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Numerical modeling of NI-monitored 3D infiltration experiment

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It is well known that the temporal changes of saturated hydraulic conductivity caused by the occurrence of air phase discontinuities often play an important role in water flow and solute transport experiments. In the present study, a series of infiltration–outflow experiments was conducted to test several working hypotheses about the mechanism of air phase trapping. The experiments were performed on a porous sample with artificial internal structure, using three sandy materials with contrasting hydraulic properties. The sample was axially symmetric with continuous preferential pathways and separate porous matrix blocks (the sample was 3.4 cm in diameter and 8.8 cm high). The infiltration experiments were monitored by neutron imaging (NI). The NI data were then used to quantify the water content of the selected sample regions.
The flow regime in the sample was studied using a three-dimensional model based on Richards' equation. The equation was solved by the finite element method. The results of the numerical simulations of the infiltration experiments were compared with the measured outflow rates and with the spatial distribution of water content determined by NI.

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