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Salt Tracer Transport Characterisation in an unsaturated, undisturbed Soil Column with Aid of ERT and GPR

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Soil heterogeneity has a strong effect on inert solute transport through the vadose zone. Under non-saturated conditions, different water fluxes can affect the preferential transport path pattern. For salt tracer transport imaging, electrical resistivity tomography (ERT) appears to be a promising tool for pedon and field scales. However, in the vadose zone, electrical resistivity changes are mainly governed by two state variables: solute concentration and water content. To resolve this ambiguity, the water content can be measured with the aid of ground penetrating radar (GPR). Thereby, spatio-temporally highly resolved datasets are gained which may provide new insights into flow and transport in unsaturated soils.

In this study we investigated inert solute transport patterns in an unsaturated, free drainage, undisturbed soil column. Therefore, steady state salt tracer leaching experiments with two considerably different flow rates were performed. The solute transfer was monitored by measuring the changes in the 3D distribution of the resistivity with ERT. To constrain the ERT data, GPR tomographies were carried out for each flow rate, respectively. Additionally, TDR probes were used for validation and calibration of both, the ERT and the GPR data.

In a first approach, selected ERT data subsets were inverted into horizontal slices of the resistivity distribution through the monolith using a 2-D imaging algorithm. Although the images reveal limitations of a 2-D imaging approach for the investigation of a cylindrical soil monolith, yet consistent regions with different tracer arrival times are

visible. This indicates that the electrical data contain information on the heterogeneity of the transport process. Both, ERT and GPR data are in agreement with the TDR data. However, with a 3D ERT inversion algorithm, the ERT and GPR data could be used to evaluate transport processes in the vadose zone.