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Mineralogy and precipitation controls on saprolite lithium isotopes during intensive weathering of basalt

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Abstract

The fractionation of lithium (Li) isotopes in saprolites under intense weathering conditions, particularly in relation to precipitation and mineral types, remains a crucial yet complex aspect of geochemical studies. This study reports Li isotope compositions from saprolites and unaltered bedrock within a basalt weathering profile on Hainan Island, China, a region known for its high rainfall and low dust levels. We observe that Li concentrations in weathering products (ranging from 2.36 to 10.65 μg g^{-1}) are generally higher than in the unaltered bedrock (6.54 μg g^{-1}). Correspondingly, the δ^7Li values of these products range from −9.3‰ to +7.4‰, typically lower than those of unaltered bedrock (+4.3‰). Our findings suggest that the impact of rainwater Li on saprolite Li isotopes is not a straightforward mixing of rainwater and bedrock, but rather is modulated by adsorption and desorption processes involving secondary minerals. Notably, the δ^7Li values in saprolites correlate with the proportion of specific secondary minerals; saprolite δ^7Li values rise with increased kaolin minerals and drop with more Fe and Al oxide/hydroxide minerals. Integrating these results with previous studies on suspended sediment leaching, we propose that the higher dissolved δ^7Li values in basaltic catchments, compared to granitic ones, are due to a greater abundance of Fe-Al (hydro)oxides in basaltic catchments. This mineralogical control on saprolite Li isotopes also implies a potential explanation for the observed variations in river δ^7Li values under different precipitation regimes, influenced by diverse secondary minerals in riverine suspended loads.

Keywords: Lithium isotopes, secondary minerals, intensive weathering, basalt weathering