Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27763

Rubidium isotopes as a novel indicator for chemical weathering of basaltic rocks

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The chemical weathering is the main pathway for materials of the continental crust to enter the Earth's surface cycle, connecting the lithosphere, atmosphere, hydrosphere, and biosphere. As an alkali metal element, the Rb isotope system is an emerging proxy to trace chemical weathering of silicate rocks[1]. However, the magnitude and mechanism of Rb isotope fractionation during chemical weathering of basaltic rocks that are an important constitution of the continental crust, remain unknown. Here, we present Rb contents and isotope compositions (δ^{87}Rb) of a weathering profile of gabbros in Zhanjiang, Guangdong Province, which exhibit large variations. The upper saprolites (depth: 400–0 cm) display a positive correlation between the Rb and Th contents, and record δ^{87}Rb values (–0.15‰ ± 0.09‰) well consistent with those of the fresh gabbros (–0.11‰ ± 0.08‰), indicating the dominance of aerosol input. The middle semi-weathered gabbros (depth: 600–400 cm) show a positive correlation between the Rb contents and δ^{87}Rb values, suggesting a mixture of aerosol Rb that is isotopically identical to the fresh gabbros and adsorbed Rb that is isotopically heavier, the latter of which gradually lost possibly due to the desorption during the later stage of chemical weathering. Our results demonstrate that strongly chemical weathering of basaltic rocks is accompanied by a significant Rb isotope fractionation via the desorption of isotopically heavier Rb onto clay minerals. This sheds new insight into using Rb isotopes to trace continental weathering intensity through Earth's history.

[1] Zhang, Z., Ma, J., Wang, Z., Zhang, L., He, X., Zhu, G., Zeng, T., Wei, G., 2021. Rubidium isotope fractionation during chemical weathering of granite. Geochimica et Cosmochimica Acta 313, 99-115