Epidote and zircon associated with the porphyry copper mineralization at the Gibraltar mine in southcentral British Columbia

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The Gibraltar porphyry-copper deposit in the Canadian Cordillera is hosted within the late Triassic, tonalitic Granite Mountain batholith. This study aims to link the geochemistry of key robust minerals (epidote, rutile, titanite and zircon) from the granite mountain batholith to surrounding glacial till. Additionally, this study aims to constrain the timing and paragenesis of the deposit using primary and alteration mineral geochemistry and distribution patterns. Understanding this porphyry deposit is key to refining our understanding of the mechanics that lead to formation of other porphyry deposits worldwide. The Granite Mountain batholith is composed of tonalitic rock suites that are primarily composed of quartz, plagioclase, hornblende, biotite, titanite, apatite and zircon, whereas their altered equivalents are dominated by an epidote-chlorite-rutile-titanite-iron oxide mineral assemblage. Propylitic alteration (epidote-chlorite–albite) is extensive through the batholith. The epidote group minerals can be directly associated with copper mineralization and the subsequent alteration halos that extend up to 10 km from the deposit. Epidote minerals occur as replacement phases of plagioclase, in disseminated grains and in veins of varying width. Wide epidote veins (>2cm) strike towards the mineralized centers and contain epidote zoned with Fe-rich rims and Al-rich cores. Dissemination of epidote occurs both in the tonalitic batholith rocks and the surrounding Nicola volcanic rocks, however, there is a higher concentration of disseminated epidote closer to the mineralized centers. There is a large compositional variation in the epidote group minerals, including clinozoisite and REE-rich allanite that occurs in the outer alteration halos, 1-2 km from the deposit and can be used as a tool to vector towards other similar deposits if found an outlying till. Minor and trace elements (titanium and rare earth elements) in zircon grains show cooler crystallization temperatures (785°C near mineralized phases compared to >817°C moving away from mineralized phases, as determined through Ti in zircon geothermometry). Relatively oxidized magmatic conditions are found in the mineralized phases of the deposit using Ce^{4+}/Ce^{3+} as a proxy for oxidation state and a combination of the lattice strain model for mineral-melt partitioning of elements, Blundy and Wood 1994, and the calculation proposed by Ballard et al. 2004.