Role of tree roots on porosity evolution during shale weathering

XIN GU[1], ELIZABETH A. HASENMUELLER[2], JASON KAYE[3] AND SUSAN L. BRANTLEY[1,4]

[1]Department of Geosciences, The Pennsylvania State University, University Park, PA 16802, USA (xug102@psu.edu)
[2]Department of Earth and Atmospheric Sciences, Saint Louis University, Saint Louis, MO 63108, USA (hasenmuellerea@slu.edu)
[3]Department of Ecosystem Science and Management, The Pennsylvania State University, University Park, PA 16802, USA (jpk12@psu.edu)
[4]Earth and Environmental Systems Institute, The Pennsylvania State University, University Park, PA 16802, USA (sxb7@psu.edu)

Porosity formation plays an essential role in transforming bedrock to regolith, and this process is highly coupled with plant growth. However, field studies aimed at quantifying weathering have largely been unable to tease out the specific contributions of biota with respect to porosity formation, and ultimately, the weathering process.

Neutron scattering is emerging as an important tool in quantifying porosity, connectivity, surface area and the fractal dimensions of pore networks in rocks. Here, we use combined small angle neutron scattering (SANS) and ultra small angle neutron scattering (USANS) to characterize the pore structure in shale chips recovered from trenches (around 1.5 m deep) at a ridge top and a mid-slope in the Susquehanna Shale Hills Critical Zone Observatory (SSHO). The shale chips were collected as two groups: showing interaction with roots and no interaction with roots.

Preliminary results show that both the porosity and connectivity of the shale chips from regolith/saprolite are higher than the unweathered bedrock. The shale chips from the ridge top have significantly higher porosity than those in mid-slope. This observation agrees with the concept that the weathering advance rate is diffusion-limited, so higher porosity result in higher weathering advance rates, as observed in ridge top settings. Tree roots have positive effects on the porosity development at mid-slope; however, they have negative impact at the ridge top. We infer that at the ridge top, the tree roots promote secondary mineral precipitation by taking up water, while at midslope where the weathering rate has been observed to be lower, tree roots enhanced the dissolution/disaggregation of primary minerals and therefore the development of the pore network without as much mineral precipitation.