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Gabbro-dominated basement at high-temperature ultramafic-hosted hydrothermal systems: insights from Onnuri vent field, Central Indian Ridge

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The composition of hydrothermal fluid in high-temperature (>200°C) ultramafic-hosted systems is strongly influenced by seawater interaction with basement rocks. The widely accepted "plum-pudding" model envisions the basement of these systems as small (<1 km²) gabbro intrusions ("plums") within peridotite-dominated matrix ("pudding"). However, direct petrological evidence supporting this model remains scarce due to limited accessibility to deep sections in these systems.

The Onnuri Oceanic Core Complex (OCC), located at 11°25'S on the Central Indian Ridge (CIR), provides a rare glimpse into the internal structure of a high-temperature ultramafic-hosted hydrothermal system, exposing its deep interior (up to 1,100 meters) along two extensive slopes. We conducted a comprehensive exploration of the Onnuri OCC, including dredging along the detachment fault surface and rock sampling via remotely operated vehicle (ROV) along the detachment fault and both the northeastern and southeastern slopes. Our findings reveal a significant lithological difference between the detachment fault surface and the steep slopes. The former is dominated by ultramafic rocks and diabase with minor gabbro, while the latter is composed primarily of gabbro with minor diabase and basalt. These results suggest a core-carapace structure for Onnuri, characterized by a gabbroic core overlain by a thin ultramafic carapace. This structure contrasts sharply with the "plum-pudding" model, which assumes limited volumes of gabbro, challenging its applicability as the dominant basement model for high-temperature ultramafic-hosted systems.

The zero-magnesium endmember composition of hydrothermal fluids from Onnuri supports a mafic-ultramafic hybrid reaction zone. Elevated hydrogen concentrations indicate active serpentinization, while moderately elevated CO_2 suggests a magmatic gas contribution. Dissolved silica and hydrogen concentrations are consistent with chlorite-magnetite-talc-fluid equilibria, indicating interaction with both olivine and plagioclase. Additionally, high K and Li concentrations point to reactions with mafic/gabbroic source rocks. The compositional similarity between Onnuri vent fluids and other ultramafic-hosted high-temperature systems, along with seismic evidence of gabbroic cores beneath similar systems, suggests that gabbro plays a significant role in shaping fluid chemistry in these environments.