

Characterizing the structure and signature of district-scale alteration surrounding a large porphyry Cu system: The case of Highland Valley Copper, British Columbia

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The Highland Valley Copper (HVC) district near Kamloops, British Columbia, is a world-class porphyry copper district hosted in the Late Triassic Guichon Creek batholith. The HVC site was chosen to study what controls the extent and the shape of porphyry deposit footprints, and to determine what is the footprint signature to distances up to 13 km away from the mineralized centers. The Guichon Creek batholith is ideal for this study because its geology is well known and shows minor lateral variability; only six major granitoid units are mapped across the batholith. The alteration assemblages observed at the district scale include potassic, sodic-calcic, sericite-chlorite, muscovite and clay. Sericite is a textural term defined by fine-grained white mica (i.e., muscovite, illite, phengite, and paragonite) interlayered with other minerals such as montmorillonite or smectite. K-feldspar veins display a radial pattern centered on the Valley deposit and extending to a distance of up to 4.5 km. Sodic-calcic and sericite-chlorite alteration both cover a larger area than potassic alteration. These alteration assemblages follow northeast- and northwest-oriented structures related to regional stresses at the time of hydrothermal activity. A sericite overprint is generally observed where sodic-calcic alteration is present, but sericite-chlorite alteration alone is also common. Muscovite and clay alteration are exclusively observed within the mineralized centers and locally at district showings. Hydrothermal alteration associated with copper introduction (i.e., potassic, muscovite and clay alteration) typically shows elevated concentrations of Mo, W, Ag, Se, Te, Bi, As, Tl, Hg, Cs, Au, and Rb to distances up to 4 km from mineralized centers. White micas, which are abundant throughout the HVC district, can be used as an exploration tool for porphyry deposits because their chemical composition is partly determined by the hydrothermal fluid temperature and pH. White micas are typically muscovitic to paragonitic within and proximal to the ore zones due to high temperature and low pH fluids, whereas distal white micas are phengitic due to lower temperature and rock-buffered fluids. The Al-OH absorption feature wavelength (2200 nm) of white mica measured by short-wave infrared (SWIR) is a proxy for their chemical composition. SWIR measurements in the HVC district show an increase in the Al-OH feature wavelength from an average of 2197.2 nm at distances <1 km from the Valley or the Lornex mineralized center to an average of 2200.9 nm at distances >11 km, consistent with muscovitic proximal white micas and more phengitic distal white micas.