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THE STUDY IN HAND SPECIMEN AND IN POLISHED SECTION OF TWO SPECIMENS OF RADIOACTIVE ORE, ONE FROM THE COPPER KING MINE AT KAMLOOPS, B.C., THE OTHER FROM A NEARBY LOCALITY, IN ORDER TO DETERMINE THEIR RELATIONSHIPS TO ONE ANOTHER.

by H. David Wilson

With acknowledgements to Doctor R.M. Thompson, of the Geology Division of the University of British Columbia for his helpful advice and photographs, and to Mr. Paul Seder for his photographs.

Very careful study! Need x-ray check on supergene radioactive minerals.

CONTENTS

TITLE - PURPOSE

THE STUDY IN HAND SPECIMEN AND IN POLISHED SECTION OF TWO SPECIMENS OF RADIOACTIVE ORE, ONE FROM THE COPPER KING MINE AT KAMLOOPS, B.C., THE OTHER FROM A NEARBY LOCALITY, IN ORDER TO DETERMINE THEIR RELATIONSHIPS TO ONE ANOTHER.

I THE COPPER KING MINE [1]

Location

The Copper King property consists of nine crown-granted claims and is situated north of the Vancouver-Kamloops highway about 16 miles west of Kamloops. The property is about a mile south of the Canadian Pacific Railway; the nearest railway station, Cherry Creek, is 2½ miles distant by road.

History

The claims were staked in 1897 and the property changed hands several times, little work being done until 1906, when the owner at that time shipped between 900-1000 tons of ore averaging .3 ounces of gold per ton, and 4.4% copper. The mine passed through several hands and was worked intermittently until, in 1940, fire destroyed the small mill which had been built on the property. The Copper King mine is credited with the production of 7,491 tons of ore, which

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[1] Mostly from Cockfield (1948).

yielded 1,183 ounces of silver, 2,180 ounces of gold, and 391,381 pounds of copper.[2]

Geology

The rocks exposed in the Nicola Map-Area range from Carboniferous to Tertiary in age, and include sedimentary and igneous types, the latter being the most widespread, and comprising both intrusives and extrusives. The copper deposits are abundant in and around the Iron Mask batholith, of Jurassic time or later, which is composed of rocks ranging from syenite to ultrabasics. The Copper King mine is situated in rocks of the Iron Mask batholith.

Mineralogy

The ore minerals of the mine occur disseminated in the country rock along a fracture zone. The country rock is diorite and the ore minerals are chalcopyrite, pyrrhotite, and bornite, with some magnetite. Cockfield (1948, pp. 109-110) says that veins of magnetite show a close connection with iron deposits in the vicinity. Malachite is found in places, and epidote is important in places as a gangue mineral. Of the two specimens studied in this report, one came from a shear-zone in ~~the waste dump~~ an open cut at Copper King; the other from a nearby locality.[3]

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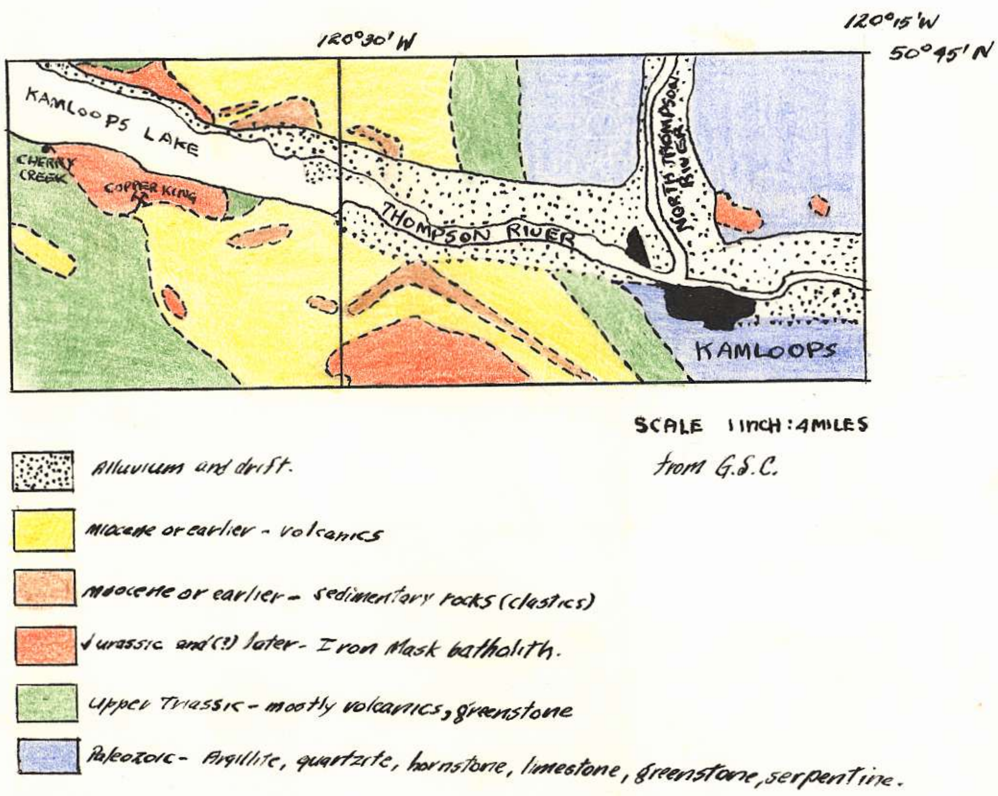
2 B.C. Minister of Mines Annual Report (1956, p. 48) gives the figures as 7,460 tons of material containing about 3% copper and 0.14 ounces of gold per ton.

3 Personal communication from Dr. R.M. Thompson.

Structure

Cockfield (1948, pp. 109-110) reports that the deposit has no defined walls but noticed that a number of fracture planes trended north to northeast and dipped steeply southeast to vertical.

Map of the Area



II MINERALOGRAPHY

MACROSCOPIC

The specimen from Copper King mine measured approximately 3" X 2" X 2" and when received for inspection, had already been cut, polished and mounted in modelling clay. This somewhat obscured the original surface of the sample, but greenish and yellow colors were still visible. This specimen will be referred to as Section 7 in the following pages.

The other sample measured about 4½" X 3" X 3" originally and displayed a number of interesting features. It was multi-colored, showing various shades of brown, red, green, yellow, and blue; but was quite dark in aspect on the whole. It was extremely brittle and in places vuggy. A dull green mineral, in places botryoidal, gave a microchemical test for copper and a bead for uranium. A bright yellow mineral showing a curved prismatic habit, almost treelike, gave tests for copper and uranium. Some dull, chocolate brown crystals, possessing good cleavage in at least two directions, gave a test for iron, copper and perhaps nickel. There was much brown powder present, in colors ranging from reddish to yellowish; it gave very strong iron tests, and was probably the ordinary oxides of iron. A steel grey, metallic, brittle mineral with a hardness of about 4, occurred in dodecahedrons, and had a

What is it.

bluish coating. This mineral gave tests for copper, iron and antimony. Tetrahedrite was later found in polished section. Chalcopyrite was quite obvious in the specimen. A small quartz vein, bearing a little chalcopyrite was seen; quartz was also seen as prismatic crystals imbedded in iron oxide in the vuggy portions. Extremely small transparent crystals were present in small amount and gave no positive tests. This specimen was broken up and the pieces used will be referred to as Sections 1-6 in the following pages.

The polished surfaces of both specimens were remarkably similar in appearance. They were both dark reddish-brown in color and showed colloform textures in the ore minerals. A particularly striking tubercle can be seen on the topside of Section 2. On the bottom of this same section is a banded structure probably due to rhythmic deposition. On most of the sections, veins of quartz can be seen to cut through some of these tubercular structures. It was noticed while grinding that the minerals have larger dimensions in two directions than they have in the third, or in other words, they seem to be flattened out. That the mineralization is in bands can be seen in Section 5.

Both specimens gave strong readings on the Geiger Counter. No primary radioactive mineral was recognized in the hand specimens.

MICROSCOPIC

Mineralogy

1. PITCHBLENDE- grey, hardness about G, isotropic, colloform, shrinkage cracks, HNO_3, U-bead.

2. CHALCOPYRITE- yellow, hardness C, isotropic, HNO_3.

3. TETRAHEDRITE- bluish grey, hardness D, isotropic, HNO_3 stains, KCN brings out scratches, microchemical test gave copper, iron, antimony.

4. SIEGENITE[4]- white, hardness about E.

5. BORNITE- pinkish brown, soft, isotropic, HNO_3 eff., KCN, $FeCl_3$, purple tarnish.

6. COVELLITE- dark blue, soft, anisotropic orange, HNO_3, KCN, under crossed nicols looks scaly, associated with bornite.

7. MILLERITE (?)- yellow (much paler than chalcopyrite), anisotropic blue to pale yellow, associated with siegenite and chalcopyrite; extremely fine grained and scarce, had to observe under oil immersion. Secs. 4,5,6,7.

8. UNKNOWN- (see Plate I)- pale purple under oil immersion. Perhaps CHALCOCITE. Anisotropic. Section 1.

9. SIDERITE (?), ANKERITE (?)- general effervescence on sections. Soft brown mineral seen on the surface of the sections with the unaided eye, especially Section 5.

10. QUARTZ- dark grey, hard, hexagonal outlines, also prismatic with pyramidal terminations.

It should be noted here that none of the minerals polished very well. This made it necessary to use the oil immersion lens for the following observations.

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4 Personal communication from Dr. R.M. Thompson.

Textures and Structures

Colloform textures:

Botryoidal pitchblende showing syneuresis cracks and interference surfaces was the most obvious example of colloform texture. Plate III, which was taken from Section 4, shows an instance where pitchblende encloses an intergrowth of chalcopyrite, tetrahedrite, and siegenite. Siegenite occurs as a thin, fine-grained skin hugging the inner surface of the pitchblende, and also as euhedral crystals within the chalcopyrite. Pitchblende also occurs enclosed by these other minerals. This can be seen in most sections, and a fair example is shown in Plate V from Section 7. Euhedral quartz is present in both examples. In places, the pitchblende occurs alone in quartz. Some of the shrinkage cracks in pitchblende are filled by the other minerals, indicating that these minerals came somewhat later than the pitchblende.

A good example of botryoidal chalcopyrite, although on a small scale, can be seen in Section 1, from which Plate II was taken.

Where pitchblende does not form the outer rim of a tubercle, siegenite for the most part does. A good example of this can be seen in Section 5, where a thin, fine grained skin of siegenite encloses a grain composed mostly of bornite, with chalcopyrite and covellite.

Lattice textures:

A lattice texture exemplified by Plate I of Section 1 exhibits laths of chalcopyrite arranged in an orderly manner in grains of bornite. This lattice texture is seen also in Specimens 2, 3, 5, and 7. In most cases, the laths narrow where they meet, but in some cases they appear to widen, as in a grain which is mostly chalcopyrite. For the latter example, see Section 6. In Section 6, the chalcopyrite seems to be guided in part through the bornite by dendritic "fractures". However, the bornite still possesses the familiar lattice texture, with the laths of chalcopyrite pinching together at the joins. There is in the bornite, besides the larger laths, a very much finer texture of chalcopyrite almost so fine as to be invisible under oil immersion. The dendritic "fractures" do not in every place coincide with the chalcopite "veins", but traverse the bornite unattended by chalcopyrite, and in places cut also across chalcopyrite laths. The dendritic pattern could be caused by veins of an unknown black (in reflected light) mineral, somewhat sooty, instead of by fractures. Another example of this dendritic pattern is seen in Section 1. Here there is no bornite, and the pattern is much denser. A lesser example of the latter is seen in Section 7.

A lattice texture is produced by veins of tetrahedrite in chalcopyrite, predominantly in one direction, but in some places, two. The veins swell at contacts. The grain has an outer rim of chalcopyrite. This lattice texture could have been caused by replacement. This is seen in Section 2.

Rim Textures:

In Section 1, chalcopyrite showing euhedral quartz outlines inside and outside the grain has a rim around the outside of tetrahedrite, which also rims the euhedral quartz inside the chalcopyrite grain. This suggests replacement along grain boundaries.

In Section 2, chalcopyrite showing euhedral outlines of quartz has a solid center of tetrahedrite. This could be "atoll" texture produced by inner replacement of chalcopyrite. Rims of chalcopyrite are also seen around tetrahedrite in Sections 6 and 7.

A variation on the latter texture is seen in Sections 2 and 7, where the bornite-chalcopyrite intergrowth, mentioned earlier, forms the rims around tetrahedrite. Covellite selectively replaces bornite in these examples.

A rather interesting but sole example of its type in these sections was the texture seen under oil immersion on Section 6. Figure 1 was drawn from this and shows a double rim around what was taken to be millerite because of its color and anisotropism. The outer rim is composed of siegenite, which is veined by chalcopyrite of the inner rim. Probably due to shrinkage. Sentence?

Emulsion Textures:

Sections 1 and 7 show an emulsion texture of chalcopyrite in tetrahedrite.

An emulsion texture of tetrahedrite in chalcopyrite can be seen in Sections 1 and 7.

Replacement Veins:

In Sections 2, 3, and 7, what appear to be replacement veins of tetrahedrite occur in chalcopyrite. They do not appear to be guided by fractures and in Sections 2 and 3 occur seemingly at random. The guided replacement in Section 7 was discussed above under "Lattice Textures".

Section 2 shows replacement of tetrahedrite by chalcopyrite guided along fractures. This particular texture was seen only on this section and in a very limited part of it.

Selective Replacement:

Covellite selectively replaces bornite, leaving chalcopyrite. This is seen in all sections where bornite and chalcopyrite are present as an intergrowth. The replacement is of supergene origin.

Comb Structure:

In Section 7, there is one quartz vein which, under crossed nicols, suggests that comb structure is present.

Doubtful textures:

There were textures seen, which, because of the inferior polish or the extreme fineness of the textures, could not be identified.

Sections 4, 5, 6, and 7 showed an intergrowth of chalcopyrite and the mineral identified as millerite. Because of the extreme fineness, the texture could not be identified. There was a strong association here of siegenite with a lesser one of tetrahedrite and bornite.

Section 1 showed an intergrowth of a white mineral in tetrahedrite. The texture was too fine to define precisely, but there appeared to be lath-shaped bodies aligned side-by-side of the white mineral and also polygonal shapes caused by stringers of the same mineral in the tetrahedrite.

Post-ore fracturing is evident in all the sections.

III PARAGENESIS

The minerals seem to have been deposited rhythmically, from the megascopic evidence of Specimen 2. Within one cycle, the order seems to have been: pitchblende - siegenite - chalcopyrite, millerite, tetrahedrite, bornite - quartz. This latter arrangement can be seen in some of the tubercles; for example, Sections 2, 4, and 5. Tetrahedrite and chalcopyrite seem to replace one another; any one could overlap the other. There is the problem of the later quartz veins cutting through pre-existing structures, as can be seen in almost all the sections. This could be the result of stress applied to the partially crystalline vein material, collapsing the tubercles (notice the broken pitchblende structure in Plate IV) and ejecting the fluids from them. The veins were found to carry the same minerals, barring perhaps pitchblende, as the tubercles.

Covellite is definitely the latest mineral and its supergene origin is attested to by its scaly, patchy appearance and its affinity for bornite.

IV TEMPERATURE OF DEPOSITION

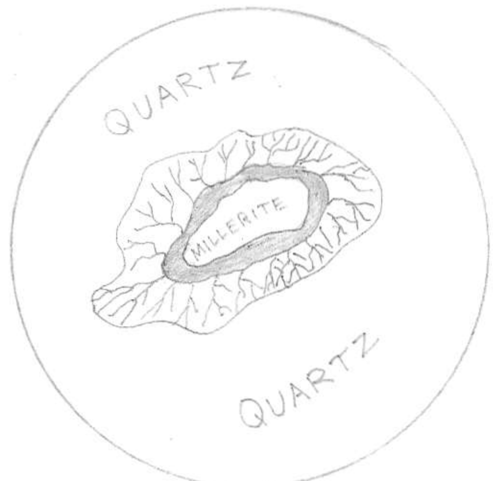
In this regard, the interpretation of textures is critical. In particular, if the intergrowth between bornite and chalcopyrite is regarded as being indicative of exsolution, the temperature of formation of these minerals according to Edwards (1954, pp. 102-103), would have to be over 475° C. Although Edwards (1954, p. 160) says that colloform textures are not of much value in estimating the temperature of deposition of hydrothermal ores, the general appearance of the minerals in the sections and the vugginess of the hand specimens suggest more strongly a low temperature [+ pressure ?] of deposition. However, this vugginess could have been caused by the leaching action of the strongly-evident weathering processes.

V CONCLUSION

Although the history of this particular deposit is somewhat obscure, the evidence given by the mineralogical and textural features of the two specimens proves that they are directly related to one another. The probability that two such deposits could occur in such a limited area and not be directly related, is infinitely small.

Whatever relation these radioactive deposits have to the copper deposits of the Copper King mine itself was not made evident during this study.

FIGURE 1.



Drawing from Section 6. Shows grain with a core of millerite, inner rim of chalcopyrite, and outer rim of siegenite, being veined by the chalcopyrite. Radial texture probably due to shrinkage. Oil immersion.

X 800

PLATE I - Photograph from Section 1. Oil immersion 1/7 a, 5 seconds, no eyepiece. T- tetrahedrite, B- bornite, C- chalcopyrite, U- unknown (chalcocite?)

X 650

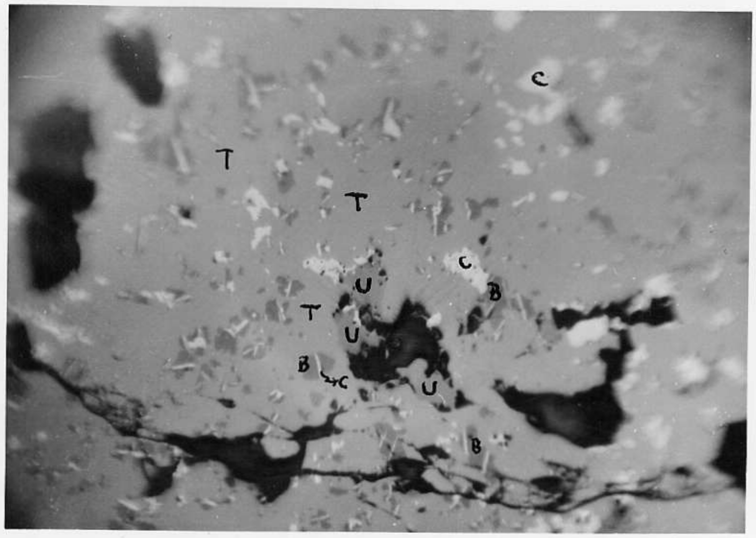


PLATE II - Photograph from Section 1. Botryoidal chalcopyrite in gangue of quartz. Medium power, 3b, 3 seconds, no eyepiece. X 85.

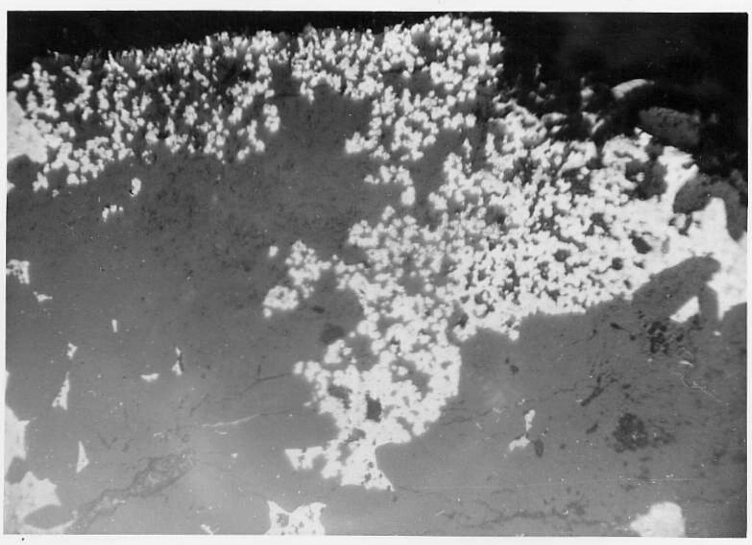


PLATE III - Photograph of Section 4. Colloform pitchblende enclosing chalcopyrite, tetrahedrite, siegenite, and euhedral quartz. Medium power, 3b, 3 seconds, no eyepiece. X 85.

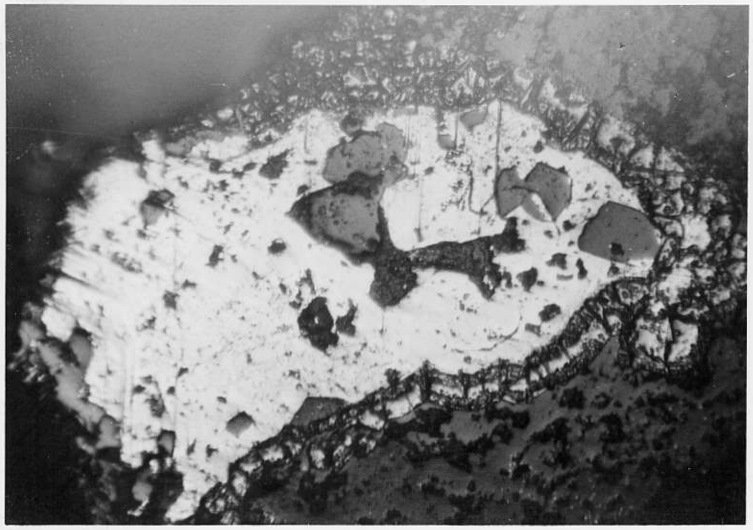
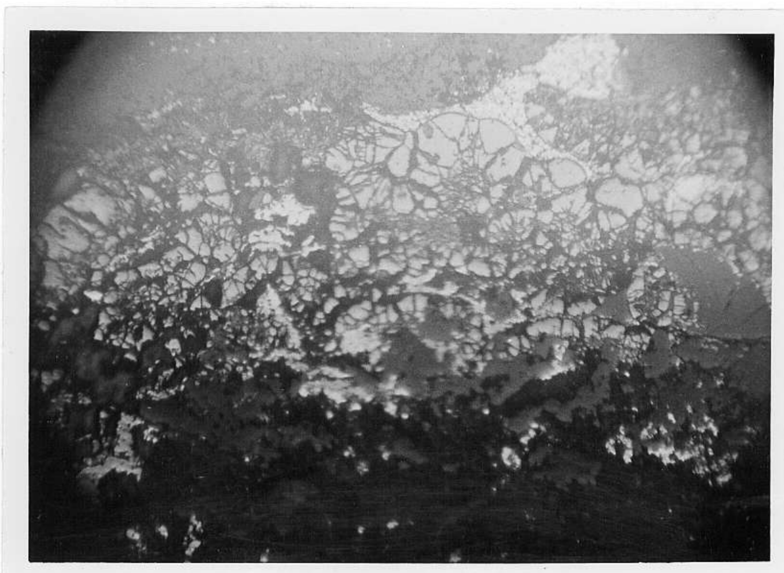


PLATE IV - Photograph from Section 7. Colloform pitchblende with chalcopyrite, tetrahedrite, siegenite and quartz. X 65

PLATE V - Photograph from Section 7. Colloform pitchblende with chalcopyrite, tetrahedrite, siegenite and quartz. X 65.



BIBLIOGRAPHY

BASTIN, E.S., "Interpretation of Ore Textures", Geological Society of America, Memoir 45, 1950.

B.C. MINISTER OF MINES ANNUAL REPORT, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1906, 1908, 1909, 1913, 1919, 1922, 1923, 1924, 1929, 1930, 1935, 1939, 1956.

COCKFIELD, W.E., "Geology and Mineral Deposits of Nicola Map-Area, British Columbia", G.S.C. Memoir 249, 1948.

DANA, J.D., "Manual of Mineralogy", sixteenth revised edition, by Cornelius S. Hurlbut, Jr., John Wiley and Sons, New York, 1956.

EDWARDS, A.B., "Textures of the Ore Minerals and Their Significance", Australasian Institute of Mining and Metallurgy (Inc.), Melbourne, 1954.

HEDLEY, M.S., and de P. WATSON, K., "Lode Gold Deposits of Central Southern British Columbia", B.C. Department of Mines, Bulletin number 20, part III, 1945.

SHORT, M.N., "Microscopic Determination of the Ore Minerals", U.S.G.S. Bulletin 825, 1931.

THOMPSON, R.M., personal communications.