Organo-mineral interactions in soils as delineated from nanoSIMS

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Soil structure is resulting from soil forming processes involving organic and mineral materials at the molecular scale, and determines major soil functions. In this context soil organic matter is not only of importance as a carbon sink, but also as a gluing agent for soil structure.

The spatial distribution of elements characteristic of organic matter (e.g., C or N) and minerals (e.g., Fe, Al, O, or Si) in soils and sediments at the sub-micrometer scale is of special interest for the identification of key biogeochemical processes, such as C sequestration. Nanoscale secondary ion mass spectrometry (NanoSIMS) delivers high lateral resolution and the simultaneous measurement of seven ionic species. NanoSIMS provides unrivalled insights into the microstructure of soils, sediments and organo-mineral associations. This makes it a promising tool to gain insights into soil and sediment systems at the relevant sub-micrometer scale. Research has mainly focused on the preferential adherence of OM to specific single minerals and mineral clusters, their arrangement (patchy or homogeneous coatings), and spatial heterogeneity. Labeled OM enriched with ^{15}N and/or ^{13}C can be directly observed in situ on mineral surfaces of grainy samples (e.g., clay fraction). However, the technique typically fails to provide quantitative data on the concentration of certain ion species. The scaling factors developed in a recent study [1] enable accounting for matrix effects of various minerals on the detected quantity of organic matter.

Examples will show the application of the technique to study the biogeochemical element distribution in different soil compartments. The formation of organo-mineral associations during the initial development of soils is delineated in a chronosequence study. Visualization of element distributions with high spatial resolution allowed distinguishing different zones of minerogenesis and organo-mineral interactions in the rhizosphere of a soil. The results allow to draw conclusions about soil forming processes at plant-soil interfaces.

[1] Schurig *et al.* (2016) *Clays and Clay minerals*, in press.