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Ore-forming processes in the Pogo Au deposit: an intrusion-related partial melting overprint on an orogenic deposit

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We show via petrographic and field observations that Pogo belongs to the Big Bell-Hemlo class of deposits wherein an early phase of shear zone-hosted metamorphic gold subsequently undergoes amphibolite facies or higher grade metamorphism. A subsequent magmatic-hydrothermal event overprinted and upgraded the existing orogenic Au deposit. The post-peak-metamorphism intrusive event, assisted by rapid exhumation during the Cretaceous, induced flux and decompression melting of the amphibolite facies parautochthonous North American gneiss country rock, generating melts and hydrothermal fluids that modified the original orogenic Au mineral assemblages and changed the tenor of mineralization. The influx of magmatic fluids to the hot, rapidly exhuming gneiss generates water-rich partial melts, preserved as migmatites. Pogo migmatites range from syn-kinematic (transposed into the metamorphic foliation) to post-kinematic (undeformed and cross-cutting metamorphic foliation). Post-kinematic migmatites are often pegmatitic leucosomes consisting of quartz, K-feldspar, biotite, and plagioclase feldspar; biotite-rich melanosomes or reaction selvedges may or may not be present, reflecting a combination of static melt generation and dynamic melt migration. These melts infiltrated pre-existing Au-bearing metamorphic quartz veins, as indicated by quartz cathodoluminescent textures and trace elements, and the occurrence of what is called Type 1 and Type 4 quartz. Type 1 and 4 quartz are petrogenetically similar, consisting of subrounded quartz crystals in a matrix of poikilitic K-feldspar and preferentially sericitized plagioclase; the only distinction between them is whether or not the interstitial feldspar is macroscopically visible. The same texture occurs in the classic Liese vein lodes. This new interpretative framework reconciles earlier work that focuses on either the orogenic or magmatic-hydrothermal characteristics of the deposit.

Immiscible Bi-rich polymetallic melts co-existed with the silicate melt and aqueous fluids and are preserved as rounded inclusions of Bi minerals in quartz with trails of fluid inclusions behind them. The pathways these Bi melts took through quartz grains are visible in cathodoluminescent images. As the silicate partial melts cooled and crystallized, they exsolved hydrothermal fluids that metasomatically altered the host rock. This complex sequence of events obfuscates the origin of ore formation because each type of mineralization spatially overprints earlier mineralization events.