

Lithium isotopic behavior during water-rock interaction at high-temperature deduced from submarine hydrothermal systems

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The Li concentrations and its isotopic compositions ($\delta^7\text{Li}$) of submarine vent fluids are expected to be a good tracer for investigating hydrothermal systems deep under the seafloor because of significant differences in Li concentrations and $\delta^7\text{Li}$ values between seawater (0.026 mmol/kg and +31.0 ‰) and MORB (0.94 mmol/kg and +3.7 ‰). Although several geochemical studies on Li of vent fluids at MOR sites have been reported, there were no systematic data on $\delta^7\text{Li}$ values in hydrothermal systems at arc and back-arc basins with various geological settings compared to MOR. Therefore, we determined Li concentrations and its isotopic compositions of 11 end-member vent fluids from 5 arc/back-arc hydrothermal systems in the western Pacific to understand Li behavior during water-rock interaction at high-temperature and high-pressure situations in different geological settings.

In sediment-starved hydrothermal systems (e.g. Manus Basin, Izu-Bonin Arc, and Mariana Trough), based on the mass balance calculations, Li concentrations and $\delta^7\text{Li}$ values of end-member fluids were mainly dominated by seawater-rock interactions at high-temperature in an equilibrium state. There were small variations in Li due to host rocks, temperature-related partitioning of rock Li into fluid phase, and isotopic fractionation during incongruent formation and dissolution of secondary minerals. In phase-separated hydrothermal systems (e.g. North Fiji Basin), lower Li concentrations and similar $\delta^7\text{Li}$ values of vapor-rich end-member fluids indicated that the phase separation process caused depletion of Li in vapor phase with no isotopic fractionation. In sediment-hosted hydrothermal systems (e.g. Okinawa Trough), significantly-high Li concentrations and lower $\delta^7\text{Li}$ values of end-member fluids were predominantly-derived from marine sediments. Moreover, our mass balance calculation indicated that Li in sediment-hosted hydrothermal fluids were determined by Li in marine sediments and the degree of fluid-sediment interaction.