Utility of Lithium Isotopes as a Tracer of Weathering Processes: A Case Study from the Southern Alps, South Island, New Zealand

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Continental weathering of silicates exerts a major control on Earth's climate as it consumes atmospheric carbon dioxide. Weathering rates are affected by a multitude of processes, including uplift, erosion and temperature. However, the exact linkages between weathering and climate remain poorly constrained.

Lithium (Li) and its isotopes are effective tracers of weathering processes. In this study, we have determined Li concentrations and δ^7Li signatures of rivers, hydrothermal springs and rocks from across the Southern Alps, New Zealand, to evaluate the major climatic and tectonic controls affecting Li isotope fractionation during weathering. The Southern Alps are ideal to this end, as they are a pristine and relatively monolithological metasedimentary belt, which is affected by an asymmetric climatic regime and differing rates of uplift and erosion.

We find that the δ^7Li value of glacial (δ^7Li = +12.0 to +14.5‰) and non-glacial (δ^7Li = +11.8 to +26.1‰) rivers is significantly different from the catchment bedrock (average δ^7Li = -0.2 ± 1.6‰), whereas hydrothermal springs can have δ^7Li signatures as low as the bedrock values (δ^7Li_{spring} = +0.2 to +10.8‰). The δ^7Li values of these (temperate) glacial rivers are lower than those measured in glacial rivers in Iceland (δ^7Li =16.3-36.8‰ [1]) and Greenland (δ^7Li = 25.3-26.7‰ [2]).

Our data indicate that the metamorphic grade of river catchment host rocks and water temperature have little effect upon the δ^7Li signature of river waters, and so do not control the isotopic fractionation of Li. In addition, it is unlikely that the glacial rivers are affected by formation of Fe-oxyhydroxides, as SO_4^{2-} concentrations are low in these rivers. Consistent with other studies, it appears that the formation of clays as secondary alteration products during chemical weathering is the overarching control on Li isotopic fractionation in this setting.

[1] Pogge von Strandmann (2006) *EPSL* **251**, 134-147. [2] Wimpenny *et al* (2010) *EPSL* **290**, 427-437.