The Schaft Creek copper-molybdenum-gold-silver porphyry deposit, northwestern British Columbia

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ABSTRACT

The Schaft Creek calc-alkaline porphyry deposit is located in northwestern British Columbia, 61 km south of Telegraph Creek. The deposit was discovered by prospecting in 1957. Between 1968 and 1981, 60 200 m of core drilling in 230 holes were completed which outlined a proven and probable open pit reserve of 971 495 000 tonnes grading 0.298% Cu, 0.033% MoS_2, 0.14 g/t Au and 1.20 g/t Ag. .02 Mo

The deposit is within Stikinia, part of the accreted Intermontane Superterrane, and is contained within a belt of Upper Triassic Stuhini Group andesite flows, pyroclastics and epiclastics that are intruded on the west and northwest by the Late Triassic Hickman Pluton and the mid-Jurassic Yehiniko Pluton, respectively. Mineralization is genetically linked to numerous irregular quartz feldspar porphyry dikes which have been dated at 220 Ma (Norian) (Logan and Drobe, in prep.), suggesting a temporal relationship with the Hickman Batholith.

The reserve is contained within three distinct zones: (a) the Liard (Main) zone, a bowl-shaped body of disseminated and vein mineralization in volcanic rocks; (b) the West Breccia zone, a lenticular shallow north-plunging tourmaline-sulphide matrix breccia; and (c) the Paramount zone, a moderately east-dipping intrusive breccia complex.

Alteration assemblages and sulphide zones are intimately associated in the Liard zone. The quartz-K-feldspar-biotite-magnetite (potassic) assemblage is roughly coincident with the bornite zone; whereas, the sericite-chlorite-calcite assemblage (phyllic) contains the bulk of the molybdenite and chalcopyrite; and the epidote-chlorite assemblage (propylitic) has pyrite as the main sulphide.

A paragenetic sequence for the Schaft Creek deposit involves early quartz veins and widespread fracture-controlled potassic and propylitic alteration preceding to a main stage of brecciation, pervasive potassic and propylitic alteration and sulphide deposition. Phyllic alteration overprinted the potassic zone as the hydrothermal system waned. Molybdenite- and chlorite-coated fractures and carbonate and gypsum veining represent the last stages.

The shape and attitude of mineralized zones and pattern of alteration and sulphide zones suggest the deposit is recumbent; the main Liard zone represents the upper levels of the hydrothermal system, the Paramount zone is the intrusive core and the West Breccia zone is an explosive breccia into weakly altered country rock.

Introduction

The Schaft Creek deposit is located at 57°21′N and 131°00′W; (NTS 104G, 6E and 7W); between Mess and Schaft Creeks, 61 km south of Telegraph Creek, and 80 km southwest of the village of Iskut on the Stewart-Cassiar highway (Fig. 1). The deposit is exposed on the gentle west-facing slope of Schaft Creek valley at an average elevation of 1000 m (Plate 1).

Access is by fixed wing aircraft to a 1000 m long gravel airstrip in Schaft Creek valley. Both Raspberry Pass and More Creek have been studied as possible access routes to connect Schaft Creek with the Stewart-Cassiar highway. The Raspberry Pass route would require 66 km of road construction, roughly following the old Telegraph Trail through Mount Edziza Provincial Park. An access corridor through the Park was grandfathered to the project by the provincial government in 1983. The More Creek route requires 76 km of construction and would involve appreciable rock work.

Potential hydroelectric power generation sites on the Stikine and Iskut Rivers and More Creek have been studied by B.C. Hydro. Hotspring occurrences near Mess Creek suggest a possibility for geothermal energy as an alternate power source.

History

The original copper showing, a rather unimpressive outcrop of altered malachite-stained andesite, was discovered in 1957 by Nick Bird prospecting for the BIK Syndicate, under the supervision of W.St. C. Dunn of Silver Standard Mines Ltd. Liard Copper Mines, a private company, was formed by the participants of the BIK Syndicate to hold the property. In 1965 the property was optioned to ASARCO who carried out exploration in 1966 and 1967. Paramount Mining Ltd. located adjoining claims in 1966 and discovered extensions to mineralization. The two properties were optioned to Hecla Mining Company in 1968 and extensive exploration was conducted. Hecla terminated its agreement with Paramount in 1973 and those claims subsequently lapsed. By 1977 a total of 104 diamond drill holes aggregating 34 500 m had been completed which indicated a resource of approximately 330 000 000 tonnes averaging 0.40% Cu and 0.036% MoS_2 at a waste to ore ratio of 1.5 to 1 (Fox et al., 1976) on the Liard claims. Teck Corporation assumed Hecla's option in 1978 and restaked the former Paramount ground to the north. In 1980 and 1981 the proposed initial pit was drilled off in detail and condemnation drilling of the proposed mill site and tailings pond areas was initiated. By the end of 1981 about 60 200 m had been core drilled in 230 holes. No further work has been carried out.

Ownership

The property is owned by Liard Copper Mines Ltd., which is 78.05% owned by Teck Corporation. Upon production and prior to recoupment of all expenditures, net proceeds will be divided 80% to Teck directly, and the remaining 20% on the basis of 30% to Liard and 70% to Teck. After payback net proceeds will be divided 30% to Liard, 66.5% to Teck and 3.5% to Hecla.

Reserves

An open pit geological reserve calculation was carried out by International Geosystems Ltd. in 1981. A geostatistical block model was developed using an inverse distance method for calculating grades from drill hole assays. At 0.189% Cu-equivalent cutoff grade, the total proven and probable reserve is 971 495 000 tonnes grad-

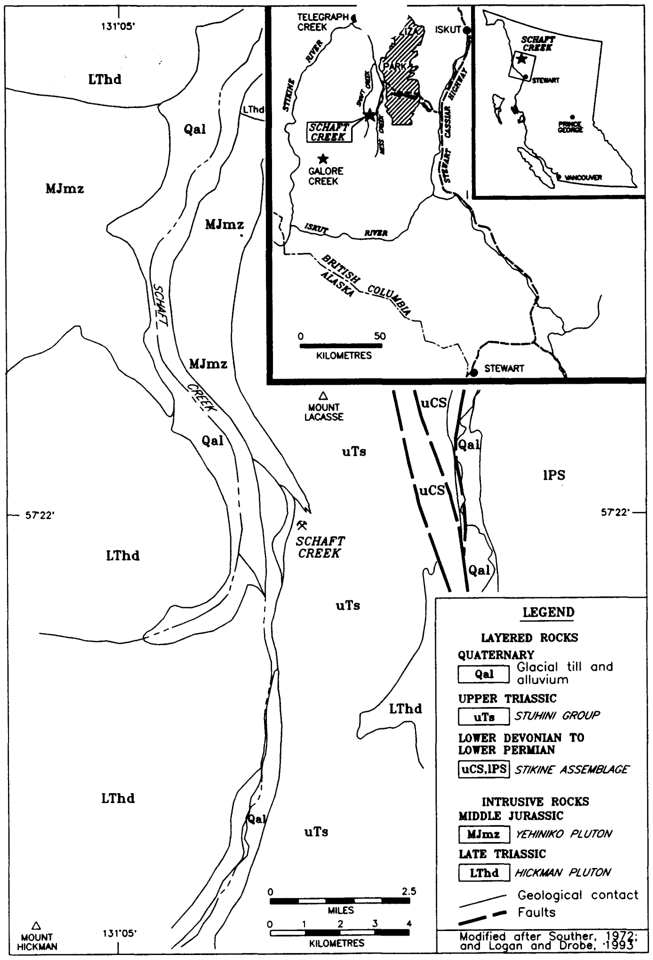

FIGURE 1. Location map and regional geology.

ing 0.298% Cu, 0.033% MoS_2, 0.14 g/t Au and 1.20 g/t Ag with a 1.24:1 strip ratio. Reserves at various cutoff grades are shown in Table 1. A second, more recent, reserve calculation employing a three-dimensional solids geological model using the GEMCOM PC-Mine program gave similar estimates.

Applied Exploration Techniques

The deposit was discovered by grassroots prospecting and probably would have gone undetected in a regional silt sampling program because no streams directly drain the area. Induced polarization surveys effectively outlined the Liard and Paramount zones by defining the pyrite halo (Fig. 3). The strongest anomaly trends north along the West Breccia zone and connects with the Paramount zone (Linder, 1975). Magnetic surveys were inconclusive because the varied magnetic response of unaltered volcanic rocks was indistinguishable from the effects of alteration. Geochemical soil survey results were erratic due to the presence of a till layer averaging 10 m thick.

Regional Geol /

The Schaft Creek deposit occurs within a 10 km by 50 km belt of Upper Triassic volcanic rocks thought to be part of the Stuhini Group (Holbek, 1988; Logan and Drobe, 1993). The belt is in fault contact on the east with Paleozoic rocks of the Stikine assemblage, and is intruded on the west and southeast by the Upper Triassic Hickman Pluton and on the northwest by the mid-Jurassic Yehiniko Pluton (Fig. 1).

Host volcanic rocks are intercalated andesitic and basaltic flows, pyroclastics and derived volcaniclastic rocks which are at least 1200 m thick. Small dike-like felsic porphyry intrusions cut the host volcanic rocks and are especially numerous in the Liard zone.

Geology of Ore Deposit

Because of thick till cover, plan geology and structural interpretation of the Schaft Creek deposit is based largely on drill core data. Core logging during the Teck Corporation, 1981 drill program employed the Geolog System (Blanchet and Godwin, 1972; Godwin et al., 1985) which facilitated evaluation of the deposit by standard spread sheet programs and CAD plots.

The deposit consists of three distinct but connected zones: (a) the Liard (Main) zone hosted mainly by andesite flows and epiclastic rocks; (b) the West Breccia zone, a fault-bounded tourmaline-sulphide matrix breccia; and (c) the Paramount zone, an intrusive breccia in altered andesite, granodiorite and quartz monzonite (Fig. 2).

Lithology

Volcanic Rocks

The host volcanic rocks comprise flows, pyroclastic and epiclastic rocks of andesite composition containing 40% to 60% subhederal plagioclase (andesine to labradorite) phenocrysts, accessory augite and minor leucoxene and apatite (Fox et al., 1976). For the purpose of core logging these rocks were subdivided into five textural subunits: (1) fine grained andesite (ANDS): massive flows, dark grey where unaltered, and distinguished by their lack of distinct phenocrysts, (2) plagioclase porphyry andesite (ANPF): flows containing up to 60% euhedral plagioclase and accessory augite phenocrysts roughly aligned in a dark to green aphanitic groundmass, (3) andesite lapilli (ANLP): pyroclastics whose fragments are subrounded to angular, massive to porphyritic, have sharp margins and comprise up to 40% of the rock, (4) andesite tuff (ANTF): epiclastic tuffs or wackes, green to brown with recognizable bedding, and (5) andesite conglomerate (ANCG): sedimentary rocks composed of polylithic, subrounded to rounded clasts in a lithic matrix. The latter two units provide the only useful guide to bedding attitudes.

West of the deposit and bordering the Hickman Pluton is a north-trending body of augite porphyry basalt (PPAU) distinguished by its coarse-grained, euhedral, augite phenocrysts in a dark green, highly magnetic matrix. It has been interpreted to be both intrusive and extrusive in occurrence (Lange, 1971). A second smaller body occurs within the southern part of the Liard zone. The augite porphyry basalt normally is relatively fresh with minor pyrite confined to fractures. The weak mineralization may be due either to

TABLE 1. Proven and probable open pit reserve

Cutoff grade (% Cu equiv.)	Tonnage ('000t)	NSR/Tonne ore ($US)*	Cu equiv. grade*	Cu %	MoS_2%	Au g/t	Ag g/t	Strip ratio
0.063	1 292 599	3.45	0.348	0.255	0.027	0.10	0.99	0.68
0.126	1 140 497	3.92	0.395	0.277	0.030	0.14	1.10	0.90
0.189	971 495	4.18	0.421	0.298	0.033	0.14	1.20	1.24
0.252	769 713	4.68	0.472	0.325	0.038	0.17	1.34	1.82
0.315	572 249	5.24	0.528	0.353	0.043	0.21	1.47	2.80

*NSR and Cu Equivalents are based on formulae from Goldie and Tredger (1990), using metal prices as of April, 1993.

emplacement during late stages of the [illegible]alizing event or to its weakly fractured character or distance from source.

Intrusive Rocks

Irregular, north-striking, steeply dipping quartz-feldspar porphyry dikes (PPFQ) cut the volcanic rocks. The dikes are normally less than 30 m wide and constitute about 10% of the host rocks of the deposit. They are composed of about 60% plagioclase (andesine), 10% quartz and minor mafics in a fine matrix of feldspar, quartz, chlorite, sericite and iron oxides (Fox et al., 1976). Two sub-groups of dikes were recognized: (a) pink quartz plagioclase porphyry, readily identified by scattered, partially resorbed quartz grains 2 mm to 3 mm in diameter and (b) grey to light brown plagioclase porphyry distinguished by its lack of quartz phenocrysts and presence of abundant subrounded plagioclase phenocrysts. In general the dikes are leucocratic and are distinguished from granodiorite-quartz monzonite by their lack of mafics and porphyritic texture. They are commonly bordered by bleached, highly altered andesite wallrock and appear to be intimately associated with the mineralizing event.

Irregular granodiorite-quartz monzonite (GRDR-QZMZ) bodies are the predominant intrusions in the Paramount zone. Some are difficult to distinguish from quartz-feldspar porphyry dikes, but in general they have a distinct hypidiomorphic granular texture. Euhedral hornblende is ubiquitous and generally altered to chlorite and biotite. The intrusive rocks are variably altered, occasionally fresh, and contain disseminated pyrite and chalcopyrite. These intrusions are probably non-porphyritic equivalents of the quartz-feldspar porphyry dikes in the Liard zone.

A small body of diorite (DIOR) has been encountered only in zones of intense alteration. It is composed of equigranular euhedral pseudomorphs of augite altered to chlorite and/or biotite, and feldspar altered to a mixture of sericite-chlorite and calcite.

Postmineralization augite basalt (D/BS) dikes, usually less than 3 m wide, occur in swarms. The unaltered dikes cut all rock units, trend north to northwest and dip steeply east and west.

Breccias

Breccias form a significant part of the mineralized zones, particularly the West Breccia zone and the Paramount zone. They have been subdivided into three types based primarily on matrix composition.

Tourmaline breccia (TOBR) has a matrix composed of fine-grained tourmaline with lesser amounts of chlorite, quartz, pyrite, chalcopyrite and specular hematite. This unit comprises the West Breccia zone, an irregular, north-trending linear to lenticular body dipping steeply eastward. Contacts with country rock are sharply defined where fault-bounded, but gradational through a crackle zone in other areas. Fragments are angular to subrounded andesite and quartz-feldspar porphyry which have been bleached by silicification and sericitization. There is a general zoning outward from the core where quartz feldspar porphyry fragments predominate to the borders where volcanic country rock fragments are abundant. Chalcopyrite and pyrite are the dominant sulphides accompanied by minor molybdenite, occurring predominately in the matrix. Bornite is absent.

Intrusive breccia (BRXX) matrix varies from quartz, epidote, chlorite and sulphides to comminuted rock. It occurs in the west side of the Liard zone and throughout the Paramount zone and unlike the tourmaline breccia, bornite is common and molybdenite also may be abundant in the matrix. Fragments consist of subangular to subrounded andesite and granodiorite-quartz monzonite that are variably altered to chlorite-epidote or quartz-orthoclase.

Sutherland Brown (1971) postulated that these breccias are explosive in origin and related to porphyry dikes originating from the Hickman Batholith at no great depth. Further drilling has shown these two breccia types are subhorizontal with volatiles increasing to the south suggesting an intrusive source to the north in the Paramount zone.

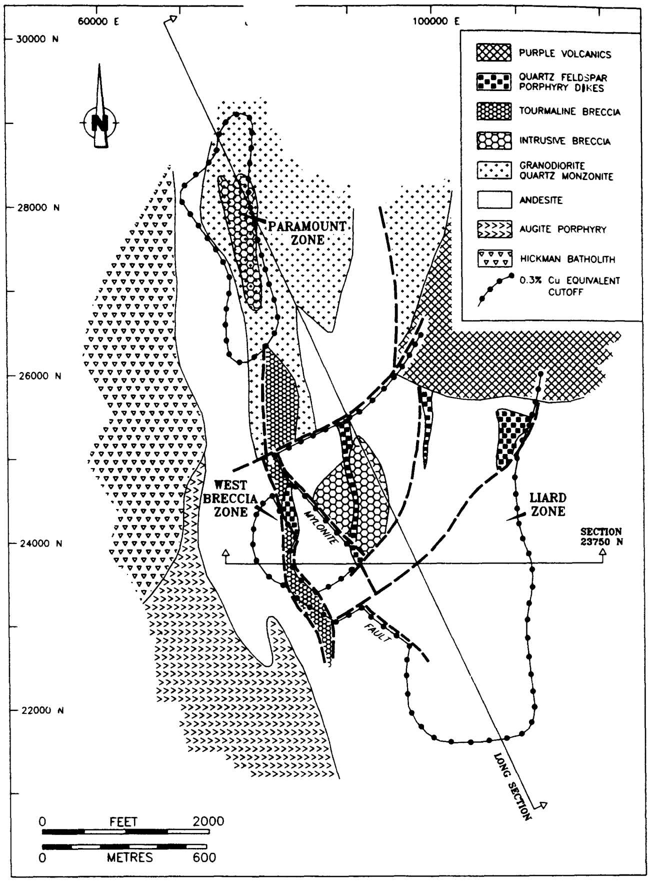

FIGURE 2. Geological plan map.

A third breccia, labelled igneous porphyry breccia (PPBR) has been identified in only two drill holes in the south portion of the Paramount zone. This breccia has a matrix similar to the quartz-feldspar porphyry dikes, but lacks sulphides and may be a pebble dike. Fragments are mainly andesite, which are rounded and highly altered to quartz and K-feldspar assemblages and comprise about 30% of the rock.

Purple Volcanics

Relatively fresh, sparsely mineralized, flow breccias, known locally as "Purple Volcanics" (PVLP) overlie the mineralized andesites on the northeast side of the Liard zone. Finely-disseminated hematite gives the rock its typical purple colour. Also characteristic are lenses of epidote up to 15 cm in diameter. Drilling shows that the Liard zone extends at least 100 m north under the Purple Volcanic "cap".

The Purple Volcanics may be in a fault contact with (Lange, 1971), unconformably overlie (Linder, 1975), or disconformably overlie (Fox et al., 1976), the host volcanic rocks. Although the exact nature of the contact is uncertain, it is likely that the Purple Volcanics post-date mineralization based on their very weak mineralization and alteration.

Age

Fossils from thin sedimentary interbeds within the host Stuhini Group volcanic rocks are identified as Late Triassic (Norian) (Logan and Drobe, 1993). U-Pb zircon data from an altered and mineralized quartz-feldspar porphyry dike from the Liard zone give a best age estimate of 220 Ma (Logan and Drobe, in prep.). Thus the Late Triassic, Norian age of emplacement for the porphyry dikes provides a lower limit on the age of mineralization. The K-Ar age of 185 Ma ± 5 Ma (Panteleyev and Dudas, 1973) from hydrother-

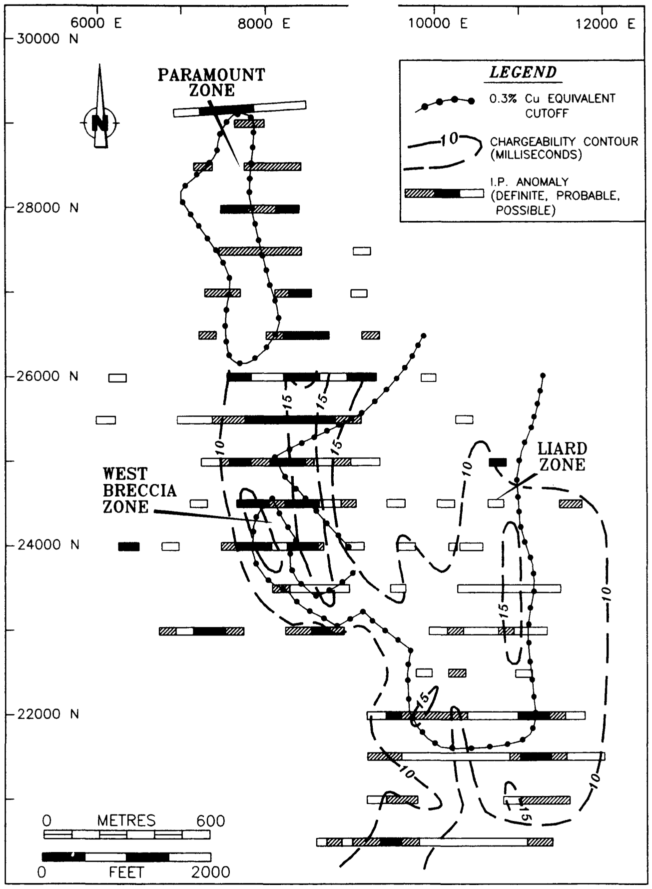

FIGURE 3. Induced polarization surveys.

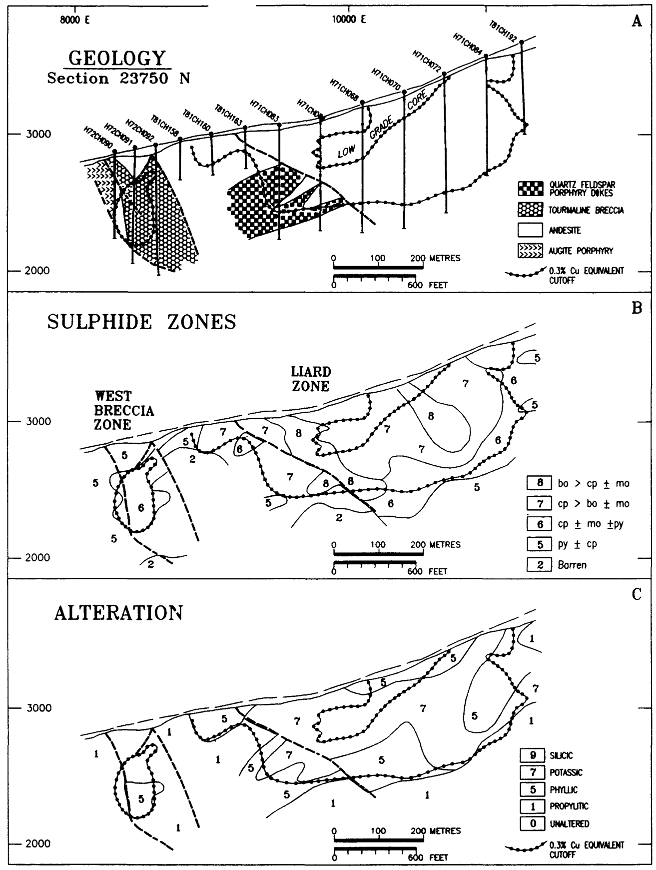

FIGURE 4. Section 23750 N: A — geology; B — sulphide zones; C — alteration facies.

mal biotites probably reflects argon loss related to the intrusion of the adjacent Yeheniko Pluton (Logan, 1993 pers. comm.). The quartz monzonite phase of the Yeheniko Pluton has been dated by Rb-Sr whole rock and biotite K-Ar methods which gave dates of 178 Ma ± 11 Ma and 172 Ma ± 6 Ma, respectively (Holbek, 1988).

Structure

The host volcanic rocks appear to strike northwest and dip steeply northeast and southwest in outcrops measured east of the deposit (Lange, 1971). Bedding attitudes observed in core are consistent with this trend.

Numerous gouge shear and mylonite zones occur in the deposit. More intense alteration and higher grade mineralization is located along most fault zones suggesting pre-mineralization ground preparation. A north-striking and east-dipping fault bounds the Liard zone on the west and is termed the "Mylonite Fault" (Fox et al., 1976). The West Breccia zone is a locus for north-trending faults which controlled its emplacement. Several northeast-trending and northwest-dipping normal faults progressively downdrop the Liard zone to the northwest (Figs. 2, 4a and 5a).

Mineralization

The sulphide mineralogy consists of chalcopyrite, pyrite, bornite and molybdenite in order of decreasing abundance. Sphalerite and galena have not been observed in the ore zone but occur locally in narrow carbonate veins in relatively unaltered rock outside the copper deposit. Minor amounts of malachite and chalcocite after bornite occur along fractures in weathered rock.

Of the three zones at Schaft Creek; the Liard zone contains the largest reserve having a known length of about 1000 m, a width of 700 m and an average thickness of 300 m. The zone is bowl shaped with a 20° north plunge. The west boundary dips about 45° east and the eastern boundary 80° west (Linder, 1975). Chalcopyrite, bornite, and molybdenite are the principal sulphides. Pyrite occurs in minor amounts within the deposit but dominates in the periphery (Fig. 4b).

The West Breccia zone is a linear, north-striking body of variable width averaging about 100 m. It has a length of 500 m and has been intersected in drilling to depths greater than 300 m. The breccia is locally high grade; pyrite is the main sulphide with lesser chalcopyrite and molybdenite.

The Paramount zone has received less attention than the other zones, but appears to be a moderately east-dipping body about 200 m wide and at least 500 m thick and 700 m long. Pyrite, bornite and chalcopyrite occur in about equal amounts; molybdenite values are higher than in the Liard or West Breccia zones.

A comparison between copper and molybdenite grade and host lithology (Fig. 6) shows that:

1. the best copper and molybdenite grades are in the tourmaline breccia and highly altered diorite;
2. the intrusive rocks (GRDR-QZMZ and PPFQ) are slightly less mineralized than the host volcanic rocks and breccias; and
3. within the andesites, the tuff and conglomerate subunits have significantly higher copper and molybdenite content possibly due to their higher permeability.

Sulphide Zonation

The concept of sulphide zoning has been recognized by several authors. Fox et al. (1976) described zoning in the Liard zone as follows "...a zone containing bornite is overlapped by a broader zone characterized by chalcopyrite and molybdenite. Pyrite is found throughout the entire deposit except for parts of the bornite zone

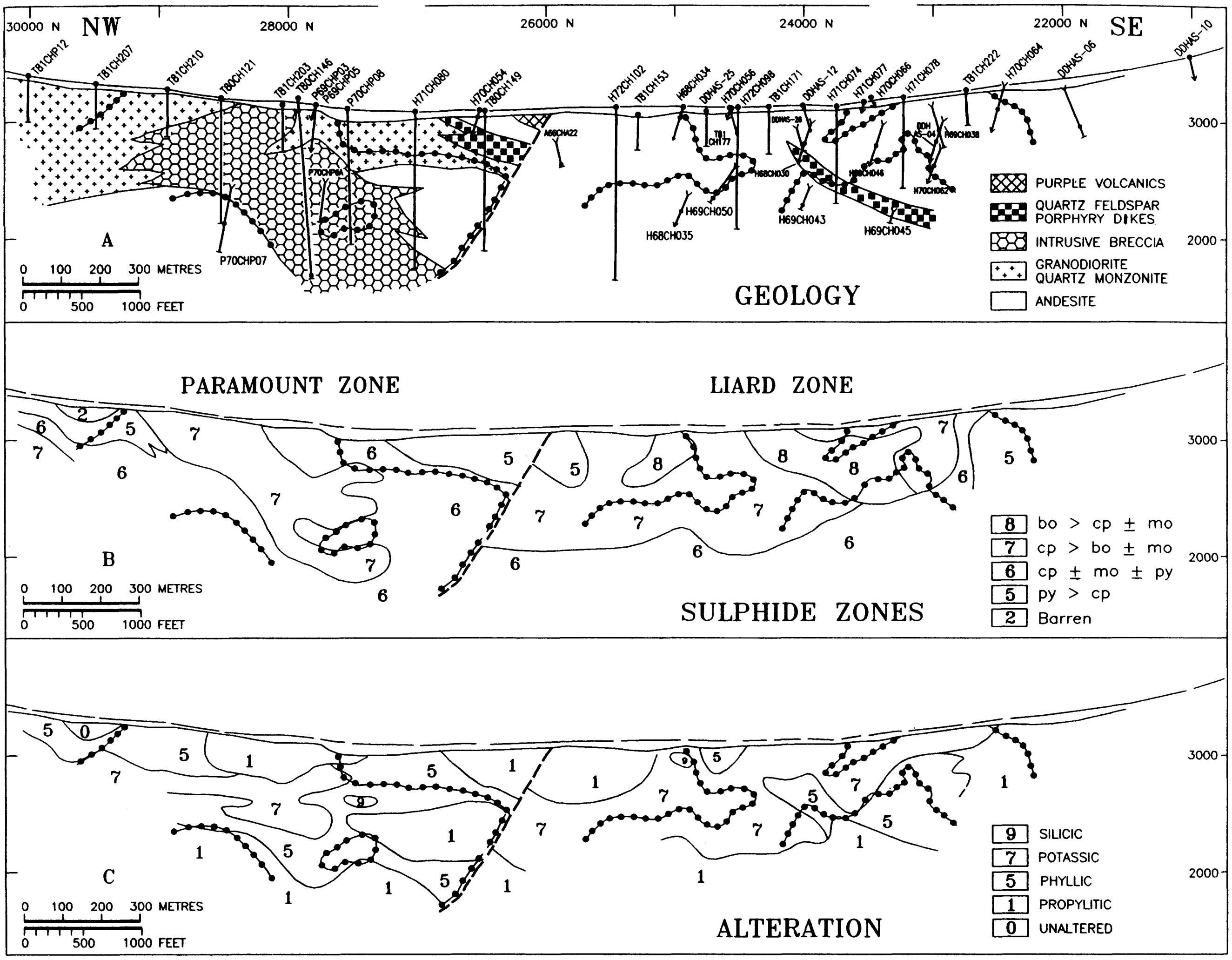

FIGURE 5. Longitudinal section: A — geology; B — sulphide zones; C — alteration facies.

and some of the felsic porphyry".

For the purpose of core-logging these zones were defined and a single number assigned to each as follows:

(8) bornite > chalcopyrite ± molybdenite
(7) chalcopyrite > bornite ± molybdenite
(6) chalcopyrite + molybdenite ± pyrite
(5) pyrite > chalcopyrite

Bornite Zone (8)

Bornite has three modes of occurrence; (1) within stockwork quartz veins; (2) as matrix replacement in intrusive breccia with quartz and chlorite; and (3) as fine grains along fractures and disseminated in highly altered andesite. The bornite zone in the Liard zone is roughly peripheral to a low-grade highly altered "core" zone (Fig. 4b).

Chalcopyrite Zone (7 and 6)

Chalcopyrite is the most abundant and widespread sulphide in the Liard zone. It commonly occurs as discrete blebs and veinlets, less frequently in quartz veins and disseminated in the quartz-feldspar porphyry. Chalcopyrite is most intense in the eastern half of the Liard zone (Fig. 4b). In the Paramount zone chalcopyrite and bornite are coincident with the intrusive breccia (Fig. 5b).

Pyrite Zone (5)

Pyrite is dominant on the periphery of the copper mineralized area (Figs. 3b and 4b) and is associated with chlorite and epidote within narrow fractures. Minor pyrite is disseminated in the feldspar quartz porphyry dikes intergrown with mafic minerals. Pyrite is mutually exclusive of bornite and the two minerals have not been observed in contact with each other.

Molybdenite Zone

The occurrence of molybdenite is not strictly related to the other sulphide zones. Although molybdenite is observed frequently with bornite in the breccia matrix or in quartz veining (sometimes spectacular), the most common mode is as a thin coating on fine fractures. These fractures have little attendant alteration and are assumed to be a late stage.

Alteration

The bulk of the Schaft Creek deposit is hosted in andesitic rocks with alteration assemblages that closely correspond to the modified porphyry model of Guilbert and Lowell (1974) for deposits hosted in intermediate volcanic rocks. Following their model a number was assigned to each of the alteration facies which were identified according to the following criteria:

(9) silicic: abundance (greater than 10% of core volume) of quartz veins
(7) potassic: presence of K-feldspar selvages around quartz veins
(5) phyllic: alteration of mafic minerals to sericite-chlorite and plagioclase to sericite-carbonate
(1) propylitic: abundance of chlorite and epidote in fractures

Figures 4 and 5 present sections with geology, sulphide zones

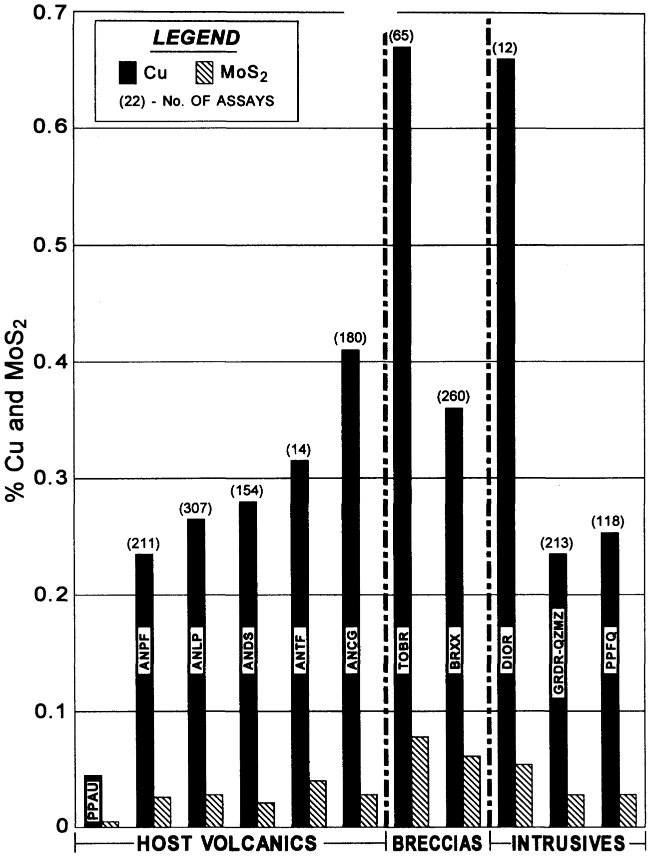

FIGURE 6. Average Cu and MoS_2 content for different rock types (see text for rock codes).

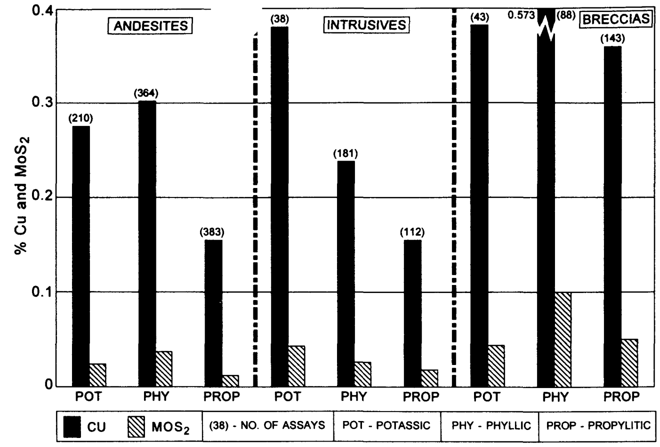

FIGURE 7. Average Cu and MoS_2 content vs rock type and alteration facies.

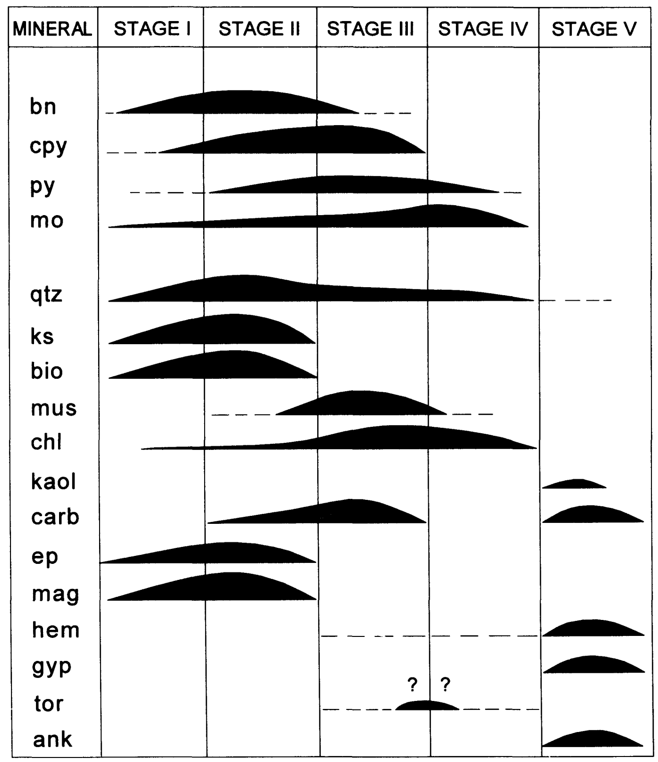

FIGURE 8. Paragenetic sequence of sulphides and alteration minerals.

and alteration facies for comparative purposes. The relationship of rock type and alteration facies to copper and molybdenum tenor is illustrated in Figure 7. Copper and molybdenum values are similar in potassic and phyllic altered andesites and both decrease in the propylitic altered rocks. The intrusive rocks have decreasing copper and molybdenum content from potassic through phyllic to propylitic alteration.

The relationship of mineralization to alteration in the breccias is not clear. In general the breccias have a higher copper and molybdenum tenor than the other rocks. Classifying the breccias into an alteration facies proved difficult because the fragments are variably altered and the matrix alteration assemblage is often quite different from the alteration assemblage of the fragments. As a general rule, tourmaline breccia was classed as phyllic and chlorite matrix intrusive breccia was recorded as propylitic.

Silicic (9)

Quartz veining is intense within and peripheral to the intrusive breccia, decreasing gradually outward to the east. In some cases weakly mineralized quartz veining is so intense the rock is sub-ore grade forming a "low-grade core" (Figs. 4a, c).

Potassic (7)

Potassic alteration was defined by the presence of K-feldspar selvages. Secondary K-feldspar is intimately associated with the development of biotite, magnetite and moderate quartz veining, and these minerals were used to help define the distribution of potassic alteration. Where potassic alteration is intense, drill core is distinctively polished and is a dark grey to black colour.

Phyllic (5)

The determination of phyllic alteration was quite subjective. The diagnostic mineral, sericite, is extremely fine-grained and was recognized megascopically only on the basis of the softness and light green colour it imparts to altered plagioclase grains. Other characteristics of the phyllic zone are a general bleaching of the rock, the development of calcite as disseminated aggregates and granules after plagioclase, and the presence of pervasive chlorite probably after biotite. Phyllic alteration appears to be a retrograde alteration superimposed on the potassic zone.

Propylitic (1)

Epidote, the diagnostic mineral for the propylitic zone, occurs as small disseminated grains, large subrounded patches and as fracture fillings with calcite and chlorite. The first two modes of occurrence may be primary deuteric features of the andesite. Pyrite is the dominant sulphide in epidote-rich rocks.

The appearance of epidote is an important exploration guide in the volcanic-hosted parts of the deposit, in that epidote-rich rocks are usually below cutoff grade.

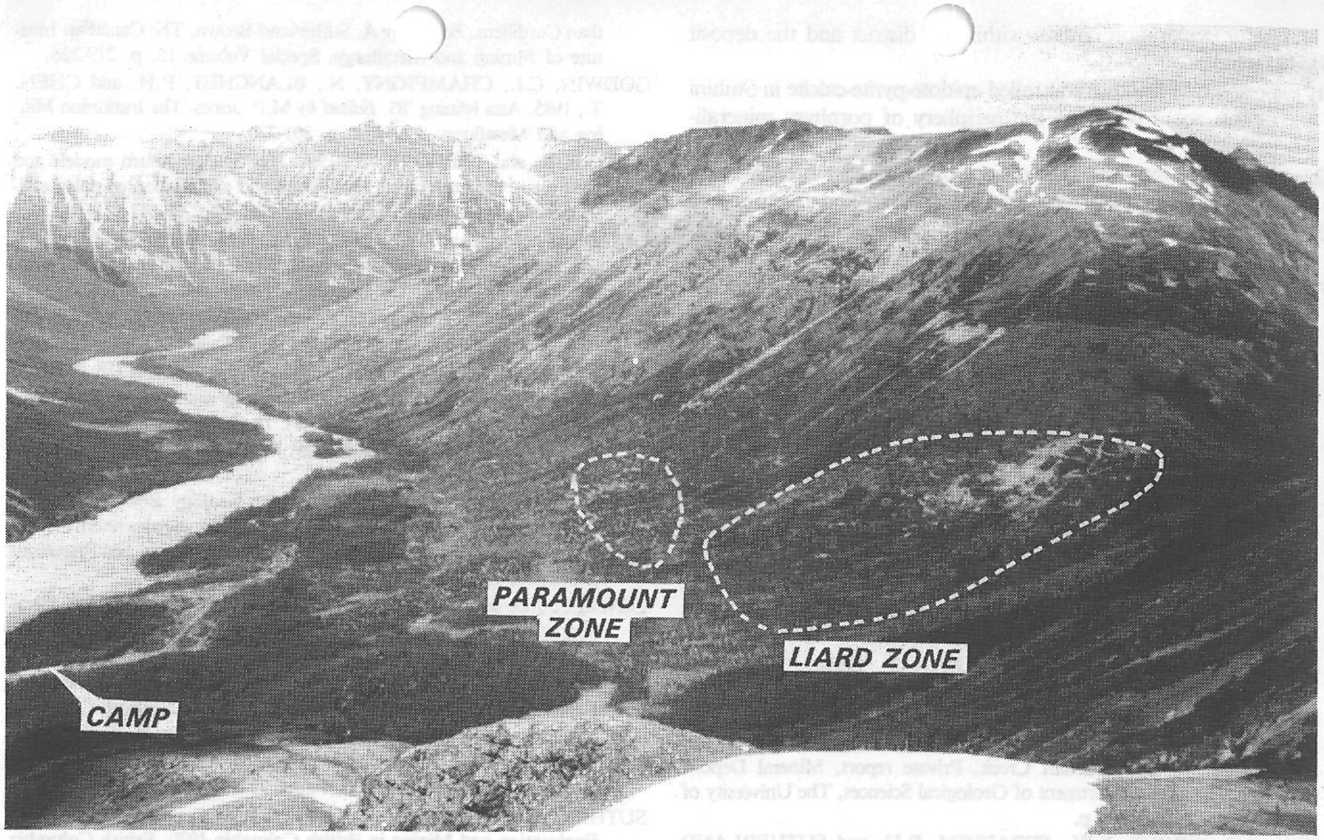

FIGURE 9. The Schaft Creek porphyry deposit lies east of Schaft Creek, on the lower slopes of Mount La Casse. View is to the north (photo and caption courtesy of J.M. Logan).

Fluid Inclusions

An examination of secondary inclusions within quartz veinlets from potassic-altered andesite indicates temperatures between 180°C and 330°C and salinities between 3 wt% and 15 wt% NaCl. The lower temperatures may reflect later cooler secondary fluids or possibly leaked inclusions (Dunne, 1994).

Supergene Alteration

The deposit lacks any significant supergene enrichment probably due to glacial erosion. However, malachite is developed on fractures in near-surface, weathered rock to depths of 10 m to 20 m. Deeper occurrences of malachite at higher elevations on the east side of the Liard zone under the Purple Volcanics may be a remnant of paleo-weathering that has escaped the scouring effects of valley glaciers. Gypsum after anhydrite extends to a depth of about 50 m which marks the lower limit of groundwater incursion into the deposit.

Economics

Preliminary metallurgical testwork has indicated 85% copper and 80% molybdenite recoveries to a 25% grade bulk copper concentrate. About 50% of the gold and 80% of the silver is recovered in the bulk concentrate.

Sufficient exploration work has been done to outline the Liard and West Breccia zones. Extensions to mineralization that may occur are not considered critical to the project's economics. An initial pit has been defined and drilled in detail, but large diameter drilling or underground drifting for metallurgical bulk sampling remains to be done. Condemnation drilling of the millsite and tailings pond area will be required prior to feasibility. In addition, gold mineralization within and peripheral to the deposit should be evaluated further.

Conclusion

The following paragenetic sequence is based on megascopic observations. Detailed petrographic study has not been completed, however the patterns observed suggest a coherent progression of mineralization and alteration as the hydrothermal system advanced and then waned. The following stages in the evolution of the Schaft Creek deposit are proposed (Fig. 8):

STAGE I — Early quartz veining with attendant potassic and propylitic alteration. Minor amounts of bornite, chalcopyrite, molybdenum, and pyrite deposited.

STAGE II — Main stage - brecciation, widespread potassic and propylitic alteration; fracture controlled deposition of bornite, chalcopyrite and pyrite.

STAGE III — Transition stage - retrograde phyllic alteration overprinted on potassic zone; chalcopyrite is the dominate sulphide. Emplacement of quartz feldspar porphyry dikes.

STAGE IV — Molybdenite and chlorite in "dry" fractures.

STAGE V — Carbonate-ankerite and gypsum veining.

The alteration assemblages and sulphide zoning are intimately associated in the Liard zone of the Schaft Creek deposit. The quartz-K-feldspar-biotite-magnetite assemblage (potassic) is associated with bornite; the sericite-chlorite-calcite assemblage (phyllic) contains the bulk of chalcopyrite and molybdenite; and the epidote-chlorite-carbonate assemblage (propylitic) has pyrite as the main sulphide. Breccias do not fit well into the alteration zoning pattern.

The subhorizontal attitude of the breccia bodies and the general pattern of alteration and sulphide zones permits the interpretation that the deposit may be recumbent. In this interpretation the Liard zone represents the top of the hydrothermal system and the Paramount zone the deeper, intrusive core. The West Breccia zone is an explosive breccia channelled along fault zones in relatively unaltered country rock.

Useful exploration criteria withi district and the deposit itself include:

1. presence of fracture controlled epidote-pyrite-calcite in Stuhini Group rocks occur on the periphery of porphyry mineralization;
2. intrusive complexity as evidenced by tourmaline breccias, porphyritic felsic dikes and intensive faulting and fracturing;
3. increasing chalcopyrite: pyrite ratio indicates increasing proximity to ore grade mineralization; and
4. early stage stockwork quartz veining within the core of the hydrothermal system but may be low grade.

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