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USE OF MULTIELEMENT ASSOCIATIONS IN TILL FOR DETECTING CONCEALED Cu MINERALIZATION, SOUTH-CENTRAL BRITISH COLUMBIA

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Introduction

The Quesnel Terrane of British Columbia hosts a number of Cu-porphyry deposits (Fig. 1). In its southern sector, it includes the Highland Valley Copper (production plus reserves of 8.48 Mt Cu and 0.22 Mt Mo), the Gibraltar (reserves of 1.87 Mt Cu and 0.060 Mt Mo), and Mount Polley (0.007 Mt Cu, 0.95 tonnes Au) deposits (Fig. 1). In the south, the Quesnel terrane dominantly consists of Mesozoic Nicola volcanic rocks and granitic intrusions.

Within the Interior Plateau of central British Columbia, a nearly continuous cover of glacial sediments on top of prospective geology in the Quesnel terrane makes mineral exploration difficult. We present results of a principal component analysis conducted with a till geochemical data from the Bonaparte Lake map area (Plouffe et al., 2010) (Figs. 1 and 2) to evaluate the mineral potential of a large area covered by glacial till.

Bedrock and surficial geology

The Quesnel Terrane within the study area includes Upper Paleozoic sedimentary rocks of the Harper Ranch Group to the south and volcanic and sedimentary rocks of the Upper Triassic and Lower Jurassic Nicola Group to the north (Fig. 2). Late Triassic to Cretaceous granitic rocks have intruded the Quesnel Terrane. These include the Raft, Thuya and Takomkane batholiths.

The Bonaparte Lake map area was last glaciated during the Late Wisconsinan Fraser glaciation. The region experienced two phases of ice flow during this glacial event. An earlier flow during ice advance derived from the Cariboo Mountains and directed towards the west to southwest, and a second phase at glacial maximum generally to the north and south from an ice divide located at 52° latitude (Plouffe et al., 2011) (Fig. 2). The region is covered by variable thickness of glacial deposits including till, glaciofluvial and glaciolacustrine sediments. Bedrock exposures are generally sporadic but more abundant on hills and ridges.

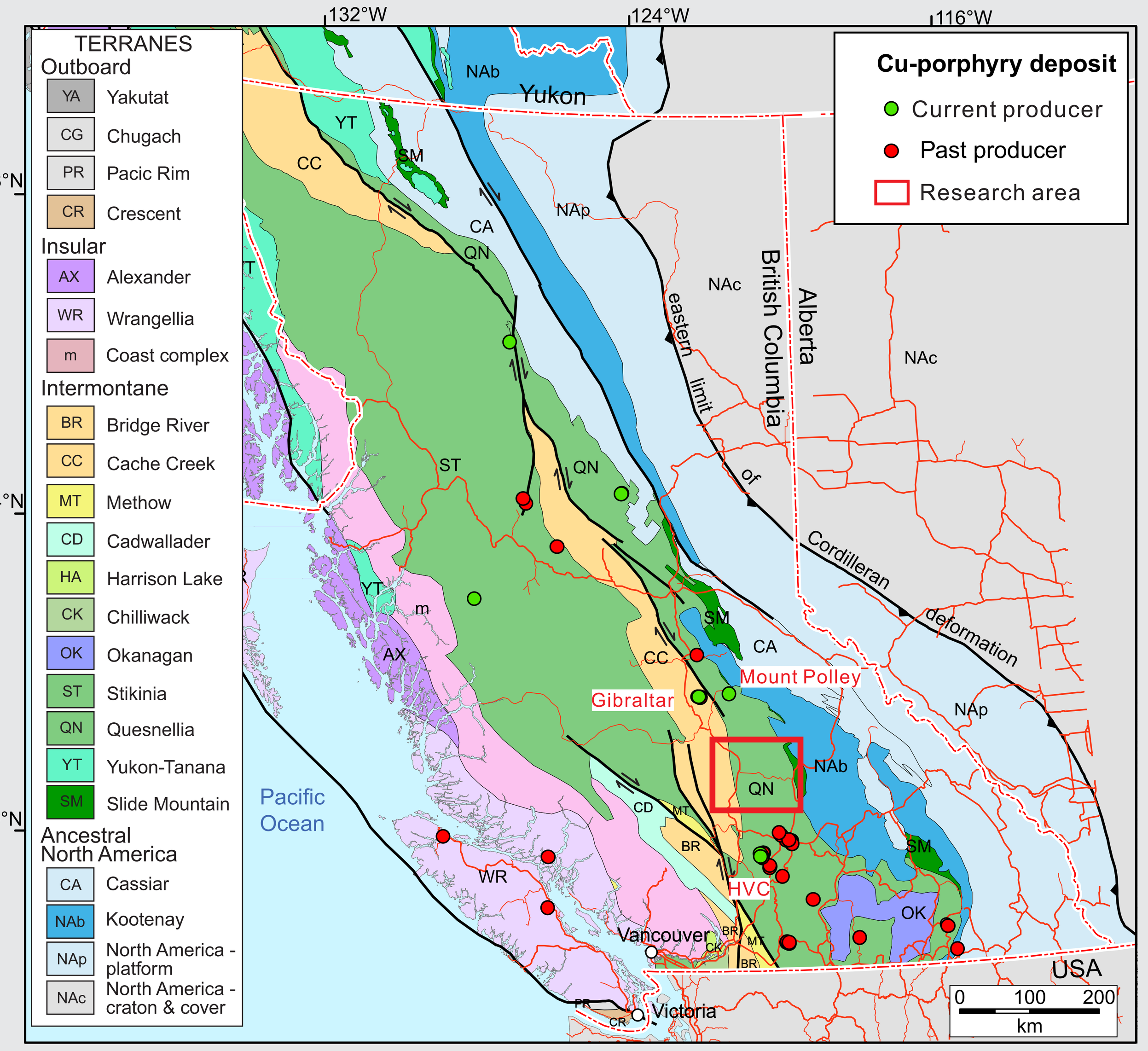

Figure 1. Location of the Bonaparte Lake area (red box). Producing and past-producing Cu-porphyry deposits in British Columbia (MINFILE, 2017) along with geological terranes (Colpron and Nelson, 2011). HVC = Highland Valley Copper.

Objectives

1. Identifying elemental assemblages associated with Cu in till samples;
2. Detecting geochemical signatures in till that can reflect buried Cu deposits.

Data and Methods

Principal component analysis (PCA) is conducted on geochemical analyses of the clay fraction (<2 μm) of basal till (n=726, Plouffe et al. 2010) determined after an aqua regia leach. Kriging is applied based on PC scores to detect prospective areas.

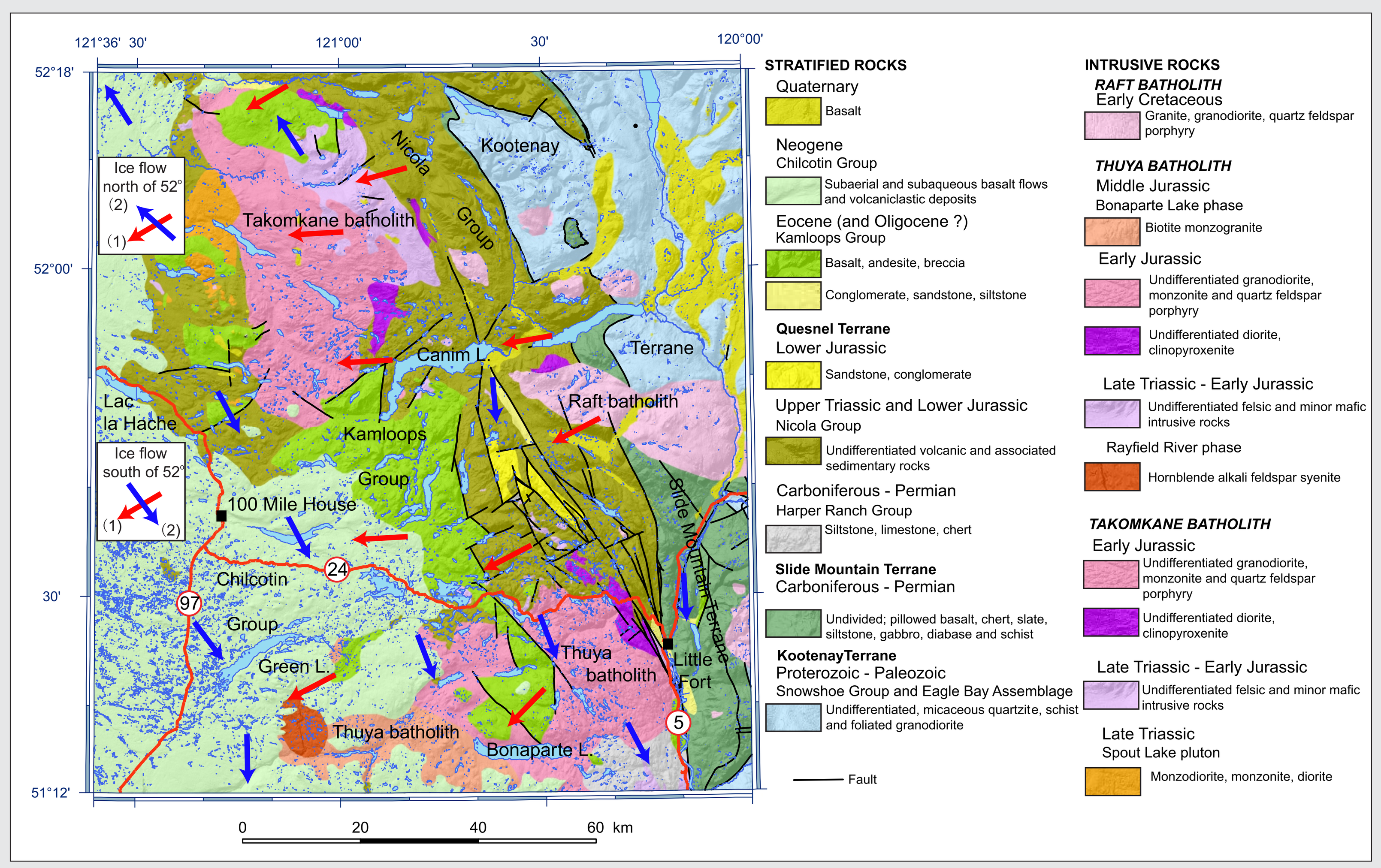

Figure 2. Bedrock geology map and legend of the Bonaparte Lake region; modified from Plouffe and Ferbey (2015).

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Results

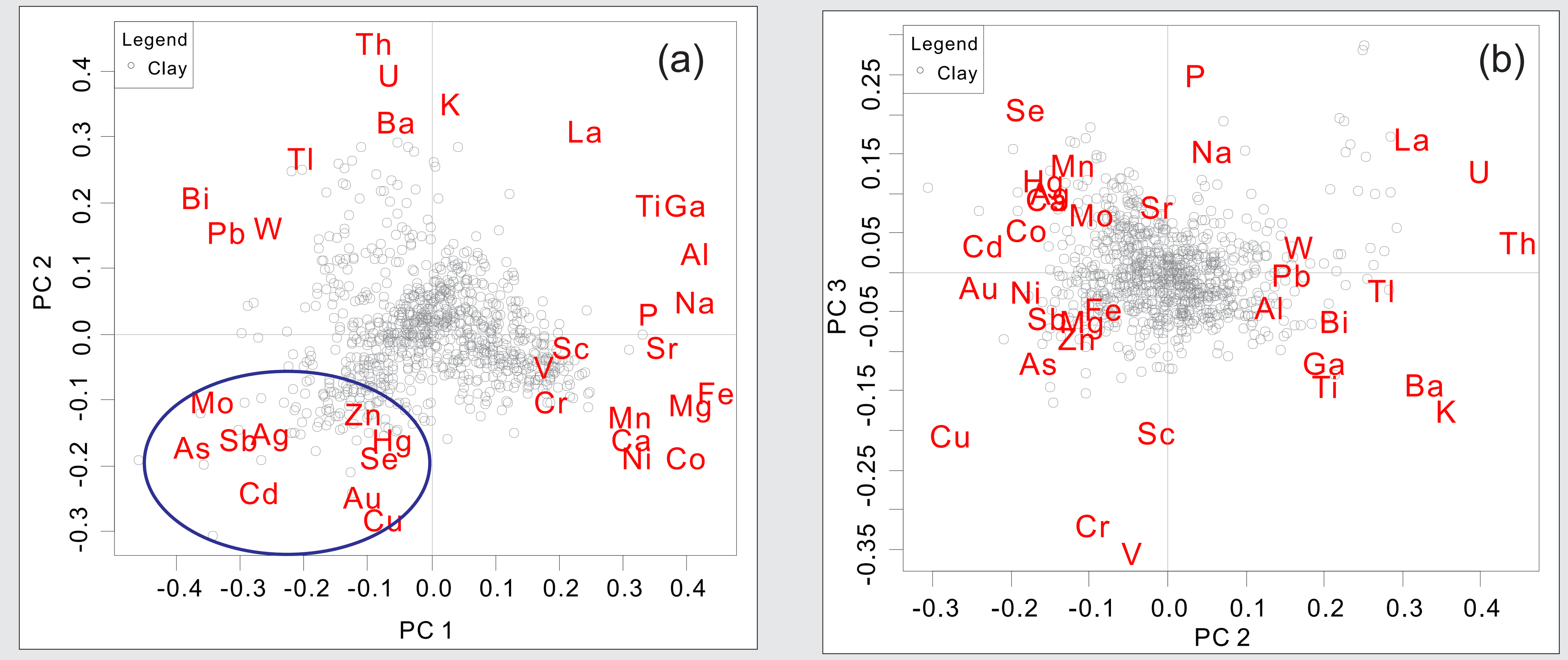

Figure 3. (a) Biplot of PC1 versus PC2 after log-centred transformation; (b) PC2 versus PC3 after log-centred transformation.

The PCA captures two element associations with Cu; Cu-Au-Mo-Ag-As-Hg-Pb-Sb, accounting for 32.3% of the total Cu variance in PC2, and Cu-Cr-V as accounting for 16.8% of the total Cu variance in PC3 (Fig. 3). The association of Cu-Au-Mo-Ag-As-Hg-Pb-Sb can also be observed in negative PC1, although Cu does not have high loading on this PC (2.5%). The Cu-Au-Mo-Ag-As-Hg-Pb-Sb association (Fig. 3a) likely relates to porphyry-style mineralization. On the other hand, a combination of lithologies (mafic/ultramafic) and mineralization influence the Cu-Cr-V-As association (Fig. 3b).

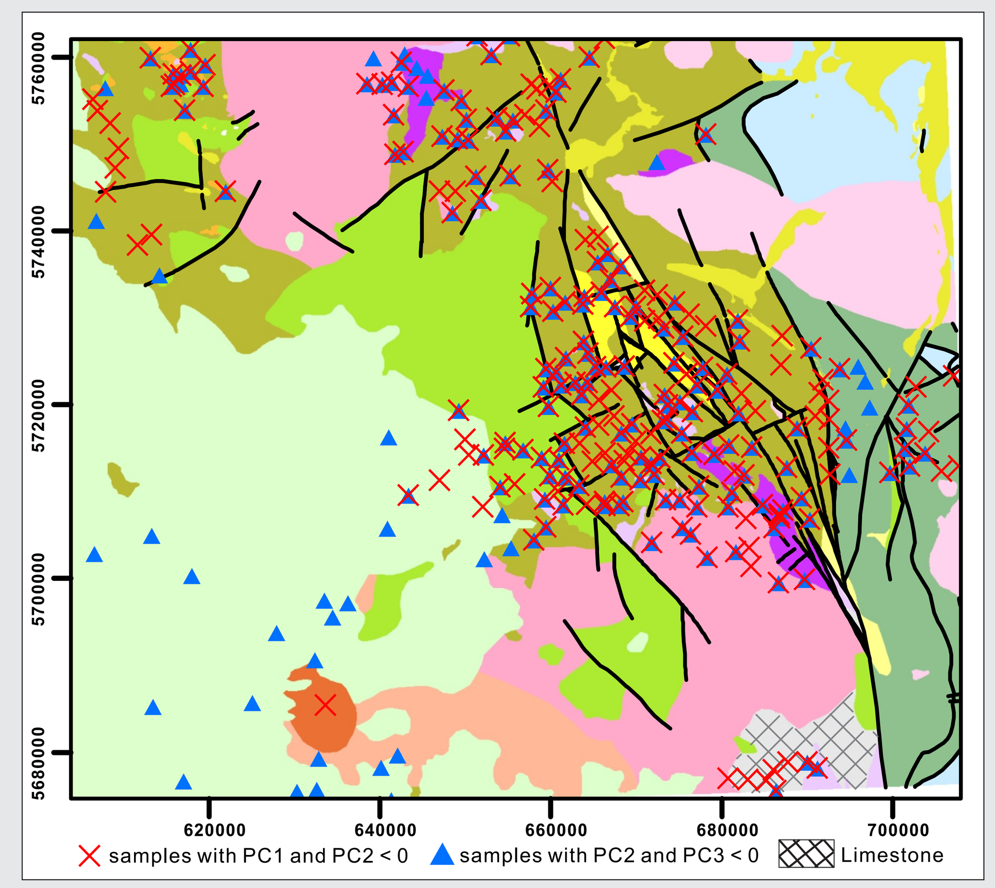

Figure 4. Locations of samples with PC1 and PC2 < 0 and those with PC2 and PC3 < 0.

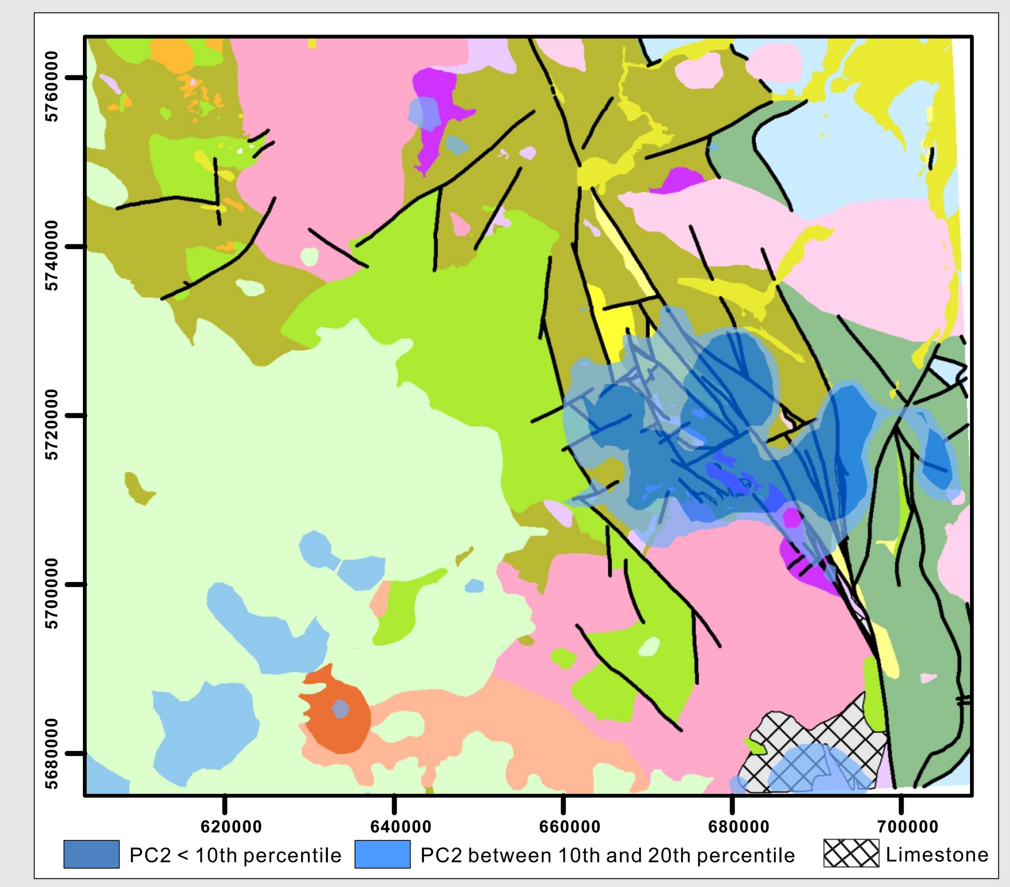

Figure 5. Kriging interpolation map of PC2

The locations of the samples with PC1 and PC2 < 0 and those with PC2 and PC3 < 0 and the Kriging interpolation map show that Cu and the associated multi-element anomalies occur at the northern boundary of the Thuya batholith (Figs. 4 and 5). This region was defined as prospective for Cu-Au porphyry mineralization based on the Cu, chalcopyrite, and gold grain content of till (Plouffe and Ferbey, 2015). The elemental association (PC1 and PC2 < 0) supports this interpretation (Fig. 4). The few samples with PC1 and PC2 <0 on the eastern sector of the region mapped as Chilcotin basalts could reflect glacial transport to the west during the first phase of ice movements. On the other hand, the mafic nature of the bedrock, as oppose to Cu mineralization, could explain the few samples with PC2 and PC3 < 0 in the southwest, throughout the region mapped as Chilcotin Group basalt.

Summary

This study shows that multivariate data analysis can delineate potential prospective areas for Cu mineralization based on elemental associations measured in till. These results should be further tested with additional public domain geological data such as till mineralogy, stream sediment geochemistry, geophysics and bedrock mapping.

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