Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.26846

Fractionation of K isotopes in coastal groundwater systems: Implications for the global K cycle and oceanic isotope budgets

MR. JUN MU, PHD[1], JINGJING SU[1], YUEQING XIE[1] AND WEIQIANG LI[2]

[1]School of Earth Sciences and Engineering, Nanjing University
[2]Nanjing University

The coastal groundwater system plays a pivotal role in the global hydrological and biogeochemical cycles, with groundwater-derived solutes (e.g., nitrogen, phosphorus) estimated to be equivalent to that of the river input into the ocean[1-2], thereby influencing the chemical composition of oceans. To date, little is known about potassium (K) fate in coastal aquifers and the impact of submarine groundwater discharge (SGD) on seawater δ^{41}K values, which are ~0.55‰ enriched in δ^{41}K relative to the bulk silicate Earth. Here, we present the K isotope and hydrochemical data of recharging river water, as well as unconfined and confined groundwater in the coastal region of Jiangsu province, China. The K isotope signatures revealed distinct fractionation mechanisms, with δ^{41}K values exhibiting an overall increase in unconfined aquifers (-0.41‰ to 0.78‰) and confined aquifers (-0.14‰ to 1.37‰). Specifically, chemical weathering and clay adsorption processes collectively govern the K concentrations and δ^{41}K values of non-seawater-influenced groundwater. In contrast, in seawater-influenced groundwater, the formation of clay minerals that sequester K from aquifers results in an elevation of δ^{41}K values to 0.78‰–1.37‰, as increased ionic strength inhibit K adsorption onto clays. Thus, a clay incorporation-induced K isotopic fractionation factor (α=0.9997 to 0.9999) was derived using the Rayleigh fractionation model. Utilizing a K mass-balance model in conjunction with Monte Carlo simulations, we evaluated the response of seawater δ^{41}K values to SGD. Our results indicate that the δ^{41}K value of seawater increases by more than 0.3‰ when the K flux from SGD is comparable to the riverine input. This study highlights the role of SGD in the global K cycle and the oceanic isotopic budget, with important implications for the temporal evolution of seawater K isotope values.

[1] Goldschmidt, Rodellas V, Garcia-Orellana J, Masqué P, Feldman M, Weinstein Y (2015), *Proceedings of the National Academy of Sciences* 112, 3926-3930.

[2] Goldschmidt, Santos IR, Chen X, Lecher AL, Sawyer AH, Moosdorf N, Rodellas V, Tamborski J, Cho H-M, Dimova N, Sugimoto R, Bonaglia S, Li H, Hajati M-C, Li L (2021), *Nature Reviews Earth & Environment* 2, 307-323.