Geophysical Research Abstracts,
Vol. 11, EGU2009-4362, 2009
EGU General Assembly 2009

The origin of nitrogen in reforested lignite-rich mine soils revealed by stable isotope analysis

A. Chabbi (1), M. Sebilo (2), C. Rumpel (2), W. Schaaf (1), and A. Mariotti (2)

(1) Department of Soil Protection & Recultivation, Brandenburg University of Technology, Cottbus, Germany, (2) BIOEMCO (UMR CNRS-Université Pierre et Marie Curie-INRA-IRD), Paris, France (cornelia.rumpel@grignon.inra.fr)

Restoration of the nitrogen cycle is an important step in the recovery of an ecosystem after mining. Carbon and nitrogen in rehabilitated lignite containing mine soils can be derived from plant material as well as from lignite inherent to the parent substrate. We assessed the use elemental and stable carbon and nitrogen isotope measurements to trace the orgin of soil nitrogen and applied these techniques to elucidate the origin of mineral N in the soil and the soil solution.

The conceptual approach of this study included physical fractionation in addition to sampling of vegetation and soil from a lignite-containing mine site rehabilitated in 1985 with Pinus Nigra. We studied the elemental and isotopic composition of bulk samples as well as isolated fractions and soil solution. Isotopic mass balance calculations showed that the highest contribution of plant derived nitrogen to the mineral soil can be observed in the top 0-10 cm, amounting to values between 15 and 27 % of the total nitrogen present at this depth. Below, the contribution of plant derived nitrogen is between 2 and 11 %, whereas it is almost absent in 110 cm depth. 14C activity measurements indicated a plant-derived C contribution of 59 and 16 % of total C in the H horizon of the forest floor and the 0-5 cm layer of the mineral soil respectively. Lignite contribution to the H horizon is due to deposition of lignite-rich airborne contamination. In 100 cm depth, similar to plant-derived N, contribution of plant-derived C was absent. Using these data, we calculated a C/N ratio of plant-derived SOM between 24 and 17 in the H and 0-5 cm layers, which are values commonly observed for Pinus ecosystems and indicate that the use of stable N isotopes may be adequate to calculate the contribution of plant-derived N.

NH4-N sampled from soil solution is almost exclusively derived from plant material in 0-5 cm depth. In 20-40 cm depth, which corresponds to a good portion of the rooting zone of the plants, lowest contribution of plant-derived N to NH4-N was recorded. This may be explained either by preferential uptake of plant-derived N or by isotopic fractionation of nitrogen during its uptake. Even in the lowest soil horizons, plant-derived N still represents more than 20 % of soil solution NH4-N despite the absence of plant-derived N in the solid phase.

Our data indicate that the stable carbon and nitrogen isotopic composition of the soil samples are the result of mixing between plant material and substrate inherent lignite. Stable N isotopes may be used as indicators of nitrogen contribution from plants to solid samples as well as soil solution. N-isotope composition of ammonia shows low spatial and inter-annual variability, despite strong concentration changes. Plant-derived nitrogen contributes in higher amounts to the soil solution compared to the bulk mineral soil.