Response of weathering processes to rain events in a highly-weathered catchment (Guadeloupe, France): insights from Li isotopes

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In tropical islands, storms are responsible up to ~50 % of total annual rainfall and they result in rapid increases in discharge from rivers. Yet storm events are notoriously under-sampled and their effects on weathering rates and processes are poorly constrained. To fill this gap, we have undertaken high-frequency sampling of the Quiock Creek catchment in Guadeloupe (part of the Critical Zone Observatory OBSERA) over a period of 21 days, encompassing several storm events. Analyses of Li isotopes (δ^7Li), which are fractionated during weathering processes, provide insight into the interactions between rock, water and secondary minerals.

The δ^7Li value of river waters and shallow groundwater decreases during rain events. The Li isotope composition of the river baseflow is 9.3‰ and Li concentrations are ~60 µmol/kg but during a storm these values decrease to, respectively, 7.8‰ and ~40 µmol/kg. The change in δ^7Li cannot be due to an increased contribution from throughfall, which had a δ^7Li value of 13.3‰ throughout the sampling campaign. Li/Na and Al/Cl ratios in the river waters increase during the storm events, whereas Ca/Mg and Ca/Li decreases, which suggests that the decrease of δ^7Li is likely a result of the dissolution of low-δ^7Li secondary mineral phases in the shallow groundwaters as suggested in a previous study [1].

Soil solutions tend to have higher Li concentrations and lower δ^7Li values (~7 ‰) compared to the river waters and shallow groundwaters. After a rain event, the composition of soil solutions from the lower part of the profile (> ~150 cm below the surface) is unchanged, whereas in the upper part of the profile δ^7Li values increase by 2-4 ‰. Considered together, our data provide first-order constraints on the behaviour of Li isotopes during weathering in tropical climates during storm events.

[1] Clergue et al., 2015. Chem. Geol., 414, 2015, 28-41.