

Thallium isotope fractionation during magma degassing: evidence from experiments and Kamchatka arc lavas

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Thallium (Tl) isotope ratios are an emerging tool that can be used to trace crustal recycling processes in arc lavas and ocean island basalts. Thallium is a highly volatile metal that is enriched in volcanic fumaroles [1], but it is unknown whether degassing of Tl from subaerial lavas has a significant effect on their residual Tl isotope compositions. Here we present Tl isotope and concentration data from degassing experiments that are best explained by Rayleigh kinetic isotope fractionation during Tl loss. Our data closely follow predicted isotope fractionation models in which TlCl is the primary degassed species and where Tl diffusion in the gas phase is the main factor controlling the magnitude of isotope fractionation [2]. We show that degassing into air should be associated with a net Tl isotope fractionation factor of $\alpha_{\text{net}} = 0.99967$. We also show that lavas from three volcanoes in the Kamchatka arc exhibit Tl isotope and concentration patterns that closely follow the experimental results, implying that degassing played an important role in the observed Tl isotope compositions in these three volcanoes. Literature inspection of Tl isotope data for subaerial lavas reveal that the majority of these appear largely unaffected by degassing, although a few samples from both ocean island basalts and arc volcanoes can be identified that likely experienced some Tl degassing coupled with Rayleigh isotope fractionation.

[1] Baker et al. (2009), *Geochim. Cosmochim. Acta* 73, 6340-635.

[2] Sossi et al. (2020), *Geochim. Cosmochim. Acta* 288, 316-340.