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Chemical heterogeneity of humic substances and mobile soil colloids studied by X-ray microscopy and microspectroscopy

M. SCHUMACHER[1], A.C. SCHEINOST[2], I. CHRISTL[1], C. JACOBSEN[3] AND R. KRETZSCHMAR[1]

[1] Swiss Federal Insitute of Technology (ETH), Zurich, Switzerland (schumacher@env.ethz.ch; christl@env.ethz.ch; kretzschmar@env.ethz.ch)
[2] European Synchrotron Radiation Facility (ESRF), Grenoble, France (andreas.scheinost@esrf.fr)
[3] State University New York (SUNY), Stony Brook, USA (jacobsen@xray1.physics.sunysb.edu)

Humic substances play an important role in many biogeochemical processes. The bulk chemical properties of humic substances have been investigated extensively during the past decades, applying a wide range of analytical techniques. Due to the inability of most methods to provide spatially resolved information, little is still known about the chemical heterogeneity of humic substances at the microscopic level [1,2]. Scanning Transmission X-ray Microscopy (STXM) offers a new tool for investigating the morphology and the chemical functional group composition of humic colloids with a spatial resolution of about 30 nm. Since the quantitative interpretation of C-XANES spectra of humic substances is not yet fully understood, our objectives were (i) to analyze a set of well-characterized standard humic substances by C-XANES spectroscopy and compare the spectral features with data obtained from solid-state CP-MAS ^{13}C-NMR microspectroscopy for characterizing mobile soil colloids. Soil material from three soil types was analyzed in order to show the chemical decomposition of humic substances with varying water content, pH and depth. The results show that STXM is well suited to investigate semi-quantitatively the chemical functional group distribution of humic substances and mobile soil colloids. With the use of X-rays with wavelengths of 280 eV, it is possible to map the carbon content of humic substances and colloidal particles in the presence of water and iron with an extremely low amount of sample material. Furthermore, the high spatial resolution allows to resolve and image intra-particular heterogeneities at the micron and submicron scale. All these unique features are making STXM a unique tool for the in-situ investigation of environmental samples.

References

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