



Quantification of black carbon in soil: introducing a sliding scale with STXM and NEXAFS spectroscopy

J. Lehmann (1), K. Heymann (1), J. Skjemstad (2), E. Krull (2), M. Schmidt (3)

(1) Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853, USA (Email: CL273@cornell.edu / Phone: 607-254-1236), (2) CSIRO Land and Water, Glen Osmond SA 5064, Australia, (3) Department of Geography, University of Zuerich, CH-8046 Zuerich, Switzerland

Quantification of black carbon in soils continues to be one of the greatest challenges to advances in understanding black carbon properties and dynamics. The challenge mainly arises from the fact that black carbon constitutes a continuum of substances with necessarily different properties. Any given method so far defined a certain cut-off in chemical properties as the criterion for whether a certain form of carbon is considered black carbon or not. These cutoff points are often difficult to define. In addition, different study objectives as well as different environments may necessitate different definitions of black carbon. These constraints may make a method favorable that uses a sliding scale of organo-chemical properties that can be developed for specific types of black carbons or research questions. We use synchrotron-based Scanning Transmission X-ray Microscopy (STXM) in combination with Near-Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy to develop criteria for chemical properties that warrant defining a certain form of organic matter as black carbon. Once defined, these spectral properties can be applied to NEXAFS spectra collected from total soil using fluorescence or total electron yield. NEXAFS spectra were collected from standard substances used for an international ring trial for the quantification of black carbon. Single black carbon particles from soils of known age revealed a greater aromaticity than spectral properties of standard soot and chars would suggest. The significant systematic variation in chemical forms within black carbon properties from soils results in a wide range of possible definitions and therefore calculable quantities of black carbon. The quantification of total black carbon in soil using a sliding scale of spectral properties determined by STXM of individual black carbon particles may

offer a significant advance for studying black carbon dynamics.