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Orogenic Gold Bonanza Linked to Recycling of Oceanic Exhalative Systems

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As their name implies, orogenic gold deposits are formed in convergent tectonic margins, whereby deformation, metamorphism, fluid migration, and magmatism shape the architecture of the crust. The interaction between crust, mantle, and hydrosphere has hampered our understanding of the fluid and metal sources involved in the genesis of this deposits. However, Mass Independence Fractionation (MIF) and trace elements in pyrite can fingerprint the signature of hydrothermal fluids in Archean deposits. We focus on the $\Delta^{33}S$ and trace element signature of pyrite of the Golden Mile deposit and compare it with the current multiple S isotope data generated from orogenic gold deposits in the Yilgarn Craton of Western Australia. Overwhelmingly, most orogenic gold deposits display small $\Delta^{33}S$ values (~0.2‰), which are consistent with mixing of a minute portion of sedimentary sources ($\Delta^{33}S$ ~ up to 8.0‰) with a dominant contribution of S from the mantle ($\Delta^{33}S$ ~ 0‰). However, pyrite from the high-grade Oroya style (>120 g/t Au and Te), documented in the Golden Mile deposit, display negative sulfur isotope signatures ($\Delta^{33}S$ ~ -0.9‰) and anomalous Au and Te concentrations (up to ~37 and ~182 ppm). Since Au is primarily transported by S complexes (e.g., S_3^- and HS^-) and associated with Te in a number of auriferous ores worldwide, we conclude the three elements were ultimately derived from the same fluid source. We reconcile the signature recorded by $\Delta^{33}S$ values and the Au and Te enrichment in Oroya pyrite with a specific episode of mineralization, whereby fluids and metals were sourced from a VMS system and volatilized via interaction with the metasomatized mantle in a subduction zone.