

Mercury Distribution and Mineral Hosts in Archean Gold Systems: Insights From the Abitibi and Pontiac Subprovinces

Florent L. Bigot¹, Stéphane De Souza¹, Michel Jébrak¹, Olivier Côté-Mantha², Patrick Mercier-Langevin²

¹Université Du Québec À Montréal, Montreal, Canada, ²Agnico Eagle Mines Limited, Val-d'Or, Canada

Mercury (Hg) is a volatile pathfinder element with untapped potential in gold exploration, yet its mineralogical hosts and behavior within Archean hydrothermal systems remain poorly constrained. Understanding how Hg partitions during ore formation is essential for reconstructing fluid pathways and metal deposition processes in gold-bearing systems. This study investigates Hg distribution across several mineralized environments in the Abitibi and Pontiac subprovinces (Canada), including orogenic gold, volcanogenic massive sulfide (VMS), and intrusion-related/skarn systems.

We combine direct mercury analysis (DMA), step-heating experiments (300–900°C), whole-rock geochemistry, and electron probe microanalysis (EPMA). High-precision DMA reveals that most host rocks and many mineralized samples contain extremely low Hg concentrations, typically in the low-ppb range, defining a very low regional geochemical background. Several investigated orogenic gold deposits, including Belleterre (Pontiac) and Goldex (Val-d'Or), display particularly low Hg contents approaching background levels even in mineralized rocks. In contrast, other Val-d'Or orogenic gold deposits (Triangle and Ormaque) locally exhibit higher Hg concentrations. Across most analyzed samples, Hg concentrations show no clear systematic relationship with Au grade.

In orogenic gold deposits, vein quartz and silicates are systematically Hg-poor (<0.01–0.1 ppb), confirming they do not represent significant Hg reservoirs. Instead, across all studied systems, sulfide-rich lithologies host the majority of the Hg budget. Step-heating experiments show dominant Hg release between 300 and 500°C, suggesting Hg is primarily structurally incorporated within common sulfides such as pyrite, pyrrhotite, and sphalerite rather than forming discrete Hg minerals.

In Te-rich samples, strong correlations between Hg, Te, and Cu suggest a shift toward telluride-associated Hg. Distinct thermal release patterns between VMS and orogenic gold deposit samples indicate that Hg partitioning is strongly influenced by hydrothermal fluid evolution and mineral assemblages. Ongoing EPMA and Hg isotope analyses will further constrain Hg hosts, metal sources, and the potential use of Hg as an exploration tool.