A MICROSCOPIC STUDY OF THE DOLLY VARDEN ORES.

Geology 9

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Contents

Introduction.

This report is based on a mineralogical study of Dolly Varden Ore.The work was undertaken as a part of the course of Geology 9.Representative polished sections from various parts of the mine were made and studied with a reflecting microscope,in an effort to identify the minerals and understand something of their paragenesis.

Location.

The Dolly Varden Mine is situated in the Kitsault River Valley about 18 miles from the head of Alice Arm. Alice Arm is a long inlet of water on the West Coast of British Columbia,near the Alaskan Boundary.A railway from the mine ,covers the 18 miles to tidewater.

History.

In 1898,the Portland Canal area became recognized as a favourable area for prospecting.It was not until 1915 however,that the Dolly Varden claims were staked, and work begun by the Dolly Varden Mines Company.In 1919 the Taylor Engineering Company,which had been employed in building a railroad to the mine,assumed control.In three years of operation,they mined 36,609 tons of ore,from which 1,304,409 ounces of silver were extracted.In 1922 they ceased operations.Since that time, several people have exercised options on the claims, but it has not regained anything like its peak production.

General Geology.

The Dolly Varden Mine lies in the Interior Belt of mineralization,about five miles from the East edge of the Coast Range Batholith.

The oldest rocks in the area are the tuffs and agglomerates of the Dolly Varden Formation.These are overlain by the Kitsault River Formation and more specifically the argillites of the Bear River Series. These are both believed to be Lower Jurassic.The Coast Range Batholith intrusion in Upper Jurassic times,is probably closely associated with the ore bodies.In addition,there is a series of lamprophyre and diabase dykes,which are later than the above.

Table of Formations

Post Jurassic	Lamprophyre and diabase dykes
	Intrusive Contact
Mesozoic Jurassic	Kitsault River Formation-Argillites (Fossiliferous) 2,500'
	Dolly Varden Formation-Agglomerates and tuffs.3000'_

Mine Geology and Structure.

In the mine the main quartz vein,traced for 1500 feet,lies in part between a green and purple breccia and in part,in the latter.Its general strike is East and West and it dips 60 degrees to the North. Numerous reverse faults running North and South and dipping West,offset the vein.At a still later period, normal faults also cut the vein.These faults offset the vein horizontally for a distance of 50 to 160 feet.S

Some of the lamprophyre dykes which cut the vein, occurred before the faulting, and some after. Considerable erosion has taken place since the igneous intrusions, leaving a very rugged topography. The workings of the mine are from 1500 to 2000 feet above sea-level.

The minerals occurring in the vein are pyrite, sphalerite, galena and very rarely, tetrahedrite and chalcopyrite. In the silver minerals are included argentite, pearceite, pyrargyrite and native silver. Quartz and small amounts of chalcite and barite are found in the gangue. Some pyrite, quartz and sericite are found in the foot-walls. The purple breccia of the hanging-wall has not been altered by solutions accompanying ore deposition.

The ore decreases rapidly in value with depth. Below 400 feet from the surface, the mineralization no longer forms commercial ore.

Mineralization.

Eight polished sections from representative parts of the mine, were made and studied. These are described below. Enlarged drawings have been made of parts of some of them. The sections were studied under the reflecting microscope, with magnifications of 70 and 140 times. Etched tests were carried out on their surfaces, and these tests were further supplemented by microchemical methods.

Section 1.

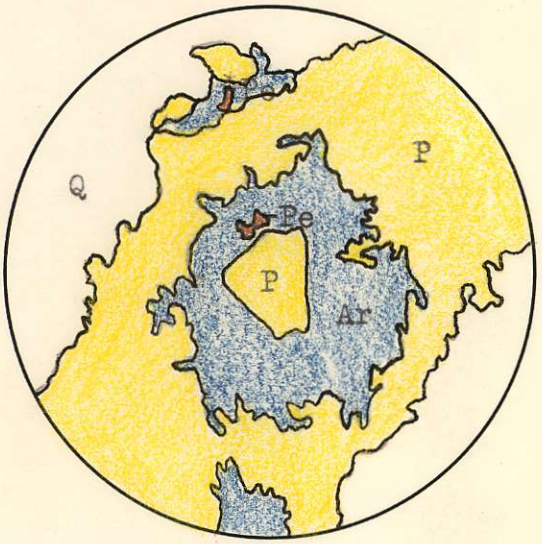
From 151 stope near east end.50' below the surface.

This section contains quartz and barite,pyrite and ruby silver.The quartz is irregularly fractured, almost brecciated.Pyrite occurs along irregular cracks and is also fractured.The pyrargyrite is not very continuous,occurring in patches in the quartz.Its relation with the pyrite is not clear,but it is not fractured. In some parts of the section,it is diffused enough through the quartz to give this a distinct red colour. There are traces of a mineral appearing to be barite associated with the pyrite in the cracks.

Section 2.

From 151 stope near east end.50' below the surface.

This section contains quartz,pyrite,argentite and pearceite.The pyrite occurs along fractures in the quartz.The argentite occurs both in the pyrite and along boundaries between the pyrite and the quartz. it is not fractured like the pyrite.The boundary between the argentite and the pyrite is irregular showing a considerable time difference, but does not show which is the older.In one place, a smooth-sided island of pyrite is left surrounded by argentite.It is unlikely that it would assume this shape if it was the latter of the two.



Q : Quartz

P : Pyrite

Ar: Argentite

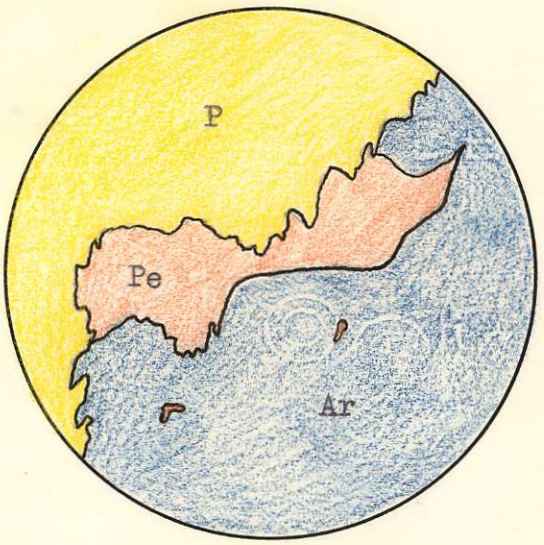
Pe: Pearceite

Magnification X70

P : Pyrite

Ar: Argentite

Pe: Pearceite



Magnification X140

There are some small patches which give the etch reactions and microchemical tests of pearceite. These patches occur along the boundary of the pyrite and argentite or as small specks in the argentite. Its relationship to the other two is uncertain, but it is probably later.

Q : Quartz

Ar: Argentite

Ag: Native Silver

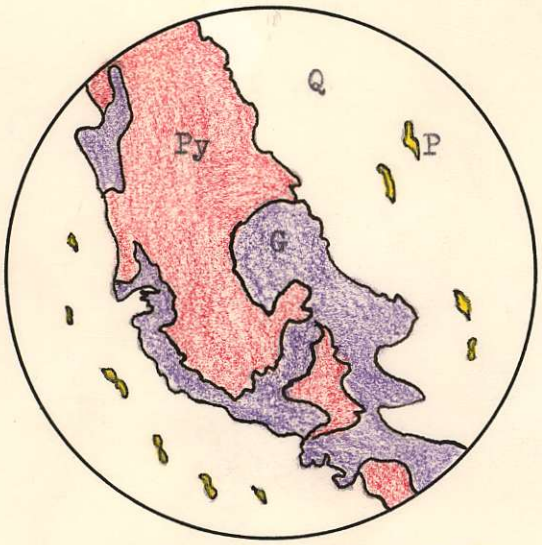
Magnification X 70

Section 3.

The ore for this section was taken from No. 252 stope,40 feet from the surface.

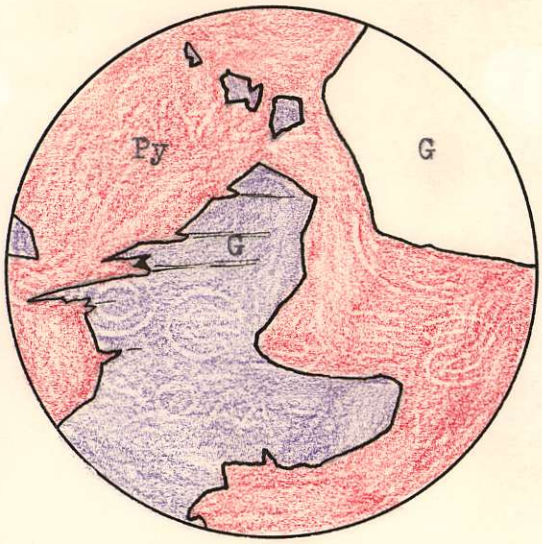
The section contains quartz and barite,pyrite , argentite and native silver.

The main quartz mass is crossed with irregular fractures.Pyrite occurs in this in irregular non-continuous patches and is itself fractured.Recrystallized quartz occurs around the borders of vugs.One of these crystals is three-eights of an inch long.The remaining cavities of the vugs are filled with argentite.Finally,along the edges of the argentite,are some elongated patches of native silver.

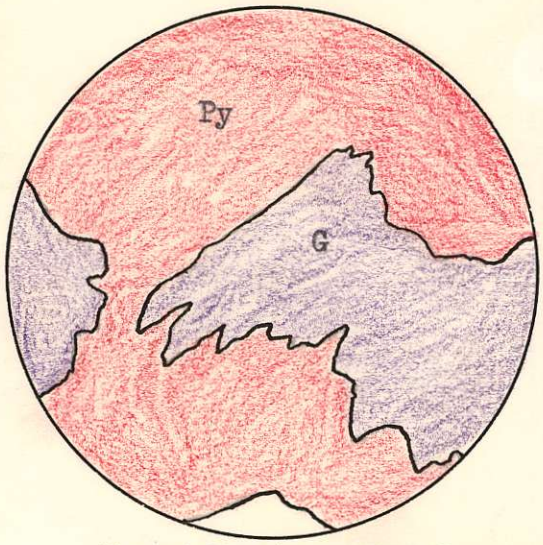


Q : Quartz
P : Pyrite
G : Galena
Py: Pyrargyrite

Magnification X 70



Magnification X 140



Magnification X 140

Sections 4 and 5.

These specimens of ore were taken from No 151 stope, 60 to 80 feet from the surface.

The sections contain quartz, pyrite, galena and pyrargyrite.

The quartz is called "black quartz". The dark color of it is due to the inclusion of some mineral, probably argentite. Scattered through the quartz is some fractured

pyrite.Some ruby silver is also found in isolated patches in fractures in the quartz.

In some veinlets in the quartz are found galena and pyrargyrite.A great number of the boundaries are found to be smooth,straight or gently curved lines. This would suggest contemporaneous deposition.In a relatively few places,the pyrargyrite exhibits cusps entering along the cleavage of the galena.This would make the pyrargyrite later than the galena.There are a few islands of pyrite contained in the galena.

Section 6.

This section is from near the hanging-wall of No 452 A stope,at about 150 feet from the surface.

The section contains quartz,pyrite,sphalerite and small amounts of chalcopyrite and pyrargyrite.

The quartz does not seem as badly fractured as some of that from the higher levels.The pyrite occurs as discontinuous veinlets up to .5 centimetres across. The sphalerite contains much iron and forms large masses in the section.It shows irregular contacts with both the quartz and pyrite.Unlike the pyrite, it is not fractured and in places it partly fills the fracture in the pyrite.

The chalcopyrite occurs as minute specks in the sphalerite,visible only under the high power objective. The pyrargyrite forms slightly larger specks,scattered through or along the edge of the sphalerite.

Section 7.

This section is also from No 452A stope.

It is similar to section 6, except that the sphalerite occurs in small narrow bodies in the pyrite. There are a few scattered specks of pyrargyrite in the quartz and very few in the sphalerite. In a few of the cracks in the quartz, there are faint traces of a mineral which is probably pyrargyrite.

Calcite occurs in the quartz in small irregular-shaped vugs.

Section 8.

The ore for this section is from No 436 stope, about 150 feet below the surface. It contains quartz and calcite, pyrite, sphalerite and pyrargyrite.

The pyrite and sphalerite are much more widely disseminated throughout the quartz. The section also has a greater amount of calcite. Some of this has weathered out to give the quartz a pock-marked appearance.

+ argentite

Paragenisis

The order of mineralization can be determined fairly easily from the polished sections,but it is very difficult to tell whether the mineralization is primary or secondary.General field relations should form an important part of the evidence in such determinations,and should be used to substantiate the findings in the polished sections.

A few of the criteria used in estimating replacement of one mineral by a later one were, regular or irregular contacts,irregular veinlets of the replacing mineral in the host,cross-cutting veinlets,cusps along the crystal boundaries of the host and common orientation of islands of the host mineral in the replacing mineral.Also fracturing or faulting which affected one mineral and not another established an age relationship.

The constituent minerals are considered in turn.

Pyrite-This was one of the earliest minerals. It filled fractures in the quartz and was itself fractured.It was replaced by argentite,pearceite and pyrargyrite.

Sphalerite-This contains a high percentage of iron.On the basis of fracturing it is placed next to the pyrite in order.

Chalcopyrite-The chalcopyrite forms minute specks in the sphalerite.It probably came in with the sphalerite and was precipitated due to unmixing on cooling.

Galena-This mineral is later than the above mentioned minerals.Its relations with argentite could not be determined from the sections studied. Usually it is earlier.It is concluded to be earlier than the pyrargyrite.

Argentite-This mineral replaces the pyrite and is itself replaced by pearceite and pyrargyrite. Near the surface it fills vugs around the edge of which quartz crystals have grown.Here it is replaced by native silver.At greater depths it is found disseminated in the quartz.

Pearceite-This mineral replaces the argentite. it is probably earlier than the pyrargyrite.

Pyrargyrite-This mineral is scattered through the brecciated quartz and also occurs in veinlets. Some of the contacts with galena suggest contemporaneous deposition.In other places it intrudes the galena along cleavage faces.It probably was later than the galena.

Native Silver-This mineral could have been formed by the action of ferrous sulphate on argentite.The pyrite would have formed a source for the ferrous sulphate.This would make the native silver supergene.

Limonite-This mineral is found along the fractures of the hand samples containing native silver.It is obviously secondary and later than the other minerals.

Quartz- This was the earliest material to enter the vein.In places there is a black quartz

which contains disseminated argentite.This would be later than the first quartz.Near the surface there is some recrystallized quartz on the borders of vugs.

Barite-This is formed in the lower levels along the fractures and contacts.It is probably the same age as the spalerite.

Calcite-Calcite occurs in some small vugs.It is later than the quartz but its relations with the other minerals is not clear.

Succession-

Quartz and pyrite were intreduced in the first period of mineralization.After minor faulting this was followed by sphalerite and chalcopyrite along the veins.There was metasomatic replacement along the veins.After a period of faulting argentite and black quartz were introduced.Further fracturing occured before the antrance of galena,argentite, pearceite and pyrargyrite.Finally there was faulting and the formation of native silver and limonite from circulating ground-water.

Conclusions-

The Dolly Varden ore-body is a low temperature type of deposit.There have been at least two periods of mineralization and probably three.The quartz, pyrite and sphalerite leave little doubt as to their hypogene origin.At the other end of the list the native silver and limonite are almost sure to have been formed by the enrichment of descending solutions.

The intermediate minerals can have been formed by either hypogene or supergene solutions.In either

case,fracturing after the first mineralization made the entrance of mineral bearing solutions possible.

A strong argument in favour of secondary mineralization is that the mineral zone conforms closely to the topography.It is hard to believe that primary minerals introduced at depth,in Jurassic times,would conform so closely to a surface formed after long periods of erosion.However,cases have been cited of definite mesothermal deposits that had this characteristic.

One of the arguments in favour of primary mineralization is the lack of a sufficient source for secondary silver sulphantimonides and sulphe arsenides.No tetrahedrite was found in the polished sections although small amounts have been reported from the mine.Arsenopyrite is also very rare or missing.This makes the appearance of the silver minerals very hard to expain unless they were primary.

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