In spite of 2 erroneous statements
a first class effort.

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A MINERALOGRAPHIC STUDY
OF THE
DOLLY VARDEN ORE

A report submitted in accordance with the
requirements of the Geology 409 mineralographic
course at the University of British Columbia.

JAMES ALBERT SOLES

April, 1952

ACKNOWLEDGMENTS

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Thanks are also due to Mr. J.A. Donnan for preparing a thin section; to Dr. K.C. McTaggart and Mr. Jack Gower for assistance in the petrographic study of the thin sections; and to Dr. Harry V. Warren for his enthusiastic encouragement at times when it was needed.

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Location and Access

The Dolly Varden mine is located at the headwaters of the Kitzault river, 18 miles from the head of Alice Arm, which extends northeast from Observatory Inlet, B.C. It is within the Kitzault River Section of the Nass River Mining Division. [7]

Pacific coast steamships supply bi-weekly transportation between the area and other coastal ports; from Alice Arm a good road follows the Kitzault valley to its head, serving the various mines presently operating. Ready access to marine transportation has made operation of some mines in the area possible.

History

The Dolly Varden was the oldest, richest, and shortest-lived mine in the section. Its finding and development paved the way for the discovery and development of the more successful mines now operating. Briefly its history is as follows:

1910-1915	Discovery, staking and exploration of Dolly Varden claims by Evindson, Pearson, and partners.
1915-1918	Dolly Varden Mines Limited continued the development, and contracted with Taylor Engineering Company to build a railroad from Alice Arm to the property.
1919-1921	The Taylor Engineering Company assumed ownership by default of contract, and began shipping ore to the Anyox smelter. Exploration was sacrificed for production, resulting in rapid depletion of reserves and curtailment of operations in 1920. Approximately 36,000 tons averaging 38 oz. Ag/ton were shipped during this period.
1935-1939	T.W. Falconer leased the property from Dolly Varden Mines Limited, and high-graded open cuts and glory-holes over the period, the ore being shipped to the Tacoma smelter.
1940-1952	The mine has been inoperative for the last 12 years. Since 1944, however, several small mines on the same belt (e.g. Torbritt Silver Mines, Esperanza Mines Limited, and others) have developed into good producers.

Topography

The map-area embraces 50 square miles within the drainage basin of the Kitzault river, which flows southwest into Alice Arm. The eastern contact of the Coast Range batholith is found a few miles to the west, and its typical topography is reflected in the area in steep-sided valleys and rugged peaks. The relief is fairly strong, the highest elevation being 5450 feet and the lowest 850 feet above sea level. The mine lies on the steep west wall of the valley, 700 feet above the river. Regional glaciation has been effective to elevations of 5400 feet or more, but the ice appears to have been stagnant, since the lower part of the valleys are unglaciated. A local alpine glacier has extensively eroded the upper reaches of the Kitzault valley; differential erosion in the lower part has produced steep canyons and wide valleys.

General Geology

The area lies in a mineral belt fringing the Coast Range batholith. Sedimentary and volcanic rocks strike roughly parallel to the contact, which trends generally northwesterly in the area. In the Kitzault river district the rocks consist of a sedimentary series overlying volcanic fragmental rocks similar to those of the Jurassic Bear River formation (Hazelton Group) of the Portland Canal district. The belt probably was elevated at the end of the Jurassic period, after deposition of the sediments.

Geological Section
(after George Hanson)

Pleistocene & Recent	River gravels and glacial drift
Post-Jurassic	Lamprophyre and diabase dykes
Jurassic	Intrusive contact
	Lamprophyre and diabase dykes
	Intrusive contact
	Kitsault River Formation
	Dolly Varden Formation

Dolly Varden Formation

The Dolly Varden rocks underlie about one-half of the area, crossing it in a NE-SW band 1½ miles wide. Purple and green tuffs and breccias predominate, with some intercalated andesite flows. The green members contain fragments of porphyrite, tuff, feldspar, and quartz, and are much weathered. Calcite, sericite, and chlorite are the common alteration products. The purple members are much similar, but contain more magnetite and hematite in some areas; chlorite and epidote are the chief alteration products.

Kitzault River Formation

This formation is a series of sedimentaries, consisting chiefly of black argillites, overlying the Dolly Varden formation to the north, northeast, and east to a depth of 2,500 feet or more. The attitude of the beds of both formations is concordant.

Lamprophyre Dykes

The dyke material is black, resembling diabase, and is intrusive into the volcanics and argillites. It is altered chiefly to chlorite and calcite. The ages of the dykes vary widely, apparently ranging through Jurassic into Post-Jurassic periods.

Structure

The argillite outcropping along the Kitzault river north of Evindson creek is in a synclinal fold; this is succeeded by an anticline between Trout lake and the Kitzault river. An anticline is also thought to cross Combination mountain. Folding transverse to the main structural lines caused the formation of a transverse anticline at the mouth of Evindson creek; this is succeeded by a syncline about one mile farther north.

Faulting is extensive; most faults have a north-south trend, some are east-west, and the majority are reverse faults. Horizontal offsets up to 160 feet have been noted; vertical displacement is generally small.

Mine Geology

The Dolly Varden deposit is a replacement vein, varying from an inch to 25 feet in width, following a fault fracture between the purple and green breccias of the Dolly Varden formation. The vein strikes approximately N 55° E, dips northwest from 45° to 60° ; it is displaced irregularly and frequently by the series of steeply-dipping north-south reverse faults, and by one horizontal fault. The vein is bordered on the hanging-wall by a silicified fault gouge and on the foot-wall by silicified sericitized green tuffs, in which some mineral replacement has occurred. Mineralization apparently did not extend into the gouge or the overlying purple tuffs and breccias.

Fault movement and fracturing influenced both the mineralogy and disposition of the vein very extensively. Warren and Brown (15) outline the structural features as follows:

(1) Faulting along the hanging-wall of the vein, probably subsequent to movements allowing passage of the first of the hydrothermal solutions, and likely providing conduits for later juvenile solutions.

(2) A series of north-south reverse faults with little vertical displacement, but showing horizontal movement up to 130 feet. The vein is cut by these into several segments. The horizontal fault also appears to be of this age.

(3) Further fracturing and intrusion of diabase. Most of the dykes are narrow and unimportant, but one, from 10 to 16 feet wide, is found useful as a structural reference plane.

(4) A normal fault, named the 205 fault, cuts all other structures, including the diabase. This fault afforded a passage for circulation of meteoric waters.

Economic Geology

General Mineralization

Silver was the only metal of commercial value during the production life of the mine. The most important minerals in producing the high grade ore are argentite, ruby silver, and native silver, and all of these rapidly diminish in amount at depth until the vein becomes non-commercial near the 300-foot level.

The surface expression of the vein is a cap of ferruginous gossan, which changes rapidly into unoxidized vein material at a depth of 8 or 10 feet. Native silver occurs directly beneath it in masses, plates, and veinlets in fractured quartz; the thick plates rapidly decrease in size to thin stringers in the main part of the vein, but continue to some depth near the 205 fault. It is superseded in the lower parts of the mine by argentite and the ruby silvers; these in turn give way to the base metal sulphides found more consistently at depth.

The grade of ore shipped varied from 1200 oz. Ag/ton in the near-surface enriched zones to 10 oz./ton in the 400 level.

Detailed Mineralogy

Two schools of thought have arisen concerning the origin of the ore minerals. Hanson (8), (9) felt that the rich silver deposits are the result of supergene enrichment of low grade argentiferous galena and tetrahedrite ore (protore); Graham (6) has agreed with him. Dolmage (3) previously had suggested a hypogene origin for most of the silver minerals. Warren and Brown (15), in an attempt to clarify the point, carried out a mineralographic investigation of the ore, finally reaching the conclusion that most of the minerals are of hypogene origin. The conclusions reached in the present study deviates little from the latter theory.

The study of polished and thin sections of the ore has revealed that the following minerals are present:

Metallic	Gangue
Pyrite	Quartz
Sphalerite	Calcite
Chalcopyrite	
Tetrahedrite	
Galena	
Argyrodite	
Argentite	
Pyrargyrite	
Polybasite	
Native Silver	
Cerussite	

The illustrations bear inscriptions which give the positions of the various specimens in the mine; these may be correlated with the enclosed map of a section through the orebody.

Quartz

Quartz is the major constituent of the vein, comprising 70-80% of the specimens studied. It occurs in two ways: as massive anhedral crystals throughout the major part of the orebody, closely associated with pyrite; and as euhedral crystals extending into vughs and along fissures. Such different occurrences strongly indicate two generations of quartz or a period of recrystallization following the major intrusion. Some recrystallization has apparently followed brecciation and deposition of argentite and pyrargyrite, since inclusions of these minerals in cryptocrystalline masses of quartz surrounding anhedral grains is a common feature of the orebody.

The quartz in contact with the primary ore minerals, notably sphalerite and galena, appears to have been subject to replacement, as is indicated by rounding of grains, dispersion of grains in a sea of the later minerals close to the contact (Fig. 2), and the general widening of fissures in quartz. The later euhedral crystals were apparently resistant to attack by the second-generation silver solutions,for no digestion of grains occurred (Fig. 9).

Pyrite

Pyrite is the most abundant of the metallic minerals, and is one of the earliest. The great majority was introduced with the earliest quartz, in which it is found dispersed at random in massive fine-grained bodies, or as subhedral and euhedral crystals. It occurs at all depths, and does not appear to vary in concentration. The sections indicate that it has been generally resistant to replacement by other minerals, but some instances do occur, and are discussed below. Silver values in the massive portions have been found to be negligible.

Sphalerite

Sphalerite is found distributed throughout the sections. It is very sparse in the upper levels of the mine, particularly in 151 stope, and is very light-colored, but with increasing depth the amount and iron content increase until in the 400 level sections it comprises 60% or more of the 'ore' minerals and appears almost black in color; the reason for the rapid change from iron-poor to iron-rich sphalerite is not discussed in detail in the texts consulted (4),(13).

A study of the polished sections, however, indicates that the sphalerite absorbed iron rather than exolved it (as pyrrhotite, which is lacking), and its ability to absorb decreased with distance from the source. The sphalerite is apparently subsequent to the primary quartz-pyrite deposition, showing minor replacement of both, at depth, along fractures and brecciated zones (Figs. (1),(2); the upper levels showed the pyrite to be more resistant to replacement by sphalerite. It would appear, then, that a high temperature gradient existed during the sphalerite mineralization, and the rate of substitution of Zn with Fe decreased according to this decrease in temperature in the more elevated parts of the vein.

The sphalerite has been replaced extensively by subsequent minerals (Fig. 2) such as galena and argentite. Secondary twinning is conspicuous in all sections; it has apparently been caused by shearing stresses during fracturing.

Chalcopyrite

Chalcopyrite occurs throughout the sphalerite in formless grains varying from 1-100 microns (Fig. 2); contemporaneous deposition appears certain, since no chalcopyrite is contained in galena or the other minerals. In no instance was an exsolution texture observed; the blebs of chalcopyrite are relatively widely dispersed, rounded, and completely unoriented, yet the minute size of the bodies suggests that unmixing from solid solution took place. The concentration within the sphalerite was obviously low, and for this reason an 'emulsion' texture possibly did not result; it would be difficult to ascertain without further information the extent to which segregation has taken place.

Galena

Galena is widely dispersed throughout the sections in veinlets and masses, increasing in amount at depth with decreasing silver mineralization. It appears to have gained access through fracturing of the vein subsequent to deposition of the sphalerite, which it intrudes, surrounds, and apparently replaces wherever the two are in contact. Sea-and-island texture and fracture stoping are commonly seen in the lower levels where the association is not complicated by silver minerals (Fig. 2).

The galena has been subject to stress in a few places, which indicates further movement within the orebody; however, the period of stress could not be dated.

Tetrahedrite

Tetrahedrite seems to be very uncommon to the orebody as a whole; of the thirty or more polished sections studied it occurred only three times, and in all of these occurrences it appeared contemporaneous with galena (Fig. 3). Brown (2) reports it as being disseminated in quartz and associated with argentite in veinlets, but neither case was observed in the present study. He also reports that the copper assay on one shipment was 0.19%, corresponding to approximately 1% of tetrahedrite; such an assay could be obtained from or greatly supplemented by the amount of chalcopyrite seen at lower depths, if this was the origin of the sample.

An X-ray photograph of the mineral was taken by Dr. R.M. Thompson, who noted that the ~~space group~~ UNIT CELL was extremely large; this fact suggests that the tetrahedrite is a highly argentiferous variety, although no silver was detected in microchemical tests. Such a composition would make the mineral a potential source of silver for supergene (or hypogene) enrichment of the orebody, but it is not present in sufficient quantity to provide the massive deposits of silver minerals so characteristic of the upper levels. Guild (7) states:

> "---the early minerals of silver are confined mainly if not entirely to tetrahedrite and argentiferous galena. They are therefore held to be the source of the later enriched products. Tetrahedrite is probably the most prolific source...".

Apparently this observation does not apply to the Dolly Varden ore.

Argentite

Argentite is the most consistent mineral of economic importance in the productive part of the orebody. It is found disseminated throughout quartz in interstices, grains, fissures, and vugh fillings, the content decreasing with depth. A study of thin sections showed that the argentite is commonly found dispersed in microscopic blebs throughout masses of quartz besides occupying veinlets; no argentite was seen within the euhedral crystals of quartz, however, hence a variation in the mineralization is indicated.

A logical interpretation may be as follows:

(1) The argentite was first introduced into the quartz after it had been strongly brecciated, producing the finely disseminated 'black quartz' mineralization;

(2) Later fracturing and brecciation, probably accompanied by recrystallization of quartz, produced fissures and vughs for a second period of argentite deposition.

This theory is strongly supported by several observations:

(a) The argentite is associated in two ways with the galena, despite the decrease in concentration at depth: contemporaneously, showing mutual boundaries and complete lack of replacement textures, (Fig. 4A); as a replacement mineral, rimming the galena along fissures and quartz contacts (Fig. 4B). The latter is merely an observation, and the writer does not preclude the possibility of migration of argentite to the borders during deposition of minerals from a mixed solution.

(b) In Figure 5 the mineral argyrodite is shown in association with galena. The argyrodite is either contemporaneous with the argentite or precedes it, and either case proves the argentite to be subsequent to the galena; the former shows replacement of galena by argyrodite, and the latter replacement of possibly both by argentite. Other areas (not shown) indicate a contemporary age for the argyrodite and argentite.

(c) As previously stated, no disseminated argentite was seen in the euhedral crystals of quartz lining vughs and veinlets; this would indicate that the quartz recrystallization (or possibly deposition) preceded a secondary influx of argentite.

Pyrargyrite

Pyrargyrite occurs in circumstances similar to argentite, except that it appears less frequently at depth. It is disseminated in like fashion throughout brecciated quartz, staining it a characteristic ruby red; it is found in contact with argentite and galena in veins and stringers; and it replaces pyrite to some extent along fractures.

The age relation with argentite is doubtful, since the boundaries between the two are smooth — in many cases the argentite appears as corroded remnants in pyrargyrite (Fig. 6), and in other cases the two are found in harmony along veinlets. The fact that it is dispersed in quartz in a fashion similar to the early argentite, and is not seen rimming galena, would suggest that its deposition was contemporaneous with that of the early argentite and hence prior to the period of recrystallization of the quartz; but its occurrence in veinlets also cannot be overlooked, ard probably indicates a second period of deposition contemporaneous with the second injection of argentite.

Where in contact with galena, the pyrargyrite shows smooth boundaries with no trace of replacement textures (Fig. 7), and therefore contemporaneous deposition is suggested.

Polybasite

Polybasite is closely associated with pyrargyrite in veins in the higher levels, or in fissures alone. In most cases it appears to replace pyrargyrite, for although the contacts are smooth, its disposition along the borders of the pyrargyrite and quartz indicates a later period of deposition. Figures (6) and (8) show its relatien with pyrargyrite and argentite, which it also appears to be replacing. Figure (7) shows that it is also subsequent to galena, intruding it along cleavage planes in contrast to pyrargyrite; apparently in this case the access to the vein was a weak zone within the centre of the pyrargyrite rather than at the quartz border. The polybasite is in turn being replaced by native silver.

Since the polybasite is later than the main suite of minerals, and does not appear below the 200 level, a hypogene origin perhaps would appear questionable; however, it is found in veinlets and vughs with argentite (Fig. 9), in which environment it shows no replacement textures, and its relation with galena suggests injection rather than deposition from meteoric solutions. It would appear that the second wave of argentiferous solutions not only deposited argentite and possibly pyrargyrite, but enriched some of the previously-deposited pyrargyrite zones.

Guild notes that Weed and Pirsson[1] have described one occurrence of polybasite as "an alteration product of galena, and to be mixed with and grade into pyrargyrite, which in some cases is its undoubted alteration produet." This interpretation cannot readily be applied to the Dolly Varden occurrence.

Figure (8) exhibits a curious structural relationship between argentite, pyrargyrite, and polybasite, in that an interfingering is evident. The polybasite is later than the other two, and appears to replace the argentite preferentially where possible; the interfingering, therefore, might suggest that there was a restricted intergrowth of argentite and pyrargyrite during their deposition.

Native Silver

All the preceding silver minerals have been replaced in places by native silver, most conspicuously in the upper levels and at depth along the 205 fault. Beneath the oxidized surface outcrops it is found in plates and masses; at lower horizons it fills fissures and extends into veinlets, replacing the previously deposited silver antimonides and sulfides (Figs. (6),(8); a supergene origin appears to be the most likely, from the distribution of the mineral. The pyrite would yield an ample supply of sulphuric acid and ferrous sulphate to effect leaching of the

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[1] Weed and Pirssen "Geology of the Little Belt Mountains, Mont." U.S.G.S. 20th Ann. Rpt. Pt. 3, p. 411, 1899.

primary silver minerals; later reduction of the silver to the native state by the sulfo-salts and pyrite would take place beneath the zone of oxidation.

Argyrodite

Argyrodite was identified only in one section from 252 stope. It occurs with argentite in veinlets and fissures (Fig. 5), and is apparently directly associated with pyrite since it does not appear in the more massive areas of argentite outside of the strongly pyritized quartz; the reason for this is not known. A contemporaneous relation with the argentite is suggested, as has been previously noted, by general dispersion of either mineral in the other, but good criteria are lacking and previous deposition with later replacement by argentite may have been the case. The mineral is likely not abundant, since no penalties were imposed by the smelters for germanium content in the ore.

Optical data and etch behaviour are as follows:

Color: - - - - - - - - - Gray with pinkish tinge
Hardness:- - - - - - - - B (as galena)
Sectility: - - - - - - - Very brittle
Anisotropism:- - - - - Isotropic
Internal Reflection: - None
Etch Tests:
    $HgCl_2$ - Blue-Irridescent tarnish (rapid)
    KOH - Slight gray stain (slow, doubtful)
    KCN - Gray-brown stain (etches out scratches)
    HCl - Negative
    $FeCl_3$ - Tarnishes irridescent (quickly)
    HNO_3 - Slight brown stain, fumes similar
    A.Reg.- Brown-black, slowly

Cerussite

Cerussite was observed in one polished section of ore from 456 stope, the exact position being unknown, but assumed to be near the

205 fault; a thin section was cut in order to determine the mineral accurately. It is found bordering veinlets of galena in quartz, and is clearly an alteration product of the galena, for a narrow transition rim of an undetermined mineral is present in all cases (Fig. 10). The cerussite was likely formed by the reaction of the galena with meteoric carbonate waters; although the apparent lack of colloform structure and the presence of hypogene calcite in the orbody might suggest alteration by hypogene solutions, it was noted that no alteration took place where hypogene calcite was seen in contact with galena (Fig. 3).

Calcite

Calcite is fairly abundant in the orebody as a gangue mineral, taking second place after the quartz. It is found with galena in veinlets transecting sphalerite and quartz (Fig. 3), and in vughs with argentite (Fig. 11); it appears to be contemporaneous with the second generation of argentite (and perhaps with galena also), and is considered hypogene because of this association.

Barite

This mineral has been reported by Brown as being present in small quantities and Hanson states it is common at depth, but none was seen in the present study although a considerable amount of time was spent in searching for it.

History of Mineralization

Movement in the plane of the vein prior to dissection by the north-south faults is certainly responsible for the access of mineralizing solutions. The quartz and pyrite probably first intruded along a weak zone (or fault) in the volcanics, and were later subjected to fracturing and brecciation by intermittent differential movement along the same plane, thus providing channels for the ore-forming solutions. This interpretation is in accordance with that of Brown, who was fully acquainted with the property.

Following the primary quartz-pyrite intrusion, the sequence of events appears to be as follows:

(1) Fracturing of the vein materials by movement close to the vein, followed or accompanied by invasion of mineral solutions which deposited sphalerite and chalcopyrite in the shattered quartz;

(2) Further movement and extensive fracturing, producing channels for the injection of galena, tetrahedrite and first-generation silver minerals, probably accompanied by recrystallization or deposition of quartz in the later stages;

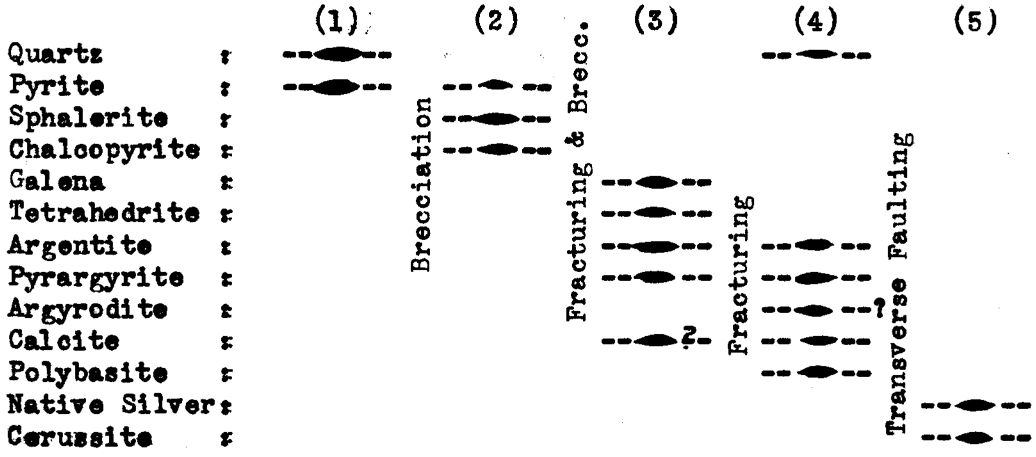
(3) Repeated movement, probably a continuation of (2), accompanied by quartz deposition or recrystallization, producing fissures and vughs for the deposition of second-generation silver minerals and calcite. Fracturing within the vein would appear to be more intense at the higher levels, since the galena at depth is only warped and replaced along the borders of veinlets.

(4) Post-mineralization faulting transverse to the vein, cutting it into segments;

(5) Supergene alteration of the hypogene silver minerals to native silver near the surface and along 205 fault. Movement subsequent to the last mineralization phase has, according to Warren and Brown, preceded the enrichment of the orebody with native

silver.

The following table summarizes the sequence of deposition of the minerals as controlled by fault movements subsequent to the primary quartz-pyrite deposition:



Phases (2), (3), and (4) likely were not widely separated and an overlapping in mineralization was highly probable; this would explain some of the conflicting relations noted with respect to the ruby silvers, argentite, and galena.

Conclusions

The study of polished and thin sections of the Dolly Varden ore has led to the following interpretations:

(a) The majority of the silver minerals are of hypogene origin. Assuming that there was a sufficient supply of argentiferous tetrahedrite, which does not appear to be the case, to provide silver for supergene enrichment, one would expect to find secondary copper minerals; these are not present. Similarly, if galena were carrying the silver — of which there is no did you try it?

indication — anglesite would probably be found in large quantities in the upper levels; such is not the case. The fact that such supergene minerals are absent; that the boundaries between the silver minerals and the galena are confluent in most cases; that the pyrargyrite and polybasite are found 'locked' in recrystallized quartz; and that the minerals continne to depth despite a lack of passage for meteoric waters (Warren and Brown), precludes the possibility of a supergene origin. Native silver, necessarily, is the exception.

(b) Two temperatures of intrusion are indicated: mesothermal, in the range of 250° - 500°C, when the quartz, pyrite, and sphalerite were introduced — a high gradient is suggested, as has previously been mentioned, regarding the sphalerite intrusion; and low mesothermal to epithermal, ranging probably from 200°- 300°C, during the deposition of galena, the silver minerals, and calcite. The second-generation argentite was probably introduced at the lower temperatures, presumably above 179°C since the argentite appeared isotropic; the optical characteristics of acanthite, however, are little removed from those of the isometric version (argentite) of temperatures above 179°C, hence a spectrographic ?
analysis of the sulphide would be necessary to determine with ?
certainty whether the temperature of deposition was above or below the inversion point.

(c) The well-brecciated quartz, excluding possibly some of the recrystallized portions of the vein, would yield readily to crushing, but it is doubtful if a sufficiently fine grind could be obtained to free all the argentite and ruby silver for concentrating. The galena and sphalerite could be separated sufficiently well for concentration with a 200-mesh grind or less; chalcopyrite is irrecoverable economically and would pass into the sphalerite fraction.

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Plate I

(1)

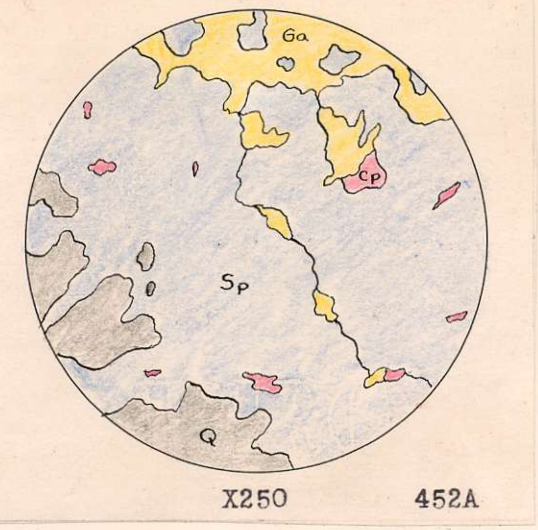


Figure 1. Sphalerite (Sp) containing chalcopyrite (Cp) replacing quartz, and being replaced by galena (Ga).

(2)

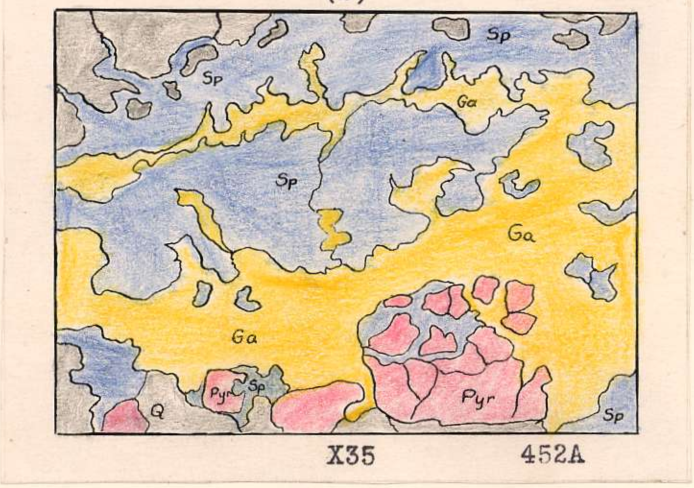


Figure 2. The same, also showing slight replacement of pyrite (Pyr) by sphalerite.

Plate II

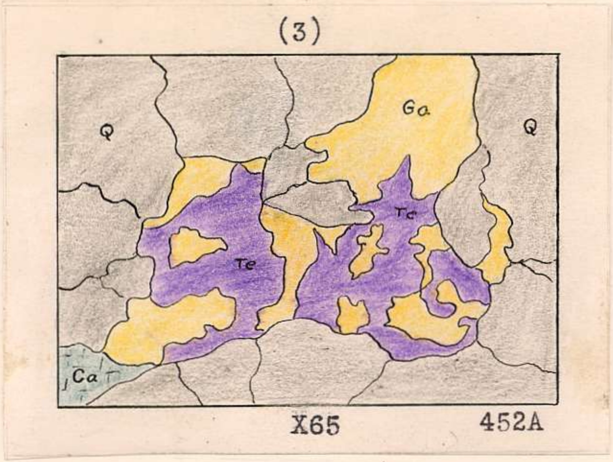


Figure 3. Contemporaneous (?) galena (Ga) and tetrahedrite (Te) in quartz (Q) with calcite (ca).

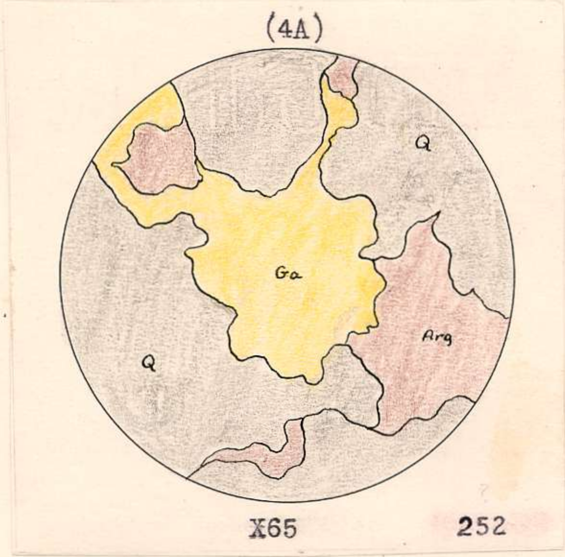
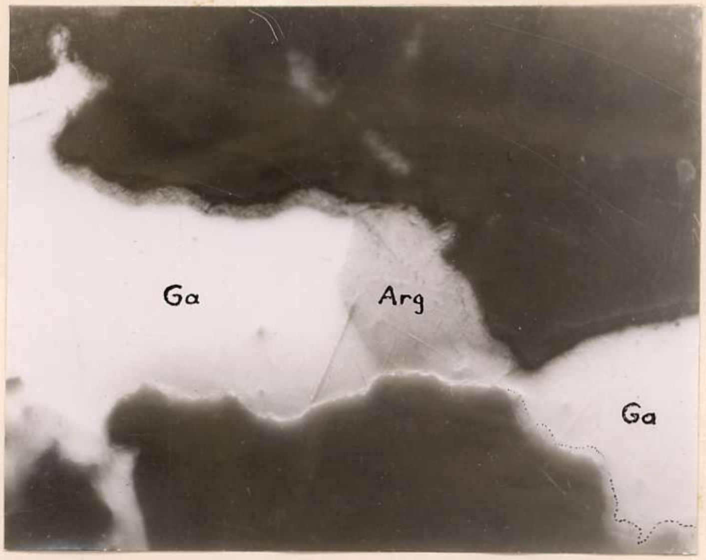


Figure 4A. Argentite (Arg) and galena (Ga) in veinlets in quartz (Q), showing a possible contemporaneous relation.

Plate III

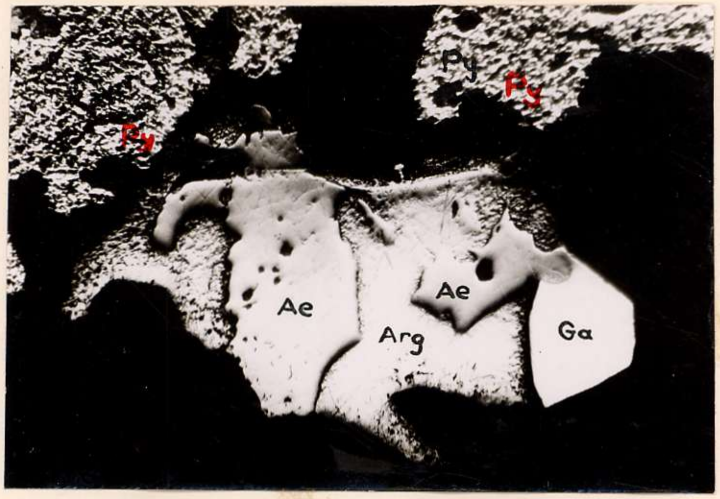
(4B)



X150 452A

Figure 4B. Argentite (Arg) rimming galena (Ga) along a fissure in quartz (dark).

(5)



X250 252#10

Figure 5. Galena (Ga), argentite (Arg) and argyrodite (Ae) in an enlarged fissure in quartz (Q) which contains pyrite (Py). The dark specks on the Argyrodite are inclusions of argentite (etched with KCN).

Plate IV

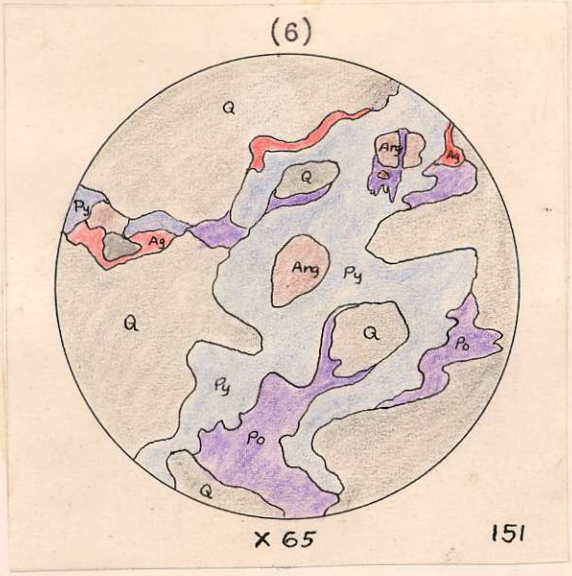


Figure 6. Polybasite (Po) and native silver (Ag) replacing pyrargyrite (Py) and residuals (?) of argentite (Ar) along a fissure in quartz (Q). Euhedral crystals of quartz can be seen.

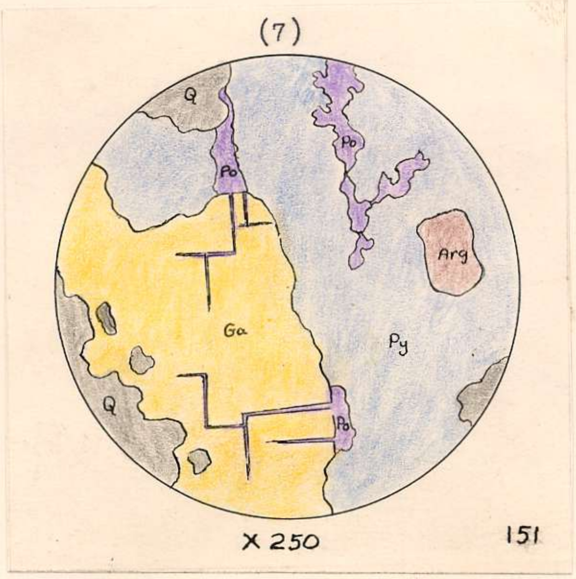


Figure 7. Polybasite (Po) intruding galena (Ga) along cleavage planes, and seaming pyrargyrite (Py) which contains an inclusion of argentite (Arg).

(8)

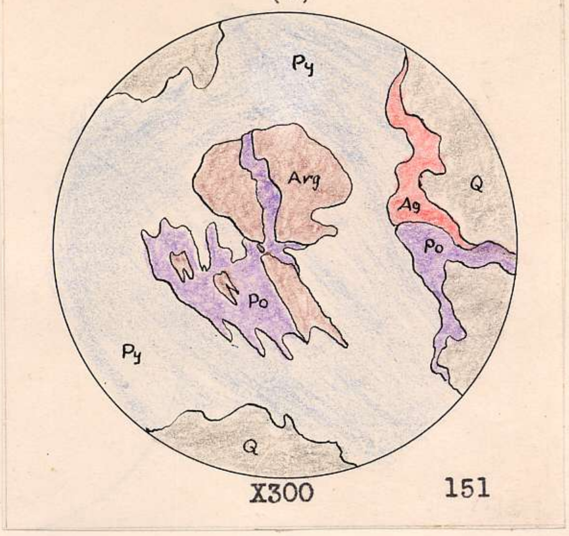


Figure 8. Polybasite (Po) showing possible selective replacement of argentite (Arg) in pyrargyrite (Py). Native silver (Ag) appears to replace both polybasite and pyrargyrite.

(9)

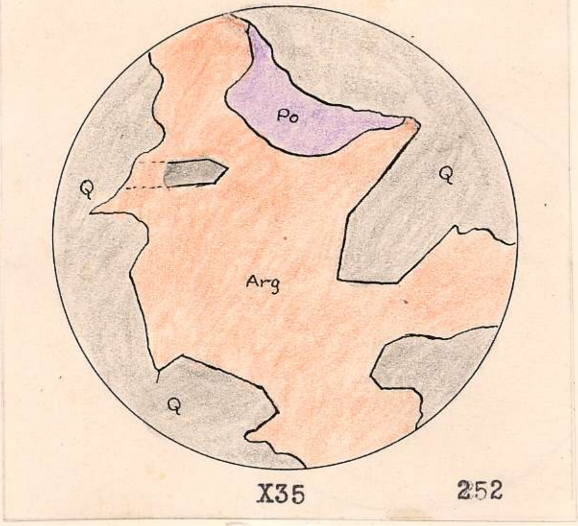


Figure 9. Argentite (Arg) and polybasite (Po) in a vugh, with euhedral crystals of quartz.

Plate VI

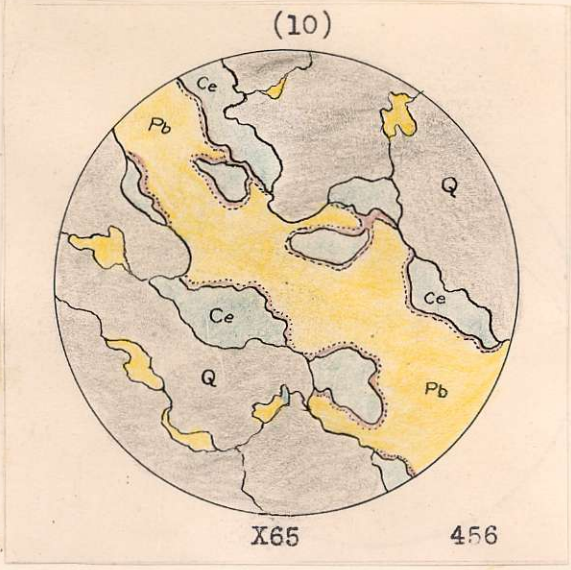


Figure 10. Galena (Pb) being altered to cerussite (Ce) in a veinlet in quartz (Q). An undetermined transition mineral (brown) rims the cerussite.

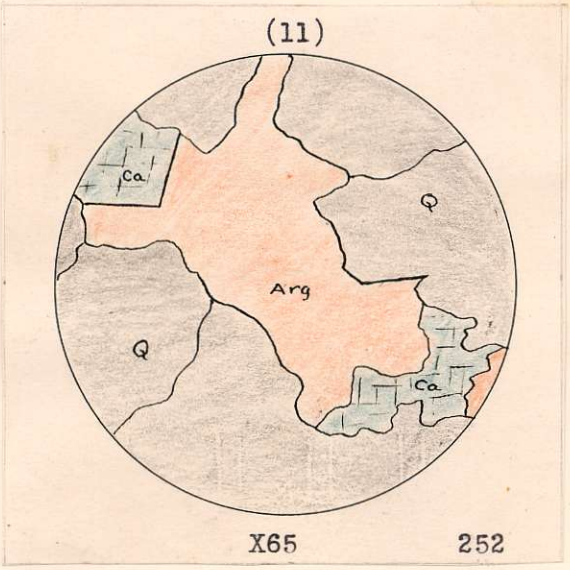
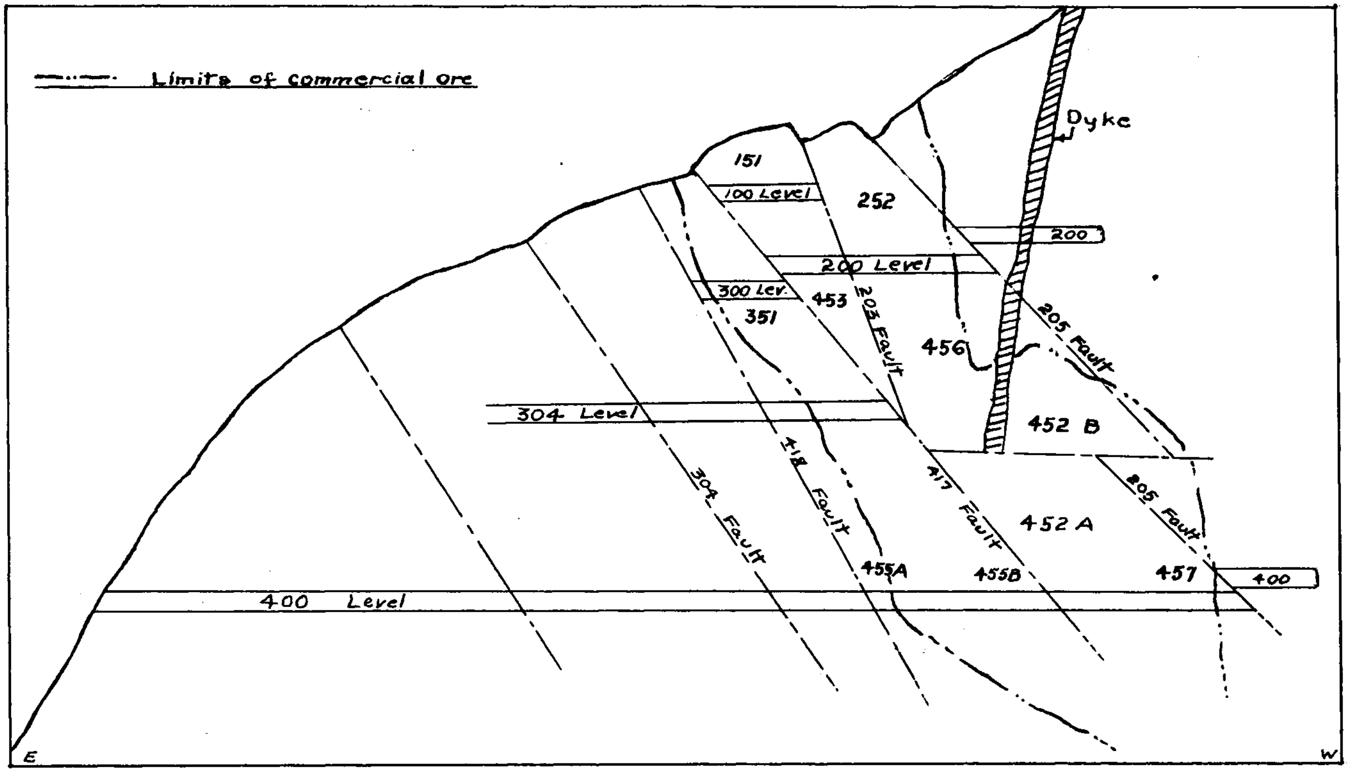


Figure 11. Argentite (Arg) and euhedral calcite (Ca) in a quartz fissure. Contemporaneous deposition is indicated.



Vertical Projection of the Orebody