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Item 18

REPORT ON THE GEOLOGY OF THE COPPER BASIN PROPERTY OF THE COPPER CANYON MINING CO.
BY J. C. JONES.

THE COPPER BASIN PROPERTY OF THE COPPER CANYON MINING CO.

Approximately eight days were spent in an examination of this property located about eight miles south west of Battle Mountain, Nevada. The object of the examination was to determine the principal geologic factors that had caused the deposition and extent of the copper ores. The information gathered, while more or less fragmentary, should aid in the further development of the property.

The rocks exposed on the property fall naturally into two groups; the sedimentary series composed of shales, sandstones and quartzites; and the intrusive quartz monzonite porphyry and diorite. The sediments are but a part of the thicker series occurring in the vicinity. J.M.Hill gives the following general section; (page 66, Bull. 594, U.S.G.S.)

Thin and thick bedded, medium to gray limestones	2000 feet
Medium and fine grained, red-brown conglomerate with red and yellow micaceous sandstones at top	1500 "
Vitrous white quartzite, weathers in red and brown colors	1000 "
Black shales with red sandstone at top	thickness unknown.

The limestones outcrop just beyond the northern edge of the property on a high ridge running to the east. The upper beds of the sandstones underlying include a number of thin beds of limestone and appear on the Surprise Claim and again at the extreme south east of the property on the Bluebird Claim. Very little of the massive white quarzite occurs on the property and the sedimentary rocks are practically confined to the second member of the section given.

The sedimentary beds dip rather uniformly to the east at an angle of 45°, the strike being a few degrees east of north. The only point where the dip and strike diverged noticeably from this general direction was in the open cut on the Carrissa where a minor fold apparently arches over the nose of the ridge to the south.

There are several faults with a general northerly trend that tend to duplicate the section. One of these passes through the gulch just west of the Surprize Claim at the north, is cut at the entrance of the long tunnel on the Copper Queen, and apparently is just being entered at the face of the long tunnel on the Raven. Another passes along the eastern edge of the property. Another has been cut by the tunnel on the Buena Ventura, the Widow incline follows still another, and doubtless there are others that could be accurately located should it be desirable to make a detailed geological survey of the property. With the exception of the Widow incline wherever

these faults have been intersected in the openings they have been zones of crushed and altered material twenty feet or more in width and without very definite walls. As far as could be observed they have little relation to the copper ores although they served as channels for later solutions that deposited a little gold.

The quartz monzonite porphyry occurs as dikes cutting the sandstones and other sedimentaries. The dikes vary in width from a foot or so to large masses up to eight hundred feet across. The porphyry is characterized by large rounded crystals of quartz and rectangular plagicolase feldspars embodied in a fine grained ground mass composed of quartz, orthoclase, plagioclase, hornblende, biotite and magnetite. When fresh the rock has a greenish cast and is easily recognized, but the bulk of the porphyry has been altered to a grayish white color due to the kaclinization of the feldspars and the bleaching of the dark colored minerals. When intensely altered it is practically impossible to distinguish it from the pebbly phases of the sandstones similarly altered. Usually, however, the rectangular outline of the feldspars is retained and as the porphyry is massive and cut by many thin seams of quartz running in all directions through it while the alteration of the sandstones is rather a general silicification they may be generally separated.

The diorite is dark greenish, coarsely crystalline, and even grained, and is frequently cut by a network of veinlets of iron sulphides. It is composed of actinolite, biotite, epidote, magnetite, and clouded plagioclase. Originally it contained hornblende but this has been altered to actinolite and epidote probably at the time the veinlets of pyrite and pyrrhotite were introduced. The diorite is found in the long tunnel on the Copper Queen and Elvira claims and at the northern end of the Linda Vista. It probably represents the main mass of the intrusive rock underlying the area while the porphyry is the border phase that came in immediate contact with the sedimentary rocks. The gradation between the diorite and porphyry can be observed on the southern end of the Elvira Claim.

The immediate effect of the intrusion of the diorite and porphyry upon the sedimentaries was rather slight. Only on the Copper Queen and Copper King claims were the rocks altered extensively. Here the presence of the thin beds of limestone permitted the development of considerable garnet, epidote, pyroxene, and a little chalcopyrite. The limestone beds have in some instances been completely replaced by the minerals mentioned. Unfortunately the amount of copper deposited at this point is slight and little or no ore of shipping grade can be expected here. While a typical contact metamorphic deposit yet it is the only one on the property. Apparently only the diorite formed this type of deposit and had it come in contact with the massive limestone a few hundred feet above possibly much larger bodies of ore would have been formed.

In the vicinity of the porphyry dikes the only evidence of alteration is the general silicification of the sandstones and the development of occasional bunches of chlorite giving the sandstones a greenish cast. The porphyry occurs in the vicinity of practically all of the openings in which ore is found. At the glory hole on the Sweet Marie the porphyry occurs to the north, west, and south, and several dikes have been cut in the workings.

The leases on the Raven and Daley have the porphyry to the east and south, while a dike occurs to the south of the lease on the Henrietta, and others near the leases on the Empire. With the single exception of the glory hole, however, the ore is at a considerable distance from the dikes and the relation between dikes and ore does not seem to be an immediate one. Nevertheless the dikes are of some value as indicators of ore deposits though the search must cover a considerable area in their vicinity.

The occurences of copper ore may be grouped in five types: the contact metamorphic deposit already mentioned on the Copper Queen; as quartz-chalcocité veins; as irregular lenses of chalcocite in the chloritized and silicified beds of the sandstones; as disseminated chalcocitized pyrite in the softened and altered sedimentaries; and as individual beds of sandy shales impregnated with the copper carbonates. All of the types save the last have been deposited by ascending solutions and are primary in origin.

The veins are most typically developed in the leases on the Raven and Daley claims. On the Goss lease a shaft has been sunk on a quartz chalcocite vein dipping 80° south and striking south 58° east. It varies in width from a few inches to a foot or so and contains quartz and chalcocite which has partially weathered to cuprite, forming a high grade ore. The ore is somewhat irregularly distributed through the vein in lenses but the vein fissure is constant and easily followed. An examination of a polished slab of the ore showed that pyrite was the original sulphide mineral. This has been almost completely replaced by the chalcocite and only a few fragments of the pyrite remain. In many instances the fragments of pyrite have a narrow film of bornite between the chalcocite and the pyrite indicating that the replacement progressed by stagessas the iron was taken into solution by the copper bearing waters. All of the veins observed had the same general dip and strike as the one mentioned and they appear to be persistant. They can probably be followed both vertically and horizontally until they enter the porphyry.

The irregular lenses of chalcocite are most typically shown in the glory hole on the Sweet Marie. They occur as two sub-types; either as large bodies in the greenish chloritized sandstones or as smaller but much more numerous bunches in the coarser grained beds of the sediments. One of the larger bodies was discovered in the "tunnel cut" west of the north incline. The body was roughly lenticular in outline approximately four feet in breadth and ten to fifteen feet in diameter. It was cut on the south by the fissure followed by the incline but feathered out on the other edges. It dipped 45° to the east following the bedding of the sandstones and was discovered on following the fissure from the surface cut by a short tunnel.

The principal vein followed by the inclines and the underground drifts is a somewhat poorly defined fracture line dipping about 30° to the east and with a strike varying from 40° to a few degrees east of north, approximately parallel to the strike of the sandstones. In the coarser and more silicified beds cut by the fissure bunches of chalcocite up to twelve inches in diameter occur with but slight intervals between forming a shipping grade of ore. The drift south from the bottom of the north incline follows such a bed to the intersection with the underhand stope between the inclines. The drift to the north on the intermediate level from the same incline has followed another bed. There are probably three or four such beds cut by the present workings, the two mentioned and the two in the surface cuts to the west in the

glory hole, and there are surface indications that there is at least one more to the east that has not yet been intersected by the present openings.

The chalcocite ore on the Rice and Dollinger lease on the Daley claim, the open cut on the McDonald property just west of the property, and the lease on the Henrietta have a similar occurrence. Usually a finer grained bed underlies the ore bearing bed and a surface cut on the western side of the Humboldt claim showing a few copper stains at present in a fine grained bed underlying a coarser sandstone offers an opportunity to test the value of such an occurrence as an indication of an ore body of this type.

An examination of polished slabs of the ore from the glory hole disclosed a few fragments of pyrite almost completely replaced by chalcocite. Here the replacement seemed to be direct as but few specks of bornite could be seen. The chalcocite in turn is seamed with cuprite and stained by the copper carbonates from the action of the surface water.

The fourth type of deposit, the disseminated chalcocite in the altered sandstones, is best shown in the crosscuts into the foot wall of the glory hole. The various crosscuts show that back of the ore zone followed by the drifts and stopes there is a zone 60 to 100 feet in width where the sedimentary rocks have been intensely altered and kaolinized. In the crosscut on the lower level back of the north incline these altered beds have considerable disseminated pyrite and are cut by a network of stringers of quartz and pyrite up to one inch in width. For the most part the pyrite in the stringers and disseminated through the altered sediments is partially or completely replaced with chalcocite. Occasional bunches of chalcocite similar to those distributed in the coarser grained beds furnishing the ore at present also occur. Seams of halloysite, a clay like mineral, containing pyrite in perfect cubical crystals intersect the stringers of quartz and occasionally follow along them. At times the pyrite associated with the halloysite completely fills the fissures as a mass of friable crystals.

Chalcanthite, a copper sulphate resulting from the leaching of the ore above, occurs on the clayey walls of the crosscut and at times on the faces of the pyrite crystals. In the latter case the faces of the crystals are perfectly fresh with no indication of tarnish or replacement of the iron by copper. Occasionally near the vein the crystals are somewhat affected demonstrating the possibility of the formation of chalcocite by the surface waters. It is evident however, that the main period of the replacement of the pyrite in the quartz stringers and disseminated throughout the altered rock occurred before the development of the halloysite veins. As halloysite is generally formed through the action of the heated waters it is probable that it was deposited by the later period of mineralization connected with the gold ores associated with the faults. As a study of polished sections of the chalcocite ore shows it to be entirely similar to that found elsewhere in the mine the conclusion is warranted that it too belongs to the earlier period of mineralization related to the intrusion of the porphyry.

A short cross cut at the bottom of the ten foot shaft below the lower level discloses entirely similar conditions. Briefly summing up the history of the disseminated deposits it would appear that closely following the intrusion of the porphyry copper bearing solutions percolating the sandstones replaced the pyrite by dissolving out the iron and depositing copper forming chalcocite,

the pyrite having been first introduced at the time of the intrusion of the dikes. At a much later period heated solutions that may have been associated with the flows of rhyolite and andesite found capping the older rocks in the district, rose through rocks, softening and altering them to their present condition, and depositing the halloysite veins with the second generation of pyrite. Finally the surface waters have carried the copper sulphate down from the weathered ore above and has deposited it on the walls of the cross cut.

The crosscuts from the surface and intermediate levels have all the ear marks of being leached. The pyrite has been entirely oxidized and the rocks are stained with the iron oxide. A few samples were taken from the intermediate cross-cut and found to carry from a trace to one percent of copper, the higher values being associated with the streaks of iron oxide marking the former position of the quartz-pyrite stringers.

Wherever any of the previously mentioned chalcocite ore have been examined it has been found that the chalcocite has originated as a replacement of previously existing pyrite and it is necessary to determine whether the copper has come from solutions originating in the depths of the earth or whether they have been the surface solutions resulting from the leaching of the portions of the ore bodies now removed by erosion. In other words whether the ore is primary or secondary in origin. If secondary the deposits may be expected to diminish in value at a shallower depth than if they are primary.

As has already been stated it is believed that the chalcocite is primary in origin. The data accumulated that bears on the question is as follows: the chalcocite is massive and occasionally shows cleavage lines that indicate its formation through the replacement of bornite; in some instances the bornite is still present and as a rule the sequence in the formation of chalcocite from pyrite by ascending solutions follows the gradual replacement of the iron forming chalcopyrite-bornite-chalcocite. In the disseminated ore it has been clearly established that the chalcocitization of the pyrite preceded the second period of mineralization which formed the halloysite-pyrite veins; finally the present surface waters have just begun to attack the pyrite on the lower level and could not have possibly caused the chalcocite that has largely replaced the quartz-pyrite stringers and disseminated pyrite.

The carbonate ores however have resulted from the weathering of the ores previously mentioned and are secondary in origin. The copper that has been leached has been largely redeposited in the finer grained beds that contained more or less clay. The selective action of the clay is well illustrated by the porphyry at the shaft at the southern end of the Eagle claim. Here the feldspars have been altered to kaolin while the remaining minerals are still rather fresh. The altered feldspars are stained green by copper carbonates while the remainder of the minerals have no copper deposited on them.

Wherever the finer grained beds have come in contact with the veins or lenses of chalcocite ore they are frequently permeated with the copper carbonates for a distance of twenty to fifty feet in either direction and have furnished a large amount of the ore shipped to the present . The carbonate ore is however limited in depth. Much of the chalcocite weathers directly to cuprite, the red oxide of copper. The cuprite is closely associated with the chalcocite and does not migrate to any great extent, being usually found within a few inches of the chalcocite from which it was formed. It is apparently a rather reliable indicator of the near vicinity or former presence of the chalcocite.

In searching for further bodies of the high grade surface ores the following principles are indicated: Wherever the east-west quartz-chalcocite veins occur they should be followed to their intersection with the finer grained sedimentaries which should be found impregnated with the copper carbonates for a considerable distance on either side. Usually there is enough high grade chalcocite ore in the veins to pay the cost of development. The veins should be carefully distinguished from the post mineral fissures that frequently have a similar course. The latter are of some value however as they frequently, as in the glory hole, intersect bodies and bedded deposits of the chalcocite ore.

Wherever a coarse grained silicified sandstone overlies a fine grained bed in the vicinity of dikes, especially if some copper stains are present, there should be enough surface work done to determine the presence or absence of a bedded deposit of chalcocite such as has been developed in the glory hole. Such an occurence has been mentioned on the Humboldt claim.

While a considerable tonnage of shipping ore is still to be won from the high grade ores yet in my opinion the greater possibilities lie in the large body of lower grade ore appearing in the foot wall of the glory hole on the lower level. As far as can be judged from the present openings there is a very good possibility of developing a body of ore large enough to justify the installation of a mill and smelter. I would advise the sinking of the north incline along the eastward dipping bedding fault at least fifty feet and driving a crosscut to the west to the foot wall of the disseminated ore. If the size and grade of the body continues at this depth further exploration will be justified until the limits of the ore body is known and a final judgment reached.

Respectfully submitted,

(Signed) J. C. JONES.