District-scale porphyry-related hydrothermal alteration and the quantitative use of feldspar staining: the case of Highland Valley Copper, British Columbia

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Porphyry copper deposit formation involves the convective circulation of large quantities of magmatic fluids exsolved from a magma chamber. Magmatic fluids typically mix with meteoric and formation waters, and react with the country rock causing hydrothermal alteration that may extend far away from the central mineralized zones. In the Highland Valley Copper (HVC) district near Kamloops, British Columbia, four mineralized porphyry Cu-Mo centers are hosted in the Late Triassic Guichon Creek batholith. The spatial distribution of district-scale hydrothermal alteration at HVC is strongly controlled by structural permeability and is expressed as veins and vein selvages that occur up to 10 kilometers from the centers. Throughout the district, there is a strong correlation between vein intensity and orientation, and proximity to syn-mineralization fault zones. The main fracture-controlled alteration assemblages include, from oldest to youngest: (1) potassic alteration (K-feldspar±biotite) striking dominantly NNE and approximately easterly, (2) sodic-calcic alteration (albite-chlorite-epidote±actinolite±diopside± garnet) striking dominantly NNE and WNW, (3) coarse-grained white mica alteration striking dominantly NE and NW, and (4) white mica-chlorite-prehnite alteration striking dominantly NNE. Quantitative image analysis of feldspar-stained rock slabs using ImageJ software is an inexpensive and effective technique to calculate K-feldspar and plagioclase modal percentages and to assess the effect of hydrothermal alteration on the abundance of feldspar species in rocks. The image analysis provides textural information by measuring the size and shape of zones of interest representing all isolated objects in the image (i.e., individual feldspar grains or clusters of interconnected grains). Ellipses can also be fitted to these zones of interest in order to calculate their aspect ratio. Vein-controlled potassic alteration introduces K-feldspar along planes, which can be detected by identifying samples containing anomalously large and elongate fit ellipses corresponding to interconnected grains in veins. Due to sodic-calcic alteration destroying K-feldspar, it can be identified by a ratio of K-feldspar to plagioclase, and a K-feldspar grain count per unit area decreasing by up to three and two orders of magnitude, respectively. Quantifying feldspar alteration can significantly improve the maps of alteration distribution and intensity by recognizing otherwise cryptic features not consistently observed by geologists in the field. NSERC-CMIC Mineral Exploration Footprints Project Contribution Number 114.