MICROSCOPIC EXAMINATION

of ORE from the

CARIBOO-HUDSON MINE,

600048

Barkerville Area, B. C.

Geology 9 Thesis submitted by

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INTRODUCTION.

This thesis was prepared under the direction of Dr. H. V. Warren for credit in the geology nine course given at the University of British Columbia. The laboratory work in connection with the paper consisted of a study of polished specimens of ore under a low power microscope. The specimens, which are ore from the Cariboo-Hudson mine, were polished by myself in the laboratory at the University.

Mine Location.

The location of the Cariboo-Hudson mine is southeast, a distance of about sixteen miles as the crow flies, from the town of Barkerville, B. C. The mine is situated on the divide between Pearce and Harvey Creeks near the source of Cunningham Creek. Access to the property is by road from Barkerville, the last six miles being a sleigh-road constructed by the mine Company.

Geology of Area.

All of the following geological notes are taken from the paper "Geology and Mineral Developments of Cariboo District, British Columbia," by W. E. Cockfield and A. H. Lang, published in the C. I. M. M. transactions, volume XL, 1937.

"The oldest rocks of the district are known as the Cariboo Series and consist of quartzites, argillites, and limestones, with types gradational between these. These rocks are non-fossiliferous, and this lack of fossils, coupled with the degree of metamorphism and the lithological similarity to known Precambrian rocks farther south, leads to the conclusion that they, also, are of Precambrian Age. The Cariboo series has an apparent thickness of many thousands of feet. In his mapping of Barkerville Area, Uglow subdivided the series into three formations, which, from oldest to youngest, are the Richfield, Barkerville, and Pleasant Valley. The lowest, or Richfield, formation is the most extensive and consists of quartzose sediments with interbedded argillite, some limestone, and minor amounts of conglomerate and graphitic schist. The rocks are much altered and are either fossile or schistose and in many places altered to quartz sericite schists."

"The Barkerville formation is composed essentially of limestone but contains beds of relatively pure quartzite as well as argillite, schistose quartzite, and calcareous schist. In the upper part of the Richfield, beds and lenses of limestone are common, and many of the other rocks are calcareous. This increase in the amount of limey material marks a transition between the two formations and in places renders the boundary between the two somewhat arbitrary."

"Overlying the Barkerville formation is the Pleasant Valley, consisting chiefly of argillite, slate, and phyllite, with minor amounts of quartzite, schist, and limestone."

"The Cariboo series is bent into an anticlinal fold which so far has been traced some fifty miles along its strike, with the total length of this structure unknown. On the northeastern limb of the anticline, the Cariboo series is overlain, unconformably, by the Slide Mountain series of upper Palaeozoic Age, and, on the southwestern limb, by the Argillites and basalts of the Quesnel River group, of Jurassic Age. The Cariboo series as a whole appears to become more calcareous along its strike to the southeast."

"Over most of the area, exposures of igneous rocks are infrequent. A few altered acidic sills and dykes which cut the Cariboo series are probably the equivalent of Uglow's Proserpine intrusives. Dykes that are somewhat more basic were found, and are probably younger than the Proserpine rocks."

Mineral Deposits.

"The only mineral production in Barkerville and Keithley areas at the present time is from placer gold and lode gold deposits. The important lode gold deposits are confined to the rocks of the Cariboo series, and do not occur, so far as is known, in the rocks of the Slide Mountain series. They are most abundant in the Richfield formation. Hanson has mapped a belt in the upper part of the Richfield, extending from Island Mountain to Grouse Creek, and containing many of the lode gold deposits of that section, which he has named the Barkerville Gold Belt. This belt Hanson has divided into five members, which, from lowest to highest, are the Basal, Lowhee, B. C., Rainbow, and Baker. The Baker member forms the uppermost part of the Richfield and lies immediately under the Barkerville formation. Below the rocks of the gold belt is a thick mass of quartzite, and above is the limestone and associated rocks of the Barkerville. Hanson points out that the rocks of the belt as a whole were more easily fractured than the rocks above or below, and that within the belt itself are several comparatively unyielding members, so that stresses were relieved in a small part of the belt, that is, in the Rainbow and in the lower part of the Baker member."

"An attempt was made to trace the rocks of this belt southeastward from Grouse Creek. Rocks of the belt were recognized on Antler Mountain. Few outcrops occur between upper Antler Creek and Cunningham Creek, that is, on Nugget Mountain. From upper Cunningham Creet southeastward, there is a broad belt containing much limestone--referred to as the Hudson member of the Richfield formation--that is farther, stratigraphically, from the top of the Richfield than is Hanson's belt, and contains most of the known lode gold deposits of that vicinity. From upper Cunningham Creek to Harvey Creek, the mineralization is spread over a wider area than in the immediate vicinity of Barkerville, and limestone forms a conspicuous feature of the rocks in this section."

The Cariboo-Hudson mine is located on this Hudson member of the Richfield formation slightly to the southeast of Hanson's gold belt.

"Hanson has divided the lode gold deposits into two types:

1. Gold-bearing pyritic quartz veins; and
2. Gold-bearing pyritic replacement deposits.

The quartz veins are further subdivided into four types:

a. Large veins, in general parallel to the strike and dip of the strata.

b. Lenticular veins, parallel to the strike and dip of the strata.

c. Transverse veins, crossing the strata nearly at right angles.

d. Diagonal veins, striking in general north 70 degrees east to nearly east.

"Of the quartz veins, types c and d, namely, veins transverse and diagonal to the strike of the strata, appear to by the most important. Veins parallel to the strike of the strata or bedded veins have not as yet been proved to be of commercial importance."

"The deposit on the Cariboo-Hudson property is in the form of a zone of veins and lenses of quartz and has been traced at intervals in a direction about south 45 degrees east for some 500 feet. Other veins, uncovered 1000 feet still farther to the southeast, may represent the continuation of the same zone. One short adit has been driven in the hanging-wall of one of the veins, which at the surface has a maximum width of seven feet and is well mineralized with pyrite and galena, the sulfides probably averaging about 10 per cent of the vein matter. Scheelite and Ankerite occur as gangue minerals." From the strike of the veins given above, they appear to be of the a and b types, rather than the c and d.*

From the above report, the chief mineralization at this property is in different types of veins in a slightly different member of the formation than the producing mines in the Barkerville district. Also its ore differs from the proved mines in that it contains considerable amounts of galena and sphalerite. Therefore the more detailed geological work done on the ores of these mines cannot be said to hold for the Cariboo-Hudson property.

SAMPLES.

The samples of ore used in the examination were supplied by Dr. Warren; and consisted of specimens obtained from a grab sample of the first vein explored at the mine.

All the specimens have the same general characteristics, and consist chiefly of a mixture of quartz, pyrite, galena, and sphalerite, the sulfides being in the massive state. The amount of quartz present in the ore varies from 20 to 50 per cent, that of pyrite is about 20 per cent, with galena and sphalerite making up the remainder. There seems to be slightly more sphalerite than galena in the ore. In two of the specimens, massive pieces of pyrite, up to an inch in size, predominated. The specimens are full of fractures, so much so that they can be broken with the hands. This makes grinding and polishing of the samples very difficult.

The results of the examination are based on a study of the following polished specimens.

No. 1. Equal amounts of finely mixed sulfides and quartz. The quartz shows a great deal of fracturing.

No. 2. Massive pyrite, some galena, sphalerite and quartz.

No. 3. Very much mixed sulfides and quartz, pyrite being the chief sulfide. The sample was very weak structurally and had to be mounted in bakelite for polishing.

No. 4. Similar to No. 1 specimen.

No. 5. A bakelite briquette containing mainly iron and lead sulfides.

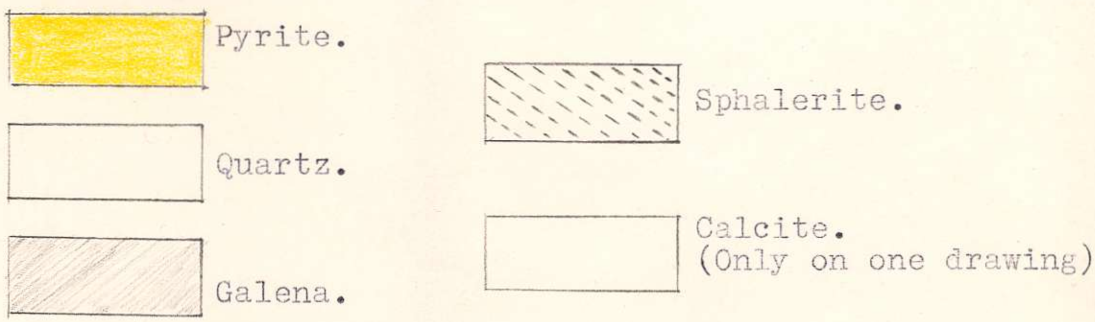
The particles in a briquetted sample of 40 mesh ore were so badly fractured that they could not be polished.

EXAMINATION OF POLISHED SPECIMENS.

Drawings.

The number on each drawing corresponds to the number of the specimen from which it was obtained. The letter with each number gives the sequence of the drawings. For instance, drawing 1c is the third sketch made from specimen number 1.

Each mineral is distinguished on the drawings in the following manner.



The circle around each drawing represents the size of the microscopic field, and the square, that of the opening in a 10 mesh screen.

The purpose of drawing 1a is to show that pyrite is the first mineralization, followed by quartz. Number 1b shows galena intruding into fractures in the quartz, while sphalerite appears to replace some of the galena. But in drawing 2a, galena might be taken as being later in origin than sphalerite. From the conditions shown in these two drawings and also in number 3a, the conclusion is drawn that probably galena and sphalerite are contemporaneous in this ore. The lead and zinc sulfides appear to have solidified from mineral bearing solutions together. Also they must have cooled rapidly, as there are practically no crystals of either visible.

A piece of massive pyrite is shown in drawing 2b. The pyrite is very much fractured and broken up, the crevices being filled with quartz. ~~Sphalerite has replaced the quartz.~~ Sphalerite has replaced the quartz to a small extent.

In addition to showing galena to be contemporaneous with sphalerite, drawing 3a shows the tendency of sphalerite to deposit around pieces of pyrite. This is probably due to the fact that sphalerite is able to absorb a certain percentage of iron sulfide, and therefore can eat away, or "leach", the pyrite.

Drawing number 3b, 3c, 4a, 5a are not meant to be complete, as only that part of the field where the gold occurred was drawn in detail. The last drawing, number 4b, shows the occurence of calcite. It appears to be the last mineralization, cutting galena and sphalerite.

Paragenisis of ore.

Excluding gold, the paragenisis of the minerals in the ore seems to be as follows.

Pyrite--Quartz--Sphalerite and Galena--Calcite.

Previous to each mineralization the vein was subjected to great forces, including tension, which shattered it and left open fractures. These fractures made it very easy for the mineral bearing solutions to penetrate throughout the vein. During such action the previously deposited minerals do not seem to have been remelted, as even the pyrite particles have rough uneven edges.

Gold Occurence.

The visible gold in the ore appears to occur in the following ways:

1. At the head of fiord-like intrusions of sphalerite in pyrite (drawing 3b.)
2. On pyrite (drawing 3c.)
3. On the contact between sphalerite and pyrite (drawing 4a.)
4. On the contact between pyrite and (probably) Galena (drawing 5a.)
5. In sphalerite, surrounding quartz inclusions (drawing 4b.)

It is likely that in 2. the gold is on the contact between either galena or sphalerite and pyrite, and, in polishing the section, the other sulfide has been removed.

From the above, it is seen that gold is found most commonly along the contact between galena or sphalerite and pyrite. Also, some gold was carried along in solution with sphalerite and tends to separate out around such bodies as quartz inclusions. It appears obvious that the gold was deposited at the same time as galena and sphalerite. Neglecting the rather indefinite position of calcite, this fixes the time of gold deposition to be during the last mineralization of the vein.

This theory of gold deposition is borne out by the following assays on the ore, which were kindly supplied by Dr. Warren.

Sample No.	Composition.	Oz. Au per ton.
1	SiO_2	Trace
2	PbS	Trace
3	FeS_2	0.05
4	ZnS	0.40
5	PbS plus FeS_2	2.00
6	ZnS plus FeS_2	1.90
7	PbS plus ZnS	0.10
8	Mixture	4.39
9	ZnS plus SiO_2	4.55
10	Fines	0.70
11	Coarse	0.90
12	FeS_2 plus SiO_2	0.80

From an analysis of these assays it appears that most of the gold occurs along the contacts between the newest and older mineralizations,i.e. $\left.\begin{array}{r}\mathrm{ZnS}\\ \mathrm{PbS}\end{array}\right)$ and $\left(\begin{array}{l}\mathrm{SiO_2}\\ \mathrm{FeS}\end{array}\right.$

METALLURGICAL TREATMENT OF ORE.

Treatment of the ore should not present any very difficult metallurgical problems. Probably grinding to minus 100 mesh will unlock all the sulfide particles. Due to the high sulfide content of the ore, and its very much fractured nature, crushing and grinding will be very easy. Quartz is the hardest mineral present, and it is highly fractured. Also, the solid quartz contains very little of the other minerals and therefore will not have to be ground to very fine particles. There is apparently no gold in the pure quartz. After grinding, most of the gold will be found on the faces of the different sulfide particles. A small part of it will be contained in the small pieces of sulfides (chiefly ZnS). Also, at this stage, there should be some free gold particles present.

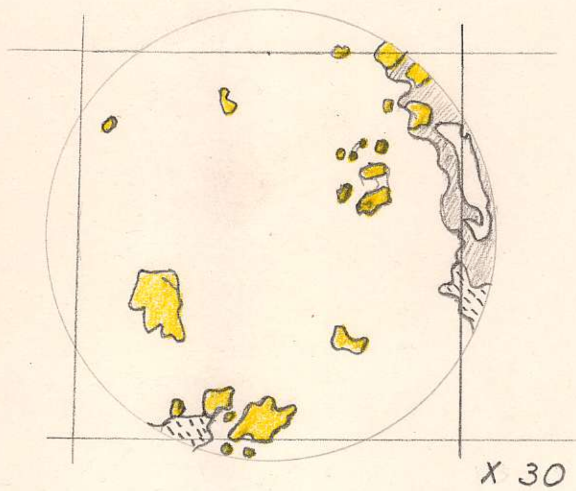
Although the main values in the ore are gold, the lead and zinc contents are sufficient to be of commercial importance. In testing to find the best method of treatment for the ore the following flowsheet could be tried.

Grind to minus 100 mesh. Pass the pulp over blanket or amalgamation tables to recover the coarsest free gold. Recover separate lead and zinc concentrates by selective flotation.

Cyanide the flotation tailings.

The lead and zinc concentrates would of course contain considerable gold. Economic considerations would determine whether it is best to recover the gold this way or by cyanidation before flotation.

Drawing No. 1 a.

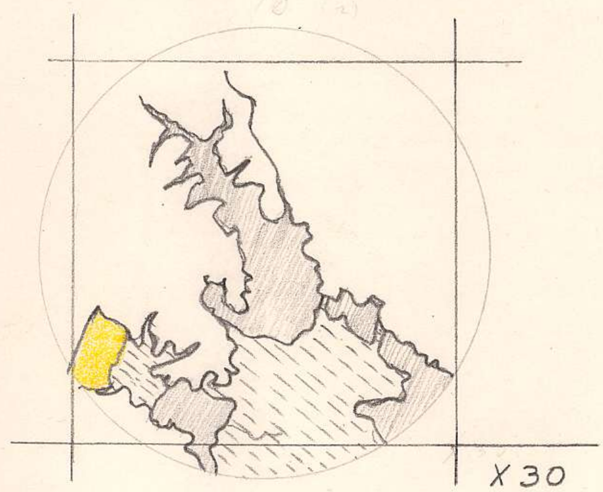


Pyrite first mineralization.

Then quartz has replaced some of the pyrite.

Galena and sphalerite have replaced quartz around the pyrite to some extent.

Drawing No. 1 b.

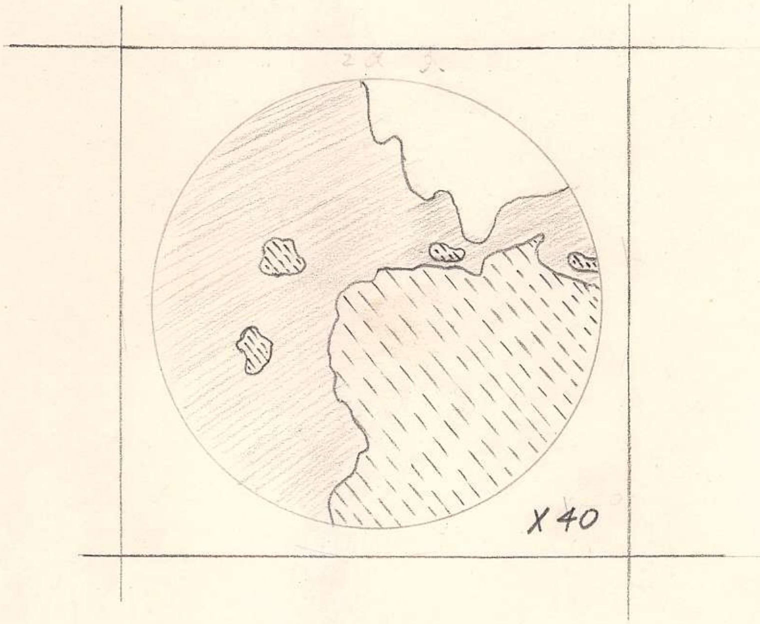


Quartz groundmass.

Galena intruding into fractures in the quartz.

Sphalerite appears to be later than galena, replacing it to some extent.

Drawing No. 2 a.



Galena appears to be either contemporaneous with or later than sphalerite.

Sphalerite "islands" in galena.

Smooth boundaries between the minerals.

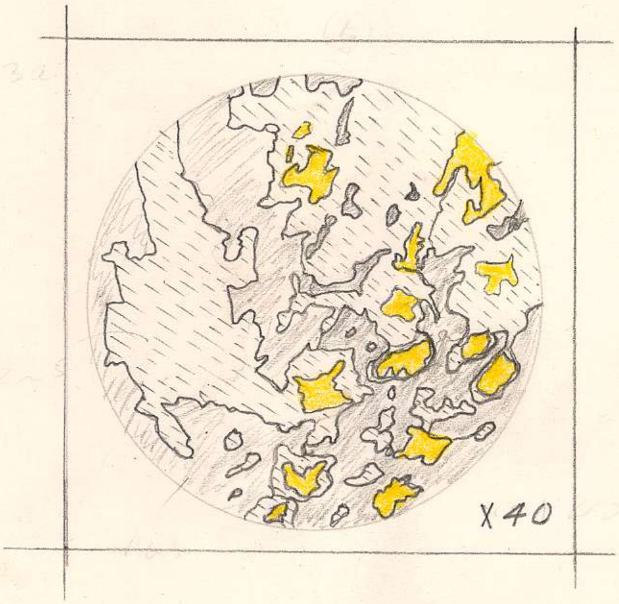
Drawing No. 2 b.

Massive pyrite, showing its fractured nature.

Quartz intruding into the crevices in the pyrite.

Also shows "leaching" action of sphalerite on pyrite.

Drawing No. 3 a.



Solid sulfides.

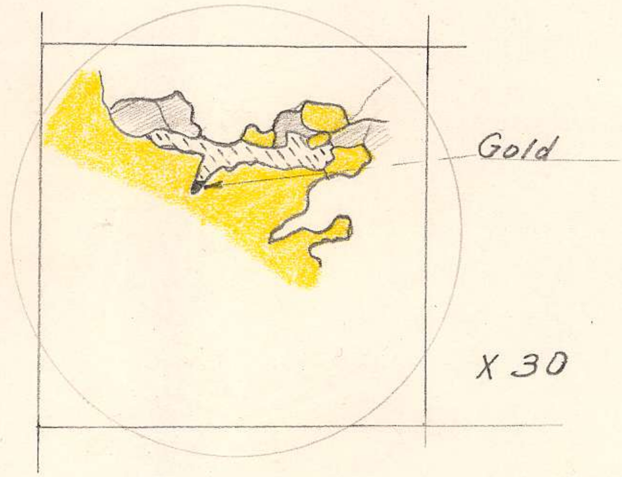
Pyrite the first mineralization.

Galena and sphalerite "intruding" into each other.

"Islands" of galena in sphalerite.
"Islands" of sphalerite in galena.
Therefore galena and sphalerite are contemporaneous.

Also shows "leaching" action of sphalerite around pyrite particles.

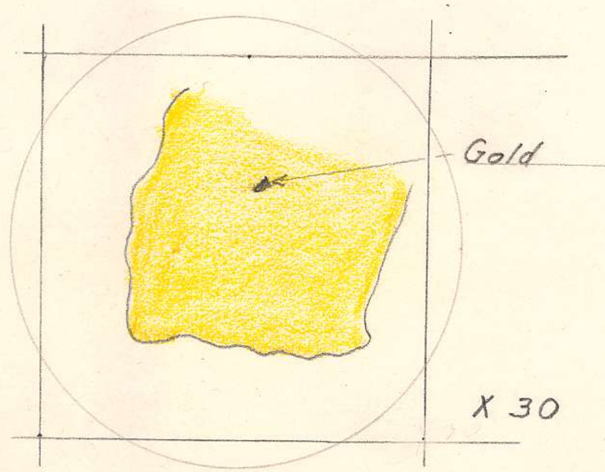
Drawing No. 3 b. -- visible gold.



Gold at the head of a channel of sphalerite into pyrite.

Size of gold particle -- 35 microns

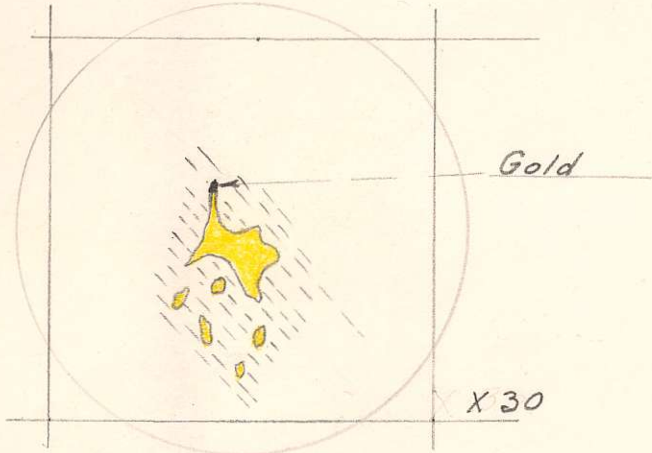
Drawing No. 3 c.



Gold on a piece of pyrite.

Size of gold particle -- 35 microns.

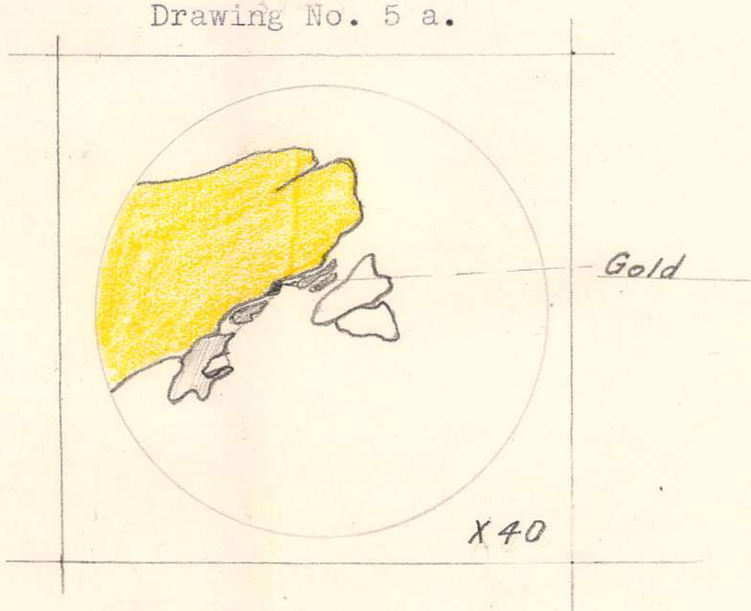
Drawing No. 4 a. -- visible gold.



Gold at point of contact of sphalerite and pyrite.

Size of gold particle -- 30 microns

Drawing No. 5 a.



Gold on the edge of a piece of pyrite; probably the contact between pyrite and galena or sphalerite.

Size of gold particle -- 30 microns

Drawing No. 4 b. -- visible gold.

Very fine gold particles in sphalerite around a quartz inclusion.

Also calcite shown as the latest mineralization, intruding into galena and sphalerite.

Size of gold particle -- 5 microns.