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Potassium isotopic compositions of Mariana arc lavas and implications for K recycling

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Recycling of surface material over Earth's geological history through the subduction of oceanic crust can generate chemical heterogeneity within the mantle [1]. To trace the chemical evolution of the mantle it is necessary to understand controls on the composition of recycling material; one such control is the flux of elements to volcanic arcs from subducting slab derived components.

Novel stable isotope systems, that offer promise as tracers of crustal recycling, have been investigated in recent years [1, 2]. Potassium (K) is one such system, for which recent advances in mass spectrometry have allowed high precision isotopic investigation. Mid-ocean ridge basalts (MORB), ocean island basalts (OIB) and altered mafic oceanic crust (AMOC) have been measured for K isotopes [3, 4], but few volcanic arcs have been studied [5]. The perturbation of K isotopes in subducted material during subduction could impact the recycled composition.

We present ^{41}K data for lavas from the Marianas arc, these samples show variations in trace elements that can distinguish slab derived components of sediment melt and aqueous fluid from subducted mafic crust [6]. Our results show that the ^{41}K of Mariana arc lavas on average are isotopically heavier (≈0.1 ‰) than AMOC, MORB and OIB, in agreement with studies from other volcanic arcs [5]. Therefore, processes in the generation of arc magmas may fractionate K coming from subducted slabs and modify the recycled K composition. Additionally, no variation between tracers of slab components such as Ba/Th and ^{41}K is observed.

Using these results and existing uranium isotope data we develop Monte Carlo models of crustal recycling. Our models evolve the K/U and Th/U ratios (important for the thermal evolution of Earth) as well as the associated ^{41}K and ^{238}U composition of the upper mantle to trace crustal recycling and inform on the generation of chemical heterogeneity.

[1] Andersen et al., (2015) Nature. 517, 356-359. [2] Freymuth et al., (2015) EPSL. 432, 176-186. [3] Tuller-Ross et al., (2019) GCA. 259, 144-154. [4] Hu et al., (2020) Sci. Adv. 6 (49). [5] Parendo et al., (2022) EPSL. 578, 117291. [6] Elliott et al., (1997) JGR. 102, 14991-15019.