

Alteration Assemblages and Quantitative Mineralogy of the Boundary Zone Zn-Pb \pm Ag Deposit, Yukon, Canada

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The Boundary Zone Zn-Pb \pm Ag deposit, Selwyn Basin, Canada, is a recently discovered clastic-dominated (CD-type) occurrence with two distinct ore mineralization stages within the Late Ordovician-Early Silurian Duo Lake and Middle-Late Devonian Portrait Lake Formations. Understanding the intricacies of the alteration assemblages allows for developing vectors toward the base metals that are essential for meeting net-zero targets and renewable energy generation. Seventy-three drill core samples from nine drill holes were analyzed using quantitative X-ray diffraction (QXRD), electron probe microanalysis (EPMA), and U-Pb secondary ion mass spectrometry (SIMS) to examine alteration assemblages linked to the sulfide mineralization.

Sulfide formation at the Boundary Zone occurs with quartz, pyrite, barian-mica, fluorapatite, and siderite, with specific assemblages associated with different host rocks (biosiliceous mudstones, conglomerates, and volcanoclastics). Stratabound ore-stage I mineralization in the Duo Lake and Portrait Lake Formations involves the replacement of radiolarian-rich mudstone beds. This mineralization is coeval with the transformation of Opal-A to chalcedony and microquartz in and around the mineralized intervals. Additionally, in the Portrait Lake Formation, authigenic barite replacement by pyrite and barian-mica is observed. The dissolution-reprecipitation of quartz, likely preserved porosity and coupled with barite dissolution, generated permeability facilitating metal-bearing fluid flow.

Ore-stage II sulfides formed via hydrothermal fluid-induced brecciation and veining of the host rocks with stylolitic margins and are accompanied by fluorapatite, megaquartz, and pyrobitumen. Mg-siderite formed together with early vein sphalerite and as late cavity fillings contemporaneous with bladed megaquartz in the Portrait Lake Formation. Fluorapatite in one vein that crosscut ore-stage I records a Middle Jurassic U-Pb age; however, timing related to ore-stage II is undetermined. Collectively, the multiple mineralizing events at the Boundary Zone indicate a protracted history of ore formation and host rock alterations, likely spanning from diagenetic stages to periods of Cordilleran-related deformation within the Selwyn Basin.