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MINERAGRAPHIC REPORT ON THE NICOLA AND OLYMPIC PROPERTIES

by

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REPORT ON THE MINES AND METALS

OF THE

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NICOLA MINES AND METALS.

INTRODUCTION.

This property is on Stump Lake, 30 miles south of Kamloops in the Nicola Mining Division. It is one of the oldest properties in British Columbia, having shipped ore in 1890 to the smelter at Swansea, South Wales. The valuable minerals are silver and gold. Discontinuous operation at the property has been carried on since about 1885. Recently the company has been reorganized with resulting litigation which makes information difficult to obtain. In 1933 two shafts had been sunk, that on the Joshua vein being the deepest at 550 feet. A winze on the Enterprise vein was down to 440 feet and several thousand feet of tunnels, crosscuts and drifts had been driven on the several veins.

GENERAL GEOLOGY.

The ore bodies are found as numerous veins and shear zones in a dark green diabase porphyrite and some tuffaceous sediments.(1) These veins are considered by Camsell(2) to be of a type that have been formed at an intermediate depth by ascending thermal waters, probably in genetic connection with an area of Jurassic granites lying to the westward of Stump lake. Richmond(3) has noted a banded structure in the quartz

(1) Dawson - G.S.C. Ann.Rept. 1894, p.333B.
(2) G.S.C. Summ.Rept. 1919, part B.
(3) Minister of Mines Rept. 1933, p.178.

and crushed quartz, sheared and pyritized country-rock and altered dyke matter in shear zones and veins which he ascribes to intense faulting and warping. He also observed that such faulting and warping of the veins was accompanied by better values and widths of veins. The average vein width varies from 10 inches to 5 feet, with some splitting and associated stringers.

Camsell observed the following minerals in the vicinity of Stump Lake: pyrite, chalcopyrite, galena, sphalerite, jamesonite, tetrahedrite, quartz and calcite. His provisional paragenesis shows quartz deposited first, followed by pyrite, sphalerite, tetrahedrite, chalcopyrite, galena and calcite, in that order.

ACKNOWLEDGMENTS.

The writer wishes to express his appreciation to J.M. Cummings for assistance in micro-chemistry and in micro-photography. Dr. Warren supervised the microscopic examination and his suggestions on the subject were of great value. Assay results were obtained through the courtesy of J.M. Black and J.M. Cummings.

MINERALOGY.

Megascopically the ore shows a decidedly homogeneous dissemination of sulphides in quartz, this dissemination continuing with decreasing amounts of sulphides into the greenish country rock along the vein wall. The ore is very compact and the specimens examined showed singularly little fracturing in view of Richmond's observation on the intense warping and faulting. The rack with its metallic disseminations, principally pyrite and galena, is included as small lumps, whose maximum size could not be determined, in the quartz of the vein. This has in places lent a greenish tinge to the quartz. The following metallic minerals in the order of their abundance were megascopically determined, with the exception of the last which could be sean only under the microscope.

Pyrite
Sphalerite
Galena
Chalcopyrite
An undetermined grey mineral.

The major gangue mineral was quartz, of the white milky variety. No calcite was seen in the specimens examined. The rock, which might also be considered as gangue, was undetermined but was green, soft and generally resembled serpentine.

Pyrite. This ubiquitous mineral was found invariably as small well-crystallized grains, scattered through the quartz, rock and less commonly among the other sulphides. It was found to contain frequent minute inclusions of quartz and the other common sulphides. Excellent, almost rectangular striations were noted in one or two sections. It was commonly much fractured, the fractures being healed with quartz and occasionally with the other sulphides. It was frequently noted as inclusions in quartz and the other sulphides, such inclusions being both fragments and well-formed crystals. Finally it may be said to be the most prominent and well distributed metallic mineral, giving its typical yellow colour to the ore. A study of the various slides left a general impression that the majority of the pyrite tends to be segregated from the other sulphides and to occur as clusters and disseminated and fractured crystals in the quartz and as single crystals in the rock.

<u>Sphalerite</u>. This mineral differs from the remaining sulphides in its occurrence in large blebs up to $\frac{3}{4}$ inch in diameter in the specimens examined. It is also present disseminated in small grains in the country rock. It contains invariably small scattered and rounded to elongated inclusions of chalcopyrite. Upon these inclusions in a few instances, it exercises a noticeable control, the chalcopyrite being then found in approximately parallel but discontinuous lines of blebs at roughly 60° to each other. When this control is exercised, the inclusions tend to be elongated in the direction of the lines. This would appear to be due to either the isometric-tetrahedral crystallization or the duodecahedral cleavage. Sphalerite is commonly intergrown with chalcapyrite

and galena, and is also found as rare inclusions in the galena but never in the chalcopyrite. It was also noticed that the sphalerite contained some inclusions of galena and pyrite.

Galena. This mineral is generally present in irregular anhedral blebs but occasionally is found in subhedral masses. It is most closely associated with chalcopyrite, the two minerals nearly always being found together. It was present as inclusions in the undetermined mineral and commonly in the sphalerite. It was also occasionally noted disseminated in the country rock. In section #3 it is found as stringers in the quartz, which would suggest previous deposition of the latter. Galena definitely fills fractures in the pyrite, and shows a tendency to vein the sphalerite. The characteristic triangular pitting is very prominently shown in most specimens.

Chalcopyrite. Chalcopyrite appears entirely as anhedral masses and blebs. Probably its most common form is in characteristic blebs in the sphalerite, but it is fairly common in larger masses. These are usually associated with galena and sphalerite and are found along the contact of the latter two, in one instance forming a continuous band separating them. It tends to be intergrown with galena and occasionally appears as inclusions in the latter. Inclusions in chalcopyrite are very rare, and when found are always small grains of galena.

Undetermined Grey Mineral. The following results of etching tests are given, and with the exception of the hardness which is definitely higher than that of galena, sphalerite or chalcopyrite, they would indicate stibnite.

Hardness - 5

HNO_3 - faint fume tarnish

HCl - negative

KCN - iridescent stain and slight yellow deposit

$HgCl_2$ - negative

$FeCl_3$ - negative

KOH - brown stain with yellow precipitate.

The mineral occurs in only two sections in quantities insufficient for microchemical tests. It is associated in both occurrences with galena and chalcopyrite along their contact with the sphalerite. One occurrence (illustrated in sketch #1) shows partial inclusions of galena, chalcopyrite and quartz.

Quartz. Quartz forms the main filling of the vein and is present in slightly greater quantity than that of the combined sulphides and included rock. It appears to have filled all the crevices and interstices in the vein. It is somewhat fractured and, in section #3, stringers of galena through it appear to vein it. It is typically milky white in colour and commonly anhedral. Also in section #3, good examples of anhedral quartz crystals were found surrounded by galena and chalcopyrite.

Paragenesis.

The following list of minerals is in the order in which they are considered by the writer to have been deposited. It will be noted that this order differs in one instance from that of Camsell.

Pyrite

Quartz

Sphalerite

Grey mineral

(Chalcopyrite
(
(Galena

Despite the fact that the various sections show nearly all the minerals in contact, little definite indication of a definite order of deposition of the minerals was observed. Undoubtedly pyrite was deposited first as its fractures are healed by most of the other minerals, including quartz (see illustration #2). Quartz is considered to be next deposited, principally on evidence in section #3 (see illustration #4). Fractures in the quartz are much fewer than in pyrite and are apparently healed by galena, and well-shaped crystals of quartz are found in the galena. As the galena and remaining sulphides appear to be nearly contemporaneous, quartz is placed ahead of them. The undetermined mineral is tentatively placed ahead of sphalerite on account of its distinct veining (see illustration #1) by chalcopyrite. Sphalerite has inclusions of both galena and chalcopyrite, but the latter two are found most commonly around its edges and so appear slightly later. Chalcopyrite and galena are always present together and appear to be contemporaneous.

DESCRIPTION OF SECTIONS.

Nicola #1. This slide presents an excellent general sample of the ore. All the minerals are present, the undetermined one in only one small mass. Veining of the pyrite is shown, and the intergrowth of the sphalerite, chalcopyrite and galena. It will be noticed that the pyrite appears to be more fractured than the quartz. No rock is present in this slide.

Nicola #2. This slide shows excellent examples of other sulphides and quartz healing the fractured pyrite (illustration #2). It was also in this slide that the best showing of the undetermined mineral was seen (illustration #1). This showing was obliterated by subsequent polishing. The sphalerite is not as well developed in this section as in the others. Excellent striations of pyrite may be noted in one or two places under a thin film of quartz.

Nicola #3. This slide is of particular interest for its occurrences of quartz and galena. The quartz is but little fractured but where fractures do occur they appear to have been filled by galena. Quartz inclusions in galena show good hexagonal crystals.

Nicola #4. The control of the sphalerite on its chalcopyrite inclusions is best shown in this section (photograph #1). All the minerals identified are present, and appear in their most characteristic form. The country rock is also present with its disseminated mineralization.

Nicola #5. This section was included because it shows interesting relations of galena veining sphalerite. The large size of the sphalerite mass is typical of the ore, as is the rock inclusion also shown.

Two other sections were made but failed to show any fractures not present in the five sections described.

INVESTIGATIONS FOR ORE-DRESSING.

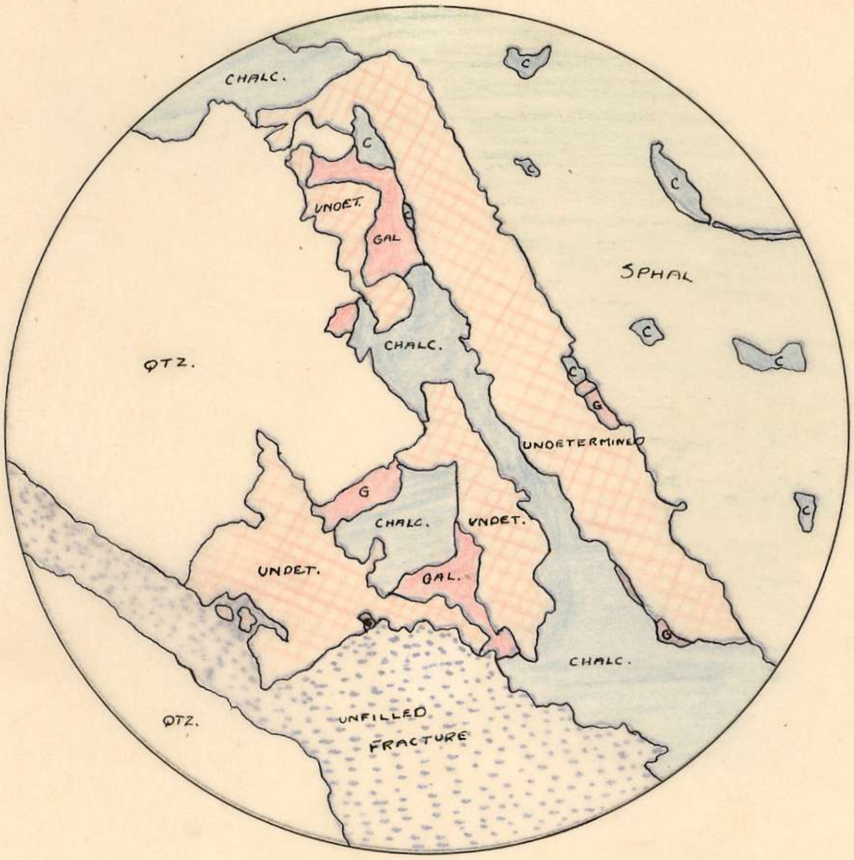
This section was added to the report to demonstrate the possibilities of applying mineragraphy to the problems of ore-dressing. By use of a micrometer eye-piece the average size of grain was determined for pyrite. The application of similar determinations for the other sulphides would be very difficult owing to their lack of crystallization and intricate intergrowth. Average size of grain for sphalerite was measured megascopically, as a very large proportion of the mineral could be recovered if the ore was broken to the size of these larger blebs. It is the opinion of the writer that it would be comparatively simple to unlock the sulphides from the quartz by breaking to the average size of pyrite. Preferential flotation could then be employed to separate the sulphides from the quartz and the pyrite from the other sulphides. If sphalerite proved to be the important mineral it would be sufficient to break only to the size of its larger grains. It would, however, be largely contaminated with all the other minerals.

Results. Pyrite - 70 determinations - Average size 0.48 mm. maximum grain 1.7 mm. Minimum grain 0.05 mm.

Sphalerite - 10 determinations - Average size of larger masses 7.85 mm.

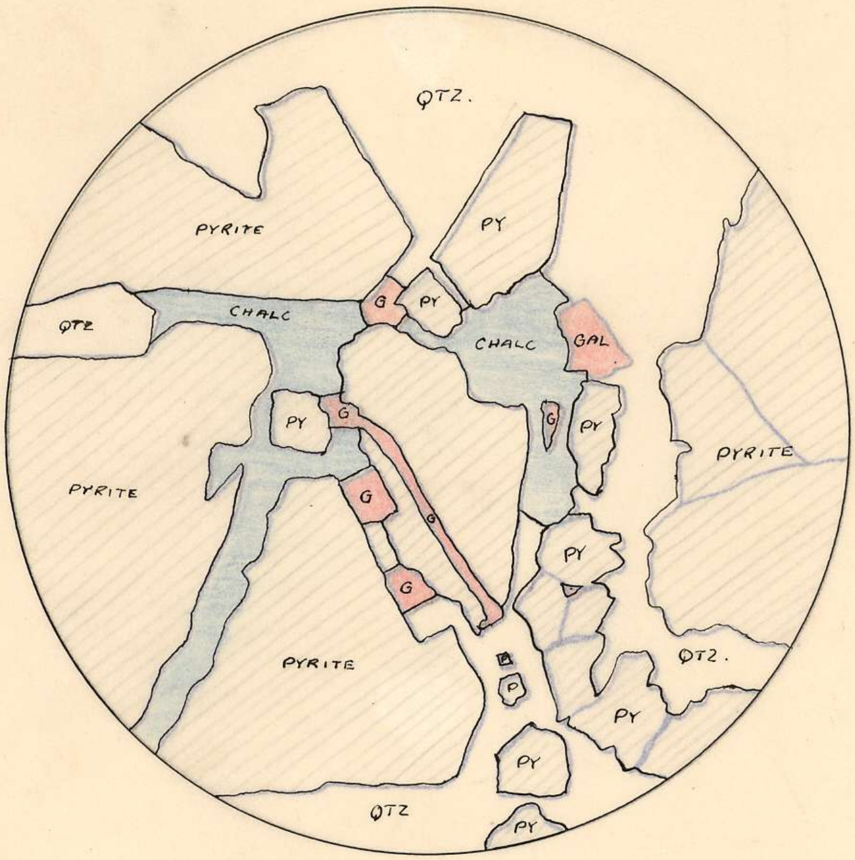
A more practical method would be to break the ore to various sizes and then pass it through a nest of screens of decreasing mesh. The products from the various screen sizes could then be examined under the microscope for their average content of the several minerals. This method would allow for vagaries of breaking under practical conditions, which in an ore as compact as this could not be estimated.

Nicola
Illustration #1
Mag. 360 x



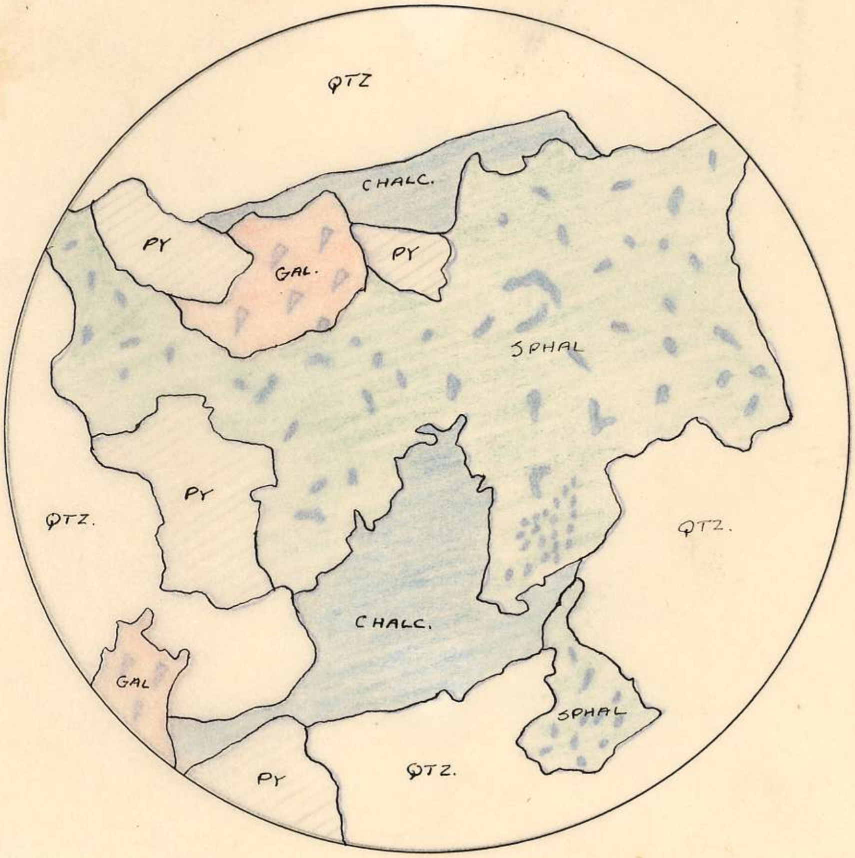
From slide #2 showing the largest occurrence of the undetermined mineral and its association with sphalerite, galena, chalcopyrite and quartz.

Nicola
Illustration #2
Mag. 50 x



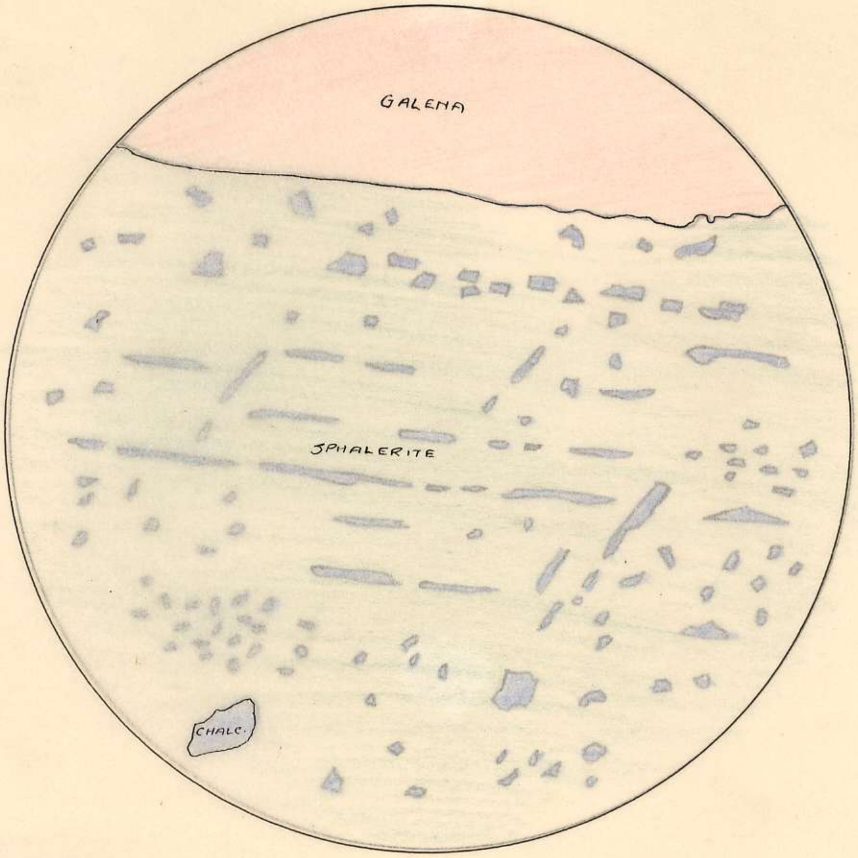
From Section #2 showing fractures in pyrite filled by chalcopyrite, galena, and quartz.

Nicola
Illustration #3
Mag. 50 x



From slide #1 showing the general relationship of the sulphides.

Nicola
Illustration #4
Mag. 360 x



From section #4 showing the control of the sphalerite over its chalcopyrite inclusions.

THE OLYMPIC PROPERTY.

This report is appended to complete the description of laboratory work done in the past year but is secondary to the foregoing one. Results obtained in the laboratory will be described as briefly as possible, as H.W. Smith has made a complete report on the ore, and reference is made to his report for geological descriptions, etc.

MINERALIZATION.

Samples of the ore examined represented only parts of one vein on the property and did not include all the minerals previously identified. These samples were silver-grey in colour with a few black masses of sphalerite up to one inch in diameter. They were massive and tough but showed much fracturing under the microscope and corresponding friability in hand specimens. Minerals identified in the approximate order of their abundance were: arsenopyrite, quartz, sphalerite, pyrite, chalcopyrite, galena, and tetrahedrite (?).

Arsenopyrite. In poorly crystallized agglomerates forming the bulk of the specimens and as veins in the sphalerite. Much fractured.

Quartz. Filling all the interstices, shows considerable fracturing. Thought to be of two generations, one veining the pyrite and arsenopyrite and as hexagonal crystals in galena (illustration #3), the other filling the rest of the vein -

fairly well fractured.

Pyrite. In rather poor crystals - much fractured, tending to be segregated from the rest of the sulphides except arsenopyrite.

Chalcopyrite. In large anhedral masses, also in anhedral to subhedral particles in the sphalerite.

Sphalerite. In large anhedral masses, veined by tetrahedrite and apparently arsenopyrite (illustration #1). Contains many inclusions of chalcopyrite over which it shows some cleavage control. Veined also by chalcopyrite and quartz.

Galena. In anhedral masses with occasional crystal faces - appears to have flowed round the other sulphides. As inclusions in sphalerite.

Tetrahedrite (?). As veins and agglomerates in sphalerite and less commonly in chalcopyrite. This mineral was indicated by etch tests, with a confirmatory micro-chemical test for copper (Photograph #1).

PARAGENESIS.

The order of deposition of the minerals was very doubtful, but appeared to be as follows.

1. Pyrite
2. Arsenopyrite
3. Quartz
4. Sphalerite
5. (Tetrahedrite
(Chalcopyrite
(Galena
6. Quartz

The pyrite and arsenopyrite were probably deposited first as they tend to show crystal faces. The remaining sulphides appear to be intergrown, sphalerite containing inclusions of chalcopyrite, galena and chalcopyrite. Apparent replacement of arsenopyrite by sphalerite is shown in illustration #2 and arsenopyrite cut by quartz in illustration #1. Quartz was found veining arsenopyrite and forming a thin film between it and quartz of a slightly darker colour. It also appeared as crystals in galena (illustration #3) and so one generation was placed before the group with which galena is thought to be contemporaneous, and the other which appears to fill fissures between all the sulphides is thought to have come in after it.

DESCRIPTION OF SECTIONS.

Section #1. This proved to be the most interesting section polished. It shows the tetrahedrite veining the sphalerite and the arsenopyrite either veining or replaced by the sphalerite (illustration #1). Possible replacement of arsenopyrite by sphalerite is shown also (illustration #2).

Section #2. This section was polished to gain more tetrahedrite, which is present in it. Its principal minerals are arsenopryite and sphalerite with smaller quantities of all the others.

Section #3. Shows the pyrite and chalcopyrite in larger quantities. From this section the illustration (#3), showing quartz crystals in galena was made.

<u>Section #4</u>. This section shows the relations between chalcopyrite, pyrite, galena, arsenopyrite and quartz.

Three other sections were made but were not considered to be worth including in this report as they showed no features of interest.

ASSAY RESULTS

These results are added here as they were not available when the report was written.

Nicola.

Mixed sulphides and quartz (middling)	0.56 oz./ton.
Pure pyrite	0.60 oz./ton.
Pure sphalerite	0.20 oz./ton.
Pure galena	0.24 oz./ton.

These results are too incomplete to draw any inferences from them, other than that the gold appears to be largely associated with pyrite. The other sulphides are slightly auriferous, and it might be considered that the gold was approximately contemporaneous with them, but tended to be deposited on the pyrite which was already crystallized.

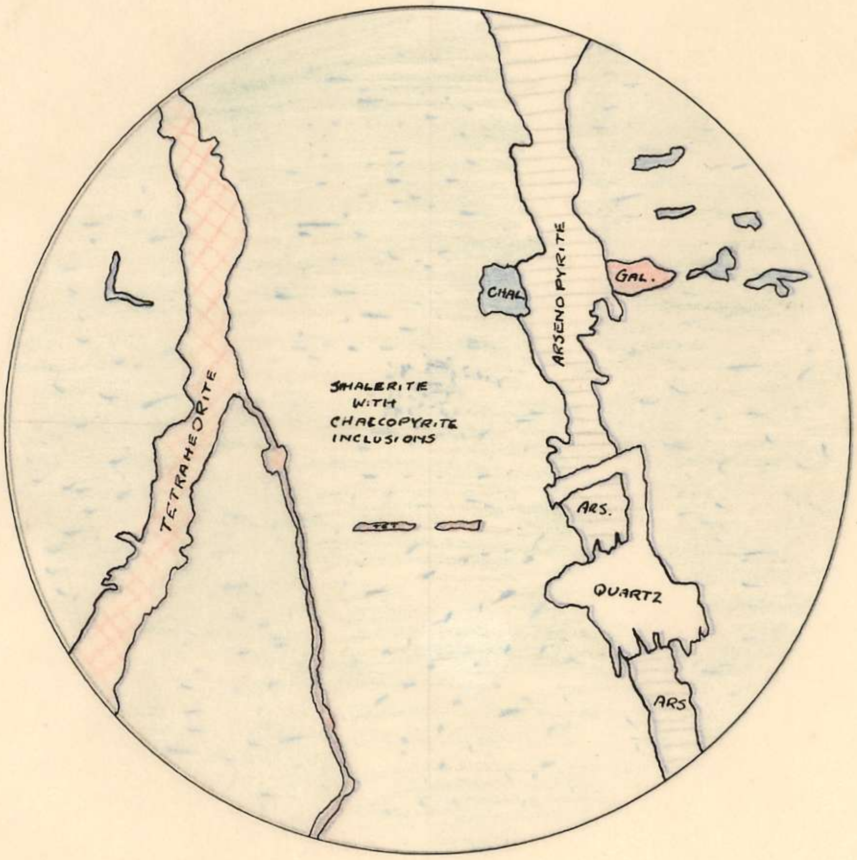
Olympic.

Ore +4 mesh	0.18 oz./ton.
Ore -40 mesh	0.28 oz./ton.
Pure arsenopyrite	0.50 oz./ton.
Pure arsenopyrite with quartz	0.50 oz./ton.
Pure pyrite	0.10 oz./ton.
Pure pyrite with quartz	0.20 oz./ton.
Sphalerite with quartz	0.10 oz./ton.

These results indicate that the gold values are higher in the fine material. This in turn may be considered to mean that the gold occurs on the crystals rather than in them and is thus higher where there is more crystal face per unit weight of sulphides.

The gold is probably contemporaneous with the sphalerite, chalcopyrite, etc. and appears to have been deposited on the earlier minerals, apparently favouring the arsenopyrite to the pyrite. It is noticeable that in the pyrite and arsenopyrite, values tend to be high in proportion to the sulphide present when quartz is also present. This appears to indicate that gold is slightly more concentrated on the sulphide quartz contacts.

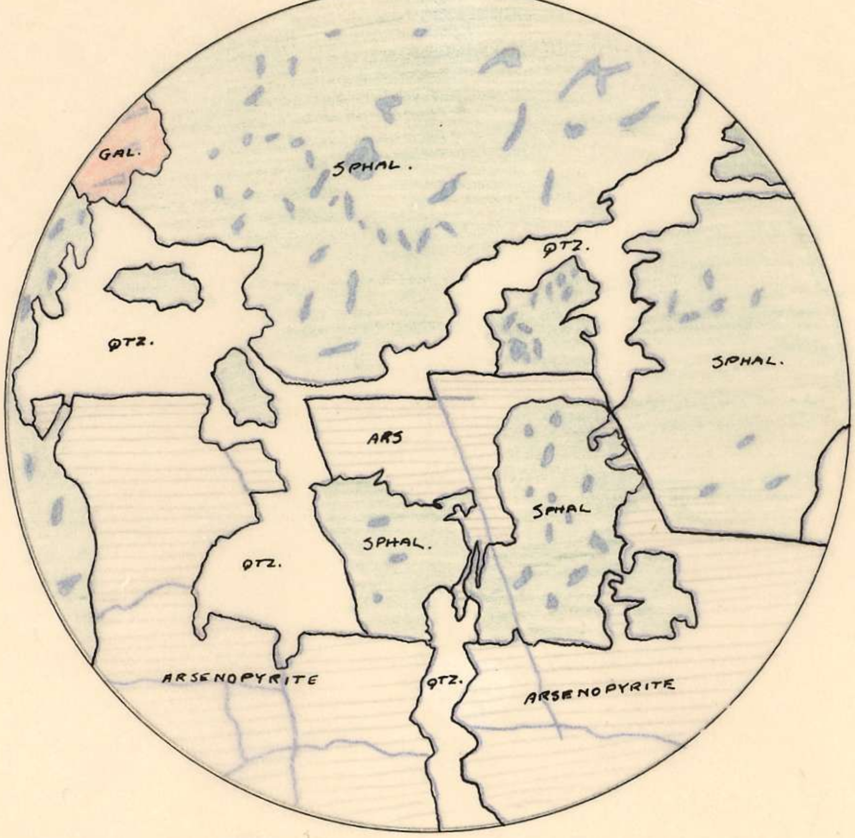
Olympic
Illustration #1
Mag. 70 x



From Section #1 showing tetrahedrite veining sphalerite. The arsenopyrite also appears to vein the sphalerite and is itself cut by quartz.

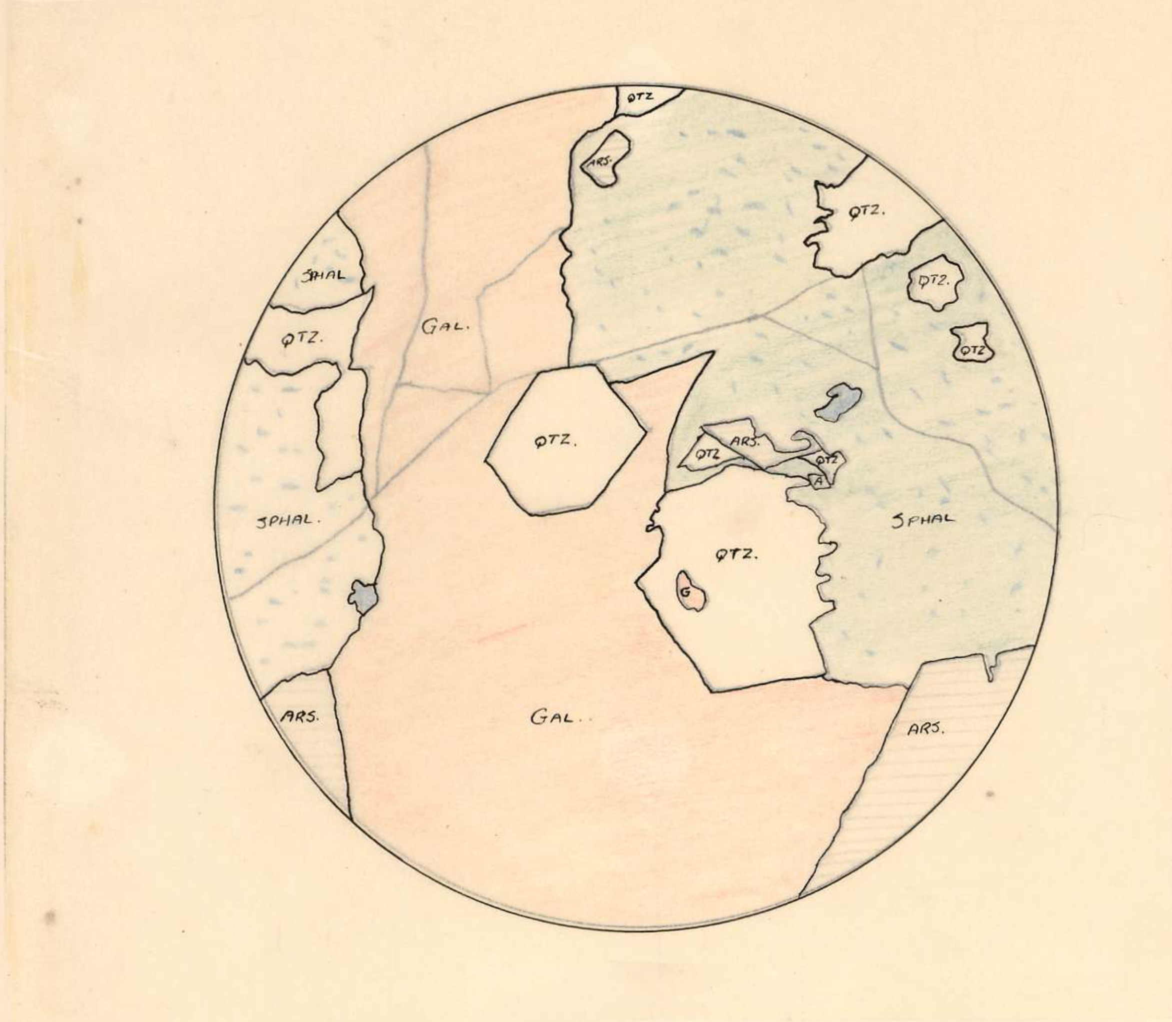
Copper mercuric thiocyanate crystals from microchemical tests on the tetrahedrite?

Olympic
Illustration #2
Mag. 70 x



From Section #1 showing crystal or cleavage faces of arsenopyrite. The sphalerite is shown filling a fracture in the arsenopyrite at the left, and possibly replacing it in the centre.

Olympic
Illustration #3
Mag. 70 x



From Section #3 showing an excellent hexagonal quartz crystal in galena and another partial crystal with an inclusion of galena.