Implications of the 2740 Ma Cote Gold Au(-Cu) deposit for Archean gold metallogeny and porphyry Au deposit formation in the Archean Swayze greenstone belt, northern Ontario

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Ore-deposit models, which are fundamental to mineral exploration, result from integrating robust field observations with high-quality mineral-chemical-isotopic data. New discoveries departing from current models demand explanation, and in some cases new deposit models result (e.g., IOCG). The recent (2009/2010) discovery of the Cote Gold Au(-Cu) deposit in the Archean Swayze greenstone belt, northern Ontario, challenges the age-restricted view of porphyry Cu-Au models. The +8 Moz Au deposit is hosted by a subvolcanic tonalite-diorite intrusive complex where magmatic-hydrothermal breccia bodies occur. Gold mineralization, of disseminated-, fracture- and vein-types, is spatially associated with hydrothermal biotite and muscovite alteration that is similar to potassic and phyllic alteration, respectively, in porphyry-type settings. A robust program involving core logging and field mapping with structural analysis integrated with detailed petrographic studies, geochronology, lithogeochemistry, isotopes, and fluid inclusion studies (microthermometry and evaporate mound SEM-EDS analysis) was used to assess the deposit's origin. That the age of host rocks (U-Pb zircon, titanite) and timing of alteration (U-Pb titanite) and mineralization (Re-Os molybdenite) centre on 2740 Ma and pre-dates the age of regional deformation (ca. 2680 Ma), in addition to the co-spatial nature of mineralization and alteration, suggests a magmatic-hydrothermal connection. Structural analysis of auriferous quartz veins also indicates a relationship to the intrusive centre versus regional deformation, which is further supported by a 2740 Ma molybdenite age for one such gold-mineralized vein. Fluid-chemical data indicates fluid mixing with ?34S (py, cpy, moly = 0 ± 1‰) and fluid inclusions (mixed H2O-CO2 fluid (XCO2=0.10); Na-K-Ca-Fe-Mn-Cl-F-S chemistry) suggesting a magmatic fluid reservoir whereas ?18O (qtz = 7-12‰) also indicates a possible seawater contribution. These observations are best reconciled with a deposit model involving Au(-Cu) mineralization originating from exsolution of magmatic fluids from a high-level, hydrous intermediate magma in the same manner as models for younger porphyry analogues.