Weathering control of mineral-carbon sorption at hillslopes under different climates

KYUNGSOO YOO[1]*, ADRIAN WACKETT[2], RONALD AMUNDSON[3] AND ARJUN HEIMSATH[4]

[1]Department of Soil, Water, and Climate, University of Minnesota (*correspondence: kyoo@umn.edu)
[2]Department of Soil, Water, and Climate, University of Minnesota (wacke051@umn.edu)
[3]Dept of Environmental Science, Policy, & Management U.C. Berkeley (earthy@berkeley.edu)
[4]School of Earth and Space Exploration, Arizona State University (Arjun.Heimsath@asu.edu)

There has been an important paradigm shift in understanding major controls of carbon turnover in soils. Contrary to or in addition to the long-held view that intrinsic molecular structure of organic matter determines its decomposability in soils, associations between organic matter and minerals are increasingly considered as primarily controlling the turnover of organic matter. This alternative view allows consideration of the soil carbon cycle from the perspective of mineral weathering. Here we investigated two hillslopes in Southeast Australia that share well-constrained but similar granodiorite bedrocks and catchment-averaged denudation rates. Neither hillslope has been cultivated. The two sites differ, however, in their present climates. Frog's Hollow (FH) is significantly drier (MAP of 550-750 mm) and cooler than Nunnnock River (NR) (MAP of 1200 mm). Along the two hillslope transects, we determined carbon contents, XRD mineralogy, elemental chemistry, and BET mineral surface area. Soil carbon inventories are substantially larger at NR (4.4 – 9.3 kg C m^{-2}) than FH (1.8 – 7.9 kg C m^{-2}), as is the BET mineral surface area (6-9 m^2g^{-1} at NR vs. 3-9 m^2g^{-1} at FH). At both sites, soil carbon contents, BET mineral surface area, and mineral surface area occluded by organic matter significantly increase from the ridge soils to depositional hollow soils. The intensity of this increase is substantially larger at FH. These results suggest that minerals' differential capacity to sorb organic matter may contribute to larger soil carbon storage at the wetter and warmer NR site. On a landscape scale, the drier FH environment, presumably due to the contrast in soil moisture between convex and convergent parts of the hillslope, exhibits a stronger topographic control on the generation of mineral surface area and carbon-mineral interactions.