For Prosperity's sake: A Late Cretaceous theme to porphyry systems in the SW Coast Mtns

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Why Taseko Lakes?

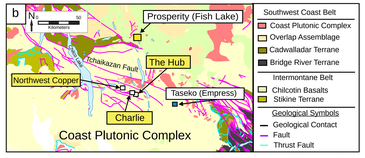
a) Location map of study area, showing the location of the Cretaceous Prosperity Cu-Au porphyry deposit and other known producing deposits, with inset map of British Columbia showing the location of Prosperity mine.

■ Porphyry-style mineralization and alteration observed within the rocks of the Southwest Coast Mountains of B.C (Fig.a)

■ The study area is recognized as a potential region for porphyry-style mineralization in the same geological environment as that of Prosperity.

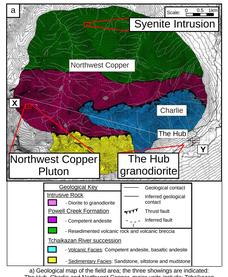
■ Prosperity is a huge, calc-alkaline porphyry system, located just 25 km from the study area.

■ Does the study area therefore represent another region of potential exploration for Cu (Mo±Au) porphyry deposits?



b) Regional geologic map, including terranes and known mineral deposits within the Taseko Lakes region, including Prosperity (Cu-Au porphyry) and Taseko (Empress) (Cu-Au porphyry). The position of the study area and the three prospects studied is also marked.

Host Units



a) Geological map of the field area; the three showings are indicated. The Hub, Charlie and Northwest Copper, major units include: Tchaikazan Succession and Powell Creek Formation. (For cross section see Hypothesized model of Taseko Lakes panel)

■ The Taseko Lakes field area consists of three areas of interest (Showings)(Fig. a):

1) The Hub **-** host to intrusion-related and vein-hosted Cu-Mo mineralization within a 79.56±0.42 Ma (Ar^{40}-Ar^{39} biotite) granodiorite.

2) Charlie **-** characterized by vein-hosted mineralization within the andesite packages of the Lower Cretaceous Tchaikazan Succession .

3) Northwest Copper **-** exhibit vein-hosted mineralization within the subaerial volcanic rocks of the Powell Creek Formation.

The Hub is located within the base of the Tchaikazan Valley. The geological trenches (mapped by the author) parallel the Tchaikazan River. Charlie and Northwest Copper are located several km to the Northwest of The Hub

▶ Tchaikazan River Succession: Separated into two facies:
▶ 1) Sedimentary-dominated facies - well-organized fine-coarse grained clastic sediments and minor volcanics
▶ 2) Volcanic-dominated facies - dominated by the intercalation of sedimentary and subaerial volcanic rocks. Coherent andesite flows are common, together with brecciated volcanic units.

▶ Powell Creek Formation:
▶ Massive coherent andesites, volcanic breccias and resedimented volcanic rocks.
▶ Resedimented units are characterized by sub-rounded andesite clasts within a granular sandstone matrix

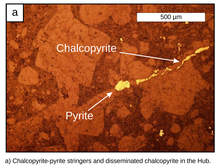
What are the Styles of Mineralization?

■ Porphyry-style mineralization is observed within all three showings.

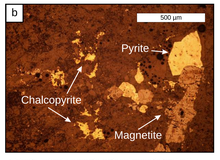
■ Mineralization in the Taseko Lakes area is varied: disseminated within intrusive units (The Hub)(Fig.a, b), vein-hosted (The Hub, Charlie and Northwest Copper) and late fracture-coating.

■ Chalcopyrite, molybdenite, magnetite together with abundant pyrite are common, galena occurs only in quartz veins of the Charlie showing.

■ Veins are divided into four stages: early-, main-, late- and post mineralization based upon their mineralogy, texture and crosscutting relationships.



a) Chalcopyrite-pyrite stringers and disseminated chalcopyrite in the Hub.



b) Interstial-textured chalcopyrite, pyrite and magnetite from the Hub .

Vein Stages:

Early-stage veins - (1) Quartz-rich veinlets and (2) Magnetite stringers and Quartz-Magnetite veins.

Main-stage veins - Quartz-magnetite-chalcopyrite-pyrite veins.

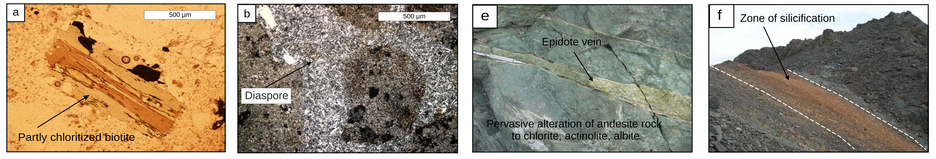
Late-stage veins - (1) Chalcopyrite-molybdenite stringers, (2) Quartz-chalcopyrite-pyrite veins and (3) Quartz-pyrite veins.

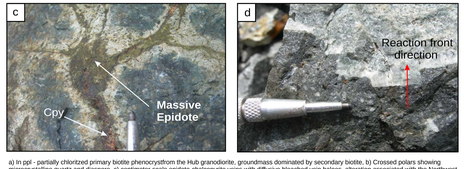
Post-Mineralization veins - (1) Quartz only veins (2) Calcite only veins.

Major vein types within the three showings of the Taseko Lakes Region, based upon mineralogy, texture, crosscutting relationships and where in the region they occur.

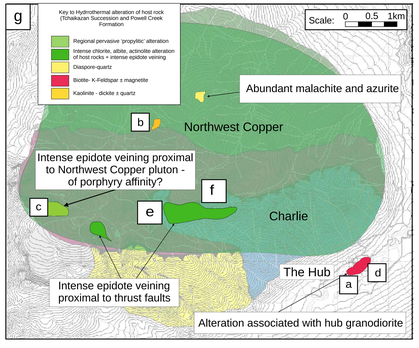
Vein Type	Shape and Size	Cross cutting relationships	Occurences
Barren Quartz veins	Up to 1 mm wide, massive	Cut plag phenocrysts	Hub, Charlie and Northwest Cu
Pyr-qtz ± cpy veins	2-3 mm wide	Cut by barren qtz veins	Hub, Charlie and Northwest Cu
Qtz-mag ± cpy ± pyr veins	~3 mm, irredular, discont'	Cut weak potassic alteration	The Hub only
Cpy-moly veins	<0.5 mm wide, irregular	Cut potassic alteration of plag	The Hub only
Qtz-mag veins	Up to 15 mm wide, massive	Cut strong magnetite alteration	Hub and Northwest Copper
Quartz only veins	Several cm wide, planar	Cut phyllic alteration	Hub, Charlie and Northwest Cu
Qtz-Cpy ± pyr veins	cm wide, planar, continuous	Cut andesite rocks	Hub, Charlie and Northwest Cu
Epidote only veins	cm-wide, planar to diffusive	Cut andesite rocks	Charlie and Northwest Copper
Epidote ± Cpy ± mag veins	Several cm wide, continuous	Cross cut Tchaikzan Succession	Charlie and Northwest Copper
Calcite ± epidote veins	cm-wide, generally massive	Cut andesite rocks	Charlie and Northwest Copper
Calcite only veins	mm-cm, can be diffusive	Cut andesite rocks	Charlie and Northwest Copper

What are the Styles of Hydrothermal Alteration?





a) In ppl - partially chlorized primary biotite phenocrystfrom the Hub granodiorite, groundmass dominated by secondary biotite, b) Crossed polars showing microcrystalline quartz and diaspore, c) centimeter-scale epidote-chalcopyrite veins with diffusive bleached vein haloes, alteration associated with the Northwest Copper pluton and d) Silicified reaction front at the Hub showing, dark material is a magnetite-flooded granodiorite, lighter is a phyllic-altered Hub granodiorite.



■ Large areas of Northwest Copper and Charlie and dominated by pervasive chlorite, albite, actinolite and epidote alteration of the host volcanic units (Fig. g). Could be interpreted as regional metamorphic hydration or distal hydrothermal alteration related to porphyry at depth.

■ Intense epidote veining occurs proximal to the Northwest Copper pluton where it is accompanied by chalcopyrite (Fig.c, e, g).

■ Discrete zones of intense hydrothermal alteration are located in Northwest Copper and include quartz-diaspore dominated assemblages, often accompanied by malachite and azurite (Fig. g) and minor zones of kaolinite-dickite.

■ The Hub is characterized by chlorite, sericite, secondary biotite and K-feldspar - more typical of the potassic alteration recognized as porphyry-style hydrothermal alteration (Fig. g).

■ Minor alteration minerals identified using portable infrared mineral analyzer (PIMA) are: prehnite, palygorskite and diaspore, which occur in discrete, localized zones (Fig. g).

Right - Overlay with alteration map and the main alteration assemblages observed in the study area, with the locations of the photographs of alteration (above)

Intrusive units

■ Intrusive lithologies occur in all three of the study areas: The Hub, Charlie and Northwest Copper (see above).

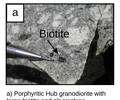
■ At the Hub showing a granodiorite-diorite intrusion is the dominant intrusive phase (Fig. a), a late porphyritic feldspar dyke crosscuts this main body.

■ Ar^{40}-Ar^{39} dating of primary phases (biotite) yielded a cooling age of 79.56±0.42 Ma.

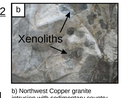
■ Charlie and Northwest Copper contain numerous porphyritic feldspar-hornblende dykes.

■ Northwest Copper area contains several larger intrusive bodies: the largest of these, to the northern portion of the study area (Northwest Copper Pluton) is largely granitic in composition, varying to diorite (Fig. b). Late aplite dykes are abundant and crosscut the intrusion.

■ A smaller syenite intrusion, partially outcrops also in Northwest Copper, (Fig. c), the subsurface extent is not known.



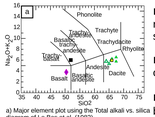
a) Porphyritic Hub granodiorite with large biotite and plagioclase phenocrysts



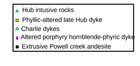
b) Northwest Copper granite intrusion with sedimentary country rock xenoliths from the Tchaikazan Succession

c) Crosscutting nepheline syenite dyke from Northwest Copper

Intrusive Geochemistry



a) Major element plot using the Total alkali vs. silica diagram of Le Bas et al. (1982).



■ Hydrothermal alteration makes the classification of rocks problematic; therefore only the least altered samples were selected for geochemical analysis (Fig. a).

■ Feldspar destructive alteration (phyllic) causes the loss of alkalis (Na_2O and CaO).

■ Increases in Mg, Fe, K_2O, Al_2O and SiO_2 can be caused by the fixation of Mg(Fe) in solution to form chlorite.

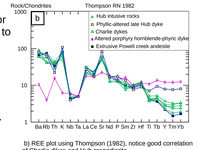
■ Element mobility is important in the classification of altered rocks, therefore use of the relatively immobile elements is preferred (see below, Fig. b).

■ All rocks display similar REE profiles, except for the altered porphyry dyke, this is expected owing to its highly altered state.

■ The two Charlie dykes display similar REE patterns.

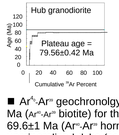
■ Samples display negative Nb and Ti relative to REE, which is common for calc-alkaline magmas.

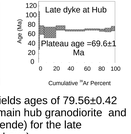
■ Therefore, igneous geochemistry displays typical calc-alkaline trends.



b) REE plot using Thompson (1982), notice good correlation of Charlie dikes and Hub granodiorite.

Geochronology



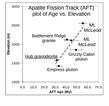


■ Ar^{40}-Ar^{39} geochronolgy yields ages of 79.56±0.42 Ma (Ar^{40}-Ar^{39} biotite) for the main hub granodiorite and 69.6±1 Ma (Ar^{40}-Ar^{39} hornblende) for the late unmineralized dyke (see above).

■ A porphyritic dyke at Charlie yielded an age of 80.7±0.8 Ma using U/Pb zircon.

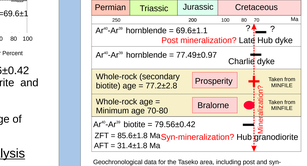
Thermochronology: Preliminary Analysis

■ Apatite fission track age of 31.4±1.8 Ma (below), represents the time the mineral cooled below closure temperature of ~100-120°C; corresponding to ~4km for a geotherm of 25°C /km and 10-20°C surface temperature.



■ AFT age-elevation plot (m) for 5 samples of Cretaceous igneous intrusions in the Taseko Lake region. Best fit line through the data yields an average exhumation rate of 40m/Myr between 55-30 Ma.

Timing of Mineralization



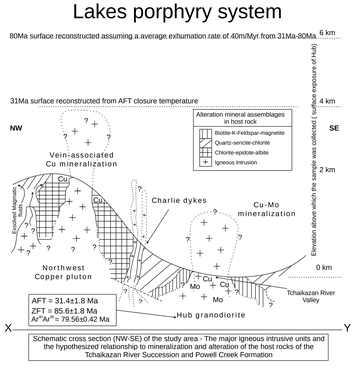
Geochronological data for the Taseko area, including post and syn-mineralization intrusions at the Hub and dates collected from sources for the major Cretaceous mineral deposits: Prosperity and Bralorne.

■ Relative ages show that mineralization in the Taseko Lakes region occurred between at least 80 Ma and ~70 Ma.

■ This timing of mineralization is tantalizingly similar to that for the Prosperity deposit.

■ Prosperity shares some genetic relationships with Taskeko, was there a series of Late Cretaceous porphyries intruded in this region of the Coast Mountains.

Hypothesized model of Taseko Lakes porphyry system



Schematic cross section (NW-SE) of the study area - The major igneous intrusive units and the hypothesized relationship to mineralization and alteration of the host rocks of the Tchaikazan River Succession and Powell Creek Formation

Conclusions

■ The Taseko Lakes Region with its numerous polymetallic mineral showings hosts an intrusion-related, porphyry Cu(±Mo)-style mineralization in a granodiorite stock and a stockwork of quartz+chalcopyrite±molybdenite±pyrite veins (the Hub). The granodiorite has a cooling age of 79.56 ±0.42 Ma (Ar^{40}-Ar^{39} biotite).

■ The Charlie/Northwest Copper showings are polymetallic and vein-hosted. Alteration assemblages are propylitic overprinted by discrete areas of kaolinite-dickite and diaspore-quartz.

■Low-temperature thermochronology suggests the current exposure of the porphyry in the Hub is ~ 6km below the current erosion surface at the time of formation.

■This data also suggests that the Northwest Copper showings are not likely of epithermal affinity.

■ The region has similar geological characteristics to that of Prosperity.

■ Should more exploration be done in the Taskeo Lakes region?

Key Research Questions being addressed by this study

◆ What were the physio-chemical conditions acting upon the system?
◆ Are the three showings really related to the same underlying system at depth?
◆ How do these showings fit into the region's other porphyry Cu(±Mo±Au) systems?
◆ What is their position within the greater scheme of Canadian Cordilleran tectonism?

References and Acknowledgments

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