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

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The Brucejack Au-Ag deposit is a recently discovered, large and exceptionally high-grade (up to 41,000 g/ton Au) intermediate- or low-sulphidation epithermal deposit located in the Stewart-Eskay Creek mining district of northwestern British Columbia, Canada. The deposit is characterised by multi-generational sub-vertical quartz-carbonate-sulphide vein stockworks and subordinate vein breccias hosted within a deformed island arc-related sequence of latitic flows, lapilli tuffs, locally derived pyroclastic conglomerate and sandstone, and minor mudstone belonging to the Lower Jurassic Hazelton Group. Regionally, the deposit forms part of the Sulphurets Au-Ag-Cu camp, a 25 km long trend marked by gossans that hosts several world-class Cu-Au-(Mo) porphyry deposits (e.g., Kerr-Sulphurets-Mitchell, Snowfield) along a district scale unconformity between the Hazelton and Upper Triassic Stuhini Groups. Emplacement of the deposit is believed to have been associated with ca. 188 Ma regional N-S extension and related deep-seated porphyry magmatism, both being late stage manifestations of the Late Triassic-Early Jurassic development of the Stikine volcanic arc terrane. High-grade Au-Ag mineralisation in the Valley of the Kings zone at Brucejack occurs primarily as coarse aggregates of electrum within three early- to intermediate-stage vein phases: (1) electrum-bearing deformed quartz-carbonate ± sericite stockwork veins and breccias, which are spatially associated with subvertical stringer quartz veinlets, also hosting electrum; (2) Zn-Pb-(Cu) sulphide veins containing common Ag-sulphosalts and electrum; and (3) highly deformed carbonate ± quartz veins containing abundant orange-colored, Mn-bearing calcite, and subordinate electrum and Ag-sulphosalts. Emplacement of Au-Ag mineralized veins was preceded by an earlier veining event characterised by discontinuous, highly-deformed pyrite stringer veins containing carbonate and quartz and accompanied by sericite-chlorite ± quartz-pyrite alteration of the wall-rocks. Quartz-carbonate shear veins and white bull quartz-carbonate tension gash veins post-date mineralisation and are likely related to Cretaceous tectonism. Our recently initiated project aims to develop a detailed, integrated genetic model for the Brucejack deposit by: (1) chemically (including isotopically) and petrographically characterising its ores and associated hydrothermal alteration, (2) determining the composition of its mineralising fluids through fluid inclusion analysis, and (3) reconstructing the physiochemical conditions that controlled Au mineralisation through thermodynamic analysis and quantitatively testing plausible models of ore formation. If successful, the project will improve on existing models for the genesis of epithermal Au deposits and the strategies that guide their exploration. Locally, it will also improve understanding of the genetic links between Au mineralisation at Brucejack and Cu-Au-(Mo) mineralisation in adjacent world-class porphyry deposits of the Sulphurets camp.