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Evidence from HP/UHP metasediments for recycling of isotopically heterogeneous potassium into the mantle

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Abstract

Potassium isotopes may provide a novel approach for fingerprinting recycled sediments in the mantle due to the significant differences in K abundance and isotopic ratio between subducting sediment and the mantle. However, the behavior of K isotopes in sediments during subduction zone metamorphism is still unknown. Here we investigate K isotopic composition of a set of well-characterized high- to ultrahigh-pressure metasediments from the Schistes Lustrés nappe (western Alps), which represents marine sediments subducted down to ~90 km depth in a cold subduction zone, and their protoliths from the Lavagna nappe (Apennines, Italy). The metasediments display $\delta^{41}K_{SRM\ 3141a}$ values from –0.76‰ to –0.48‰, which are on average lower than the mantle value (–0.43‰) but similar to those of non-metamorphic equivalents (–0.79‰ to –0.49‰). No systemic variation of $\delta^{41}K$ with metamorphic grade is observed, suggesting negligible K isotope fractionation in these sediments during prograde metamorphism. This is in accord with the limited loss of K during the entire metamorphic history as evidenced by the constancy of K/Rb and K/Cs ratios between metamorphic and non-metamorphic sediments and the absence of correlations of $\delta^{41}K$ with K/Rb and K/Cs. The heterogeneous $\delta^{41}K$ values of metasediments are most likely inherited from their protoliths, which experienced different degrees of chemical weathering depending on their provenances. Our results demonstrate that the variable and light K isotopic signatures in subducting sediments could be preserved to depths of at least 90 km along a cold geotherm gradient, indicating that the introduction of sediments into the mantle could produce K isotope heterogeneity in the source regions of mantle-derived lavas.

Keywords: Potassium isotopes, metasediment, metamorphism, subduction zone; Isotopes, Minerals, and Petrology: Honoring John Valley