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The Behavior of K Stable Isotopes Accompanying the Subduction of the Oceanic Crust and Sediments

HENG CHEN[1], BAPTISTE DEBRET[2,3], EDWARD INGLIS[4], HELEN M WILLIAMS[5] AND ALEX N HALLIDAY[6]

[1]Lamont-Doherty Earth Observatory
[2]Université de Paris, Institut de physique du globe de Paris, CNRS UMR 7154
[3]Université de Paris, Institut de physique du globe de Paris
[4]Cardiff University
[5]University of Cambridge
[6]Columbia University

Presenting Author: hc3158@columbia.edu

Potassium is a highly fluid-mobile LILE element, and its stable isotopic composition ($\delta^{41}K$) may trace fluid-related processes in subduction zones. We have determined the $\delta^{41}K$ of 27 samples of metamorphosed sediment, basalt, and gabbro from three meta-ophiolites in the Western European Alps, in order to investigate the effects of prograde metamorphism on K mobility in slab derived fluids and the isotope compositions of the mantle wedge and arc basalts. Each of these ophiolites has been metamorphosed under P-T conditions representative of a subduction gradient [1], and they display significant changes in Fe and Zn stable isotopes that broadly correlate with increasing metamorphic grade [2, 3].

Our results show no simple trends of K stable isotope composition with increasing metamorphic grade. The greenschist facies metagabbros have isotopically heavier $\delta^{41}K$ relative to fresh MORB and the BSE (-0.42 ± 0.08‰) [4], and likely preserve K isotopic signatures modified by seafloor hydrothermal activity [5]. The blueschist facies metagabbros are strongly enriched in fluid-mobile elements such as B and K, and display a large range in $\delta^{41}K$, between -1.93 and -0.03‰. However, there is no covariation with K content and indicators of fluid-rock interaction (*e.g.,* Rb/Nb). In these samples the range in $\delta^{41}K$ likely reflects the combination of fluid metasomatism released from proximal metasediments, which drives compositions heavier, and dehydration during prograde metamorphism, which leads to lighter values [5]. The eclogite metasediments are slightly lighter in K isotope composition than the BSE, but the majority of eclogitic metabasalts and metagabbros are heavier, except for those with extremely low [K].

Therefore, K isotopes are sensitive to metasomatism, but subduction does not necessarily simply release isotopically heavy K from slabs [5]. Both metasomatism and dehydration modify the K isotope compositions of slabs such that recycling models need to be reassessed in order to better understand mantle heterogeneity.

References

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