A Spectromicroscopic Study of Soil Organic Matter

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Introduction: Soil Organic Matter (SOM) can be described as the total of organic compounds in soils excluding undecayed plant and animal tissues, their "partial decomposition" products, and the soil biomass. SOM plays an important role in the chemical reactivity of soils. Most information on the chemical behavior of SOM is obtained from probing the different functional groups present in SOM. The disadvantage of most conventional techniques used to characterize SOM group functionality is that only the bulk chemistry is probed.

We used the scanning transmission x-ray microscope (STXM) at beamline X1A to image the morphology of SOM in a hydrated New Hampshire peat bog soil at a 100nm spatial resolution. Stacked[1] spectra at the same resolution were taken at the 280-300eV energy range. In order to speciate the SOM Carbon, SOM spectra were "fingerprinted" with small organic acids with known structure. Since functional groups in both the reference organic acids and SOM represent C in different bonding environments, these functional groups showed up as distinct peaks in the C 1s excitation NEXAFS spectra.

Figure 1 shows spectra collected of different particles present in the soil. We were able to assign the different peaks present by fingerprinting these spectra with reference spectra of small organic acids.

This approach enabled us to study both the physical and chemical properties of SOM *in situ* and with a high spatial resolution. Future *ab initio* calculations will be performed on the C 1s excitation spectra of reference compounds that represent the local atomic and the delocalized electronic environment of all different functional groups that could be present in SOM. The experimental and computational studies of the small model components will be used as a basis for quantitative speciation of the principle components of the complex SOM.

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References: 1. C. Jacobsen *et al*., "Soft x-ray spectroscopy from image sequences with sub-100 nm spatial resolutions," Journal of Microscopy 197 p 173-184, 2000

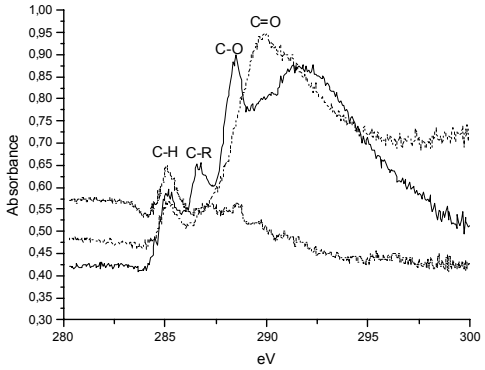

Figure 1. C1s excitation spectra of different soil particles