

Experimental quantification of K isotope fractionation during high-temperature basalt alteration at hydrothermal conditions

SOISIRI CHARIN¹, GUY N EVANS², WILLIAM E SEYFRIED JR.³ AND XIN-YUAN ZHENG³

¹University of MinnesotaT

²University of Minnesota

³University of Minnesota - Twin Cities

Presenting Author: chari018@umn.edu

The study of seafloor basalt alteration and its role in regulating ocean- and oceanic crust chemistry has the implication of understanding mass and heat exchange in mid-ocean ridge, mantle heterogeneity, nutrient cycles, and long-term stability of atmospheric CO₂ [1]. Ongoing research on stable K isotope ratios (⁴¹K) has shown great promise of this new isotope system in tracing hydrothermal process and associated geochemical reactions. Seawater ⁴¹K differs significantly from that of basalts by ~0.6‰, thereby marking stable K isotopes as a possible tool in assessing fluid-rock interactions which prevails in mid-ocean ridges [2]. Field and experimental studies have shown leaching of K from basalts at elevated temperatures. A recent study of high-temperature altered oceanic crust from the East Pacific Rise [3] reported a range of ⁴¹K values that hinted at significant K isotope fractionation. However, unequivocal constraints on the direction and magnitude of K isotope fractionation based on analyses of natural samples are challenging.

Here, we report results from three sets of high-temperature basalt alteration experiments at 350°C and 400°C and 500 bars. We analyzed K isotopes on both initial reactants (synthetic (Na,K)Cl and (Na,Ca)Cl fluids and unaltered EPR basalts) and post-reaction products. We discovered surprisingly large K isotope fractionation between reactant fluids and EPR basalt ($\Delta^{41}\text{K}_{\text{fluid-basalt}}$) as $-0.15 \pm 0.06\text{‰}$ (2SD) at 350°C and $-0.24 \pm 0.06\text{‰}$ (2SD) at 400°C (Fig 1). The K isotope ratios and chemical analyses collectively pointed to the leaching of K from basalts, associated with preferential release of lighter K isotopes (³⁹K) relative to the heavier ones (⁴¹K) into the fluid at 350°C and 400°C. Our results indicate that K isotope fractionation during high-temperature basalt alteration can be a viable mechanism that affects the potassium isotope composition of hydrothermal fluids.

[1] Wang et al., (2021), *Geochemistry*. 125786.

[2] Tuller-Ross et al., (2019), *Chem. Geol.* **525**, 37–45.

[3] Li et al., (2024), *Earth Planet. Sci.* **625**, 118448.

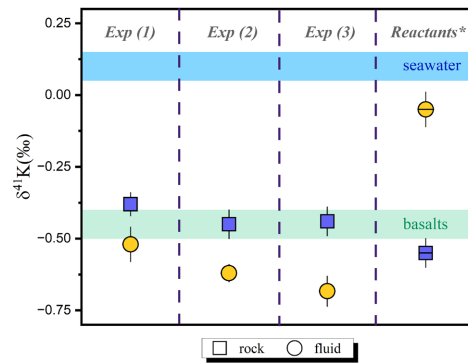


Fig.1 Charin et al., 2024 (unpublished manuscript)