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The Louise Lake copper-molybdenum-gold-arsenic high level porphyry system, west-central British Columbia

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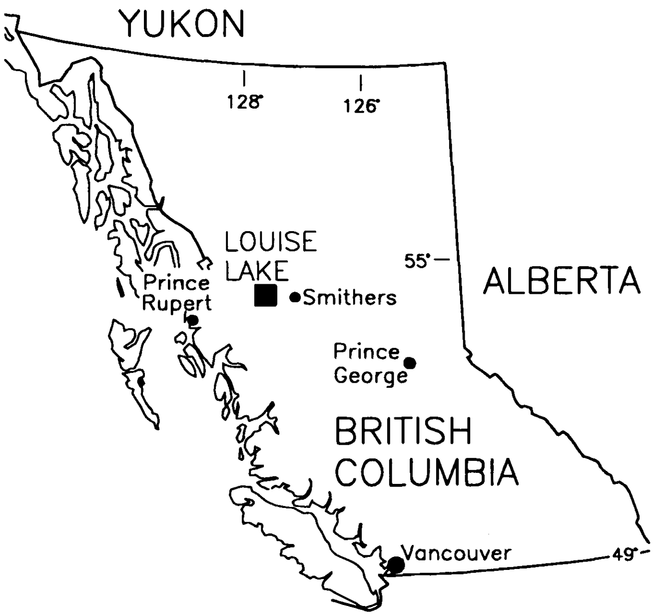

FIGURE 1. Location map, Louise Lake.

ABSTRACT

The Louise Lake Cu-Mo-Au-As high level porphyry system, located 33 km west of Smithers, British Columbia, has been explored by several companies since its discovery in 1968. The property is situated in the Intermontane tectonic belt near the western end of the Skeena arch. A regional scale fault occupying the Coal Creek Lineament separates Skeena Group sedimentary rocks on the northwest from Hazelton Group volcanic rocks on the southeast. Alteration and mineralization are controlled by a 100 m thick swarm of moderately northwest-dipping feldspar porphyry sills that intrude Skeena Group sedimentary rocks. Primary mineralization consists of disseminated and fracture-controlled pyrite, tennantite/enargite, chalcopyrite, and molybdenite, with minor secondary chalcocite and bornite. Gold is probably associated with the tennantite/enargite. A geological resource of 50 million tonnes grading 0.3% Cu, 0.3 g/t Au, and 0.02% Mo has been calculated using a cutoff of 0.2% Cu. The geometry of the porphyry intrusions, the phyllic-argillic alteration zoning, and the unusual presence of tennantite/enargite indicate that the deposit formed near the top of a porphyry hydrothermal system.

Introduction

The Louise Lake deposit is located west of Louise Lake near the headwaters of Coal Creek (NTS 93L/13, latitude 54°47′N, longitude 127°41′W) at an elevation of 1000 m. The property is 33 km west of Smithers in the Hazelton Mountains of west-central British Columbia (Fig. 1). Access to the property is by logging roads or helicopter from Smithers.

Copper mineralization was first discovered in a gossanous outcrop immediately west of Louise Lake in 1968 during regional prospecting by Mastodon-Highland Bell Mines Ltd. Mastodon-Highland carried out magnetometer and induced polarization surveys and trenched the showing that same year. Canadian Superior Exploration Limited acquired the property in 1969 and completed soil geochemical and additional induced polarization surveys on the property. In 1970, Canadian Superior drilled 2021 m in 17 NQ diamond drill holes which outlined a small tonnage grading 0.3% Cu. No further work was carried out on the property between 1971 and 1974. Further geochemical and airborne surveys were completed by various operators between 1975 and 1986.

Corona Corporation did extensive work between 1987 and 1989 including resampling of the Canadian Superior core, re-opening and resampling the Mastodon-Highland trenches, and 916 m of diamond drilling. This work was centred around a higher grade copper-gold mineralized zone related to a major shear structure intersected by the Canadian Superior drill holes in the centre of the porphyry system. Corona encountered low-grade copper-gold mineralization over significant widths in several drill holes (e.g. Hole C-19, drilled in 1989, intersected 178.3 m grading 0.24% Cu and 0.27 g/t Au).

In 1992, Equity Silver Mines Ltd. further tested the extent of copper-gold bulk tonnage mineralization with thirteen diamond drill holes totalling 2652 m. From this work, a mineral resource of 50 million tonnes grading 0.3% Cu and 0.3 g/t Au was estimated using a 0.2% Cu cutoff.

The property is currently owned by 402774 B.C. Ltd.

Regional Geology

The Louise Lake Cu-Mo-Au-As deposit is situated in the Intermontane tectonic belt of west-central British Columbia near the western end of a transverse Mesozoic feature known as the Skeena arch (Wheeler and Gabrielse, 1972). The arch comprises Middle Jurassic to Lower Cretaceous sedimentary and volcanic rocks that have been cross-cut by numerous block faults and occasional thrusts, and intruded by Late Cretaceous and Eocene felsic and intermediate intrusive rocks (Carter, 1981). This general setting is common km northeast along trend are highly anomalous in copper and molybdenum (Gaba, 1992), sugg ; another mineralized zone. The faulted southwestern trend o. e Big Onion system is overburden covered and, like the northeastern area, has not been explored. An untested 600 m by 1200 m induced polarization anomaly 1 km south of Big Onion is also a prime exploration target.

Age and correlation of mineralized intrusions at the Big Onion prospect is uncertain. It remains enigmatic whether intrusion and mineralization is Eocene, or whether the mid-Cretaceous ages reliably indicate a much older event. The 112 Ma to 117 ± 4 Ma age is inconclusive because it is a whole rock K-Ar determination of extreme phyllic alteration of a premineral intrusion. It is also an anomalous date for west-central British Columbia where copper-molybdenum porphyry deposits are typically early Eocene or late Cretaceous. The 49.5 ± 1.9 Ma K-Ar date of a postmineral quartz-monzonite dike at Big Onion is similar to dates of Nanika intrusions which range from 56 Ma to 49 Ma (Carter, 1976). Nanika stocks at the Berg, Lucky Ship, Mt. Thomlinson and Red Bird prospects contain significant porphyry copper and molybdenum deposits. Carter (1976) notes that large pyrite haloes and deep oxidation characterize Nanika-type porphyry deposits. Like Big Onion, the Berg deposit has developed a Recent thick supergene enrichment zone (Heberlein, this volume). The Big Onion deposit is dissimilar to 50 Ma to 52 Ma Babine-type copper-molybdenum porphyry deposits such as Bell and Granisle located 40 km to the northeast which are associated with distinctive biotite-feldspar porphyritic granodiorite. Big Onion is also notably different from the Glacier Gulch porphyry molybdenum prospect, located 25 km west, associated with a 70 Ma Bulkley intrusive suite. The Big Onion prospect is tentatively correlated with Nanika-type porphyry deposits.

In a Basin-and-Range tectonic regime porphyry copper deposits with large pyrite haloes, such as the Nanika-type, have potential for creation and preservation of Tertiary supergene copper enrichment zones. Such deposits, known and undiscovered, may have a viable economic future as SX-EW projects.

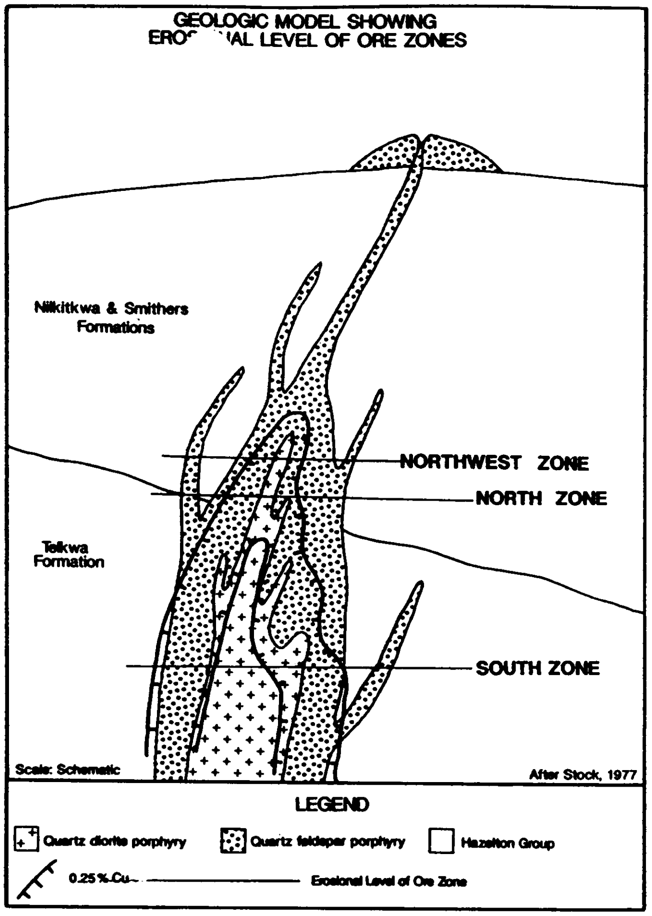

FIGURE 5. Big Onion geologic model showing erosional level of ore zones.

Acknowledgments

The senior author has very little first-hand familiarity with the Big Onion deposit and has acted primarily as a compiler of data obtained by Geoff Stock for Canadian Superior Exploration Limited and by Ed McCrossan for Varitech Resources Limited. John Baker, former exploration manager for Canadian Superior, provided considerable insight into the history of discovery and geology of the deposit, in particular the supergene zone. Tom Schroeter inspired and encouraged the writing of this paper and kindly supplied the photograph of the Big Onion deposit. Constructive comments by reviewers Don MacIntyre and Bob Cathro improved the manuscript, in particular, by pointing out existence of unpublished K-Ar ages, for which Jim Mortensen kindly provided details.

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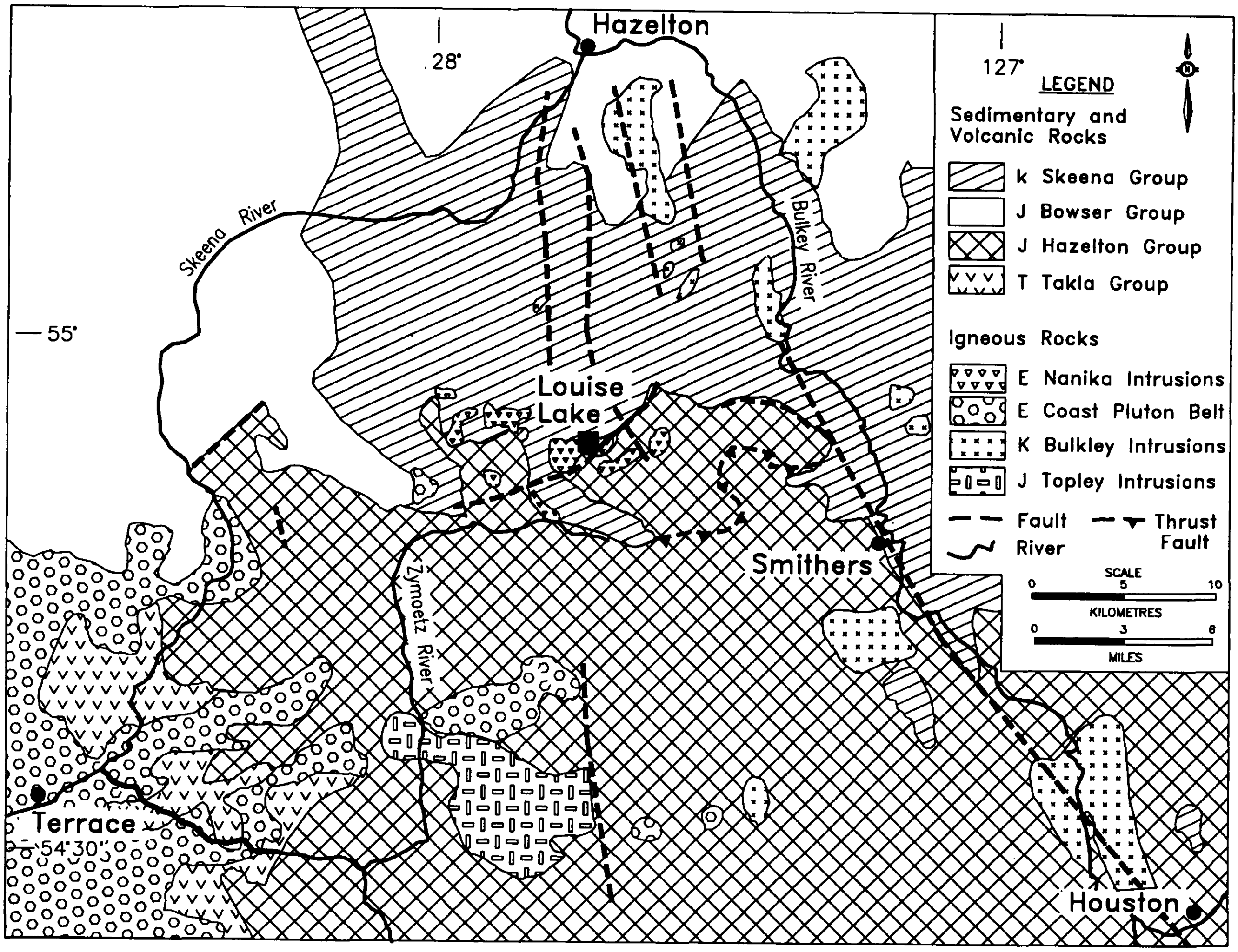

FIGURE 2. Geological setting, Louise Lake.

to many porphyry style deposits and showings throughout the western Cordillera (Fig. 2).

Property Geology

The 060° trending Coal Creek Lineament is regional in nature and separates Lower Cretaceous Skeena Group sedimentary rocks on the north from Jurassic Hazelton Group volcanic rocks on the south (Fig. 3). Mineralization occurs 500 m west of Louise Lake where Skeena Group rocks have been intruded and altered by feldspar porphyry sills of quartz monzonite composition (Figs. 4 and 5).

Skeena Group Sedimentary Rocks

As observed in rare outcrops and drill core, the sedimentary section consists of polymictic conglomerate, arkose, arenite, greywacke and argillite with minor interbedded pyroclastic rocks. The conglomerate is composed of rounded to well-rounded pebbles of fine-grained tuff and feldspar porphyry in about equal proportions with a small number of chert and indistinguishable clasts. Pebbles are generally flattened in a plane parallel to the bedding of interbedded sandstone. A sandy matrix comprises 10% to 15% of the rock. Bedding angles dip moderately to the northwest and are easier to observe in argillite than in sandstone.

Intrusive Rocks

Eocene Nanika intrusive rocks of altered feldspar porphyritic quartz monzonite composition are observed in trenches on a small knoll 500 m west of Louise Lake (Tipper and Richards, 1976). The rocks are a bleached, moderately to strongly altered pyrite-quartz-sericite-kaolinite intrusion with 10% to 20% anhedral to euhedral, clay altered feldspar phenocrysts in a fine- to very fine-grained matrix. There are no visible mafic minerals. Strongly altered feldspar porphyry is impossible to separate from highly altered feldspathic sedimentary rocks. As observed in core, both sedimentary rocks and altered feldspar porphyry are cross-cut by 10 m to 20 m wide postmineral quartz feldspar porphyry and pebble dikes.

Structure

Mineralization and alteration are spatially controlled in an overall sense by feldspar porphyry intrusions. Contacts observed in drill core suggest these intrusions represent a swarm of sills up to 100 m thick that dip at 30° to the northwest. Northwesterly-striking postmineral faults cross-cut and displace the sills.

Alteration

The intensity and type of alteration is controlled by lithology and quartz/sulphide veining and results in three distinct alteration zones spatially related to the feldspar porphyry sills. A highly pervasive silicified and sericitized central zone with intense quartz-pyrite stockwork grades outward to an intermediate zone of moderate pervasive clay and quartz-sericite alteration associated with moderate quartz-pyrite veining. Both are surrounded by a peripheral argillic zone of strong kaolinization and weak quartz-pyrite veining. Within this over-all pattern the conglomerate and arkose display more in-

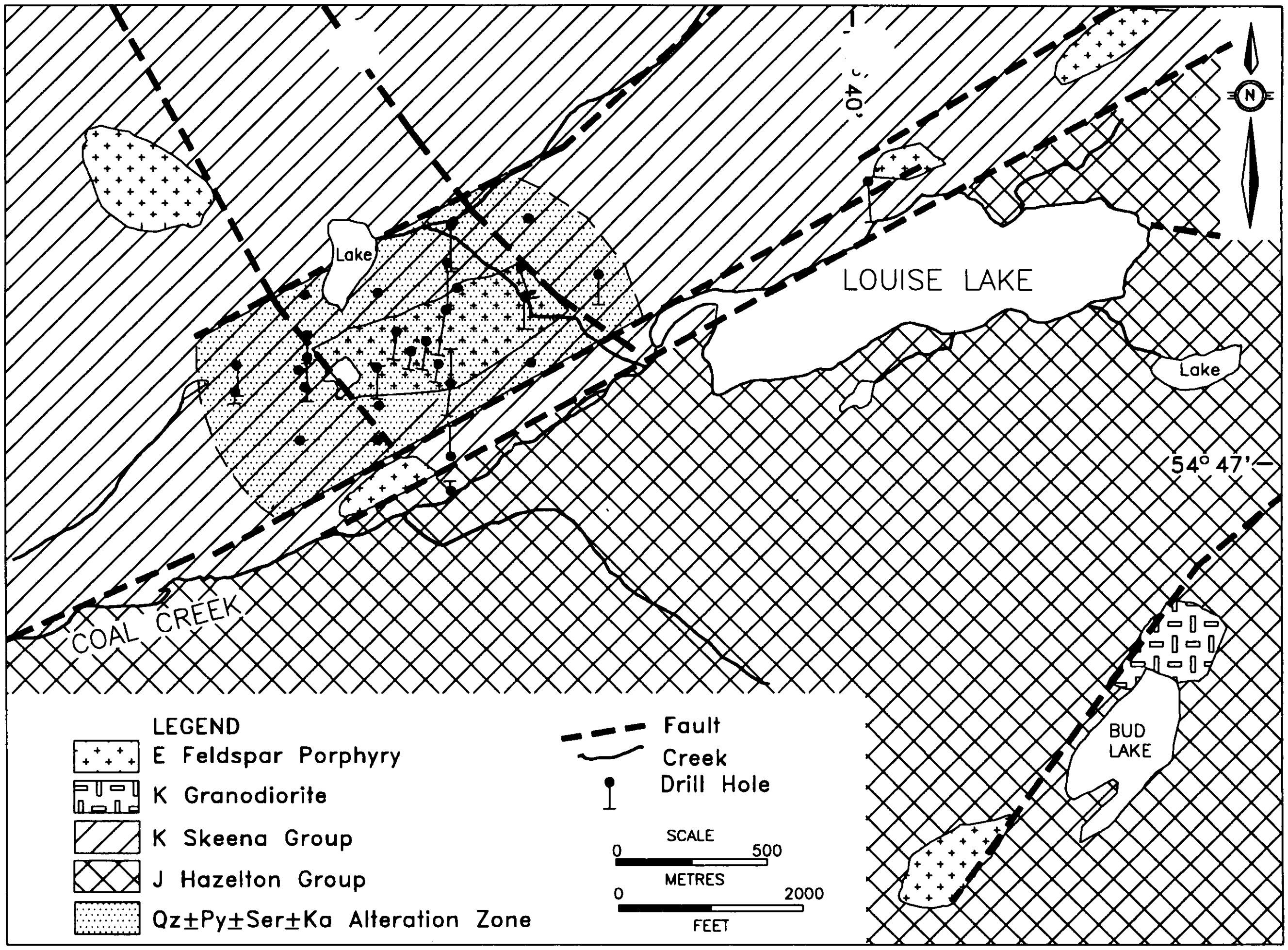

FIGURE 3. Property geology, Louise Lake.

tense kaolinite alteration than the arenite and argillite. Some clay alteration may be the result of supergene alteration of sericite related to large zones of postmineral fracturing associated with the northwesterly trending faults which cross-cut the area.

Mineralization

Pyrite is ubiquitous within all alteration zones in amounts varying from 1% to 10%. It occurs as disseminations, fracture fillings, veinlets and in quartz-pyrite veins and stockworks.

On a smaller scale, stockwork mineralization is characterized by four stages of pyrite and quartz veining. The first stage of quartz veining is the most prominent with azimuths of 030° and steep dips to the northwest. These veins vary in width from 5 mm to 10 mm and are often characterized by hairline pyrite seams along the edges. The second stage of mineralization consists of an east-west set of nearly vertical banded quartz veins 10 mm to 30 mm in width. These veins are characterized by thin massive pyrite seams along their margins and scattered tetrahedrite crystals. The third stage of mineralization is represented by steeply dipping sets of pyrite-tetrahedrite filled fractures oriented at azimuths 300°, 090°, and 030°, and by a nearly flat-lying set. These three stages of sulphide mineralization are followed by a set of vertical, barren, vuggy, bull-quartz veins trending at 360°. Stockworks with pyrite filled fractures are more extensive than stockworks with quartz filled fractures.

A minor amount of sulphide mineralization occurs as thin seams along bedding plans in the argillites and sandstones.

Tennantite and to a lesser extent chalcopyrite, enargite (R. Kirkham, pers. comm., 1994) and molybdenite are the minerals of possible economic interest. They occur in pyritic fractures, as disseminations, and in some quartz-pyrite veins in both the porphyry and sedimentary rocks. The fine-grained nature of the tennantite makes copper grades difficult to estimate in hand specimen.

Chalcopyrite most commonly occurs as rare blebs or veins. An exception is a 15 m interval of pyrite-chalcopyrite-molybdenite stockwork in Canadian Superior drill hole DDH-5 (1970). Minor smears of molybdenite in pyrite filled fractures occur throughout the mineralized zone. Molybdenum grades as determined by ICP range from 100 ppm to 400 ppm.

Other sulphide minerals present in rare amounts are stibnite, sphalerite, chalcocite and bornite. It is not known how gold occurs but it appears to be associated with the tennantite.

Weathering and Supergene

Minor bornite coatings and sooty chalcocite have been observed in trenches. Their fine-grained nature required X-ray diffraction techniques for positive identification (E. Wosniuk, unpub., 1969). These minerals are probably of supergene origin.

Exploration Techniques

Geochemistry

Copper and gold soil geochemistry was an effective exploration technique in the immediate area of the trenches where an elongated 350 m by 150 m anomaly with a trend of 060° parallels the Coal Creek Fault.

Arsenic and antimony rock geochemistry was effective in locating blind mineralization in a down-dropped fault block southwest of the trenched area.

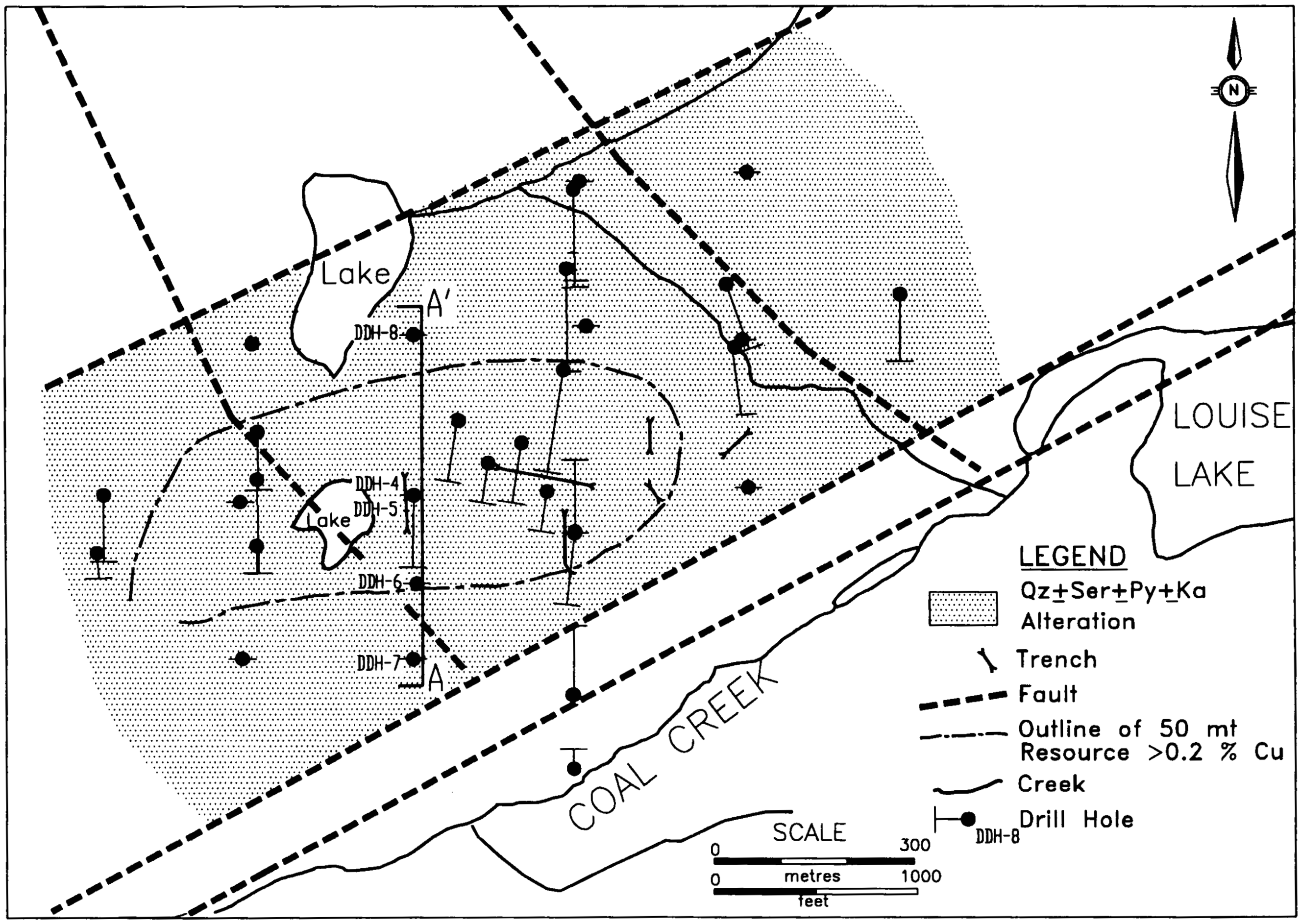

FIGURE 4. Drill hole and trench plan, Louise Lake.

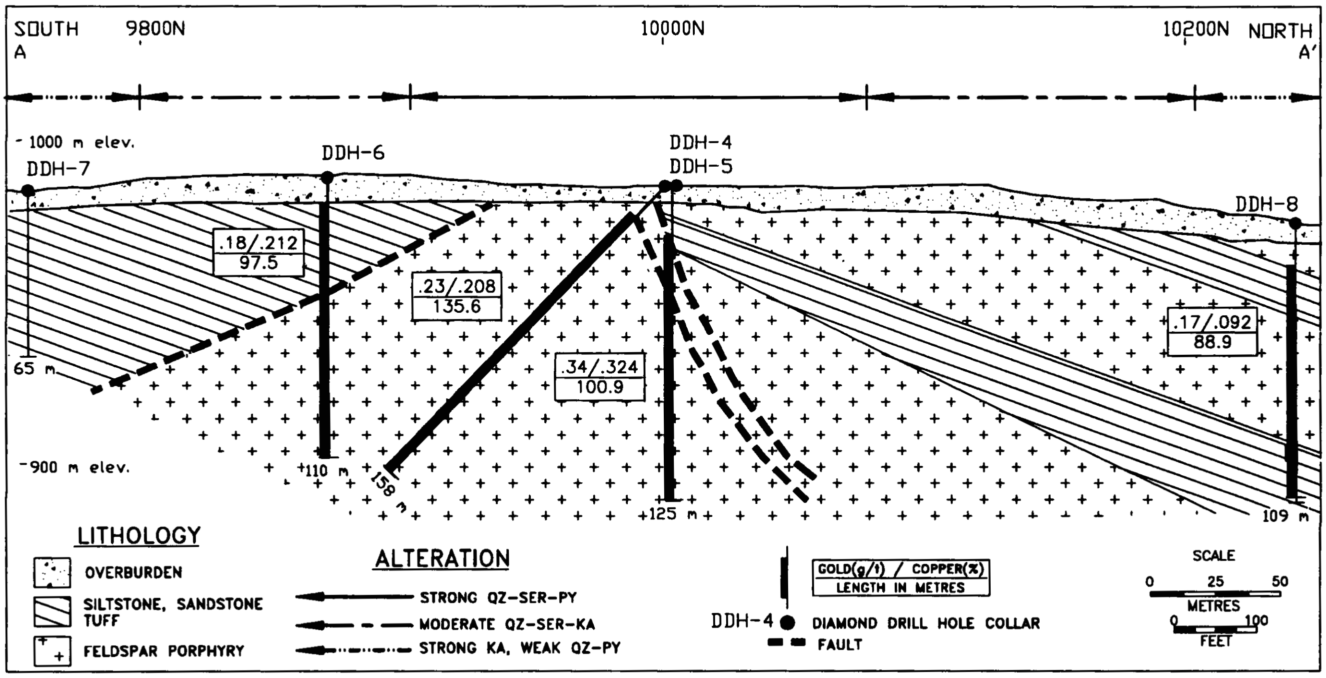

FIGURE 5. Cross-section A-A′, Louise Lake.

Geophysics

An airborne magnetic survey by Noranda (1980) indicates that Hazelton Group volcanic rocks south of Coal Creek have a higher magnetic susceptibility than the sedimentary Skeena Group rocks. The deposit itself shows no anomalous magnetic response.

An induced polarization survey completed by Canadian Superior (1969) identified an anomalous area which correlates well with the mineralized zone (Fig. 6). It also indicates that the mineralized zone

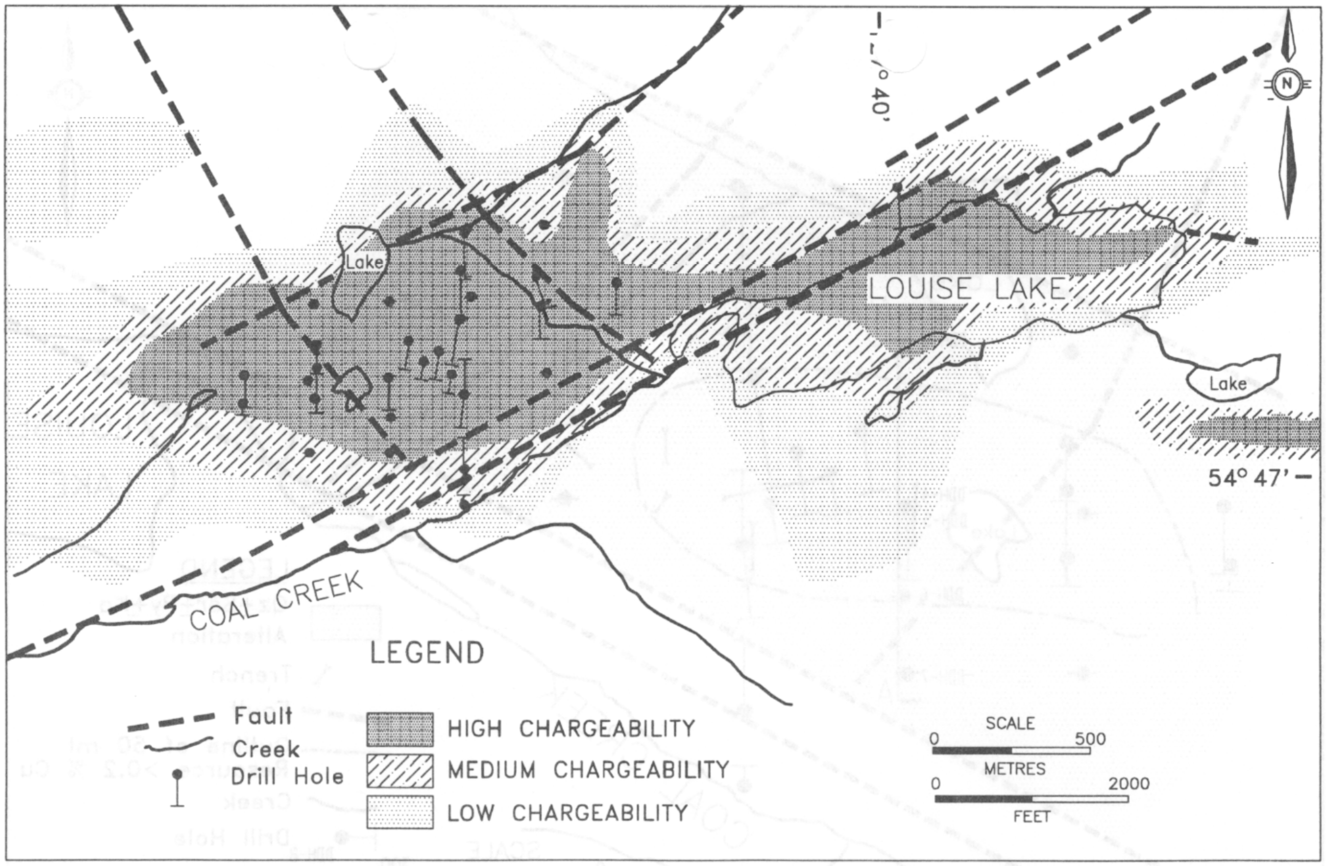

FIGURE 6. Geophysics, Louise Lake.

is sinistrally offset about 1000 m by the Coal Creek Fault. The area under Louise Lake has yet to be explored to test the possibility that part of the mineralized zone exists under the lake.

Economics

Reserves

Equity Silver Mines Ltd. calculated the drill-indicated geologic resource to be 50 million tonnes grading 0.3% Cu, 0.3 g/t Au and 0.02% Mo with 0.9% As. The deposit is not completely closed off to the southwest by drilling to date.

Metallurgy

Standard flotation tests by the Metallurgy Department of Equity Silver Mines Ltd. produced similar recoveries for copper and arsenic, indicating that most of the copper is present in tennantite and/or enargite. The cleaner concentrate contained 20% Cu and 7.6% As. Recoveries for copper and gold were 95% and 90%, respectively.

Mining

A standard open-pit mining operation is anticipated if this deposit becomes economic in the future. Mining of the down-dropped portion of the deposit to the southwest would require a substantial increase in the stripping ratio.

Environmental

Coal Creek is a tributary of the Copper (Zymeotz) River which has regionally important fisheries values. These values would have to be addressed by any proposed mining/milling operation at this site. No baseline environmental or acid base accounting studies have been conducted on the property to date.

Discussion and Conclusion

The presence of large feldspar porphyry sills with associated phyllic-argillic alteration zoning and the unusual presence of tennantite/enargite mineralization indicate that this deposit formed near the top of a porphyry system (Lowell and Guilbert, 1970).

Porphyry deposits of this type are not common in that the alteration zonation and metal signature span the porphyry/epithermal distinction. The occurrence of a siliceous alteration core (instead of biotite or K-feldspar) surrounded by widespread phyllic and argillic alteration is suggestive more of an epithermal than a porphyry zonation.

Other examples of such high-level systems in British Columbia occur in the Red Dog and Hushamu areas on northern Vancouver Island.

The Louise Lake deposit is similar to the Kerr deposit of northwest British Columbia in that tennantite/tetrahedrite are common as are chalcopyrite and bornite, and widespread sericitic alteration of sedimentary and volcanic rocks. The Kerr deposit lacks the argillic signature and also contains abundant chlorite in the central portion of the alteration system.

In the case of Louise Lake, the presence of gold is a positive economic feature but this benefit must be balanced against the impact that high levels of arsenic would have on the marketability of the concentrate.

Acknowledgments

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