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FTIR spectroscopic analysis of organic matter originating from pedogenetic and geogenic processes

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Soil organic matter consists of different organic matter (OM) pools such as plant litter in different stages of decomposition and old organic carbon, which may originate from pedogenic (e.g. Chernozems), from geogenetic (e.g. brown coal) or anthropogenic processes (e.g. soot originating from coal burning). Such old organic carbon (C) often called black carbon could be a significant fraction of the organic carbon buried in soils and sediments. For a soil from a long-term field experiment at Halle, old carbon as a result of Chernozem genesis (pedogenetic) and/or brown coal dust deposition (geogenetic) was documented (Rethemeyer et al. 2004, Ellerbrock and Kaiser, 2005). For topsoil samples from this site the effect of fertilization and growing crop on the composition of soluble OM fractions were studied by FTIR. However ^{14}C analysis of sequentially isolated water and sodium pyrophosphate soluble soil organic matter fractions show that these fractions contain a high amount of old C. This could be caused by partly soluble Chernozem C and Brown coal C. Consequently it was difficult to distinguish between effects of fertilizers + crops and effects of soluble old C fraction on OM composition. For that a characterization of the old C fractions and their solubility is needed.

Differences in genesis of pedogenetic and geogenetic OM fractions could result in differences of their functional composition. Functional composition means kind and amount of functional groups like hydroxyl or carboxyl groups. Differences in functional composition could be detected be spectroscopic methods like FTIR. Mine soils from coal mining contain only geogenetic old C fractions. Therefore FTIR spectra of these old OM fraction could help to interpret the data from the different soluble OM fractions obtained from the Chernozem topsoils at Halle. However during reclaiming especially the topsoil of mine soils will be influences by land use. To investigate the original old C and old C fractions which were influenced by land use we take reclaimed mine soil samples from the topsoil (0-16 cm) and the subsoil (83-110 cm) of lignite-containing mine soil profile under forest (Northeast Germany).

As the old OM fractions could be different according to different deposition processes during their genesis, we fractionated the soil samples into different particle sizes (2-0.65 mm, 0.63-0.2 mm and $<$ 0.2 mm) by wet sieving. Differently soluble OM fractions were isolated from the particle size fraction by sequential extraction: 1. step: water extraction directly after ultra sonic treatment, 2. step: water extraction (24 h), 3. step: sodium pyrophosphate extraction. The OM fractions were characterized by FTIR.

About 1 to 5% of the OM from the different particle size fraction was soluble in water or sodium pyrophosphate solution. The FTIR spectra indicated, that the composition of OM fractions from the subsoil samples to that of the topsoil samples. For example the water soluble OM fractions isolated from the coarser sized particles of the subsoil samples show higher absorption intensities of the CO band than those of the corresponding topsoil sample. Additionally the FTIR spectra indicated that the pyrophosphate soluble OM fractions contain higher amounts of CO groups than the corresponding water soluble OM fractions. It could be concluded that the old C from the studied soil samples is partly soluble, and that the isolated OM fractions differ in composition. The most distinct differences in composition of OM fractions were observed for the topsoil samples, OM input from forest litter could cause this. The FTIR spectra of the soluble OM fractions from the subsoil samples were used to improve the interpretation of the FTIR spectra of the Chernozem topsoil samples from Halle.

Reference

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