

Li isotopes as weathering tracer in the Susquehanna Shale Hills Critical Zone Observatory

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Lithium isotopes are a promising weathering tracer for abiotic processes as isotope fractionation is mainly controlled by silicate weathering depending on the weathering rate. The well-investigated Susquehanna Shale Hills Critical Zone Observatory (USA) provides an ideal field laboratory to explore Li isotopes as proxy for shale weathering. It is a first-order catchment in a temperate climate within a tectonically quiescent setting with soil formation initiated after the last glacial maximum. Chemical weathering is limited by dissolution kinetics and realized through several reaction fronts occurring at various depths (20 m ~ carbonate dissolution, 5-6 m ~ plagioclase dissolution and <2 m ~ clay mineral dissolution and transformation) [1].

Despite significant depletion of Li, bulk soils from different horizons and locations reveal largely homogeneous Li isotope signature, which is close to those of bulk bedrocks with $\delta^7\text{Li}$ value around 1.5‰. In contrast groundwater, soil water and stream water are significantly enriched in isotopically heavy Li and show spatial and temporal variations. Deep groundwater shows the highest Li concentrations (5 to 6 ppb) together with $\delta^7\text{Li}$ values between 16 to 24‰. Groundwater from medium to shallow depth reveals very variable Li concentration (0.3 to 5 ppb) and isotope composition with $\delta^7\text{Li}$ values between 14 and 39‰ suggesting different water pathways at different times in the year. The stream exhibits less variability with lower values $\delta^7\text{Li}$ (25 to 30‰) at the headwater which is dominated by surface run-off compared to the outlet (30 to 35‰). Micro-sized particles removed from the system as suspended load are tested as missing reservoir for isotopically light Li. This study will give important constraints on weathering mechanisms together with water pathways in shale.

[1] Brantley et al. (2013) *ESPL* **38**, 1280-1298.