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Ponded and tension infiltration visualized by CT, MR imaging and dye tracing

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Two noninvasive visualization methods were employed to study process of infiltration in undisturbed core of coarse sandy loam. Destructive dye tracer experiment was performed on the same soil core. The aim was to study wetting dynamics and preferential pathways formation of near saturated flow during tension and ponded infiltration. Images were acquired by means of nuclear magnetic resonance (MR) during significant stages of the experiment. Different MRI techniques were used for particular stages of the experiment. Propagation of the wetting front at the very beginning of the infiltrations was monitored by means of fast vertical two-dimensional (2D) imaging. Horizontal multiple 2D slices and multiple-slice 2D maps of longitudinal relaxivity (T_1) were acquired during the steady state flow and during the equilibrium state after the drainage. 2D multiple slices covers half of the sample volume. The maps of T_1 represent surface-to-volume ratio of water phase. Proton density M0 represents water content. In MR images only water present in large pores is visible. Water in soil matrix does not produce reliable signal.

3D scanning of naturally dry soil cores was performed after experiments were finished. Images were segmented using morphological operations erosion and dilatation by selected thresholds of Hounsfield units (HU) to exclude isolated voxels of high porosity and to locate potential preferential pathways. Binarized and original images were compared with the MR M0 maps for all stages of the experiment.

The preferential pathways identified by three visualization methods differ to some extent. The MR images are not pixel to pixel comparable to CT images because the presence of paramagnetic particles causes local image distortions. The geometrical

comparison of CT and MR images remains a challenge. MR imaging showed that the flow in the upper part of soil core reflects most the changes of boundary condition. In the upper part the MR signal was much stronger for ponded infiltration than for tension infiltration. The changes in the bottom part of the soil core remained less pronounced.