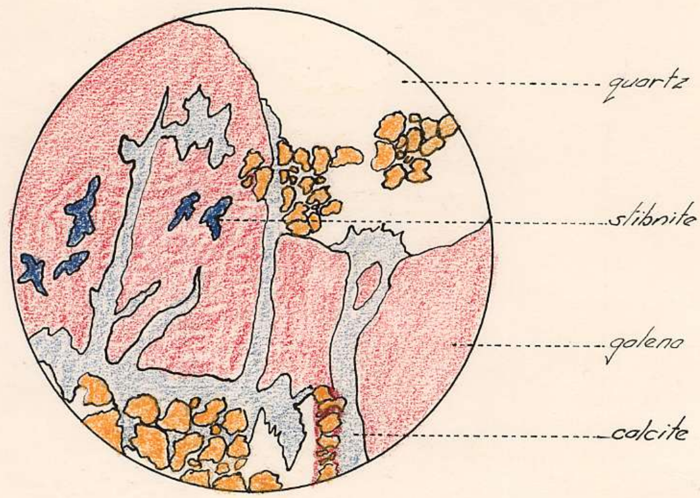
Sec 5



X30

Sec 6

14.



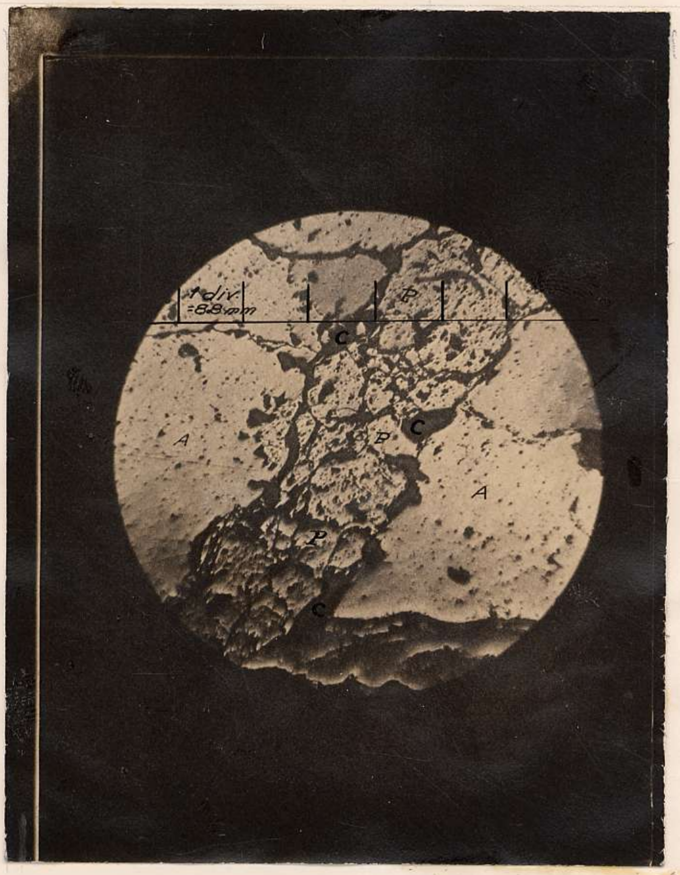
X30

Sec. 8

S = stibnite.

A = arsenopyrite

Corresponds to Sec. 1



A : arsenopyrite

P : pyrite

C : calcite

Corresponds to Sec. 2.