A MINERALOGRAPHICAL REPORT ON TWO RELATED MINERAL DEPOSITS ON THE SHELL PROPERTY IN THE AIKEN LAKE AREA

A report submitted in partial fulfilment of the Geology 409 course at the University of British Columbia

By

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ABSTRACT

This report concerns the result of a mineralographical examination of specimens from a magnetite deposit, and specimens from a near-by chalcopyrite vein. The mineralogy and paragenesis of each deposit are presented and comparisons are made between the two deposits. Evidence is put forward to substantiate the classification of both deposits as contact-metamorphic, and to illustrate the genetic relationships between the two deposits. An attempt was made to discover with which mineral the gold is associated, but evidence required for a precise answer could not be obtained.

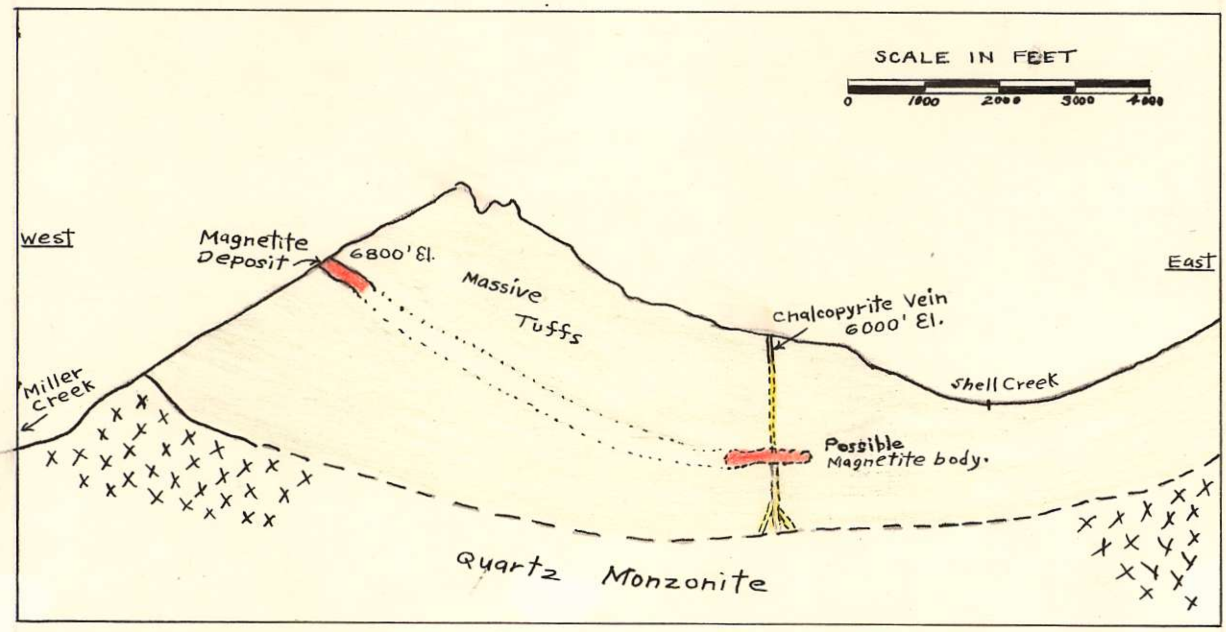
INTRODUCTION

This report contains the results of an examination of two apparently related deposits on the Shell property. This property, a group of mineral claims, is located in north-central British Columbia, about 13 miles north of Aiken Lake. In this area the main rocks are the andesitic tuffs of the Takla Group (Penn. to Jur.). Here and there stocks of plutonic rocks outcrop, representing the partially unroofed Cassiar-Omineca Batholith. The stock occurring on the Shell is composed of quartz monzonite, and seems to be genetically related to the mineral deposits.

The first of the two deposits concerned with in this report is a magnetite body about 2000 feet long and averaging

15 feet in thickness. It is situated high on a mountain side into which it dips at roughly 30°. Most of the mountain is composed of andesitic tuffs, but near the base it is cut by a quartz monzonite stock.

On the other side of the mountain, and at a lower elevation, there is a second deposit. It is a massive chalcopyrite vein about 200 feet in length and up to 4 feet in width. Its dip is almost vertical. The space relations between the magnetite body, the chalcopyrite vein, the quartz monzonite stock, and the tuffs are shown in the following rough sketch.



The only work that has been done on the Shell property was done by Springer Sturgeon Gold Mines Limited during the summer of 1947. The nature of this work was purely exploratory. Although the writer was employed by the above company in this work, the specimens used in the laboratory examination were collected by Dr. W. White.

Since these deposits have not been previously investigated, the chief purpose of the examinatiea was to determine their mineralogy and paragenesis. The second purpose was to decide whether the two deposits are genetically related by comparing the mineralogy and paragenesis of each. The final, and minor purpose, was to determine with which minerals the gold is associated.

RESULTS OF THE EXAMINATION

The mineralogy of the two deposits was found to be quite simple, and typical of contact-metamorphic deposits. An almost identical set of minerals occurs in both deposits, but the relative abundance of these minerals differs. The mineralogy of the deposits listed in the order of abundance is as follows:

Magnetite Deposit	Massive Sulphide Vein
Magnetite	Chalcopyrite
Pyrite	Pyrite
Chalcopyrite	magnetite
Quartz	Quartz
Sphalerite	Unknown
Gold (not seen)	Sphalerite
	Gold (not seen)

In addition to the above minerals, a small amount of pyrrhotite was identified in a hand specimen of the sulphide vein by Dr. White. None, however, was found in the polished sections. Although not present in the two deposits considered here, molybdenite occurs in the quartz veins on the nearby Croyden workings (C.M.&S.). This mineral is mentioned only as further evidence supporting the contact-metamorphic theory of origin of the deposits in the area.

No secondary minerals were found during the laboratory examination. Some were noted in the field, such as malachite, chalcocite, and limonite, but their distribution was restricted almost entirely to the weathered surfaces of the deposits.

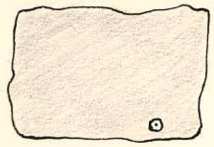
A brief description of the mode of occurrence of each mineral is given in the following pages.

Magnetite

Magnetite comprises about ninety percent of the magnetite body. Most of this deposit is represented by Section#1. Typical of high temperature deposition, the magnetite occurs both massively and in coarse grains, some of which are quite well formed (see Photograph #1). Angular quartz grains are scattered throughout, generally interstitial between magnetite grains. Here and there, fragments of unreplaced tuffs can be seen.. In the field larger replicas of these fragments remain in the lenticular magnetite body as horses.

As shown in Photograph #1, the magnetite grains

Section #1.



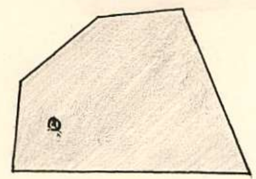
Photograph #1

have been spread, broken, and partly replaced(?) by chalcopyrite. There is no doubt that the chalcopyrite came in after the magnetite was consolidated.

The sulphides are not spread uniformly throughout the magnetite body, but are found in irregular zones in which the sulphides have been concentrated by unknown controls. In parts of these sulphide zones, magnetite comprises only about fifty percent of the "ore". Sections #2 and #3 represent these zones. Here the magnetite is veined by quartz, pyrite, and chalcopyrite in that order (see Photographs #2 and #3).

In the massive chalcopyrite vein, magnetite is only a minor mineral in comparison to the chalcopyrite, and cmmprises probably less than ten percent of the vein. The magnetite occurs only as fragments, some of which are composed partly

Section #3

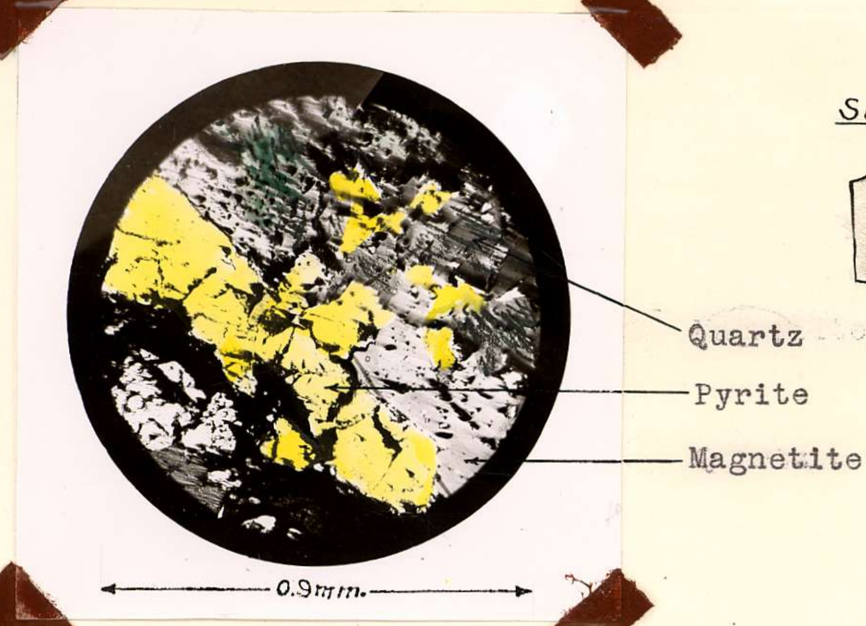


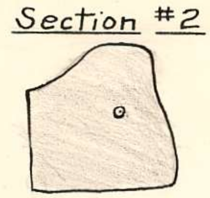
Photograph #2

of quartz (see Photograph #4) and some partly of pyrite. The fragments range in size up to one inch, but the larger fragments are heavily veined by the chalcopyrite.

The occurrence of the magnetite in the vein is rather interesting. Its presence is due to one of two possible processes: a) that the magnetite first replaced the country rock where the vein now is, and was itself later replaced by the chalcopyrite, and b) that the magnetite was carried up in fragments from an underlying magnetite body through which the vein passes. All the evidence found in the field and in the laboratory favours the latter postulation. The most important evidence is listed below:

a) The occurrence of magnetite in isolated fragments, not associated with country rock.





Photograph #3

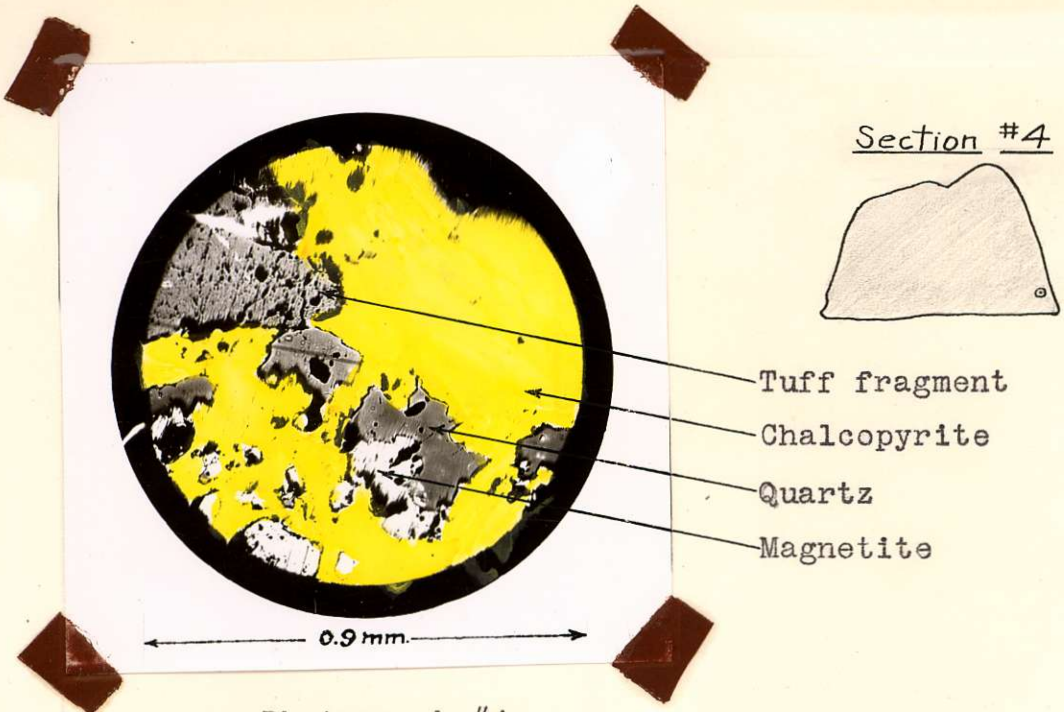
b) The lack of magnetite in visible amounts in the wall rock, (indicating that no magnetite body was present where the vein now outcrops, unless it was entirely replaced by the chalcopyrite, except for the small fragments in the vein).

c) The magnetite is not easily replaced by the chalcopyrite (see page (10).

d) Quartz and magnetite do not occur associated, in the wall rock, as they do in the fragments and in the known magnetite deposit.

e) The chalcopyrite vein has all the indications of being formed by fissure filling, rather than by replacement of the country rock.

Thus, it can be concluded that the chalcopyrite vein cuts a magnetite body lying somewhere between the surface



Photograph #4

and the contact with the intrusive stock. Possibly this body is a continuation of the known magnetite body. The spacial relation between the magnetite body and the chalcopyrite vein permits and even suggests such a possibility, but the notorious tendency for most contact-metamorphic deposits to be very irregular detracts from the likelihood of the possibility.

The mechanism by which iron is brought in to form magnetite deposits has long been a matter of dispute. The theory held by Lindgren and many other geologists maintains that the iron is carried in the form of ferric chloride or fluoride, and precipitated by reaction with the country rock, which is characteristically limey around such deposits. The following equations exemplify this theory:

$$2FeCl_3 + 3CaCO_3 \longrightarrow Fe_2O_3 + 3CaCl_2 + 3CO_2$$

$$2\ FeF_3 + 3CaCO_3 \longrightarrow Fe_2O_3 + 3CaF_2 + 3CO_2$$

This theory, however, is not entirely satisfactory. The lack of chlorine and fluorine-bearing minerals in the area makes it unlikely that either of these two volatiles were responsible for carrying the enormous amount of magnetite occurring in the region. The mechanism suggested by S. J. Shand for the transference of iron conforms more readily with the field data. He suggests that the iron was carried in solution in the form of ferrous hydroxide hydrosol. Under reduced pressures this substance undergoes self-oxidation, yielding magnetite with the expulsion of hydrogen. This reaction may be represented by the following equation:

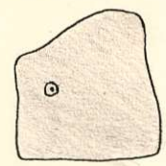
$$3Fe(OH)_2 + \text{heat and reduced pressures} \longrightarrow Fe_3O_4 + 2H_2O + H_2\uparrow$$

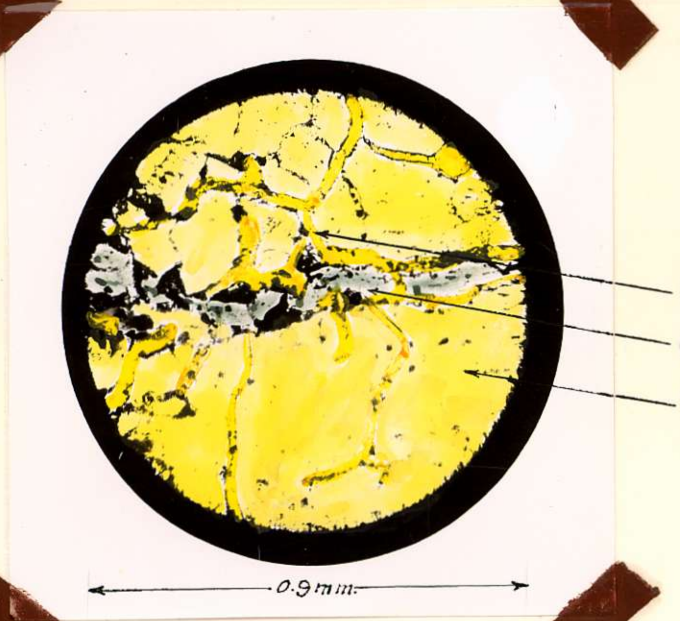
The reduction in pressure is assumed to occur during the ascent of the solutions into the overlying rocks.

Chalcopyrite

Massive chalcopyrite comprises at least seventy-five percent of the chalcopyrite vein. It forms the groundmass in which there are fragments of magnetite, quartz, pyrite, country rock, and combinations of these. Chalcopyrite is the latest major mineral in both the vein and the magnetite body, and veins the magnetite, quartz, and pyrite (see Photographs #2 and #5).

Section #2





Photograph #5

In the magnetite deposit, the chalcopyrite is superseded in abundance by both the magnetite and the pyrite. When the chalcopyrite came into the sulphide zones, the pyrite and quartz were already consolidated in the magnetite. On entering, the chalcopyrite has generally followed the same microscopic passageways that were previously used by the quartz and the pyrite. In doing so, the chalcopyrite reveals a tendency towards selective replacement, both quartz and pyrite being preferred to the magnetite. Photograph #2 shows the chalcopyrite replacing the quartz but shunning the magnetite. The irregular non-equidimentional shapes of the pyrite grains, and the higher degree of fragmentation of the grains, suggest that the pyrite is more susceptible to replacement by the chalcopyrite than is the magnetite. In Photograph #5, where chalcopyrite has followed a quartz stringer into pyrite, the chalcopyrite has come in alongside the quartz, and has preferred to branch into the pyrite rather than the quartz. This suggests, but does not prove, that the pyrite is more susceptible to replacement than is the quartz. Therefore, the indicated order of decreasing susceptibility to replacement is pyrite, quartz, and magnetite.

Pyrite

Pyrite is the second most abundant mineral in both deposits. In the chalcopyrite vein, pyrite occurs in corroded subhedral grains ranging from 2mm downward. Some lineation of the pyrite grains seems to be present in Section #2. This appears to be the result of flow of the mineralizing solutions in the vein fissure, or less likely, the result of partial replacement of previous pyrite veinlets. As previously mentioned, pyrite also occurs as a component of the magnetite-quartz fragments in the chalcopyrite vein. Most of the evidence seems to suggest that neither the pyrite nor the magnetite is in place in the chalcopyrite vein, but that both have been brought up in fragments from a deeper deposit by the chalcopyrite-bearing solutions.

In the sulphide zones of the magnetite body, the pyrite has much the same mode of occurrence as in the chalcopyrite vein. Here, however, the pyrite grains are in place. They have not been transported after crystallization, although they are fractured and partially replaced. Commonly the pyrite is found in massive form, but occasionally euhedral grains are found.

As is characteristic of practically all contact-metamorphic deposits, the pyrite preceded the chalcopyrite but followed the magnetite. In Photograph #3 pyrite is shown cutting the magnetite and quartz.

Quartz

Quartz is present in two forms. In its earliest occurrence the quartz crystallized in rather course angular shapes (1-2 mm) among similar grains of magnetite. Although it seems to have been essentially contemporaneous with the magnetite, the shape of the quartz has generally been controlled by the gaps left between the magnetite grains. In a few places the relations between the quartz and the magnetite suggest that some of this quartz was deposited prior to the magnetite, but there is no substantial evidence of this.

There is, however, no doubt that most of the quartz succeded the magnetite (see Photograph #2), and all the quartz preceded the chalcopyrite. The paragenetic relation is best shown in sections from the magnetite body.

Sphalerite

Sphalerite is present but only in very small amounts. It occurs in small anhedral grains, seldom exceeding .1 mm in length, in both the vein and the magnetite body. The grains are scattered throughout the chalcopyrite, and seem to be contemporaneous with, or slightly later than that mineral. The sphalerite is present in the same manner, and in approximately the same relative amounts in the chalcopyrite of both the magnetite body and the chalcopyrite vein.

Unknown Mineral

As was shown in the lists (page 3), the mineralogies of the two deposits are identical except for the occurrence of the unknown mineral. It was found in all sections made from the chalcopyrite vein, but in none of those made from the magnetite deposit. The writer cannot explain this fact, although it may be the result of an unfortunate choice of sections.

The "Unknown", a pinkish cream mineral, has a distribution and abundance that is very similar to that of sphalerite. However, the grains are somewhat larger than those of sphalerite, ranging up to .3 mm in length and averaging 1-2 mm. Although always in the chalcopyrite, this mineral was found in several places to be in contact with corroded pyrite grains. This fact, noted merely in passing, is of dubious value, however, since many grains of the unknown mineral were found isolated in the chalcopyrite, and one was found in contact with a quartz grain. The unknown mineral seems to have entered with the chalcopyrite or shortly thereafter, and is probably contemporaneous with the sphalerite.

Since this mineral occurs only in very small grains, it could not be identified with the facilities available. Pending an X-ray report on this mineral from Dr. Thompson, only its properties can be given in this report.

<u>Unknown Mineral</u> (see Photograph #6)

> Colour pinkish cream, about the same as pyrrhotite; hardness C. Medium anisotropic, with mauve polarization colours; gives two extinctions per revolution. HNO_3, HCl, KCN, $FeCl_3$, KOH, $HgCl_2$ and aqua regia negative. Non-magnetic. Invariably in chalcopyrite: and shows practically no relief in chalcopyrite.

Superficially the mineral is similar to pyrrhotite, cubanite, and emplectite. However, it differs from pyrrhotite and cubanite in being non-magnetic and negative to all reagents including aqua regia; and it differs from emplectite in being negative to aqua regia.

A "microchem" test was attempted; but only copper was found. Since it was impossible to determine whether the minute speck analysed was pure, the copper may have come from some adhered chalcopyrite.

The properties determined for this unknown mineral do not correspond to those for any mineral listed in . . Short's "Microscopic Determination of the Ore Minerals".

Gold

No gold could be found in the sections that were made, although assays showed it to be present. A series of assays was run on selected specimens from the magnetite body containing different amounts of sulphides. The results of these assays (in the files of Springer Sturgeon Gold Mines Limited) show that generally, the amount of gold present varies directly with the percentage of copper. This condition, although quite marked, did not hold for all assays made, and was especially lacking where the copper percentage was rather high. It may be concluded, however, that the gold is associated with the sulphides, probably chiefly with the chalcopyrite. The results of some typical assays (made available by Dr. White) are shown below.

<u>Chalcopyrite Vein</u>

Gold	Silver	Copper
0.47 oz/ton	1.9 oz/ton	20.5%
0.44 oz/ton	2.0 oz/ton	22.5%

<u>Magnetite Deposit</u>

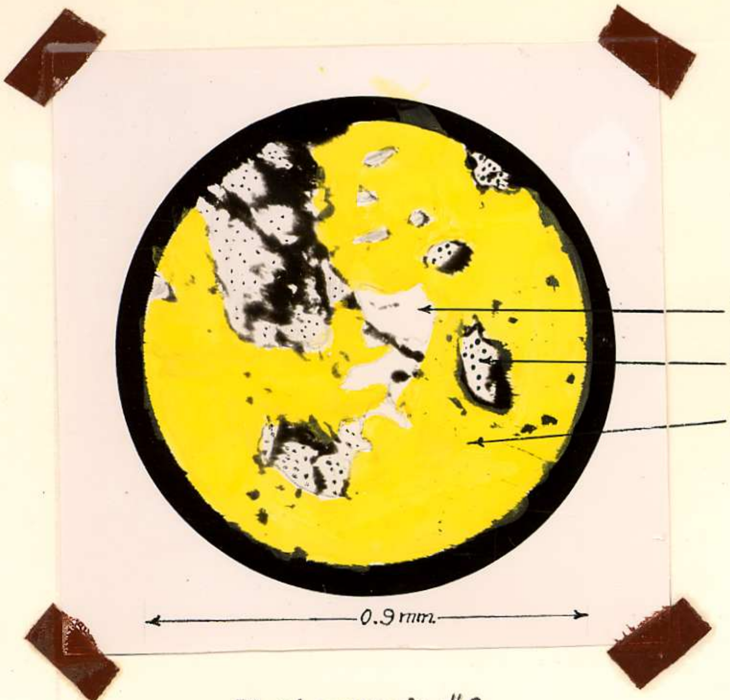
Gold	Silver
trace	0.2 oz/ton

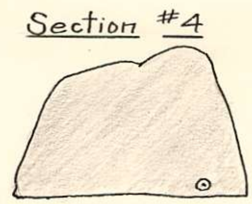
<u>Sulphide Zone in Magnetite Deposit</u>

Gold	Silver
0.86 oz/ton	2.0 oz/ton

. . .

All the minerals, except the "Unknown", found in the polished sections, were determined from the descriptions given in M.N.Short's "Microscopic Determination of Ore Minerals".





Photograph #6

PARAGENESIS

The parageneses of both deposits were found to be typical of contact-metamorphic deposits. Since the parageneses are identical, the chart below is true for both deposits.

Mineral	Time of deposition
Magnetite	____________
Quartz	..__________________________
Pyrite	____________
Chalcopyrite	__________
Sphalerite	___..
Unknown Mineral	___..
Gold	....

(Dots signify probable time of deposition)

CONCLUSIONS

Both deposits are the result of contact-metamorphism, and both owe their origin to the intrusion of the quartz monzonite stock. The deposits are typical in mineralogy, texture, and mode of occurrence of many magnetite and chalcopyrite deposits scattered throughout the Western Cordillera. Although both deposits have the same origin, the chalcopyrite vein was deposited later, during a lower temperature period, than the magnetite. The magnetite body was formed by replacement of the country rock (tuffs); but the chalcopyrite vein was formed by deposition in a fissure, opened probably by the intrusion of the stock. The microscopic examination also revealed the probability of another magnetite deposit, possibly a continuation of the known one, lying below and cut by the chalcopyrite vein.

The gold is associated with the sulphides, but whether it is with the pyrite or the chalcopyrite could not be determined definitely, although there is some indication that it is with the chalcopyrite.

APPENDIX OF SECTIONS

Section #1: (from magnetite deposit)

Minerals present in order of abundance:

magnetite
quartz (and Ca, Fe silicates)
chalcopyrite
pyrite (1 grain)

In addition to these, there is some unaltered tuffaceous material, fragments of which are present in all the sections. The more important features illustrated by this section are as follows:

a) Coarse grained texture of the magnetite.

b) Interstitial position of quartz and other silicates.

c) Chalcopyrite intruded among magnetite grains. It has disturbed and spread some of the magnetite grains.

Section #2: (from sulphide zone in magnetite deposit)

Minerals present in order of abundance:

pyrite
magnetite
quartz
chalcopyrite
sphalerite (3 small grains)

The more important features illustrated by this section are as follows:

a) Chalcopyrite veining pyrite

b) Quartz veining magnetite

c) Quartz veining pyrite

d) Tendency for chalcopyrite to replace quartz rather than magnetite, and pyrite rather than quartz.

Section #3: (from sulphide zone in magnetite deposit)

Minerals present in order of abundance:

magnetite
pyrite
quartz
chalcopyrite
sphalerite

The features illustrated by this section are a repetition of those in Section #2, but some of the features are better shown here.

Section #4:(from chalcopyrite vein)

The minerals present in order of abundance:

chalcopyrite
pyrite
magnetite
quartz
"unknown"
sphalerite

The more important features illustrated by this section are as follows:

a) Numerous fragments of pyrite, magnetite,and quartz in a chalcopyrite groundmass.

b) Odd shapes of some pyrite grains due to corrosion by chalcopyrite.

c) Vague lineal grouping of the pyrite grains parallel to the length of the section.

d) Several typical occurrences of the known mineral.

Section #5: (from chalcopyrite vein)

Minerals present in order of abundance:

chalcopyrite
pyrite
magnetite
quartz
"unknown"
sphalerite

This section shows all the features of Section #4, but the following are also illustrated:

a) Pyrite veining magnetite.

b) Overall lineation of the fragments.

c) Chalcopyrite following path used by the pyrite in veining the magnetite.

d) Quartz veining the pyrite.

e) The unknown mineral is again well shown.

Section #6: (from chalcopyrite vein)

Minerals present in order of abundance:

chalcopyrite
pyrite
magnetite
quartz
"unknown"
sphalerite

The features of this section are similar to those of sections #4 and #5. The section is included only to provide more examples of the unknown mineral.

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