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Characterizing the district-scale alteration surrounding a large porphyry Cu system: The footprint of Highland Valley Copper, British Columbia

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Introduction

- The large quantities of hydrothermal fluids involved in porphyry Cu formation circulate much farther, and react with a volume of rock much larger than that of the economic mineralization itself.
- This project aims to define the extent, mineralogy and chemistry of this hydrothermal alteration footprint as far as observable.
- The study is conducted in the Highland Valley Copper district, where four major porphyry Cu (± Mo) mineralized centers are hosted in the Late Triassic calk-alkaline Guichon Creek Batholith.

Research Questions

- What is the mappable extent and the geometry of the district-scale distal alteration surrounding porphyry Cu deposits?
- How does the mineralogy and chemistry of alteration evolve through time and space?

Methods

- Mapping was conducted over two field seasons at scales of either 1:5 000 or 1:10 000.
- Vein orientation, thickness and frequency were recorded on every visited outcrop.
- Sampling was focused on hydrothermal alteration. Samples were taken every 250 to 500 meters, were cut into slabs for staining, and sent to ACME Labs for whole rock geochemistry.
- SWIR measurements were taken from the slabs using TerraSpec before staining.

Results and Discussion

- Five main alteration assemblages are defined in the HVC district: potassic characterized by pervasive biotite, potassic characterized by K-feldspar veins, sodic-calcic, muscovite, and illite-chlorite alteration (Figs. 1 and 3). Clay alteration characterized by kaolinite, dickite and montmorillonite is also present in the open pits.
- Potassic alteration is characterized by a main proximal zone extending from the mineralized zone up to roughly 4 km away, and by smaller distal zones observed on each traverse between 6.5 and 9 km away from the mineralized zone.
- There is a positive correlation between potassic alteration and the distribution of chalcophile elements such as Cu, Pb and Bi. Lead shows positive anomalies near margins of potassic alteration.
- Sodic-calcic alteration forms a NW-SE elongated zone which extends up to 7 km away from Valley and Lornex.
- There is a positive colleration between sodic-calcic alteration and Sr distribution, and a negative correlation between sodic calcic alteration and Rb and Pb distribution.
- Muscovite alteration associated with Cu introduction only extends up to roughly 1.5 km from the center of mineralized zones.
- The temporal evolution of alteration in the district is characterized by an early Cu mineralization event (Bethlehem system), followed by district-scale sodic-calcic alteration, followed by Cu mineralization at Valley, Lornex, Highmont and J.A. (Fig. 2).
- SWIR shows an increase in AlOH feature absorption wavelength for white mica (i.e., illite, muscovite, paragonite, phengite) away from the mineralized center (Fig. 4).

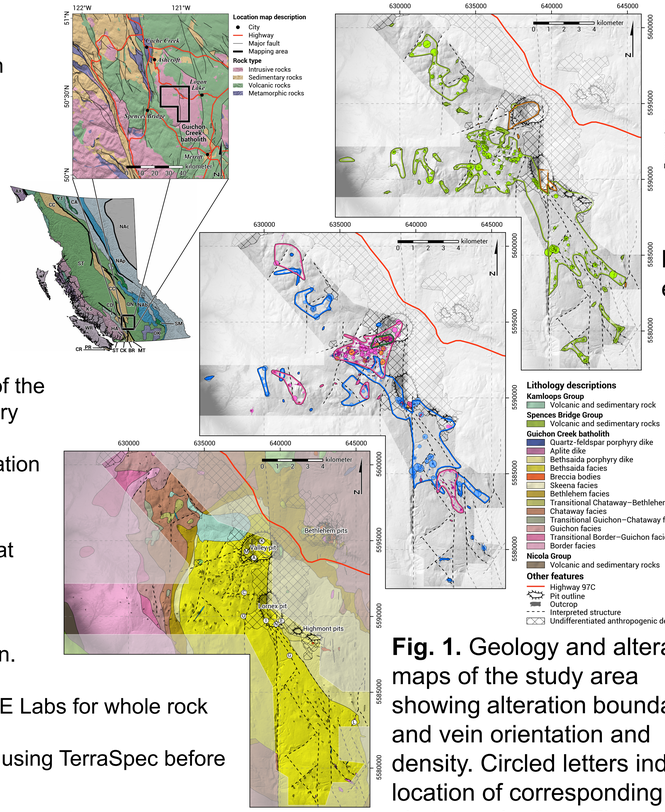

Fig. 1. Geology and alteration maps of the study area showing alteration boundaries, and vein orientation and density. Circled letters indicate location of corresponding photographs from Figure 3.

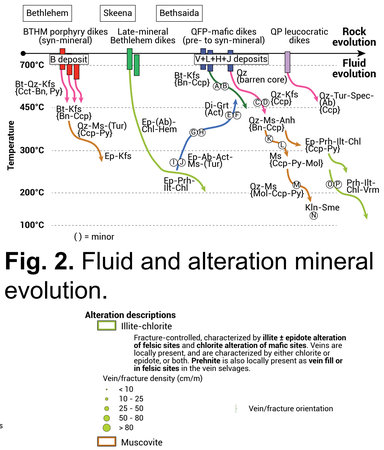

Fig. 2. Fluid and alteration mineral evolution.

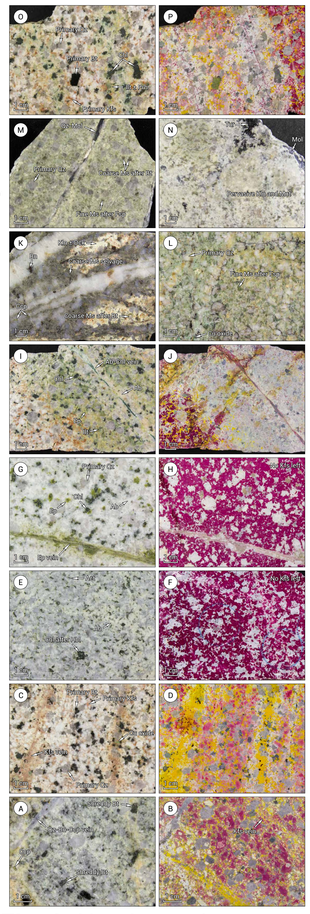

Fig. 3. Hand sample photographs: potassic (A to D), sodic-calcic (E to J), muscovite (K to M), clay (N), and illite-chlorite alteration (O, P). Photos B, D, F, H, J, and P are stained (pink=Pl, yellow=Kfs).

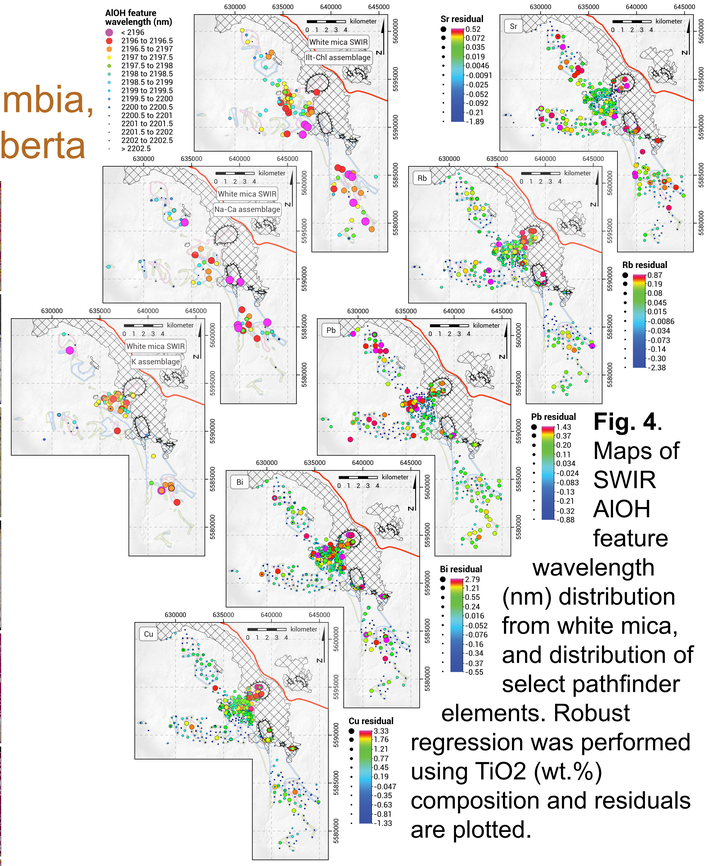

Fig. 4. Maps of SWIR AlOH feature wavelength (nm) distribution from white mica, and distribution of select pathfinder elements. Robust regression was performed using TiO2 (wt.%) composition and residuals are plotted.

Acknowledgements

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