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Impacts of lithological discontinuities on the vertical distribution of dissolved trace elements in stratified soils

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Runoff generation processes in low mountain ranges in middle Europe are strongly influenced by lateral fluxes of soil water caused by periglacial cover beds. Less attention has been paid to the stratification of soils in hydrologic research as a major trigger of lateral slope water paths (REISS & CHIFFLARD 2014) although especially in the low mountain ranges in Middle Europe subsurface stormflow generation is strongly influenced by the periglacial cover beds (MOLDENHAUER et al. 2013) which are a typical example for stratified soils and almost widespread everywhere in the low mountain ranges. By contrast in soil science the Substrate-Oriented-Soil-Evolution-Model (LORZ et al. 2011) underlines the importance of stratified soils and lithological discontinuities (LD) as a key element controlling ecological processes and depth functions of soil properties. Whereas depth distributions of e.g. trace elements in the soil matrix at the point scale have been already detected, investigations of dissolved trace metal concentrations in the soil pore water and their depth distribution depending on soil stratification are scarce. Based on a typical depth distribution of trace metal concentrations in soil pore water depending on lithological discontinuities these depth functions may indicate zones of preferential transport. Additionally, there is still a missing link of investigations at different scales regarding the impacts of the geochemical barriers and the pronounced depth distributions on the chemical composition of the subsurface stormflow and consequently the hillslope runoff.
Therefore, we validated the hypotheses that LDs act as geochemical barriers for their vertical distribution at the point and hillslope scale and that this typical depth functions of trace elements can be used to identify sources of subsurface stormflow at the catchment scale.
To address these objectives, our research and sampling design is based on a multi-scale approach combining experimental research at the point and hillslope scale in a small forested catchment (0.24 square kilometer) in Central-Germany called “Krofdorfer Forst”. The study area is totally covered by beech forest and characterized as a typically sloped terrain of the mid-latitudes with periglacial cover beds. The catchment is devoid of any riparian zone and is characterized by steep hillslopes that issue directly into the receiving creek. At the point scale the impacts of LDs on the depth distribution of metals (Cr, Mn, Fe, Ni, Cu, Zn, Ar, Se, Cd, Pb) and alkaline earths (Na, Mg, K, Ca) were investigated. Soil water samples were captured at several soil profiles along a hillslope (upper, middle, foot slope) by soil solution access tubes which are installed in different depths depending on the LDs ranging from 10 cm to 110 cm. Soil water samples were taken since October 2012 in an irregular interval. In a complementary effort the temporal variability of the same geochemical parameters mentioned above were investigated in a high temporal resolution in the catchment runoff by using an automatic water sampler. All water samples were filtered and analyzed by using an ICP-MS.
First results show that especially manganese is a very suitable element to identify chemical depth functions in soil pore water at the point scale. For this element the LDs act as geochemical barrier. Further elements have to be considered under different aspects since their depth distribution depends not on the lithological discontinuities. At the catchment scale the temporal variability of manganese concentration during different rainfall-runoff events can be used to detect sources of subsurface stormflow.

References

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