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Geologic Setting and Timing of Mineralization at the World-Class Banded Iron Formation-Hosted Amaruq Gold Deposit, Churchill Province, Nunavut, Canada

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Precambrian gold deposits associated with Algoma-type banded iron formations (BIF) are complex systems in which lithological and structural traps are the principal controls on the location and geometry of ore zones. One such deposit is the 6.1 Moz Amaruq gold deposit, which is part of the polydeformed and metamorphosed Neoarchean (ca. 2.73–2.63 Ga) Woodburn Lake greenstone belt, within the Rae craton of the western Churchill province, Canada. The host rocks at Amaruq consist of a moderately to steeply dipping, 250-m-thick tectonostratigraphic sequence comprising BIF interlayered with greywacke, siltstone, black shale, and mafic-ultramafic magmatic rocks, which have been affected by Archean and Paleoproterozoic orogens. The ore zones at Amaruq are predominantly controlled by pre-ore tight and isoclinal F_1 folds and D_1 shear zones that are overprinted by syn-ore upright and isoclinal northeast-trending and plunging F_2 folds and associated D_2 shear zones. Progressive strain accommodation during D_2 led to the development of northwest-verging thrusts and recumbent F_2 folds. Subsequent deformation consists of open to chevron-style, northeast- and southwest-plunging F_3 folds, and north-south and east-west D_4 and D_5 normal faults and shear zones, respectively. The Amaruq gold deposit comprises the Whale Tail and IVR zones, which are characterized by contrasting styles of mineralization and associated metamorphosed calcic and potassic hydrothermal alteration halos. The IVR and Whale Tail zones are located in the hinge zone and along the limb of a deposit-scale F_2 fold, respectively. The mineralized zones all contain pyrrhotite and calcite and consist of 1) stratabound (Ca-Fe)-amphibole-biotite-epidote-garnet±arsenopyrite-gersdorffite replacement-style zones in chert-poor BIF layers associated with ultramafic rocks; 2) (Ca-Fe)-amphibole-stilpnomelane-biotite-chlorite-arsenopyrite±löllingite-bearing zones of diffuse veining (“silica-flooding”) in chert-rich BIF units interlayered with black shale and siltstone beds; and 3) shear and extensional quartz±calcite veins with (Ca-Fe)-amphibole and/or sericite/biotite in high-strain zones close to sheared and/or folded contacts between volcanic and sedimentary rocks. The first and second styles of mineralization are more common in the Whale Tail zone, whereas the third style is better developed in the IVR zone. The metamorphic paragenesis of silicate (e.g., amphiboles and micas) and sulphide minerals (e.g., arsenopyrite and löllingite) provide evidence for pre- to early-D_2 mineralization and syn-D_2 peak metamorphism. Rheological contrasts between BIF, sedimentary, and mafic-ultramafic rocks contributed to strain partitioning, which channeled ore-forming fluid flow in structurally and chemically favorable lithologies such as BIF and chert. Previous research in the western Churchill province indicated that gold was introduced during the Trans-Hudson orogen (ca. 1.91–1.81 Ga). However, a series of Re-Os model ages as old as 2.3 Ga were obtained at the Meliadine deposit, and as old as 2.6 Ga at Amaruq (this study), thus suggesting a multiphased hydrothermal history. The timing of the gold mineralization and the possibility of an Archean gold heritage represent key issues that are being addressed through this study to help in the development of improved geologic and exploration models for orogenic gold deposits in the Churchill province and other Archean terranes.