K isotopic responses to silicate weathering and global K cycling

WEIQIANG LI[1], SHILEI LI[1], BRIAN L. BEARD[2], MAUREEN E. RAYMO[3], YANG CHEN[1], JUN CHEN[1]

[1] School of Earth Sciences and Engineering, Nanjing University, China. liweiqiang@nju.edu.cn

[2] Department of Geoscience, University of Wisconsin-Madison, United States

[3] Lamont-Doherty Earth Observatory, Columbia University, United States

Potassium stable isotopes (^{39}K and ^{41}K) can be used to trace silicate weathering processes because K is a major element and ~90% of K in riverine dissolved loads is derived from silicate weathering. Furthermore, K stable isotopes may provide novel constraints for geological cycling of alkali elements. Here we report a systematic investigation of K isotopes in dissolved load from major rivers and their tributaries in China (n=22), as well as river sediments from two small watersheds that drain granitic rocks. The studied rivers cover large catchments with remarkable variations in climate, lithology, and topography, allowing investigation of the behavior of K isotopes in river systems during the weathering of continental crust. Our results show that the Changjiang river has little seasonal variation in the riverine dissolved $\delta^{41}K$ except for the beginning of the wet season in a year. During silicate weathering, heavy K isotopes are preferentially partitioned into aqueous solutions by a factor of up to 0.55 ± 0.29‰ (n=7), based on measurements of K isotope compositions of dissolved riverine load and the <2μm clay fraction in sediments from two different catchments. Moreover, $\delta^{41}K$ values of riverine dissolved load vary remarkably and correlate negatively with the chemical weathering intensity of the drainage basin. Based on this correlation, we estimate that the average $\delta^{41}K$ of global riverine runoff is –0.22‰ relative to NIST SRM3134a. Modeling incorporating K isotope mass balance leads to better constrained K fluxes for modern global K cycling, and the results show that the $\delta^{41}K$ value of seawater is sensitive to continental weathering intensity changes. Therefore, K stable isotopes will be useful in elucidating continental weathering and global cycling of alkali elements.