



Properties and Function of Black Carbon in Soil

J. Lehmann, B. Liang, D. Solomon

Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853, USA (Email: CL273@cornell.edu / Phone: 607-254-1236)

While the quantification of black carbon (C) in soils poses great challenges and very little is known about global black C stocks, even less information is available about the properties or the function of black C in soil. This shortcoming is partly rooted in the fact that no suitable techniques are available to physically isolate black C. A second challenge is the fact that black C is present as very small particles in soil and therefore bulk properties may be less important than surface properties, for which no suitable techniques have been available up to now. In this study, black C particles derived from biomass burning were ultra-sectioned using a novel embedding procedure, and cross-sectional maps of C forms were obtained by synchrotron-based Scanning Transmission X-ray Microscopy (STXM) using Near-Edge X-ray Absorption Fine Structure (NEXAFS) analysis. Compared to fresh charcoal which showed mainly amorphous C structures, black C isolated from soil with a burning history dating back several hundred years had significant proportions of carbonyl- and carboxyl-C. The surfaces of black C particles were oxidized to a higher degree compared to the center of the particles. Although the bulk of black C is aromatic, black C surfaces have significant amounts of functional groups that can affect nutrient and C cycling. Principle component analysis of the cross-sections provided evidence for oxidation of the black C particle as well as adsorption of non-black C to black C surfaces. While black C is commonly considered to be an inert pool of soil organic matter, our results indicate that black C may influence biogeochemical cycles in soil. Further, comparison between particles from different soils showed that black C properties vary widely and should be considered when assessing the role of black C in soil.