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3D imaging of infiltrating water in a lysimeter using electrical resistivity tomography (ERT)

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Electrical resistivity tomography (ERT) is applied to visualize the infiltration process of water in an unsaturated sediment using a lysimeter laboratory experiment. The study aimed at quantifying the water retention capability of slag heap material in order to assess the groundwater pollution risk. For this purpose the temporal changes of electrical resistivity caused by changes of saturation and subsequent solution processes after a short continuous irrigation of the whole sediment surface are evaluated.

A cylindrical lysimeter column (diameter 0.3 m, height 0.8 m) is filled with homogenized material from a slag heap. At five equidistant depth levels between 5 cm and 25 cm 80 electrodes are arranged in horizontal rings. At each time step 320 single measurements in dipole-dipole configuration are conducted within about 70 min and form one ERT dataset. The first dataset before irrigation characterizes the initial state. After irrigation (1 l of water within 30 min) 30 additional datasets are measured at distinct time steps up to 20 days. All datasets are inverted by a time lapse 3D finite element inversion algorithm. The inversion results for the first 24 hours reveal a downward moving front of decreasing resistivities. In the later time steps the evaporation process (i.e. increasing resistivities caused by drying after a few days) can be monitored qualitatively, too. For comparison the water movement in the lysimeter is simulated using the transport model HYDRUS. The simulated changes of water saturation confirm with the ERT results qualitatively in terms of infiltration velocity. To relate the resistivity changes quantitatively to the saturation changes, however, complex solution processes in the slag heap material need to be considered. This will form the next step of the investigation.