Use of multielement associations in till for detecting concealed Cu mineralization, south central British

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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. 2). 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 of the Quesnel terrane poses a difficulty to mineral exploration. 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. 2 and 3) to evaluate the mineral potential of a large area covered by glacial till.
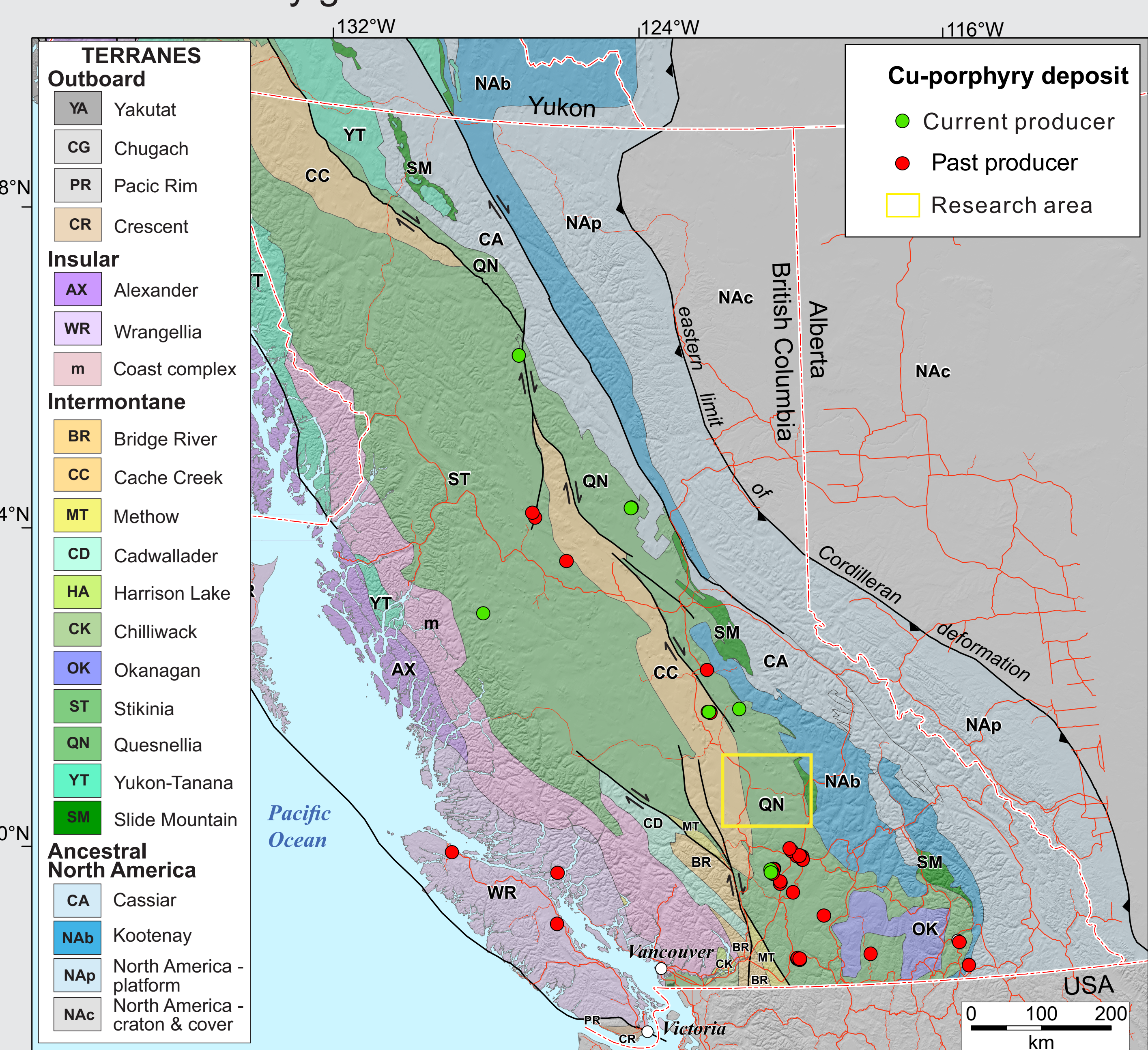

Fig. 1 Location of the Bonaparte Lake area (yellow box). Producing and past-producing Cu-porphyry deposits in British Columbia (MINFILE, 2015) along with geological terranes (Colpron and Nelson, 2011).
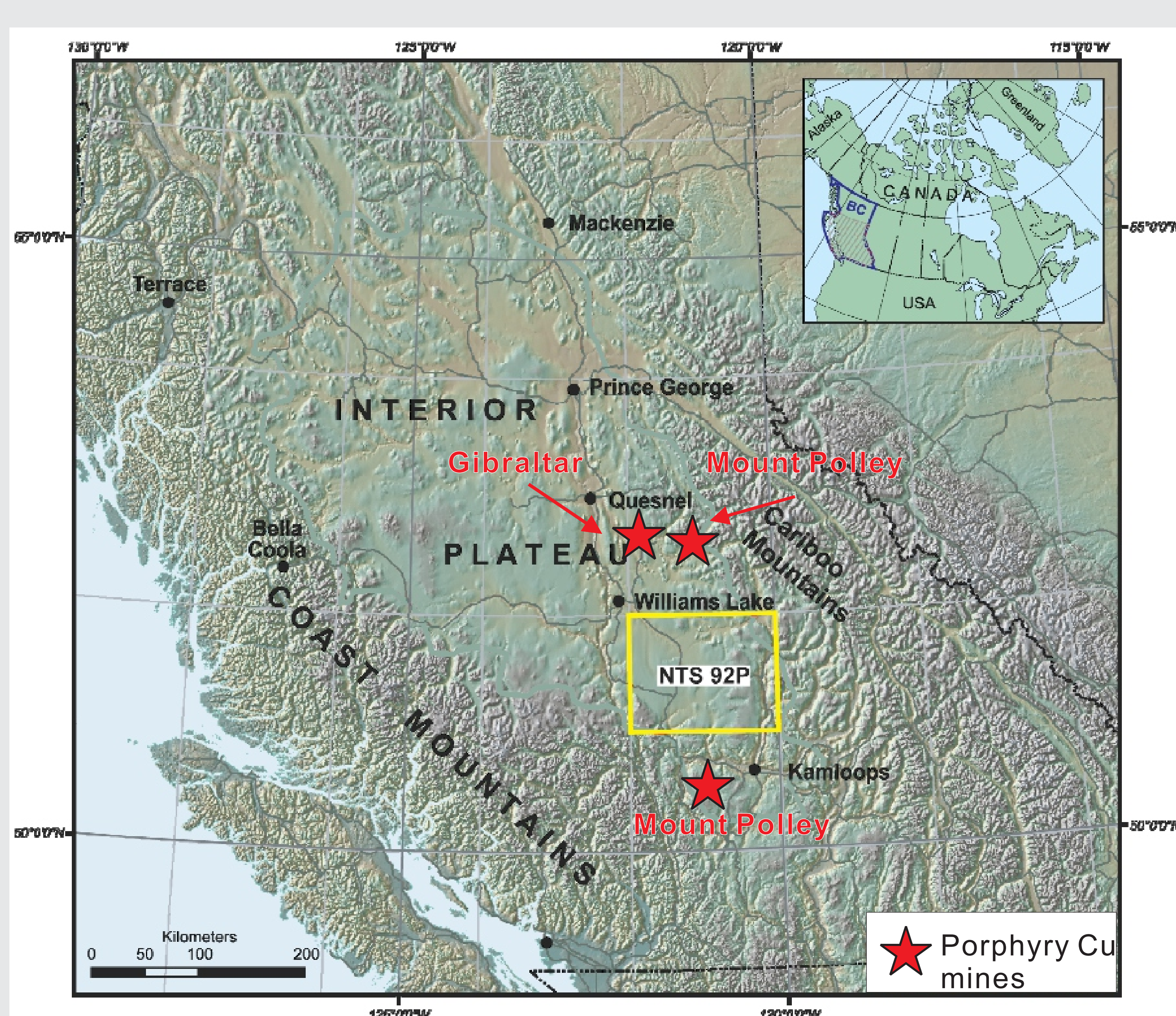

Fig. 2. Bonaparte Lake map area (NTS 92P, yellow box) in British Columbia.

Geological setting

The Bonaparte Lake map area experienced two phases of ice flow during the last glaciation. An earlier flow during ice advance directed towards the west to southwest and a second phase at glacial maximum generally to the south (Plouffe et al., 2011) (Fig. 3).

Objectives

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

Data and methods

Principal component analysis (PCA) is conducted on the aqua regia leach of the clay fraction (<2 µm) of basal till (n=936, Plouffe et al. 2010). Unsupervised mode random forest (RF) is used to classify samples. Kriging interpolations are applied based on PC scores and votes of RF to detect prospective areas.

Fig. 3 Bedrock geology map and legend of the Bonaparte Lake region; modified from Plouffe and Ferbey (2015).

Results

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. 4). Association of Cu-Mn-Ca-Fe-Al is also observed in PC2 (Fig. 4A) which could reflect the presence of epidote. Epidote is known to be abundant in till near porphyry deposits (Plouffe et al. 2016).
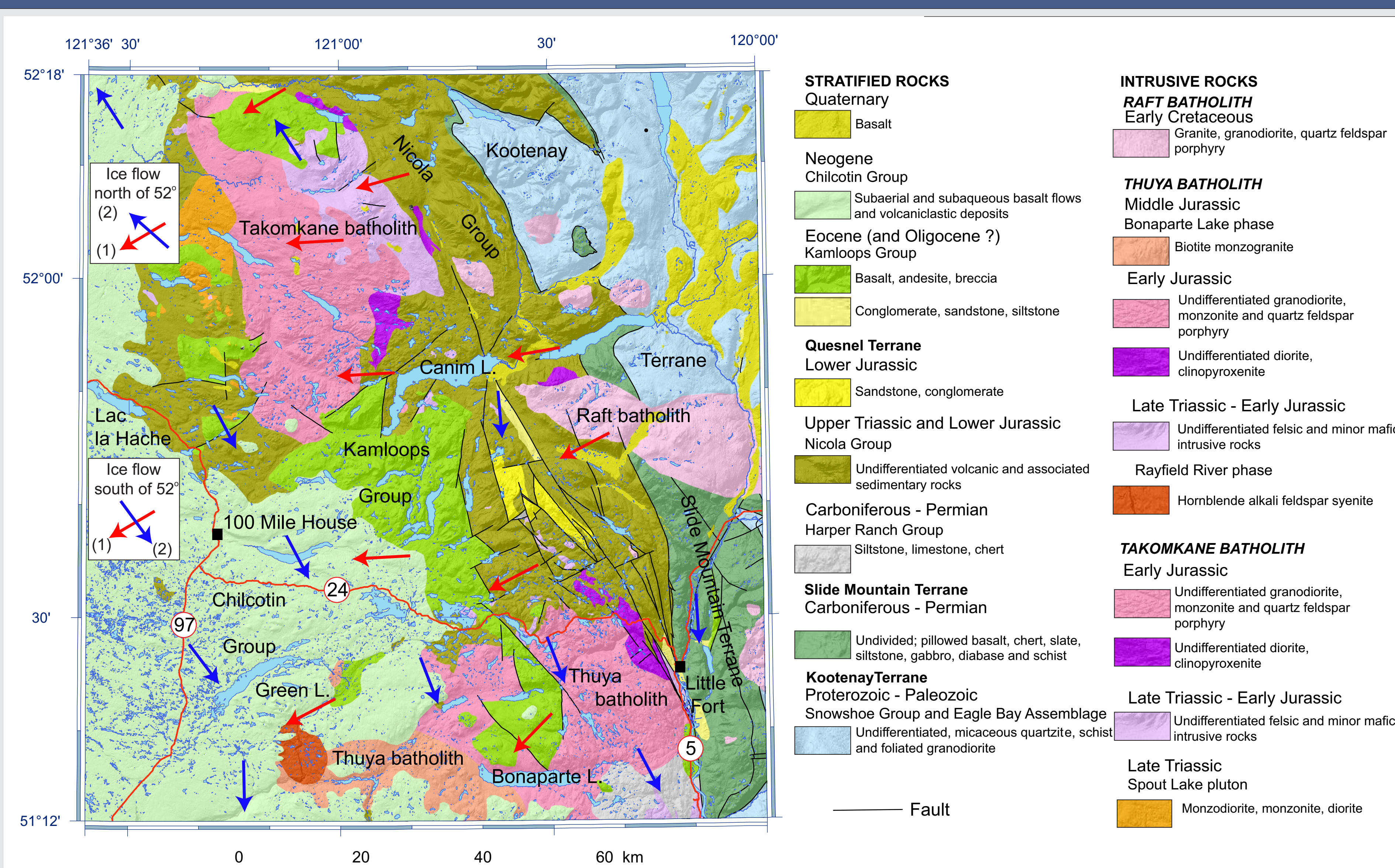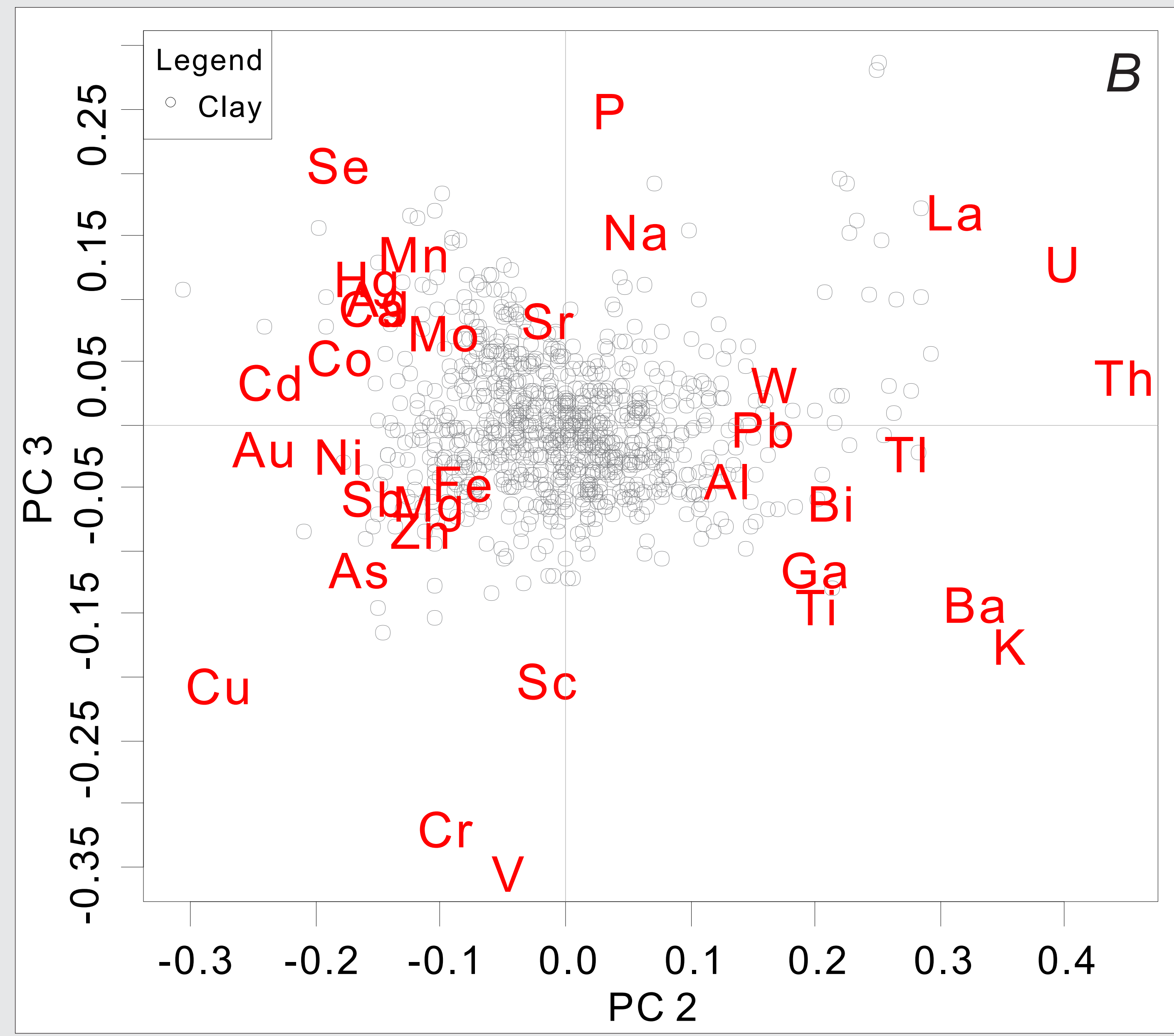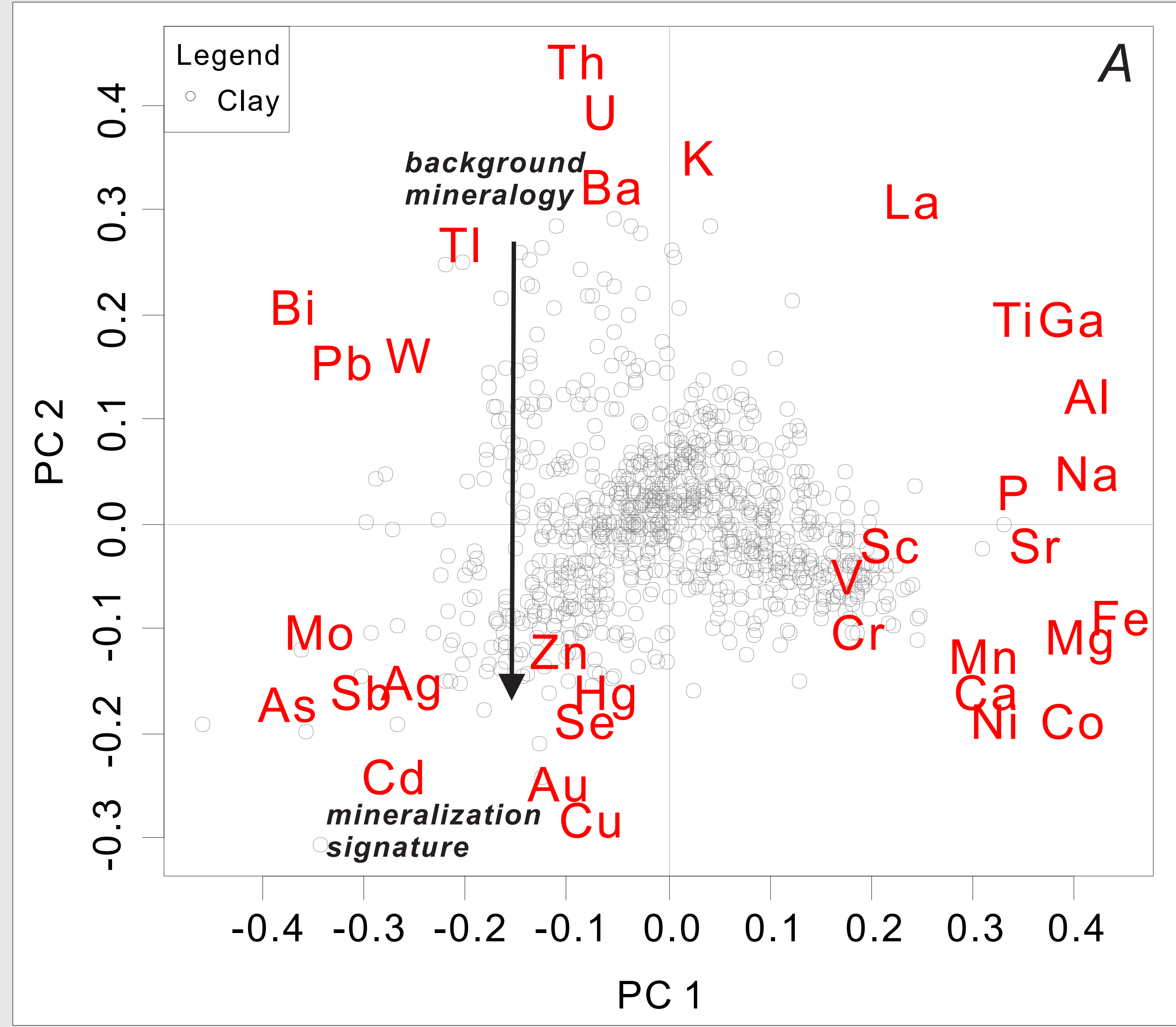

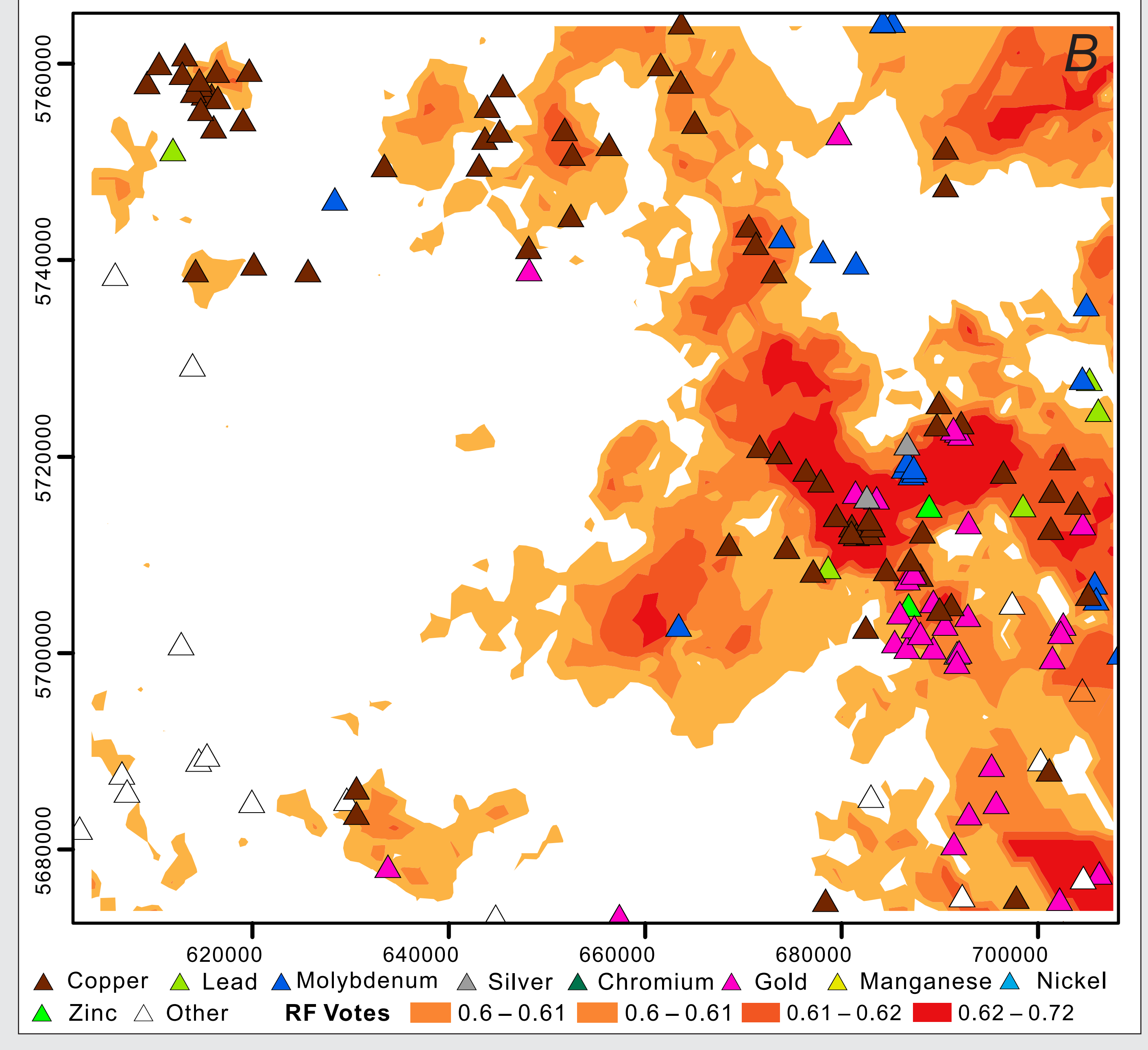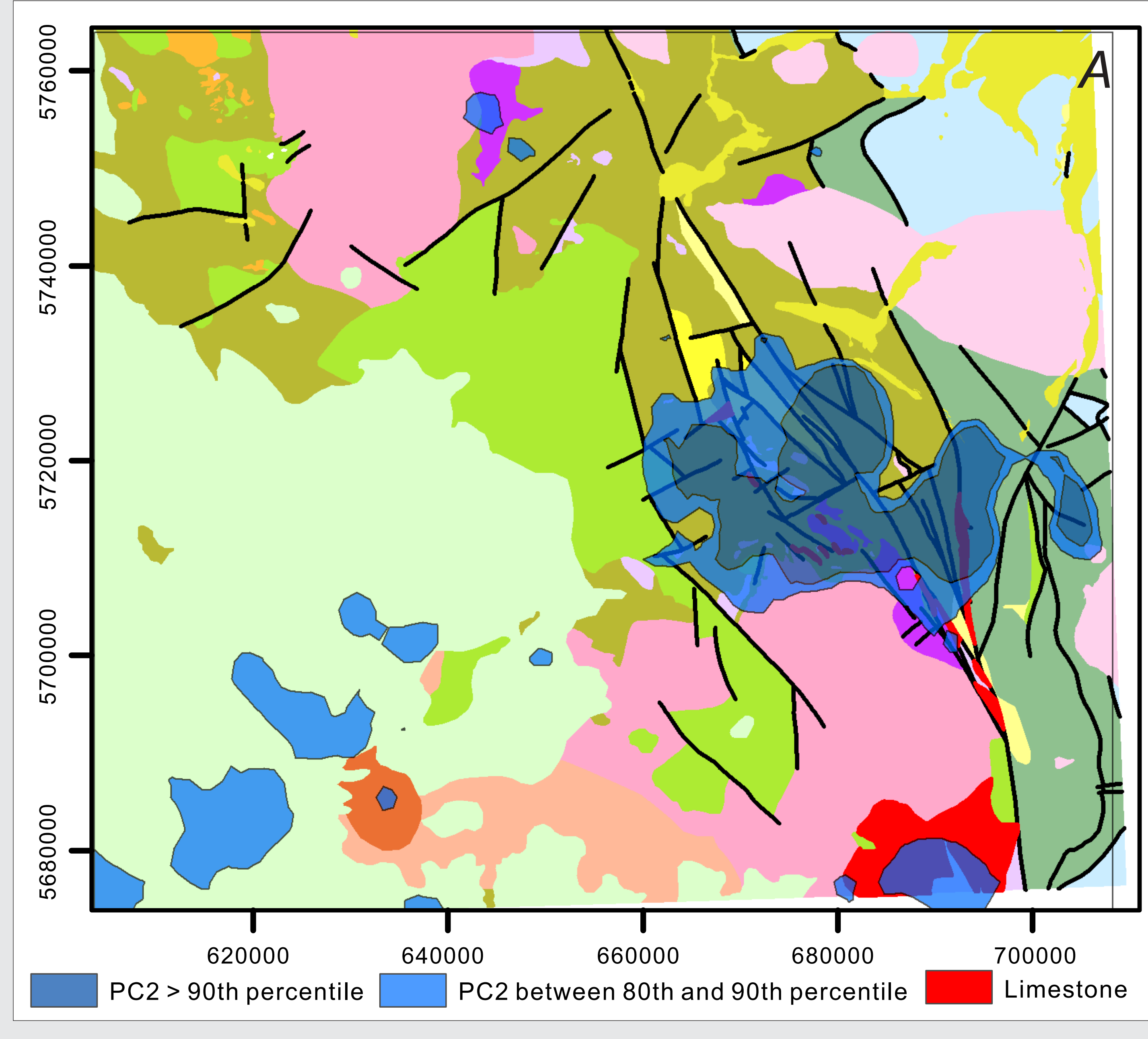Fig. 4 A. Biplot of PC1 vs. PC2. B. Biplot of PC1 vs. PC2, after log centred transformation.

Fig. 5 A. Prediction map using PC2. B. Prediction map using RF votes. Known mineral occurrences (MINFILE, 2017) are shown with triangles.

The Kriging interpolation maps using PC2 and RF votes show that the Cu and associated multi-element anomalies occur at the northern boundary of the Thuya batholith and places where faults and limestone occur (Fig. 5). This region was defined as prospective for Cu-Au mineralization based on the Cu, chalcopyrite, and gold grain content of till (Plouffe and Ferbey, 2015). Sporadic anomalies also occur in the southwestern part of the map area (Fig. 5). Based on the element association of known mineralization and bed rock geology, it is possible that skarn/porphyry type Cu deposits occur in the anomalous areas.

Summary

This study shows that multivariate analysis can delineate potential prospective areas for Cu mineralization based on elemental association measured in till. RF, a relatively new machine learning algorithm, delineates geochemical anomalies that correspond to the localities of known mineral occurrences. These results should be further tested with other data, such as till mineralogy, stream sediment geochemistry, geophysics and bedrock geology.

References
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