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

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The Brucejack Au-Ag deposit is a recently discovered, large, and exceptionally high-grade (up to 41000 g/t) intermediate- or possibly low-sulphidation epithermal deposit located in northwestern British Columbia. With commissioning completed in May of 2017 and commercial production achieved two months later, the deposit is host to Canada's newest gold mine. Our project is taking advantage of the unparalleled opportunity offered by the extensive preproduction exploration and mine-development workings at Brucejack to investigate(1) the chemical characteristics of its ores and associated hydrothermal alteration, (2) the general mechanisms responsible for gold transport at temperatures characteristic of the epithermal realm, (3) the physicochemical conditions controlling gold deposition during the different stages of mineralisation, and (4) the genetic relationship with spatially associated porphyry systems (if any). Results from our investigations of mineralized quartz-electrum ± carbonate veins from the Valley of the Kings (VOK) zone at Brucejack indicate that the deposit formed from a hydrothermal system with a complex history of multiple, possibly long-lived, mineralizing events. The formation of five syn-mineral vein stages and sub-stages appears to have resulted from multiple pulses of fluid that circulated through the deposit under dynamic physicochemical conditions, including fluid-overpressure and silica-dissolution events. Preliminary transmission electron microscopic (TEM) imaging has revealed the presence of ~< 1 to 10 nm wide spherical nanocrystals of electrum within these veins, suggesting that boiling-mediated nanoparticle suspensions (colloids) may have played a role in greatly increasing the capacity of the ore-forming fluid to carry gold by allowing for physical transport. Analyses of pre-electrum pyrite using EMP-WDS and LA-ICP-MS methods show that arsenic-rich growth zones contain up to 1920 ppm gold, indicating that auriferous pyrite mineralization, likely related to a phyllic alteration of the volcano-sedimentary country rocks surrounding older neighboring porphyry deposits, is also partially responsible for the 8.6 million ounce gold reserve at Brucejack. We are progressing towards the development of a detailed genetic model for Brucejack by (1) continuing chemical and petrographic characterisation of the Brucejack ores and associated hydrothermal alteration, (2) determining the composition of the mineralising fluids through fluid inclusion analysis, and (3) reconstructing the physiochemical conditions that controlled gold 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. Locally, it will also improve understanding of the relationship between gold mineralization at Brucejack and Cu-gold-(Mo) mineralization in adjacent world-class porphyry deposits of the Sulphurets camp.