Geophysical Research Abstracts
Vol. 16, EGU2014-12547-1, 2014
EGU General Assembly 2014

Capacity of microorganisms to decompose organic carbon affected by an increasing content of reactive mineral phases in a podzolic soil chronosequence

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Soil organic matter stabilization has received considerable interest in the last decades due to the importance of the soil organic carbon (SOC) pool in the global C budget. There is increasing evidence that the formation of organo-mineral associations play a major role in the mechanisms of organic carbon stabilization, indicating that the persistence of organic matter in soils relates primarily to soil physico-chemical and biological conditions than to intrinsic recalcitrance. Al and Fe oxy-hydroxides and short-range ordered aluminosilicates are known for their high capacity to sorb organic carbon. However, the impact of the evolution of these reactive mineral phases over short time scale on the distribution of microorganisms and their ability to decompose SOC is still poorly understood.

To further study the short-term evolution of organo-mineral associations, we investigated a 500-year podzolic soil chronosequence which is characterized by an increasing amount of secondary reactive mineral phases with pedogenesis and soil age, and thus by increased organo-mineral associations. In order to determine the impact of these secondary mineral phases on the degradation of SOC by microorganisms, an incubation experiment was carried out using soil horizons up to 1m deep from 6 profiles of different ages along the chronosequence. Furthermore, we used amino sugars and phospholipid fatty acids as tracers of dead and living microbial biomass, respectively, in the incubated samples.

Our results show that SOC mineralization was significantly lower in the illuvial Bh/Bhs horizons (which contain more reactive mineral phases) compared to the surface E horizons (depleted in reactive mineral phases), although the content in amino sugars is similar in these horizons. In the deeper Bw and BC horizons, as well as in the young profiles (<300 yrs) that have not yet undergone podzolization and related formation of organo-mineral associations, SOC mineralization rates were the highest. These findings suggest that stabilization of OC through organo-mineral interactions with reactive mineral phases in our study site strongly controls the ability of microorganisms to decompose soil organic matter.