An integrated structural, fluid inclusion, and stable isotope study of auriferous veins, The Ovens, southern Nova Scotia

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The Ovens area of southern Nova Scotia is underlain by interbedded slate and sandstone of the Meguma Group that were metamorphosed and deformed during the Acadian Orogeny. Rocks outcrop in the hinge zone of a northeast-trending anticline (chevron) and are cut by numerous auriferous quartz veins. Structural analysis of bedding-concordant and -discordant vein types indicates emplacement late in the deformation history during flexural-slip folding. Mutually cross-cutting relationships of the veins suggest synchronous emplacement of all vein types.

Quartz vein material collected from all vein types was examined for fluid inclusions. Results of a petrographic study indicate that inclusions are of secondary and pseudo-secondary origin and record fluid migration during vein formation and subsequent deformation. The presence of abundant imploded inclusions in scheelite and, more rarely, in quartz reflects fluid over-pressuring synchronous with vein emplacement. Petrography combined with thermometric measurements indicate the following inclusion types: (1) L_{H2O}-V with 4–19 wt. % eq. NaCl and minor amounts of dissolved carbonic species; (2) L_{H2O}-V-Halite with 30–36 wt. % NaCl; (3) carbonic CH_4- and CO_2-rich types with the latter characterized by very high densities; (4) H_2O-CO_2 with minor CH_4 and 5–10 wt. % NaCl. Isochoric projections combined with homogenization temperatures indicate a potentially large range in entrapment temperatures and/or ambient fluid pressure.

Analysis of 17 quartz vein samples from all structural

settings for $\delta^{18}O$ indicate uniform results (avg. = 15.2 ± 0.5‰), implying similar temperature for veins. These data also suggest a uniform fluid reservoir with $\delta^{18}O_{H2O}$ values of 11.2 to 10.0‰, for vein formation temperatures of 400° to 350°C, respectively.

Collectively the structural, fluid inclusion, and stable isotope data suggest the following. (1) Quartz veins formed synchronously late in the folding history of the area from a fluid of uniform temperature and $\delta^{18}O_{H2O}$ value. (2) Fluid inclusion isochores imply a large variation in fluid pressure (i.e., 0.5 to 5 kbar) during vein formation. The large variation in fluid pressure may have influenced episodic flexural-slip fold growth, which is supported by mutually cross-cutting vein types. (3) Variation in the nature of the fluid chemistry may relate to interaction of a saline fluid at variable fluid pressures with graphite-bearing wall rock, thereby generating a fluid with varying CO_2:CH_4 as a function of fO_2. Alternative models involving multiple episodes of vein formation would require the fortuitous coincidence of quartz deposition from fluids of varying temperature and appropriate $\delta^{18}O_{H2O}$ values, which is considered unlikely.