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Occluded in soil aggregates - the fate of microscale organic matter particles

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Soil structure is known to play a vital role for a large number of soil functions including the long term sequestration of organic carbon (OC). The restricted bioavailability of OC in intact soil aggregates is assumed to be related to the reduced diffusion of water and enzymes and to the restricted accessibility by microbial cells itself. The use of density fractionation protocols allows to differentiate between free soil organic matter (SOM) particles and such entrapped in aggregated soil structures, the occluded particulate organic matter (oPOM) fractions. Besides a rather undecomposed large oPOM fraction, an operationally defined small oPOM fraction (oPOMsmall) turned out to represent an old and often relatively stable SOM fraction. By just using a 20 μm sieve to rinse off excessive Sodium Polytungstate from the oPOM fraction it is possible to obtain a highly decomposed oPOMsmall with low 14C contents but large contents of either aliphatic or aromatic OC.
To discuss the distribution, composition and fate of the oPOMsmall I will present a range of analytical approaches reaching from incubation experiments, to the analyses of the chemical composition (e.g. Cu-oxide extraction, 13C-CPMAS NMR spectroscopy) and isotope analyses (e.g. 13C, 14C). In parallel the use of state of the art imaging techniques (e.g. scanning electron microscopy (SEM), nano-scale secondary ion mass spectrometry (NanoSIMS)) allows to locate the small OM particles within intact soil microscale structures. It is demonstrated that the oPOMsmall represents an important OC pool in soils reaching over a wide range of climatic regions (e.g. Alaska, Central Europe), and over diverse land management systems. For OC rich soils in Central Russia and Permafrost soils it even can represent the most important particulate OM fraction. At the same time it can also be demonstrated that these micro scale OM particles represent an important agent in the formation of soil aggregates and thus soil structure development.