Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24428

Reconsidering The Role of Gabbro in Generating Ultramafic-Hosted Seafloor Vent Fluids

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“Ultramafic-hosted” or “ultramafic-influenced” seafloor hydrothermal systems associated with oceanic core complexes exhibit diverse vent fluid chemistry, ranging from the alkaline, Fe-poor vent fluids of Lost City Hydrothermal Field on the Atlantis Massif to the highly acidic, Fe-rich vent fluids of Rainbow Vent Field on the Rainbow Massif. Compared to basalt-hosted systems, vent fluids at both sites are rich in molecular hydrogen and methane and poor in silica- and sulfide.

Despite their divergent temperature, pH, and metal concentrations, vent fluids at both Rainbow and Lost City have been attributed to hydrothermal alteration of tectonically uplifted mantle peridotite, with pyroxene hydrolysis reactions producing acidic fluids at high temperatures and olivine hydrolysis reactions producing alkaline vent fluids at lower temperatures. However, extensive oceanic drilling of the Atlantis Massif, and seismic surveys of both the Rainbow and Atlantis Massif, reveal mixed seafloor lithology comprising variably serpentinized peridotite and hydrothermally altered gabbro. Furthermore, detailed studies of vent fluids collected from both sites have long indicated that gabbro, as well as peridotite, contributes to vent fluid chemistry and heat budgets.

Here, we present recently acquired isotopic and chemical data of Lost City vent fluids and thermodynamic calculations pertaining to both vent fields to reconsider the role of mafic components, plagioclase and clinopyroxene, in generating observed vent fluid chemistry. Fundamentally, we consider whether such vent fluids could arise from olivine-rich mafic rocks, gabbro or basalt. The answer to this question has implications for estimating the prevalence of such ultramafic-hosted vent systems on the modern seafloor and for considering the importance of such systems for hydrothermal fluxes of biologically important trace metals and other components early in Earth’s history, when higher mantle potential temperatures are proposed to have produced more Mg-rich (olivine normative) oceanic crust, but likely inhibited tectonic exposure of mantle peridotite along oceanic spreading centers.