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Decoding the Extensive Hydrothermal Alteration at the Kudz Ze Kayah Replacement-Style VMS Deposit, Finlayson Lake District, Yukon

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The Kudz Ze Kayah deposit is a bimodal-felsic, replacement-style volcanogenic massive sulfide (VMS) deposit that contains a mineral resource of 19.1 Mt grading @ 6.6 wt % Zn, 0.9 wt % Cu, 2.0 wt % Pb, 1.4 g/t Au, and 156 g/t Ag. The deposit is hosted by rocks of the Yukon-Tanana terrane in the Finlayson Lake District in south-central Yukon, a district that contains >40 Mt of polymetallic VMS mineralization.

The deposit is hosted within Late Devonian volcanosedimentary rocks of the upper Kudz Ze Kayah formation, which are interpreted to be deposited in a continental back-arc environment. Volcaniclastic rocks (tuffs, crystal tuffs, and lapilli tuffs) and argillites are interbedded, and coherent volcanic rocks (mafic sills and felsic sills, flows and cryptodomes) are interbedded with or emplaced within the volcanosedimentary pile. Replacement-style VMS mineralization and associated hydrothermal alteration were facilitated by rapid deposition rates of the volcaniclastic rocks and by the contrasts in porosity and permeability between the volcaniclastic and coherent rocks.

Drill core and outcrop observations in the deposit area indicate that VMS-related hydrothermal alteration extends several kilometres beyond the mineralization. Pervasive white mica and chlorite alteration occur proximal to the massive sulfide lenses (within 10s of meters) both in the hanging wall and the footwall, and zones of strong and moderate white mica alteration ± chlorite-carbonate extend laterally and into the hanging wall and footwall stratigraphy (100s - 1,000s of meters). Alteration indices in lithogeochemical data (e.g., AI, CCPI, Al_2O_3/Na_2O, Ba/Sr), mass balance calculations, and petrographic observations indicate that widespread feldspar destruction (low Na and Ca, mass losses of Na) and formation of white mica (mass gains of K) and chlorite (mass gains of Fe and Mg) were the main alteration processes. Barite is a common gangue mineral within the mineralization, and elevated Ba values occur proximal to the mineralized lenses. Electron microprobe (EMPA) and scanning electron microscopy (SEM) results indicate that Ba is a minor constituent in K-feldspar, biotite, and white micas in addition to barite. Volatile metals in whole rock samples (e.g., Sb, Tl, and Mo) also form halos with elevated values up to 200 - 300 m into the hanging wall and footwall to the mineralization.

Petrographic and EMPA analyses of white mica, biotite, chlorite, and carbonate show that Mg-rich varieties are more common proximal to mineralization and formed earlier in the deposit paragenesis than the Fe-rich varieties. Short wave infrared data for mica and chlorite, however, shows no clear spatial trends across the deposit area. Phyllosilicates with distinct Mg- or Fe-rich compositions are juxtaposed proximal to the massive sulfide lenses and likely formed at different temperatures; this is interpreted to indicate multiple overprinting fluid pulses over the lifetime of the hydrothermal system.

Integration of fieldwork, petrography, lithogeochemistry, and EMPA-SEM methods offers unique opportunities to study the evolution of an ancient hydrothermal system and a replacement-style VMS deposit; the results will improve vectoring towards VMS mineralization in similar, extensively altered environments.