A MINERAGRAPHIC STUDY

OF THE ORES OF

THE SALLY MINES, BEAVERDELL B.C.

BY C.E. CLEVELAND.

UNIVERSITY OF B.C.

APRIL 1933.

C O N T E N T S

I L L U S T R A T I O N S.

A MINERAGRAPHIC STUDY
OF THE ORES OF
THE SALLY MINES, BEAVERDELL B.C.

INTRODUCTION.

Location.

The Sally Mines are situated in the Beaverdell Map Area, fifty miles north of the town of Carmi, a point on the Kettle Valley Railroad. They lie on the western slope of Wallace Mountain at an elevation of four thousand feet and overlook the settlement of Beaverdell lying in the valley of the Westkettle River.

Communication.

The Mines are within easy reach of the Kettle Valley Railroad which runs along the western side of the Westkettle River. There is a road from Beaverdell to the Mines.

Explanation of The Map.

The map represents the underground workings of the Sally Mines as developed in 1934. The numbers of all samples referred to in this report are plotted in location on the map.

There is a key map of the mines accompanying the report.

GENERAL GEOLOGY OF BEAVERDELL MAP AREA.

Table of Formation.

Age	Formation	Lithology
Quaternary		River Alluvium Glacial Drift.
Miocene	Nipple Mountain Series.	Lavas, andesites dacites, trachytes.
Oligocene	Curry Creek Series	Tuffs, conglomerates sandstone, agglomerates.
Eocene	Beaverdell Batholith	Augite porphyry, Quartz monzonite.
Jurassic	West Fork Batholith	Quartz Diorite.
Mesozoic		Volcanic rocks, and subordinate sediments, schists and coarse grained intrusives.

GENERAL GEOLOGY OF BEAVERDELL MAP AREA.
(Cont.)

As this paper is primarily written in the interests of mineragraphic and economic information regarding certain ores to be found in the map area the writer would refer the reader to Reinecke's report of the Beaverdell Map Area Geological Memoir #79 for detailed information regarding the geology of the district. The preceding table gives a concise representation of the geological ages and formations, and their related lithology.

ECONOMIC GEOLOGY.

Three types of ore deposits are found within the Beaverdell Area. They are:

(I) Mineralized shear zones.

(2) Stocks.

(3) Contact metamorphic deposits.

The last two types of ore deposits are not connected with the ores of the Sally Mine and will not be discussed.

ECONOMIC GEOLOGY. (Cont.)

The Mineralized Shear Zone.

The ore deposits of the Sally Mines are associated with the mineralized shear zones. consisting of tabular bodies of brecciated and partly altered country rock, quartz, ore minerals, and in places entruded and altered rock. These zones lie between well defined solid unaltered walls of country rock.

Distribution.

The mineralized shear zones which carry the silver found at the Sally Mines extend over an area of about three square miles on Wallace Mountain. At Carmi they carry value in gold and small quantities of silver,while at Mt. Arlington, six miles north of the Sally Mines they are reported to carry values in copper as well as gold.

Mineralogy.

The ore deposits on Wallace Mt. consist of pyrite, galena, sphalente, tetrahedrite, pyrargyrite, native silver, and perhaps Argentite.

ECONOMIC GEOLOGY. (Cont.)

Mineralogy.

The gangue consists of sericite, quartz, barite, iron oxide and calcite. Argentite was found present in extremely small quantites included in the galena.

The Country Rock.

The mineralized shear zones are found only in the West Kettle quartz diorite. The silver-bearing galena ores which occur in these zones were poorly developed and very scarce in the older rocks of the Wallace group. They have never been found in the Beaverdell quartz monzonite.

Since the ore bodies of the Sally Mines are essentially galena ore bodies it is essential to consider the fact that they are restricted almost wholly to the shear zones of the quartz diorite.

The shear zones strike east west and dip south. See map of Sally Mines where they cross at a contact from the quartz diorite to rocks of the Wallace group the well defined walls

ECONOMIC GEOLOGY. (Cont.)

The Country Rock. (Cont.)

of the shear zone present in the quartz diorite are absent in the latter. Only slight Mineralization occurs when the zone extends into the Wallace group. Reinecke says:

" The clean cut shear zones in the quartz diorite appear to have furnished more space for the deposition of the galena ores than the shattered areas in the Wallace group."

The shear zones are absent from the Beaverdell quartz monzonite and also the ore.

Structural Features of the Shear Zones.

The typical shear zones are from one to ten feet wide and with minor exceptions they strike east and west and dip to the south. Cross faults often displace the zones.

Textural Features of the Deposits.

The material in the zone is either vein filling or altered and replaced country rock and dyke matter.

ECONOMIC GEOLOGY. (Cont.)

The Country Rock. (Cont.)

Textural Features of the Deposits.

In speaking of the veins Reinecke says in the following:

" One occasionally finds well banded veins in which successive bands succeed each other with some regularity, and in which there is a definite sequence of mineral from the margin towards the centre; but more often the banding is very irregular or absent, and the veins are made up of aggregate of coarse interlocking crystals which appear to have crystallized together."

The quartz diorite of the is fresh. The altered rock within the shear zone consists of fragments of quartz diorite, intensely altered by the ore-bearing solutions.

Surficial Alteration and Secondary Deposition.

Little gossan is found with the ores and the zone of the surface alteration is seldom more than a few feet thick, with the result that unaltered ore is found very close to the surface.

ECONOMIC GEOLOGY. (Cont.)

Surficial Alteration and Secondary Deposition.

The depth of the ground water on Wallace Mountain level varies from fifteen feet to forty feet. Surficial alteration by surface waters with the deposition of secondary sulphides below the ground water level has been slight within this area.

Genesis of the Ores.

The following hypothesis is put forward by Reinecke:

"The ores upon Wallace Mountain were deposited in the shear zones by hot ascending solutions which partly replaced the brecciated country rock and partly filled cavities between the broken fragments. The depth at which they were found was less than two thousand feet. The hot waters were probably derived from the intrusion of the stock like mass of Beaverdell quartz monzonite."

Sequence of Intrusion and Ore Formation.

(I) The formation of east-west shear zones in the Westkettle quartz diorite.

ECONOMIC GEOLOGY. (Cont.)

Sequence of Intrusion and Ore Formation. (Cont.)

(2) The intrusion of the Beaverdell quartz monzonite preceded by the intrusion of dykes of andesite, and accompanied by intrusions of aplite dykes;
(3) The formation of sericite in the shear zones during the intrusion of the quartz monzonite.
(4) The formation of Quartz and pyrite, and the other metallic sulphides.
(5) Faulting and offsetting of the ores.
(6) The formation of native silver, iron oxide, chlorite, calcite, and kaolin.

DESCRIPTION OF THE POLISHED SECTIONS.

Specimen Sally G.

The sample from which the polished section was prepared was collected by Mr. Allan Morley and has been given no location in the mine. It is, however, a typical sample of the ore and contains predominantly, pyrite, galena, and sulphide. Figure I. illustrates the arrangement of the minerals as seen in the polished sections.

DESCRIPTION OF THE POLISHED SECTIONS.(Cont.)

Figure I.

This illustration shows a predominant amount of pyrite and sphalerite with a smaller quantity of galena. The sphalerite is shown filling the interstices of the pyrite which appears to have been shattered.

Specimen Sally No. 2.

This polished section was prepared from sample No. 2 containing galena pyrite sphalerite and ruby silver. From this section the relationship between the above minerals was studied. The section is illustrated by Figures 2, 3, 4, 5.

Figure No. 2.

This illustration shows the ruby silver cutting the sphalerite and a border of sphalerite between the galena and ruby silver. Small amounts of quartz are present throughout the sphalerite.

Figure No. 3.

The marginal border of the sphalerite between the galena and ruby silver is repeated

DESCRIPTION OF POLISHED SECTIONS. (Cont.)

Figure No. 3. (Cont.)

in this illustration. The galena appears to have cut off the ruby silver at "A" in the illustration. The pyrite is shown definitely cut by the ruby silver. A piece of isolated quartz in the centre of the illustration has suggestions of its crystal form.

Figure No. 4.

This illustration seems to confirm the information regarding the age relationship of the galena and ruby silver of the last illustration. The ruby silver appears again as though it had been cut off by the flowage of galena. This is shown at "B" and "C" in the illustration. There are remnants of sphalerite and ruby silver shown in the galena.

Figure No. 5.

This is a further illustration of the "galena cut" ruby silver shown at "A" "B" and "C". There is also repitition of the border of sphalerite between the galena and ruby silver.

DESCRIPTION OF POLISHED SECTIONS. (Cont.)

Figure No. 5. (COnt.)

Also see Figure 4, 3, 2. In this illustration the smooth contacts of the large mass of ruby silver in the lower centre portion of the drawing with the galena suggests that the two minerals may have been contemporaneous in deposition.

Specimen Sally No. 3.

This polished section was prepared from Sample No.3 and gave a relationship between the pyrite and galena. This relationship is illustrated in Figure No. 6.

Figure No. 6.

Galena is shown along with a smaller amount of sphalerite in veinlets cutting the pyrite. The uncolored portions in the pyrite are probably filled with mineral but owing to the poor surface contacts nothing could be deciphered.

DESCRIPTION OF THE POLISHED SECTIONS.(Cont.)

Specimen Sally No. 10.

This polished section was prepared from a specimen of sample 10. From it was obtained a relationship between the quartz and galena. Figures 7 and 8 are illustrations from this polished section.

Figure No. 7.

Pyrite, galena, and quartz, are shown together in this illustration. There is a suggestion of the galena embaying the pyrite. Several hexagonal crystals of quartz were noticed in the polished section and one of them is illustrated here.

Figure No. 8.

This illustration shows no relationship between the minerals present, although the galena appears to be embayed by the pyrite. No weight can be put on this point, however, as this would require the pyrite to be younger than the galena, a relation which is not correct according to further studies made.

DESCRIPTION OF THE POLISHED SECTIONS. (Cont.)

Specimen Sally No. II.

This polished section gave a relationship between the galena and sphalerite. The section was prepared from Sample II. Figure 9 is an illustration taken from the section showing the relationship of the two minerals mentioned above.

Figure No. 9.

Galena, quartz, pyrite, and sphalerite are shown in the illustration. The galena is shown cutting the sphalerite.

Specimen Sally I2.(A).

This polished section exhibits two minerals not previously illustrated namely chalcopyrite and what is believed to be pyrrhotite. The writer had a suspicion that the latter was a copper mineral perhaps an arsenide but further tests proved it probably as pyrrhotite. The section contains a good deal of the mineral and it appears to be associated with the chalcopyrite. Figures I0 and II are illustrations from this polished section.

DESCRIPTION OF THE POLISHED SECTIONS. (Cont.)

Specimen Sally I2 (A) (Cont.)

Figure No. IO.

This illustration shows quartz, chalcopyrite, and sphalerite. The chalcopyrite appears to cut the sphalerite. There is nothing distinctive concerning the quartz.

Figure No. II.

An abundance of the mineral, determined as pyrrhotite, is shown in this illustration. In one place it appears to cut the chalcopyrite.

Specimen Sally I2. (B).

This polished section was also made from a specimen of Sample I2. From the section relationships were found between quartz and pyrite, galena and pyrite. Figures I2 and I3 are illustrations from this section.

Figure No. I2.

This illustration shows pyrite invaded by quartz. The sphalerite contained pyrite which

DESCRIPTION OF THE POLISHED SECTIONS. (Cont.)

Specimen Sally I2. (B).

Figure No. I2. (Cont.)

might be remnants of this latter mineral in the sphalerite. No conclusions could be drawn with regard to the relationship of the sphalerite to the other two minerals as seen in this illustration.

Figure No. I3.

Galena is shown cutting the pyrite. In several places the galena veinlets contain little islands of pyrite. In one portion of the illustration the contact between the pyrite and galena suggests the flowage of galena along crystal borders of the pyrite.

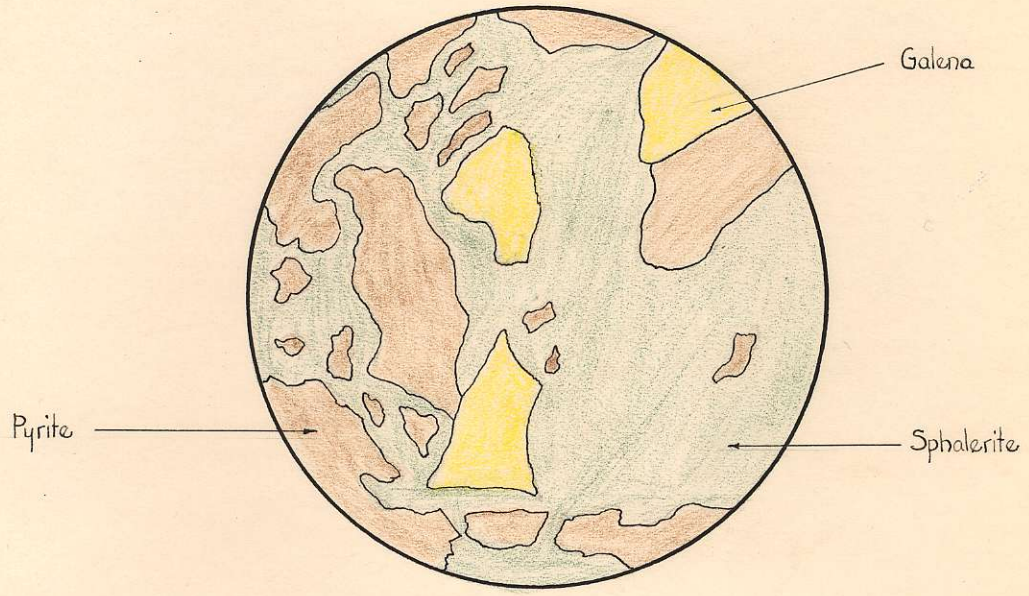


Figure I----X 40

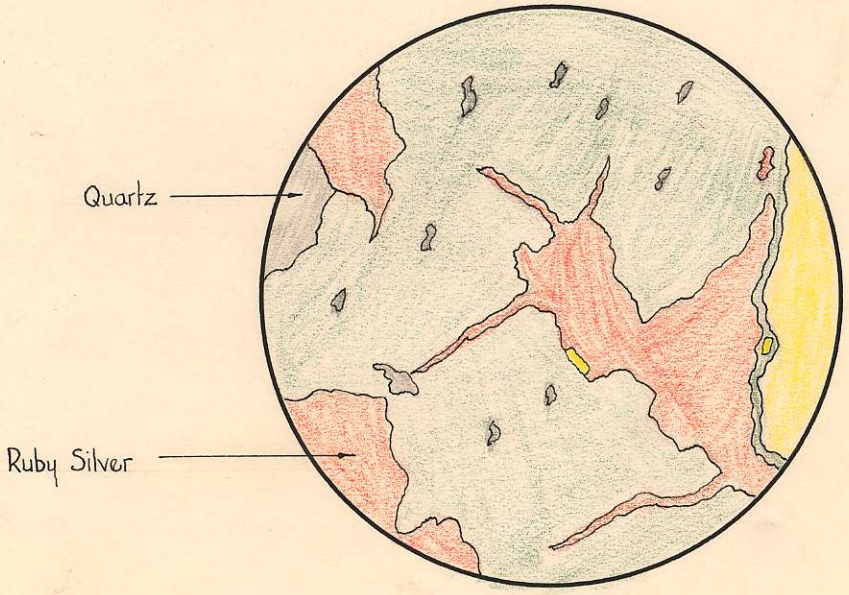


Figure 2 ----X 40.

Skeletal showing typical

relationships between galena, sphalerite,

and ruby silver. X 40

(Figure 9)

$\frac{1\frac{1}{2}}{4} \times 40$

$\frac{3}{2} \times \frac{1}{4} \times \frac{40}{10} = 15$

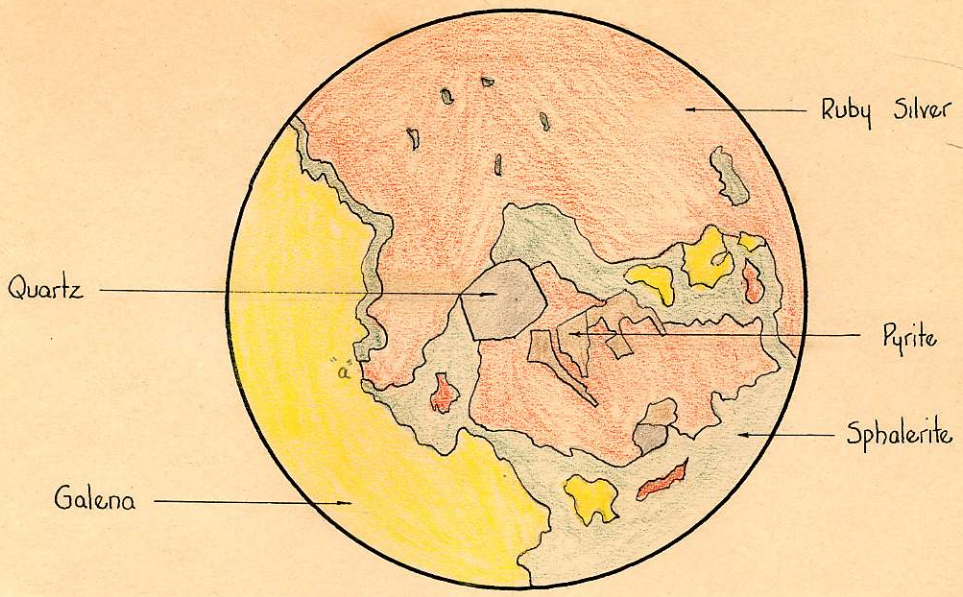


Figure 3 ----X 40

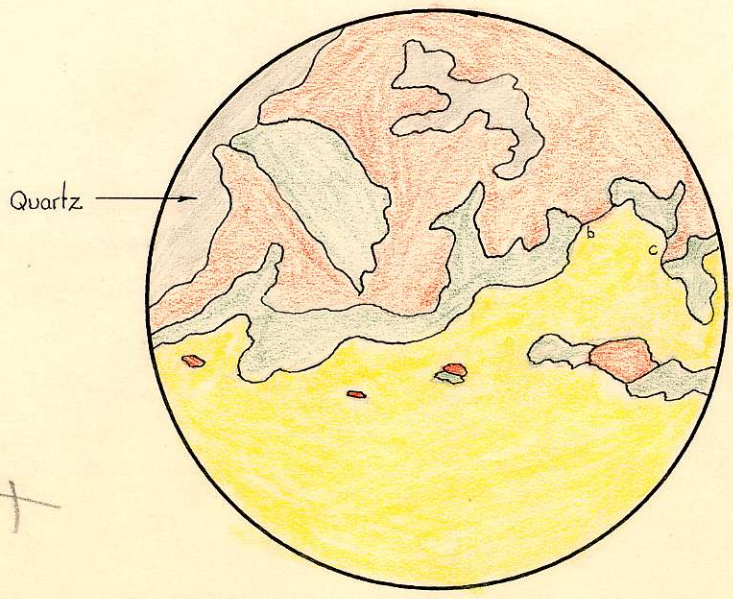


Figure 4 ----X 40

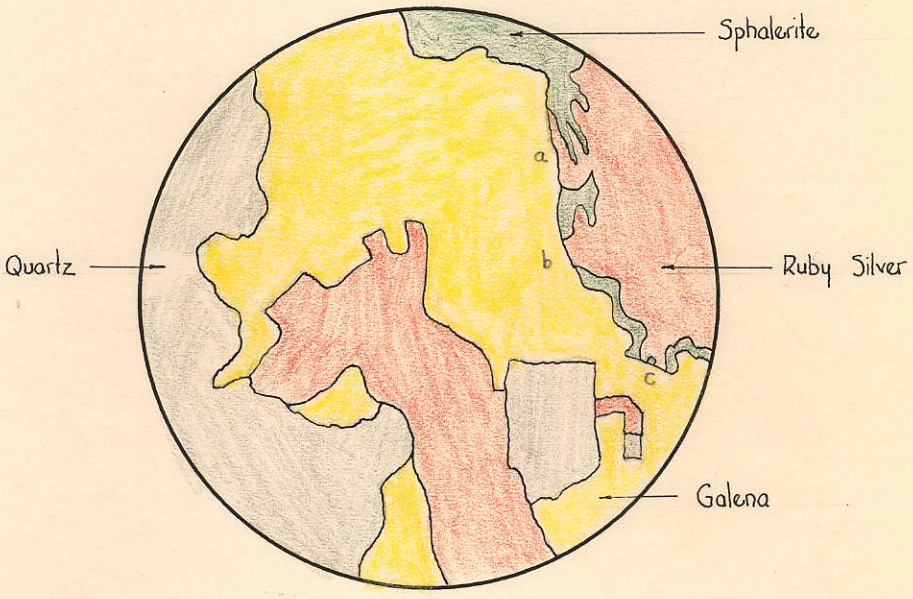


Figure 5 ----X 40

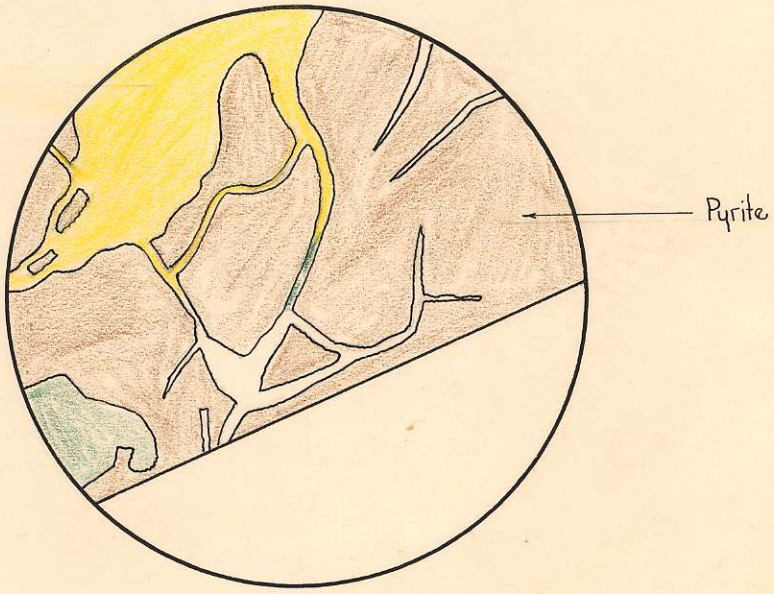


Figure 6 ----X40

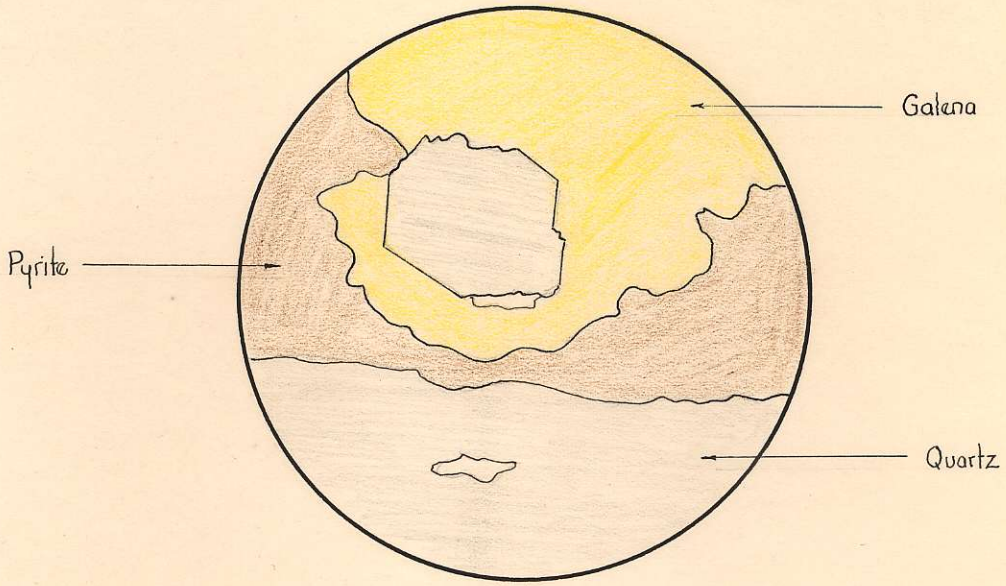


Figure 7----X 40

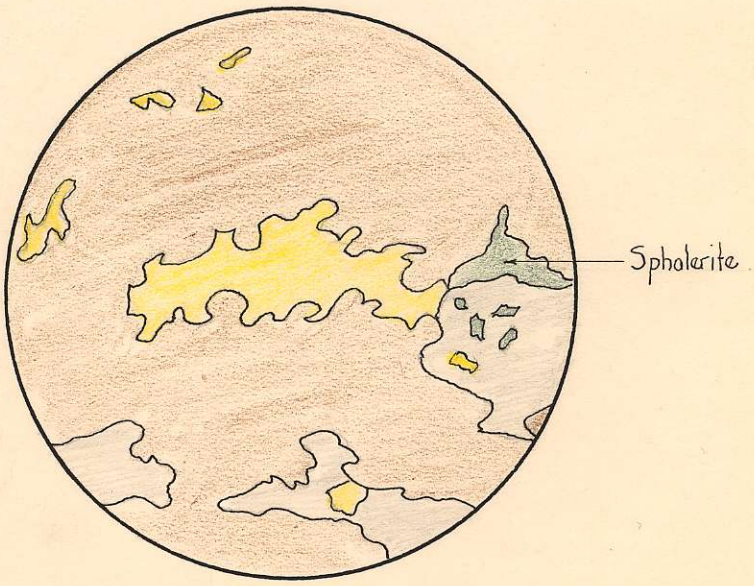
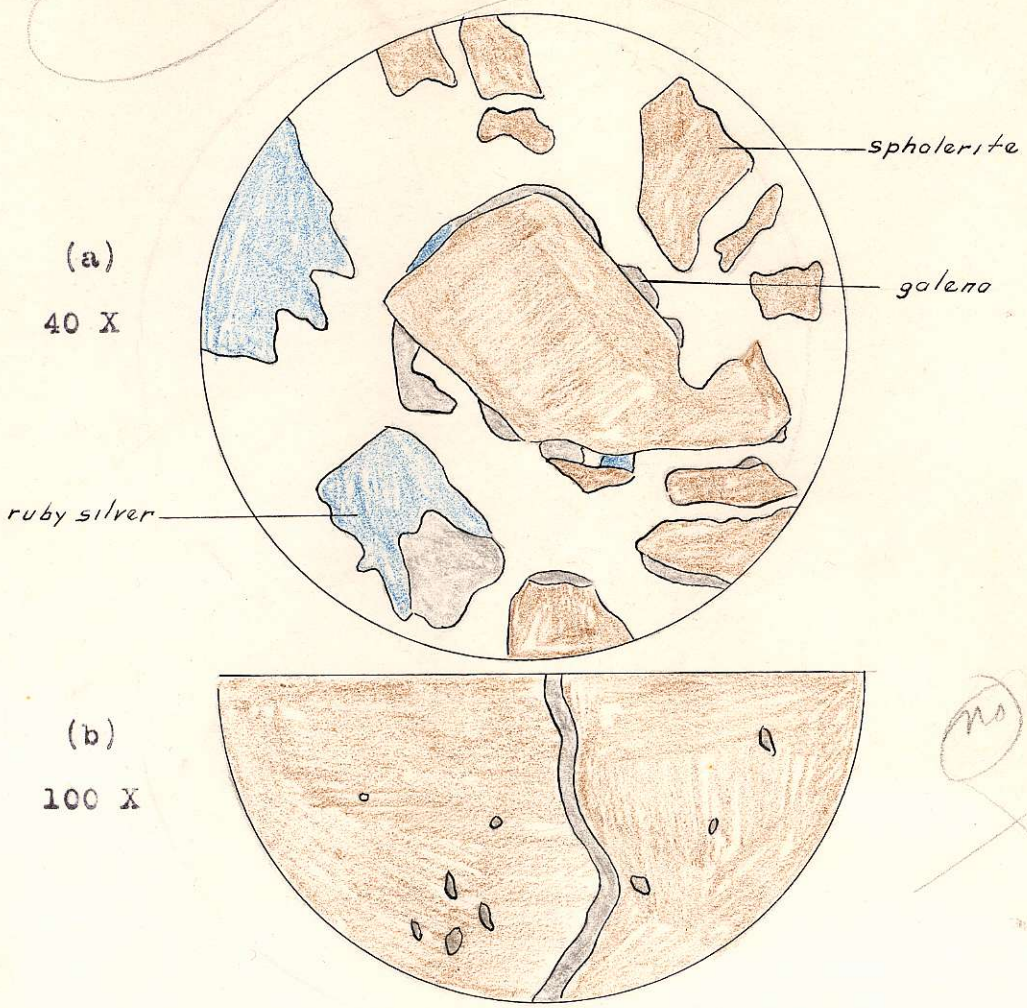


Figure 8----X 40

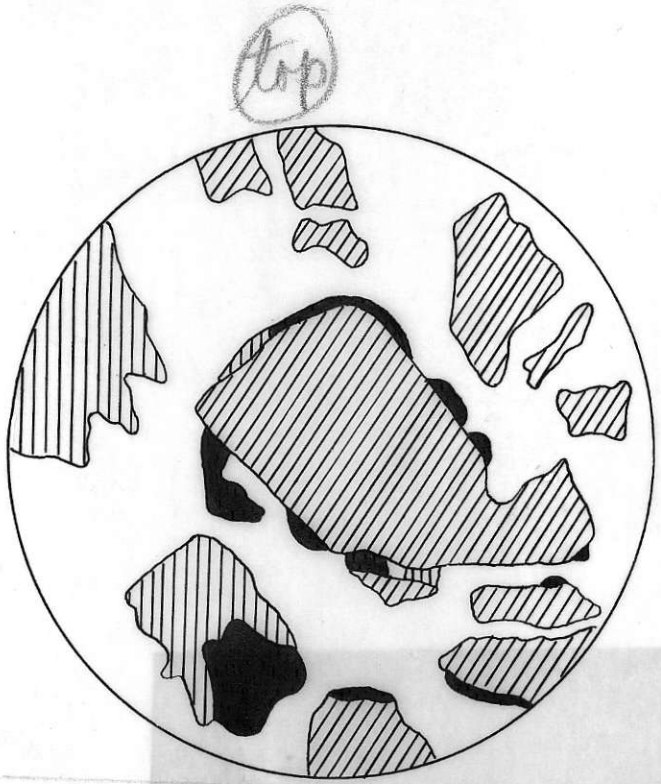
Figure 9 (a & b).



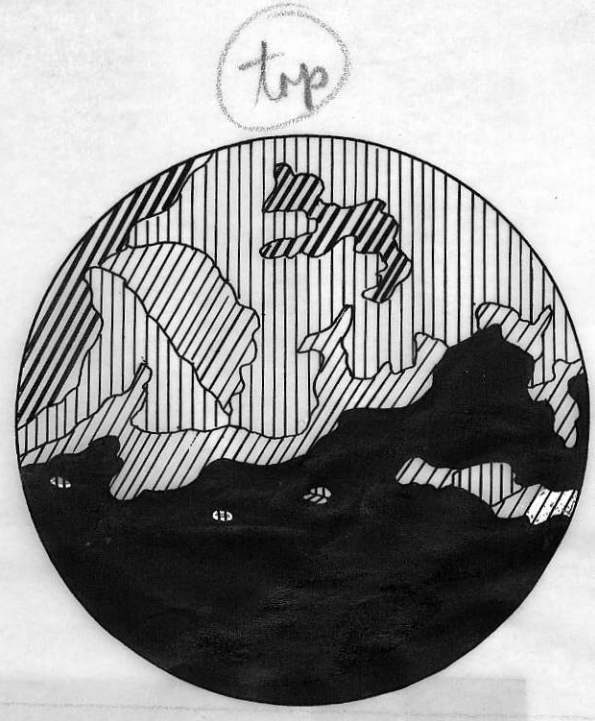
Section of ore from the Beaverdell area, showing

(a) Ruby silver and galena encircling sphalerite which shows, the order of deposition. namely, sphalerite followed closely by galena and ruby silver with no break between deposition of different minerals.

(b) Galena veining sphalerite.



1 5/8"



1 5/8"

LEGEND

RUBY SILVER

QUARTZ

SPHALERITE

GALENA

3 1/2"

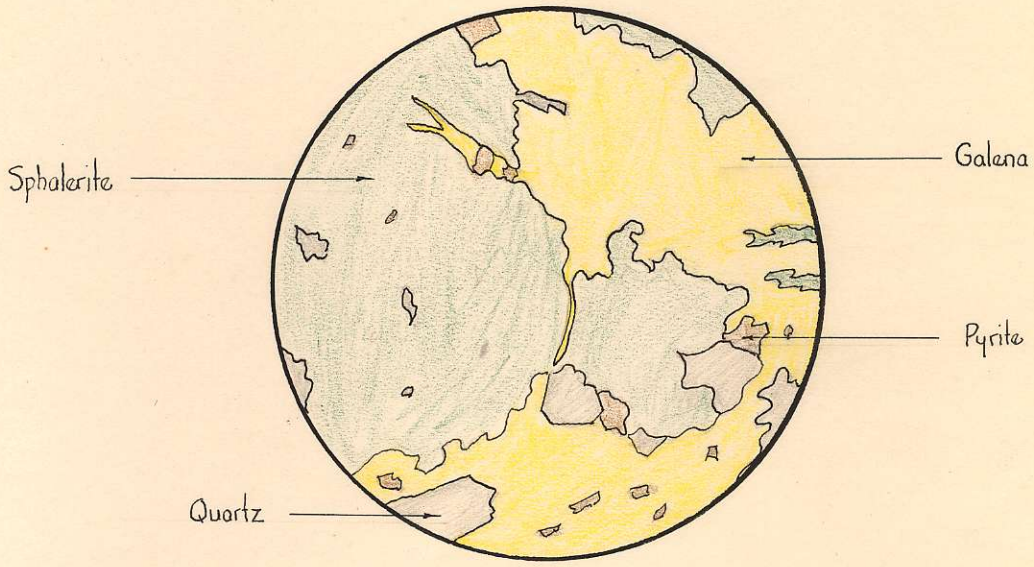


Figure 9----X 40

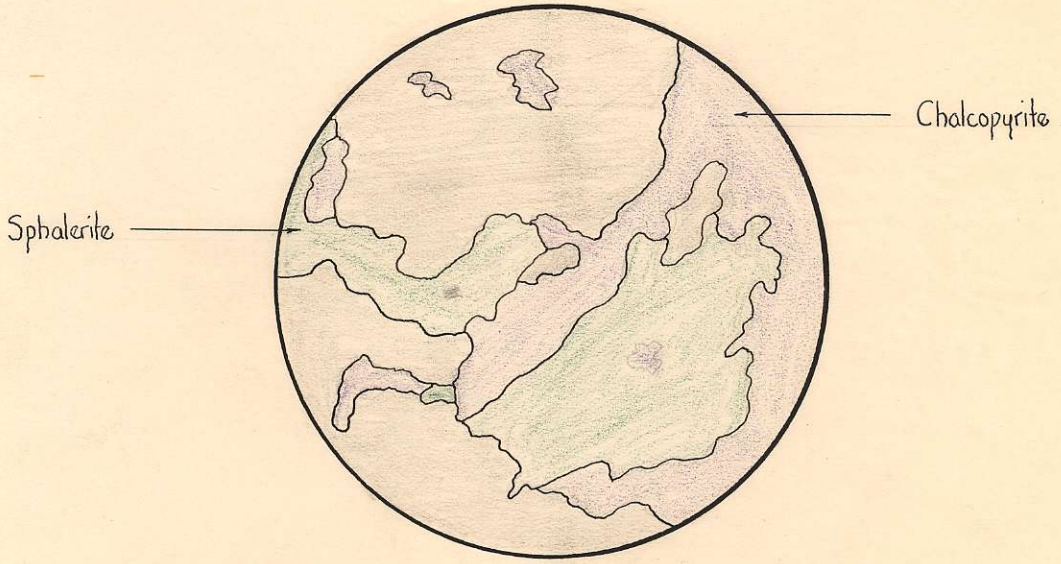


Figure I0-----X 40

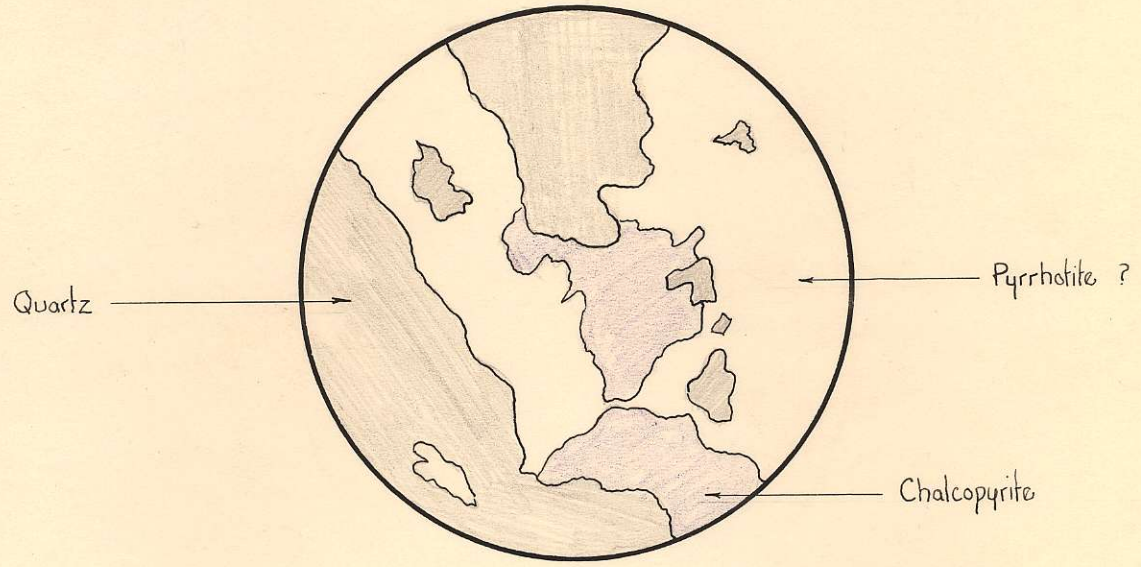


Figure II----X40

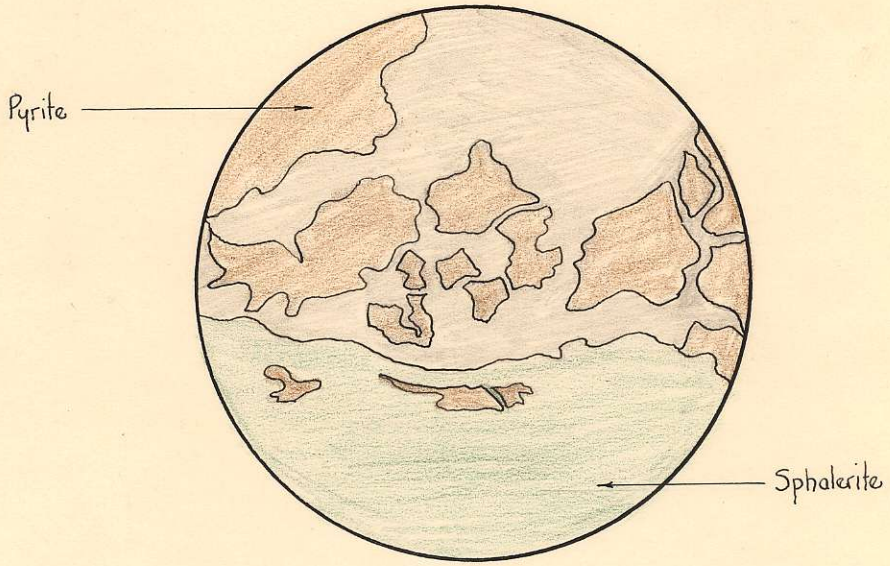


Figure I2----X40

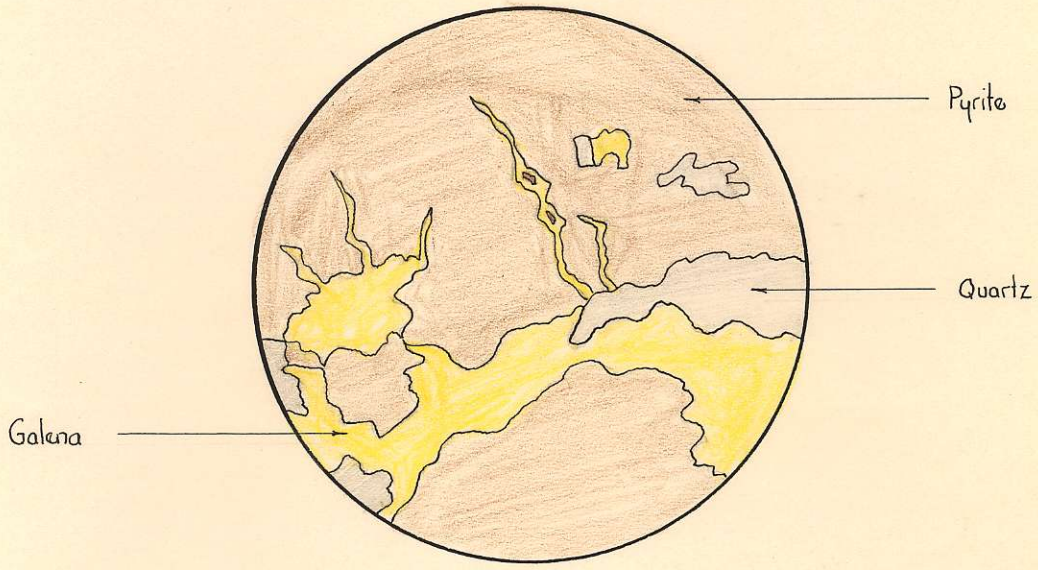


Figure I3 ----X 40

PARAGENESIS.

From the study of the ore samples dealt with in this report the minerals found were probably formed in the following chronological sequence: Pyrite, pyrrhotite? quartz; sphalerite; then ruby silver, galena, tetrahedrite, argentite, chalcopyrite; native silver. The last mineral to form was probably calcite.

Pyrite appeared in all cases to be cut or followed by a generation of quartz. See Figure 7 and I2. Reinecke in his report speaks of a first generation of quartz followed by pyrite and then another deposition of quartz. The writer found no definite evidence of these two generations of quartz and therefore could not satisfy this condition. Reinecke also claims a second generation of pyrite. The pyrrhotite? as illustrated in Figure II appears as though it might be younger than the chalcopyrite. Due to the limited amount of time given to the study of this mineral the writer could not satisfy himself as to the age relationship of this mineral but believes that it must be much older than the chalcopyrite. The sphalerite definitely cuts the pyrite and is therefore younger than the pyrite. This is illustrated by Figure I and 6.

The ruby silver appears to be older than the galena. All evidence obtained points towards this Probability. See Figures 3, 4, and 5.

PARAGENESIS. (Cont.)

The ruby silver is younger than the sphalerite as shown by Figure 2 where it is shown veining the sphalerite. It also veins the pyrite Figure 3. In most cases the galena appears to be younger than the ruby silver. There is however, a possibility of contemporanity. Galena was found definitely cutting pyrite and sphalerite and is therefore younger. See Figures 6 and 9. Tetrahedrite was found in small amounts in some of the hand specimens but in no polished section was it observed and therefore nothing definite will be said about its relationship. With more time it might have been possible to get enough of this mineral in one specimen to make a polished section. Small specks of argentite appeared in one of the polished sections and were held within the galena. They were so small that it was almost impossible to determine them. They were extremely soft and had the characteristic appearance of native silver as seen under the microscope. The chalcopyrite appears to be younger than the sphalerite Figure IO. The suggestion of pyrrhotite cutting the chalcopyrite is shown in Figure II.

Native silver is present in several of the hand specimens especially in sample I2. It has a somewhat abborescent form and has probably been deposited in fractures of the rock as a secondary mineral.

PARAGENESIS. (Cont.)

Veinlets of calcite cut the minerals and rock. See a specimen of Sample I2. It seems quite evident that calcite was the last of the above minerals to form in the veins.

Regarding the ruby silver, from studies made of the polished sections and the samples it is reasonable to believe that the ruby silver is primary. Its occurrence with fresh and unaltered pyrite, sphalerite, and galena, points towards this fact.

LIST OF SAMPLES.

Sample I.

Contains coarse galena, granular pyrite, and small amounts of sphalerite. Calcite is abundant and appears to cut the minerals. A considerable amount of lime and carbinate derived from the calcite is present.

Sample 2.

Contains massive coarse galena with ruby silver, fine grained pyrite, massive sphalerite, chalcopyrite and quartz, a small portion of which is honey-combed. One specimen of this sample is rich in ruby silver and the minerals tend to be banded.

Sample 3.

Contains galena, massive sphalerite, pyrite and chalcopyrite. One specimen is banded.

Sample 4.

Contains coarse grained galena, fine grained pyrite, and a minor amount of sphalerite. Also tetrahedrite in small amounts.

LIST OF SAMPLES. (Cont.)

Sample 5.

Contains predominantly massive sphalerite and chalcopyrite with minor amounts of pyrite.

Sample 6.

Contains galena, massive sphalerite, and small amount of pyrite and chalcopyrite.

Sample 7.

Contains fine grained galena, masses of fine grained pyrite, and fracture filling ruby silver?

Sample 8.

Contains the same minerals as Sample 7 with the repeated occurrence of ruby silver.

Sample 9.

Contains coarse grained galena, chalcopyrite, and pyrite.

Sample IO.

Contains coarse grained galena, massive sphalerite, fine grained pyrite and specks of bornite.

LIST OF SAMPLES. (Cont.)

Sample II.

Contains fine grained galena, pyrite, chalcopyrite and small amounts of native silver with specks of bornite. Small amounts of calcite are present.

Sample I2.

Contains massive sphalerite, galena, fine grained pyrite and chalcopyrite. One specimen contains a large mass of native silver; another contains veinlets of calcite.

LIST OF POLISHED SECTIONS.

I.	Specimen	Sally	I2 (A)	From	Sample	I2.
2.	"	"	I2 (B)	"	"	" .
3.	"	"	II	"	"	II.
4.	"	"	I0	"	"	I0.
5.	"	"	3	"	"	3.
6.	"	"	2	"	"	2.
7.	"	"	G	Grab	Sample.	

4348 W. I4th. Ave.,
Vancouver, B.C.,
May I4, I934.

Dr. H. Warren,
University of B.C.

Dear Dr. Warren:

I am sorry to have been so long returning the report, but I was not able to get to copying it until yesterday morning. I am sending the copy to my father to-day.

If, by any chance, you should find it necessary to prepare it for publication before hearing from the company, I would suggest the following alterations, for the reasons stated.

(I) Page I., "Location" - "fifty miles north of Carmi" should read "five miles south of Carmi" however, Beaverdell is now a much larger place than Carmi, and is also a point on the Kettle Valley Railroad.

(2) Page I., "Location" - "Westkettle" should read "West Kettle".

(3) Page I., "Explanation of the Map" - "The map represents the underground workings of the Sally Mines as developed in I934" this is incorrect, as only the parts of the workings from which samples were taken are represented.

(4) Page 3., "Economic Geology",- "The last two types of ore deposites are not ~~found~~ connected with the ores of the Sally Mine". I am not certain, but if this (#3) refers to deposits at the contact line of the formations, it may be untrue, as there are workings of the Sally on the borderline of the formations in which ore has been found. In fact samples #I and #2 come from somewhere near the Wallace formation, though as nearly as I can tell from the map they were not in it.

(5) Page 4., "Mineralogy" - "perhaps argentite" - argentite is not only definitely found in Sally ores, but in certain workings has been a very large part of them, occuring in well defined crystals and large flakes, up to ~~XXXXXXXX~~ 4"x5"xI".

(6) Page 5., "Country Rock" - "galena ores -----poorly developed and very scarce in the Wallace group" - I understand that since Reinecke's time large deposits of comparatively low grade (about 40 oz.) ore have been located in the Wallace groups. This does not affect the Sally to any extent, but might not please the other mines which have properties on or across the line of contact.

(7) Page 7., "Textural Features" - omission, line one of final paragraph of this section - "the diorite of the (?) is fresh".

(8) Page 9., - acknowledgement of collection - I have not collected any of the samples, it was entirely done by Mr. Boydell Montgomery, a McGill student now at the Sally, and if any reference is made to it, he should have the credit.

I hope these corrections are not toopetty, but I presume you would rather have anything published exact. I do not see anything approaching a major mistake, and believe these small errors arise from depending on Reinecke's report, which, while exact and exhaustive when made, was compiled previous to all modern development on the hill, which began about 1917. The Reinecke report is, of course, by no means outmoded, but subsequent developments, while chiefly confirming his deductions, have made it necessary to revise some of the minor ones.

I will let you know whenever I hear from the Company what they have to say as to publication, but do not believe there will be the least objection.

Yours truly,

Alan P. Morley.

Alan P. Morley

4293 W. 11th Ave.

Phone Ell. 1572 R.