

Characterization of mineral-associated organic matter: a combined approach of AFM and NanoSIMS

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The heterogeneous spatial distribution and amount of organic matter (OM) in soils, especially at the micro- or submicron-scale, has major consequences for the soil microstructure and for the accessibility of OM to decomposing microbial communities. Processes occurring at the microscale control soil properties and processes at larger scales, such as macro-aggregation and carbon turnover. Since OM acts as substrate and most important driver for biogeochemical processes, particular attention should be paid to its spatial interaction with soil minerals. In contrast to bulk analysis, Nanoscale Secondary Ion Mass Spectrometry (NanoSIMS) offers the possibility to examine the composition and spatial distribution of OM within the intact organo-mineral matrix. Nevertheless, the yield of secondary electrons is influenced by the individual topography of the analysed particles, which aggravated the quantitative interpretation of the data. A combination of NanoSIMS and Atomic Force Microscopy (AFM), enabled us to visualize and quantify the topographical features of individual particles and correct the NanoSIMS data for this effect.

We performed adsorption experiments with water-soluble soil OM in 6 concentration steps, which was extracted from forest floor layer of a Podzol, and adsorbed to illite. Upon the end of the sorption experiments the liquid phase and the solid phase were separated and the carbon content was analysed with TOC- and C/N-measurement, respectively. For the spatially resolved analyses, the samples were applied as thin layers onto silicon wafers and individual particles were chosen by means of the AFM. Subsequently, the identical particles were analysed with NanoSIMS to investigate the distribution of C, N, O, Si, P and Al.

The recorded data were analysed for differences in elemental distribution between the different concentration steps. Additionally, we performed a correlation of the detectable counts with the topography of the particle within one concentration step and compared these results as a function of the carbon content at the mineral phase.