Controls on Si isotopic fractionations in the forested tropical watershed of Mule Hole (Southern India)

J. RIOTTE[1,2]*, J.-D. MEUNIER[3], T. ZAMBARDI[1], S. AUDRY[1], D. BARBONI[3], K. ANUPAMA[4], S. PRASAD[4], J. CHMELEFF[1], F. POITRASSON[1], M. SEKHAR[2,5], J.-J. BRAUN[1]

[1] GET, UPS/IRD/CNRS, Toulouse, France
[2] Indo-French Cell for Water Sciences, IISc Bangalore, India
[3] CEREGE, AMU/CNRS/IRD, Aix en Provence , France
[4] French Institute of Pondicherry, Pondicherry, India
[5] Indian Institute of Science, Bangalore, India

Silicon isotopic fractionations during water-plant-rock interactions were investigated in the tropical forested watershed of Mule Hole (Southern India) to assess: (1) the homogeneity of δ^{30}Si in litter (tree leaves, grass) and soil amorphous silica (ASi), (2) the δ^{30}Si produced during phytolith dissolution, (3) the isotopic silica budget at the soil-plant scale and (4) the consistency between water sources and δ^{30}Si variations in a short-lived stream.

The δ^{30}Si of present-day litter phytoliths and soil ASi varies within a narrow range, from 1.10 to 1.40‰ for almost all samples, making the δ^{30}Si a possible proxy of litter/phytolith contribution to silica budgets. Litter-ash dissolution exhibits δ^{30}Si as low as -1.41‰ after few minutes of water-ash interaction, but after few hours a composition close to phytoliths (>1‰) is recovered. At the soil-plant scale, the average δ^{30}Si of soil infiltrating solutions confirms phytoliths as the source of soil dissolved Si. The isotopic budget of dissolved Si within the soil layer implies that up to 4400 mol.ha^{-1}.yr^{-1} of silica could be taken up by the vegetation, which is twice more than the initial estimation from the solute budget only (Riotte et al., 2014 GCA). Assuming a Rayleigh model once Si is taken up by plants, the additional silica (likely stored in woody stems) should have a δ^{30}Si close to 0‰, i.e. enriched in light Si isotopes compared to the litter. Possible Si sources include weathering of Al-poor primary minerals from the soil, desorption from soil clays or deep root uptake. At the outlet of the watershed, the stream exhibits low δ^{30}Si (0.28 to 0.71‰) during peak flows and high δ^{30}Si (1.29 to 1.61‰) during recessions, at the end of the rainy season. While heavy δ^{30}Si signatures are consistent with soil seepage contribution, the light δ^{30}Si during peak flow is not matching the overland flow signature. A minor but significant contribution of phytoliths dissolution from the suspended load may explain the low δ^{30}Si. This study highlights the potential of δ^{30}Si for improving silica budgets at both soil-plant and watershed scales.