The nature and origin of the Brucejack high-grade epithermal gold deposit, British Columbia, Canada

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A major challenge in understanding the genesis of epithermal gold deposits is that existing genetic models do not satisfactorily explain the mechanisms responsible for high-grade gold deposition at temperatures characteristic of the epithermal realm (150–300°C). Although transport by dissolution in an aqueous hydrothermal liquid is the widely proposed mechanism for mobilizing gold within Earth's upper crust, experiments have shown that the solubility of gold is too low in hydrothermal liquids at temperatures of < 400°C to account for the extraordinarily high grades observed in some epithermal deposits. Resolving the issue of how exceptionally high grade epithermal gold deposits form will be an important step in elucidating the broader question of how these deposits truly relate to the higher temperature copper–molybdenum±gold porphyry systems with which they are commonly associated. The Brucejack deposit, currently undergoing preproduction mine development in northwestern British Columbia, is host to one of the highest grade epithermal gold deposits in the world. The well-explored nature of epithermal gold mineralization on the Brucejack property, combined with its proximity to well-explored, world-class copper-gold-molybdenum porphyry deposits (Snowfield and Kerr-Sulphurets-Mitchell) of the Stikine Arc, offer an unparalleled opportunity to study the genesis of epithermal gold deposits, investigate their hydrothermal evolution, and, importantly, test their relationship to spatially associated porphyry systems. Preliminary results from our petrographic and mineral-chemistry investigations of mineralized quartz-electrum±carbonate veins from Brucejack indicate that the deposit formed from a hydrothermal system with a complex history of multiple, possibly long-lived, mineralizing events. The formation of the five syn-mineral vein stages and substages appear to have resulted from multiple pulses of fluid that circulated through the deposit under dynamic physicochemical conditions, including possible fluid-overpressure and silica-dissolution events. We aim to develop a detailed genetic model for Brucejack by: (1) continuing chemical and petrographic characterisation of Brucejack ores and associated hydrothermal alteration, (2) determining the composition of mineralising fluids through fluid inclusion analysis, and (3) reconstructing the physiochemical conditions that controlled Au mineralisation through thermodynamic modelling. If successful, our study will improve on existing genetic models for epithermal gold deposits and the strategies that guide their exploration.