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# Potassium isotope fractionation during silicate-carbonatite melt immiscibility and phlogopite fractional crystallization

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## Abstract

Potassium (K) isotopes have been used as a tracer of K recycling in the Earth, but K isotope fractionation during magma evolution is poorly constrained. Here, we present K isotope data for a magmatic suite of alkaline silicate-carbonatite affinity. The suite was formed from liquid-liquid immiscibility and subsequent phlogopite fractionation. The K isotopic signatures of different rock types are in the following order: alkaline silicate lavas ($\delta^{41}K$ = –0.424 to 0.090‰) > carbonatitic silicate lavas ($\delta^{41}K$ = –0.640 to –0.035‰) > carbonatites ($\delta^{41}K$ = –0.858 and –0.258‰). Phlogopite phenocrysts in the silicate lavas are isotopically lighter ($\delta^{41}K$ = –0.628 to –0.534‰) than the lavas in which they occur ($\Delta^{41}K_{\text{Phlogopite-whole rock}}$ = –0.502 to –0.109‰). Correlations between $\delta^{41}K$ values and chemical proxies of melt immiscibility and phlogopite fractionation indicate that K isotopes are significantly fractionated by both processes at a ~0.6‰ magnitude. Such K isotope variation overlaps the range of $\delta^{41}K$ in arc lavas. Compilations of literature data further confirm the critical roles of melt immiscibility and phlogopite fractionation in K isotope variations of high-K lavas ($K_2O$ >1 wt%) from post-collision orogenic and intra-continental settings. In comparison, basaltic arc lavas are depleted in $K_2O$ (mostly <1 wt%) and lack evidence of significant phlogopite fractionation. The K isotope variations of arc lavas are mainly controlled by their mantle sources, which were metasomatized by melt or fluid released from the subducting slab. Therefore, K recycling and K isotope variation are controlled by distinct mechanisms in different tectonic settings.

**Keywords:** K isotopes, silicate rock, carbonatite, melt immiscibility, phlogopite, fractional crystallization