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Influence of particulate weathering on elemental cycles: evidence from lithium isotopes

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Continental weathering is a critical process in climate stabilization and global elemental cycling. Every year, continental physical erosion and chemical weathering supply billions of tonnes of particles (~1.8×10^{13} kg/yr) and dissolved material (~3.8×10^{12} kg/yr) to the ocean by river transportation through estuaries. Differences in the estuarine environment, compared to the continents, such as salinity, can lead to rapid changes in the rates of mineral dissolution and secondary mineral formation (e.g. clays, oxides/(oxy)hydroxides). Estuarine processes are therefore critical for determining material fluxes entering the oceans, and hence for marine biogeochemical cycles. However, as yet, such processes have not been fully investigated, especially for mobile elements, including Li.

In this study, we have explored samples from two river estuaries: the Amazon and an Icelandic basaltic river. Specifically, we have examined both the dissolved load and multiple selective leachates of the particulate samples. For estuarine water samples, the concentrations of mobile elements in the dissolved loads generally indicate conservative mixing of river water and seawater. The particles, on the other hand, clearly remove Mg, K, and Li from the water, which implies secondary mineral formation is occurring.

We also conducted water-rock interaction experiments with increasing salinity to mimic the estuarine geochemical environment. These experiments reveal that, compared to the continental environment, the high dissolved Li concentration in estuaries may enhance the Li incorporation by particles. Thus, the alteration of river-derived particles in estuaries can modify continental weathering signatures and fluxes, impacting elemental cycles and CO_2 drawdown.