Rare-earth-element variability in gangue mineralogy of Meguma-hosted auriferous quartz veins, Nova Scotia: possible consequence of unmixing of H_20-$C0_2$-NaCl-CH_4 fluids

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Auriferous quartz veins in the metaturbiditic Lower Paleozoic Meguma Group of southern Nova Scotia contain a diverse assemblage of gangue minerals. For example, in addition to quartz, native gold and sulphides there occurs plag, Kf, tour, carb, chl, bt, ms, gar, apatite, amph, epdt, sch and andalusite, albeit in highly variable quantities. Paragenetically an early stage of Ca-rich plag ($An_{30.70}$)-tour (sch_{50}.drv_{50})-bt (mg-0.50±0.05).gar ± sulphides is overprinted by a later hypogene assemblage of alb-ms-chl-sph-carb-sch ± sulphides (±Au). Stage 1 is constrained by garnet-biotite geothermometry at ca. 475°C, while the latter stage is considered to have formed at 300±50°C (O isotopes, fluid inclusions). Fluid inclusion studies indicate the vein-forming

fluid was a mixed H_20-$C0_2$-CH_4 ($XC0_2$-0.10±0.05) brine with 4.6 wt.% equivalent NaC1 (+Ca, K, Fe, Mg). Evidence of fluid unmixing is present in most specimens examined.

We have analyzed plag, chl, bt, apatite and carb from quartz veins in a variety of gold deposits for trace elements, including the REE's. Although major element chemistry of the minerals is remarkably uniform within a deposit, the trace-and RE-element chemistry is highly variable. For example, chondrite-normalized REE profiles (CNRP) for plag and ch1 from Beaver Dam show a 100 fold range with fractionation ($(La/Lu)_N$) minor (5-2) for plag but extreme (50-5) for ch1. Normalized values of other trace elements (Rb, Sr, Ba, Li, Pb, Y, Li, Ca) show <10 fold maximum variation that does not correlate with the CNRP's. Similarly, a large variation in CNRP's for carb from 9 deposits is observed with variable fractionation ($(La/Lu)_N$ = <1>) and chondritic abundances (>10x) within and between deposits. Again, other trace elements do not show obvious correlations. However, we do note that coexisting vein phases (e.g., bt-plag) give comparable CNRP's indicating that locally equilibrium conditions prevailed between mineral phases and that the fluid was of uniform composition with respect to the REE's.

The CNRP's for the vein minerals contrast markedly with the shale-like CNRP for the Maguma Group host rocks, which remain constant regardless of intensity of alteration types (e.g., sulphide, phyllic, silicification). This variation of CNRP's between wall rock and vein minerals contrasts with what is generally observed in granite-hosted vein mineralization. For example, vein (alb, triplite, clay) and greisen (ms) minerals at the East Kemptville tin deposit mimict closely the CNRP of the host leucogranite.

Possible explanations for the observed variability of the CNRP's of the gangue minerals in the gold veins include: (1) variable mixing of two (or more) fluids with contrasting absolute REE contents; (2) variable contamination of wall rock by a single, homogeneous (with respect to REE's) fluid; and (3) unmixing of the ore-forming fluid due to H_20-$C0_2$ immiscibility. The third possibility is considered the most viable considering the known temperature constraints for the mineral paragenesis, uniform isotopic (O, C, S) compositions of vein minerals, fluid inclusion thermometric measurements and leachate analyses, and constant CNRP's for fresh and altered wall rocks. In addition, the experimental and empirical observations that LREE's and HREE's are preferentially partitioned by Cl and $C0_2$ complexes, respectively, would be consistent with the observations noted above.