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 8.49 Mt Cu and 0.22 Mi Mo), the Gibraltar (reserves of 1.87 Mt Cu and 0.360 Mt Mo), and Mount Polley (0.07 Mt Cu, 0.95 tonnes Au) deposits (Fig. 1). In the north, 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 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.

Objectives
1. Identifying elemental assemblages associated with Cu in till samples;
2. Detecting geochronological 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 aqueous leach. Kriging is applied based on PC scores to detect prospective areas.

References

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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.

Figure 2: Bedrock geology map and legend of the Bonaparte Lake region; modified from Plouffe et al., 2010. (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-Cu-Mo-Ag-As-Hg-Pb-Sb, accounting for 32.3% of the total Cu variance in PC1, and Cu-Cr-V-As in PC2 (Fig. 3). The location of Cu-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-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 5: Kriging interpolation map of PC2.

Figure 3: Locations of samples with PC1 and PC2 < 0 and those with PC2 and PC3 < 0. 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 by Cu-porphyry mineralization based on the Cu, chalcocite, and pyritization (Fig. 4). The few samples with PC1 and PC2 < 0 on the eastern sector of the region mapped as Chilcotin basaltic could reflect glacial transport to the west due to the ice movements. On the western side of the bedrock, the mafic nature of the bedrock, as opposed 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 geologic data such as till mineralogy, stream sediment geochemistry, geophysics and bedrock mapping.