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# Mercury distribution and partitioning in Archean gold systems: Constraints on hydrothermal processes and Hg mobilization

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Mercury (Hg) is a highly volatile, chalcophile element and a sensitive tracer of fluid pathways, metal transport mechanisms, and metal enrichment processes within the Earth's crust. Despite its potential as a tracer, the mineralogical hosts and redistribution mechanisms of Hg in Archean mineralized systems remain poorly constrained. Understanding how Hg partitions between fluids and minerals during ore formation is critical for evaluating its behavior in sulfide-rich crustal environments and its relationship with gold precipitation.

This study investigates Hg distribution across mineralized systems in the Abitibi and Pontiac subprovinces (Superior Province, Canada), including volcanogenic massive sulfide (VMS), orogenic gold, and intrusion-related/skarn systems. We employ a multi-scale analytical approach combining direct mercury analysis (DMA), step-heating experiments (300–900°C), whole-rock geochemistry, and in situ mineral-scale characterization (EPMA).

Preliminary results indicate that vein quartz and silicate-dominated lithologies are below detection limits (<0.01–0.1 ppb Hg), demonstrating that silicate phases are not significant Hg reservoirs during fluid-rock interaction. In contrast, sulfide-rich lithologies host the bulk of the Hg budget. Thermal release profiles show dominant Hg liberation between 300 and 500°C, consistent with incorporation within common sulfide phases (e.g., pyrite, pyrrhotite, and sphalerite) rather than discrete Hg minerals. In Te-rich samples, correlations between Hg, Te, and Cu suggest that Hg partitioning is influenced by Te-bearing mineral assemblages. These observations are consistent with partial sequestration of Hg into Te-rich phases, including discrete Hg–Te minerals, reflecting a modification of Hg host preference under Te-enriched conditions. Temperature-resolved release patterns reveal deposit-specific signatures, indicating multiple Hg reservoirs and highlighting the influence of mineral assemblage and fluid composition on Hg partitioning.

These observations suggest that in Archean ore systems, Hg behavior is governed by sulfide abundance and fluid-driven mobilization rather than independent Hg mineral saturation. The observed variability between VMS and orogenic gold systems highlights how different hydrothermal regimes and host-rock compositions influence Hg partitioning and its distribution within auriferous mineral assemblages. Ongoing EPMA and Hg isotope analyses will further constrain micro-scale partitioning and sources of Hg, refining our understanding of Hg mobilization in Archean crustal hydrothermal systems and its relationship to gold-bearing mineralization.