Geochemical parameters constraining mineralization within an IOCG metallogenic domain: Case studies at the Mt. Thom and Copper Lake Cu-(Co-Au-Ni) deposits, Nova Scotia

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The Cobequid-Chedabucto Fault Zone (CCFZ) separates two major tectonic elements of Nova Scotia, the Meguma and Avalon terranes. Near this fault are numerous occurrences of Fe-oxide, Fe-carbonate, barite, sulphides (Fe, Cu, Ni, Co), and Au in variably veined and altered metasedimentary rocks of Late Devonian-Carboniferous age. The most prominent mineralization is at the past-producing Londonderry (LDR; Fe), Copper Lake (CPL; Cu-Au) and Brookfield (BRK; Ba) deposits. Significant Cu-(Co-Ni-Au) mineralization is present at Mt. Thom (MT). Also near the CCFZ are ca. 325–330 Ma ($^{40}Ar/^{39}Ar$) basic-felsic intrusions, similar in age to the 320 Ma age (Re-Os; $^{40}Ar/^{39}Ar$) for mineralization at CPL. At MT mineralization is in fault-breccia zones in a fine-grained, chemically evolved, graphic- and granophyric-textured, 330 Ma ($^{40}Ar/^{39}Ar$) leucogranite and in pervasively altered metasiltstone. Veins are dominated by Fe-carbonate, specularite and minor quartz, along with Cu-Fe sulphides. At CPL, mineralization occurs as siderite-sulphide (Py-Cpy) ± quartz veins in dark, variably altered metasiltstone that is locally sulphidic; no magmatic activity has yet been implicated for this mineralization. EMPA analyses and imaging, together with whole-rock geochemistry on samples from MT and CPL, indicate pervasive development of alteration on a microscopic scale, with quartz dissolution and variable development of Fe-Mg-Ca carbonates, Ab, Ms, and Chl with lesser Apt, Rt, Zr and REE phases; zones of Phl-Scp are present only at MT. The REE patterns for vein carbonates from LDR, MT and CPL settings are broadly similar and match previous data for BRK, but not data for local MVT Zn-Pb districts. The patterns are LREE-depleted, thus consistent with the presence of LREE-rich accessory phases that co-precipitated and depleted the fluid in LREE. Isotopic analyses (C, O, S, Sr) of vein carbonate, quartz and sulphide yield uniform results and, for mineral formation at 250 °C, indicate fluids with the following: $\delta^{18}O_{H2O}$ = +4 to +10‰, $\delta^{13}C_{H2CO3}$ = -5 to -10‰, $\delta^{34}S_{H2S}$ = -2 to +12‰ and Sr_i = 0.71 to 0.76. These isotopic signatures are distinct from fluids implicated in MVT mineralization (e.g., Gays River). Preliminary fluid inclusion data indicate that mineralizing fluids were of moderate to hypersaline composition and moderate temperature (200–

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250°C). Collectively, the data indicate that development of widespread Na-Ca ± K alteration and associated Cu-Fe-Ba-Co-Ni-Au enrichment of IOCG-type was coincident with high heat-flow owing to focussed magmatism near the CCFZ, and that movement along this fault probably facilitated infiltration of mineralizing fluids of mixed parentage.