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GEOLOGY OF THE POTHOOK ALKALIC COPPER-GOLD PORPHYRY DEPOSIT, AFTON MINING CAMP, BRITISH COLUMBIA (92I/9, 10)

Clifford R. Stanley, Mineral Deposit Research Unit, U.B.C.

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INTRODUCTION

The Pothook deposit is one of several alkalic porphyry copper-gold deposits (Afton, Crescent, Ajax East, Ajax West) developed in the Afton mining camp, located 10 kilometres west of Kamloops, British Columbia. These deposits are all hosted by the Iron Mask batholith, a large composite alkalic intrusion of earliest Jurassic age that intrudes latest Triassic Nicola volcanic rocks of the Quesnellia oceanic island arc terrain (Souther, 1992). The Pothook deposit is located on the southwestern edge of the Iron Mask batholith, approximately 750 metres southeast of the much larger Afton copper-gold deposit (Figure 1). It contained a geological reserve of 3.26 million tonnes grading 0.40% copper and 0.16 gram per tonne gold ($0.40 copper equivalent cut-off; Bond, 1985).

Between October 1986 and September 1988, Afton Operating Corporation, a division of Teck Corporation, mined 2.60 million tonnes of ore with an average grade of 0.35% copper and 0.21 gram of gold per tonne from an open-pit, with a stripping ratio of 1:1.9 (L. Tsang, personal communication, 1993).

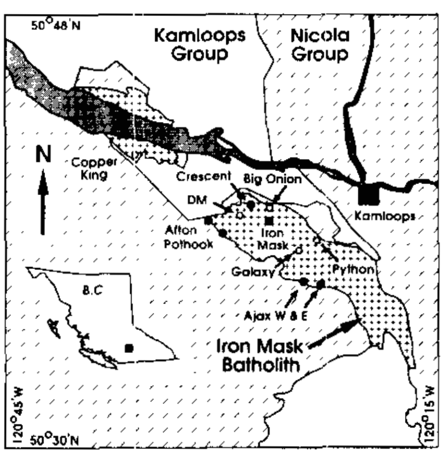

Figure 1. Generalized geological map of the Iron Mask batholith, showing locations of the principle mineral deposits (after Kwong, 1977).

Detailed open-pit mapping at 1:300 scale, more regional mapping of the area around the Pothook deposit at 1:2400 scale, and drill-core logging carried out during the summer of 1993 have documented the complicated geological history of the deposit. An open-pit map of the Pothook deposit is presented in Figure 2.

GEOLOGICAL HISTORY

The geological history of the Pothook zone is summarized in Table 1 and a full description of the geological units and events is presented in chronological order below.

LATE TRIASSIC

Several different volcanic lithologies act as host-rocks for the Iron Mask batholith in the deposit area. These consist of: dark green to black, aphyric to plagioclase-phyric, massive basalt flows; maroon to dark grey, aphyric to sparsely plagioclase or augite-phyric, poorly bedded, ash to lapilli mafic tuffs and lesser blocky agglomerates; black, crowded, augite-phyric, massive basalt flows; dark grey, crowded plagioclase-phyric andesite flows and feeder dikes; and dark green to black, crowded augite-phyric picrite flows (Snyder and Russell, 1993b). These units comprise the Carnian to Norian (latest Triassic) Nicola Group on the southwestern edge of the Iron Mask batholith (Preto, 1977).

EARLY JURASSIC

The Nicola Group was intruded during the earliest Jurassic (at approximately 2073 Ma; Ghosh, 1993) by the Iron Mask batholith. Several intrusive bodies comprise the batholith; all are exposed in the Pothook open pit.

POTHOOK DIORITE

The first to intrude was the Pothook diorite phase, a predominantly fine to medium-grained, equigranular, plagioclase-augite diorite with late poikilitic biotite containing both plagioclase and augite inclusions (Snyder and Russell, 1993a). Disseminated magnetite in variable concentrations up to 10%, and accessory potassium feldspar and apatite also occur. The Pothook diorite incorporated

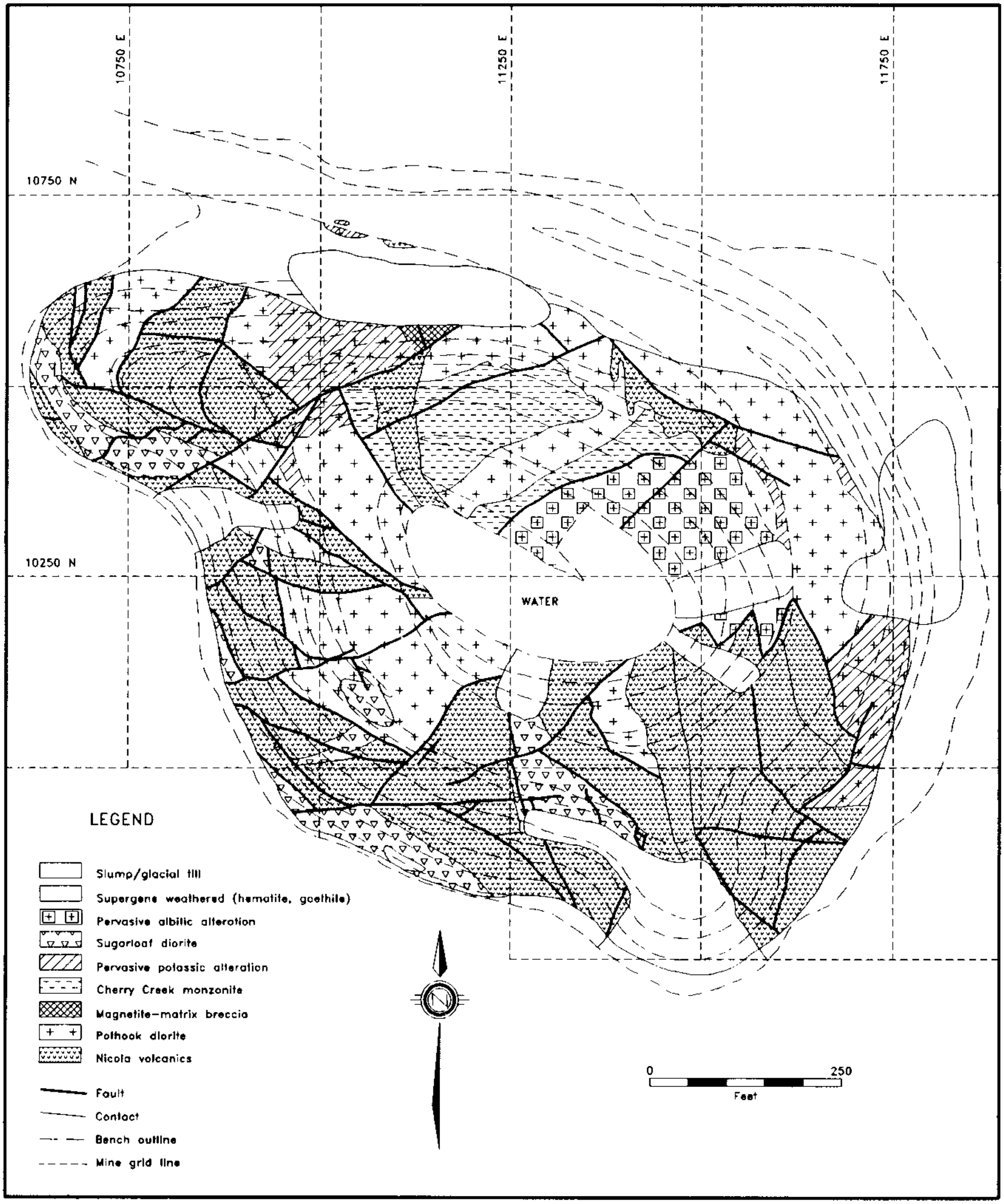

Figure 2. Geological map of the Pothook alkalic porphyry copper-gold deposit open pit.

TABLE 1
SUMMARY OF CHRONOLOGY OF INTRUSIVE, STRUCTURAL, ALTERATION/METAMORPHISM/WEATHERING EVENTS IN THE POTHOOK ALKALIC PORPHYRY COPPER-GOLD DEPOSIT

Event	Age	Intrusion	Faulting	Alteration / Metamorphism / Weathering
1	earliest Jurassic	Fine to medium-grained Pothook diorite intrudes Nicola volcanics		Hornfels in adjacent Nicola volcanics
2	earliest Jurassic	Medium-grained Pothook diorite intrudes fine to medium-grained Pothook diorite		
3	earliest Jurassic		Steep NNW and ENE faulting disrupts intrusive contacts	
4	earliest Jurassic			Magnetite-apatite-actinolite blebs, veins and breccias cut Pothook diorite
5	earliest Jurassic	Cherry Creek monzonite intrudes earlier Pothook diorite phase		
6	earliest Jurassic			Pervasive potassic alteration - K-spar replacement / mag destruction in Pothook diorite
7	earliest Jurassic		Steep NNW and ENE faulting disrupts intrusive contacts	
8	earliest Jurassic	Sugarloaf diorite dikes intrude volcanics and fine to medium-grained Pothook diorite		act-plag hornfels contact metamorphic replacement of Nicola volcanics
9	earliest Jurassic			Pervasive albitic alteration - alb replacement of feldspar and aug, chl replacement of biot
10	earliest Jurassic			K-feldspar-epidote veins cut Pothook diorite and Cherry Creek monzonite
11	earliest Jurassic		Steep NNW and ENE faulting disrupts intrusive contacts	
12	earliest Jurassic			Iron-oxide-**Cu-sulphide** (chlorite-epidote) veins and breccias cut all lithologies
13	earliest Jurassic			Chlorite / kaolinite veins fill joints and microfractures in all lithologies
14	earliest Jurassic			Calcite veins and crackle zones cut all lithologies
15	Eocene		Shallow NW faulting throws tops to SW	
16	Eocene	Aphyric mafic dikes associated with Kamloops Group volcanics cut Pothook diorite		
17	Eocene			Quartz veins cut all lithologies
18	Eocene to Pleistocene			Supergene weathering dissolves cpy, precipitates native Cu, chal and earthy hematite
19	Eocene to Pleistocene		Steep NW reverse faulting down drops supergene-weathered zones into grabens	
20	Pleistocene			Glacial erosion produces current exposure level

mag=magnetite; act= actinolite; plag-plagioclase; alb-albite; aug-augite; chl-chlorite; biot-biotite; cpy-chalcopyrite; chal=chalcocite numerous blocks of volcanic rocks as xenoliths within the intrusion. In places, especially near the margins of the diorite, these xenoliths are sufficiently abundant to comprise an intrusion breccia. Apophyses of Pothook diorite also intruded along faults and steeply dipping depositional contacts in the volcanic hostrocks. A fine-grained chilled margin of the diorite occurs at the intrusive contacts with these volcanics. Volcanic rocks adjacent to the diorite contact recrystallized to a biotite hornfels containing less than 1% disseminated pyrite cubes and disseminated magnetite.

A medium-grained variety of Pothook diorite was intersected at depth in exploration drill-holes. This later variety intrudes the fine to medium-grained Pothook diorite variety, but is otherwise petrologically similar. It is not observed to intrude, nor contain xenoliths of, Nicola volcanic rocks.

After the Pothook diorite intrusion had cooled sufficiently to allow brittle fracture, an episode of largely steep faulting disrupted the diorite-volcanic contact and juxtaposed volcanic rocks, without contact metamorphic recrystallization effects, and diorite. Displacements along these numerous, steeply dipping faults (most have dips >70) are probably vertical, appear to be generally less than 100 metres, and several sets of fault orientations were observed (NNW and ENE; Figure 3). This faulting appears to predate the pervasive potassic alteration described below.

After and probably during this steep faulting, magnetite-apatite-actinolite veins, blebs, schleiren and breccias formed along dilatant fractures. These fractures also occasionally contain epidote and chlorite, both within the structures and in alteration envelopes surrounding them.

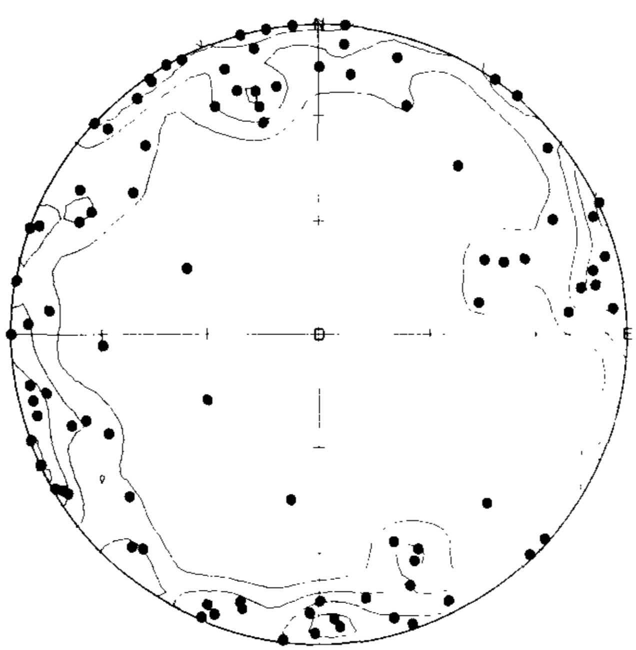

Figure 3. Stereonet of poles to steeply dipping faults cutting Pothook diorite and Nicola volcanics (n = 97).

Blebs and schleiren tend to occur in large envelopes about major magnetite veins. The Magnet showing, and probably other magnetite veins in the Iron Mask batholith, formed at this time (Cann, 1979). In the Pothook deposit area, all of these magnetite-bearing structures are hosted by the fine to medium-grained Pothook diorite or by intrusion breccia with a fine to medium-grained Pothook diorite matrix. These magnetite-bearing structures may have formed from coalescing orthomagmatic hydrothermal fluids evolved from other, still molten, parts of the Pothook diorite during late stage crystallization.

CHERRY CREEK MONZONITE

The Cherry Creek monzonite phase of the Iron Mask batholith was next to intrude. In the Pothook area, it intruded only Pothook diorite (Stanley *et al.*, 1994, this volume). This intrusion is generally a very fine grained, equigranular, potassium feldspar-plagioclase-biotite-augite monzonite with accessory magnetite and apatite, and trace quartz (Snyder and Russell, 1993a). It also contains small miarolitic cavities filled with quartz, and locally exhibits an aplitic texture. Its emplacement was apparently controlled by pre-existing structures within the Pothook diorite; it does not intrude Nicola volcanic rocks in the Pothook area (Stanley *et al.*, 1994). No contact metamorphic effects were observed in Pothook diorite adjacent to the Cherry Creek monzonite.

A generally pervasive potassic alteration occurs within but near the margins of the Cherry Creek monzonite and in Pothook diorite adjacent to exposures of Cherry Creek monzonite in the open pit. This alteration involved the 'selective pervasive' replacement of plagioclase by potassium feldspar in both phases, and the partial destruction of disseminated magnetite in the Pothook diorite. Biotite remained stable, but augite was commonly replaced by epidote. At the margins, this 'selective pervasive' alteration grades outward into fractures with potassic alteration envelopes, indicating that at least the outer parts of these alteration zones formed from coalescing alteration envelopes. The close spatial association between this alteration and the monzonite suggests that the alteration is probably deuteric and was related to and occurred during the late stages of cooling of the monzonite. The widespread nature of this alteration, and the pink colour imparted by the potassium feldspar, have caused pervasive, potassically altered fine to medium-grained Pothook diorite to be confused with the fine-grained Cherry Creek monzonite in the past (Stanley *et al.*, 1994, this volume). In the Pothook open-pit, this early pervasive potassic alteration is restricted to the north wall, adjacent to and above the exposure of Cherry Creek monzonite.

After intrusion of the Cherry Creek monzonite, additional steep faulting took place. Displacements occurred largely along pre-existing structures, and this further disrupted intrusive contacts along the southwest edge of the batholith.

SUGARLOAF DIORITE

The second period of faulting was followed by the intrusion of the Sugarloaf diorite into earlier phases of the Iron Mask batholith and surrounding rocks. This diorite contains large, sparse to crowded, stubby hornblende phenocrysts, generally smaller augite and commonly trachytically aligned plagioclase phenocrysts. These are set in an aphanitic groundmass of plagioclase and potassium feldspar with disseminated magnetite (Snyder and Russell, 1993a). The Sugarloaf diorite was emplaced as a set of northwest-trending, steeply dipping dikes along the southwestern edge of the batholith. These intrude Nicola volcanics more commonly than Pothook diorite, do not intrude the Cherry Creek monzonite, and are widest, most abundant, and, in some cases radially oriented, around Sugarloaf Hill, which is thought to be a volcanic neck and intrusive centre (Snyder and Russell, 1993b). As such, the intrusive form of the Sugarloaf diorite resembles the classic hypabyssal volcanic neck at Shiprock, New Mexico (Press and Siever, 1978).

Sugarloaf diorite produced contact metamorphism in adjacent volcanic rocks. This involved the complete recrystallization of mafic volcanic rocks to an actinolite-plagioclase hornfels with abundant disseminated magnetite. This contact metamorphism was texturally destructive so the protoliths of amphibolitized Nicola volcanic rocks cannot be ascertained. No contact metamorphic effects are apparent in Pothook diorite where it is intruded by the Sugarloaf diorite dikes, probably because of the low hydration state of the Pothook diorite and the stabilities of the minerals comprising it under those metamorphic conditions. The more extensive recrystallization of volcanic hostrocks associated with emplacement of the small Sugarloaf diorite dikes may suggest that these dikes were intruded at higher temperatures than the Pothook diorite. Alternatively, the probably higher volatile fugacity of the Sugarloaf phase, as indicated by its more porphyritic texture, may have more efficiently catalyzed recrystallization and metasomatism, forming the higher grade hornfels.

Another stage of hydrothermal alteration took place after intrusion of the Sugarloaf diorite. This took the form of partial to pervasive albitic alteration and was confined to the intrusive rocks. This alteration becomes pervasive where envelopes surrounding fractures coalesce. It probably occurred during cooling of the Sugarloaf diorite, and may also have been deuteric. In the Pothook diorite, albite replaced plagioclase, augite and potassium feldspar, and chlorite replaced biotite. Moderate but subequal amounts of chalcopyrite and pyrite precipitation accompanied this alteration. This albitic alteration is most intense (pervasive) on the southeast wall of the open pit, below the ramp, where the Pothook diorite consists almost completely of albite. Elsewhere, Pothook diorite is incompletely albitized, occasionally in fracture envelopes, where plagioclase is selectively but pervasively replaced by albite but chlorite has not replaced biotite, and augite and potassium feldspar remained stable. The Sugarloaf diorite is only 'selective pervasively' albitized. Albite replaced plagioclase and potassium feldspar, but hornblende generally remained stable. Sugarloaf diorite also contains blebs of epidote thought to be related to this alteration event.

The pervasive albitic alteration is overprinted by fracture-controlled potassic alteration represented by through-going potassium feldspar-biotite-epidote veins. These were strongly controlled by steeply dipping, north-northwest-striking fractures (Figure 4) and are restricted to the Pothook diorite and Cherry Creek monzonite intrusions. These veins are not significantly dilatant but are continuous across 20 vertical and 30 horizontal metres and in many places constitute 'sheeted' vein sets. During this hydrothermal alteration, different vein and envelope alteration mineral assemblages were produced in different lithologies. Specifically, in unaltered to moderately albitized Pothook diorite and Cherry Creek monzonite, the veins are primarily filled by potassium feldspar and biotite and have epidote envelopes. In pervasively albitized Pothook diorite, the veins are commonly filled by epidote and have potassium feldspar and biotite envelopes. In pervasive potassically altered Pothook diorite, the veins are generally filled only by epidote. All of these potassium feldspar - epidote veins contain small but subequal amounts of chalcopyrite and pyrite, and are well developed on the southeast wall of the open pit above the ramp, and along the north wall of the open-pit just above the ramp on the lower benches. This structurally controlled potassic alteration introduced a small amount of copper and gold mineralization, as chalcopyrite and bornite, in the veins.

Following the episode of fracture-controlled potassic alteration, further steep faulting dissected many of the Sugarloaf diorite dikes and through-going potassium feld-

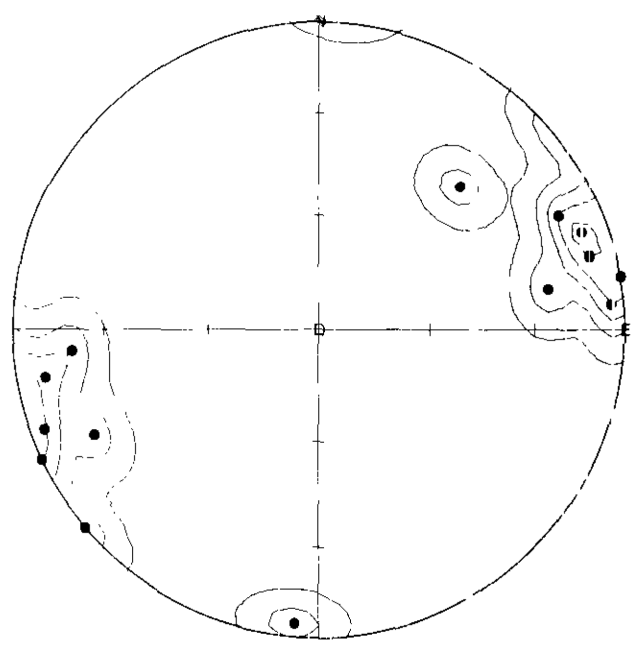

Figure 4. Stereonet of poles to structurally controlled potassium feldspar - epidote veins (n = 1[illegible]).

spar-epidote veins, and further disrupted the margin of the Iron Mask batholith. Much of this movement took place along pre-existing structures.

COPPER-GOLD MINERALIZATION

None of the previously described pervasive or fracture-controlled hydrothermal alteration events is characterized by the introduction of significant amounts of copper to the Pothook area. The copper ore-forming event is represented by iron oxide - sulphide veins. On the southwest side of the open-pit, these veins are characterized by a chlorite-pyrite-chalcopyrite-magnetite-(specular) hematite mineral assemblage, whereas on the northeast side they contain chalcopyrite, bornite and magnetite. These veins, like the potassium feldspar-epidote veins that they cut, were not significantly dilatant. Similarly, they also have a preferred orientation approximately perpendicular to the orientation of the potassium feldspar - epidote veins, ranging from west-southwest to northwest with dips generally greater than 45 (Figure 5). The density of these mineralized veins appears to control ore grade, and produced some very significant copper and gold concentrations (occasionally up to 2% Cu and 2 g/t Au in exploration drilling samples). Where these veins cut Nicola volcanic rocks or their metamorphosed equivalents, significant chlorite selvages and envelopes are developed. Where they cut intrusive rocks, epidote envelopes and selvages predominate on the vein margins. These veins are not through-going and tend to dissipate into micro-fractures with epidote or chlorite envelopes. Previously existing fault zones are also at least partially filled by these iron oxide - sulphide veins.

In the centre of the open pit, and seen only in drill core, there is a large body of hydrothermal breccia that contains rotated and clasts of Pothook diorite, Cherry

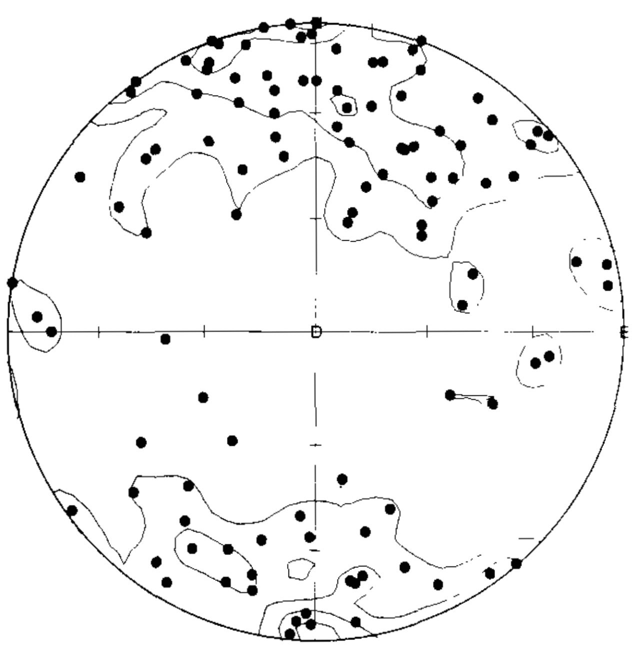

Figure 5. Stereonet of poles to iron oxide - sulphide veins (n = 112).

Creek monzonite, Sugarloaf diorite, and Nicola volcanics in a matrix of rock flour, chlorite and pyrite, with subordinate amounts of magnetite, chalcopyrite and bornite. In places, especially toward the centre of the breccia, these clasts are well rounded due to milling, range in size from 5 to 100 millimetres, and are clast supported. Toward the margins of the breccia, fragments are larger and more angular, and the breccia grades into a crackle zone with unrotated fragments in a disrupted stockwork of iron oxide - sulphide veins. As such, the hydrothermal breccia and veins are interpreted to be genetically related.

The mineralizing episode that produced the sulphide-bearing veins and breccia was followed by, or possibly evolved into, a propylitic episode of chlorite veining without significant amounts of associated copper or gold mineralization. Chlorite veinlets fill narrow fractures at all scales, from large through-going joints down to micro-fractures, in both volcanic and intrusive rocks. They are responsible for the predominantly dark colour of rock exposures in the open pit because blasting has broken the rocks along these veins, exposing dark green chlorite. This chlorite veining event involved no other alteration minerals, except for minor amounts of calcite and disseminated pyrite intergrown with the chlorite. Chlorite veins do not occur in pervasive albitically altered Pothook diorite. Rather, late kaolinite-calcite-filled microfractures are prevalent (Bond, 1985). These veins may be the equivalent to the chlorite veins, but contain no chlorite because of the lack of iron and magnesium in intensely albitized Pothook diorite.

Calcite veins crosscut the propylitic chlorite veins. In the intrusive units, these veins consist solely of calcite with no associated alteration envelopes. In the Nicola volcanic rocks, they are commonly associated with talc and serpentine, and have chlorite selvages. Calcite veins have no preferred orientation, and are not through-going. In general, wider calcite veins tend to be truncated by smaller, crosscutting calcite veins. Wider calcite veins are generally isolated from each other, and thus are rarely widespread and abundant enough to form crackle zones. Nevertheless, the overall distribution of these calcite veins suggest that the rocks have been intensively shattered, in spite of the relative absence of large crackle zones. The calcite veins postdate the sulphide-bearing veins and probably formed from lower temperature fluids. They also partially fill pre-existing fault zones.

EOCENE

Another episode of faulting followed the mineralizing and alteration events. Unlike the earlier episodes of faulting, movement occurred along relatively shallow planes with southeasterly strikes and dips generally less than 30 to the southwest (Figure 6). Numerous faults with this orientation cut the upper southwest wall of the open pit, and display spoon-like, concave-upward (listric) forms. The displacement direction is generally to the southwest, and movements of up to 50 metres are indicated on individual fault planes. Given the number of these faults, the main mass of Pothook diorite and Sugar-

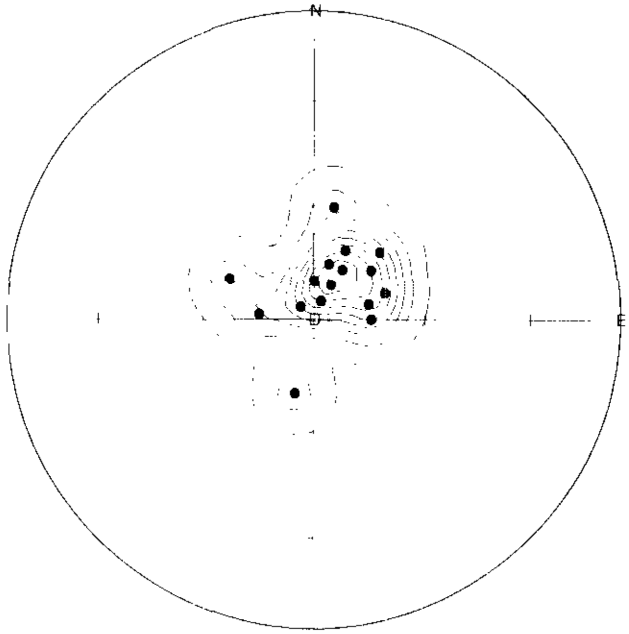

Figure 6. Stereonet of poles to shallow listric faults with southwesterly directed throw (n = 16).

loaf diorite dikes above these faults may have been displaced significant distances from the margin of the batholith (up to or exceeding 250 m) onto unmetamorphosed Nicola volcanics. This stage of faulting may reflect unroofing of the batholith, possibly during a period of extensional tectonics that affected the region during the Eocene (Souther, 1992).

Late, relatively rare mafic dikes intruded the Pothook area during the Eocene. These are aphyric to sparsely plagioclase phyric and are unaltered. They may be feeder dikes to the mafic volcanic rocks in the Eocene Kamloops Group, which fills grabens formed during extension (Souther, 1992).

Rare, late quartz-calcite-chlorite veins cut through all lithologies in the open pit. They partially fill all faults, including those with shallow dips, and previously formed veins with open spaces. They also fill shallow-dipping fractures oriented parallel to the shallow-dipping 'detatchment' faults. These veins contain amethystine quartz and may be related to hydrothermal activity associated with Kamloops Group mafic volcanic feeder dikes.

During a period of late Tertiary supergene weathering, some of the chalcopyrite and bornite was destroyed and replaced by native copper, chalcocite and earthy hematite. Pyrite was also partially destroyed and replaced by earthy hematite and goethite during this supergene event. This weathering appears to have occurred without significant supergene enrichment, but local movements into adjacent fractures undoubtedly occurred. This relative lack of copper mobility was probably due to the high calcite and low pyrite abundances in the deposit. The relative absence of pyrite limited the amount of acid that could be produced during weathering, and the of calcite neutralized any acid that was produced. This prevented descending meteoric fluids becoming sufficiently acidic to transport copper downward to form a supergene enrichment blanket. Instead, the meteoric fluids caused the destruction of primary copper sulphide mineralization and the formation of secondary native copper and chalcocite. This produced a supergene blanket without copper enrichment (*cf.* Kwong, 1987). This weathering is predominantly fracture controlled, often occurring in open spaces thought to be originally filled by calcite, and penetrates to depths of up to 50 metres below the bedrock surface in unfractured rocks and to depths greater than 200 metres along faults.

Finally, further movement on pre-existing, northwest-striking faults down-dropped supergene weathered material into grabens where they were protected from subsequent Pleistocene glacial erosion.

ORE DISTRIBUTION

Copper and gold grades in both exploration drill-holes and production blast-holes were examined to assess lithological and structural controls on mineralization. Scatterplots of copper and gold concentrations are presented in Figure 7. This demonstrates that copper and gold concentrations are not well correlated, and that, in general, high copper concentrations occur in samples with relatively low gold grades, and *vice versa.* This lack of correlation between copper and gold grade is different from most other alkalic porphyry copper-gold deposits, which commonly exhibit strongly correlated copper and gold concentrations, and relatively constant copper/gold ratios within individual deposits (average ratios in individual deposits range from 10 000 to 25 000 Stanley, 1993).

Figures 8 and 9 are bubble plots of copper and gold blast-hole assays from the 2340-foot bench in the Pothook open pit. Higher copper grades exhibit a strong structural control and define trends with variable strikes. Many of these trends can be traced directly into fault zones mapped on the 2340-foot bench (Figure 2). These

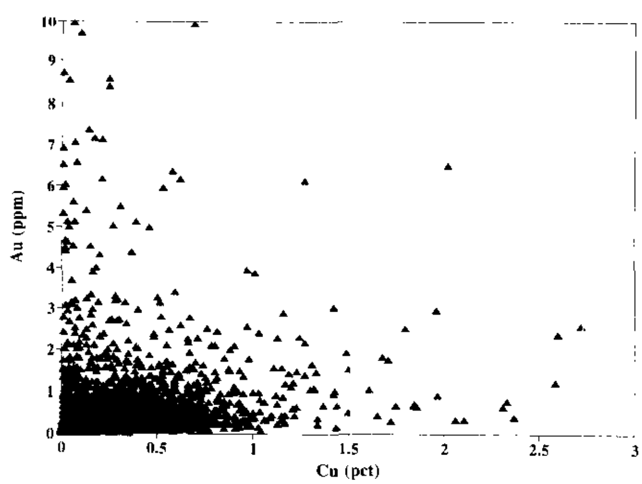

Figure 7. Scatterplot of exploration drill-hole and production blast-hole copper and gold assays from the 2100, 2160, 2220, 2280, 2340 and 2400-foot benches in the Pothook open pit (n = 3992).

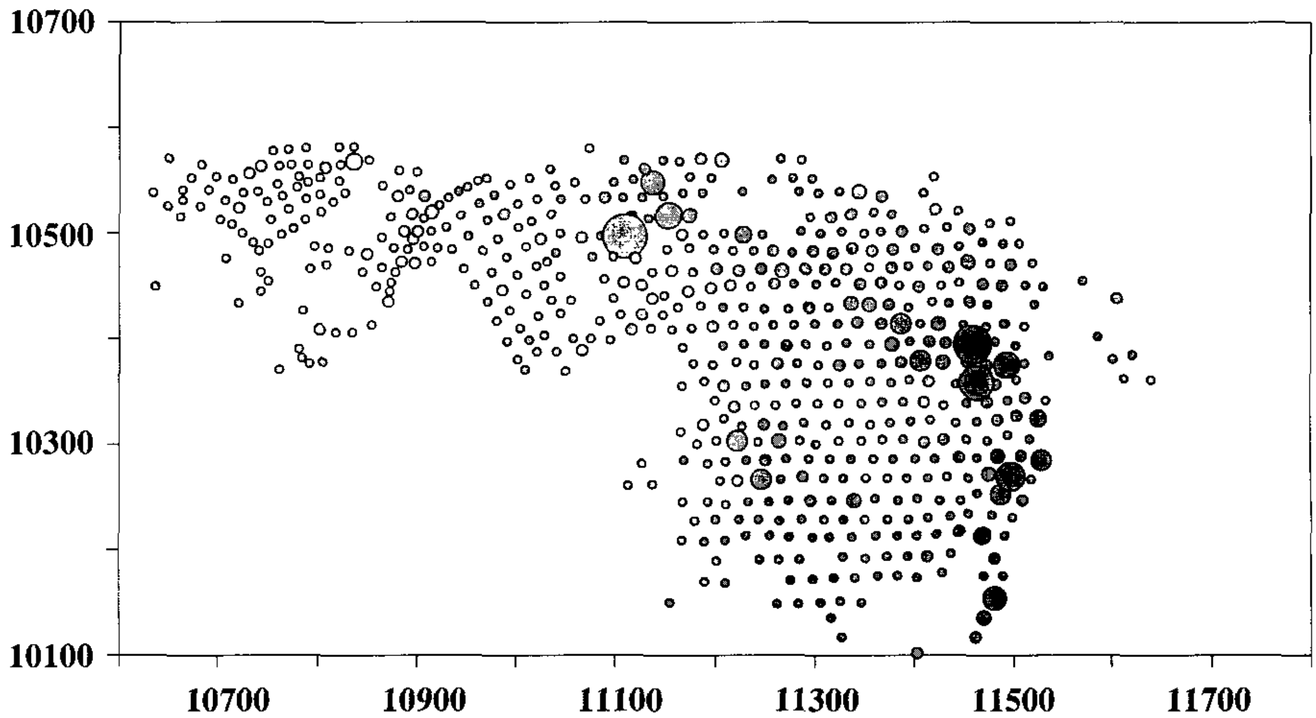

Figure 8. Bubble plot of production blast-hole copper assays from the 2340-foot bench of the Pothook open pit. Assays have been transformed and scaled to enhance geochemical contract. The smallest and largest bubbles corresponds to copper grades of 0.01% and 2.60%, respectively (n = 635).

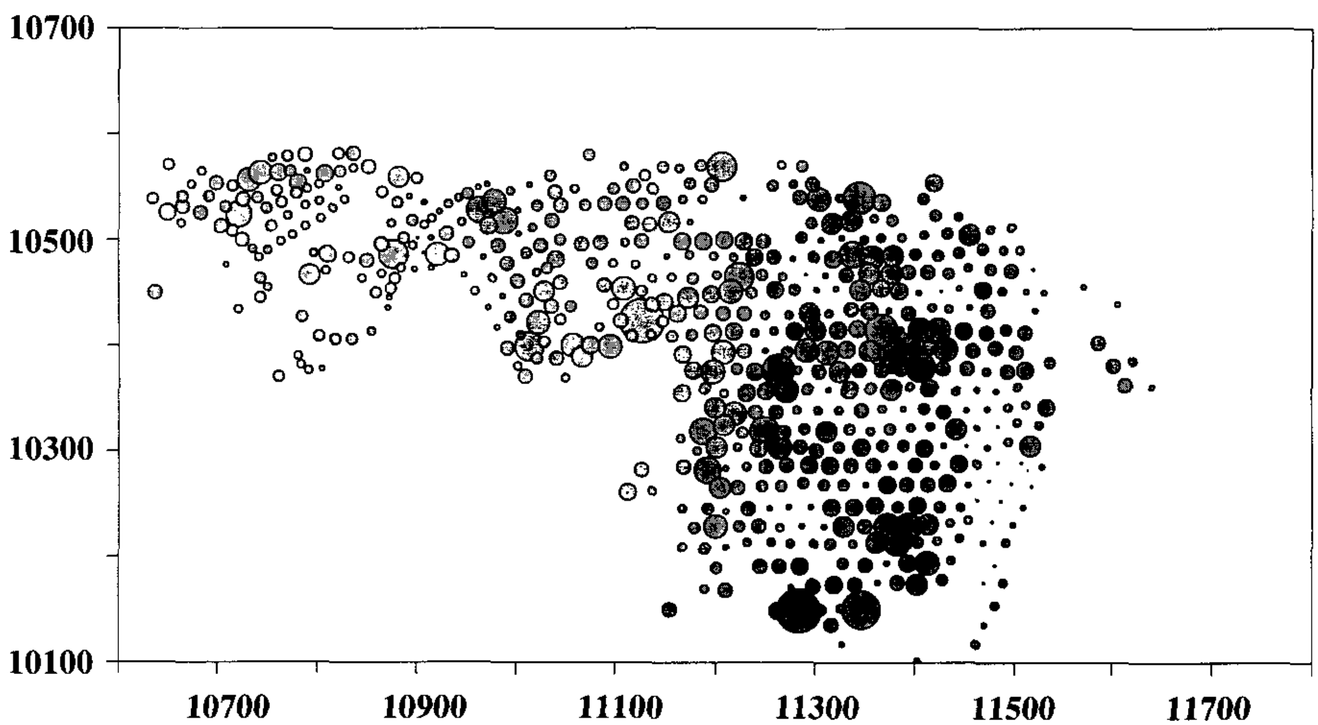

Figure 9. Bubble plot of production blast-hole gold assays from the 2340-foot bench of the Pothook open pit. Assays have been transformed and scaled to enchance geochemical contract. The smallest and largest bubbles correspond to gold grades of 0.034 and 28.972 grams per tonne, respectively (*n* = 635).

fault zones are steeply dipping and were active before, during and after mineralization in the Pothook deposit.

The distribution of higher gold concentrations, however, suggests that the gold and copper mineralization in the Pothook deposit is not identically controlled (Figure 9). In fact, there is little correspondence between the locations of high gold and high copper concentrations in blast holes. The lack of correlation between copper and gold, in terms of both magnitude and space, may be due in part to local mobility during supergene weathering, or to inaccuracies produced by nugget effects. However, given the relatively high density of blast-holes (approximately 20-foot spacing), the spacing of assays in exploration drill-core samples (continuous, immediately adjacent intervals), and the masses of these samples (>2 kg), it is more likely that copper and gold do not share an identical mineral paragenesis. Whereas the timing of copper mineralization can be determined because the copper minerals are visible, the timing of gold mineralization remains unclear. Copper and gold may have been introduced at different times, or by the different means, during the hydrothermal history of the deposit.

CONCLUSIONS

In the Pothook area, the Pothook diorite, Cherry Creek monzonite and Sugarloaf diorite all intruded latest Triassic Nicola volcanics during the earliest Jurassic. These intrusions and their host-rocks have been affected by several, largely pre-mineral, stages of hydrothermal alteration: magnetite veins and breccias controlled by fractures in the Pothook diorite; pervasive potassic alteration associated with the Cherry Creek monzonite; pervasive albitic alteration associated with the Sugarloaf diorite; and late, potassium feldspar - epidote veins.

Copper-gold mineralization in the Pothook area appears to be most closely related to Sugarloaf diorite dikes that cut Nicola volcanics along the southwest margin of the Iron Mask batholith. Mineralization occurs predominantly in hydrothermal breccia and steeply dipping, east-striking veins that cut all three phases of the batholith and the surrounding Nicola volcanics. The Pothook orebody is characterized by abundant pyrite, magnetite, chlorite and minor (specular) hematite gangue and chalcopyrite, bornite and native copper ore minerals.

Ore-stage mineral zoning is spatially consistent with both the predominant orientation of the veins and a hydrothermal fluid source in the Sugarloaf diorite dikes. The zoning of pyrite-chalcopyrite and chalcopyrite-bornite mineral assemblages across the deposit suggests that copper and gold mineralization may have precipitated under variable temperature and/or fluid sulphidation conditions (Einaudi, 1993) encountered as fluids migrated away from the Sugarloaf diorite dikes.

Precipitation of copper and gold occurred after the pervasive albitic alteration event that affected all intrusive rock types, and contact metamorphism of volcanics adjacent to Sugarloaf diorite dikes. The hostrocks to mineralization appear to have been made more competent by these pre-mineral alteration events such that they fractured more brittley and acted as ready hosts for mineralization.

Late, post-mineral chlorite veins cut unalbitized rocks, whereas kaolinite veinlets cut albitized rocks. Later calcite veins cut all lithologies.

During the Eocene, low-angle 'detachment' faulting, mafic dike emplacement and graben formation reflect the extensional tectonic episode that affected the Pothook area. Late quartz-bearing veins are associated with this tectonic and intrusive episode.

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