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Solute transport in heterogeneous undisturbed soil cores during recurrent ponded infiltration

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The presence of entrapped air in porous material affects the water flow during recurrent ponded infiltration. The aim of this research is to investigate the effect of entrapped air on solute transport by means of experiments done on large undisturbed soil samples in laboratory with two conservative tracers. Breakthrough of the potassium bromide and deuterium was tested on two samples of sandy loam soil. Samples were carefully collected at the experimental site in Korkusova Hut (Sumava Mountains) and Uhlirska (Jizera Mountains) in plastic cylinders. Special sample treatment was used to prevent bypass flow along the sample walls. The surface at the soil core perimeter was covered with fine soil material while the core was gradually transferred from one plastic tube to another of the same internal diameter with the use of hydraulic jack.
Recurrent ponded infiltration consisted of three infiltration runs. First infiltration run was done into naturally dry soil. Subsequent two runs were conducted into soil with the higher initial water content. In order to demonstrate the effect of entrapped air dissolution the third infiltration was conducted with partly de-aerated water. The constant level of ponding was held during each infiltration run at the top of the sample. Water drained freely through the perforated plate at the bottom. Pressure heads and water contents (TDR) were continuously measured by tensiometers in three depths. Cumulative outflow and sample weight were also monitored during experiments.
The pulse of potassium bromide and deuterium was applied in the ponding water at the top of the soil core during quasi steady state flow. Breakthrough curves (BTCs) were acquired by electrochemical in-line analysis of bromide ions in the effluent. Samples of the effluent were taken regularly in the fraction collector. Deuterium concentrations in water samples were analyzed by laser spectroscopy.
The results of the experiment show drop in quasi-steady outflow rates between first and second infiltration run. The average outflow rate was increased during the third infiltration which is most probably caused by the entrapped air bubbles dissolution in de-aerated water. BTCs of bromide and deuterium were nearly identical. The BTCs show clearly the extent of entrapped air effect on tracer transport in the undisturbed soil column.
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