Potassium Isotope Fractionation in the Continental Crust

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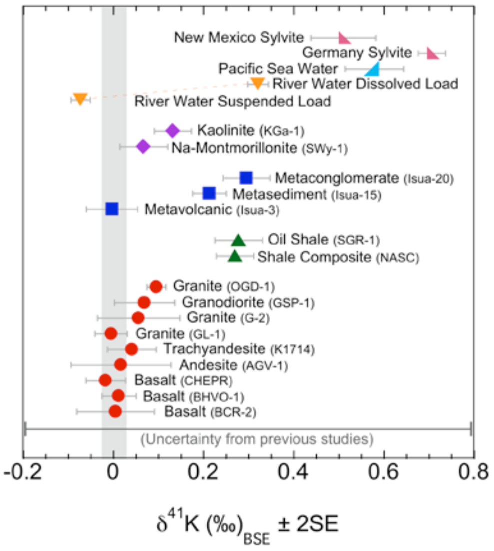
We recently reported new ultra-precise measurements of K isotopes by Multi Collector-Inductively Coupled Plasma-Mass Spectrometry (MC-ICP-MS) equipped with a hexapole collision gas cell [1]. This new development allows us to use K isotopes as a tool to study the K cycle and different K reservoirs on the Earth. Basalts define the bulk silicate Earth (BSE) K isotope composition, which is used as a reference for all K isotope measurements as $\delta^{41}K_{BSE}$ values. We focused our initial measurements on rocks from the upper continental crust, which is highly enriched in K. The igneous rocks (*e.g.*, basalt, andesite and granite), including a 3.8 Ga old metavolcanic rock from Isua, have very uniform $\delta^{41}K_{BSE}$ values. This implies relatively small K isotope fractionation during high-temperature magmatic processes, but three out of four granites are 0.056 to 0.095 per mil heavier than the BSE value. In contrast, $\delta^{41}K_{BSE}$ values of marine sedimentary and meta-sedimentary rocks, including the ancient Isua metasediments, are significantly higher (~0.3 per mil). Seawater has even higher $\delta^{41}K_{BSE}$ of 0.579, suggesting that a substantial portion of the K in marine sediments may be derived from seawater, as non-marine clays have lower $\delta^{41}K_{BSE}$ values. There is a large fractionation during weathering of rocks: river suspended loads have $\delta^{41}K_{BSE}$ = –0.073 while dissolved load is 0.321 per mil. Average upper crust appear to be heavier than the BSE, thus there must be complementary depleted K reservoirs in the lower crust or upper mantle. Also, since shales are heavier than igneous rocks, other sediments may have lighter isotope signatures. Clearly, K isotope variations have a great potential for constraining/evaluating crust and mantle evolution processes.



[1] Wang and Jacobsen (2016) *Geochim. Cosmochim. Acta* **178**, 223-232.