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Formation and preservation of ultramafic-hosted seafloor massive sulfide deposits: Insights from the Gygra deposit, Knipovich Ridge

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The Gygra deposit (77.43°N, 7.71°E, ~2700 m water depth), discovered in December 2024 during the UiB–UiT–SODIR expedition, represents an extinct seafloor massive sulfide (eSMS) type of mineralization. It is currently the only known eSMS deposit along the Knipovich Ridge and is located approximately 1 km south of the active Jøtul vent field [1, 2]. With an average Cu grade of ~9.7 wt.%, the Gygra deposit is the most copper-rich eSMS deposit documented worldwide to date. Copper shows a statistically significant positive correlation with a range of chalcophile elements, including Zn, Bi, Co, As, Ag, In, Sn, Te, and Cd.

The deposit is localized along the eastern bounding fault of the rift valley and is spatially distinct from the axial volcanic ridge (AVR), demonstrating that hydrothermal circulation and sulfide deposition were structurally controlled rather than directly linked to axial magmatism. The massive sulfide mineralization is emplaced within strongly hydrothermally altered ultramafic rocks and is overlain by fresh basaltic lava flows and a cover of continent-derived sediments, reflecting post-mineralization volcanic and sedimentary processes. The mineral assemblage is dominated by chalcopyrite, bornite, pyrite, pyrrhotite, and quartz, consistent with high-temperature, Cu-rich hydrothermal conditions and limited subsequent oxidative overprinting.

Fluid inclusion microthermometry indicates that ore-forming fluids reached temperatures of up to 350 °C and salinities exceeding 5 wt.% NaCl equivalent. The inclusions show uniform degrees of fill, consistent with entrapment from a single-phase fluid. Raman spectroscopic analyses reveal the presence of CO_2 and hydrocarbons, including CH_4.

The high buffering capacity of ultramafic host rocks, combined with low redox conditions sustained by ongoing serpentinization, inhibits sulfide dissolution and oxidation. These conditions play a critical role in the preservation of ultramafic-hosted seafloor massive sulfide mineralization during the extinct stage.

References:

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