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Fluid Inclusions Resolve Whether Magmatic or Metamorphic Fluids Produced the Fenelon Gold deposit in the Northern Abitibi Greenstone Belt

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The multimillion-ounce Fenelon gold deposit in the Northern Abitibi Greenstone Belt, Québec, Canada, hosts gold and sulfide mineralization within silicified shear zones and veins. The mineralization is spatially associated with 2704-2696 Ma dioritic intrusions that were emplaced in wacke and graphitic argillites. Gold-bearing zones are cut by later quartz–carbonate ± tourmaline shear and extensional veins that typically contain little gold but mineralogically and texturally resemble gold-bearing veins in orogenic gold deposits in the Southern Abitibi Greenstone Belt. Here we present a fluid inclusion study of gold-bearing mineralization and the later quartz–carbonate veins, and use the data to develop genetic models for both systems.

The gold-bearing veins trapped high-salinity (~6 to >20 wt.% NaCl eq.) H_2O–NaCl–$CaCl_2$ fluids. In contrast, the later quartz–carbonate veins trapped low-salinity (~1-5 wt.% NaCl eq.) H_2O–CO_2–NaCl fluids. Raman spectra indicate significant CH_4 in some inclusions of both fluid types, but only in samples collected proximal to graphitic argillite; concentrations of CH_4 in fluid inclusions occurring in diorite-hosted veins are near or below the detection limits. The spatial association of gold, reduced sulfide assemblages, CH_4-bearing fluid inclusions, and carbon-rich metasedimentary rocks indicates that reducing conditions adjacent to graphitic argillite destabilized metal-sulfide and -chloride complexes, promoting gold and base metal sulfide precipitation.

Intersections of the isochores for pure CH_4 and CO_2 inclusions (purity confirmed with Raman spectroscopy) with those for coexisting aqueous inclusions indicate that the dominant trapping conditions were ~275–375 °C and 1.1–2.6 kbar. Some inclusions record higher homogenization temperatures (up to 430 °C), which, when pressure-corrected, reflect temperatures in excess of ~500 °C. These data are most consistent with Fenelon being a relatively deep intrusion-related gold deposit produced by magmatic-hydrothermal fluids.

The isochores for quartz–carbonate±tourmaline vein-hosted fluid inclusions indicate trapping at ~280–400 °C and 4.3–6.5 kbar. These low-salinity, deep aqueous-carbonic fluids are interpreted to be metamorphic in origin, sharing characteristics with the fluids observed in Archean orogenic gold systems. The corresponding veins contribute only a minor proportion of the gold in the Fenelon deposit but may represent promising exploration targets elsewhere in the belt.