Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36523

Evaluation of a magmatic fluid contribution to the unusual Te-enrichment of volcanogenic massive sulfides in the Matagami district, Québec, Canada

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Volcanogenic Massive Sulfides (VMS) deposits provide sources of base metals (Cu, Zn, Pb), in certain cases precious metals (Au, Ag) and can be enriched in semi-volatile trace elements (e.g., Te, Bi, Sb, Se, Sn and Tl). The principal source of metals is a high-temperature reaction zone, where metals are leached from volcano-sedimentary sequences by seawater-derived fluids in an extensive submarine setting. However, the contribution of metal-rich magmatic fluids, derived from underlying synvolcanic intrusions, is debated. To evaluate the relative contributions of these sources, geochemical tools such as trace element and isotopic compositions (S and Pb) of sulfides can be employed. Recently, trace element chemistry of sulfides, particularly pyrite (such as Te, Sb, As), has been recognized as a sensitive tracer of magmatic input in submarine subduction-related hydrothermal systems.

The 2.7 Ga Matagami mining camp, Abitibi, Canada, represents an important Zn-rich VMS district comprising 19 deposits and prospects, including 13 past producers. Most deposits are spatially associated with 1) the synvolcanic mafic layered intrusion of the Bell River Complex, which is widely interpreted as the primary thermal engine driving VMS formation in the Matagami camp and 2) the Key Tuffite, an interpreted exhalative horizon. However, within this district, VMS deposits display a wide range of geometries formed either through exhalative processes that produced sulfide mounds or through subseafloor replacement. Nevertheless, several deposits at Matagami exhibit geological features that could be linked to a contribution of magmatic fluids, such as extensive magnetite replacement of the massive sulfides, the abundance of talc alteration, and the high concentration of Te associated with Altaite (PbTe) or Mattagamite ($CoTe_2$). The important Te enrichments in certain deposits, in contrast with other Te-depleted deposits, may imply variable degrees of magmatic contribution across the Matagami camp. In this context, we apply the trace element chemistry of sulfides to better constrain the potential input of magmatic fluids into the Matagami VMS deposits and assess how this contribution may account for the differences observed in Te enrichment among the deposits.