Tracing fluid flow in a Carlin-type hydrothermal system using isotopic, chemical, and textural alteration of calcite

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Understanding the nature and extent of fluid flow in hydrothermal ore system relies on indirect measurements of fluid-rock interaction in wall rocks. Oxygen isotope ratios measured from micro-drilled calcite in limestone wall rocks at the Banshee Carlin-type Au deposit show marked depletion both proximal and distal to Au-mineralization indicating isotopic exchange between wall rock calcite and hydrothermal fluids. Isotopic alteration is spatially coincident with mineralization and puts minimum constraints on hydrothermal fluid infiltration outside of visible indicators (i.e. carbonate dissolution and silicification). Additionally, isotopic depletion is nearly homogenous at hand specimen scale indicating near complete alteration of limestone protolith. The primary mechanism of isotopic exchange is coupled dissolution-precipitation leading to pseudomorphic replacement of calcite during hydrothermal fluid infiltration. Surface reactions between calcite and the hydrothermal fluids are evidenced by textural and chemical variations between altered and unaltered calcite in wall rock limestone and limestone breccia. Cathodo-luminescence reveals distinct changes in the luminescence of altered calcite relative to unaltered equivalent calcite, and LA-ICPMS data from altered and unaltered calcite shows that observed CL responses are due to changes in calcite mineral chemistry. Altered samples exhibit bright CL responses in calcite with increases in Mn and Fe. Together, these dataset show alteration in wall rock calcite at Banshee up to 100 meters outside of mineralization and define the most distal expression of low temperature hydrothermal alteration in calcite bearing rocks at the Banshee deposit.