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A new insight into microscale natural organic matter dynamics - using NanoSIMS

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The knowledge about the factors controlling the preservation of soil organic matter (SOM) and the involved mechanisms has substantially improved over the last years. Nevertheless, these processes are still hard to evaluate in situ.

In the presented work, we studied the alteration of the spatial distribution of isotopically labelled OM in situ with time on single particles and within intact soil aggregates.

As single particles we used a fine silt / clay mixture (<6.3 μm) from an Albic Luvisol (Germany). The intact soil aggregates (<6.3 mm) were derived from a Haplic Chernozem (Russia). These sample materials were selected due to their significantly different 14C signatures with modern SOM of the fine silt / clay mixture and very old SOM of the aggregates. The sample composition was evaluated by 13C-CPMAS NMR spectroscopy and energy dispersive X-ray spectroscopy (EDX).

To track the in situ fate of fresh introduced OM both sample materials were incubated and isotopically labelled. We used a labelled amino acid mixture (min. 98 atom% 13C and 15N) as readily bioavailable OM input and isotopic tracer. The samples were incubated for 6 days and sub-samples were regularly withdrawn. The single particles were deposited on silicon wafers, whereas aggregates were resin embedded for subsequent analyses by scanning electron microscopy (SEM) and nano-scale secondary ion mass spectrometry (NanoSIMS 50).

With the isotopic sensitivity of the NanoSIMS 50, we were able to follow the fate of 13C and 15N, which we expect to be influenced by diffusion, sorption and microbial activity. A clear isotopic enrichment was found for both analysed sample materials. Furthermore, we showed spatial heterogeneities in the isotopic enrichment on the surface of single particles. The analysed microaggregates of the fine silt / clay mixture were less enriched in 13C and 15N than single particles. The given results demonstrate the high potential of the NanoSIMS technique for studies on the fate of OM at a microscale.