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Iron isotope variations in Réunion hotspot mantle source

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The sensitivity of iron isotope fractionation to oxidative, thermal, and petrological conditions makes it an ideal tool to study the effects of shallow and deep differentiation processes. On Earth, Fe isotopes are known to be fractionated by late-stage processes such as fractional crystallization, which are well-documented by co-variations of δ56Fe (56Fe/54Fesample ÷ 56Fe/54Festandard * 1000 – 1000) and MgO (1). Réunion Island basalts and cumulate dunite xenoliths, in contrast, display no significant correlation between δ56Fe (-0.067 to 0.211‰ and MgO (11-41 wt.%). Compared with well-studied, highly magnesian Kilauea Iki lavas (1), which generally possess δ56Fe < 0.05‰ elevated δ56Fe is also observed in Réunion picrites with MgO > 20 wt.%. Réunion samples show a weak positive correlation between SiO_2 and δ56Fe and a weak negative correlation between $Fe2O_3$(T) and δ56Fe. However, the total range of these major element oxides amongst the sample set is relatively restricted at ∼10 wt.% and ∼5 wt.%, respectively.

We interpret the limited correlation of δ56Fe and MgO to represent the combined effects of fractional crystallization and variable δ56Fe in the Réunion hotspot source. Such variability combined with Fe isotope fractionation during shallow level differentiation may effectively decouple δ56Fe from typical major element proxies. While the cause of δ56Fe variability in the Réunion source cannot be elucidated by Fe isotopes alone, the Réunion hotspot is known to possess Hadean Nd isotope signatures and fractionated highly siderophile element patterns. Future efforts to investigate the siderophile element and isotope compositions of Réunion and other ocean islands may benefit from the combined use of non-traditional stable isotopes to discriminate between hypotheses regarding the ancient components of hotspots and mantle plumes.

(1) Zhong, F.-Z., Dauphas, N. & Helz, R.T. Iron isotope fractionation during magmatic differentiation in Kilauea Iki lava lake. Science 20, 1620-1622 (2008).