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Soil organic matter composition along a chronosequence in the arctic coastal plain of Northern Alaska

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Various studies show drastic alterations in arctic soils due to climatic change. As over 25% of the global soil carbon (C) is stored in permafrost affected soils, these changes are of special concern. But while bulk soils react relatively slow to changing conditions, the study of soil organic matter (SOM) fractions offer a more detailed picture of the dynamics of differently preserved SOM pools in the climate sensitive arctic regions. Especially the comparison of the mineral associated clay sized SOM with the particulate light OM fractions (POM) may provide a great insight to the carbon stabilization in arctic environments under changing climatic conditions. It can also be assumed that the microbial utilization of different C substrates reflect changes in the quantity and quality of recalcitrant (e.g. black carbon) and labile (e.g. fresh litter) C pools among changing soil conditions (e.g. due to increasing active layers).

Soil chronosequences offer the possibility to study alterations in SOM dynamics over timescales of centuries to millennia. Approximately 50-75% of Alaska's Arctic Coastal Plain is covered with thaw lakes and drained thaw lakes that follow a 5,000 yr cycle of development (between creation and final drainage). The drained thaw lakes offer the possibility to study SOM dynamics affected by permafrost processes over millennial timescales. In April 2010 we sampled 16 soil cores (including the active and permanent layer) reaching from young drained lakes (0-50 years since drainage) to ancient drained lakes (3000-5500 years since drainage). Air dried soil samples from soil horizons of the active and permanent layer were subjected to density fractionation in order to differentiate particulate OM and mineral associated OM. The chemical composition of the SOM fractions was analyzed by 13C CPMAS NMR spectroscopy.

First results show the highly heterogeneous distribution of SOM fractions in the soil cores as driven by cryoturbation. We found small POM (< 20 μm) occluded in aggregated soil structures which differed in the chemical composition from larger organic particles. This was clearly shown by increased amounts of aliphatic C in these small POM fractions. As revealed by 13C NMR, with advancing soil age increasing aliphaticity was detected in occluded small POM fractions. These first results also demonstrate the good applicability of the density fractionation protocol to the studied Cryosols, which is usually used in temperate soils.