Chronology and origin of cross-cutting vein systems: complex hydrothermal history of the Cobequid Fault Zone, Nova Scotia, Canada

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Intra-continental shear zones developed during continental collision are commonly sites of prolonged magmatism and mineralization. The Cobequid Fault Zone formed part of a NE–SW-trending orogen-parallel shear system in the late Devonian–early Carboniferous, where syn-tectonic granite-gabbro plutons were progressively deformed. In late Carboniferous to Permian, Alleghanian collision of Africa with Laurentia formed the E–W trending Minas Fault Zone, reactivating the Cobequid Fault Zone. The 50 Ma history of hydrothermal mineralization after pluton emplacement was investigated from cross-cutting relationships of veins in the Horton Group in the field and SEM and EMP study of thin sections. The general paragenesis is: albite ± quartz ± chlorite ± monazite → biotite → calcite, allanite, pyrite → Fe-carbonates, Fe-oxides, minor sulphides, calcite, and synchysite. Chronology was determined from literature reports and new U-Pb LA-ICPMS dating of monazite and allanite in veins. Monazite in quartz-chlorite veins cutting the Horton Group at West Advocate was dated 338.9 ± 4.1 Ma, a little older than ~334 Ma subvolcanic lamprophyre northeast of Parrsboro that includes magmatic allanite, calcite, and sulphides. Similar minerals, including monazite, are found in nearby veins. This monazite has two age modes: ~334 Ma and ~312 Ma, with a composite Concordia age of 320.2 ± 6.7 Ma. Allanite from veins in the same area yielded an intercept of 312 ± 6 Ma, but showed scatter reflecting its metamict character. Widespread veins of Fe-carbonates, magnetite, and sulphides (Fe, Cu, Zn) crosscut the monazite-bearing veins in both areas. Hydrothermal REE minerals in sedimentary host rocks are different from those in adjacent granite plutons, suggesting the importance of local derivation of REE and the role of fluorine in REE mobility.

The new data constrain timing of deformation and clarify palinspastic reconstruction of the fault system. Nd isotope determinations on Horton Group rocks constrain Meguma vs. Avalon sources of sediment. Vein mineralization occurred during basin inversion and shows less relationship with timing of magmatism. The sequence of mineralization, from ~355 Ma riebeckite and albite veins, through ~345 Ma potassic alteration, ~334 Ma calcite, monazite, and allanite, to ~327–305 Ma siderite-magnetite and sulphide mineralization, resembles iron-oxide–copper–gold (IOCG) systems in the literature. The system studied here resulted from volatiles derived from a deeply subducted slab with little terrigenous sediment, availability of mantle heat to melt the overlying metasomatized mantle, and strike-slip faulting that facilitated the rise of magmas, resulting in high heat flow driving an active hydrothermal system.

Atlantic Geology, 2017, Volume 53
Atlantic Geoscience Society Abstracts – 43rd Colloquium & Annual General Meeting 2017
doi: 10.4138/atlgeol.2017.006