A REPORT ON
THE MINERALS AND THEIR OCCURENCE
OF THE
MINTO GOLD MINE, B. C.

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in which is included
a note on
their probable paragenesis.

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by

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University of
British Columbia.

A report on the occurence and paragenesis of the minerals of the Minto Gold Mine, B. C.

1. Introduction.

2. Location of the mine.

3. General geology.

4. The minerals.

5. Examination of sections - with drawings.

6. Paragenesis.

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INTRODUCTION

The preparation of this report comprises the course of Geology 9 at the University of British Columbia. It includes grinding and polishing the sections, and examining them under the reflecting microscope. The work was done at the University under the supervision of Dr. H. V. Warren, of the Geology Department, who supplied the ore samples. The ore examined was from the Minto gold mine in the Bridge River district of British Columbia.

The report is not presented as a detailed geological study of the mine; it is merely a record of observations taken in a microscopic examination of polished sections from a few specimens of the mine ore. Special note is made of compositional and structural associations. The first associations are pointed out;the second serve as evidence in giving a tentative report on the paragenetic relations of the minerals.

Acknowledgement is made to Dr. Warren for his helpfull comment and suggestion; to Gorden Brown, who made several microphotographs of the gold occurences in the ore; and to Gerald H.Gwyn, who has been working independently on this ore,

INTRODUCTION (Continued)

and has fairly definitely identified the mineral, heretofore taken as stibnite, to be an antimony-bismuth telluride, with possibly some gold.

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LOCATION of the MINE

The Minto mine is situated about a mile below the junction of Gun Creek with Bridge River, on the main Bridge River highway. The elevation of the mine is about 2300 feet above sea-level.

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GENERAL GEOLOGY

Information concerning the geology of this property is rather scarce. The regional geology is well recorded in Memoir 2I3 of the Geological Survey of Canada,"Geology and Mineral Deposits of the Bridge River Mining Camp", by C.E.Cairnes; however, although other mines are dealt with in detail, the Minto for some ungiven reason has been entirely omitted.

A short write-up is given in the I933 Report of the Minister of Mines. It is here stated that the general rock formation is the Bridge River Series. The age of this series is Pennsylvanian- Permian. It consists of mainly contorted, thin-bedded, GENERAL GEOLOGY (Cont.)

cherty quartzites separated by thin films of argillite schist, dark colored altered argillites and crystalline limestone lenses with arenaceous schist; other beds are flows of black and green metabasalt. In the vicinity of intrusives the rocks have been metamorphosed to quartz-mica schist, squeezed conglomerate and sandstone, phyllite, talcose, sericitic, and chlorite schists.

The following is a summary of the report given in the I933 Report of the Minister of Mines. It serves to give an idea of the type of occurence, the size, grade and persistency of the ore veins......

The two main tunnels of the mine, the HAGMO and the WARREN follow a pronounced shearing in massive greenstone. This shear-zone has afforded a course for the mineralizing solutions.

The HAGMO, 200 feet above the camp consists of a 75 foot cross-cut to the shear-zone where a small quartz vein is encountered. Drifting on this vein has opened up an ore-shoot nearly 200 feet long averaging 5½ feet wide and with a reported gold content of .40 oz. per ton. One section of 22 feet yielded high gold values. A cross-cut at 390 feet from the portal shows 20 feet of sheared low-grade ore.

GENERAL GEOLOGY (Cont.)

The mineralization is said to consist of arsenopyrite, pyrite and lesser amounts of galena and sphalerite - no mention is made of the chalcopyrite or the Sb, Bi, Au(?) telluride found in the examination on which this report is based.

The Warren tunnel is 100 feet higher than the Hagmo. At the collar of this tunnel the vein width was 5 feet, of which about 50% was quartz. Within a short distance the vein material was all quartz - and continued so the length of the drifting. A sample across the face 35 feet in assayed .40 oz. of gold per ton, and an average assay is reported to run .30 Oz. per ton.

It will be noticed that the amount of metallic mineralization tends to be rather uncertain, the amount of gangue varying greatly. Some of the samples were almost solid arsenopyrite with minor other minerals; others were largely quartz and calcite. An assay of picked ore done by G. E. Gwyn ran as high as 32 oz. of gold per ton; others were much lower.

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The MINERALS

The metallic minerals seen are, in order of abundance, arsenopyrite, pyrite, sphalerite, the previously mentioned Sb, Bi, Au(?) telluride, chalcopyrite, galena, and native gold. Quartz and calcite occur in varying amounts.

Arsenopyrite was, in all sections very much in evidence, ranging from massive material with but little of the other minerals, to scatterings in quartz.

Pyrite was much less abundant and, although seen in all sections, was fairly common in some and almost lacking in others.

Sphalerite was invariably associated with chalcopyrite. It occured in minor quantities.

The Sb, Bi, Au(?) telluride was about as abundant as the last named combination and seems to occur commonly with it. This mineral has been previously taken for stibnite it is thought, but microchemical tests have conclusively shown it to be an altogether different mineral. Tests with nitric acid give a brown black stain, while other chemicals used, HCl, $FeCl_3$, KOH, $HgCl_2$, and KCN are negative. Tests done by G. H. Gwyn have given good reactions for Sb, Bi, and Te, and there may also be some gold in the mineral. He has tentative-

The MINERALS (Cont.)

ly identified it as nagyagite. No stibnite was seen.

Galena was seen only once in the sections examined: however, it undoubtedly occurs in greater amounts elsewhere, having been mentioned in the Report of the Minister of Mines already referred to.

Native gold was seen in several places although repeated sections were cut before it was discovered. It seems to be patchy, and was not seen in many places where the minerals with which it seems to be associated were abundant. It may be that gold, besides occuring in this form, is present in the antimony-bismuth telluride described above.

It should be kept in mind that the relative abundance of these minerals is here arrived at by examination of only a few samples. However, these are thought to be representative, and this order of abundance is probably general -- except for the stibnite which is very likely more common than these observations would lead one to believe.

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EXAMINATION of the SECTIONS- with drawings.

Polished sections of a suite of samples taken from various parts of the mine were examined under the reflecting microscope. Several sections were cut from each and representative drawings made.

It is proposed to deal with the sections individually, giving diagrams and notes on each. Mineral associations and significant structural features will be pointed out.

By doing this it is hoped that the reader himself will be able to obtain a clear idea of the mineral associations and the relative ages from the evidence presented.

Finally, a summary report will be made, conclusions based on the material preceding it. The object of this summary will be to present a suggested paragenetic order of the minerals. The conclusions will be supported by reference to numbered diagrams to illustrate the relative age of each mineral;

All magnifications are 30 diameters.

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406 Stope

Ore from this part of the mine was largely arsenopyrite; with it occured minor amounts of the sphalerite-chalcopyrite combination, Sb, Bi, Au(?) telluride, pyrite, galena, native gold and calcite and quartz.

Veining was very much in evidence and the relative ages of all the minerals was indicated in a single section. The majority of the drawings were taken from this ore.

Sphalerite and the Sb, Bi, (Au) telluride which seem to occur together were much more abundant here than in any other part of the mine represented by samples supplied for this work. The only gold seen was in these samples and showed a close association with the last two minerals.

Associations (A) and structures (B) are shown in the following diagrams.

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A. Associations. There is a noticeable association between telluride, arsenopyrite and native gold, which is shown in Fig. 7. Sphalerite seems to accompany the telluride to some degree.

A. Associations.

406 Stope.

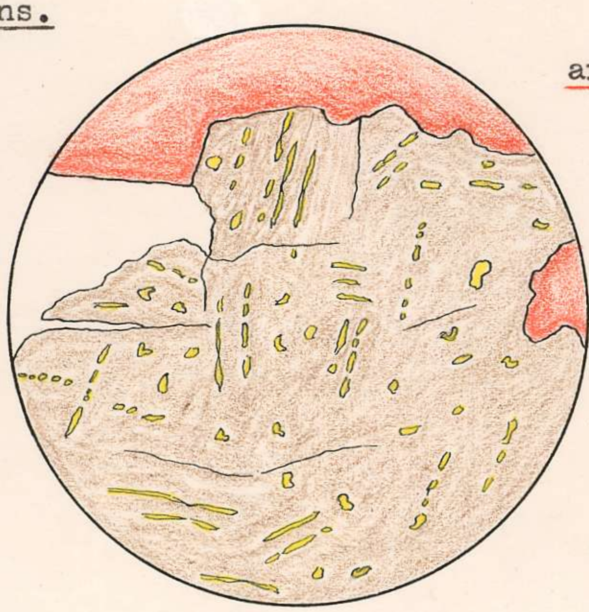

Figure I.

Fig. I shows the invariable presence of chalcopyrite with sphalerite. The chalcopyrite occurs as lines and specks in the sphalerite. The lines are in many cases parallel and the specks commonly form dotted lines. This orientation is very similar to the common granophyric intergrowth of quartz and feldspar in igneous rocks; here the structure denotes simultaneous crystallization, that is the minerals have come out of solution together. An analogy might be drawn here between this phenomenon and the deposition from solution of the sphalerite and chalcopyrite, the solvent in the former being the molten magma and in the second, the mineralizing solution.

In both cases it denotes contemporaneity.

B. Structures.

406 Stope.

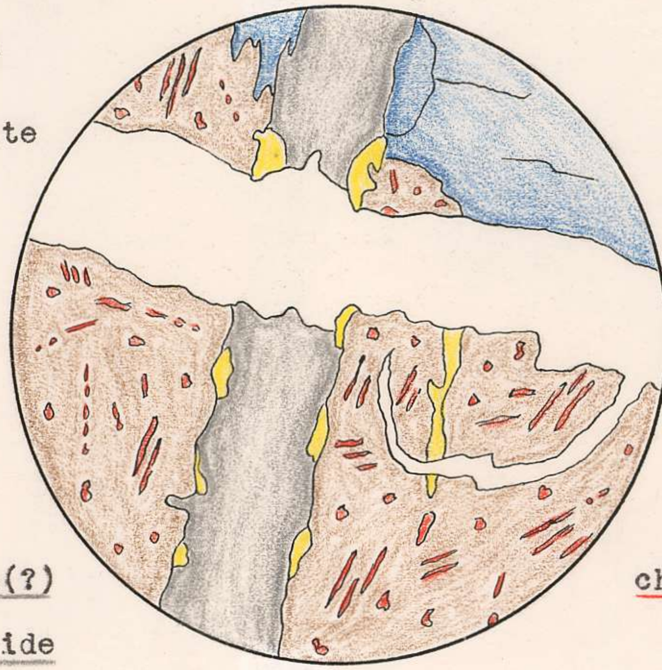

Figure 2.

Fig. 2 shows a telluride vein cutting sphalerite-chalcopyrite and arsenopyrite.

Pyrite fragments occur uniformly along the telluride vein contact and the suggestion is that formerly a vein of pyrite occupied the space later invaded by the telluride.

A rather erratic pyrite veinlet, cut by later calcite is seen to enter the sphalerite.

The calcite cuts across everything and is obviously later than the other minerals.

406 Stope.

Figure 3.

Fig. 3 shows as does Fig. 2 the relationship of the telluride mineral to sphalerite-chalcopyrite and arsenopyrite. It shows very distinct veining and places the telluride as of later origin than the other two minerals.

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406 Stope.

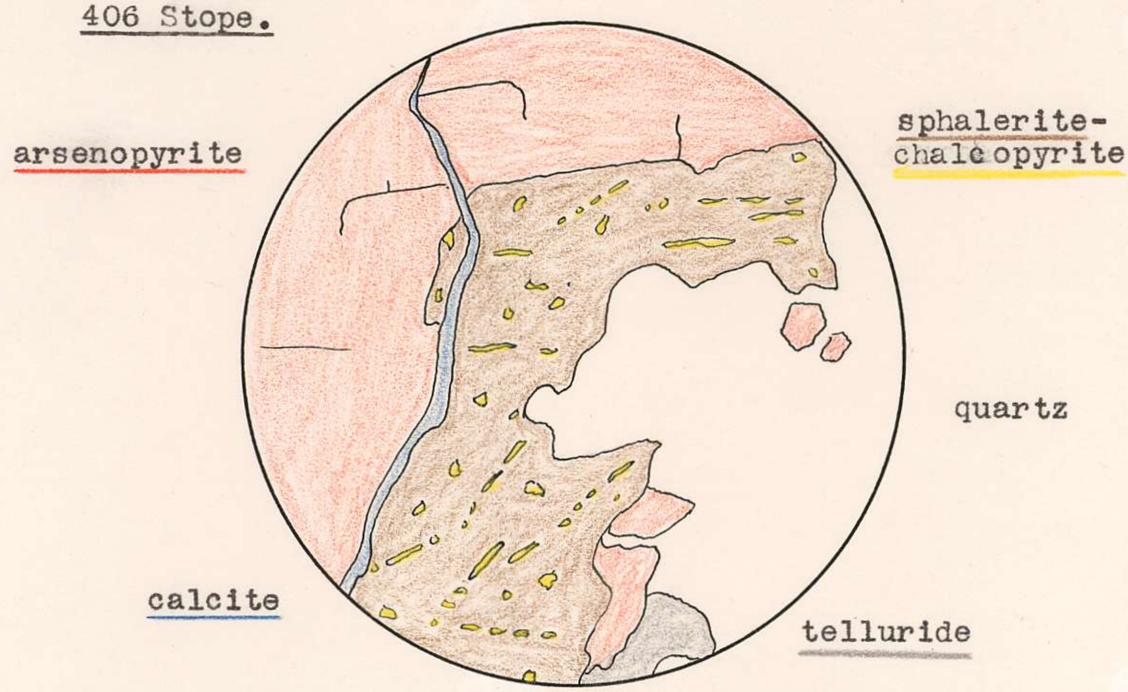

Figure 4.

Fig. 4 shows a characteristic sphalerite-arsenopyrite contact.

Some uncertainty is felt in placing one of these minerals chronologically before the other, but for the following reasons it is felt fairly certain that sphalerite is younger than arsenopyrite.

(1). Arsenopyrite is so very much more abundant than sphalerite that, were it later, it would surely have scattered the sphalerite and would have completely enclosed some of it. As it is, no particles of sphalerite were observed to be completely isolated in this way; neither, however was any arsenopyrite seen completely enclosed by sphalerite.

(2). There is a semblance of continuity of sphalerite particles noticeable on a large scale. This suggests a vein broken up by later minerals; it can be followed for some distance and at times occurs with arsenopyrite on either side as if it might once have veined it.

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406 Stope.

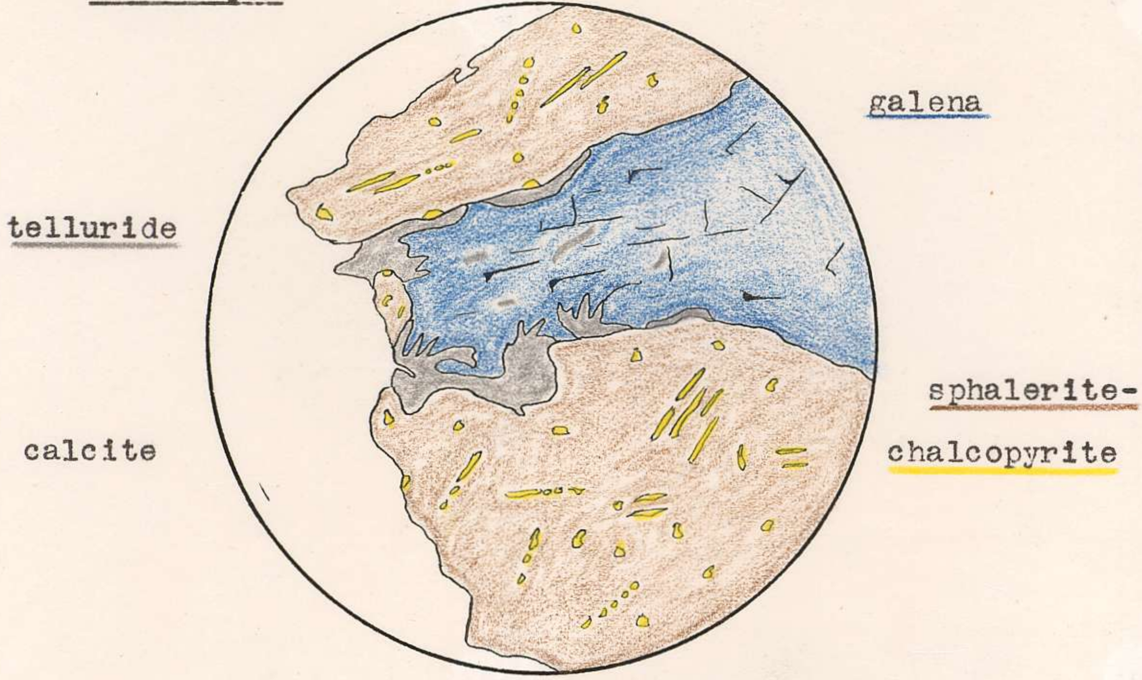

Figure 5.

Fig. 5 shows a portion of the only galena seen in any specimen It is not sufficiently abundant to illustrate its relations to all the minerals in the ore. It appears to have invaded the sphalerite and to be veined by the telluride An etch test brings out a few impurities in it some of which are telluride; others may be sphalerite.

406 Stope.

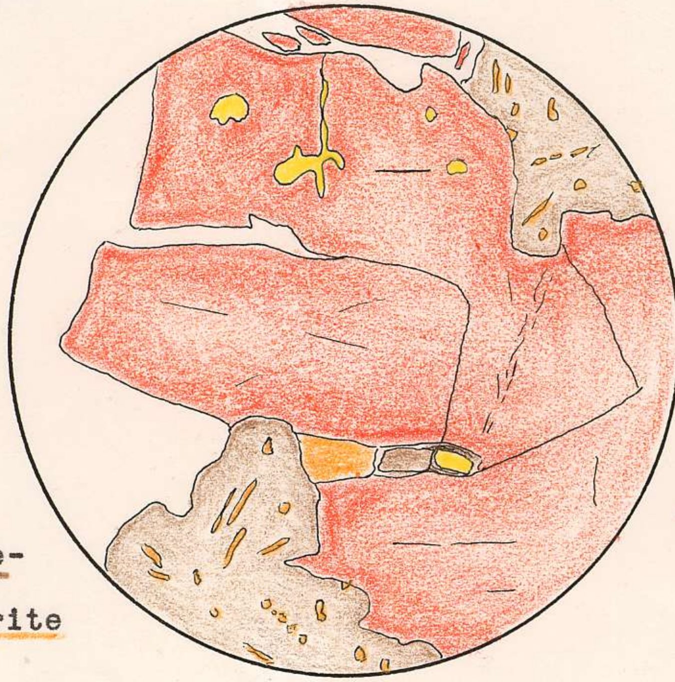

Figure 6.

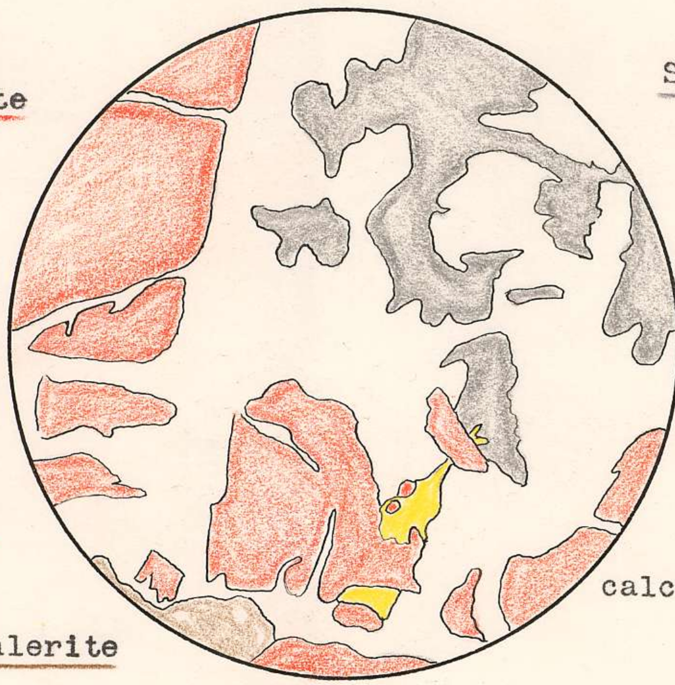

Figure 7.

Figures 6 and 7 may be considered as one; they are immediately adjacent.

It is thought that the presence of the telluride seen in Fig. 7 has considerable significance. All free gold seen was invariably in contact with this mineral or close to it. It is also apparent that the gold in both diagrams is in contact with arsenopyrite; in Fig. 6 it veins and occurs within the arsenopyrite. In another case, not illustrated, free gold was seen within arsenopyrite. This association has been recored from sources outside the Minto, and it is thought probable that the arsenopyrite has to some degree a precipitating effect on the gold-bearing solutions. In this case, another factor undoubtedly had some influence on the deposition; that is, the strength of the arsenopyrite and its ability to hold a crack or fracture.

These probalities help to explain the association noted on page 8 under the heading of "Associations".

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Number 5 Level

In the ore specimens from this region there was considerably more quartz-calcite gangue and the metallic minerals are much more broken up than in others. Quartz and calcite are the only minerals forming veins, and arsenopyrite and pyrite are the only common metallic minerals.

The telluride and sphalerite are practically absent; telluride was occasionally seen as fine shreads or detached particles in the quartz.

No gold or galena was observed.

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#5 Level.

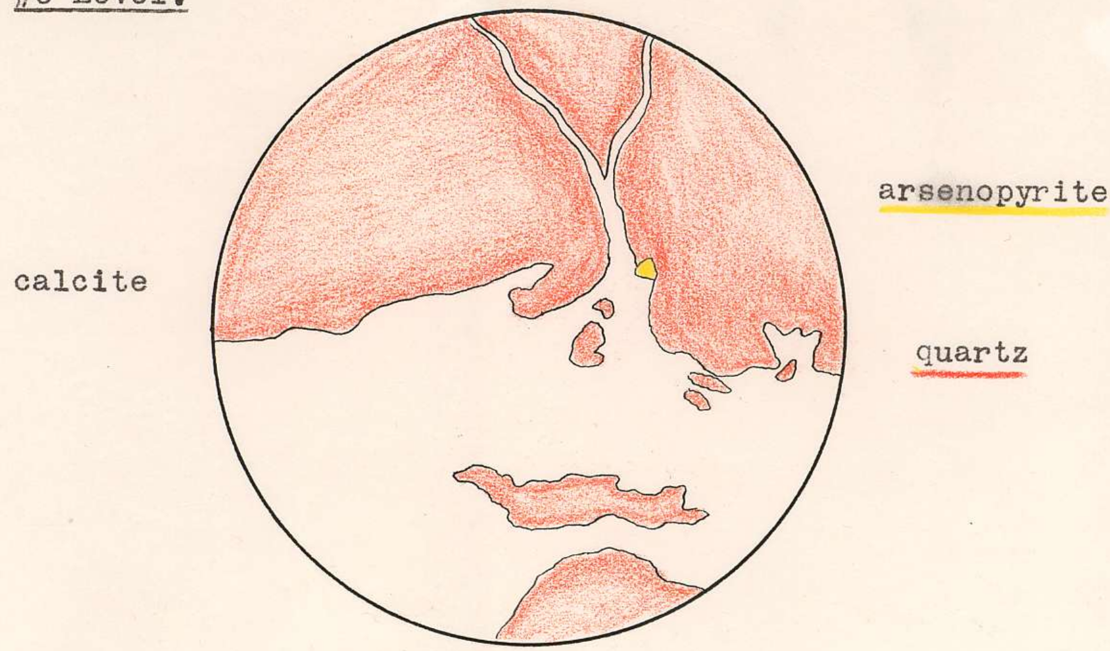

Figure 8.

Shows calcite veining quartz.

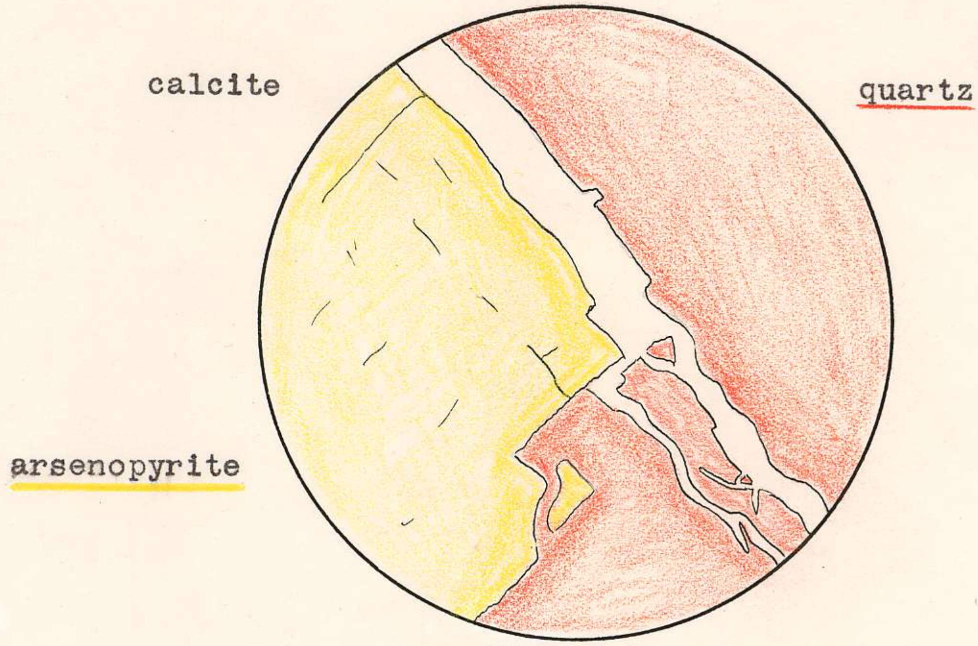

Figure 9.

Shows calcite cutting quartz and illustrates its tendency to follow the contact of this and another mineral.

#5 Level.

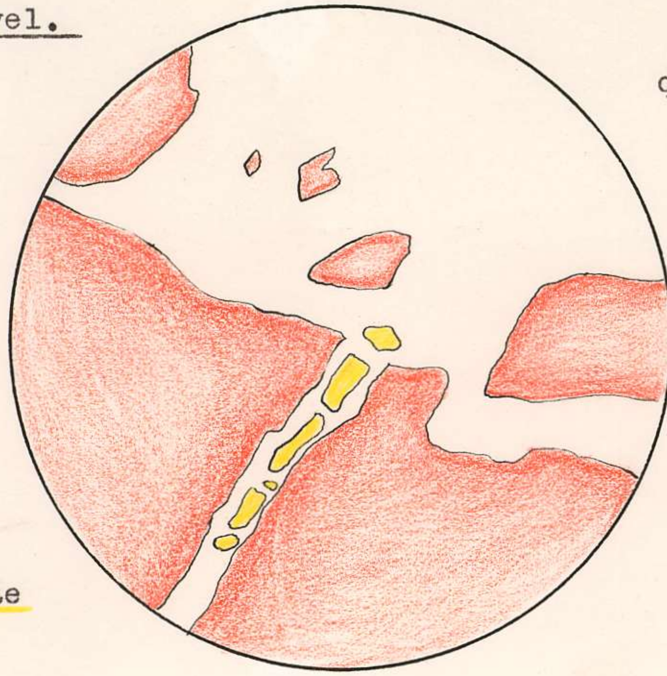

Figure 10.

Fig. 10 shows pyrite in relation to arsenopyrite in such a way as to suggest a vein. The pyrite vein(?) has been followed by quartz and although broken up can be imagined as having definitely cut the arsenopyrite at one time.

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Number 4 Level

Ore samples from this level were almost solid arsenopyrite and were reported to run as high as 14. oz. of gold per ton.

No native gold was seen although several sections were cut. Bearing in mind the telluride-arsenopyrite-native gold association noted elsewhere, and as very little of these minerals were seen, this is what might be expected. However as previously pointed out, the values appear to be rather uncertain and it is quite possible that the gold was missed in the sections cut.

It was seen in ore from 406 stope that the gold was commonly in contact with arsenopyrite, was in one case in this mineral(Figures 6 and 7): however, the telluride mineral was always close by. In Number 4 level ore, although very little telluride was seen, the gold, if it was there, may have been with either of these two minerals in such a fine state as to be beyond the range of the microscope used.

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4 Level.

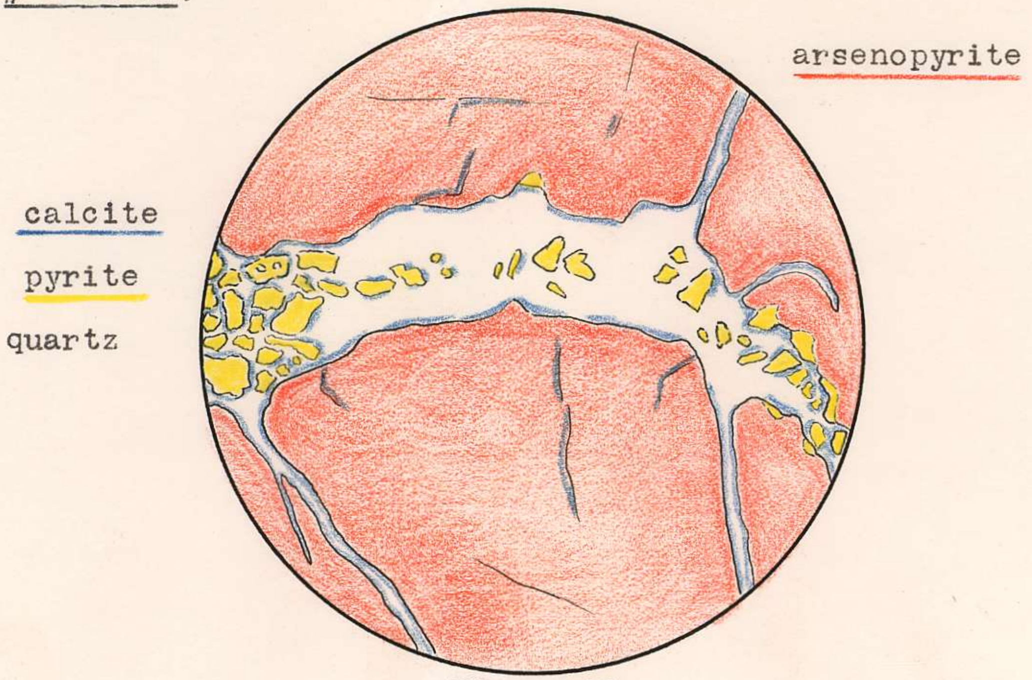

Figure 11.

Fig. 11 shows a quartz- calcite vein cutting arsenopyrite. A considerable number of pyrite fragments occur in the quartz and along the contact and the suggestion is, as in Fig. 10, that this may indicate a previous pyrite vein. It will be noticed that a number of the particles of pyrite are in direct contact with the arsenopyrite. They occur as embayments and the two minerals seem to blend into one another, the contact is so close. The pyrite seems to have replaced the arsenopyrite to some extent. The fragments in the quartz are typically anhedral and uneven.

Calcite occurs mostly at the contact of the quartz with the other minerals, and in the fine cracks in the arsenopyrite.

4 Level.

Figure 12.

Fig. 12 shows a common occurence of the telluride mineral in quartz. The telluride is very ragged and indented and several particles are separated from the main vein-like mass by quartz. Its form here is totally different from that in the other minerals which it is seen clearly to vein; there it is unbroken an can usually be traced until it thins and pinches out, showing evenly curved boundaries along its length.

It is thought possible that its occurence in quartz is as inclusions, rather than as veins or replacements.

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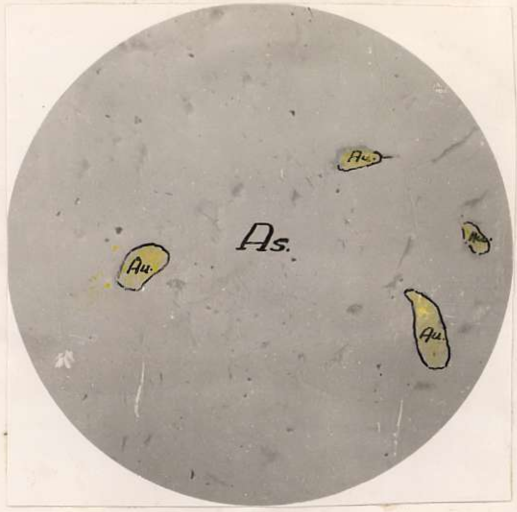
Addendum.



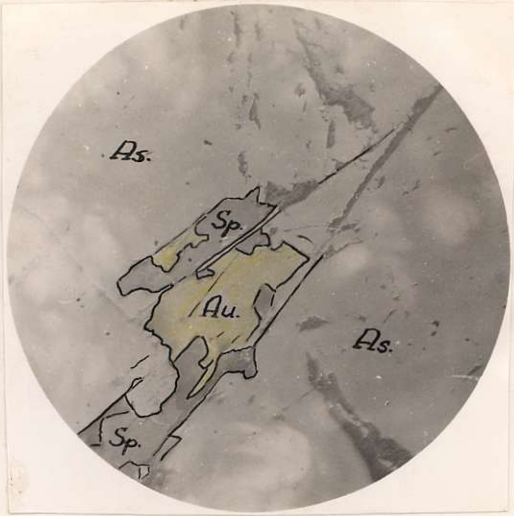


Plate I. Plate II.

The two attached microphotographs give actual views of the gold occurences seen under the microscope. The magnification is about 270 diameters.

Plate I shows gold within arsenopyrite; just beyond the limits of the photograph gold occured as clear veins in the arsenopyrite (Fig. 6). Also outside the photograph and not in contact with, but close by the arsenopyrite was a fairly large particle of telluride mineral.

Plate II shows gold veining sphalerite in a crack in arsenopyrite.

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PARAGENESIS

The probable chronological order of deposition of the minerals, from the oldest to the latest is,

1. Arsenopyrite.
2. Sphalerite and Chalcopyrite.
3. Pyrite or Galena.
4. Sb, Bi, Au(?) Telluride and probably Native Gold.
5. Quartz.
6. Calcite.

The relation of arsenopyrite to most of the other minerals is quite clear. Fractures and cracks in this mineral contain definite veins of telluride, quartz and calcite. The relative ages of arsenopyrite, sphalerite-chalcopyrite and pyrite are less obvious but are thought to be correctly placed in the above list. Minerals veining arsenopyrite are shown in Figures 2, 3, 6, 10, 11.

Sphalerite and chalcopyrite are contemporaneous; one never occurs without the other, and they have apparently been deposited from the same solution. (Fig. 1)

The relation of sphalerite-chalcopyrite to arsenopyrite is not positive. However, as pointed

Paragenesis (Cont.)

out in notes accompanying Fig. 4, there is a semblance of continuity in the sphalerite which can be traced over a distance. Considering the observations set down in these notes it is thought with some degree of certainty that sphalerite is later than arsenopyrite.

Whether pyrite or galena comes next in the sequence is not known. Galena was not seen in sufficient quantities to give any clue to its exact age. Fig. 5 shows it apparently cutting sphalerite and containing veins of telluride. It has been placed as younger than sphalerite and older than the telluride; its relation to pyrite could not be seen.

Fig. 2 shows pyrite cutting sphalerite; this occurence is the only evidence on which it is concluded to be later than sphalerite. In no other place was such a vein seen, the pyrite as a rule being fragmental. Figures 10 and 11 show pyrite in cross-cut relation to arsenopyrite.

In placing the telluride mineral a little hesitancy is felt, due to the fact that its occurence might be interpreted in two ways. It appears at times as apparent inclusions in quartz in the form of wisps or shreds; elsewhere, its form

Paragenesis (Cont.)

resembles a vein, although very irregular. There were not seen any well defined veins as in the other minerals. Had the telluride been later than the quartz it seems reasonable to expect clear-cut veins in the cracks or fractures which must have existed to allow the passage of the later calcite solutions and the subsequent formation of the calcite veins. (Figures 8 and 9) It has been seen that pyrite maintained the appearance of a vein while enclosed in later quartz (Figures 10 and 11) and it is probable that the telluride is a similar occurence. It is a very soft mineral and tends to be indented by a needle drawn across it rather than to flake off; having these physical properties, it would feasibly hold together better under strain or movement than would the more brittle pyrite. Considering this, its occurence as ragged, partly broken, indented and abruptly terminated vein-like masses, and as isolated drawn out fragments is reasonable. For these reasons it has been placed before quartz. However, it may be a later replacement.

Quartz (probably) and calcite were the last to be deposited, with calcite coming in probably

Paragenesis (Cont.)

with, and certainly later than the quartz. In some cases they appear to be rather intimately intergrown, and it was noted that a surface which was to all appearances quartz (tested by hardness) would often when treated with HCl give off gas. This may have been due to a primary mixture of the two or to calcite deposited in minute cracks in the quartz. In some sections examined calcite was seen to vein the quartz, (Figures 8 and 9) and is here obviously later. In most cases where only quartz was visible an acid test showed the presence of calcite at the contact of quartz with the other minerals (Fig. 11); in similar instances calcite was seen to occupy tiny cracks in the arsenopyrite and other minerals where no quartz had penetrated. In these last cases the calcite probably came in in a highly tenuous solution, invading the quartz contacts and penetrating beyond into tiny cracks past the limits of the quartz; in other cases it formed substantial veins in quartz (Figures 8 and 9) and in other minerals (Figures 2 and 4).

Native gold is seen veining sphalerite(PlateII) but structural relations with other minerals are lacking. However, because of its frequently noted association with the telluride mineral it is thought

Paragenesis (Cont.)

to be contemporaneous with this mineral.

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