Potassium Isotopic Inputs to Subduction Zones

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Seafloor subduction transports crustal materials and volatiles to the mantle, imparting a continental signature, including K enrichment, to arc volcanic rocks. Potassium isotopes are a potential tracer of this recycling process due to the high solubility of K in high-T aqueous solutions and enrichment of K in slab-hosted hydrous phases compared to mantle minerals. Recent advances in analytical capabilities permit detection of sub-per mil (‰) differences in $\delta^{41}K$ values $[(^{41}K/^{39}K_{sample} - {}^{41}K/^{39}K_{standard})/{}^{41}K/^{39}K_{standard} \times 1000]$ between some arc lavas and ultrapotassic rocks and the overall homogeneous Bulk Silicate Earth (BSE) [1, 2]. Constraining the variability of K isotope ratios in subducting crust and sediment provides a basis for assessing the role of recycled lithologies in arc genesis and global K cycling.

We measured high-precision $\delta^{41}K$ values for representative subducting sediments and altered oceanic crust drilled from several active subduction systems to evaluate the range and mechanism of K isotopic variation. The sediment samples were derived mainly from circum-Pacific margins and have different lithological types, ages, and depositional depths. These samples were measured previously for Mg isotopes [3]. The altered oceanic crust samples were drilled at ODP Site 801 in the oldest known oceanic crust (ca. 170 Ma) of the Pacific in front of the Mariana trench; they have undergone prolonged low-temperature alteration. We document a large variation of $\delta^{41}K$ in both subducting sediments (~ 0.8‰) and altered oceanic crust (~ 0.5‰) with values both higher and lower than the BSE ($\delta^{41}K \sim -0.5$‰). The the lower $\delta^{41}K$ values may reflect an inherited terrestrial weathering signature and/or in-situ clay formation, whereas the higher $\delta^{41}K$ values could be linked to uptake of isotopically heavy seawater K ($\delta^{41}K \sim 0.1$‰). Our findings suggest that both chemical weathering and alteration of oceanic crust lead to significant K isotope fractionation. Subduction of these isotopically heterogeneous crustal lithologies may be a cause of isotopically distinct volcanic rocks.

[1] Parendo *et al.* (2017) *AGU abs.* V13E-07.
[2] Morgan *et al.* (2018) *J. Anal. At. Spectrom.* **33**, 175-186.
[3] Hu *et al.* (2017) *Chem. Geol.* **466**, 15-31.