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Imaging water and solute fluxes in porous media by Magnetic Resonance Imaging: Experimental and modelling results

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Magnetic Resonance Imaging (MRI) offers the possibility to monitor water and solute fluxes directly by flow imaging techniques. The advantage of MRI is the non-invasive measurements in 3 dimensions and a relatively high temporal resolution. For slow flow rates and water fluxes - typical for soils - tracer substances can be used which were applied to the flowing medium. As an alternative to the common used paramagnetic ions we chose D_2O as a tracer substance. The aim of this study is to evaluate the usefulness of D_2O as a water tracer for monitoring flow processes in natural porous media using the MRI technique. For this feasibility study we chose a packed soil column, which was constantly percolated with water. To monitor the solute flux in a heterogeneous structure a cylindrical body was situated in the soil column in form of a Teflon body. This obstacle forces the water and solute to bypass which was monitored by MRI. Additionally, the transport of D_2O is compared with a classical paramagnetic tracer ($NiCl_2$). In a second step, we will use a numerical model to evaluate the tracer movement through the column on the basis of independently determined hydraulic parameters. Finally, we compared calculated water velocities derived from the MRI images with velocities taken from the numerical simulations.