

Stable Mg isotope composition of Earth's mantle

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Magnesium has three stable isotopes (24, 25, 26) and is Earth's second most abundant lithophile element. The advent of MC-ICP-MS has allowed routine stable isotope analysis of Mg, yet no consensus exists on the isotopic homogeneity and composition of Earth's largest Mg reservoir, the mantle, which contains >99% of Earth's Mg [1, 2]. Moreover, it is uncertain whether the mantle and the magmas it produces have the same Mg isotope composition as chondrites and achondrites [3, 4]. For example, laser ablation MC-ICP-MS studies of mantle olivine [1, 2] have yielded conflicting results with one study measuring minimal isotopic variation [1], and another measuring large (2‰) variations in $\delta^{25}\text{Mg}$ [2] attributed to high-T mantle metasomatism and melt extraction. The Mg isotopic composition of Earth has been compared with meteoritic Mg in two recent studies [3, 4] also yielding contrasting results. In one case, Earth's mantle was shown to have non-chondritic Mg [3], yet a study of Hawaiian basalts did not discern a Mg isotopic difference as compared to chondritic Mg [4].

We have determined the Mg isotope composition of olivines from 20 mantle xenoliths from east Australia, west Antarctica, Jordan, Yemen and Greenland. The xenoliths include fertile lherzolites through to depleted harzburgites and 'dry' peridotites through to apatite±amphibole-harzburgites and wehrlites, and represent early Archaean to Permian lithospheric mantle. Mg isotopes were determined by pseudo-high-resolution MC-ICP-MS on Mg purified to >99% by a series of chemical extraction techniques. The olivines have $\delta^{25}\text{Mg}_{\text{DSM-3}} = -0.20$ to -0.09% with an external reproducibility of $\leq \pm 0.05\%$. The data indicate the mantle is homogeneous within analytical uncertainties, with no variations correlated with lithospheric age or location, or degree of mantle metasomatism or fertility. Furthermore, no stable Mg isotope differences between the peridotites and pallasite olivine or chondrites are resolvable.

[1] Norman *et al.* (2006) *Geophys. Res. Lett.* **33**, L15202, doi:10.1029/2006GL026446. [2] Pearson *et al.* (2006) *Chem. Geol.* **226**, 115-133. [3] Wiechert & Halliday (2007) *EPSL* **256**, 360-371. [4] Teng *et al.* (2007) *EPSL* **261**, 84-92.

Timescales of crustal assimilation at intra-oceanic arcs: U-series and geochemical constraints from Lopevi Volcano, Vanuatu, SW Pacific

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The extent and geochemical impact of crustal contamination during magmatic evolution in intra-oceanic subduction zone settings is assumed to be of minimal significance and is poorly constrained. However, acquiring such information is a first-order priority before meaningful timescales of magma generation and crustal residence beneath volcanoes can be determined.

Despite relatively homogeneous Sr-Nd isotopic compositions (compared to other Vanuatu arc lavas) of high-MgO basalts and differentiates erupted over the last 100 years at Lopevi volcano, the rock suite displays a strong negative correlation between $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratio and indices of differentiation (e.g. SiO_2). This presents compelling evidence for the interaction of rising mafic magmas with 'primitive' sub-arc crust and provides an excellent framework within which to investigate and ascertain timescales of crustal interaction using U-series data.

Quantitative geochemical modelling of whole-rock trace element ratios, $^{87}\text{Sr}/^{86}\text{Sr}$ isotope compositions and U-series data shows that assimilation of a relatively small-degree partial melt of >380kyr-old mafic oceanic crust (similar to Pacific- or Indian-MORB in $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic composition) during fractional crystallisation of magma exerts major control on ($^{230}\text{Th}/^{232}\text{Th}$) and ($^{226}\text{Ra}/^{230}\text{Th}$) activity ratios of the lavas. The incorporation of higher ($^{230}\text{Th}/^{232}\text{Th}$) and lower ($^{226}\text{Ra}/^{230}\text{Th}$) assimilated material draws the samples much closer towards secular equilibrium than that of simple closed-system differentiation, reducing calculated apparent timescales of closed-system differentiation from Th isotope composition (10^4 - 10^5) by orders of magnitude. Modelling suggests that assimilation occurs extremely rapidly at Lopevi with maximum timescales for magma generation, differentiation and eruption in the order of 10^2 years.