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Hydrological and erosion controls on chemical weathering: insights from stream Li and Sr in Small Alpine Catchments

MS. AKANKSHA PRAHARAJ[1,2], JULIEN BOUCHEZ[3], WILLIAM RAPUC[4], ROBERT HILTON[5], MATEJA OGRIC[6], CAROLINE LE BOUTEILLER[7] AND MATHIEU DELLINGER[8]

[1]Institut de Physique du Globe de Paris
[2]CNRS - Université Savoie Mont-Blanc
[3]Université Paris-Cité, Institut de physique du globe de Paris, CNRS
[4]CNRS - EDYTEM - Université Savoie Mont Blanc
[5]University of Oxford
[6]Durham University
[7]Institut des Géosciences de l'Environnement
[8]CNRS - Université Savoie Mont Blanc

Understanding the controls on chemical weathering fluxes is essential for reconstructing and predicting the evolution of the critical zone. Lithium (Li) and strontium (Sr) serve as potent tools in this regard, as Li isotopic fractionation traces the extent of weathering processes, while $^{87}Sr/^{86}Sr$ ratios trace weathering sources. However, disentangling the influence of hydrological factors and physical erosion rates on Li concentrations and isotopic fractionation remains a challenge. We measured Li and Sr concentrations and isotope composition in four small river catchments (area < 2 km²) in the French and Swiss Alps, each characterised by diverse erosion rates, runoff patterns, precipitation levels, mean annual precipitation, and vegetation cover. In each catchment time series of stream samples were collected during both base flow and storm events from different seasons, for which we investigated the concentration (C) and isotope composition (I) vs discharge (Q) relationships . Our findings revealed a negative correlation between Li concentrations with discharge in all these catchments, with a stronger influence of hydrology than physical erosion in one of the catchments. The dissolved δ^7Li across the four catchments ranges between 3.83‰ and 16.63‰, while $^{87}Sr/^{86}Sr$ varies between 0.707914 and 0.708292. δ^7Li in one of the catchments is higher in the fall (~11 ± 0.5‰) and lower in summer (~9 ± 0.5‰) revealing seasonal influence. The comparable $^{87}Sr/^{86}Sr$ values suggest a common origin for the chemical weathering fluxes in these catchments, whereas the different δ^7Li evolution during a given storm event between two catchments highlights the role of water transit time. These results have important implications for understanding the factors governing weathering fluxes and, consequently, for modelling the past and future trajectories of the critical zone in the European Alps.