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A MICROSCOPIC EXAMINATION OF THE ORES OF THE DUTHIE MINE

BY

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DUTHIE MINES

LOCATION.

The Duthie Mines is situated on the western slope of Hudson Bay Mountain approximately fifteen miles from Smithers. There is a good gravel road connecting it with Smithers.

GENERAL GEOLOGY OF HUDSON BAY MOUNTAIN.#

Hudson Bay Mountain lies 25 miles north-east of the eastern contact of the Coast Range batholith and within the limits of a broad belt largely underlain by Jurassic strata of the Hazelton series. It is an isolated mass rising to nearly nine thousand feet in elevation with a width of ten miles and a length of twenty miles. The longer axis trends north-west.

The sedimentary series are classed thus:

Hazelton Group.

(a) Lower Volcanic Division: andesitic flows, limestone and fragmental rocks. At the summits it grades into the Lower Sedimentary Division.

(b) Middle Sedimentary Division: well bedded series of limestone and indurated sandstone with cherty and fissile shaly bands.

(c) Upper Volcanic Division: It lies over the

#Jones, R. H. B.,Summary Report, 1925,Part A. G.S.C., Page 120.

greater part of the area and underlies nearly all the southern slope of the mountain. It consists of flows, breccias, tuffs and agglomerates.

(d) Upper Sedimentary Division: argillites and slates with a smaller amount of sandstone, bands of conglomerate and coal seams.

Skeena.

It lies unconformably on the Hazelton group.

Intrusives.

These consist of stocks and irregular masses from diorite to granodiorite. Dykes and possibly sills are also present and vary from diorites to quartz feldspar porphyries. They are younger than the Hazelton group and may be Jurassic, early Cretaceous, and even in part Tertiary in age.

Block faulting, doming and overthurst faulting are quite common. Lines of shearing are also common besides faulting, and the mineralizing solutions confined themselves to the fractures which often have a parallel arrangement. The fractures and shear zones which were favorable to mineralization are closely associated with the south-east portion of the mountain. The veins in the southern slope are mainly of the sheared and sheeted-zone types. The ore deposits are mostly in the andesites and in many cases are associated with rehyolite. They were formed mostly by the filling of openings, but some were formed by replacement.

Some of the veins are banded, and others are composed of brecciated wall rock cemented by the ore minerals. The replacement of the wall rock accompanied the fissure filling.

The ore bearing solutions obviously came from the granite intrusion and associated dykes. There was probably a focal centre from which the ore minerals were introduced. This is partly verified by a zonal distribution of ore on the west slope where a gradation exists from pyrrhotite-sphalerite ore through sphalerite-chalcopyrite to galena-sphalerite.

There are two fairly regular systems of fissures in which the ore occurs, striking north-east and north-west. The north-east trending fissures are prominent on the west slope and the north-west ones on the east slope.

The wall rock is altered and bleached. Most of the ore deposits are replacement fissure veins.

On Hudson Bay Mountain the ore can be classified thus:

1. Pyrrhotite-sphalerite ores with some pyrite and lesser amounts of arsenopyrite and chalcopyrite.

2. Sphalerite-arsenopyrite ores with chalcopyrite and pyrite.

3. Galena-sphalerite ores with chalcopyrite, tetrahedrite pyrite, and in some places arsenopyrite.

4. Chalcopyrite-bornite ores.

5. Magnetite-chalcopyrite ores.

GENERAL GEOLOGY OF THE DUTHIE MINE.#

There are several veins on the Duthie property, namely, the Henderson, Ashman, Fault Plane, Dome, Stranger and Main, of which the Henderson is the most important.

The area around is underlain by the Upper Volcanic Division of the Hazelton series consisting of rhyolite and andesite. There are several dykes cutting these rocks and striking approximately north and south. The largest is about fifty feet wide and consists of a medium grained diorite. It is intensely altered near the Henderson vein and is silicified and only slightly mineralized with small stringers of ore. It is pre-mineralization in age. The other dykes are not altered much and are not mineralized. They offset the vein and part of the vein east of each dyke has been displaced to the south. In general the north-south dykes are post-mineralization in age.

The ore bearing veins are in shear zones with a strike about 65°E and dipping steeply south-west.

The ore is in fissure veins, which in places show conclusive evidence of crustification or banding. Replacement of the wall rock has caused it to be mineralized, and some fragments of the wall rock enclosed in the ore have been partly replaced.

#Jones, R. H. B., G.S.C. Summary Report, 1925, Part A. Page 120.

The Henderson and the Ashman veins converge on the property. The latter has an approximate strike north-east and dips north-west. Within the area developed the distance between them is approximately 150 feet. The Henderson is of predominant importance.

The plan of the workings can be seen on Page 134 of the Report of the Minister of Mines, 1927.

The cross-section of the workings are shown in the Report of the Minister of Mines, c.10, 1934.

The plan of the claims are on Page 136 of the Report of the Minister of Mines. 1927

MINERALOGY.

Minerals.

The following minerals were identified: 1. arsenopyrite; 2. pyrite; 3. sphalerite; 4. pyrrhotite; 5. galena; 6. tetrahedrite intergrowth; 7. chalcopyrite; 8. pyrargarite; 9. unknown; 10. quartz; 11. rhodocrosite, or manganese bearing siderite.

Arsenopyrite. It is very abundant, being present in most of the sections and usually lies in quartz. Good crystal form is often exhibited and the crystals vary in size. Frequently arsenopyrite is fractures and the fractures filled by galena, tetrahedrite, sphalerite and chalcopyrite.

Pyrite. It is present in most sections though

usually not as abundant as arsenopyrite. Sometimes it is also fractured.

Sphalerite. It is very common and at times contains inclusions which are usually chalcopyrite and galena. In one or two sections pyrrhotite was present in sphalerite as small inclusions.

Pyrrhotite. It is present in several sections, but being only abundant in Section 8. Usually it is associated with galena either as inclusions or in contact with it.

Galena. It is common in most of the sections and nearly always contains long irregular shaped inclusions of tetrahedrite, few inclusions of ruby silver, and in some sections inclusions of the unknown mineral. Chalcopyrite was often seen in galena.

Tetrahedrite. An intergrowth is included under this name and most probably consists of tetrahedrite and freibergite. They both displayed the same etch tests as tetrahedrite. Assays, which had been run on samples as clean as could be obtained were as thus:#

	%	%	
Sulphur	21.8	20.7	
Antimony	25.0	25.5	
Copper	19.0	18.0	
Iron	4.0	5.0	
Zinc	4.0	2.5	
Silver	25.3†	26.8†	† oz. per ton.
Gold	2.1†	2.1†	
Bismuth	Nil	Nil	
Arsenic	Nil	Nil	
Tellurium	Nil	Nil	

#Report of the Minister of Mines, N.110, 1923.

It occurs in galena as long irregular shaped inclusions, in irregular masses in contact with galena and sphalerite, and also as blebs in sphalerite. One of the minerals of the intergrowth contains usually numerous small inclusions of chalcopyrite and galena, whereas the other mineral is barren.

Chalcopyrite. It occurs in most of the sections, although never abundant with the exception of one or two sections. It lies in galena, tetrahedrite, ruby silver and sphalerite, occurring mostly as small inclusions.

Pyrargarite. It is never abundant except in a couple of sections, and is usually present in small blebs and associated with tetrahedrite and galena. It often contains inclusions of chalcopyrite.

Unknown. It is present in only some of the sections and is found only as small inclusions in galena and often in contact with tetrahedrite.

Quartz and rhodocrosite are common. A micro chemical test showed that the carbonate contained manganese. It is either manganese bearing siderite or rhodocrosite.

DESCRIPTION OF THE SECTIONS STUDIED.

Section 1. Surface - Humming Bird Claims, 300 feet north of trail.

Galena is abundant and contains a few small irregular shaped inclusions of tetrahedrite. The boundaries between these two are usually smooth. Chalcopyrite often

occurs as inclusions in galena and exhibits smooth boundaries. It is also found in sphalerite and even veins the latter. Sphalerite is common.

Arsenopyrite is abundant and is present usually in quartz. It often exhibits good crystal form.

Pyrite is present as some large blebs.

No ruby silver, unknown mineral, or pyrrhotite was seen. Galena is veined and replaced by anglesite (?), which follows the cleavage planes.

Sphalerite frequently surrounds small well formed quartz crystals.

Section 2. Henderson - Surface - Above Thompson Adit.

Sphalerite is quite abundant and contains small scattered inclusions of galena as well as the odd inclusion of chalcopyrite. Arsenopyrite is common and found scattered through quartz and occasionally in sphalerite. Pyrite is present in scattered blebs lying in quartz and sphalerite. It sometimes has partial crystal shape. Galena is scattered throughout quartz and sphalerite in various sized masses. It contains inclusions of tetrahedrite as well as the odd inclusion of chalcopyrite, the latter being found occasionally in tetrahedrite. Two small pieces of pyrrhotite were noticed, one in contact with chalcopyrite and tetrahedrite, and the other as an intergrowth with chalcopyrite. Both

pieces were in galena.

There are some good quartz crystals surrounded by sphalerite. Quartz is quite common. Chalcopyrite veins sphalerite. Rhodocrosite is present. No ruby silver or the unknown mineral was seen.

Section 3. Mouth of Thompson Adit.

Galena is abundant and contains many small inclusions of the unknown mineral. These inclusions are dominantly needle shaped with smooth boundaries. They have a general orientation suggesting that they separated out from solid solution and followed the cleavage planes. Tetrahedrite is also common as inclusions in galena, being irregular in shape. It is sometimes found in contact with the unknown mineral, and in every case the contacts are smooth. Several blebs of tetrahedrite were seen in quartz in contact with sphalerite, and it and galena often fill fissures in arsenopyrite. Minute inclusions of chalcopyrite are sometimes found in tetrahedrite.

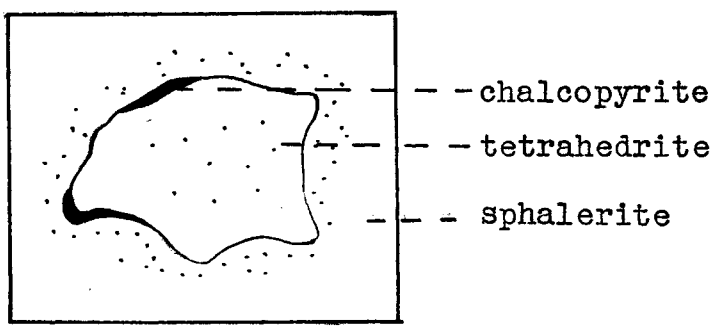
Several small blebs of ruby silver were seen in tetrahedrite and in galena. Sphalerite is mostly barren of chalcopyrite, but there are some inclusions. Arsenopyrite is abundant, and is usually found in quartz. In places it is quite fractured and healed by galena and sphalerite. Blebs of pyrite are present which are somewhat fractured, and sphalerite was observed filling some of the fissures.

There are many minute veinlets of galena, chalcopyrite and tetrahedrite cutting across sphalerite. Quartz was seen veining sphalerite.

Section 4. Henderson - McPherson - Mouth of Adit.

Sphalerite is common although somewhat barren of inclusions. It does however contain a few of chalcopyrite, galena and tetrahedrite. Tetrahedrite is present as some fair size blebs, lying in sphalerite. It contains small round and needle shaped inclusions of chalcopyrite, and also small inclusions of galena.

Some ruby silver is associated with tetrahedrite as small inclusions. Arsenopyrite is fairly abundant and lies mostly in quartz. Quartz is common and sphalerite surrounds good quartz crystals. It was noticed that surrounding the tetrahedrite in sphalerite, there were numerous small inclusions of chalcopyrite.



Section 5. Henderson - McPherson Level - 900 feet from frace.

Sphalerite is abundant and contains numerous small inclusions of pyrrhotite and galena. Pyrrhotite is abundant and is found in sphalerite, in contact with galena and tetrahedrite, in galena, in tetrahedrite, and in rhodocrosite. Its prominent position is along the boundary of galena. It appears to be closely associated with the latter, and also with sphalerite. There are some large blebs present. The boundaries between pyrrhotite, galena and tetrahedrite are smooth. Pyrrhotite contains a few inclusions of galena.

Pyrite is very common. Galena is abundant in large masses and contains long irregular shaped inclusions of tetrahedrite scattered through it. Chalcopyrite is a minor constituent and veins sphalerite and galena. There is the odd inclusion in galena. Arsenopyrite is present though not very common. Rhodocrosite is present and veins galena along the cleavage planes. Quartz is rather rare. No ruby silver or unknown mineral was seen.

Section 6. Henderson Vein - McPherson Adit - 200 feet from face.

Galena is common and contains numerous inclusions of chalcopyrite as well as scattered inclusions of tetrahedrite and the odd bleb of pyrrhotite. Tetrahedrite also contains the odd inclusion of pyrrhotite. Arsenopyrite is abundant and lies in quartz and tends to be fine grained.

In places it is veined by minute stringers of galena and chalcopyrite. There is the odd bleb of pyrite. Chalcopyrite is rather common, scattered through galena and sphalerite, and also in tetrahedrite. It was also seen veining galena along the cleavage planes with straight edges, and in one place the corners were not rounded. Sphalerite is abundant and has inclusions of chalcopyrite and galena. A few small stringers of ruby silver was seen cutting across galena and following the cleavage planes. The edges were straight. Rhodocrosite and quartz are present, and rhodocrosite cuts galena.

Section 7. Henderson Vein - McPherson Level - 15 feet from face.

Sphalerite is common and contains in places inclusions of chalcopyrite and also some small inclusions of galena. Arsenopyrite is abundant, lying in quartz and often exhibiting crystal form. A few medium sized blebs of chalcopyrite are present in quartz associated with sphalerite. Quartz is abundant and there are numerous well formed quartz crystals surrounded by sphalerite. A minor amount of rhodocrosite is present.

Section 7. 30 feet from face.

This section is practically only arsenopyrite and quartz. Arsenopyrite lies in quartz. Some blebs of sphalerite are present, and some contain inclusions of chalcopyrite. There is a very minor amount of galena in quartz.

A piece of tetrahedrite in contact with galena was seen. Some chalcopyrite is associated with galena. A minor amount of rhodocrosite is present.

Section 8. Henderson - Stope 12, Compression Level.

Sphalerite contains scattered blebs of chalcopyrite, the latter being also associated with galena. It is abundant and was seen veining rhodocrosite. Galena lies mostly in sphalerite and contains scattered inclusions of tetrahedrite, and also some small inclusions of pyrrhotite. The latter is often associated with chalcopyrite in galena. Odd very small inclusions of ruby silver in galena, and it, as well as tetrahedrite, was also seen veining the latter. Blebs of arsenopyrite and pyrite are present. Rhodocrosite veins galena.

Section 9. Henderson Vein - Compression Level - 30 feet from face.

Sphalerite is common, but is relatively barren. It contains some inclusions of galena and tetrahedrite. Large blebs of tetrahedrite occur containing numerous irregular shaped inclusions of ruby silver and inclusions of chalcopyrite and galena. Large masses of galena are present. It contains numerous small inclusions of the unknown mineral with a somewhat general orientation. Quartz is present. Rhodocrosite is very abundant and contains inclusions of tetrahedrite, galena and chalcopyrite. Odd bleb of pyrite and arsenopyrite

is present in rhodocrosite. Galena was seen veining quartz. Chalcopyrite veins tetrahedrite and sphalerite. Galena and sphalerite probably came after rhodocrosite.

Section 10. Henderson - Mill Level - 1200 feet from portal.

Arsenopyrite is abundant and some of it shows good crystal form. Chalcopyrite cuts through it in little stringers filling fissures. Sphalerite is present and although most of it is barren, it contains the odd small inclusion of pyrrhotite. Chalcopyrite is not abundant and appears to be mostly associated with arsenopyrite. Noticed several small blebs of tetrahedrite in quartz and in contact with sphalerite. Quartz and rhodocrosite are common. Sphalerite veins quartz and arsenopyrite. No galena was seen, or unknown mineral.

Section 11. Henderson - Mill Level - 50 feet from face.

Arsenopyrite is abundant and is mostly present as well shaped crystals. There are numerous well shaped quartz crystals surrounded by rhodocrosite. The latter followed quartz and is occasionally seen veining it. There are several blebs of pyrite present. Quartz and rhodocrosite are quite common.

Section 12. Ashman - Surface, just below trail west of long trench near adit. (Thompson)

Sphalerite is common and is full of inclusions

of chalcopyrite, which has a rough orientation. It also contains inclusions of galena. Sphalerite surrounds some well-shaped quartz crystals. Galena is abundant and contains inclusions of chalcopyrite and tetrahedrite, the latter often found in contact with the chalcopyrite inclusions. Arsenopyrite and pyrite are plentiful. Several small pieces of pyrrhotite in chalcopyrite were seen lying in galena. Quartz is abundant.

Section 13 - Ashman - South of X-cut near face. Compression.

Galena is common and contains irregular shaped inclusions of tetrahedrite and the unknown mineral. The latter has no definite orientation, and is often associated with tetrahedrite. Galena lies mostly in quartz. Sphalerite is present and is rather barren, containing little or no chalcopyrite. It does contain some inclusions of galena. Sphalerite surrounds some good quartz crystals. Pyrite and arsenopyrite are abundant, and lie mostly in quartz. Several veins of ruby silver cutting across galena and some small pieces of ruby silver intergrown with tetrahedrite were seen.

Section 14. Ashman Vein - Mill Level - 60 feet south of X-cut.

Tetrahedrite is common and contains the odd small inclusion of ruby silver. Galena is abundant and

contains numerous inclusions of the unknown mineral, which is often in contact with galena. It also has inclusions of tetrahedrite. Ruby silver is seen cutting across galena, and apparently following the cleavage planes. Galena and tetrahedrite lie in sphalerite and quartz. Arsenopyrite and pyrite are abundant and lie mostly in quartz. Sphalerite is common and contains numerous inclusions. It also surrounds some good quartz crystals. Quartz is plentiful.

Section 15. Fault Plane Vein - South of X-cut-between X-cut and face - Mill Level.

Sphalerite is abundant and contains numerous inclusions of galena and chalcopyrite, both of which vein it. Galena contains numerous inclusions of tetrahedrite as well as the unknown mineral. It is common in rhodocrosite, but not so much in quartz, galena, tetrahedrite, and chalcopyrite. There were some small inclusions of ruby silver in galena, which had a rough orientation, and in one place it veined the galena in a straight line. Rhodocrosite is plentiful and in places is veined by galena, which follows the cleavage planes and has a regular pattern. Angles are not rounded. Blebs of pyrite lie in rhodocrosite. Inclusions of chalcopyrite in rhodocrosite, which is influenced to a certain extent by the cleavage. Chalcopyrite is also associated with galena and tetrahedrite, occurring as inclusions. Quartz and rhodocrosite both vein sphalerite.

Section 16. Ashman Vein - Mill Level - 60 feet from face (north of X-cut).

Arsenopyrite is abundant in various size blebs and lies in quartz. Some of it has good crystal form. It is fractured in places and healed by sphalerite and galena. At times the latter two fill interspaces between crystals of arsenopyrite. Galena is common and lies amid arsenopyrite in quartz. It contains the odd inclusion of ruby silver, which lies by itself and also in contact with tetrahedrite. Ruby silver was seen in one place cutting across galena. Sphalerite is present and contains a few inclusions of chalcopyrite and galena. It also surrounds some good quartz crystals. Pyrite is present, lying in quartz.

Section 17. Level(?).

Ruby silver is abundant and lies in rhodocrosite and veins it. It is also associated with galena. Ruby silver and galena sometimes occur in the rhodocrosite as an irregular network of veins and stringers. Some sphalerite is present, as well as the odd bleb of arsenopyrite.

Galena contains the odd inclusion of chalcopyrite, and some inclusions of tetrahedrite. Several blebs of pyrrhotite are seen associated with galena. Quartz cuts rhodocrosite. Sphalerite appears to have followed rhodocrosite.

PARAGENESIS.

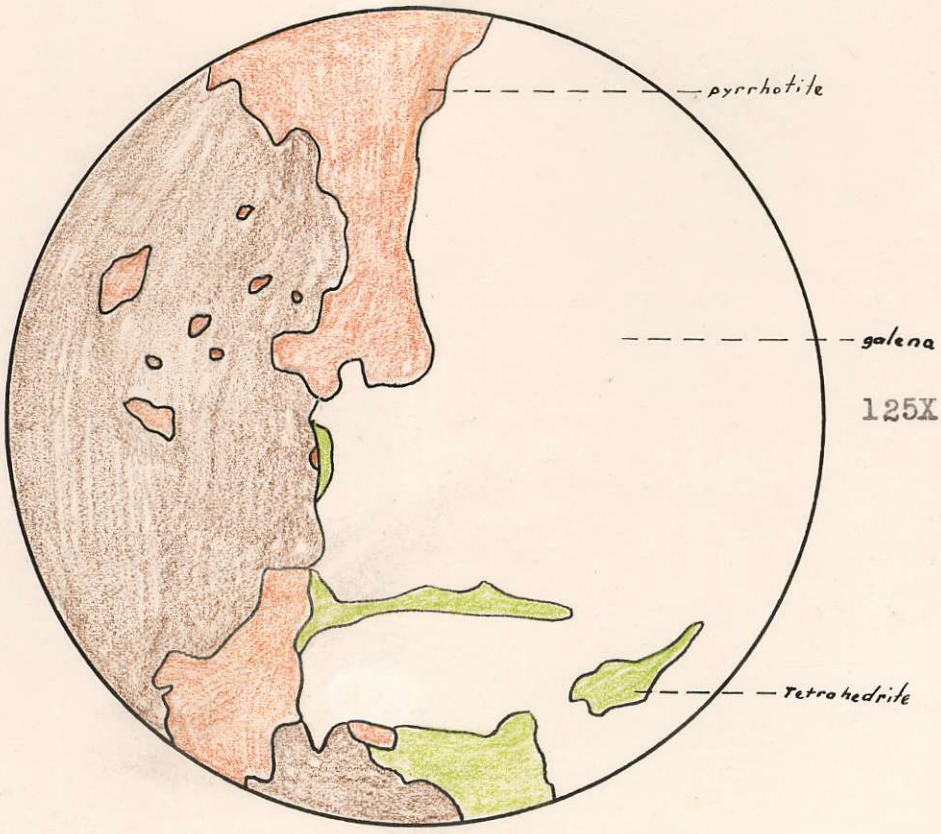
Arsenopyrite and pyrite were first introduced. This is shown by fissures in the two minerals which have been healed by sphalerite, galena, etc. Sphalerite came next as there are many veinlets of galena and tetrahedrite and chalcopyrite cutting it. As sphalerite also contains inclusions of chalcopyrite and pyrrhotite (Section 5) the former having at times a definite orientation probably fixed by cleavage planes, we should expect that they separated out from solid solution at the same time as sphalerite. This was followed by a second generation of chalcopyrite, galena, tetrahedrite, ruby silver, unknown mineral, and probably a second generation of pyrrhotite. Chalcopyrite, galena, and tetrahedrite definitely vein sphalerite, and they are also intimately associated along with ruby silver and pyrrhotite. There is no direct evidence to show if pyrrhotite separated out along with these minerals, or with sphalerite, but the former seems more plausible as pyrrhotite appears to be nearly always associated with galena as inclusions or in contact, and often in contact with chalcopyrite in galena. In one place in galena, it appeared to be intergrown with chalcopyrite. The unknown mineral was seen only in galena, and the inclusions had usually a definite orientation, which were controlled probably by cleavage planes. It probably separated out of galena from solid solution. There was an

overlapping, ruby silver, tetrahedrite and chalcopyrite separating out after galena. This is shown where these three minerals frequently vein galena. Just when quartz and rhodocrosite came in is not definite. That most of the quartz separated out before sphalerite is shown by the well shaped quartz crystals surrounded by sphalerite in practically every section. However, quartz was seen cutting sphalerite. Rhodocrosite was introduced before galena, and also after.

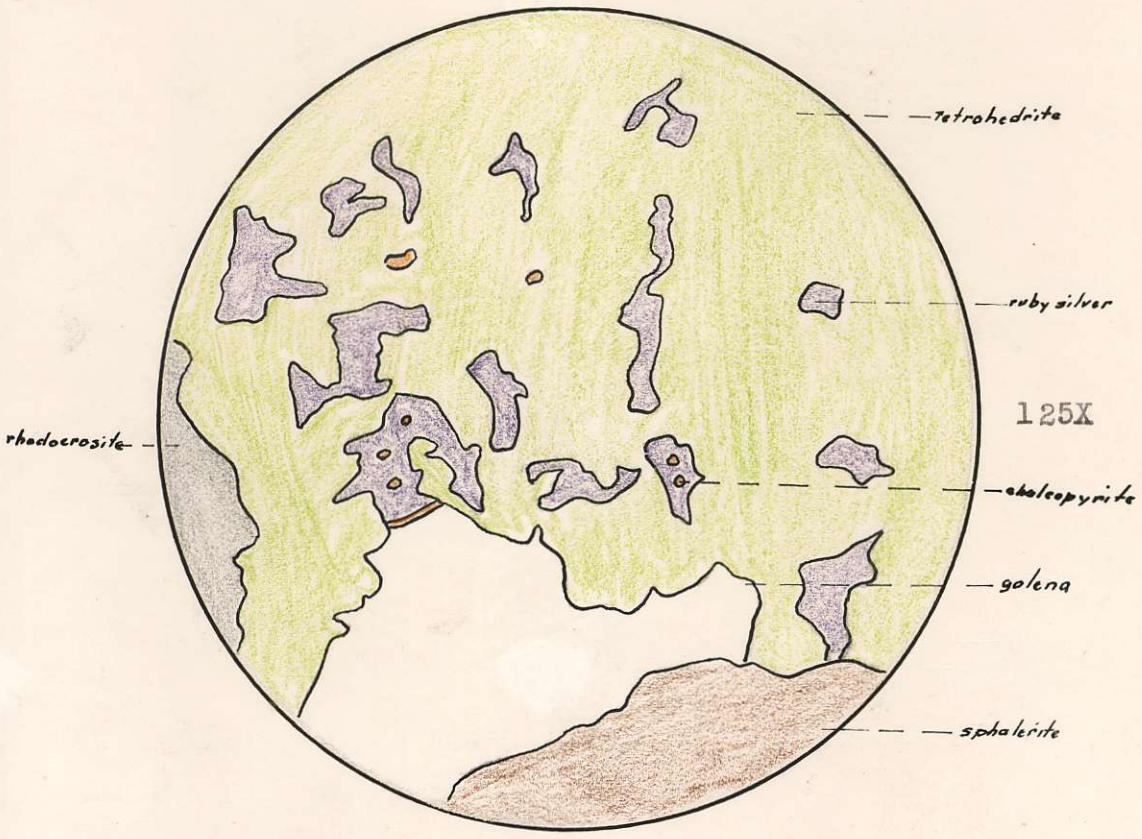
CONCLUSIONS.

That the ore deposit of the Duthie Mine is shallow seated, has been proved conclusively by field observations of the structure of the vein. There has, however, been some controversy as to whether ruby silver is primary or secondary. Personally, I would say it is the former, and base my conclusions mainly on the mineral association. There are no other minerals present that could be formed by secondary enrichment. Furthermore, the occurrence of ruby silver in tetrahedrite as shown in Illustration 2, does not point to it being a secondary mineral.

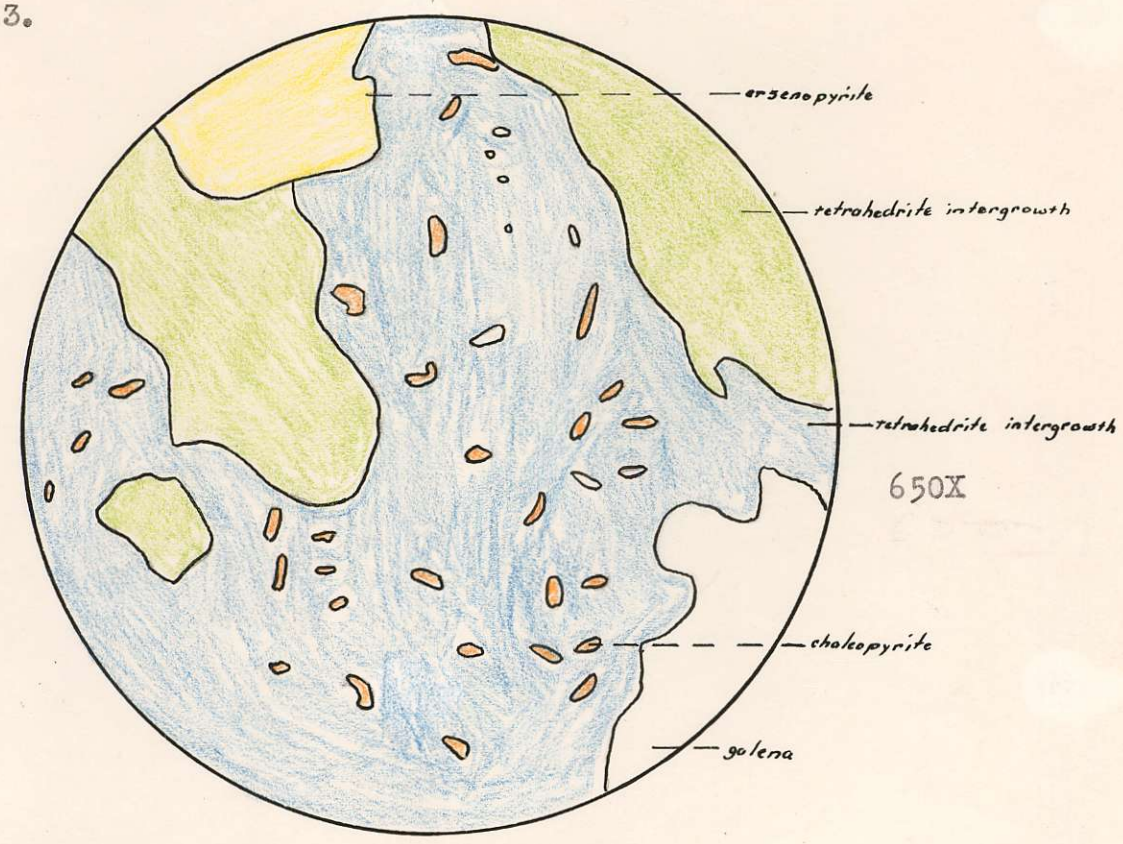
Section 5



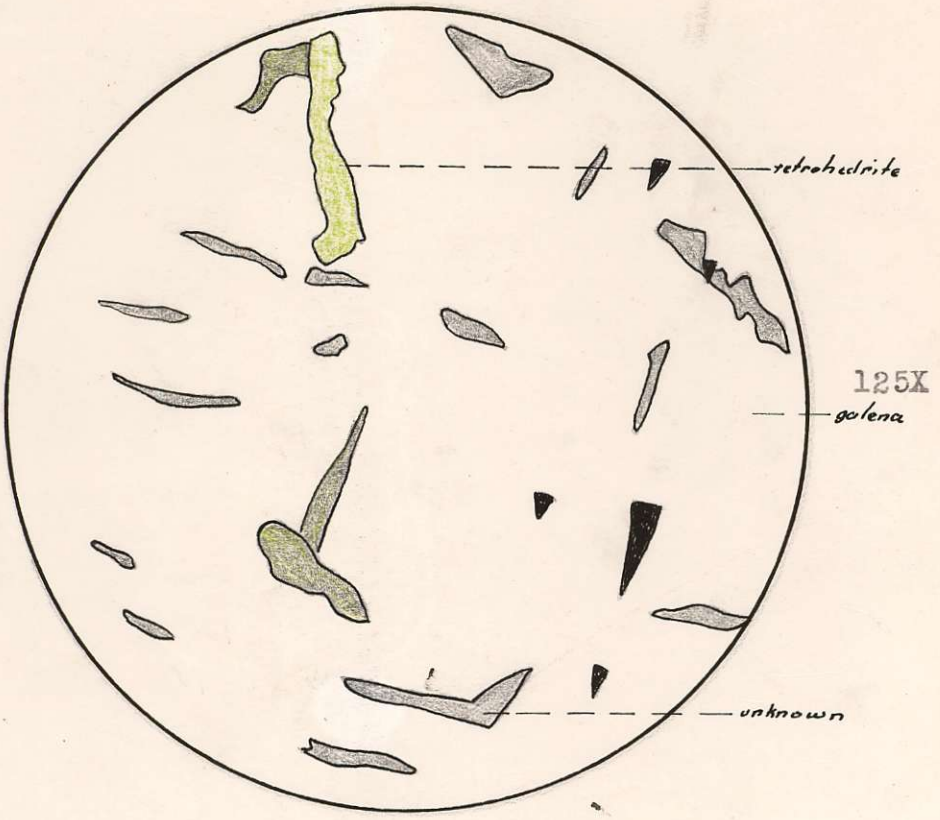
Pyrrhotite is shown in contact with galena. This is a typical occurrence in this section. Notice the small inclusions of pyrrhotite in sphalerite. Such inclusions here were very numerous.



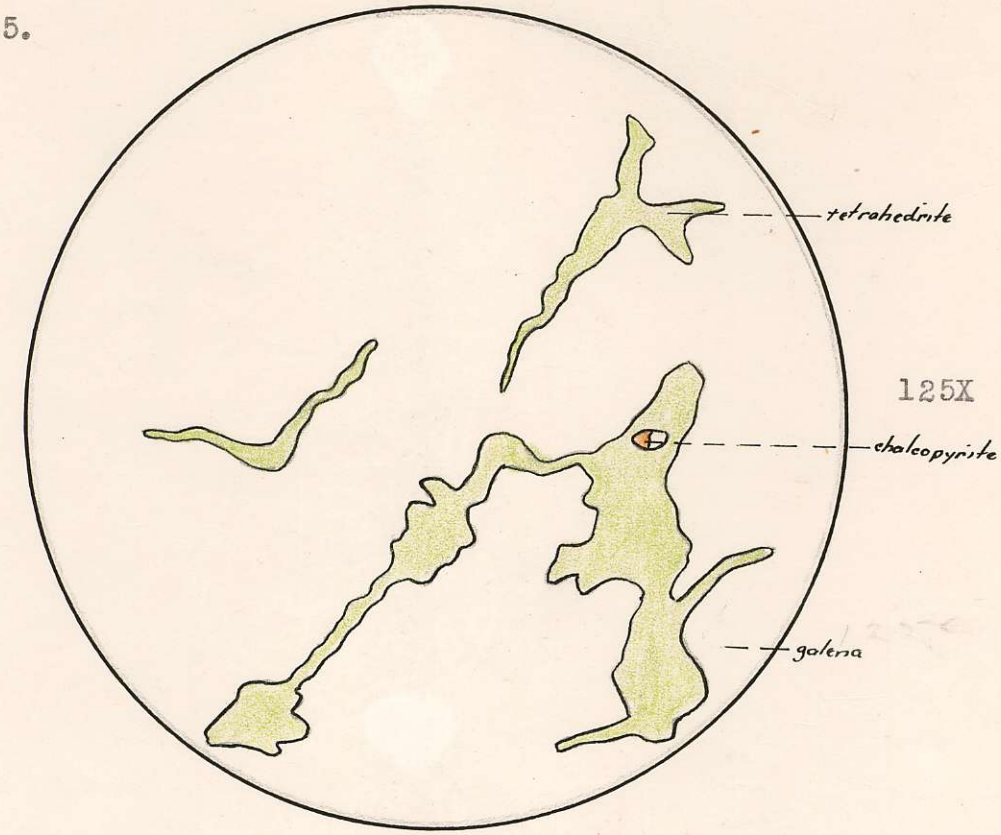
Ruby silver is illustrated as irregular masses lying in tetrahedrite. It is usually either associated with galena or tetrahedrite, and in this section this was a typical occurrence.



The tetrahedrite intergrowth is shown here. Notice that one of the minerals in the intergrowth contains numerous small inclusions of chalcopyrite and galena, whereas the other is barren. This was typical.



The unknown mineral is shown lying in galena. Note the general orientation, one direction parallel to the cleavage pits, and the other at right angles to it. This mineral was only found in galena, and sometimes in contact with tetrahedrite as shown.



Tetrahedrite is seen lying in galena. This is a typical occurrence, the tetrahedrite lying in long irregular masses as illustrated.