2210 McDonald Street,
Vancouver, British Columbia,
April 11th, 1952.

Department of Geology,
University of British Columbia,
Vancouver, British Columbia.

Gentlemen:

It gives me pleasure to submit this essay, "A Mineralographic Report on the Contact Group", for your consideration and in partial fulfilment of the course in Mineralography (Geology 409).

Yours very truly,

E. H. Kohse

E. H. Kohse

EHK/AB

1st Class.

28/35

A MINERALOGRAPHIC REPORT

ON

THE CONTACT GROUP

An essay submitted in partial fulfilment
of the requirements for the Fourth Year
Geology Course, Geology 409,
at the University of British Columbia

E. H. KOHSE

April 11, 1952

The University of British Columbia

Vancouver, B.C.

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ACKNOWLEDGMENTS

I am extremely grateful for the assistance and guidance of Doctors H. V. Warren and R. M. Thompson of the Geology Staff, University of British Columbia, and Mr. J. M. McDougall, Laboratory Assistant and post-graduate student of Geology, University of British Columbia, given during the period of laboratory work prior to the preparation of this report. I also wish to express my appreciation for the assistance given by Mr. J. Donnan, Laboratory Technician, University of British Columbia, in the preparation of the polished sections required for this study.

E. H. Kohse

E. H. Kohse

Introduction

The McDame Creek Area, in which the specimens were obtained[1], has not as yet been geologically surveyed. Mr. Leo Price with the Geological Survey of Canada worked in the area in the summer of 1949, and Mr. Hugh Gabrielse, also with the Geological Survey of Canada, worked in the area in the summers of 1950 and 1951. It was in the summer of 1951 that Mr. J. McDougall, working under Mr. Gabrielse obtained the specimens from which this report was done.

The Contact Group is actually divided into four different parts. These are as follows:[2]

#1 Pyrite, bismuthinite & cosalite mineralization in a quartz vein in porphyritic granite. + scheelite.

#2 Massive pyrrhotite zone in metamorphosed limestone.

#3 Galena, sphalerite mineralization occupying a fissure vein in a cross fracture in crystalline limestone. This is the main prospect and assays 60 ozs. of silver per ton of ore.

#4 Mineralization in the talus approximately 1 thousand feet below #3. Whether this is outcrop or not has not been determined. Megascopically the mineralization seems to be approximately that of #3.

This report will serve a three-fold purpose. First to partially fulfil the requirements of the course in mineralography (Geology 409). Second, to determine the minerals present in the specimens. Third, to determine whether #4 is a continuation of vein #3, float from vein #3, or a completely different vein.

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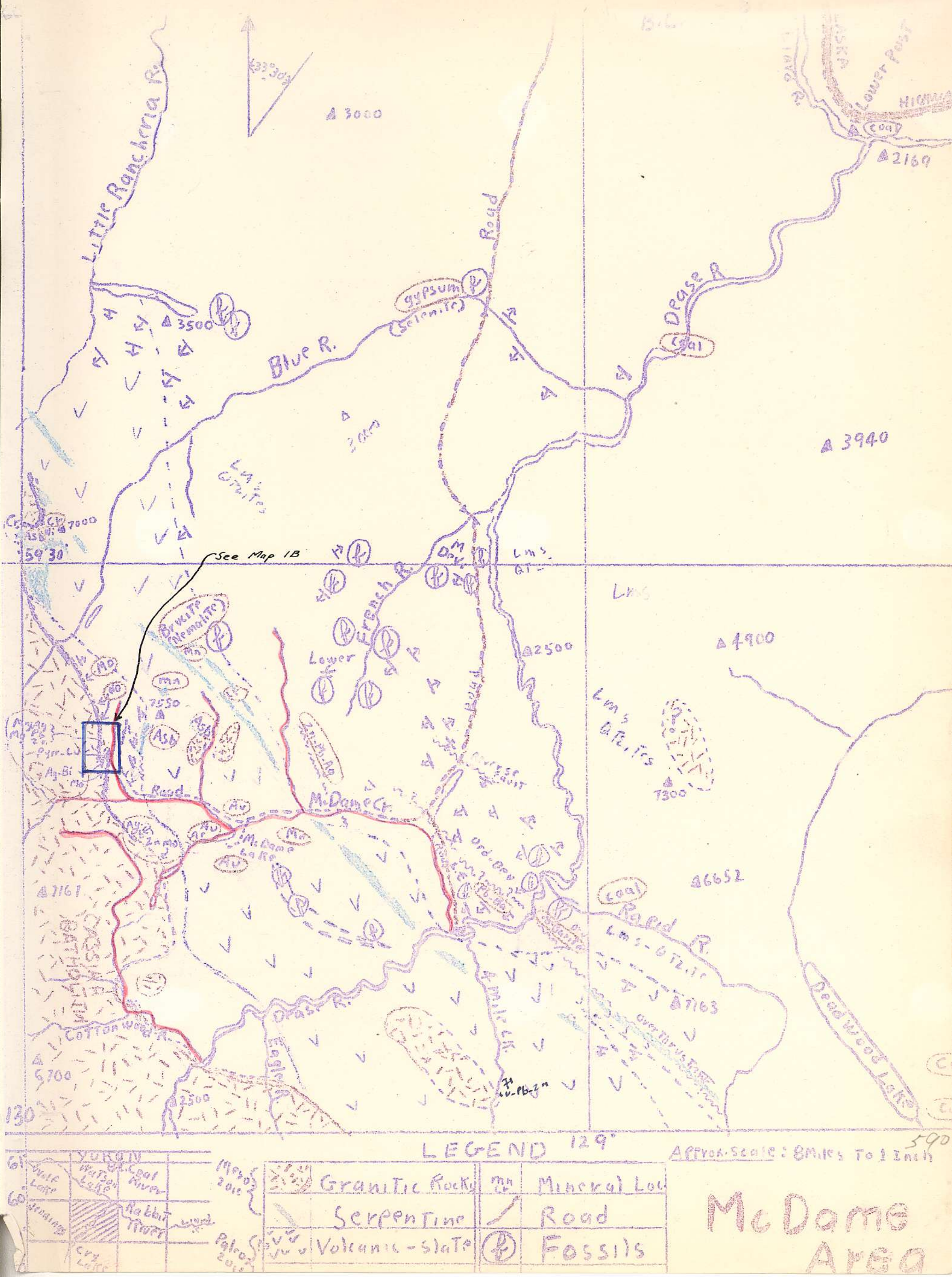
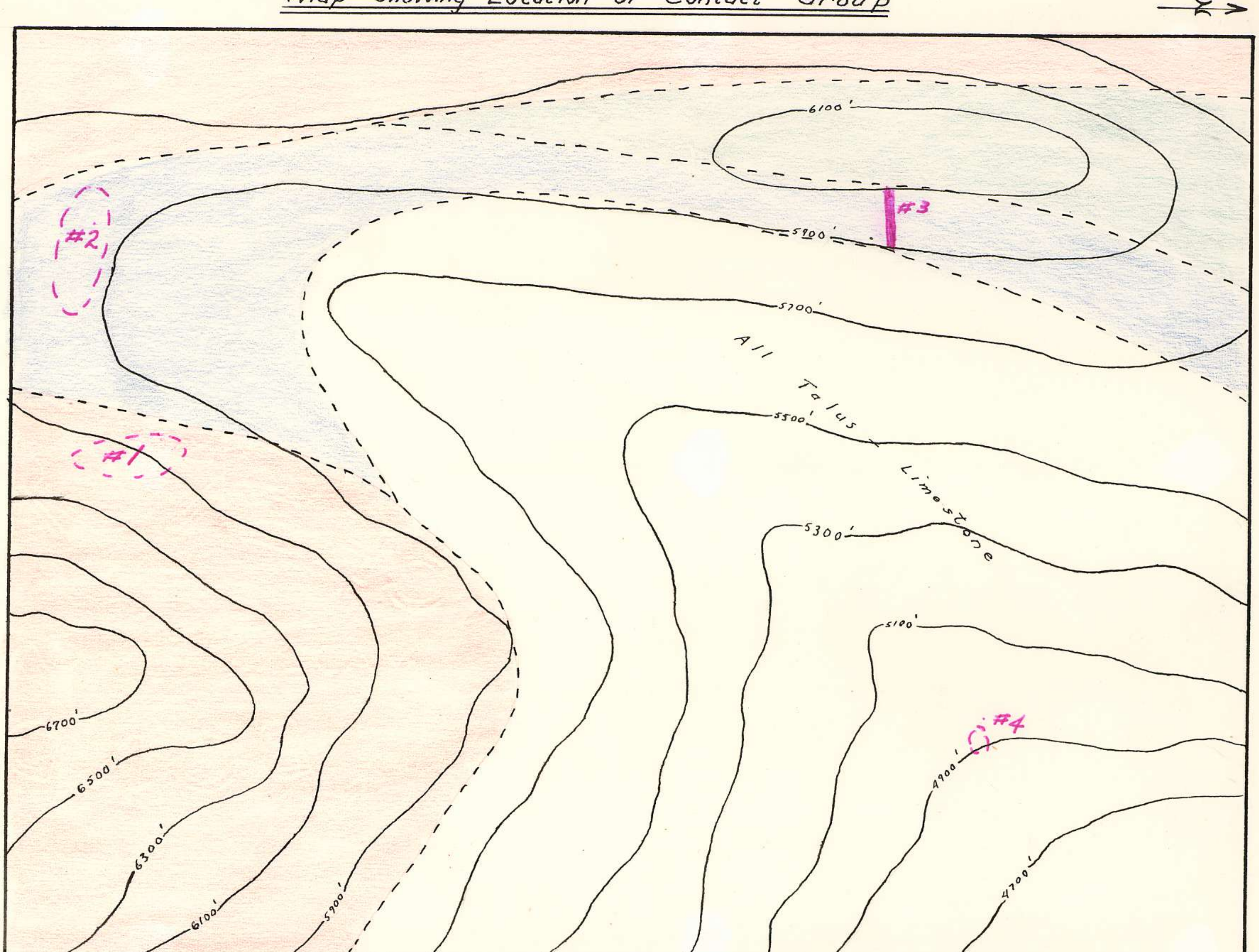
[1] See Map 1, p. 1A
[2] See Map 2, p. 1B


Little Rancheria R.
33°30'
3000
3500
gypsum
(Selen. Tr.)
Blue R.
Road
Dease R.
Coal
3940
Lms.
Qtz. Tes
7000
59 30
See Map 1B
French R.
Lower
Brucite
(Nemalite)
Mn
7550
Asb
2500
4900
Lms
Qtz. Tes
7300
Road
McDame Cr.
Au
McDame Lake
Mn
Coal
Road
Lms - Qtz. Tr.
6652
7161
CASSIAR BATHOLITH
Cottonwood R.
Dease R.
4 Mile Ck.
7163
Overthrust
Deadwood Lake
6700
2500
130°
129°
Lower Post
HIGHWAY
Coal
2169
LEGEND
Approx. Scale: 8 Miles To 1 Inch
59°
YUKON
Wolf Lake
Watson Lake
Coal River
Rabbit River
Cry Lake
Meso
Paleo
Granitic Rocks
Serpentine
Volcanic - Slate
Mineral Loc.
Road
Fossils
McDame Area

Map Showing Location of Contact Group



LEGEND

Porphyritic Granite		Metasediments (hornfels)	
Crystalline Limestone		Talus	

1B

All the samples taken were surface samples and, as yet, there has been no development work done. As far as is known the base metals in the area have not been studied before.

Mineralogy of #1.

Pyrite, bismuthinite mineralization in a quartz vein in porphyritic granite.

Megascopic

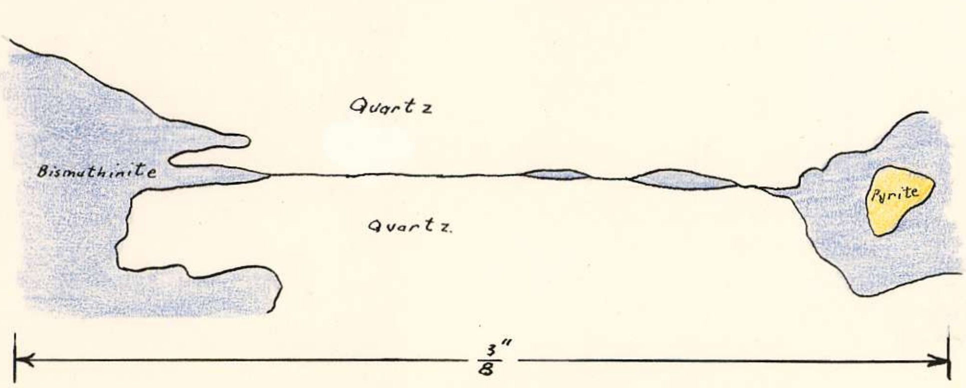
The white to rusty coloured quartz contains many vugs that are lined with small quartz crystals. Small amounts of pyrite and bismuthinite are distributed irregularly through the quartz but seem to be related to the vugs. In the weathered portion of the vein the bismuthinite appears to have weathered out leaving a box work in the quartz. This box work is covered with a yellowish oxide, possibly bismite. The vein is unprospected and may yield other minerals below the leached zone. It assays 9.02 ozs. in silver and contains copper in the bright, flaky bismuthinite.

Microscopic

Bismuthinite -

bismuthinite
The galena white/occurs in irregular masses filling minor fractures in the quartz and replacing both quartz and pyrite. (See diagram below)

Bismuthinite filling Fractures in Quartz.



Bismuthinite (cont'd.)

The main mass of bismuthinite is approximately 4 mm. long and 1 mm. wide. The bismuthinite is strongly anisotropic showing polarization colours grey-brown, dark blue to black. The etch tests were as follows: $HgCl_2$ pos., KOH neg., KCN neg., HCl neg., $FeCl_3$ neg., HNO_3 pos. - effervesces, stains irridescent to brown. Microchemical tests showed bismuth and copper. The mineral was positively identified by means of the X-ray. It is interesting to note that a portion of the bismuthinite remainedisotropic and was believed to be another mineral. However, this was also X-rayed and proved to be bismuthinite.

Pyrite -

The pale, brass yellow pyrite occurs as large fractured crystals from one eighth to three eighths inches long. The bismuthinite replaced pyrite along the quartz-pyrite boundary and also along the fractures in the pyrite.

Unknown I -

A small, creamy silver coloured mineral was observed in the bismuthinite. Its hardness was apparently the same as that of bismuthinite (B/) and it appeared to be strongly anisotropic with light to dark-grey polarization colours. The etch tests were as follows: $HgCl_2$ neg., KOH neg., KCN neg., $FeCl_3$ pos. - brown stain, HNO_3 pos. As closely as could be determined the mineral belongs to the following group: tetradymite, aikinite, calaverite, cosalite, krennerite, galenobismutite, melonite, sylvanite. Due to its extremely small size the mineral could not be X-rayed. Cosalite?

The paragenesis of this specimen is probably quartz, pyrite and bismuthinite and unknown deposited last. From the mineral assemblage it is difficult to determine the temperature range, however, on the basis of the bismuthinite it may be mesothermal. Quartz forms 75% of the polished section, pyrite approximately 20% and bismuthinite and unknown approximately 5%.

Mineralogy of #2.

Massive pyrrhotite zone in metamorphosed limestone.

Megascopic

The massive pyrrhotite specimens have a dull, earthy-brown appearance. The pyrrhotite appears to have replaced limestone; calcite and/or dolomite is the main gangue in the section.

Microscopic

Marcasite -

These sections are composed almost entirely of marcasite, which has replaced pyrrhotite. In some cases the replacement is complete, in others, the pyrrhotite remains as residual remnants. The marcasite shows a colloform banding around some of the pyrrhotite remnants. Since these are surface specimens this is probably supergene marcasite.

Pyrrhotite -

The pinkish coloured pyrrhotite takes a good polish and stands out distinctly in the ground mass of marcasite. Some of the pyrrhotite "laths" are separated by thin bands of marcasite. Where the residual pyrrhotite is more massive it is veined and corroded by marcasite.

Chalcopyrite -

The bright yellow chalcopyrite appears in irregular masses from .4 to 2 mm. in length in the marcasite. Some of the chalcopyrite grains are fractured and the fractures are filled with limonite. A few small irregular bodies of sphalerite, about 20 microns in length are present in the chalcopyrite. The chalcopyrite and sphalerite probably existed in solid solution.

Limonite -

The limonite appears as dark grey veinlets showing colloform banding. These veinlets run through the marcasite and the chalcopyrite.

Gangue -

The gangue occurs in large crystals from one quarter to three eighths of an inch long. These crystals show a strong rhombohedral cleavage and a strong effervescence with HCl. Since they are also soft, the gangue is probably a carbonate.

The paragenesis will probably be as follows: pyrrhotite, earliest, followed by chalcopyrite and sphalerite contemporaneously, marcasite, and finally limonite. The minerals in order of abundance are, marcasite 45%, gangue 23%, pyrrhotite 20%, chalcopyrite and sphalerite 7%, limonite 5%.

Some typical contact minerals such as grossularite, augite, tremolite, diopside and epidote were noted in associatinn with this deposit. Hence, it can probably be classed as pyrometasomatic.

Mineralogy of #3.

Galena, sphalerite mineralization occupying a fissure vein in a cross fracture in crystalline limestone.

Megascopic

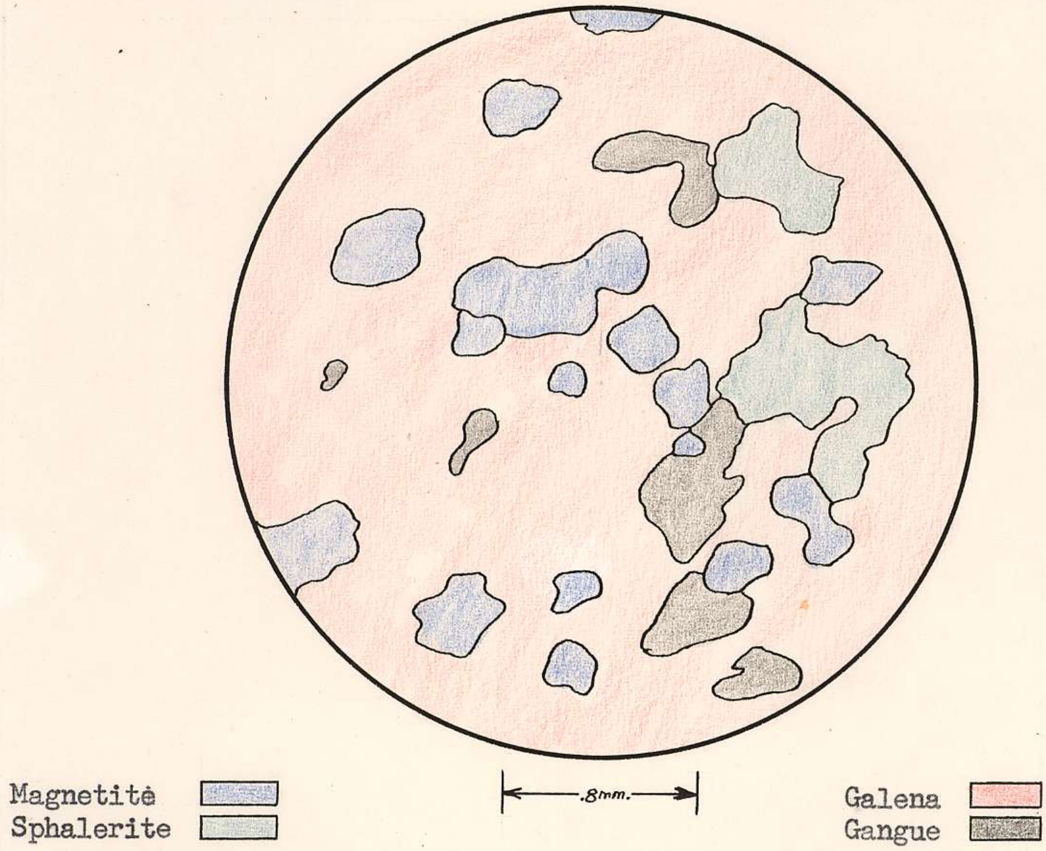
The hand specimen was massive and showed no non-metallic mineral except very small amounts of carbonate. It was composed mostly of magnetite, galena and sphalerite, in that order of abundance. The specimen showed a black coating which was due in part to MnO. ?

Microscopic

Magnetite -

Some of the sections are composed almost entirely of disseminated euhedral to subhedral grains of magnetite, with minor amounts of galena, sphalerite and gangue. In other sections isolated magnetite grains were found surrounded by galena and sphalerite. (See diagram below)

<u>Diagram Showing Relationship of Magnetite to Sphalerite, Galena & Gangue.</u>



The magnetite is seldom replaced by other minerals, though some core replacement was noted. Cores of sphalerite, galena or gangue were found. The magnetite grains range from approximately .1 mm. to .6 mm. No massive magnetite was observed.

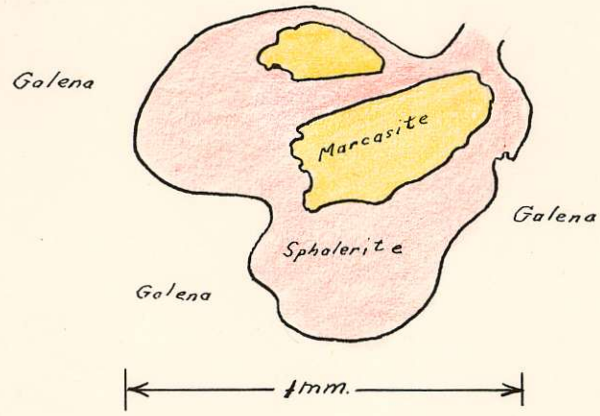
Galena -

The galena occurs as the matrix around isolated grains of arsenopyrite, sphalerite and magnetite. The arsenopyrite, sphalerite and gangue are replaced by the galena. The galena also appears as small, irregular blebs replacing the gangue around magnetite grains. Galena is of interest because it contains an unidentified very white mineral and small irregular particles of tetrahedrite. The fractures in galena are filled with limonite.

Sphalerite -

The sphalerite has a dark reddish-brown internal reflection indicating a high percentage of iron.[3] It appears to replace the gangue and is itself replaced by galena. The sphalerite has a somewhat pitted surface but shows very few inclusions. A few minor inclusions of pyrrhotite are found. The sphalerite was found to apparently replace marcasite. (See diagram below). This may indicate that the marcasite was hypogene. The size of the sphalerite grains ranges from less than .1 mm. to approximately 1 mm.

Sphalerite Replacing Marcasite (?)



Arsenopyrite -

The hard galena white arsenopyrite appears in crystals approximately .6 mm. long in galena and is partially replaced by galena. It shows its characteristic diamond shaped outline and long "lath-like" crystals and also shows bright blue and yellow polarization colours. This mineral occurs only in minor amounts.

Tetrahedrite -

Tetrahedrite was found as grey, elongate to irregular blebs in the

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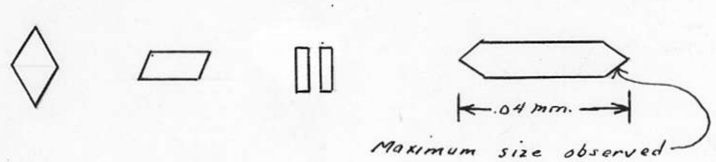
[3] A.B. Edwards, Texturesof the Ore Minerals, Melbourne, Brown, Prior, Anderson & Pty. Ltd., 1947, p.68

galena, and only in the galena. This may be the result of the unmixing of galena and tetrahedrite in solid solution. The tetrahedrite does not appear to be controlled by the cleavage planes of the galena. The blebs are generally narrow and range in length from less than .05 mm. to approximately .2 mm.

Unknown II -

This mineral had a creamy, whiter than galena colour, and was found only in galena. The crystals, which almost always show the outline of a cube, rhomb, diamond or lath, had a maximum size of .04 mm. Its hardness appeared to be nearly that of galena and it also appeared to have a weak anisotropism with colours from black to greenish-brown. An attempt was made to etch the mineral and the results are as follows: $HgCl_2$ neg., KOH pos., KCN pos., - weak irridescent tarnish, HCl pos., - rapid, black stain, $FeCl_3$ pos., HNO_3 - assumed positive. The HCl etch formed a distinct irridescent halo around the mineral. The results of the etching seem to place the mineral in the antimony, argentite group, however, due to the small size of the mineral and the fact that it is always surrounded by galena, the etch results should be used with extreme caution. An attempt was made to X-ray the mineral, but it was too small to show a definite result. The colour and crystal form of the mineral seem to point to arsenopyrite. (See diagram below).

Diagram Showing Crystal Form of Unknown Mineral II

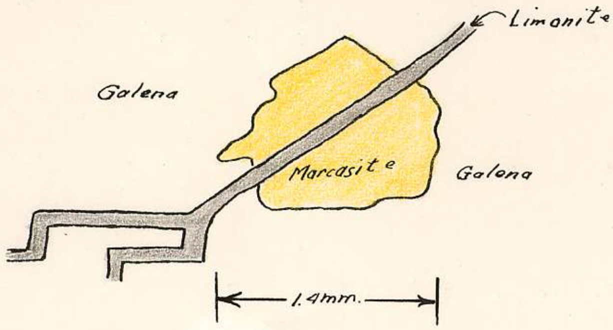


Check dyscrasite

Marcasite -

As before, the marcasite replaces pyrrhotite, however, here very few remnants of pyrrhotite remain. Marcasite was observed completely replacing a grain of pyrrhotite which was later veined by limonite. (See diagram below) Marcasite is present only in minor amounts.

Marcasite Replacing Pyrrhotite



Limonite -

The dark grey amorphous limonite fills fractures in the galena and veins the marcasite and sphalerite. It shows excellent colloform banding and dark red internal reflection. It was differentiated from sphalerite on the basis of hardness and darker colour.

Chalcopyrite and Pyrrhotite -

Minor amounts of chalcopyrite and pyrrhotite were found in the sphalerite. They appeared to be the result of unmixing.

The paragenesis of this ore is difficult to determine. Diagnostic textures are generally lacking. The residual characteristics of the magnetite grains seem to suggest that at first only magnetite and gangue were present. Later mineralizing solutions may have completely replaced the gangue, deposited the lower temperature minerals such as galena, and sphalerite and left the residual grains of magnetite unreplaced.[4] There is

4 This may be somewhat similar to Leadville, Colo., as discussed by Lindgren pp. 590-593.

also the problem of the marcasite - hypogene or supergene? The replacement of the marcasite by sphalerite would seem to indicate a hypogene origin. However, a suggested paragenesis is as follows:

Magnetite (earliest)

Arsenopyrite

Marcasite

Sphalerite (chalcopyrite & pyrrhotite as ex-solution bodies)

Galena (tetrahedrite-also possibly ex-solution)
(& Unknown II- contemporaneous)

Limonite

The minerals in order of abundance are: magnetite 30%, galena 20%, sphalerite 15%, gangue 10%, marcasite 5%, arsenopyrite 4%, pyrrhotite 4%, chalcopyrite 4%, limonite 3%, tetrahedrite 3%, Unknown II 2%.

At present there is not enough information available to accurately classify the deposit. No specimens of the wall rock were available, hence no thin sections could be made to determine if contact metamorphic silicates were present. As far as temperature is concerned, the deposit shows a wide range - from high temperature magnetite and pyrrhotite through to intermediate sphalerite and galena. From this it would appear that the deposit ranges from hypothermal to mesothermal and possibly lower.[5]

Mineralogy of #4.

Mineralization in the talus approximately 1 thousand feet below #3.

Megascopic

Only one specimen was available from this portion of the Contact Group. It appeared to have approximately the same mineralogy as #3 but with a much

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[5] A.M. Bateman, Economic Mineral Deposits, New York, John Wiley & Sons, 1950 p. 40

lower percentage of magnetite. The hand specimen seemed to be composed essentially of sphalerite, galena and pyrite.

Microscopic

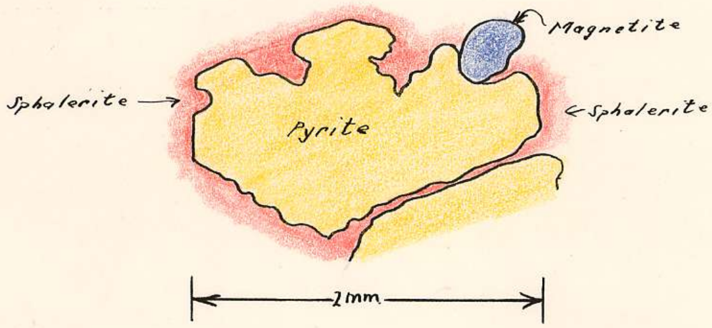
Magnetite -

As described in #3 the magnetite occurs in isolated euhedral to subhedral grains in galena, sphalerite and marcasite. The grain size ranges from .05 mm. to a maximum of .5 mm.

Pyrite -

The pyrite occurs as fractured crystals with a maximum size of approximately 2 mm. The pyrite is replaced by galena, sphalerite and pyrrhotite giving the grain boundaries a corroded effect. (See diagram below). The fractures in the pyrite are filled with galena and sphalerite.

Diagram Showing Corroded Pyrite Crystal



Galena -

Megascopically the galena appears as small irregular veinlets running across the polished section. It replaces sphalerite and pyrrhotite but shows a preference for the sphalerite. It will replace the sphalerite and leave ex-solution laths of pyrrhotite unreplaced and jutting into the galena. The galena contains isolated grains of magnetite, pyrrhotite and sphalerite, and also irregular, elongate blebs of tetrahedrite.

Tetrahedrite -

The tetrahedrite appears as elongate and irregular bodies in the galena. The percentage of tetrahedrite is higher than in #3 and the bodies are larger. Some of the tetrahedrite encloses an anisotropic unknown mineral. (See Plate I p. 16)

Unknown III -

The occurrence of this mineral is shown in Plate I, p. 16. This mineral is slightly darker than galena and appears to be slightly harder than tetrahedrite. It is strongly anisotropic with polarization colours blue to bluish white, to light green to grey. It is non-pleochroic and shows no internal reflection. An attempt was made to etch the mineral and the results are as follows: $HgCl_2$ neg., KOH neg., KCN neg., HCl neg., $FeCl_3$ neg., HNO_3 pos. - rapid, black stain. As before, this mineral is very small, (the maximum size observed was .1 mm.) and the etch tests should be used with caution. The etches place the mineral in the group with aikinite, ~~berthenite and bismuto~~plagionite. It was suggested[6] that the mineral might be a lead-antimonide.

Alabandite -

The alabandite occurs in what appears to be ex-solution intergrowth in sphalerite. This texture is well shown in Plate II, p. 16. Small irregular bodies and laths of pyrrhotite seems to have been unmixed at about the same time as the alabandite. Possibly the pyrrhotite unmixed a little later since a pyrrhotite lath was observed cutting across an alabandite lath. Alabandite also occurs in large irregular bodies about 1.5 mm. in length.

The alabandite has a hardness of C and is isotropic. Its internal reflection and powder have a greenish tinge. The etches are as follows: $HgCl_2$ neg., KOH neg., KCN neg., HCl - effervesces, liberates H_2S and tarnishes black, $FeCl_3$ neg., HNO_3 pos., liberates H_2S and etches black. The

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6 Dr. H. V. Warren

odour of H_2S is a distinctive part of these etch tests. This mineral was positively identified by X-ray methods.[7]

Sphalerite -

The sphalerite has a dark red internal reflection and runs as irregular veinlets across the polished section. It contains grains of pyrite, magnetite and pyrrhotite. It is replaced by galena but replaces pyrrhotite. The sphalerite contains ex-solution laths of alabandite and pyrrhotite (as described above).

Pyrrhotite -

The pinkish-cream coloured pyrrhotite is almost completely replaced by marcasite. In some instances, residual remnants of pyrrhotite were found completely surrounded by marcasite. Grain size ranges from small remnants in marcasite to bodies 1.4 mm. long. Pyrrhotite is replaced by galena and sphalerite.

There may be two ages of pyrrhotite in this section, An early age of pyrrhotite replaced by marcasite, galena and sphalerite, then a later age of pyrrhotite that existed in solid solution with the sphalerite.

Marcasite -

The marcasite shows colloform banding and replaces pyrrhotite. This is shown in Plate III, p.17.

Limonite -

The dark grey limonite occurs as veinlets in the galena and sphalerite. It is found only in minor amounts.

The approximate percentages of the minerals are as follows: sphalerite 30%, galena 15%, alabandite 15%, pyrite 10%, marcasite 10%, pyrrhotite 9%, magnetite 5%, tetrahedrite 3%, limonite 2%, Unknown III 1%.

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7 The X-ray work done by Dr. R.M. Thompson

Since only one polished section was available from this group it is difficult to determine the paragenesis. However, a suggested paragenesis follows:

Magnetite
Pyrite
Pyrrhotite
Sphalerite
Alabandite
Pyrrhotite
Galena
Tetrahedrite
Unknown III
Marcasite
Limonite

The temperature range of this portion of the Group is about the same as is #3, that is, from hypothermal to mesothermal and possibly lower. This is indicated by the assemblage of metallic minerals from magnetite through to galena and sphalerite. Alabandite, which is present in #4 but not in #3, is apparently a fairly high temperature mineral deposited from hot solutions by the action of H_2S upon Mn bearing waters. Due to the meagre information the deposit cannot be classified as to type.

Conclusion

As was mentioned in the introduction, a part of the problem was to determine whether #4 (the specimen obtained in the talus slope) was a continuation of Vein #3, (which runs into talus and is obscured), float from Vein #3, or a completely different vein. From the following mineralogical evidence it does not appear that #4 is float from vein #3 as it is now exposed.

(1) Presence of Alabandite and pyrite in #4.

(2) Sphalerite in #3 has many inclusions of pyrrhotite, while the sphalerite in #4 has only minor inclusions.

(3) Much higher percentage of magnetite in the specimens from #3.

(4) The general structure of the ore appears quite different. Sections from #3 give the impression of disseminated grains of magnetite, sphalerite and gangue in a matrix of galena. On the other hand the section from #4 has small veinlets of galena and sphalerite with irregular bands containing pyrite, pyrrhotite, and marcasite.

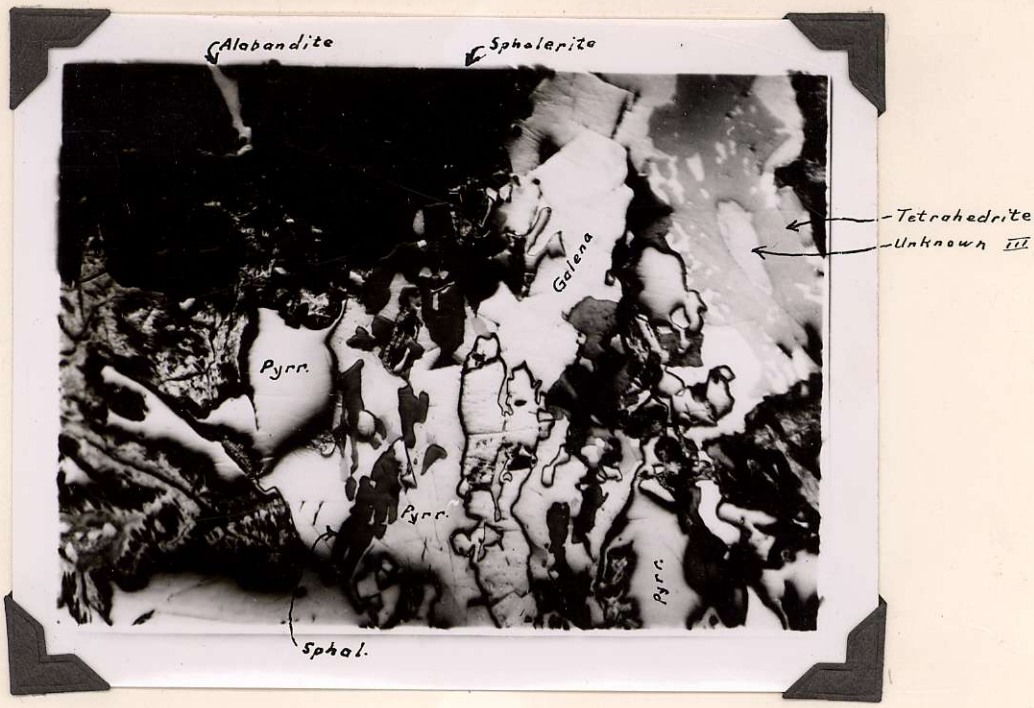
From this evidence it appears that #4 may be a new vein or it may be a continuation of old vein #3. It has not been prospected and it is not known whether #4 is float or outcrop.

The assays of the ore from the Contact Group show 60 ozs. of silver per ton. According to Edwards,[8] galena with silver in excess of 30 ozs. per ton must have silver minerals present. No silver minerals were observed in this ore, unless one of the unknowns proves to be a silver mineral. The remaining 30 ozs. of silver present can probably be accounted for if the tetrahedrite is argentiferous.

This essay has briefly touched only on the major points of the Contact Group. It will be interesting to see what future work reveals about the paragenesis, classification and correlation of these eres.

8 Edwards, op. cit., p. 90

Plate I - Unknown III in Tetrahedrite



150μ.

Plate II - Alabandite Unmixing from Sphalerite

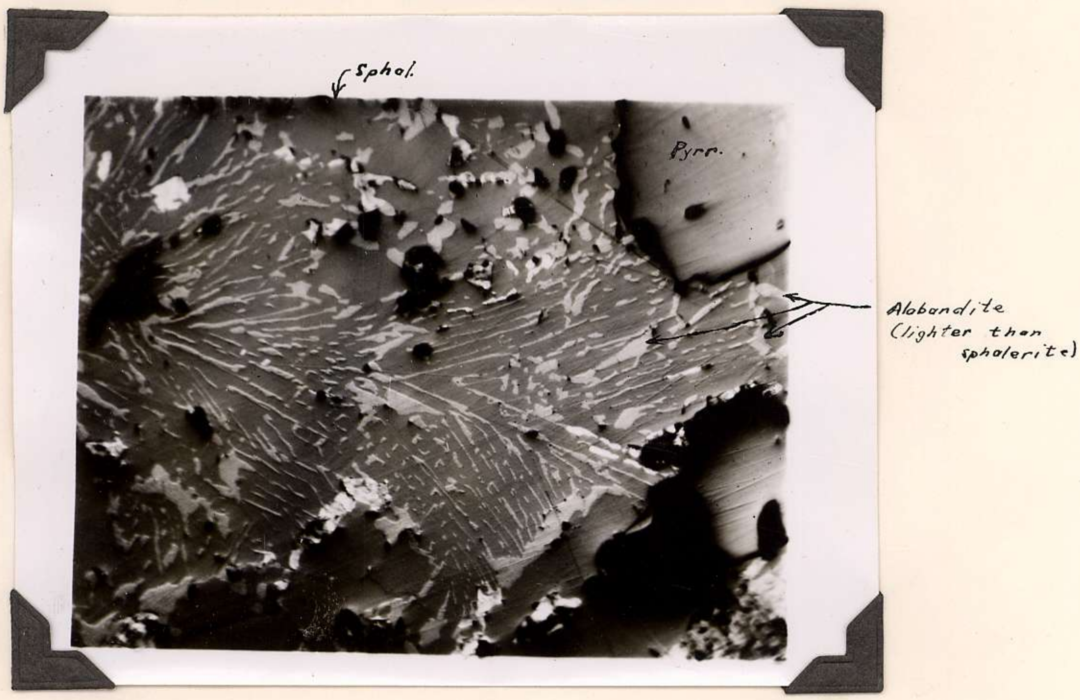
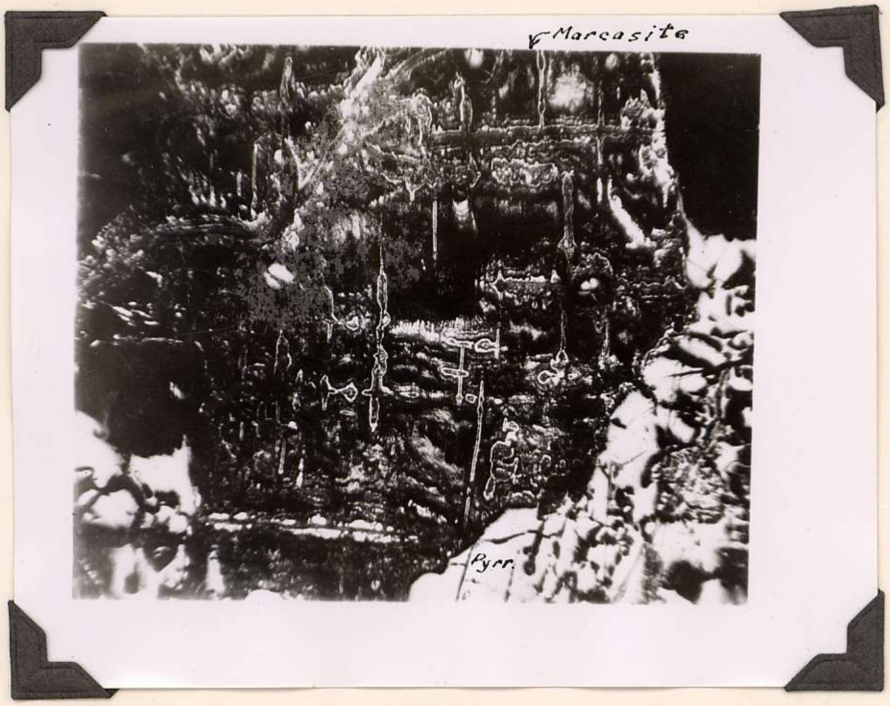


Plate III - Marcasite with Colloform Banding Replacing Pyrrhotite



List of Sections and Minerals

#1. Sections C14 and C15 -

Bismuthinite, Unknown I, Quartz, and Pyrite

#2. Sections C9 and C10 -

Pyrrhotite, Marcasite, Chalcopyrite, Sphalerite, Gangue (Carbonate)

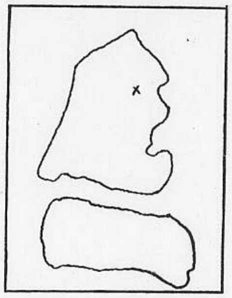
#3. Sections C2, C3, C4, C5, and C6 -

Magnetite, Arsenopyrite, Marcasite, Sphalerite, Chalcopyrite, Pyrrhotite, Galena, Tetrahedrite, Unknown II, and Limonite.

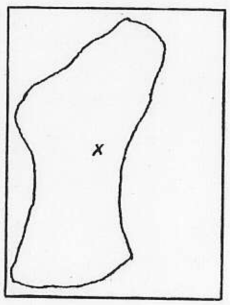
#4. Section C7 -

Magnetite, Pyrite, Pyrrhotite, Sphalerite, Alabandite, Galena, Tetrahedrite, Unknown III, Marcasite, and Limonite.

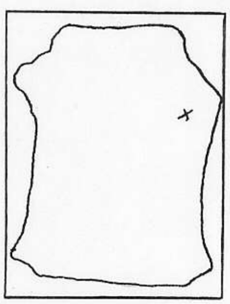
Diagrams Showing Approximate Positions of Unknowns in Sections



Group #1 - Section C15
Unknown I. - in Bismuthinite



Group #3 - Section C5
Unknow II - in Galena. This unknown also occurs in other sections of Group #3



Group #4 - Section C7
Unknown III - in Tetrahedrite.

Actual Size

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