Investigation of a Soil at the Carbon K-Absorption Edge

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Beamline(s): **X1A**

Introduction: Humic substances are considered to be the major component of the soil organic matter. These humic substances play a mayor role in controlling the physical and chemical properties of the soils, e.g. soil fertility, sorption capacity for nutrients and toxicants. So, it is of great interest how this organic matter is attached on other soil colloids. Because of their size in the colloidal range the soft X-ray microscopy with its spatial resolution under 100 nm is the useful method for investigation of those substances and their reactions.

Methods and Materials: Our investigations were performed at the beamline X1A with the scanning X-ray transmission microscope. This instrument has the possibility to combine a high spatial resolution with a high spectral resolution. The experiments were performed at the carbon K-absorption edge.
The investigated soil is a calcaric phaeozem (black soil), a soil with a high organic content (in this sample 4,1% dry base humus content). The aim was to get more information about the composition of the organic matter and if there are varieties in the composition at different spots. The taken data were analyzed with the "stack" software[1]. So it is possible to get spectra of different spots of the sample at the same time.

Results: Previous experiments have shown that the distribution of the organic matter is not homogenous on the surface of the clay particles [2]. There are areas with higher and lower amounts of carbonaceous compounds in the sample. The aromatic and aliphatic character of the organic matter can be determined from the ratios of the peak intensities in NEXAFS spectra, which are taken at different spots. This could indicate what kind of organic matter is adsorbed on the colloids. The π^*-resonances of the aromatic C-C binding is at 285 eV and the resonance of the aliphatic groups CH_2, CH_3 is at 287 eV. The spectrum in **Figure 1** looks very similar to the spectrum of the dry humic substance, extracted the from this soil, which was spectroscopically characterized in previous experiments [3]. In the spectrum in **Figure 2** the peaks for the aliphatic groups (287 eV) are higher. This organic matter has a different composition than the humic substance at the spots in figure 1.

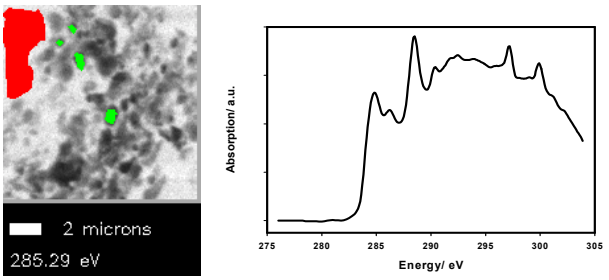

Figure 1. STXM image of the soil. The red area indicates the area of I_0 , the green dots the areas, where the right spectrum is taken. The spectrum shows the characteristic features of the dry humic substance.

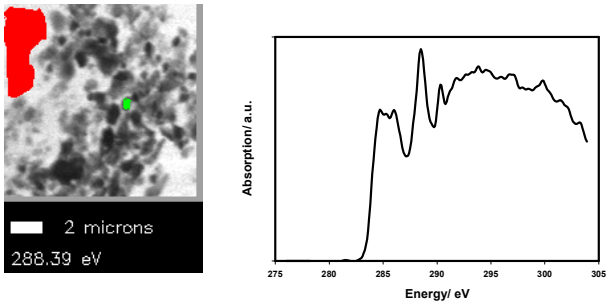

Figure 2. Spectrum of another area (green dot) shows a higher peak at the energy for the resonance of the aliphatic groups at 287 eV.

Conclusions: These experiments show the heterogeneity of the organic matter in soils of the colloidal length scale. The identification of different organic matter in this soil with NEXAFS spectra is possible. These results can be for example the basis for further studies of interactions of soil colloids with anthropogenic xenobiotica.

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References: [1] C. Jacobsen, G. Flynn, S. Wirick, C. Zimba "Soft x-ray-spectroscopy from image sequences with sub 100 nm spatial resolution.", **197,** 173-184, Journal of Microscopy, 2000; [2] C. Schmidt, U. Neuhäusler, J.Thieme, "Carbon mapping in hydrated soil samples" Abstract 7-57, NSLS Activity Report 1999; [3] C. Schmidt, J. Thieme, U. Neuhäusler, U. Schulte-Ebbert, G. Abbt-Braun, C. Specht, C. Jacobsen, "Association of particles and structures in the presence of organic matter." Proceedings 6th Intl. Conf. X-Ray Microscopy, Berkeley, California, August 1999. AIP Conference Proceedings **507**, p. 313-318, 2000