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Nuclear Magnetic Resonance Relaxation and Imaging Studies on Water Flow in Soil Cores

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Magnetic resonance imaging (MRI) is applied to the study of flow processes in a model and a natural soils core. Since flow velocities in soils are mostly too slow to be monitored directly by MRI flow velocity imaging, Gd-DTPA was used as contrast agent for the first time for flow processes in soils. Apart from its chemical stability the main advantage is the anionic net charge in neutral aqueous solution. Here we can show that this property hinders the adsorption at soil mineral surfaces and therefore retardation. Gd-DTPA turns out to be a very convenient conservative tracer for the investigation of flow processes in model and natural soil cores. With respect to the flow processes in the coaxial model soil column and the natural soil column we found total different flow patterns: In the first case tracer plume moves quite homogeneously only in the inner highly conductive core. No penetration into the outer fine material takes place. In contrast, the natural soil core shows a flow pattern which is characterized by preferential paths avoiding dense regions and preferring loose structures. In the case of the simpler model column also the local flow velocities are calculated by the application of a peak tracking algorithm.