Soil aggregation as a scale-dependent process to stabilize organic matter

JOHANNES LEHMANN[1]*, ANGELA POSSINGER[2], TARA WEBSTER[2], DAN BUCKLEY[2]

[1]Soil and Crop Sciences, Atkinson Center for a Sustainable Future, Cornell University, Ithaca, NY 14853, USA, (*correspondence: CL273@cornell.edu)
[2]Soil and Crop Sciences, Cornell University, Ithaca, NY 14853, USA

Aggregation has been discussed for several decades as a major mechanism that stabilizes organic matter in soil. Development of an aggregate hierarchy emerged as a useful approach to recognize morphologically observable scale dependency between micro- and macro-aggregates. The definition of micro-aggregate sizes with a range of 50 to 250 microns allowed physical fractionation methods to provide significant new insights into particulate organic matter dynamics within different aggregate size classes. With the advent of microscopy that is able to provide not only morphological information but also isotopic and functional group composition at sub-micrometer scale, the investigation of aggregation effects in aggregates below 50 microns is now possible. Using near-edge x-ray fine structure (NEXAFS) and electron energy loss (EEL) spectromicroscopy, NanoSIMS, and laser-ablation aerosol mass spectrometry, we show that important gradients of organic matter properties exist within aggregates smaller than 50 microns. At very small scales of microns, differences of organic matter composition between pores and on mineral surfaces (Figure) may still confer important control on mineralization. We will also critically evaluate the effect of the composition of organic matter inputs on pathways of carbon incorporation into aggregates and interactions with mineral surfaces as well as evidence for nano-aggregation during precipitation of iron oxides.

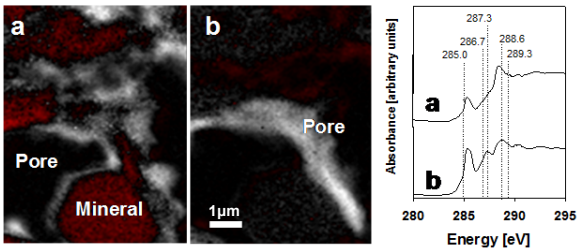

Figure: Carbon NEXAFS of a thin section of a soil showing greater proportion of carboxyl functional groups close to mineral surfaces and more aromatic functional groups in pore spaces.