Fluid-inclusion thermometric and stable isotope data constraints on the occurrence of quartz-carbonate-copper sulphide vein/fracture infill in the Caledonian Highlands, New Brunswick

F.M. Tweedale and J.J. Hanley

Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3

Outcrops of quartz-carbonate-copper sulphide-bearing veins cutting Neoproterozoic Broad River Group (BRG) metavolcanic and metasedimentary rocks occur along the Bay of Fundy coast in southern New Brunswick, approximately 75 km northeast of Saint John. The source of the vein/fracture fluid(s) is unknown. However, a single quartz grain (~0.5 cm × ~0.5 cm) in a vein sample collected within 100 m vicinity of the abandoned Vernon Mine site (NTS 21H/11E), contains hundreds of primary, two-phase (liquid + vapour) fluid inclusions (FI), the isotope and element compositions of which are theoretically equilibrated with the parent fluid. Only FIs with a clearly visible, uncompromised vapour bubble were analysed (n = 81). Qualitative microthermometric data, including homogenization temperature, melting temperature, freezing temperature (T^{ICE}), and salt content (wt. % NaCl), provides temperature constraint of minimum trapping conditions. This constraint may be extrapolated into PT-space along isochores superimposed on the melting curve for the two-component H_2O – NaCl system. Collectively, δO^{18}_{SMOW} and δC^{13}_{PDB} data, including δO18 of vein quartz and carbonate (13.7–15.1 ‰), and δC^{13} of two distinct phases of calcite (4.4–4.6 ‰), provide a qualitative pressure correction for the isochore PT field (250–275°C and 700–2000 bar). Applying the Clayton and Matsuhisa equilibrium equations to $\delta O^{18}_{mineral}$ data constrains δO^{18}_{fluid} composition to 6.1–7.3 ‰. T^{ICE} values as low as -38 °C, well below the eutectic temperature for H_2O – NaCl system (-21.1 °C), suggest a more complex fluid composition than that inferred from microthermometry, and for which future LA-ICPMS analysis will provide better constraint. At present, preliminary inferences regarding the origin of the Qtz-Cal-Cc vein/fracture infill from the Caledonian Highlands include: (1) spatial distribution of FIs in a small (< 1 cm^2 plane area) quartz grain permits the organization of 81 analysed FIs into four fluid inclusions assemblages (FIA), which invokes a multiple-reservoir fluid origin; (2) salinity variability within each FIA suggests temporal evolution of a magmatic brine, or the introduction of an exotic fluid; (3) qualitative microthermometric analysis suggests vein crystallization occurred at relatively low PT conditions, invoking the potential for magmatic-meteoric fluid interaction; (4) petrographic investigation may determine if sulphide deposition was coeval with, or post, quartz-carbonate mineralization.

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