Si isotope signatures from two small catchments in the Black Forest

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Stable Si isotopes are potentially an ideal tool to investigate the release or precipitation of Si during abiotic or biotic weathering processes which cause significant shifts in the isotope signature depending on the weathering intensity. In this study, we determine the Si isotope signature of spring and stream waters and of the principle Si pools of typical soil profiles within two small catchments located on sandstone and paragneiss, respectively, in the cold, perhumid Black Forest (Germany).

The Si isotope data were obtained on a Neptune MC-ICP-MS in solution for the water samples and in situ by coupling a UV femtosecond laser ablation system for solid samples, respectively. Bulk soils show a largely homogeneous Si isotope signature, which is close to those of bulk bedrocks with δ^{30}Si value around -0.3‰. Soil clay formation is associated with limited Si mobility, which preserves initial Si isotope signatures of parental minerals. Biogenic mineral, i.e. phytoliths, exhibit δ^{30}Si values of about -0.4‰. Springs and streams, sampled in spring and late summer, vary between -0.7 to 1.1‰ in δ^{30}Si showing spatial and temporal variations dependent on the water pathways. Groundwater in the sandstone catchment reveals constant δ^{30}Si values of 0.3 to 0.5‰, which is attributed to kaolinite formation. In contrast, water passing the soil zone shows very variable signatures. Low δ^{30}Si values down to -0.7‰ most likely reflects dissolution processes of clay minerals and phytoliths during spring. In late summer, positive δ^{30}Si values expose the impact of preferential uptake of light Si isotopes by plants. In the paragneiss catchment, this effect is likely increased by co-precipitation of isotopically light Si with Fe-oxides, which shifts surface water to δ^{30}Si values up to 1.1‰. The results on these small catchments demonstrate that Si isotopes are a powerful tool to identify weathering processes and the sources of dissolved Si, which are valuable constraints to interpret the isotope signature of large river systems.