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MINERALOGRAPHIC REPORT ON SAMPLES AND POLISHED SECTIONS  
FROM THE COPPER KING PROPERTY, NEAR KAMLOOPS, B.C.

A report submitted to Dr. R.M. Thompson as a requirement for Geology L09.

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## INTRODUCTION

The Copper King property is situated near Cherry Creek, some sixteen miles west of Kamloops, B.C. It is just north of the Trans-Canada Highway, and about one and a half miles south-east of the Glen Iron mine. It has been fairly extensively mined, though sporadically, since it was first discovered in 1897. Its major periods of production were from 1906 to 1912, and from 1938 to 1940. It has produced approximately 7,500 tons of ore, yielding nearly 400,000 pounds of copper, with appreciable amounts of gold and silver. This ore averaged about 3 percent copper, with an average of 0.14 ounces of gold per ton.

The deposit occurs near the contact of part of the Iron Mask batholith and rocks of the Triassic Nicola group which it has intruded. Tertiary volcanic rocks of the Kamloops group overlie these. The batholithic rocks consist mainly of syenite, monzonite, diorite, and gabbro.

Nearly all of the copper deposits in the area are veins, stockworks, and disseminations of replacement origin and mesothermal type. There is some degree of surface oxidation, giving a zone of oxidation about 150 feet deep, with minor enrichment. The Copper King deposit is no exception.

## MEGASCOPIIC DESCRIPTION

The samples available for this problem provided two types, wall rock, and ore samples. Both showed copper mineralization, but are best dealt with separately, for they are of a somewhat different nature.

## Country Rock

The samples of the country rock were taken solely from the igneous Iron Mask batholith. Two of them were massive, holocrystalline, fine- to medium-grained, equigranular, mesotype to leucocratic, and showed a composition banding. This banding was made apparent by colour differences: the overall colour varied between light pinkish-grey and a brick-pink colour. Composition was in general about 80% pink orthoclase, showing subhedral to anhedral crystals; the remaining 20% was made up of mafic minerals, mostly biotite, with a little hornblende, and also of less than 2% metallic minerals. The mafic minerals were considerably altered to chlorite, as shown by the green powder obtained by scratching them.

One of these specimens show<sup>ed</sup> a well developed slickenside on one side, coated with calcite. Both specimens has<sup>d</sup> small fractures in them, usually parallel to the banding, containing chalcopryrite and sooty chalcocite. Both specimens were seen to have some chalcopryrite scattered throughout them in small irregular grains; some magnetite was seen also.

Another specimen showed evidence of strong shearing and brecciation. The breccia consisted of the original rock, but was filled with recrystallized orthoclase; chalcopryrite was noticed here also, mainly concentrated around the breccia fragments. The lineation of this specimen was shown by minute calcite stringers, some of which contained bornite, chalcopryrite, and chalcocite.

All of the country rock specimens showed an almost complete lack of quartz in their mineralogical make-up. The rock can be named syenite, with perhaps a gradation into monzonite where the plagioclase content increases; an increase in plagioclase is thought to account for the lighter portions of the rock. All of the samples showed an ironstained weathered surface; as well as limonite, green malachite stains and black patches of either chalcocite or pyrolusite were apparent.

## Ore

The specimens of ore seem to have come entirely from a mineralized shear zone. It is generally crumbly, black, coarsely brecciated, with fillings of powdery black mylonitic material. The breccia particles consist mainly of cherty fragments and silicified country rock. The cementation is poorly consolidative, and seems to be composed mostly of quartz, with some calcite, limonite, and copper minerals. There is much evidence of shearing, with some well developed shiny slickenside faces.

Examination under the binocular microscope of polished surfaces of this material showed that the matrix was composed almost entirely of quartz, some of which showed good, though small, crystal development. Scattered throughout this groundmass <sup>were</sup> ~~are~~ knots of mineralization consisting predominantly of copper minerals; some of these showed a central area of a dark grey unidentified mineral, and an outer rim of colloform marcasite. Fractures in this material were seen to be filled with calcite, limonite, and copper minerals. Magnetite was seen to be present in the matrix in small quantities, and was identified by its plastic hardness to a steel needle. The copper minerals identified were chalcopyrite, bornite, chalcocite, and covellite, diagnosed in this instance solely by their respective colours.

## Radioactivity

This broken, black ore material was found to be somewhat radioactive, giving geiger counter readings varying from one to five milli-roentgens per hour. The country rock was found to give readings less than 0.02 milli-roentgens per hour, and can on this basis be regarded as not radioactive. None-the-less, slices of each were placed on unexposed film for a period of

time; on development, the film of the country rock was found not to show any evidence of radioactivity. The film of the ore sample, however, showed the presence of radioactive material scattered throughout the sample in irregular patches, with some concentration in the minute fractures running through the rock. (See envelope inside back cover).

Examination of some of the hand specimens showed the presence of a fine bright yellow sub-crystalline material occupying very few of the small fractures. A sample of this material was obtained, and a bead test was applied; this was found to fluoresce under ultra-violet light, giving a yellowish green colour to the bead. No positive test was obtained for vanadium, but the mineral was assumed to be carnotite,  $K_2(UO_2)_2(VO_4)_2 \cdot nH_2O$ .

*Why?*

#### MICROSCOPIC DESCRIPTION

Seven polished sections were used for microscopic examination. These were all of specimens of the black ore material, and all of them showed similar features. A general description can therefore be used to cover all of the minerals and textures observed.

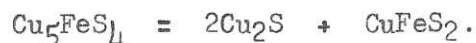
The groundmass was composed almost entirely of quartz, mostly massive and anhedral, though sometimes showing good crystal development, as shown in plate 5. Magnetite grains were scattered throughout the matrix, and in one or two instances showed an irregular rim of secondary marcasite; this was only seen where the magnetite bordered on one of the numerous tiny fractures which traversed the groundmass in all directions. These fractures were filled with calcite or limonite, or both, with occasional copper minerals. In general the matrix took a very poor polish, giving the appearance of being pitted and porous.

The metallic minerals, which nowhere amounted to single masses larger than 10 mm. across, was seen to be of two types, presumed to be early and late, judging by their relationship.

The early minerals consisted of little knots of uraninite (see appendix ii) scattered throughout the quartz groundmass. This occurred in small rounded masses showing equant grains generally arranged in an arc or a ring. Closely associated with the uraninite was another metallic mineral which eluded identification by reason of its small quantity and sparse occurrence. This mineral showed an excellent polish, with high relief indicating that it was hard; it was pinkish-white in colour, and isotropic. The uraninite (plate 6), and especially the unidentified mineral, showed a relict texture, with indistinct boundaries, and numerous intersecting cracks within them. The unidentified mineral was seen to have been replaced by chalcocite in one instance, the chalcocite being therefore of later origin (plate 5).

The second type of mineralization, and presumably a later stage, consisted entirely of copper bearing minerals; identified were: tetrahedrite, bornite, chalcopyrite, chalcocite, covellite, and native copper. These minerals occurred in two distinct environments within the same ore specimen. All of these minerals except native copper were invariably found associated with the uraninite, presumably replacing it. Here the tetrahedrite was the first mineral to be deposited, as it was seen to be replaced by the other copper minerals; tetrahedrite was not abundant (plate 3). Bornite was seen to be replaced by covellite and chalcopyrite; the latter mineral replaced the bornite along its cleavage planes as long pointed laths, amounting to a replacement Widmanstätten texture in some cases (plates 1 & 2). Chalcocite was intimately associated with these three minerals, often forming

a rim around the other minerals. It was always seen to be intimately associated with the chalcopyrite; this is probably explained by the chemical breakdown of bornite, given in the formula:



That the chalcopyrite is replacing the bornite, and is not exsolved from it, is adequately shown in plate 2 by the irregular replacement of bornite by that mineral along a well defined fracture. In one or two instances chalcopyrite and chalcocite were seen to form a graphic intergrowth, showing great irregularity (plate 4); this is indicative of contemporaneous deposition.

The second environment for the copper minerals was in the fractures that cross the quartz gangue in all directions. The minerals were here scattered as irregular masses and stringers, often enlarging from these stringers interstitially into the quartz matrix on either side. In this environment neither tetrahedrite nor bornite were found, but native copper was seen in one instance, presumably produced by reduction of some of the copper minerals already present and deposited in the fractures by circulating reducing solutions. Here again the chalcopyrite and chalcocite were seen to be intimately associated (plate 5), though not to the same degree as shown before. Covellite occurs here, apparently replacing both minerals. In many cases the chalcopyrite forms a rim around a central mass of chalcocite.

#### PARAGENESIS

As can be seen, the paragenetic sequence has been followed<sup>above</sup> to a certain extent; following the evidence of replacement and associations, both in hand specimen and in polished section, the list below summarizes the complete sequence of deposition and formation:



- I Silicification of original shear breccia, with replacement of all of the minerals present with the exception of magnetite.
- II (Deposition of uraninite;  
(Deposition of the unidentified mineral.
- III Deposition of the copper bearing minerals in the following order:
  - i) Tetrahedrite, replaced by
  - ii) Bornite;
  - iii) Chalcopyrite, chalcocite, and covellite; deposited from mineralization, and from the chemical breakdown of bornite, the products from the latter being deposited in fractures, along with small quantities of native copper.
- IV Oxidation, including the formation of marcasite and sooty chalcocite from the minerals present; also in conjunction with calcifying processes to give malachite, as well as the deposition of calcite in the fractures. The carnotite was also formed by this process.

Although the mineralization is somewhat sparse, amounting to less than 2% of the total rock in most cases, it has taken place over a long period of time; it presumably accompanied shearing, and followed it, the shear zones forming conduits for the mineralizing solutions.

As was described in the section on hand specimens, copper minerals were found to be present in the country batholithic rocks; this probably provides the source for the copper minerals found in the shear zones, or at any rate it can be said that both came from the same source. It must be admitted possible that some of the minerals present, with special reference to those in the fractures in the ore samples, may have been formed by a process akin to supergene enrichment, the minerals being leached out of the country rock by circulating waters, and re-deposited in the fractures in the weaker rocks in the shear zones.

The origin of the mineralization is undoubtedly hydrothermal, and the minerals present tend to suggest that it was of mesothermal type. A certain amount of replacement has occurred, but not enough to warrant this

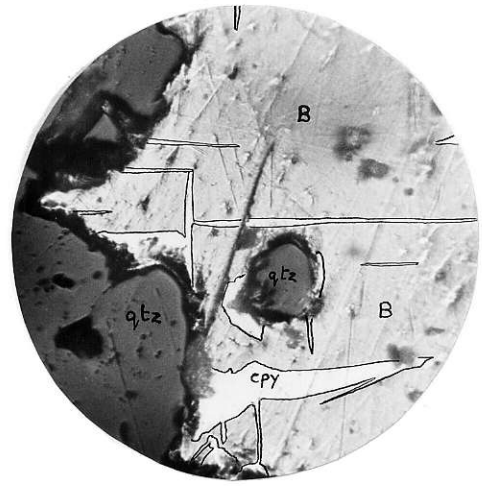
being called a hydrothermal replacement deposit. To the extent that it occupies a shear-zone, it may be called a fissure-filling deposit, yet mineralization has been slight and incomplete as judged from specimens used in this problem. Taking into account the historical descriptions of the Copper King deposit, however, it may be classed as both mesothermal vein and replacement type of deposit.

#### CONCLUSION

The Copper King deposit is a copper deposit consisting of mesothermal vein and replacement types, as well as being situated in part of a batholith containing hypogene copper minerals; supergene enrichment has not played a great part in forming this deposit, although it is in evidence.

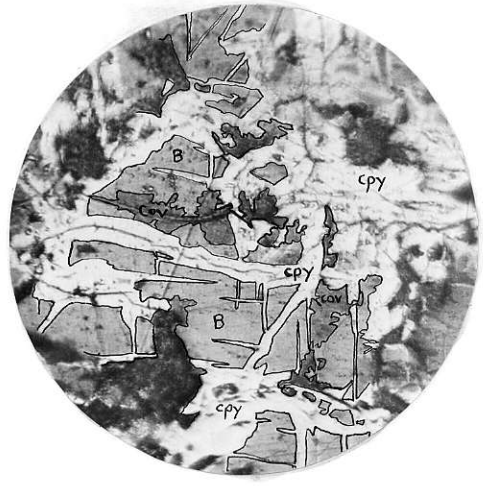
The occurrence of radioactive minerals in this deposit is of purely academic interest; it has no economic importance at present.

APPENDIX I



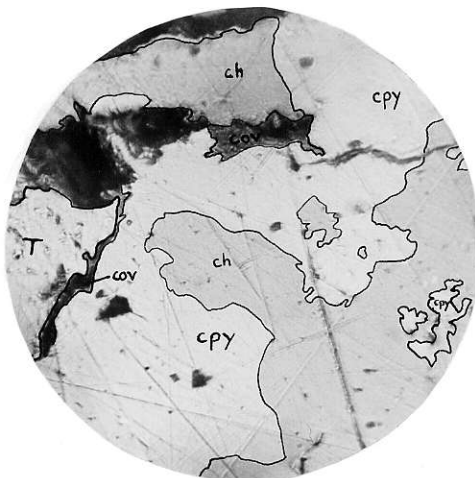
x300

Plate 1. Bornite (B) showing replacement along its cleavage by chalcopyrite (cpy).



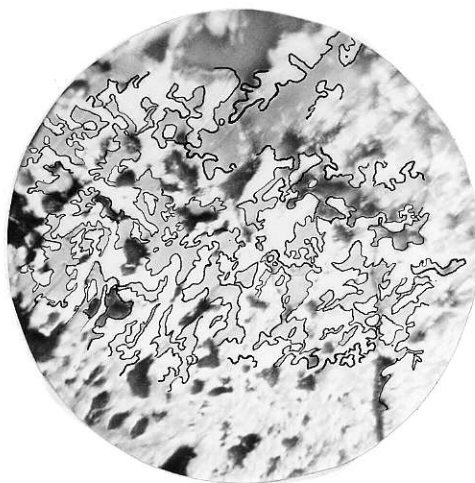
x100

Plate 2. Bornite (B), partially replaced by covellite (cov), being replaced along cleavage and fractures by chalcopyrite (cpy).



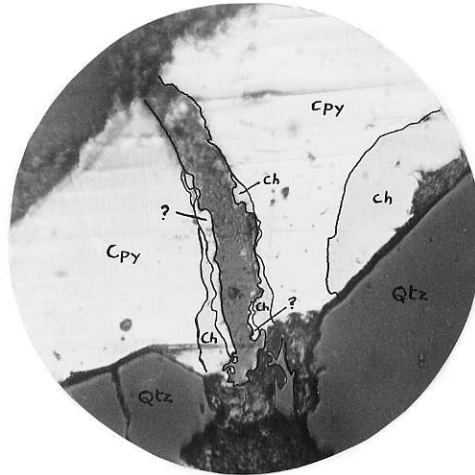
x100

Plate 3. Chalcopyrite (cpy) and chalcocite (ch) showing 'mutual boundaries' texture, suggestion contemporaneous deposition. Tetrahedrite (T) shows a rim of covellite (cov) next to chalcopyrite.



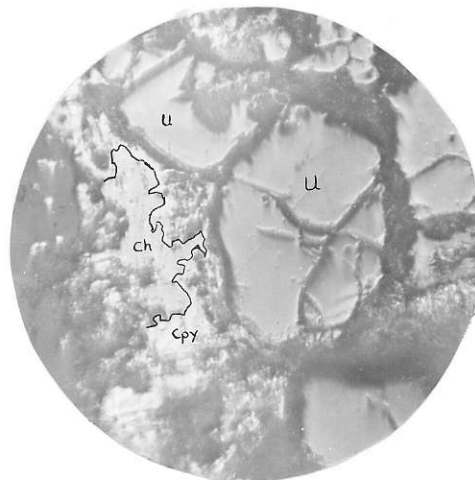
x600, oil immersion

Plate 4. Chalcopyrite (white) and chalcocite (light grey) showing graphic intergrowth, here suggestive of contemporaneous deposition.



x300

Plate 5. Unidentified mineral (?) showing a wide rim of chalcocite (ch) in contact with chalcopyrite (cpy) . The quartz (Qtz) shows good crystal development.



x600, oil immersion

Plate 6. Grains of uraninite (U) showing semi-relict structure in indirect contact with chalcopyrite (cpy) and chalcocite (ch).

## APPENDIX II

Confirmatory test for Uraninite;

Polish	- fairly good
Colour	- grey
Hardness	- very hard; about F, not scratched.
Streak	- none
Texture	- massive, equant, crystalline
Anisotropism	- isotropic
Pleochroism	- none
Twinning	- none
Internal reflection	- none
Texture under crossed Nicols	- isotropic, dark
Cleavage	- none
Association	- not closely associated.
Etch tests:	
HgCl <sub>2</sub>	- -ve
KOH	- -ve
KCN	- -ve
FeCl <sub>3</sub>	- +ve, tarnishes to a greyish-brown.
HCl	- -ve
HNO <sub>3</sub>	- +ve, stains brown in patches.
Aqua regia	-
Microchemical tests	- not applied through lack of material
Other tests	- radioactive;

