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Characterization of interactions between soil solid phase and soil solution in the initial ecosystem development phase

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In the initial phase of soil formation interactions between solid and liquid phases and processes like mineral weathering, formation of reactive surfaces and accumulation of organic matter play a decisive role in developing soil properties.

As part of the Transregional Collaborative Research Centre (SFB/TRR 38) 'Patterns and processes of initial ecosystem development' in an artificial catchment, these interactions are studied at the catchment 'Chicken Creek' (*Gerwin et al.* 2009). To link the interactions between soil solid phase and soil solution at the micro-scale with observed processes at the catchment scale, microcosm experiments under controlled laboratory conditions were carried out. Main objectives were to determine the transformation processes of C and N from litter decomposition within the gaseous, liquid and solid phase, the interaction with mineral surfaces and its role for the establishment of biogeochemical cycles.

The microcosm experiments were established in a climate chamber at constant 10 ˚C. In total 48 soil columns (diameter: 14.4 cm; height: 30 cm) were filled with two different quaternary substrates (sand and loamy sand) representing the textural variation within the catchment at a bulk density of 1.4-1.5 g*cm^{-3}. The columns were automatically irrigated four times a day with 6.6 ml each (corresponding to 600 mm*yr^{-1}). The gaseous phase in the headspace of the microcosms was analysed continuously for CO_2 and N_2O contents. C and N transformation processes were studied using ^{13}C and ^{15}N labelled litter of two different plant species occurring at the catchment (*Lotus corniculatus, Calamagrostis epigejos*) that was incorporated into the microcosm surface. All treatments including a control ran with four replicates over a period of 40 weeks. Two additional microcosms act as pure litter controls where substrate was replaced by glass pearls. Litter and substrate were analysed before and after the experiment. Percolate was continuously collected and analyzed in two weeks intervals for C and N contents (including $\delta^{13}C$), pH and ion concentrations.

The results show that the initial phase of the experiment is characterized by intensive leaching of C and N from the litter and transformation as well as leaching from the substrate. Calcium leaching is caused mainly by carbonate dissolution from the substrates. In contrast, magnesium and especially potassium are leached in initially high amounts from the litter, but are strongly retained in the soil. The addition of litter promotes microbial CO_2 production as shown by a strong increase of respiration due to easily available organic substances at the beginning of the experiment. Litter of *L. corniculatus* induced also a high initial peak in N_2O emission as well as higher nitrification and NO_3-N leaching. Leaching of DOC and TDN was clearly affected by the substrate texture, illustrated by intensive DOC leaching from the sand at the beginning of the experiment but shifting later to higher leaching rates from the loamy sand.

References:

Gerwin W, Schaaf W, Biemelt D, Fischer A, Winter S, Hüttl RF (2009) The artificial catchment "Chicken Creek" (Lusatia, Germany) - a landscape laboratory for interdisciplinary studies of initial ecosystem development. *Ecological Engineering* 35, 1786-1796.