Too much padding in form of Geology. However the scarcity of minerals made subject difficult and this should have been countered [illegible] much greater attention to detail.

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A MICROSCOPIC EXAMINATION OF THE KOOTENAY KING ORE

Geology 9

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A MICROSCOPIC EXAMINATION OF THE KOOTENAY KING ORE

Location

The Kootenay King mine is located near the summit of the front range of the Rocky mountains on Kootenay King mountain. The property is situated on Wildhorse creek at a distance of approximately six miles by road and six miles by trail from Fort Steele.

Structural Geology

The ore occurs in a bed of grey-green, dolomitic argillite, in the transition zone between the Fort Steele and Aldridge formations.

The sediments in which the deposit occurs were strongly folded prior to the mineralization. Small drag-folds suggest that, in places, strata have been overturned. A thrust fault of considerable magnitude occurs to the west of the mine and several small, possibly post-mineral, faults occur in the workings.

A fine-grained, white, sodic monzonite dyke, identical with that in the Sullivan mine, occurs in the Kootenay King, and several small syenite dykes cut the formation in the vicinity of the ore-bodies.

H. M. A. Rice in his report on the Kootenay King has noted that the Sullivan, North Star, Stemwinder, and Kootenay King mines have certain features in common:

(1) The ore occurs as differential replacement of dolomitic quartzites.

(2) These sediments lie in the zone of transition between the Aldridge and the Fort Steele formations. This is definitely known at the Kootenay King and inferred at the Sullivan, North Star, and Stemwinder mines for the following reasons:

(a) No beds of the extent and nature of those replaced are known except in this zone.

(b) The horizons appearing in the Sullivan mine are, as far as can be determined by stratigraphic measurements, in the base of the Aldridge formation.

(c) At the foot of North Star hill, on the east side where the lowest strata in this region are exposed, grey-green, dolomitic argillites occur identical with those in the top of the Fort Steele.

(3) The ore-bearing horizons have been subjected to considerable folding prior to mineralization.

(4) The ore-bodies lie on the east sides of large faults. These faults in places contain quartz veins carrying sulphides and the crushed rock in the zone of faulting is commonly highly silicified. They are, therefore, believed to be pre-mineral features.

(5) The ore-bodies have been subjected to post-mineral normal faulting.

(6) Members of the granitic rocks occur in both mines.

From items (3), (4), and (5) it is deduced that the mineralization occurred during the late stages of the main orogenic period in the area; that is in the Cretaceous or early Tertiary.

For the following reasons the source of the ore is believed to be the magma from which the granitic rocks were derived:

(1) The ore is believed to have formed at approximately the same time as the intrusion of the granitic rocks; that is during the Cretaceous or early Tertiary.

(2) Granitic rocks are present near both properties.

(3) Cassiterite, which is considered always to be a product of acid intrusives, occurs in the Sullivan mine.

The following sequence of events is suggested to account for the origin and position of the ore-bodies:

(1) Thick beds of banded dolomitic argillite, theoretically favourable for replacement, and apparently of the type that has been replaced by the sulphides to form the ore, occur between beds of argillaceous quartzite only in the zone of transition between the Aldridge and the Fort Steele formatioms.

(2) In the vicinity of the mines described pre-mineral thrust and normal faulting deformed these beds and produced in them structures suitable for the passage of the mineralizing solutions.

(3) The faults were sufficiently deep seated to tap the source of the mineralizing solutions. The fault zones may then have acted as channels for these solutions to enter the structures produced by the above processes.

(4) The solutions on entering these structures replaced certain chemically suitable horizons and so produced the ore-bodies.

Economic Geology

The ore is very similar in appearance to that of the Sullivan deposit. It consists essentially of fine-grained galena, sphalerite, and pyrite with little gangue other than unreplaced parts of the original sediments. The laminations in the replaced rock appear in the sulphides, as bands of slightly different composition, in a manner similar to the Sullivan ore. The mineralogy is,however, slightly different. The sphalerite instead of being dark brown or black as in the Sullivan ore is light green, and not easily distinguished from some of the silicates in the unreplaced rock. The predominant iron sulphide in the Kootenay King ore is pyrite instead of pyrrhotite as in the Sullivan. Both light-coloured sphalerite and pyrite have a lower proportion of iron than have black sphalerite and pyrrhotite, and the Kootenay King ore was apparently formed from solutions with a lower content of iron than was the Sullivan ore.

At the north end of the mineralized zone is a quartz vein a few feet wide. This vein is quite distinct from the main ore zone and occupies a steeply dipping fracture approximately perpendicular to the bedding. In one part of this vein an open-cut has exposed some solid galena, but elsewhere the vein appears to be barren.

On the steep hillside at an elevation of 7550 feet an open-cut exposes mineralization across a width of 15 feet, consisting of a finely crystalline mixture of lead, zinc, and iron sulphides and occurring in a sheared zone having a northerly and southerly strike. A sample taken across a width of seven feet gave the following returns: gold, 0.02 oz. per ton; silver, 6.6 oz. per ton; lead, 19.1%; zinc, 21.9%.

To explore this outcrop at depth, three tunnels have been driven. No. 1 is a crosscut and has been driven for 87 feet at a depth of 35 feet below the outcrop. This tunnel cuts the sheared zone, but the ore is confined to a narrower width than on the surface. A sample taken across a width of 40 inches assayed: gold,0.01 oz. per ton; silver, 5.1 oz. per ton; lead, 14.8%; zinc, 18.1%.

Mineralogy

The following minerals were identified under the microscope; galena, sphalerite, pyrite, and quartz. Another soft, dark gangue mineral was observed but not identified.

Of the ore minerals, the sphalerite seemed to be present in larger quantities than the galena.

Eight specimens were mounted and polished for observation; five of these were superpolished. Great difficulty was encountered in obtaining a smooth enough polish for satisfactory microscopic examination and the taking of pictures. This was the reason for making the superpolished specimens. Photographs showing the association between galena and pyrite were not good because of the relief of the pyrite over the galena. This made the galena appear black at times around the borders of the pyrite.

Galena

The galena was identified by the following properties:

(1) Hardness - soft- scratched easily by needle.

(2) Colour - white.

(3) Triangular pits observed in surface.

(4) Etch tests

(a) $FeCl_3$ and HCl - stained iridescent

(b) KCN, KOH, $HgCl_2$ and HNO_3 - negative

The galena is very finely disseminated in the ore. It appears as very small veinlets cutting the pyrite and quartz, the stringers varying in width from 25 microns to about 500 microns. It is also speckled throughout the quartz, this form constituting about 15 per cent of the galena, the particles averaging about 30 microns in size.

The galena and sphalerite are very closely associated, sphalerite being very commonly found around the boundaries of the galena and right in the galena in sizes of about 40 microns (see Illustration 3).

Sphalerite

The sphalerite was identified by the following properties:

(1) Hardness - scratched by needle, but a little harder than the galena.

(2) Colour - gray.

(3) Carbon-arc lamp - the powder under the lamp showed an amber internal reflection.

(4) Etch tests

(a) HNO_3, HCl, KCN, $FeCl_3$, KOH, and $HgCl_2$ - negative

(b) Aqua regia - a brownish stain produced.

(5) Microchemical test

The potassium mercuric thiocyanate test for zinc was positive.

As noted above, sphalerite was very closely associated with galena. The majority of the sphalerite was observed to be in the quartz. It was also very fine as in the case of the galena, ranging from 25 to 40 microns in size, but never approaching the size of the larger galena stringers.

It appeared to be very clean, no impurities being observed. Chalcopyrite, which is quite commonly found as an impurity in sphalerite, could not be seen anywhere.

Pyrite

The pyrite was identified by its general appearance, colour, and hardness.

It appeared throughout as cubes, which averaged about 175 microns in size.

The narrow spaces between the cubes were filled with galena mostly and quartz and sphalerite in some cases.

Paragenesis

The following facts were observed concerning the age relations of the minerals:

(1) Galena cutting pyrite (Illustrations 1 and 2)

(2) Quartz cutting pyrite (Illustration 1)

(3) Sphalerite bordering galena and projecting into the galena in tongue-like forms (Illustration 3)

(4) Pyrite found as crystals, intimating that the pyrite crystals have grown in their own solution. (Illustrations 1 and 2)

From these facts the suggested paragenesis is that the pyrite was present first, the galena and quartz probably were formed next at about the same time(see illustration 1), and the sphalerite came last. There is some indication of the galena cutting the quartz, but this is not positive. If it is so, the quartz probably preceded the galena. There is also the possibility of two ages of quartz being present.

The assumption that the galena preceded the sphalerite was based on the fact that the galena boundaries were very often surrounded by sphalerite and the sphalerite projected into the galena. This could mean that the galena was first deposited from solution in fracture zones. Another fracturing took place leaving narrow spaces between the galena and surrounding minerals into which a zinc solution came depositing the sphalerite.

Milling Problem

Two problems appear quite evident in connection with the galena:- (1) the recovery will not be high at the usual 200-mesh grind, and (2) there will be a large lead middling product in the flotation. As mentioned previously, approximately 15 per cent of the galena is in a speckled form about 30 microns in size. To release this a grind to about 325 mesh would be necessary, but this might not prove economical. The large lead middling product would be a result of the close association of the galena and sphalerite. On grinding the sphalerite, bordering the galena, would not be completely freed at 200 mesh. Also the very small particles present in the galena would be present in the lead concentrate as impurities.

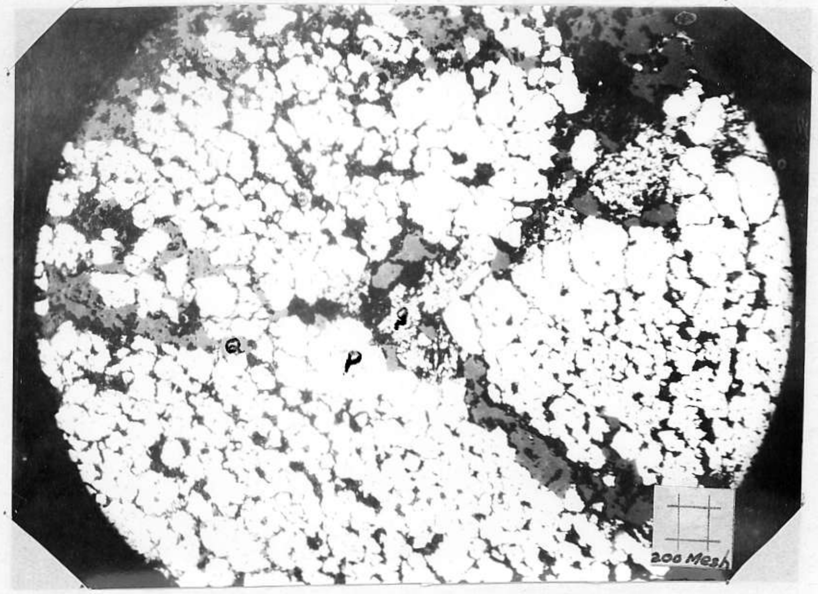

Illustration 1 - 66.7x
Galena and quartz veining pyrite
g, galena - p, pyrite - Q, quartz

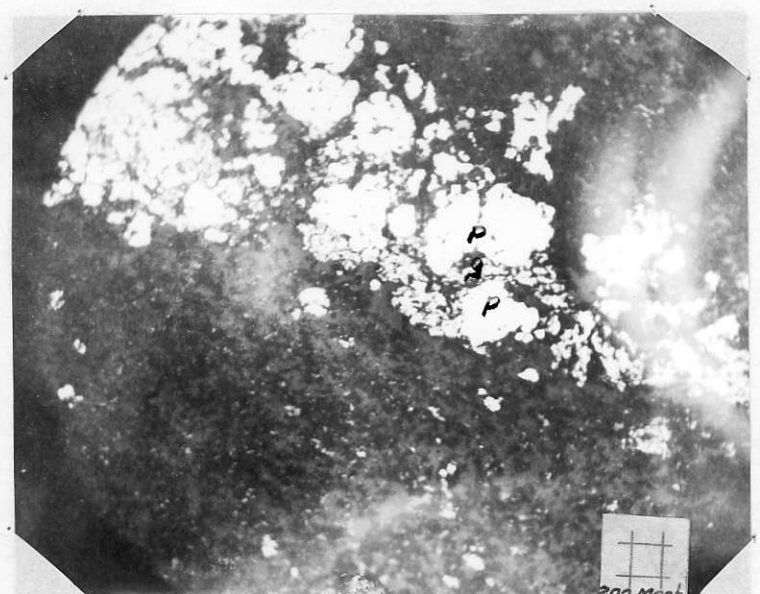

Illustration 2 - 55.5x
Galena veining pyrite
g, galena - p, pyrite

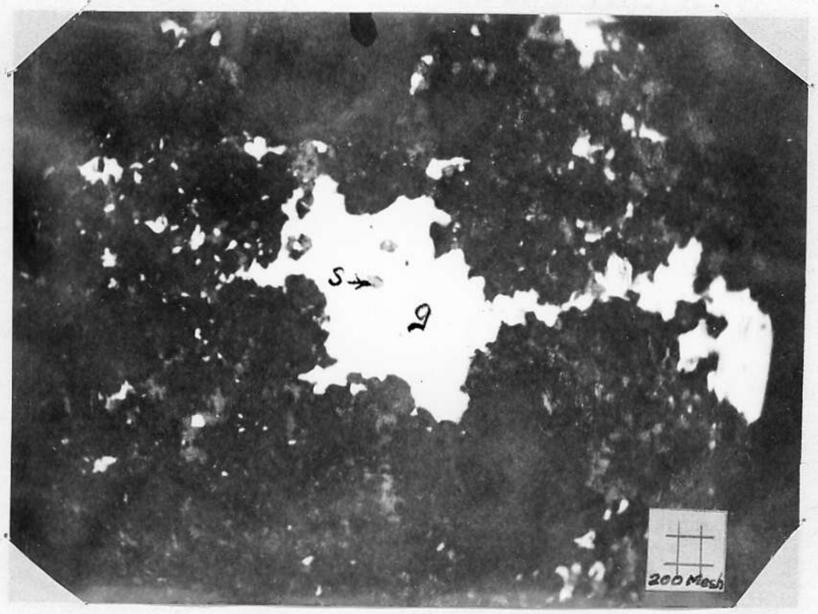

Illustration 3 - 44.5x
Sphalerite inclusions in galena
g, galena - s, sphalerite