Direct constraints on "fluid" metal content and source responsible for the formation of polymetallic Ni-Co-As-Ag-Sb-Bi ± U deposits in the Northwest Territories

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The current TGI-5- and GNWT-funded research projects in the Ore Fluids Laboratory at Saint Mary's University (Halifax) are focusing on the origin of polymetallic, uranium-bearing "five-metals" type hydrothermal vein systems in the NWT. Occurences in the East Arm of Great Slave Lake (e.g., Copper Pass, Blanchet Island) are very low in grade and tonnage at their surface expressions and lack productive U and Ag ore stages, even though they have similar paragenetic characteristics to former world-class deposits at Great Bear Lake (Eldorado-Echo Bay, Contact Lake, Terra-Norex, Silverbear, Normin). A variety of microanalytical methods (CL, SEM, fluid inclusion microthermometry, SIMS, LA-ICPMS) are being used to revise the current model for this deposit style, specifically with respect to metal sources, precipitation mechanisms, and reasons for variability in metal tenor at a regional scale. Preliminary research has focused on characterizing the onset of U and Ni-Co-As co-precipitation. Fluid salinity (~20-30 wt% $CaCl_2$ eq.) and entrapment conditions (< 0.5 kbar and 200°C) varied little with time during vein formation, however, "fluid" $\delta^{18}O$ increased by >15‰ at the onset of U-Ni-Co-As mineralization. Fluid inclusions in mineralized quartz-carbonate veins are enriched in Ca-Sr-Ba-Mn-Pb-Zn but contain only sub-ppm concentrations of ore metals. Coeval bitumen (now solid hydrocarbon) inclusions, in contrast, are metal enriched, containing wt% concentrations of U-Ni-Co-Bi-Ag-Sb-As-Mo-Cu. Integration of all data types strongly suggests that the precipitation of metals and bitumen was triggered by isothermal mixing of basement (metal-poor) and ^{18}O-rich basinal-type brines that were transporting metal-rich bitumen colloids or oil droplets. Oxidation of this hydrocarbon phase then resulted in metal precipitation. The basinal brines and associated metal-rich bitumen are thought to be derived from former overlying outliers of the Athabasca-Thelon sedimentary basins that now only outcrop ~300-1000 km E and SE of the study areas. Co-precipitation of metals and bitumen highlight the role of hydrocarbons in transporting U and other metals in these polymetallic veins systems. Importantly, high grade polymetallic vein systems in the Eastern Arm of Great Slave Lake, at Great Bear Lake and in other localities (e.g., Cobalt, Thunder Bay districts) may be linked to the metal budgets of previously overlying sedimentary basins rather than the basement rocks in which the deposits are hosted.