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Low Field NMR of Water in Soils. A Case of Study.

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The evolution of water in soils is a physical phenomenon of importance in soil science and climatology. While most investigations of soil moisture are performed inside large superconducting magnets in the laboratory, it is advantageous to do such investigations with mobile NMR equipment in the field. As a part of a DFG-funded interdisciplinary project (TR32), this work establishes preliminary results from the use of mobile NMR to measure moisture in soil columns. To demonstrate the ability of the NMR technique to follow the drying process of water in soils, daily moisture measurements were performed with a mobile NMR endoscope on three different types of soil (silt, sand, and a natural soil) during an one-step outflow experiment. The soils were packed in columns approximately one meter high. The NMR measurements were cross-validated by repetitive measurements of the mass drift due to the drying process. The NMR-endoscope exhibits a cylindrical geometry incorporating the principle of the u-shaped NMR-MOUSE. It could be raised and lowered inside a plastic tube (1 mm thick) in the soil column similar to a wire-line logging tool. Working with a frequency of 8.73 MHz, the sensitive volume has a depth of 2 mm, avoiding any boundary effects that might arise due to the tube wall. For the purpose of quantitative analysis, the water evolution (described by the Richards Equation) was modelled with the Hydrus1D Program, taking into account the boundary conditions under which the experiments were carried out. Out of these simulations, an assessment of the hydraulic parameters (K_s, α, n and l of the Van Genuchten model) of the soil is achieved. Experimental aspects such as the optimization of the endoscope, the statistical uncertainty, and the noise shielding are discussed as well.