

Lack of Mg isotope fractionation during magmatic differentiation in Kilauea Iki lava lake, Hawaii

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Magnesium (Mg) isotopes become a powerful tracer for crust-mantle interaction in the last decades. Whereas, it remains debated whether and how Mg isotopes fractionate during mantle partial melting and magma differentiation, which renders ambiguity for the explanation for the isotopic data of mantle derivatives. Here, we contribute to this puzzle by measuring the well-studied sample collection from the Kilauea Iki lava lake, Hawaii, with the critical mixture double spike technique. The lava lake samples with MgO ranging from 2.60 to 26.87 wt.%, yield a limited Mg isotopic variation from $-0.235 \pm 0.006\%$ (2 s.e.) to $-0.180 \pm 0.016\%$ (2 s.e.), with a mean of $-0.203 \pm 0.039\%$ (2 SD, N=10), which is not resolvable at the current long-term precision of $\pm 0.03\%$ (2 SD). Unlike the significant Mg isotope fractionation between olivine/clinopyroxene and melt recently reported [1,2], this study instead suggests negligible $\Delta^{26}\text{Mg}_{\text{Ol-melt}}$ and $\Delta^{26}\text{Mg}_{\text{Cpx-melt}}$: i.e., $0.019 \pm 0.039\%$ (95% c.i.) and $-0.023 \pm 0.011\%$ (95% c.i.) at $\sim 1,438\text{K}$, respectively. The differences in apparent $\Delta^{26}\text{Mg}_{\text{Ol-melt}}$ and $\Delta^{26}\text{Mg}_{\text{Cpx-melt}}$ estimated from different magma series may be related to kinetic effects during fast crystallization [3] as well as the site-specific effect of clinopyroxene [4]. As a Mg-rich mineral, fast olivine crystallization tends to enrich light Mg isotopes in this mineral [3,5]. Accordingly, the $\Delta^{26}\text{Mg}_{\text{Ol-melt}} \sim 0$ determined in this study is optimal representative of the equilibrium isotope fractionation factor. If this is indeed the case, our results suggest negligible Mg isotope fractionation during mantle peridotite melting and that alternative mechanisms (e.g., late overprint of Fe-Mg interdiffusion) are not required to explain the consistent Mg isotopic compositions between mantle peridotite and their derivatives (e.g., MORB).

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