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Characterization of flow in lignitic mine soil using neutron tomography

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The description of flow and transport processes in forest-reclaimed lignitic mine soils is still limited due to characteristic properties of the partially mixed overburden sediments and the technologies used for creating spoil heaps and for soil reclamation. For tertiary sediments, contents of lignitic dust and fragments of various sizes and shapes embedded in a coarse-textured matrix and inclined dumping structures are representing a typical dual-porosity medium with an inherent small-scale heterogeneity. The objective of the experiments was to identify flow paths as well as to visualize and quantify the local distribution of water contents under variably-saturated conditions.

At the Swiss Spallation Neutron Source SINQ (PSI, Villigen), neutron tomography and radiography (NEUTRA) was used to observe one-step in- and outflow experiments on 123 cm^3 undisturbed mine soil cores with installed mini-tensiometers. These previously deuterium-saturated cores were scanned in 3D before starting the flow experiment to obtain information about the inner structure and the positioning of the tensiometers in regions of different pore geometries. During the flow experiments, 2D radiographies were obtained to determine the spatial and temporal changes in water contents. During stationary phases and at the end, the cores were scanned in 3D. The comparisons between initial, intermediate and final 3D water content distributions indicate 3D distributed water content changes. The pressure head data indicated local nonequilibrium flow conditions. Our observations suggest that in the vicinity of fragments a more continuous pore region exists that allows for preferential flow within a relatively small fraction of the porous medium.