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A Revised Model for High Grade Ni-Co-As-Ag-U-Sb-Bi Deposits: The Product of Heating and Oxidation of Marine Evaporite Brines and Hydrocarbons from Intracratonic Basins

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High-grade, polymetallic, “five-metals” type hydrothermal vein systems represent historically important sources of silver and uranium (e.g., Cobalt, Ontario, Canada: ~460 Moz Ag; Eldorado deposit, Northwest Territories, Canada: ~13 Moz Ag; 6,000 t U_3O_8) but are now repositioned as a revelant target for exploration programs focused on a much wider variety of critical metals necessary for the transition to a post-carbon economy. In the Northwest Territories of Canada, deposits of this classification formed in the Proterozoic show widely contrasting grade and tonnage characteristics. A 5-year study revisiting these deposits and applying a variety of microanalytical methods (e.g., fluid inclusion microthermometry, stable O isotope analysis of vein minerals by SIMS, single fluid inclusion analysis by LA-ICPMS and Raman spectroscopy) leads to four key revisions to the genetic model: (i) the onset of mineralisation involved mixing and oxidation of heated, immiscible hydrocarbon fluid and marine evaporite brine introduced into structures within crystalline basement; (ii) whereas basement fluids (ancient groundwaters) and basinal brines contained only sub-ppm concentrations of ore metals, hydrocarbons were highly enriched (10s to 1000s ppm) in all relevant ore metals in this association; (iii) brines and metal-rich hydrocarbons were sourced from black shale units in former overlying intracratonic basins (e.g., Hornby Bay, Thelon, Athabasca); and (iv) fluid inclusion chemistry differentiates small, poorly-mineralized deposits that formed deeper in the basement rocks, farther from overlying sedimentary metal sources from shallower, much larger deposits that formed immediately below mature, thick basin sequences. Importantly, while basement magmatic activity may serve as a heat source driving fluid circulation, the metal endowment of this deposit style appears to be linked to only the protracted metallogenic evolution of overlying intracratonic sedimentary basins. Fluid chemistry may be used as an exploration criteria in other examples of this mineralization-style globally to differentiate between productive and unproductive "five-element" systems.