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Infiltration in heterogeneous soil monitored by neutron imaging

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The process of infiltration in near-saturated soil and fate of residual air bubbles was studied using neutron imaging. It is the continuation of previous study on flow instability.
Ponding infiltration-outflow experiment conducted at NEUTRA beamline of the Spallation Neutron Source Division, Paul Scherrer Institut aimed at i) characterizing the types of structures susceptible to air trapping, ii) monitoring of entrapped air and water redistribution during steady state flow iii) imaging the process of entrapped air dissolution. Experiments were conducted on series of undisturbed samples of soil from the Cambisol series and on an artificially prepared sample. The latter was composed of coarse sand (representing pathways of fast preferential flow), which surrounded blocks of fine ceramic. Cumulative infiltration and outflow fluxes of water were measured gravimetrically by two precision digital scales thus the full water balance data were obtained. Small samples (30 mm in diameter) were used to achieve good spatial resolution of neutron images. Degassed water was used to dissolve bubbles of entrapped air at the end of infiltration experiments.
The neutron radiography and tomography data show quantitatively exchange of water and air between domains of fine and coarse materials during quasi-steady state flow in the sample. The redistribution of the entrapped air directly affected the hydraulic conductivity. On neutron tomography images the gradual dissolving of trapped air bubbles was clearly detected. The effect also led to significant increase of hydraulic conductivity. The obtained data show clearly that air as a non-wetting phase should not be overlooked in case of near-saturated infiltration in soil with preferential flow.
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