Multistage gold enrichment in the Menneval – Saint-Quentin district, northwest New Brunswick, Canada: a distinct, shallow quartz-carbonate gold style requiring an exotic (magmatic) fluid source?

JACOB HANLEY[1], GLEN HODGE[1], BRANDON BOUCHER[2], JIM WALKER[3], AND RYAN SHARPE[4]

1. Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada <Jacob.Hanley@smu.ca>

2. Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada

3. New Brunswick Department of Energy and Resource Development, South Tetagouche, New Brunswick E2A 3Z1, Canada

4. Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada.

The Maisie and Lavoie gold occurrences in the Menneval– Saint-Quentin region of NW New Brunswick are hosted by Late Ordovician, fine-grained clastic sedimentary rocks of the Whites Brook Formation (Grog Brook Group). Gold-bearing veins comprise two generations of quartz (early, laminated and later, massive to vuggy), and contain an assemblage of electrum and trace pyrite (rarely preserved, now hematitized), and rare chalcopyrite (at Maisie) and galena-sphalerite (at Lavoie). Electrum is unambiguously late in the vein paragenesis infilling vugs and fractures.

Cathodoluminescence imaging of the textural relationships of gold and accessory minerals, combined with fluid inclusion data, indicate that veins initially formed via conventional crack-seal mechanisms as in orogenic gold systems, but transitioned to a brittle deformation regime involving the brecciation of early, laminated quartz veins. Gold and pyrite were coevally precipitated during rapid boiling ("flashing") of low salinity (1–4 wt.% NaCl equiv.), CO_2-poor fluid, at temperatures of ~100–200°C at Maisie, and ~140–250°C at Lavoie. Isotope data (Sr-O-C-S) suggest that the sedimentary host rock had a major compositional influence on fluid chemistry. However, pyrite chemistry indicates two stages of gold enrichment: (1) early, low-grade stage where Au correlates with Zn-Sn-Ag-Cu enrichment, and (2) later, higher-grade stage marked by As-Ag-Bi-Pb-Te-Sb enrichment. Sulphides in the host sedimentary rocks show enrichment in only the earlier metal assemblage. Combined with evidence for locally very high temperatures (400–≥500°C) along vein structures prior to any quartz deposition, the pyrite data suggest magmatic-epithermal fluid involvement.

At Maisie, ID-TIMS U–Pb geochronology of inherited magmatic zircon enclosed in quartz veins yielded an age of 370.03 ± 0.20 (n = 2) Ma. For comparison, a porphyry dike (immediately adjacent to the Maisie veining) gave ages of 367 ± 0.11 Ma (n = 5) and 368.15 ± 0.11 Ma (n = 1) for two zircon populations.

The results provide a maximum age constraint (Late Devonian) for gold mineralization and potentially links the most productive period of gold mineralization to a late fluid of magmatic-epithermal affinity, or some other exotic source rock.

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