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Effect of weathering and post weathering processes on lithium isotope fractionation: A case study from the Rajmahal Volcanic Province, India

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We investigated the bulk, exchangeable and oxyhydroxide phases of two basaltic weathering profiles to evaluate processes regulating distribution of Li and its isotope composition (δ^7Li). The upward increasing Li/Al ratios in both the profiles suggest that Li is enriched through its adsorption onto the clay minerals and Fe-Mn oxyhydroxides. Significant positive correlations of [Li] with [Al], [Fe] and [Mn] provide further support to the inferred adsorption of Li.

The δ^7Li values vary in the range of 6.1-8.1 ‰ for the basalts to 0.5 ‰ in the weathered materials. δ^7Li values exhibit a general upward decreasing variation in the profiles, suggestive of preferential adsorption of ^{6}Li onto clay minerals and Fe-Mn oxyhydroxides[1]. Further support for this inference comes from the inverse correlation of δ^7Li with Cs/Al and [Mn]. In one profile, the top section shows a decrease in δ^7Li, adsorbed Li (%), and pH values, whereas the underlying layer shows an increase of these parameters. These observations are presumably due to preferential desorption of ^{7}Li from interlayer sites of clay minerals from upper layer and its subsequent re-adsorption onto clay minerals and Fe-Mn oxyhydroxides in the underlying layer as ^{7}Li rich porewater migrates downward. The desorption of ^{7}Li from interlayer sites likely occurs in conjunction with Al adsorption as soil pH decreases[2], as evident from an inverse correlation observed between adsorbed Li (%) and exchangeable [Al] in upper layer.

The Rayleigh fractionation factors (α) calculated for Li adsorption are within the range of published values[1]. Calculations based on two independent approaches show that the δ^7Li values of the weathering solutions are about 9-14 ‰ higher than that of parent basalts, and are similar to those reported for rivers draining the basaltic rocks[3]. While this study underscores the importance of adsorption of Li in regulating the dissolved δ^7Li in rivers, our results also advocate for comprehensive studies to gain insight into detailed Li cycling and its impact on the δ^7Li that are transported from weathering profiles.

References

1. Wimpenny et al. (2015): GCA 168, 133-150.
2. Jin et al. (2010): GCA 74, 3669-3691.
3. Liu et al. (2015): EPSL 409, 212-224.