MICROSCOPIC DETERMINATION OF THE ORE MINERALS OF THE MINTO MINE

BY

F. RICHARDS

THE UNIVERSITY OF BRITISH COLUMBIA

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Material for Location, Communication, and History was taken from the B. C. Minister of Mines Reports from 1930 to 1934 and for General and Local Geology from W. S. McCann's Geology and Ore Deposits of the Bridge River Map-area, Memoir 130, Geological Survey of Canada, 1922, and V. J. Dolmage's Geology of the Bridge River Area, C. I. M. M. Bulletin, August, 1934.

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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 Bridge River, about two miles below the mouth of Gun Creek. Its position is approximately latitude 50° 57' North and its longitude 122° 49' West.

Communication

The mine is 40 miles from Shalalth, a station on the Pacific Great Eastern Railway, and is reached from there by a motor road. This road is passable throughout the year, except after very heavy falls of snow, when it may be closed for a few days. A regular service of trucks and stages operates along the road from Bridge River and Shalalth to the Pioneer Mine, 55 miles away. The British Columbia Telephone Company installed a telephone service in the Bridge River Walley in 1934, and during the same year, the B. C. Electric Power Company put through a power line, so that every convenience is enjoyed in the valley.

History

The property was known originally as the Alpha group, and was owned by W. Davidson. During 1929, the Consolidated Mining and Smelting Company of Canada, Limited took an option on the property, and financed all development work done on it. A drift was driven for 400 feet on a shear zone, and a crosscut driven towards a second shear. The average values in the shear in which drifting was done 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, Limited was incorporated and took over the property. The capitalization is 3,000,000 shares of no par value.

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 commercial grade.

A small mill was assembled in 1934, and a process of treating the arsenic and antimony in the ore has been worked out, so that the milling costs are only 87 cents per ton for removal of the arsenic. The concentrates are shipped to Tacoma. The Minto Company is very enthusiastic and optimistic, and believes it has a property which will be very important in the future.

General Geology

Below are given two tables of formations found in the Bridge River area, as presented by W. S. McCann in Memoir 130 of the Geological Survey of Canada and by Dr. V. J. Dolmage in the Canadian Mining and Metallurgical Bulletin for August, 1934. Dr. Dolmage's Table has been cut down for popular use.

Table of Formations (W. S. McCann)

ERA	Period	Formation	Lithological character	Thickness
Quaternary	Recent	Volcanic ash and stream deposits	White andesitic pumice, gravel, sand, silt, and clay	
	Pleistocene	Stream deposits Glacial deposits	Gravel, sand, silt, and clay Boulder clay or till	250
		Unconformity		
Tertiary		Diorite porphyry dykes	Buff or red-weathering porphyritic dykes, and sills with associated antimony deposits.	
	Oligocene(?)	Rexmount porphyry	Light-coloured intrusive stock and sills of andesite porphyry. Volcanic breccia, tuff, and lava. The latter rests in places upon conglomerate, sandstone, and shales containing a few thin seams of lignite coal.	1000 300
		Unconformity		
Mesozoic	Post Lower Cretaceous	Bendor quartz porphyry	Intrusive batholith, cupola stocks and dykes of quartz diorite, granodiorite, and quartz diorite porphyry.	
	Lower Cretaceous	Eldorado Series	Interbanded green sandstone and grey to black argillite with grey felspathic sandstone and coarse to fine conglomerate. Thin beds of crystalline limestone and interflows of andesite.	15000
		Unconformity		

Era	Period	Formation	Lithological Character	Thick-ness
Meso zoic	Upper Jurassic	Augite-diorite stock	Intrusive stocks of augite-diorite, containing gold-quartz veins.	
	Upper Triassic	Cadwallader series	Conglomerate, calcareous conglomerate and sandstone, crystalline limestone, and dolomites. Andesitic and basaltic interflows (greenstone). Lenses of black fossiliferous limestone.	21000
	Unconformity			
	Triassic(?)		Red-weathering serpentine rocks (volcanic breccia, porphyry, and dense rocks) (Shulaps volcanics).	2000
Unconformity				
Paleo zoic	Pennsylvanian-Permian	Bridge River series	Mainly contorted, thin-bedded cherty quartzites separated by thin films of argillite schist, dark-coloured altered argillites and crystalline limestone lenses and arenaceous schist. Flows of black and green metabasalt. In the vicinity of intrusive rocks, the rocks have been metamorphosed to quartz-mica schist, squeezed conglomerate and sandstone, phyllite, talcose, sericitic, and chlorite schists.	9500
			Total thickness	30150

Dolmage's Table of Formations appears on the following page.

Table of Formations (V. J. Dolmage)

Tertiary	Kersantite Dykes Felsite Dykes	
(?)	Albitite	Soda granite and aplite
Post Lower Cretaceous	Coast Range Batholith	Quartz diorite, granodiorite quartz porphyry dykes
	Bridge River Augite-diorite	Augite-diorite, diorite, quartz-diorite, etc.
Cretaceous Sediments	Eldorado Formation	Sandstone, shale, conglomerate, and limestone
Pre-Cretaceous Sediments and Volcanics	Cadwallader Formation	Argillites, greenstones, and serpentine.
	Bridge River Formation	Quartzites, argillites, greenstones, serpentine, and limestone.

Local Geology

The country rock in the property is mainly Bridge River series, and consists of altered sediments with interbeds 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 2,000 feet. 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 chloritic schists and serpentine. Calcite occurs irregularly as veinlets in the sheared mass.

The minerals found in the resulting metamorphosed rock are:- calcite, kaolin, chlorite, serpentine, zoisite, sericite, and iron oxides.

Economic Geology

Very little has been written on the economic geology of the part of the area in which the Minto Mine is located. As far as can be ascertained, the deposits lie in shear zones in the Bridge River series. The mineralization, as determined by an examination of specimens from the mine by the writer, consists of quartz, pyrite, arsenopyrite, sphalerite, stibnite, tetrahedrite(?), and chalcopyrite. Reports from the mine state that galena is present also, but none was found in the specimens examined. Mariposite and calcite are found in small fissures in the quartz.

Assays conducted by Dr. H. V. Warren and Mr. Jack Cummings of the University of British Columbia revealed that the gold occurs chiefly in the contacts between the sulphides, indicating that free gold is accumulated there, but none was found when polished specimens were examined under the microscope. The pyrite, arsenopyrite, sphalerite, and other sulphides also carry gold in smaller quantities.

The assay results of Dr. Warren and Mr. Cummings are as follows.

Samples	+4 mesh	0.66 ozs/ton
	-40 mesh	1.16 ozs/ton

Table Concentrates	-10 +20 mesh	1. 4.44 ozs/ton 2. 2.84 ozs/ton 3. 1.32 ozs/ton
	-20 +40 mesh	4.48 ozs/ton
Arsenopyrite	With quartz	1.8 ozs/ton
	Pure	1.60 ozs/ton
Pyrite	With quartz	2.50 ozs/ton
	Pure	3.50 ozs/ton
Sphalerite	Pure	1.20 ozs/ton
Sphalerite and other sulphides		0.90 ozs/ton
Sulphide contacts		28.60 ozs/ton

The pyrite was not separated quite cleanly from the other sulphides which probably accounts for the high values obtained with it.

Megascopic Examination of the Specimens

No. 2. Arsenopyrite, pyrite, sphalerite and quartz and one mineral which could not be determined megascopically. The sphalerite surrounds irregular masses of arsenopyrite and pyrite.

No. 3. Pyrite in fractured quartz, with stibnite. The pyrite is well crystallized.

No. 4. Arsenopyrite and pyrite in a gangue of quartz with mariposite(?).

No. 5. Well-crystallized pyrite in white and dark quartz. The quartz is slightly fractured.

No. 6. Arsenopyrite, sphalerite and pyrite in zones in fractured quartz. The sphalerite lies in contact with, and probably surrounds, the arsenopyrite. The pyrite occurs in dark parts of the quartz.

No. 8. Bands of arsenopyrite and pyrite fairly well crystallized in grey and white quartz. Distinct veining of the metallics by quartz is in evidence.

No. 9. Well-crystallized arsenopyrite, small quantities of pyrite crystals, and mariposite(?). The crystals occur in definite zones.

No. 10. Crystals of pyrite in vein material with calcite and small veinlets of sphalerite also carrying pyrite.

No. 11. Sphalerite in quartz with impregnations of some metallic mineral or minerals not determined megascopically. One of the metallics is probably stibnite. The sphalerite shows definite cleavage faces.

No. 12. Definite zones of arsenopyrite and pyrite in shattered quartz. Arsenopyrite and pyrite show crystal form in some places.

Remarks

From the above it is seen that the predominant metallic minerals are arsenopyrite and pyrite, while the important gangue mineral is quartz.

Sphalerite occurs in considerable quantities in some sections, but as the specimens were not marked, it is not possible to state what parts of the mine would be rich in pyrite or what its exact associations are.

Polished sections of some specimens were not prepared as they were similar to other specimens which appeared to show the relations between the minerals more clearly.

Specimen No. 8 proved of considerable interest, so that two polished sections of it were made.

The sections which proved the most interesting were Nos. 2, 5, 6, 8, 11, and 12, and drawings were made of them.

Microscopic Examination of the Polished Sections

No. 2. Gangue of quartz, with sphalerite enclosing particles of pyrite and arsenopyrite. The pyrite and arsenopyrite are not well-crystallized, though some semblance of crystal form is observed. The sphalerite is massive and contains impregnations of chalcopyrite. The sphalerite is disseminated through the quartz. Crystals of arsenopyrite and particles of pyrite are found in the sphalerite. (Fig. 2)

No. 3. Fractured crystals of pyrite with quartz, indicating that the pyrite came in first and was fractured by the quartz coming in at a later time. The stibnite observed in the hand specimen was not in evidence in the polished section. (Note. That the mineral is stibnite was proved by blow-piping). A veinlet of quartz cuts through the massive quartz gangue, indicating two generations of quartz. The later generation contains no metallic minerals.

No. 4. This section shows crystals of arsenopyrite with fracture fillings of quartz. No other metallic minerals observed.

No. 5. Good pyrite crystals in quartz gangue. A veinlet of quartz cutting the massive quartz and carrying grains of pyrite is present. The pyrite contains inclusions of sphalerite and stibnite, which appear uncrystallized. Sphalerite is also found in massive form in the quartz.

The sphalerite inclusions in the pyrite and quartz contain inclusions of chalcopyrite. (Fig. 4)

No. 6. Sphalerite is the predominant mineral in this section. Arsenopyrite and pyrite are found in contact with the sphalerite. Chalcopyrite appears in the sphalerite in controlled inclusions. The gangue mineral is quartz. (Fig. 3)

No. 8a. Arsenopyrite and pyrite crystals with fracture fillings of quartz and inclusions of sphalerite and stibnite, make up the greater part of this section. Stibnite also appears as minute inclusions in the quartz. A vein of fractured quartz appears in this section between arsenopyrite on one side and arsenopyrite and sphalerite on the other. An interesting feature is shown in Fig. 6, where massive quartz and fractured quartz, the latter containing a single crystal of pyrite, cuts across the sphalerite. (Figs. 1 & 6)

No. 8b. The most interesting part of this section is shown in Fig. 5, where a large piece of stibnite without crystal form is found surrounded by pyrite and quartz. The stibnite is apparently is platy form in fractures in the quartz. Particles of stibnite often disappeared while polishing after an etching test, showing how thin the particles were. (Fig. 5)

No. 10. The most interesting feature of this section is a straggling veinlet of quartz containing pyrite crystals, which cuts through a highly fractured field of quartz with mariposite(?) filling the cracks.

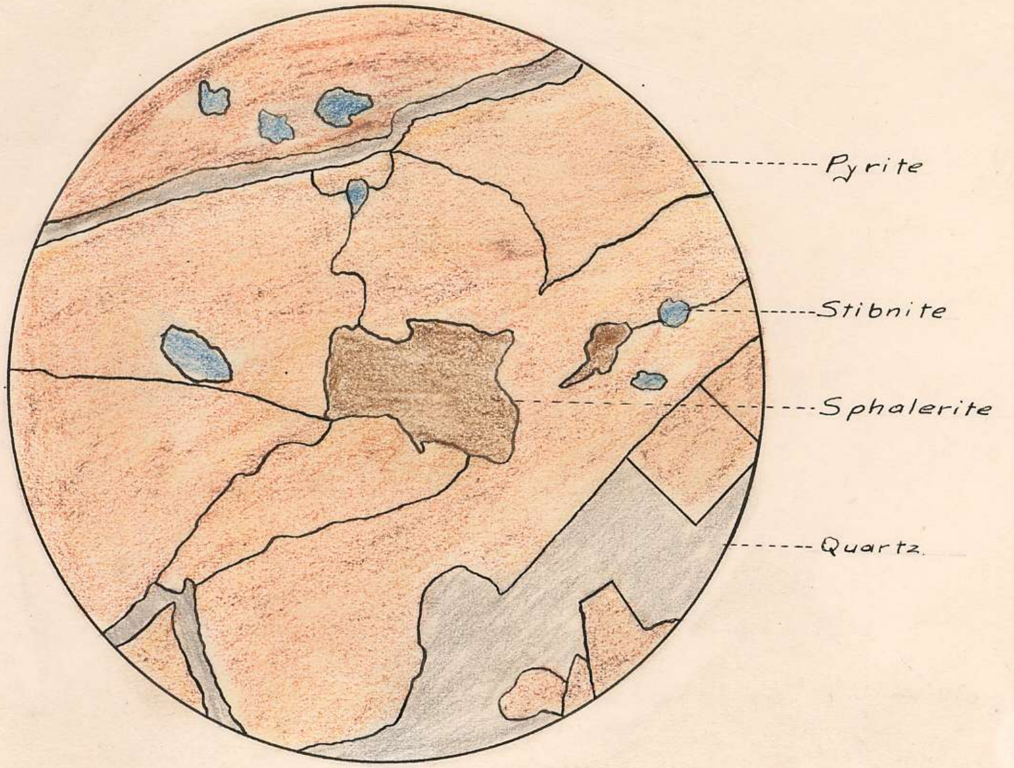
No. 11. The minerals present in this section are sphalerite, tetrahedrite(?), stibnite, arsenopyrite, and quartz. There is an almost complete lack of crystal structure. Arsenopyrite occurs as small crystals in the quartz. Tetrahedrite(?) is found as inclusions in the sphalerite, and stibnite as inclusions in the tetrahedrite(?). This section also exhibits clear glassy quartz cutting massive white quartz. The former carries no metallic minerals. (Figs. 7 & 9)

No. 12. This section consists of a gangue of quartz which appears highly fractured, with bands of crystallized pyrite and zones of arsenopyrite in almost parallel arrangement, indicating that the rock was under considerable stress at some time. The arsenopyrite is fractured, the fracture fillings being of quartz. (Fig. 8)

Remarks

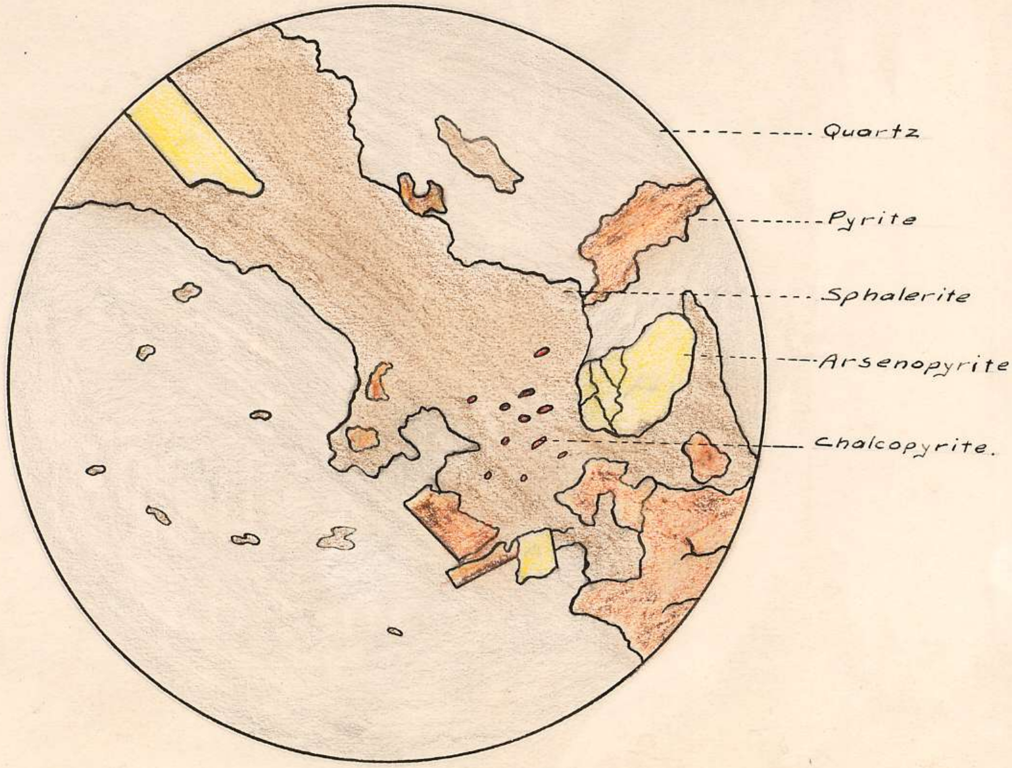
The mineral which is assumed to be tetrahedrite gave a distinct test for copper when a microchemical test was run on it, though no confirmatory antimony test was obtained. The etching tests gave a strong indication of tetrahedrite, however.

Fig. 1.



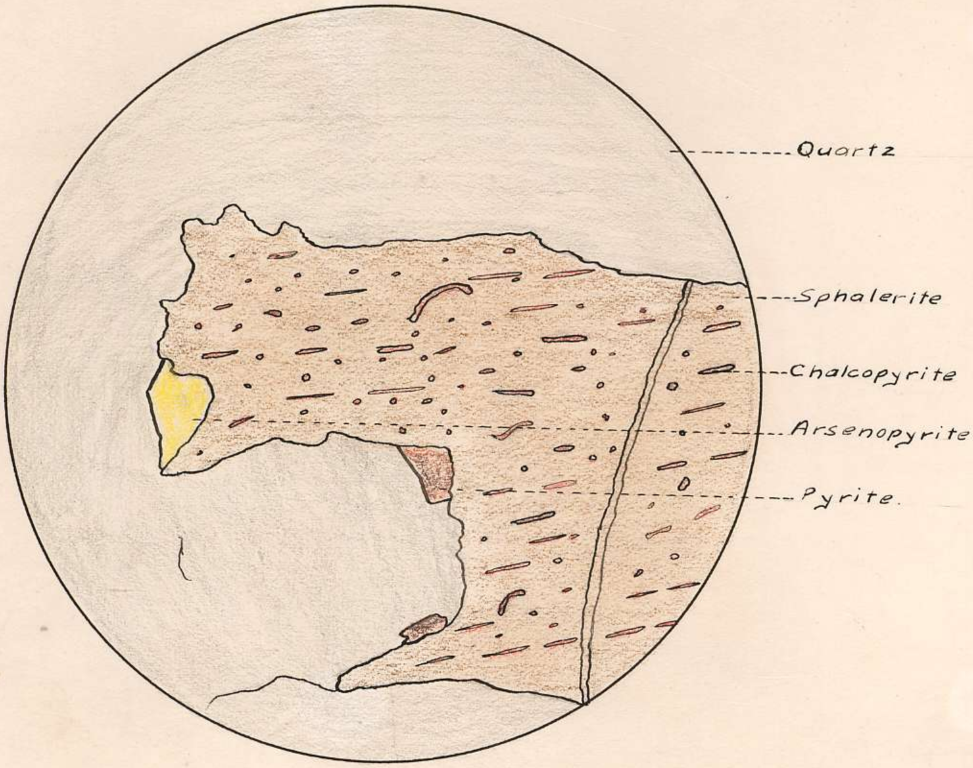
Section 8a. 40 X

Fig. 2.



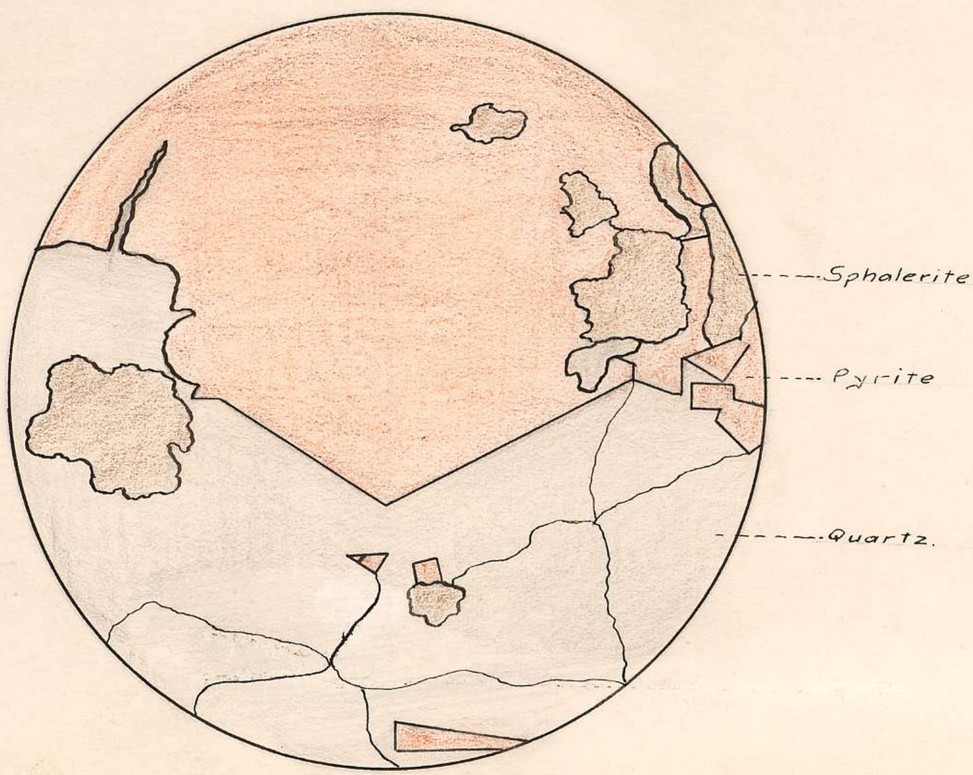
Section 2. 60 X.

Fig. 3



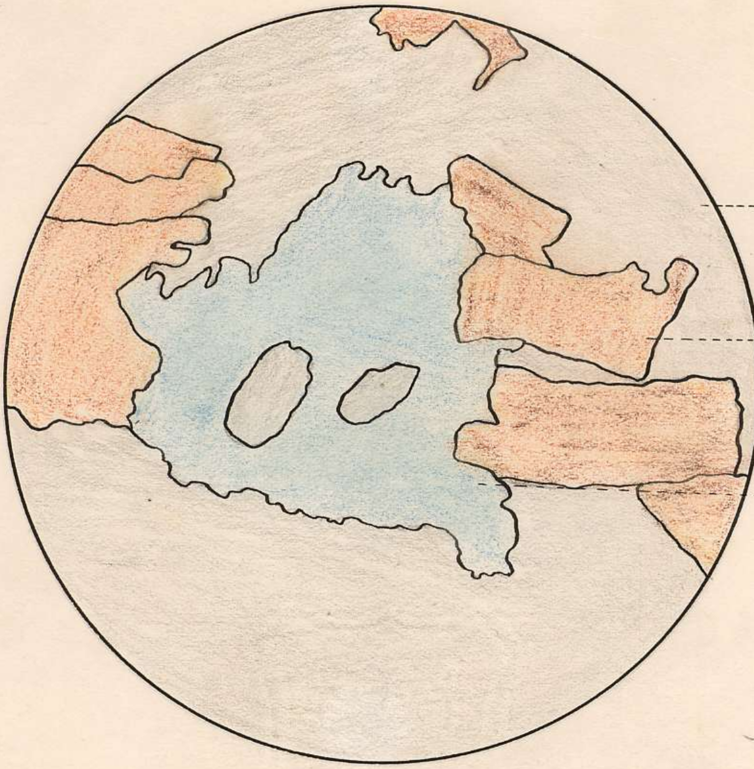
Section 6. 60 X

Fig. 4.



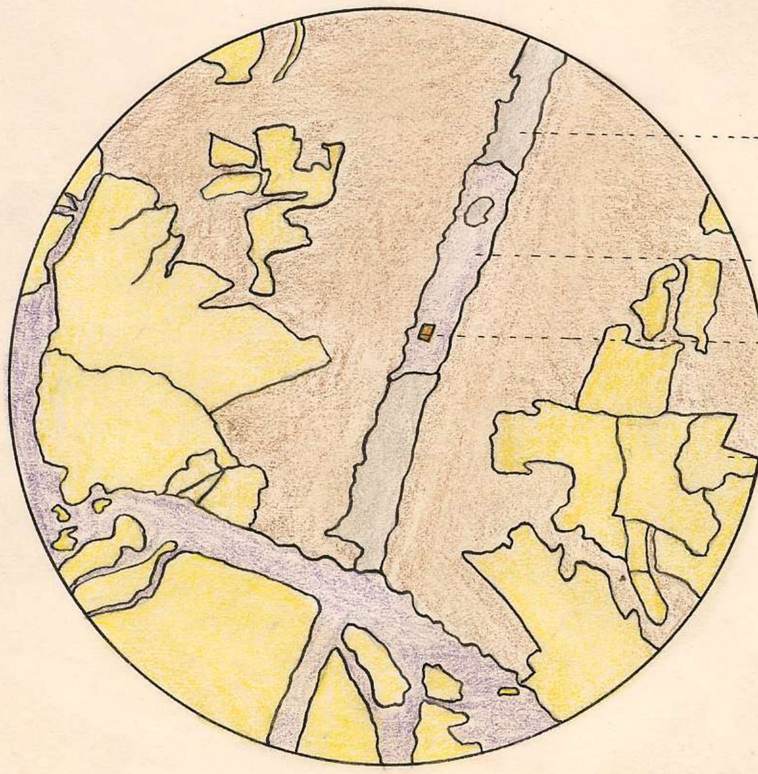
Section 5 40X

Fig. 5



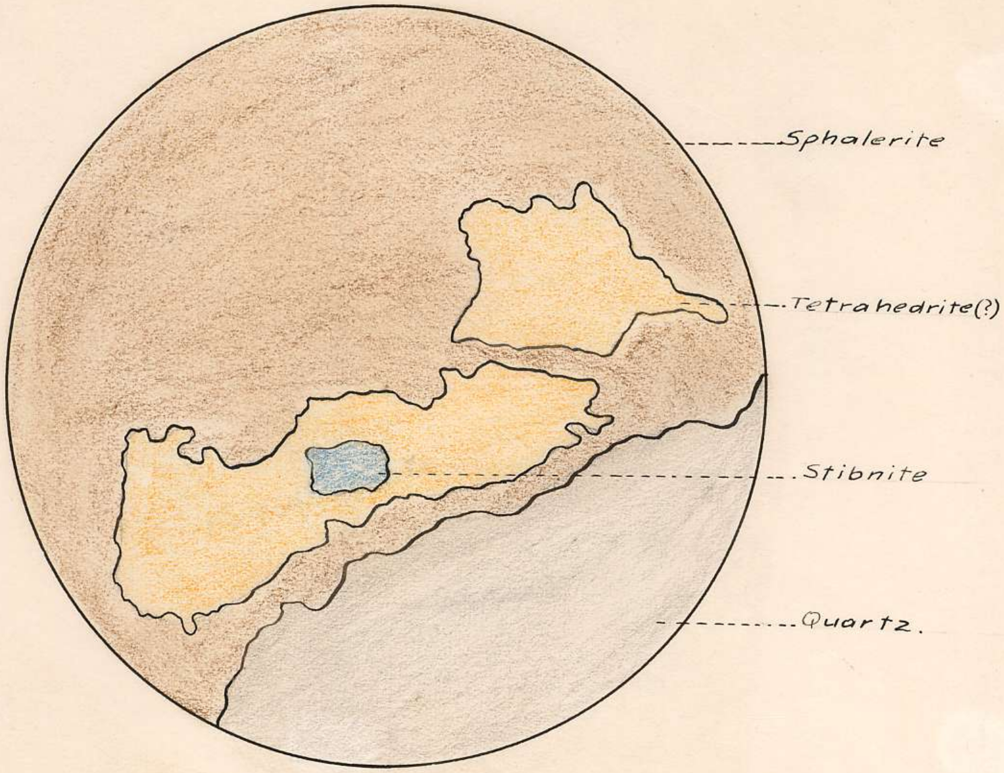
Section 8b. 40 X

Fig. 6



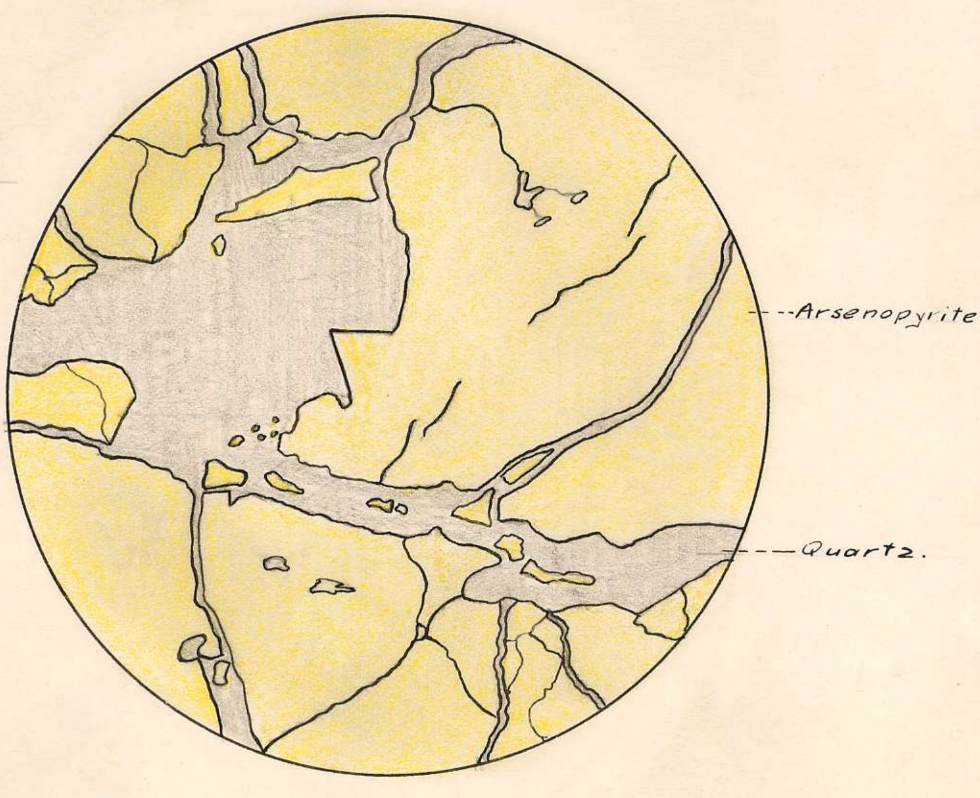
Section 8a. 40 X

Fig. 7



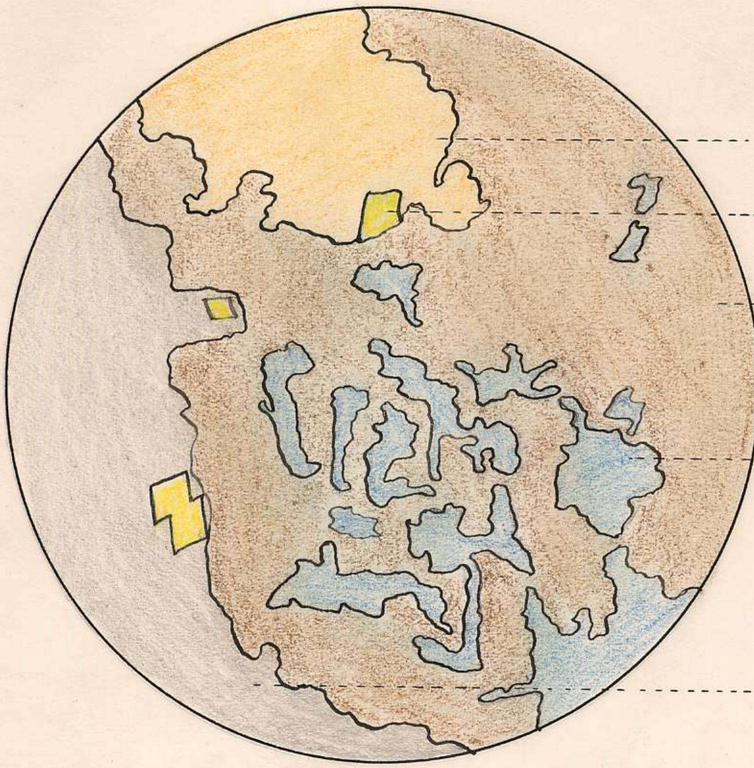
Section 11 40X.

Fig. 8.



Section 12 40X

Fig. 9.



Section 11.

40 X

Paragenesis

Order of succession of the minerals

1. Pyrite and Arsenopyrite
2. Quartz
3. Sphalerite and Chalcopyrite
4. Tetrahedrite(?)
5. Stibnite
6. Quartz

Factors leading to the above conclusions

The arsenopyrite and pyrite appear well-crystallized in many sections.

Where the arsenopyrite and pyrite are fractured, the fracture filling is quartz, showing that the quartz came in after the two metallic minerals.

The sphalerite and chalcopyrite came in later than the quartz as they are found cutting both it and the pyrite. They are an example of "Unmixing". The sphalerite, separating out at a high temperature must have contained in solid solution, iron and copper. As cooling took place, the copper and iron crystallized, and appear as chalcopyrite, arranged systematically along the cleavage planes of the crystallizing sphalerite. This would account for the control of the sphalerite over the chalcopyrite as shown in Fig. 3.

The tetrahedrite(?) and stibnite came in later than the sphalerite as they cut it. There is a very slight possibility that the tetrahedrite(?) is a replacement of the sphalerite, though no definite conclusions can be drawn from the relation of the minerals as shown in the sections examined.

In one section a piece of tetrahedrite(?) is found completely surrounding a smaller grain of stibnite. This is the main reason for placing the stibnite after the tetrahedrite rather than with it.

The second generation of quartz is assumed to come after the tetrahedrite(?) and stibnite as it appears to cut completely across the sections in which it is observed regardless of the minerals present. In only one case is it found to contain metallic minerals, so there is a possibility that what was taken for a vein in section 10 is really a wide fracture containing pyrite crystals.

The Minto deposits are probably of the lowest temperature Mesothermal type. No definite conclusions can be reached until an examination of the mineralized zones of the mine has been made.