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Volatile Geochemistry of hydrothermal vent plumes over the Central Indian Ridge, 9°44'-15°33'S

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The Korea Institute of Ocean Science & Technology (KIOST) conducted a research expedition aboard the R/V ISABU in 2023, during which hydrothermal fluids were sampled from segments 2 to 5 of Central Indian Ridge (CIR), spanning from 9°44'S to 15°33'S. This study presents the concentrations and isotopic compositions of dissolved gases (e.g., H_2, He, CH_4, and CO_2) in the hydrothermal fluid samples collected from eight vent fields. Helium isotope analyses ($^3He/^4He$ = 1.17 to 10.23 Ra, where 1 Ra = 1.4 x 10^{-6}) indicate distinct mantle sources, with plume-derived helium in segments 2 and 3 and upper mantle contributions in segments 4 and 5. The inverse relationship between $^3He/^4He$ ratios and seismic S-wave velocity anomalies (dVs; -3.47 to -2.91%) beneath the region provides additional evidence for mantle heterogeneity. The $\delta^{13}C$-CO_2 values ranging from -13.5 to -7.4‰ (vs. V-PDB) suggest the CO_2 contributions from the mantle. Elevated H_2 (1 to 86 mol.%) and CH_4 concentrations (0.3 to 4.5 mol.%) in some hydrothermal fluid samples, along with $\delta^{13}C$-CH_4 (-21.6 to -8.1‰) and δD-CH_4 (-196.0 to -87.0‰) values, point to an abiotic formation process similar to that observed at Mid-Atlantic Ridge (MAR). This implies that reductive hydrothermal conditions in the CIR could play a crucial role in generating H_2 and CH_4. Our results suggest that mantle-derived volatiles and thermal energy could drive hydrothermal reactions within the oceanic lithosphere, facilitating seawater-crust-mantle interactions that promote H_2 production, with potential relevance for future resource exploration.