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Visualization of soil structure and pore structure modifications by pioneering ground beetles (Cicindelidae) in surface sediments of an artificial catchment

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An artificial catchment was constructed to study initial soil and ecosystem development. As a key process, the pore structure dynamics in the soil at the surface strongly influences erosion, infiltration, matter dynamics, and vegetation establishment. Little is known, however, about the first macropore formation in the very early stage. This presentation focuses on observations of soil pore geometry and its effect on water flow at the surface comparing samples from three sites in the catchment and in an adjacent "younger" site composed of comparable sediments.

The surface soil was sampled in cylindrical plastic rings (10 cm^3) down to 2 cm depth in three replicates each site and six where caves from pioneering ground-dwelling beetles Cicindelidae were found. The samples were scanned with micro-X-ray computed tomography (at UFZ-Halle, Germany) with a resolution of 0.084 mm. The infiltration dynamics were visualized with neutronradiography (at Paul-Scherer-Institute, Switzerland) on slab-type soil samples in 2D.

The micro-tomographies exhibit formation of surface sealing whose thickness and intensity vary with silt and clay content. The CT images show several coarser- and finer-textured micro-layers at the sample surfaces that were formed as a consequence of repeated washing in of finer particles in underlying coarser sediment. In micro-depressions, the uppermost layers consist of sorted fine sand and silt due to wind erosion. Similar as for desert pavements, a vesicular pore structure developed in these sediments on top, but also scattered in fine sand- and silt-enriched micro-layers. The ground-dwelling activity of Cicindelidae beetles greatly modifies the soil structure through forming caves in the first centimetres of the soil. Older collapsed caves, which form isolated pores within mixed zones, were also found. The infiltration rates were severely affected both, by surface crusts and activity of ground-dwelling beetles.

The observations demonstrate relatively high abiotic and biotic dynamics of soil pore structure in the soil surface even during the very early development stages. The structure formation has potentially great effects on changing runoff and infiltration by forming sealing layers or preferential flow paths.