



Fate of small charred particles in soils - importance of aggregation

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Historic and recent fires affect a broad range of terrestrial ecosystems and are reflected in the composition of soil organic matter (SOM). Although the assignments of different sources and pools of black carbon (BC) are still under debate, the importance of BC for carbon (C) storage, nutrient supply and contaminant sorption is well recognized. Nevertheless, how processes of encapsulation of BC into aggregates may influence fate and properties of BC still needs further research.

We observed small highly aromatic particulate OM (oPOM_{small}, <20 µm) exclusively occluded within aggregates in a range of soils. As these particles were absent in the inter-aggregate soil space the question of the importance of soil aggregation for the fate of these particles is raised.

In the presented study we analysed intact soil aggregates and the distribution of highly aromatic micro-scale charred particles and mineral bound SOM in Haplic Chernozems from Central Russia. We fractionated the soils by means of density to obtain particulate and mineral bound SOM fractions. The chemical composition of the obtained fractions was studied by solid-state ¹³C-NMR spectroscopy and energy dispersive X-ray spectroscopy (EDX). For visualization of the particles and aggregates we used scanning electron microscopy (SEM) and nano-scale secondary ion mass spectrometry (NanoSIMS). The importance of oxides for aggregate formation was elucidated by analyses of extractable Fe. Furthermore, we incubated the oPOM_{small} fraction at 20°C in batch experiments to study the aggregate formation of charred particles with time. To track the fate of OM on new formed aggregates, we used a labelled amino acid mixture (min. 98 atom% ¹³C and ¹⁵N) as readily bioavailable OM input and isotopic tracer.

The matrix of the intact soil aggregates, embedded in epoxy resin, was dominated by densely packed clay particles. At all depths particulate SOM was quantitatively dominated by the aromatic oPOM fractions, inter-aggregate POM was almost absent at higher depths. The oPOM_{small} showed mainly amorphous structures and very few plant tissue structures as revealed by SEM. The oPOM_{small} fraction showed a drastic increase in the content of aromatic C with depth along with decreasing aliphatic C in the thick A horizons. Almost the entire OM of the oPOM_{small} fraction was composed of aromatic C compounds in the AB horizons. The incubation experiment with particles from the oPOM_{small} fraction revealed a fast aggregate formation in water within a few days. With the isotopic sensitivity of the NanoSIMS 50, we were able to show spatial heterogeneous enrichments in ¹³C and ¹⁵N on new formed aggregates of aromatic particles.