Neodymium stable isotope behaviour accompanying basalt weathering

JOSH GRATTAGE[1], ALEX J. MCCOY-WEST[1], SIGURDUR R. GISLASON[2], GEOFF M. NOWELL[1] AND KEVIN W. BURTON[1]

[1]Dept. Earth Sciences, Durham University, Durham, DH1 3LE, UK (*joshua.grattage@durham.ac.uk*)
[2]Institute of Earth Science, University of Iceland, IS-101 Reykjavík, Iceland

Neodymium (Nd) stable isotope behaviour during weathering is potentially controlled by a number of factors, including; source rock composition, the dissolution and precipitation of primary and secondary minerals, adsorption onto colloids or particles, and complexation with organic and inorganic ligands. This study presents comprehensive Nd stable isotope data for soils, rivers and estuarine samples from a catchment in Iceland, where source rock compositional variability is minimized.

Neodymium stable isotopes (^{146}Nd/^{144}Nd) were measured using double-spike and TIMS techniques [following 1], with a typical uncertainty of ±0.02‰ (for 5ng or more) for the δ^{146}Nd composition. Average catchment bedrock yields a δ^{146}Nd value of −0.04‰. Wetland soils, reflecting relatively high weathering degrees under variable redox conditions, possess δ^{146}Nd compositions both heavier and lighter than average catchment bedrock. Soil pore waters possess δ^{146}Nd compositions that are systematically heavier than their host soil, with δ^{146}Nd up to +0.15‰. These variations are consistent with complexation/solubilisation by organic matter or adsorption/dissolution of Fe-Mn oxyhydroxides. Rivers possess δ^{146}Nd compositions that are generally heavier than bedrock or soil (δ^{146}Nd up to 0.38‰), with elemental and isotope variations suggesting that they form a continuum with the soil pore waters. Riverine particulates are slightly heavier than the bedload, likewise estuarine particulates and bedload are also heavy. This may be due to the presence of organic matter, secondary mineral formation, or the preferential adsorption of heavy Nd isotopes onto particulates. Estuarine waters are all heavy showing trends consistent with simple mixing with seawater.

Overall, these results indicate that weathering of basalt yields waters that are heavier than the basaltic bedrock, the dominant controls on this fractionation appear to be uptake and release from organic material, the formation and dissolution of Fe-Mn oxides, and perhaps adsorption onto particulates.

[1] McCoy-West et al. (2017) EPSL 480, 121