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Microcosm experiments to study the interaction of solid and solute phases during initial soil development

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During the initial phase of soil formation mineral weathering, interactions between the solid and liquid phases as well as accumulation of organic matter play an important role for the development of soil properties and for the establishment of vegetation and the colonization of soil biota.
Our study is part of the Transregional Collaborative Research Centre (SFB/TRR 38) 'Patterns and processes of initial ecosystem development in an artificial catchment' funded by the Deutsche Forschungsgemeinschaft (DFG). The catchment ´Chicken Creek´ close to Cottbus (Germany) has a size of 6 ha and is composed of a 3-4 m layer of Quaternary loamy to sandy sediments overlying a 1-2 m clay layer.
To connect interactions between the soil solid phase and soil solution at the micro-scale with observed processes at the catchment scale we perform microcosm experiments with soil samples from the catchment under controlled laboratory conditions.
The microcosm experiments are carried out in a climate chamber at constant 10 °C corresponding to the mean annual temperature of the region. In total 48 soil columns with a diameter of 14.4 cm and height of 30 cm were filled with substrates of two textural compositions reflecting the gradients observed at the catchment and a bulk density of 1.4-1.5 g*cm3. Within the microcosms it is possible to control the gaseous phase and the water fluxes by artificial irrigation. The irrigation runs automated and quasi-continuously four times a day with 6.6 ml each (in total 600 mm*yr-1). Irrigation amount and chemical composition of the artificial rainwater are based on the annual mean at the field site. Litter of two different plant species occurring at the catchment site (Lotus corniculatus, Calamagrostis epigejos) labelled with stable isotopes (13C; 15N) is used for the experiments. All treatments including a control run with four replicates. The gaseous phase in the headspace of the microcosms is analysed continuously for CO2 and N2O contents. Percolates are continuously collected and analyzed in two weeks intervals for C and N contents, pH and ion concentrations.
Main objectives are to determine the transformation processes of C and N from litter decomposition within the liquid and solid phase, the effect on mineral surfaces and its role for the establishment of biogeochemical cycles. Potential effects of changes in soil solution composition on weathering and development of structures (reactive mineral surfaces, aggregates and crusts) will be characterized. Processes and mechanisms of DOC ad- and desorption are of particular interest.