

The Lithium Isotope ‘Croissant’ from a Reactive Transport Perspective

MATTHEW J WINNICK^{1,2}, KATE MAHER²

¹Dept. of Geosciences, University of Massachusetts Amherst,
MA; mwinnick@umass.edu

²Dept. of Earth System Science, Stanford University, CA

Lithium isotopes have emerged as a powerful tool to probe the response of global weathering to changes in climate. Due to the preferential incorporation of ^6Li into clay minerals during chemical weathering, $\delta^7\text{Li}$ may be used to interrogate the balance of primary mineral dissolution and clay precipitation. This balance has in turn been linked to erosional regimes, such that dissolved $\delta^7\text{Li}$ is thought to be maximized under moderate erosion rates. However, this link is predicated on formulating clay precipitation as a constant rate unconnected to primary mineral dissolution. In this study, we revisit the relationships between $\delta^7\text{Li}$ and erosional regime by incorporating Li isotopes into simulations of weathering profiles using the CrunchFlow reactive transport software. In these simulations, clay precipitation is treated with an affinity-dependence, and is intrinsically tied to primary mineral dissolution. Fractionation is implemented as a kinetic fractionation factor during clay precipitation, which allows the $\delta^7\text{Li}$ of dissolved and suspended loads to vary as a function of Li/Al ratios in primary and secondary minerals, matching global river observations. Model results suggest that weathering congruence and $\delta^7\text{Li}$ are largely decoupled from erosional regime, except under low-erosion conditions. Comparing our results to global river observations, we suggest that observations of low $\delta^7\text{Li}_{\text{diss}}$ under high erosion conditions likely reflect lithology rather than mechanistic links between erosion and congruence. Finally, we discuss implications of our results for the reconstruction of past weathering environments using $\delta^7\text{Li}$.