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Potassium and rubidium isotopic composition of Icelandic basalts: implications for mantle processes

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Both K and Rb are incompatible in magmatic processes but are fluid mobile in low temperature crustal processes. Previous studies show that K and Rb isotopes are subject to limited fractionation during igneous processes and magmatic evolution[1,2], thus any resolvable variability in $d^{41}K$ and $d^{87}Rb$ composition likely indicates heterogeneities in source. Recent advances in the analytical methods capable in producing high precision $d^{41}K$ and $d^{87}Rb$ data have enabled us to evaluate possible mantle-controls on these systems.

We present K and Rb isotope data for a suite of Icelandic basalts (n=31) measured with MC-ICP-MS equipped with a collision cell (Sapphire by Nu Instruments). Our sample set includes well-characterised and largely primitive basalts from all active rift-zones, two off-rift alkalic volcanic zones as well as from a series of samples from a series of eruptions at Fagradalsfjall (2021-2023) where a clear mantle control has been identified[3]. The aim of this study is to characterise $d^{41}K$ and $d^{87}Rb$ values of Icelandic basalts as well as to test possible mantle control on $d^{41}K$ and $d^{87}Rb$ values.

Measured values fall close to estimated mantle average for both isotope systems, $d^{41}K = –0.42 \pm 0.08‰$ (2SD)[1]and $d^{87}Rb = –0.12 \pm 0.08‰$ (2SD)[2], whereas some samples extend to more positive $d^{87}Rb$ values (up to 0.02‰). No resolvable variation was measured within the Fagradalsfjall samples. In comparison with $d^{41}K$ and $d^{87}Rb$ values measured in the Hekla rock suite (basalt to rhyolites)[2,4] we note that some of our samples extend towards more positive values. Considering our entire data set from rift to off-rift volcanic zones, weak – yet noticeable – correlation of $d^{41}K$ and $d^{87}Rb$ with tracers such as La/Sm and $^{87}Sr/^{86}Sr$ commonly used to detect mantle-derived variability suggests a mantle control on both $d^{41}K$ and $d^{87}Rb$. The endmembers of our data set are analytically resolvable from each other for both $d^{41}K$ and $d^{87}Rb$, therefore it is likely that the mantle beneath Iceland has heterogenous $d^{41}K$ and $d^{87}Rb$.

References:

[1] Hu et al. (2021), JGR Solid Earth 126

[2] Wang et al. (2023), GCA 354

[3] Marshall et al. (in prep)

[4] Tuller-Ross et al. (2019), Chem. Geol. 525