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Spatially resolved quantification of organic matter in synthetic organo-mineral associations by NanoSIMS

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Soil structure is resulting from soil forming processes at the molecular scale, but has feedbacks on soil functions on macroscopic or even global scales. In this framework, soil organic matter (SOM) is of special importance as a gluing agent for soil structure, besides being a carbon sink.

Conventional bulk-scale analyses allows for quantification and for a characterisation of the chemical bonding types of OM. However, all information of the spatial distribution of OM on the relevant scale of few nano- to micrometres is lost during this kind of analyses. While nano-scale secondary ion mass-spectroscopy (NanoSIMS) delivers qualitative data on the spatial distribution of SOM at the nano-scale, receiving quantitative data from this method remains challenging due to matrix and charging effects. In order to overcome this problem, the aim of this study was to develop scaling factors between conventional bulk-scale methods and NanoSIMS.

For developing these factors, dissolved organic matter (DOM) was extracted from organic material, which was sampled from a podzol. Subsequently, model minerals, such as boehmite and illite, were loaded with defined amounts of this DOM by means of sorption experiments. After the end of the experiments the liquid and solid phases were divided by means of centrifugation and the solid phase was subjected to freeze drying. Carbon and nitrogen content of the solid and liquid phases were measured via C/N and TOC analyses, respectively. The measured data was fitted with Freundlich-type adsorption isotherms. Samples for NanoSIMS analyses were distributed onto silicon wafers as individual particles. The following elements were analysed: C, N, O, Si, S and Al. Spatially resolved analysis of the NanoSIMS data yielded a increased detection of SOM on the minerals in higher concentration steps.

Linear relationships with high correlation and low deviation were found when comparing the spatially resolved NanoSIMS data with the bulk scale methods. The developed scaling factors, therefore, allow for quantification of NanoSIMS data in simple sample systems. In contrast to the bulk-methods spatial resolution and heterogeneity of SOM distribution are preserved in this new approach.