The δ^{30}Si values of soil weathering profiles: Indicators of Si pathways at the lithosphere/hydro(bio)sphere interface

K. ZIEGLER[1], O.A. CHADWICK[1], E.F. KELLY[2] AND M.A. BRZEZINSKI[3]

[1] Dept. of Geography, University of California, Santa Barbara, CA 93106, USA (kziegler@geog.ucsb.edu, oac@geog.ucsb.edu)
[2] Dept. of Soil and Crop Sciences, Colorado State University, Ft. Collins, CO 80523, USA (pedoiso@lamar.colostate.edu)
[3] Dept. of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106, USA (brzezins@lifesci.ucsb.edu)

We utilize natural variations in the abundance of Si isotopes to trace the fate of Si derived from weathering of rock in terrestrial ecosystems. Previous experimental work has indicated that phytolith (plant opal) and clay mineral formation create relatively large Si-isotopic differences between solution and solid (up to -1.5‰). Assuming simple Rayleigh-type fractionation as bedrock is converted to secondary mineral phases and as plants utilize the Si in soil-water, we expect the δ^{30}Si variations to increase. Hence, natural variations in silicon isotopes may be a useful tool for assessing the relative contribution of weathering and plant activity in silicon cycling within soils.

A detailed investigation of the Si-budget/transfer between the soil- and the biomass-pool of an arid soil (Kohala/Hawaii, basalt) demonstrates that Si-uptake by plants plays a substantial role in the Si-cycling of this 1-m thick soil. Basaltic groundwater (1500') has a δ^{30}Si-value of +0.5‰. Soil-water from the lower B-horizon has a similar value, whereas upper B- and A-horizon soil-waters are more positive by up to 1.2‰. The ^{30}Si-enrichment of solutions relative to groundwater is accompanied by a ^{30}Si-depletion in the precipitating solid phases: secondary halloysite has a δ^{30}Si-value of -2.3‰, and phytoliths range from -0.9 to -1.5‰.

Similar clay mineral/soil-water relationships are seen in a several-m-thick saprolite at the humid granitic LTER site of Rio Icacos/Puerto Rico. δ^{30}Si-values of secondary kaolinite increase with depth from -2.5 to -1.9‰, whereas soil-water has a value of -0.8‰. Remaining primary quartz has a uniform δ^{30}Si signature of -0.2 to -0.3‰.

Our Si isotope values from rock-water-biomass-systems suggest that Si isotope compositions result from the combined effects of dissolution of primary and recycled secondary minerals and inorganically and organically mediated precipitation of new phases. Once these isotopic inter-connections are resolved, we will be able to determine duration and intensities of past and recent biogeochemical processes affecting Si-budgets in weathering environments.

Late Pleistocene variations of lake level and glacial activity at Mono Lake, CA, USA

S.R.H. ZIMMERMAN, S. R. HEMMING, N. G. HEMMING, P. B. TOMASCAK

Dept. of Earth & Env. Sciences and Lamont-Doherty Earth Obs., Columbia U., NY, NY 10027; (herrzim@ldeo.columbia.edu) and (sidney@ldeo.columbia.edu)
School of Earth & Env. Sciences, Queens College, Flushing, NY 11367; (hemming@ldeo.columbia.edu)
Dept. of Geology, U. of Maryland, College Park, MD 20742; (tomascak@geol.umd.edu)

Sediments of the Wilson Creek Formation (Marine Isotope Stages 4-3-2) record the details of glacial variation in the Mono Basin, at the eastern foot of the Sierra Nevada in east-central California, USA. Preserved in the deep lake silts of the Wilson Creek Formation, Total Inorganic Carbon (wt. %TIC) and ^{87}Sr/^{86}Sr of ostracod shells record variations in the lake level related to changes in precipitation/evaporation (P/E). During periods of low P/E, conditions were similar to modern; carbonate precipitated immediately upon mixing of Ca^{2+}-rich waters with CO_3^{2-}-rich lake water, yielding low %TIC (<1%) in deep lake sediments. Sr isotopic ratios were relatively high (0.7093), due to a dominance of Sierran run-off. Conversely, periods of high P/E (high lake level), were characterized by high %TIC (4-6%) and lower ^{87}Sr/^{86}Sr (0.7089), due to greater influence of Quaternary volcanics in the eastern side of the basin.

Rafting of coarse material from valley glaciers into the lake is recorded by the >250 μ fraction of sediments, and by abundance of outsized clasts (>1cm) embedded in outcrops of the Wilson Creek Formation. Both rafting proxies were highest during early Wilson Creek time (>45 ka), reflecting the extension of long glaciers into a very deep lake. Variation of % Na_2O in the <2 μ size fraction records abundance of unaltered, clay-sized plagioclase, thought to be a measure of glacial rock flour. Covariance of magnetic susceptibility (k) and %Na_2O allows a high resolution record of rock flour contribution to the basin sediments.

Rock flour and ice-rafting proxies co-vary inversely, opposite to expectations. Possible explanations include the decoupling of flour formation by glaciers from its delivery to the lake by meltwater, or dilution of the rock flour signal by authigenic components such as sepiolite. In general, high lake level and long glaciers in early Wilson Creek time created ideal conditions for ice-rafting, followed by a lake level drop and glacier retreat. Near the end of Wilson Creek time, (<25 ka), expansion of the Tioga glaciers created large flux of rock flour, whereas rafting was low to absent due to the gap between the glacier termini and the lake shoreline.