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Fluorescence Imaging For MM-Scale Observations Of Macropore-Matrix Mass Transfer

Christoph Haas (1), Ruth Ellerbrock (1), Martin Leue (1), Rainer Horn (2), and Horst H. Gerke (1)

(1) Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e. V., Müncheberg, Germany, (2) Institute for Plant Nutrition and Soil Science, CAU Kiel, Hermann-Rodewald-Str. 2, 24118 Kiel, Germany

Macropores are important for gas, water, and heat transport in soils and play a major role for transport processes as preferential flow paths. For mass-exchange processes and water storage in soils, small-scaled soil properties are crucial. Interfaces between matrix and macropores (e.g., biopore walls) control the mass exchange by small-scale distribution of their permeability. Water and solute transfer through the interface between macropore surfaces and matrix (e.g., bio-pore walls, aggregate and crack coatings) is still not well understood. Fluorescein - a dye tracer previously used in larger scale hydrological problems – is also usable at a small-scale (i.e. soil columns $\leq$ 35 mm in edge length) to trace differences in permeability of earthworm-, root- and shrinkage-induced interfaces. The objective here was to visualize small-scaled water transport processes through reactive interfaces and to determine water and solute exchange parameters as a function of interface type (biopore; aggregate coating). The results show that the transfer of water and solutes depends on the type of interface, caused by e.g. alterations in soil structure and chemical composition of coatings. Furthermore, the results led to a hierarchical concept of preferential flow paths: Preferential flow paths in vertical direction like larger biopores are connected with the soil matrix via a network of smaller-scaled horizontal preferential flow paths.