Silicon Isotope Variations in River Waters: A Weathering Proxy?

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It has been shown that rivers contain Si with heavier dissolved isotope compositions relative to the continental crust, but reasons for this enrichment remain unclear. We compare Si isotope variations with physico-chemical parameters, such as river discharge, the water chemistry and the chemical weathering flux in order to constrain the processes controlling the Si geochemical budgets. The relative Si isotope compositions were measured using the high-resolution NuPlasma 1700 MC-ICP-MS.

An initial study to investigate the role of catchment lithology and relief, focussing on rivers in the Swiss Alps found that the main mechanism controlling the Si isotope composition of a mountainous river was a two component mixing between the seepage of soil/ground waters, with heavier Si produced by clay formation and superficial runoff with lighter Si during high discharge events. The mechanisms controlling the Si isotope composition in the lowland rivers display increasing complexity as the proportion of carbonate rocks in the catchment lithology and the proportion of forested and cultivated landscapes increase. In these instances it is impossible to resolve the extent of the isotopic fractionation and contributed flux of Si contributed by biological processes as opposed to abiotic weathering.

To investigate if the conclusions drawn form our Swiss study are widely applicable we have investigated $\delta^{30}Si$ variations in rivers from Iceland and the high Himalayan. Our results indicate that the $\delta^{30}Si$ of the Iclandic rivers (average $\delta^{30}Si$: +0.63 ±0.38‰) seems to be mainly controlled by weathering of silicates and the formation of secondary clay minerals as the dissolved $\delta^{30}Si$ depends on the Al content and scales with Al/X ratios. A similar relation has been found in one Himalayan catchment, whilst the general situation is more complex. There is also a surprising positive correlation between the $\delta^{30}Si$ composition of the Himalayan rivers (average $\delta^{30}Si$: +0.92 ±0.28‰) and the altitude, where high $\delta^{30}Si$ values have been measured for samples from the highest altitudes draining the Tibetan sedimentary series, and are correlated with $\delta^{7}Li$ variations.