



Effects of mineral characteristics on the content and stability of organic matter fractions sequentially separated from seven topsoils under temperate deciduous forest

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Mineral topsoils under forest possess high organic carbon (OC) contents and are therefore of large importance for the terrestrial C cycle. However, less is known about the mechanisms controlling the preservation of organic matter (OM) against microbial decomposition in mineral topsoils under temperate deciduous forest. We took samples from the uppermost mineral topsoil horizon (0 to 5 cm) of seven sites under mature deciduous forest in Germany showing OC contents between 69 and 164 g kg⁻¹. The study sites showed a wide range in mineral characteristics supposed to be important for OM protection against microbial attack. At first we removed the organic particles and the water-extractable OM assumed to be less associated with the mineral phase from the soil samples. Thereafter, we sequentially separated the Na-pyrophosphate extractable organic matter (OM(PY)) supposed to be indicative for OM bound via cation mediated interactions in soil and the OM remaining in the extraction residue supposed to be indicative for OM occluded in stable micro-aggregates. The OM(PY) and OM(ER) fractions were quantified and analyzed by ¹⁴C and FTIR measurements. The OC remaining in the extraction residues accounted for 38 to 59% of the bulk soil OC suggesting a much larger relevance of OM(ER) for the OM dynamic in the analyzed soils than with OM(PY) that accounted for 1.6 to 7.5% of the bulk soil OC. Regression analyses indicated an increase in the stability of OM(PY) with the content of Na-pyrophosphate soluble Mg and the soil pH. Therefore, we assume the turnover of OM(PY) in the studied forest mineral surface soils to be influenced by cation mediated interactions between organic molecules such as cross-linking. We detected an increase in the stability of OM(ER) with the contents of clay and oxalate soluble Al that were shown to be involved in the formation of aggregates smaller than 20 μm. Therefore, we assume an occlusion in highly stable micro-aggregates to be important for the turnover of OM(ER). Despite the detected influence of soil mineral characteristics on the turnover of OM(PY) and OM(ER), the Δ¹⁴C signatures indicated mean residence times less than 100 years. The presence of less stabilized OM in these fractions can be derived from methodological uncertainties and/or the fast cycling compartment of mineral-associated OM.