

GEOLOGY 9.

600443

REPORT ON POLISHED SECTIONS OF ORE
FROM NO. 8 ORE BODY OF BRITANNIA MINES.

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Metallurgy '43.

April 1943.

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INTRODUCTION.

Purpose of Investigation.

The purpose of this report is to make a preliminary investigation of ore from No. 8 Ore Body from the 4000 and 4500 foot levels at Britannia Mines, Britannia Beach, B.C. The problem as far as this report is concerned was to prepare and study polished sections, noting the following points:

- (1) Minerals present.
- (2) Relative quantities present, and their relationships.
- (3) Paragenesis.
- (4) Possible metallurgical treatment.

In particular, the last item deals with the problem of whether or not zinc and copper minerals can be separated and concentrated.

For this work four polished sections were prepared, from samples of ore which were representative of the available ore. These sections were numbered, and will be referred to as number one, two, three or four henceforth in this report.

Geology:

Since No. 8 Ore Body is a new one, there is no available information on its geology as yet.

The Britannia Beach area embraces a part of one of the numerous roof pendants remaining along the flanks and top of the Coast Range batholith.

The Britannia formation forms the southwestern part of the roof pendant and underlies a long, narrow strip of country extending from Howe Sound on the West, to Seymour Creek, on

the East. At Howe Sound the width is approximately 6000 ft. A small corner of this strip is on the north side of Britannia creek, and the formation extends across the creek, over Britannia ridge into Furry creek, and on to the main branch of Seymour creek, a distance of about 8 miles. The width of the line, in which the formation occurs in the Seymour creek watershed, is about 9000 ft. exclusive of the isolated quartzites beneath Mount Lomond. Of this 9000 ft., less than half is underlain by the Britannia formation. The remainder is occupied by later sill-like intrusives.

A series of arkoses, with some shale and metamorphosed basic volcanic rock at the base of Mount Lomond, is included in the Britannia formation. They underlie an elliptical area immediately west of Seymour lake.

The formation contains by far the greater amount of true sedimentary rocks found in the area. They vary from medium-grained quartzites to dense, black, carbonaceous slates, including in this range, grey, siliceous slates as well as dense cherts and fine, green slates which may be of tuffaceous origin. Interstratified in the formation are fine-grained tuffs, for the most part included with the slates, and a considerable thickness of plastic volcanic material. Basic crystalline rocks also occur as sills, irregular intrusives, and possibly as flows. The rocks are all highly metamorphosed. They have been sheared during tilting into their present positions, but have been greatly modified by the heat and the solutions emanating from the batholith and related intrusives.

MINERALOGRAPHY.Determination of Minerals in Specimens.

Quartz - identified by its hardness, color, and internal reflections. It was harder than the needle, and was dark grey to black in color.

Pyrite - determined by its color and hardness. It was pale brass yellow in color, and harder than the needle, and many crystals showed a typical square cross-section, since it is isometric.

Sphalerite - identified by its color, hardness, and arc light reflection. It was dark blue-grey in color, ^{and had} a hardness of about 4 which could be judged by scratching it readily with a needle. A further test consisted in flashing an arc light on the section, and the typical honey-colored reflection was shown. Some micro-chemistry tests were also run on the mineral. A little mineral was scraped out of the surface, taken into solution with 1:1 H N O₃, the solution being finally evaporated. The residue was then leached with 1:7HNO₃, the drop transferred, and a drop of potassium mercuric thiocyanate (K₂ Hg (C N S)₄) added. The result was observed after about 1 minute, and showed the typical dark feathered crosses of zinc mercuric thiocyanate.

Chalcopyrite - identified by color, hardness, etch tests and microchemistry tests. Its color was brass yellow, and it was quite soft, being easily scratched by a needle, and judged to be about 3-4. For the etch tests, as for all other etch tests, the order of reagents was to start with the least reactive, viz. Hg Cl₂, KOH, Fe Cl₃, KCN, HCl, HNO₃, aqua regia. It was negative

to all reagents except HNO_3 , which tarnished the mineral, and the aqua regia which tarnished the mineral differentially, bringing out the grain structure, and tarnished it brown quite slowly. Several microchemistry tests were run on the mineral. A drop of aqua regia was used to dissolve a fragment of the mineral, and the drop was then evaporated. A drop of 1:7 HNO_3 was used to leach the residue. The drop was transferred, and a drop of $\text{K}_2 \text{Hg} (\text{CNS})_4$ was led into this drop by the usual method of Chamot and Mason. After leaving one minute, the result was observed, and showed the usual radiating and variously oriented acicular prisms of copper mercuric thiocyanate, indicative of copper.

Chalcocite - determined by its hardness, color, and both etch tests and microchemistry tests. It was very soft, being very easily scratched with a needle: the hardness was judged to be 2-3, and its color was light blue grey. The etch tests all showed the following results - HgCl_2 - neg.; KOH - neg.; FeCl_3 - stained mineral dark blue; KCN - stained dark; HCl - neg.; HNO_3 - stained mineral dark blue. Some microchemical tests were run for copper, and showed positive results. For these microchem. tests, a small speck was carefully drilled out, making sure that no chalcopyrite was taken in with the sample. These tests seemed to be conclusive evidence to the author of the presence of chalcocite.

Gold - identified by its color and etch tests. A very small speck was noticed in one specimen, which had ^a ~~the~~ decidedly deeper ^{color than} yellow _A of the chalcopyrite. The etch tests were all negative except KCN , which immediately etched black, while the surround-

ing chalcopyrite remained unaltered. These tests also seemed conclusive enough of the presence of gold.

Description of Minerals.

The approximate relative amounts of the minerals in the four specimens were as follows, considering the total area of the polished section as 100% in each case:

Section 1 - Quartz 80%, Sphalerite 10%, Chalcopyrite 5%, Pyrite 5%

Section 2 - Quartz 50%, Pyrite 40%, Chalcopyrite 10% Sphalerite-trace.

Section 3 - Quartz 60%, Pyrite 5%, Sphalerite 25%, Chalcopyrite 10%.

Section 4 - Quartz 5%, Pyrite 80%, Sphalerite 10%, Chalcopyrite 5%.

Comparing these relative areas with areas of sections from other ore bodies at Britannia, it was observed that on the whole the sphalerite tends to be increasing in depth, and Galena which was observed in sections from other ore bodies, was not observed in the sections under discussion.

Quartz is the principal gangue mineral, but varies in quantity in the specimens from about 5 to 80%, and thus has been replaced to widely varying degrees by sulphides. It has been fractured in many places, giving different shades of grey black when observed through the microscope. The fractures are in most cases sharp and distinct. The quartz-chalcopyrite contacts are usually very irregular, as are also the quartz-sphalerite contacts.

Pyrite occurs chiefly in quartz and sphalerite and

usually occurs as definite square, rectangular, or triangular crystals. In most cases it has been severely pitted and eaten out and in many places is severely fractured. Occasional deposition of chalcopyrite and sphalerite were noticed, being deposited in large cavities entirely within the crystal. The mineral varies between a definite massive variety and very finely divided crystals. Hence there has apparently been replacement of pyrite and quartz to a large extent.

Sphalerite - a fairly abundant sulphide in the sections. It often contains inclusions of chalcopyrite, again widely varying in size from a few microns to large masses.

Many contacts of sphalerite and chalcopyrite show the closeness of their association. Sphalerite also contains inclusions of pyrite crystals. It is almost always of the massive variety, showing neither fracture nor cleavage.

Chalcopyrite - occurs usually as inclusions in either quartz or sphalerite. A very interesting point noted was that there were some inclusions of chalcopyrite in both sphalerite and quartz which could hardly be detected, while in other parts of the same specimen there were large masses of chalcopyrite present. Some sphalerite-chalcopyrite contacts were very smooth, while others were very rough and irregular. There were also a few small inclusions of chalcopyrite in pyrite crystals.

Gold - was found in section 3 only. It occurred in quartz, surrounded by small inclusions of chalcopyrite and pyrite.

Chalcocite - occurs as a few very small inclusions in sphalerite only, the sphalerite being massive in each case. The association

here is interesting - no chalcocite was found in masses of chalcopyrite, but there were a few small contacts between the two copper minerals. The largest inclusion found was about 90 microns.

Section 1. Chalcopyrite occurs both as large masses, and as very small particles disseminated through quartz. The quartz occupies almost the whole surface of the section and is massive; being fractured severely in some places. The sphalerite is massive, and contains many small pits.

Section 2. The pyrite occurs mostly as large masses, severely eaten out. The chalcopyrite is finely disseminated through the pyrite and quartz, but a few places showed the massive variety. There were a few very small particles of sphalerite making irregular contacts with chalcopyrite and pyrite.

Section 3. This specimen was by far the most interesting and revealing. Some sphalerite was observed to have replaced massive chalcopyrite in long, lenticular needles, criss-crossed. Fig. 1 shows how the gold particles occurred in this section. Some small inclusions of chalcocite in massive sphalerite are shown in Fig. 2. The pyrite occurs as widely disseminated crystals, usually of the typical square or rectangular section, and the grains have been badly eaten out and pitted. There was very little chalcopyrite in this section; and some of the particles of ^{the} copper mineral filled cavities in pyrite crystals.

Section 4. Pyrite occupied most of this section area and was again disseminated, the grains varying in size. Chalcopyrite occurred as large masses, and showed some very small

inclusions in sphalerite. The sphalerite was of the massive variety, closely associated with chalcopyrite. The section also showed two or three very small inclusions of chalcocite in the sphalerite. Another point noted was that these chalcocite inclusions showed no definite crystal form, all inclusions being quite irregular islands.

PARAGENESIS

Because of the badly fractured quartz and pyrite in most places in the sections it appears that these two minerals were deposited first. In the case of the pyrite, it exhibits its own crystal form as squares and rectangles, and where it has been fractured these fractures have been filled with sphalerite, chalcopyrite and chalcocite. These fractures in the quartz and pyrite are indicative of the fact that there has been severe movement of the ore body after they had been deposited. It also seems apparent that the sphalerite was deposited from its solution ahead of the chalcopyrite, since there is a large quantity of ZnS in this ore at 4000 and 4500 level, but ore from the upper levels of Britannia tend to show less sphalerite, and these levels correspond to the newer portions of the vein.

Since only one occurrence of gold was noticed it is difficult to say when it was deposited from solution, but since it is associated with particles of chalcopyrite near the cavity of quartz in which it lies, this relationship seems to place its deposition as late, probably later than the chalcopyrite.

Contemporaneous deposition of sphalerite and chalcopyrite

was also very common in the specimens, hence it seems that these two minerals were depositing together, probably in the last period of mineralization. Fig. 3 shows an example of this.

Fig. 2, showing the chalcocite, probably shows an example of the exsolution of the copper mineral from the sphalerite. Some of the chalcopyrite being very finely divided through massive sphalerite is probably also an example of exsolution, but the particles of the copper mineral were so small that it was difficult to predict if such were the case. Fig. 4 shows this.

Fig. 5 shows a late deposit of sphalerite and chalcopyrite filling a cavity within a crystal of pyrite, with contemporaneous deposition of chalcopyrite and sphalerite.

Crystals can only grow in their own solution. Hence for example if a complete crystal of pyrite were observed in a massive sphalerite ground mass, the pyrite must have been present first. Likewise if a mineral is fractured, and the fissures filled up with another mineral, the former mineral must have been present first. This vein mineral effervesced with HCl and hence was probably calcite. Fig. 6 shows an example of these conditions of paragenesis.

METALLURGY.

A metallurgical problem arising from these observations is whether or not the sphalerite and chalcopyrite can be separated and both concentrated. Since much of the chalcopyrite is very finely disseminated through the sphalerite, the former is difficult to recover when in that state. As Fig. 5 shows, these two minerals are sometimes deposited in pyrite crystals and here again

recovery is difficult. But there are more cases of the former problem than the latter. Most of these small inclusions of chalcopyrite are no larger than 35 microns, and hence they would require grinding to about -400 mesh to get sufficient unlocking. Whether this grind is economically feasible has not been determined.

Another point to be borne in mind is the fact that the quantity of sphalerite in Number 8 Ore Body is much greater than in some of the ore from the upper levels, which was also examined by the author. Hence this problem of unlocking would seem to be increasing with depth.

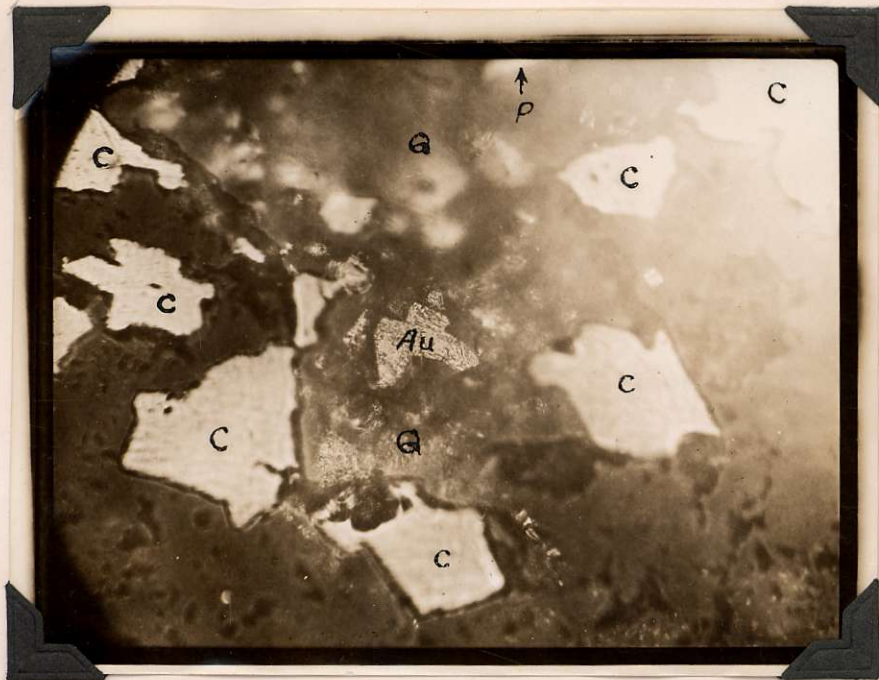
ACKNOWLEDGMENTS.

The author would like to express his sincere thanks to Dr. H. V. Warren, of the Department of Geology, University of B.C., for his very helpful suggestions. Without his cooperation, much of the work of this report would not have been possible.

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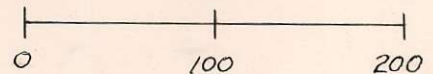
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Microns

Fig. 1.



Showing occurrence of Gold in Section 3. Note association of chalcopyrite and pyrite. The gold appears tarnished because the photo was taken after the gold was etched with KCN.

See p. 14 for legend.

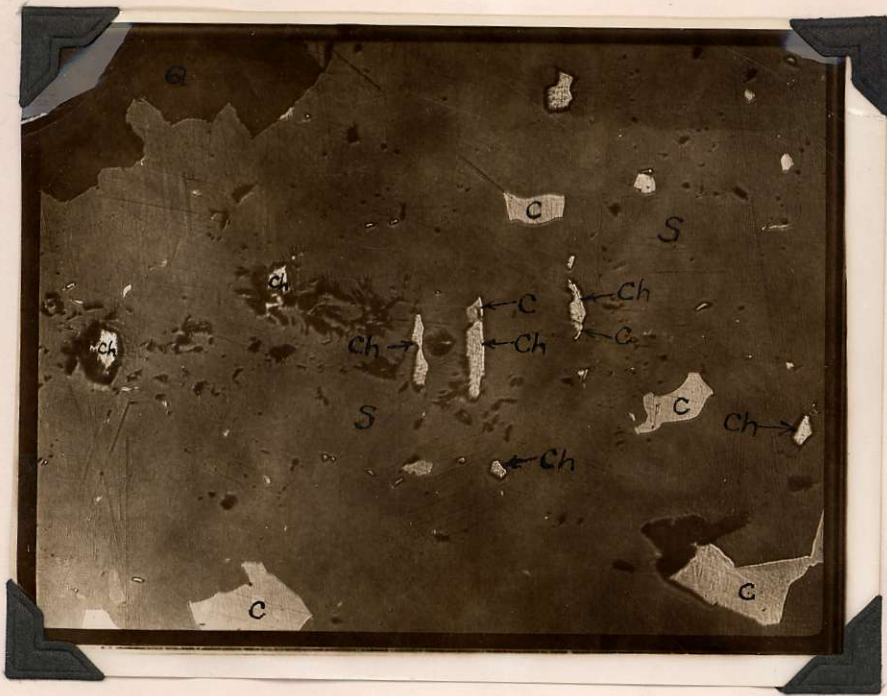
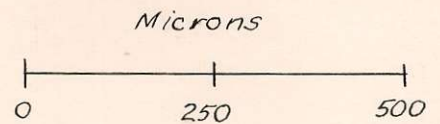


Fig. 2.



Showing occurrence of chalcocite in section 3. Note the association of the chalcocite with sphalerite and chalcopyrite. Probable example of exsolution of chalcocite.

See p. 14 for legend.

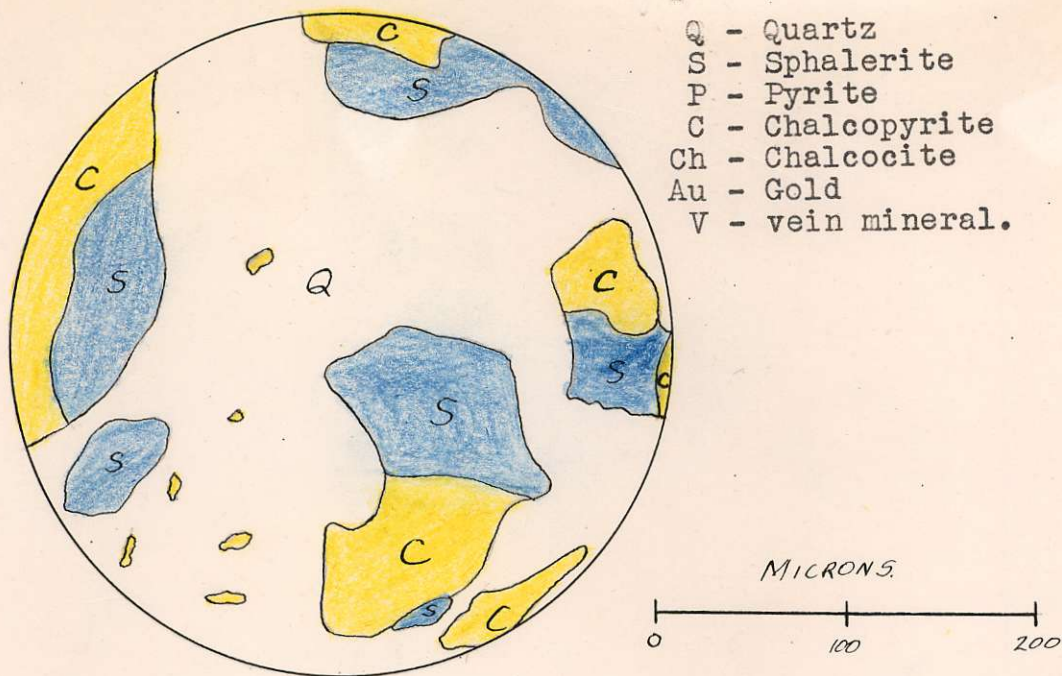


Fig. 3.

Showing contemporaneous deposition of sphalerite and chalcopyrite in section 1. Note smooth contact between the two minerals, and also small inclusions of chalcopyrite in quartz.

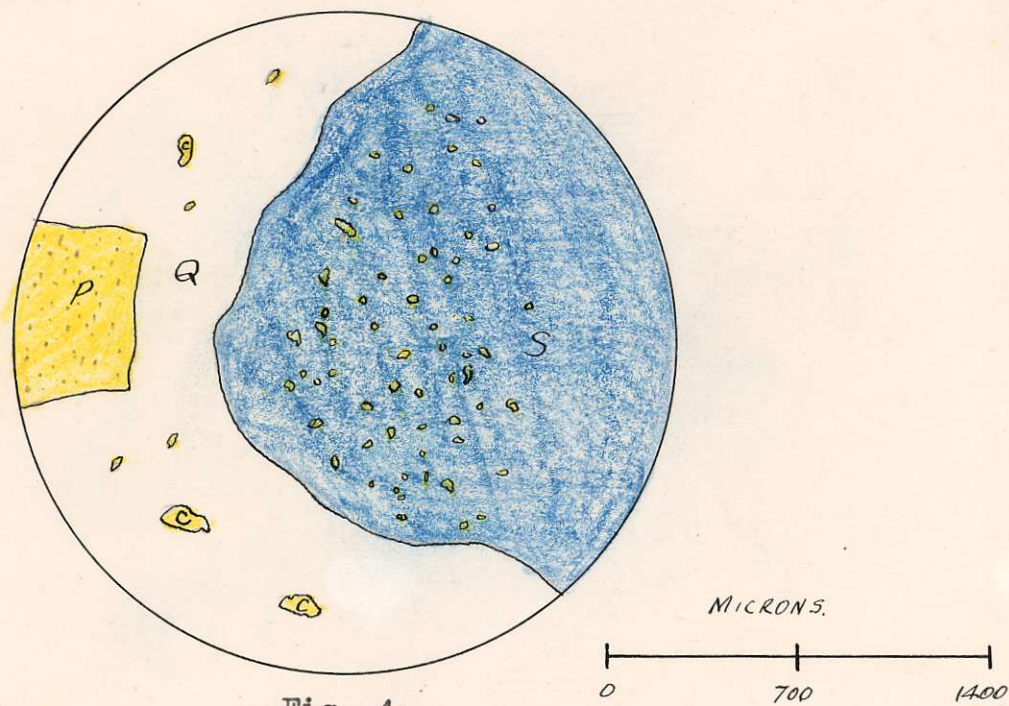


Fig. 4.

Showing probable exsolution of chalcopyrite in sphalerite - note small inclusions of chalcopyrite, and pitted and eaten out surface of pyrite. Section 3.

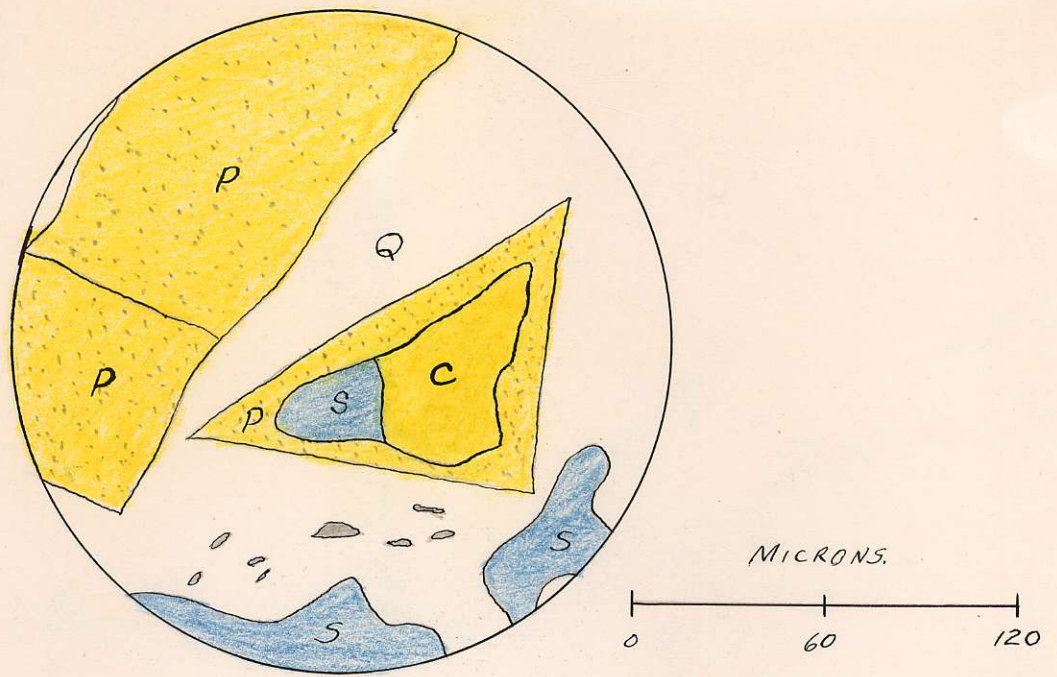


Fig. 5.

Showing deposition of chalcopyrite and sphalerite in cavity of pyrite, deposition being contemporaneous. Note pits in quartz. Section 1.

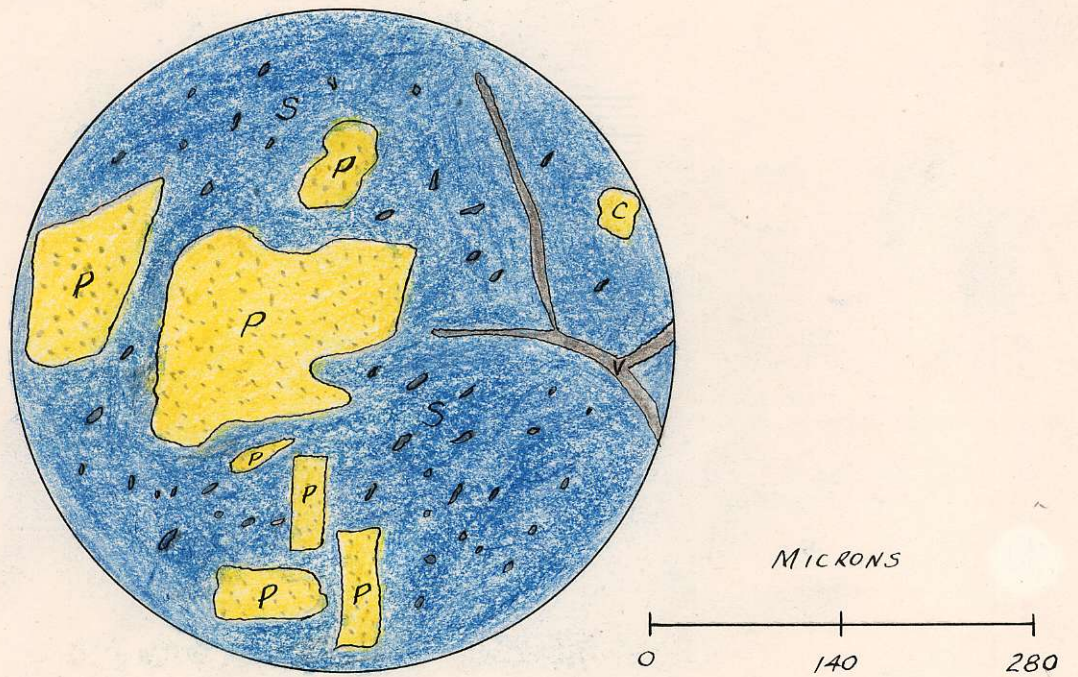


Fig. 6.

Showing pyrite crystals, present first, in sphalerite background, and vein mineral as latest deposit. Note how sphalerite is pitted. Section 1.