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BETHLEHEM COPPER--A PORPHYRY COPPER DEPOSIT IN B.C. by W.H. White

The current operation of Bethlehem Copper Corporation has revived keen interest in an area of copper mineralization that has been known and casually explored for over half a century. Compared to many mining camps, Highland Valley is very favorably located on a broad rolling plateau, easily reached by road either from Ashcroft, a railroad town on the Fraser River 30 miles to the northwest, or from Merritt, 40 miles to the south.

Highland Valley is within a metallogenic province extending from the Border north to Kamloops that is dominated by copper mineralization. Despite widespread drift cover and concealing Tertiary basalts, this region is known to contain literally hundreds of copper showings, plus the great Granby Mine at Copper Mountain. Certainly within this region other important ore bodies must exist, but their discovery is not an easy task.

Geology

Highland Valley is in the Guichon batholith, one of the smaller intrusions that fringe the eastern side of the Coast Range Batholith. The Guichon batholith is about 40 miles long in a northerly direction and 16 miles wide. It intrudes Upper Triassic volcanics of the Nicola Group and near Ashcroft it is unconformably overlain by Middle Jurassic sediments. Thus it is distinctly older than many of the granitic bodies of B.C. The main rock type is quartz diorite. Patches of Middle Tertiary basalt, in places, cap the older rocks.

On the Bethlehem property "older quartz diorite", typical of much of the Guichon batholith, is cut by a complex conveniently referred to as "younger intrusions". Rocks of this complex, gradational in composition and of slightly differing ages, include granite, hornblende quartz diorite, leuco quartz diorite, coarse-grained porphyry, and fine-grained porphyry. The porphyries and, to some extent, the hornblende quartz diorite form irregularly tabular bodies, but the leuco quartz diorite tends to form masses of roughly equi-dimensional outline. The rocks of this complex, particularly the porphyries have distinct volcanic aspects. One theory that explains the nature and distribution of the "younger complex" is that it is a crypto-volcanic structure related to Upper Cretaceous or even Lower Tertiary vulcanism.

What may be considered a still younger rock type is the rock referred to simply as "breccia". Originally believed to be some kind of intrusion breccia, this is now known to be a shatter breccia made up of fragments of all rocks of the area cemented by comminuted quartz, feldspar, mica, and other minerals. Breccia is important because wherever seen, it has carried copper mineralization. It is best exposed in the Iona zone where it forms a mass some 800 feet wide and 1,500 feet long, but it is developed in patches in the Jersey zone, and probably in the Simons zone as well. The origin of the breccia is a mystery. At this stage of development it does not seem to be a fault breccia. Perhaps it is related to deep-seated volcanic disturbances.

Structure

Wherever there is mineralization, the rocks are closely jointed. In places only one northeasterly-striking set of joints is developed, but more commonly several sets of closely-spaced joints are present. Faults are not uncommon in and near the mineralized zones. These tend to have north to northeasterly strikes and steep dips either way. A prominent group of sub-parallel faults strikes about North 20° East through the Jersey zone, and another major fault may underlie the drift-filled valley immediately east of the Iona zone. Many of the faults are pre-mineral in age.

Mineralization

Although copper minerals can be found sparsely disseminated in nearly any kind of rock in the Highland Valley area, important concentrations appear to be associated closely with rocks of the "younger complex", particularly where such rocks are thoroughly brecciated or jointed.

The main areas of mineralization on Bethlehem property are referred to as the Iona zone, Jersey zone, Simons zone, and the Snowstorm-White zone. Metallic minerals include hematite, chalcopyrite and bornite and small amounts of molybdenite. Pyrite is almost absent except in the northern end of the Jersey zone. Non-

metallic gangue minerals include secondary micas, tourmaline, epidote, zeolites, and small amounts of carbonate. Introduced quartz is not abundant.

The Iona zone is nearly all closely-jointed breccia. Some copper minerals occur in the matrix or even in fragments of the breccia, but the greater proportion are present as fillings of joints and faults. The Jersey zone has prominent fault zones cutting well-jointed rocks, but only local areas of breccia. Mineralization is disseminated in the altered and jointed rock, but vein-like bodies of massive chalcopyrite or bornite as much as six inches wide occupy fault zones. These are more common here than in the Iona zone. Thus far, the Simons zone has not been extensively explored. It is a large zone of well-jointed hornblende quartz diorite containing widely disseminated copper minerals and perhaps one or more narrower zones of more concentrated mineralization. Small amounts of high-grade bornite-chalcocite ore was mined in the past from small workings on the Snowstorm claim. This is a different kind of occurrence. The rock is older quartz diorite cut by porphyry dykes. The ore occurred in restricted "pods" within a branching shear or fracture zone that has a north to northeasterly strike and a steep dip to the east. These fractures are similar to and may be co-extensive with a mineralized, sheeted zone about 1,800 feet to the south, called the White zone.

Exploration

During the period June to September, 1955, a program of surface stripping and bulk sampling was carried on. This was considered necessary because of the high degree of surface oxidation and the disseminated and locally irregular nature of the mineralization. The Iona zone was cross-cut by three bulldozer trenches. These were 18 feet wide and ranged in depth from 6 to a maximum of 40 feet. The aim was to reach relatively fresh rock for sampling. Samples were cut from a smaller trench blasted and excavated in the floors of the main cuts. Each 20-foot sample weighed about 2,200 pounds. An old 280-foot adit driven at shallow depth in the Iona zone also was bulk sampled by drilling and blasting a channel along one wall. One trench on the Jersey zone was bulk sampled; others were made for inspection. All samples were cut down to a manageable size by passing through a small crusher and triplex splitter. The following statistics may give an idea of the scale of the operation:

Total length of bulldozer trenches	6,900 feet
Total yardage excavated (about half rock)	54,520 cubic yards
Total length bulk sampled	3,360 feet
Total weight of bulk samples	233 tons

At the present time, a program of NX and BX diamond drilling is proceeding under direction of the American Smelting and Refining Company. Two heavy machines are working steadily and to date eight holes totalling about 4,000 feet have been completed.

Exploration Results

From the results of the bulk sampling, it is estimated that the Iona zone contains 113,000 tons per vertical foot of material grading 0.49 per cent. copper. About 25 per cent. of this tonnage is material grading better than 0.70 per cent. copper. The estimate for the Jersey zone, of a distinctly lower order of accuracy because it is based on less extensive exploration, is 53,000 tons per vertical foot grading 1.00 per cent. copper. To the copper values may be added molybdenite present in amounts ranging from $\frac{1}{4}$ to $\frac{1}{2}$ pound per ton. Very low values in gold and silver are present but may not be recoverable.

Thus far, the drilling by A.S. and R. has been done mainly to delimit mineralized zones and to gain sub-surface information on the distribution of favorable rock types and structures. It is too early to assess the results in detail. However, it may be stated that holes within the mineralized zones show that primary mineralization, similar in grade to the surface persists to depths in excess of 300 feet.

Summary

The mineral deposits of Bethlehem Copper have many of the characteristics of the "Porphyry Copper" type of deposit. The mineralization is disseminated in closely-jointed rock that is more-or-less hydrothermally altered; it is related intimately to minor intrusions that have volcanic features; the copper minerals are accompanied by molybdenite in small amounts; and the deposits are very large but very low grade. However, these deposits differ from most Porphyry Copper deposits in several ways: ~~Pyrite enrichment has not occurred~~. A great deal of exploratory work remains to be done before the commercial possibilitiesof these copper deposits can be evaluated. However, the work done thus far warrants optimism in the future of the camp.