

Sulfur cycling at the Kermadec Arc revealed by sulfur isotopes

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The sulfur isotopic composition of dissolved sulfide and sulfate from hydrothermal vents depends on the origin of sulfur (seawater, rocks, magmatic sulfur) and different processes of sulfur cycling (thermochemical sulfate reduction, water/rock-interaction, SO₂ disproportionation, microbial sulfur cycling). A large range in sulfur isotopes reflect this variability, with distinct differences existing for vent systems at intraoceanic arc volcanoes compared to mid-ocean ridges.

Hydrothermal fluids collected during cruise SO253 at different submarine volcanoes along the Kermadec Arc display a high variability in $\delta^{34}\text{S}$ for sulfide (from -8.0 to 4.5‰) and sulfate (between 16.7 and 24.7‰). $\Delta^{33}\text{S}$ values for all sites range from -0.037 to 0.007‰ for sulfide, and between -0.013 and 0.020‰ for sulfate. The occurrence of sulfate in fluid samples from Brothers (upper and lower cone) and Macauley and the significant deviation of their $\delta^{34}\text{S}$ value from seawater (21.0‰) indicates SO₂ disproportionation and thus reveals a contribution of magmatic gases in addition to thermochemical sulfate reduction. The much lighter isotopic composition at Brothers (lower cone) compared to Brothers (upper cone) and Macauley may result from a different sulfur isotopic composition of the magmatic gases. In contrast, $\delta^{34}\text{S}$ values from -3.1 to 4.5 ‰ for sulfide and the absence of sulfate in fluids from Haungaroa and Brothers (caldera) reflect solely thermochemical sulfate reduction. Largely negative $\Delta^{33}\text{S}$ values for both sulfide and sulfate indicate that microbial sulfur cycling is not influencing the sulfur isotopic composition in these hydrothermal systems.

Results reveal a higher complexity in sulfur cycling at the Kermadec Arc volcanoes. Variable contributions of magmatic SO₂, thermochemical sulfate reduction and water/rock-interaction produce sulfur isotope pattern that are distinct for the different vent sites studied.