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Drivers of titanium isotope fractionation in magmatic series: A case study of Rindjani Volcano, Indonesia

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Titanium (Ti) stable isotopes are found to undergo mass-dependent fractionation during magmatic differentiation, driven primarily by the crystallization and removal of Fe-Ti oxides [i.e., 1,2]. Intriguingly, Ti isotopes appear to fractionate to different extents in different magmatic series compared to differentiation proxies like bulk SiO2. Suggested drivers of differential fractionation include a change in the melt chemistry of alkaline, tholeiitic, and calc-alkaline melts, which then drive variable bulk system Ti isotope evolution through changes in mineralogy and mineral-melt fractionation factors [3]. Central to this puzzle is understanding the fractionation factors between Fe-Ti oxides and silicate melt that drive bulk system evolution, where very little data exist.

Here we present Ti isotope measurements of a calc-alkaline differentiation suite and corresponding mineral separates from Rindjani Volcano, Indonesia. These data allow us to calculate mineral-melt fractionation factors at different stages of differentiation, as well as evaluate the major Ti removal mechanisms that drove Ti isotope evolution of the melt. We find melt-oxide fractionation factors to range from 0.33 to 0.55 permil at 980 to 900°C, similar to data from other magma series [i.e., 1,2]. We also calculate that the fraction of Ti removal accomplished by oxide crystallization (f_Tioxide) is significantly smaller here than in other magma series, due to the lower TiO2 abundance of the melt and corresponding oxides. Our findings suggest that calc-alkaline magmas experience muted Ti isotope fractionation not solely because the oxides fractionate Ti isotopes to a lesser degree, but also because the fraction of TiO2 removed by silicates (f_Tisilicates) becomes increasingly important to consider in low-Ti melts.

[1] Johnson et al. (2019) Titanium isotopic fractionation in Kilauea Iki lava lake driven by oxide crystallization. *GCA* 264, 180-190.

[2] Hoare et al. (2022) Empirical and Experimental Constraints on Fe-Ti Oxide-Melt Titanium Isotope Fractionation Factors. *GCA* in press.

[3] Hoare et al. (2020) Melt chemistry and redox conditions control titanium isotope fractionation during magmatic differentiation. *GCA* 282, 38-54.