Abstract

The Bonaparte Lake area in southern part of the Quesnellia terrane of the Canadian Cordillera is proximal (< 50 km) to several large porphyry Cu-Au and Cu-Mo deposits. This area has potential for finding more porphyry type Cu deposits, but is overlain by a thick and nearly continuous cover of glacial sediments, which adds difficulty in finding mineral deposits in underlying bedrocks. This study uses geochemical data following an aqua regia leach on the clay fraction (<2 μm) of basal till (n = 726) to assess the mineral potential in the study area. Principal component analysis (PCA) captures four PCs containing large fractions of Cu variance: PC2 (31.2%), PC6 (17%), PC3 (16.8%) and PC16 (12.6%). Copper is associated with Au-Mo-Ag-As-Hg-Pb-Sb-Zn-Ni-Co-Mn in PC2; Au-Pb-Mn-W in PC6, Cr-V-Ti in PC3 and Pb-Se-Hg in PC16. The elemental assemblages in PC2, PC6 and PC16 may reflect the geochemical signature of underlying porphyry-style polymetallic mineralization, whereas the element association in PC3 may be originated from mafic volcanic rocks of the Chilcotin Group. Partitioning around medoids based on the dissimilarity matrix produced by unsupervised random forest using elements associated with Cu yields two groups, Group A and Group B, with minor overlap. Group A likely represents till samples with a composition influenced by a mineralized provenance because the contents of elements (Cu, Au, As, Mo, Pb and Zn) are much higher than samples in Group B. The Group A samples are mostly located in the areas underlain by the Nicola Group volcanic rocks and the northern boundary of the Thuya Batholith. Group A till samples are dominantly located close to or down-ice from known mineral occurrences, suggesting that more porphyry-Cu mineralization and other multi-elemental enrichments occur in these areas, such as Au, Mo, Pb and Zn. This study

demonstrates the usefulness of multivariate analysis and unsupervised machine learning in detecting potential Cu mineralization in bedrocks based on the composition of basal till. The statistical methods used in this study may be applicable to large scale geochemical data of sediments to evaluate multi-element assemblages associated with a variety of mineralization in bedrocks.

Keywords: till geochemistry; machine learning; porphyry Cu deposits; random forest; Quesnellia