Tracing seawater evaporation and evaporite formation in the Zambian Copperbelt; evidence from fluid inclusion, crush-leach halogen and stable isotope analyses

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The Central African Copperbelt is the world's largest sediment-hosted stratiform copper deposit district, preserving regional and basinal-scale evidence of fluid flow. Investigation of vein samples from eight deposits identified vein generations formed throughout the evolution of the basin. Microthermomentric studies show that the paleofluids preserved in copper deposits were chemically complex brines with salinities between ~14 to 39 wt% NaCl equivalent, frequently containing trace amounts of CO_2. Total homogenisation generally occurred via halite dissolution at temperatures >200°C.

Analysis of fluid inclusion leachates revealed two distinct sources of salinity. Samples with Cl/Br <658, suggest salinity developed from residual fluids formed by evaporation of seawater beyond the halite precipitation point (bittern brines). Samples with Cl/Br >658 indicate a fluid with a component of salinity supplied by the dissolution of halite from evaporite sequences. Samples from pre kinematic veins show Cl/Br < 658, in contrast, post kinematic veins typically show Cl/Br > 658. δ18O values of vein quartz and carbonate vary between +7 to +26 ‰ (VSMOW), with δ^{18}OFluid from ~-1.5 to +11.5‰, indicating some equilibration and buffering by country rocks. δ^{13}C in carbonate samples varies between -1.5 to -19 ‰ (V-PDB). δD values from fluid inclusions are highly variable, and generally isotopically low -116.6 to -16.9 ‰ relative to VSMOW.

These data suggests that there is a temporal control over the sources of salinity within fluids, with initial basinal fluids comprising bittern brines formed after deposition of evaporite sequences, followed by a shift towards fluids dominated by the dissolution of halite, probably during basin inversion and orogenesis.