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THE KRAIN COPPER PROPERTY

HIGHLAND VALLEY, BRITISH COLUMBIA

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ABSTRACT

The Krain porphyry copper prospect, located 10 km north of the Bethlehem mine, has been explored intensively over the past 20 years. Reserves of 15 million tons grading .55 percent copper are indicated, and little hope remains for discovery of additional tonnage.

Krain is unique in the district in that it is partly covered by postmineral volcanics beneath which a copper enriched oxidized capping has been preserved. Despite total oxidation of primary sulfides, no significant enrichment in the form of chalcocite has occurred due to the acid neutralizing reaction of secondary calcite, which has greatly retarded the downward migration of copper.

Also unique at Krain are clear genetic and spatial ties between zonal patterns of mineralization,

alteration, and fracturing, around a quartz diorite stock which resembles the Bethlehem phase of the Guichon Batholith.

Postmineral faulting is significant.

LOCATION

The Krain property is located on the east flank of North Forge Mountain about 10 km north of the Bethlehem mine in Highland Valley district.

Latitude	50^{o} 35' N
Longitude	120^{o} 58' W
Elevation	5700' (1750 m)
N.T.S.	92I/10W

HISTORY

The earliest history at Krain is not known except that in 1907 it was named the Keystone Group, and a 5 m adit existed. Little more was done until development of the Bethlehem mine commenced in 1955, and prospects in the district began to attract the attention of mineral exploration companies. Operators at Krain, since 1955 have included Beaver Lodge Uranium, Far west Tungsten, Kennecott, North Pacific, Canex, Shulman, Noranda, Quintana and Getty, and total exploration costs have exceeded one million dollars.

Several companies recognized that part of the mineralized area at Krain was deeply oxidized and lay beneath Tertiary volcanic cover where enriched copper grades might be possible. Determined efforts were made to explore this potential, as well as to develop tonnage in the primary sulfide zone. Regional and detailed geological mapping and sampling were supplemented by geochemical, magnetometer and induced polarization surveys, and followed by considerable bulldozer trenching.

Formidable quantities of diamond drilling and percussion drilling were done throughout the years.

The most recent operators, Quintana and Getty, in 1971-72 jointly explored extensions of mineralization beneath covered areas to the north and south. In 1973 Getty continued efforts to develop deeper extensions to the south and southwest, but since then the property has been idle.

In 1972 tonnage and grade estimates were made at Krain based on results of then current and previous drilling. Mineralized rocks that could be recovered in a single openpit, 250 m deep, were included in the estimates, and a .3 percent copper cutoff grade was used. The calculations indicated a total reserve of 15 million tons grading .55 percent copper. Of this total, about 10 million tons averaging .53 percent copper contain primary sulfides, and 5 million tons grading approximately .6 percent copper contain secondary copper carbonates and oxidation products.

Overall molybdenum content was estimated to average close to .01 percent Mo although short intercepts near the core contain as much as .03 percent Mo.

GEOLOGY

The Krain prospect lies on the southern boundary of an extensive area of postmineral cover consisting of continental volcanics and interbedded sediments of the Early Tertiary Kamloops Group. Such rocks cover the northern half of the mineralized zone, and have protected a pre-Kamloops age cap as much as 100 m thick. Hypogene sulfides within this cap have been totally destroyed. In the southern part of the deposit

Pleistocene glaciation has removed most of the oxidized zone.

Mineralization at Krain occurs within quartz diorites of the Highland Valley phase (Guichon variety) of the Guichon Batholith, as defined by Northcote (1969), and within crosscutting dykes and small stocks. These dykes and stocks exhibit textures ranging from porphyritic to hypidiomorphic-granular, and the more equigranular varieties closely resemble quartz diorites of the Bethlehem phase of the batholith (Northcote, 1969).

The mineralized porphyry system at Krain occurs within a broad northwesterly trending zone containing
South Seas (formerly Trojan)
the Trojan prospect, a breccia-pipe 3 km south of Krain, and the Bethlehem deposits some 7 km further south. This northwest trending zone is characterized by numerous parallel porphyry dykes, as well as by prominent fracture

related but non-pervasive chlorite-epidote-chalcopyrite-±pyrite-±bornite hydrothermal alteration assemblages. Smaller zones of pervasive chlorite-clay alteration occur frequently within the above broad zone. These smaller zones are often at the margins of porphyry dykes; many contain conspicuous chalcopyrite. Exploration activities in the district have led to extensive trenching and drilling within and around many of these small showings.

At Krain a unique situation exists. Mineralization and alteration are closely associated with an elongate dyke-like stock which is unroofed within a very small area at the centre of the deposit. The unroofed portion appears to be an abrupt cupola-like projection which developed above the stock, To the northwest and south-east along strike the apex of the stock plunges gently away from the high point at Krain, as illustrated in

Figure 2. An approximate dip of 70° southwest on the walls of the stock is also illustrated.

Fracturing, brecciation, alteration and mineralization are all most strongly developed in and around the central cupola-like core and along the upper surface of the stock.

MINERALIZATION AND ALTERATION

Strong zonal patterns of primary sulfide mineralization and silicate alteration have been recognized around the core area. Within the core and near the contacts of the stock, chalcopyrite-bornite assemblages are found and these are associated with molybdenite-bearing quartz veinlets. Outwards, strongly fracture controlled chalcopyrite-pyrite assemblages occur with pyrite becoming more abundant outwards, both within the wall rocks and the stock. Maximum total sulfide content is about 5 percent and occurs approximately coincident with the outer limit of .1 percent copper.

Associated silicate alteration is pervasive and grades from sericite-clay-chlorite[1] assemblages in the core outwards through clay-chlorite and chlorite assemblages in the chalcopyrite zone, and further grades to chlorite-epidote assemblages in the pyrite zone. Beyond the approximate outer limit of .05 percent copper, silicate alteration is no longer pervasive although chlorite-epidote assemblages form pronounced fracture selvage halos which gradually diminish to fracture coatings over transition zones as much as a thousand metres wide.

1. Identification of sericite and clay-bearing mineral assemblages is based on physical properties and knowledge of x-ray determined mineralogy of similar rocks from the Bethlehem mine (McMillan, W. J., 1974, personal communication).

OXIDIZED ZONE

A deeply oxidized,slightly copper enriched zone has been preserved beneath Early Tertiary continental volcanic-sedimentary cover at Krain. (see Figure 2.). Malachite is the most abundant copper mineral although chrysocolla and a black waxy copper oxide (neotocite?) are often associated. These minerals form very prominent fracture coatings, some of which are botryoidal, and these also occur disseminated in cavities previously occupied by sulfides. Cuprite and disseminated native copper occur in minor quantities, most commonly in the outer parts of the deposit.

Small amounts of chalcocite in the form of thin coatings on corroded grains of sulfide are present in some drill holes near the base of the oxidized zone, overlapping the lower metre of oxidized rock and extending into the upper few metres of the primary sulfide zone. Chalcocite is not sufficiently abundant to contribute appreciably to the grade of the deposit, ~~nor to~~ and does not ~~explain the~~ account for slight enrichment of the oxidized zone over primary grade.

Disseminated calcite, which ~~may form~~ forms as much as 5 percent of the more highly altered rocks in the primary sulphide zone at Krain, is believed to have greatly influenced the migration of copper, and to have minimized ~~contributed to the small amount of~~ enrichment within the oxidized zone. It is surmised that formation of ~~The presence of~~ calcite within the ~~hydrothermal sulfide~~ system ~~is attributed to~~ resulted from the destruction of calcic plagioclase during the hydrothermal event. Calcite ~~later~~ in the oxide zone reacted to neutralize acids formed as a result of oxidation of hypogene sulfides, and precipitated copper from solution before much vertical migration could take place. It is believed however, that some net downward migration of copper must have occurred in order to give rise to slight copper enrichment within the oxidized zone, as the weathering-oxidation-leaching process progressed.

A possible alternate explanation for the slightly enriched copper grade of the oxidized zone at Krain is that it may have formed by oxidation of a pre-existing chalcocite enriched blanket, but no textural relationships were observed that could either substantiate or deny such a hypothesis. Partially oxidized sulfides present are pyrite and chalcopyrite, and the chalcocite present forms coatings on some of these grains. The simplest explanation would call for precipitation of the minor amount of copper reaching the groundwater table as chalcocite coatings on sulfide grains, in a first cycle oxidation-weathering system, under the influence of a relatively high carbonate environment.

STRUCTURE

Fracturing and faulting are prominent features of the geology at Krain, and the areas of highest fracture density are the zones of best mineralization, adjacent to the stock.

Sets of steeply dipping northeasterly and northerly trending faults are evident on Figure 1, and postmineral offsets on these faults are indicated by the map pattern. Premineral existence of some of these faults may also be demonstrated in the field, although most appear of post-mineral age. Early Tertiary Kamloops Group rocks are almost entirely found in downfaulted blocks, and vertical offsets have in several instances been substantiated by drill results. However, no measure of the net slip on these faults has been obtained, nor has it been possible to fully understand the time relationships between mineralization, first development and subsequent movements on these minor faults, and the formation of the major faults known in the region.

SUMMARY

Krain prospect is a well-explored porphyry copper occurrence which forms a small part of a much larger hydrothermally-emplaced sulfide system. Reserves of 15 million tons averaging .55 percent copper and .01 percent molybdenum are indicated, and little chance remains for discovery of additional tonnage near surface.

Unlike most other copper deposits within the Guichon Batholith, Krain displays a positive genetic and spatial relationship to a discrete stock which in this instance intrudes Guichon quartz diorite. The stock closely resembles the Bethlehem phase of the batholith, and part of the stock forms a core about which are developed strong zonal patterns in sulfide mineralogy, silicate alteration assemblages, intensity of hydrothermal alteration, and fracturing. All of these zonal features suggest a close genetic relationship between emplacement of the stock and mineralization.

Mineralized rocks at Krain, including the unroofed central part of the stock, were deeply weathered and oxidized prior to burial beneath Early Tertiary continental volcanics and sediments. Despite deep oxidation and total destruction of sulfides very little secondary chalcocite enrichment occurred, although the oxidized zone has been slightly enriched in copper, principally in the form of copper carbonate. This enrichment is interpreted to result from the influence of disseminated secondary calcite formed on the breakdown of calcic plagioclase during the hydrothermal event. This calcite reacted to neutralize acids produced during the oxidation process thereby precipitating copper carried in solution, and retarding downward migration of copper. Ultimately, as the weathering-oxidation process continued, sufficient downward transport of copper occurred to produce slight enrichment within the oxidized zone, before the deposit was buried beneath volcanic cover in the Early Tertiary.

The northern part of the Krain deposit remains buried beneath Early Tertiary cover and there the deeply oxidized cap remains intact. Southern parts of the deposit have been exposed to Pleistocene glaciation and the cap has been almost completely removed.

The present distribution of Kamloops Group rocks is strongly controlled by faults along which vertical displacements appear to be most important. Tertiary rocks are presently almost restricted to downthrown fault blocks.

REFERENCES

Northcote, K. E. (1969): Geology and Geochronology of the Guichon Creek Batholith, B. C. Dept. of Mines and Pet. Res., Bull. No. 56.