Geophysical Research Abstracts
Vol. 14, EGU2012-13072, 2012
EGU General Assembly 2012


# Organic matter stabilization in Cryosols of Northern Alaska - a combined NMR and NanoSIMS study

C. W. Mueller (1), S. Loeppmann (1), C. Hoeschen (1), J. Kao-Kniffin (2), and J. Bockheim (3)

(1) TU Muenchen, Lehrstuhl fuer Bodenkunde, Freising, Germany (carsten.mueller@wzw.tum.de), (2) Department of Horticulture, Cornell University, Ithaca, USA, (3) Department of Soil Science, University of Wisconsin, Madison, USA

Various studies predict altered organic matter (OM) dynamics in arctic soils due to climatic change. While bulk soils react slowly to changing climate, the study of soil organic matter (SOM) fractions may offer a more detailed picture of the dynamics of differently preserved SOM pools in climate sensitive arctic regions. Due to cryoturbation, especially permafrost affected soils exhibit a structurally very heterogeneous matrix across a wide range of spatial and temporal scales. However, processes controlling the stabilization and utilization of SOM happen at submicron scales. In order to combine chemical information of isolated SOM fractions and their possible role in the micro-scale architecture of Cryosols, we combined NMR spectroscopy with scanning electron microscopy (SEM) and nano-scale secondary ion mass spectrometry (NanoSIMS).

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), thus forming a natural soil chronosequence. 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. From some soil cores, subsamples were taken and embedded in epoxy resin for further in-situ microscopic and spectrometric analyses. The NanoSIMS technology allows the simultaneous analysis of e.g. 12C-, 13C-, 12C14N-, 12C15N- and 28Si- with high sensitivity and lateral resolution. This enables the analysis of biogeochemical properties and interfaces at a submicron scale.

Comparable to soils of temperate regions, we found small POM (< 20 $\mu$m) 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 CPMAS NMR, with advancing soil age increasing aliphaticity was also detected in occluded small POM fractions. By the study of micro-scale elemental distributions using NanoSIMS we were able to show the initial formation of aggregates and soil interfaces in the studied permafrost soils. With the predicted enhanced thawing of Cryosols due to global warming, the SOM stabilized within these microstructures will be more exposed to microbial utilization but also to possible translocation into water bodies as rivers and the Arctic sea.