Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30169

Tracing crustal recycling in the Central American Volcanic arc using potassium isotopes

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Recycling of crustal materials by subduction is one of the most important mechanisms producing chemical heterogeneities in the mantle, as demonstrated by the pioneering works of Drs. Catherine Chauvel and Dominique Weis. Arc magmas sample the most intensely subduction-influenced mantle wedge, and the geochemistry of arc magmas can shed light on the mechanism and flux of mass transfer between the subducting slab and the mantle wedge. Recycled crustal materials include subducting eroded forearc crust, sediment, altered oceanic crust (AOC), and other mafic and ultramafic slab components. An excellent location to study the relative importance of these components is the Central America Volcanic arc, owing to its striking along arc variation in subduction geometry, composition of overlying crust and subducting plate, as well as the geochemical characters of the arc magmas.

Here, we report K isotopic compositions of a suite of arc lavas spanning from Guatemala to Costa Rica including basalts, basaltic andesites, and high-magnesian andesites. These samples display over 0.7‰ of variation in $\delta^{41}K$, comparable to arc lavas reported in literature. Most of them are isotopically heavier compared to MORBs and the normal mantle. Unlike trace element ratios and other isotope systems such as Li and Pb, the K isotopic composition does not show systematic along-arc variation. There is also no correlation of $\delta^{41}K$ with MgO and K_2O content, suggesting K isotopes are not fractionated by magmatic differentiation in these samples. In the Nicaragua samples, high $\delta^{41}K$ is associated with high U/Th. By contrast, high $\delta^{41}K$ is associated with low U/Th in the Costa Rican samples. This suggest that slab contribution in the form of fluid and melt can both drive heavy K enrichment in arc lavas. The Nicaragua and Costa Rica samples share an ambient mantle endmember that is isotopically heavier than depleted MORB mantle, suggesting that the mantle wedge was metasomatized by a common high $\delta^{41}K$ component such as AOC-derived fluid. In summary, this study demonstrates that K isotope systematics are a powerful tracer for crustal recycling in arc magmatism.