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NMR and SIP properties of partially saturated porous silica glasses

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The signal responses of both, spectral induced polarization (SIP) and nuclear magnetic resonance (NMR) are sensitive to the inner surfaces of the water filled porous media. Therefore both methods are well suited to non-invasively determine hydrological relevant parameters such as the pore radii distributions or hydraulic permeability of fully and partially saturated rocks and soils. NMR exploits the relaxation of the magnetization of fluids in the pore space of porous medium. In SIP the frequency dependence of the complex resistivity is determined, which mainly arises from the polarization of charges at the fluid matrix interface. In this work we study the dependence of NMR and SIP signals on the inner structure of fully and partially saturated artificial porous silica glasses (VitraPOR). The samples are characterized by an accurately defined pore space with well known pore radii distributions and surface properties. The mean pore sizes of the investigated samples range from 1.0μm to 250μm. Laboratory NMR saturation recovery (T_1) and CPMG (T_2) measurements have been carried out using a 3.91 MHz NMR spectrometer. SIP measurements were conducted in an extended frequency range from 1mHz – 1MHz using four point and two point configurations for low and high frequencies ranges, respectively. A homogeneous partial saturation down to 1 vol. % has been realized by applying a uniform negative pressure gradient to the samples at each desaturation step. Additionally the corresponding pf curves have been recorded and evaluated. On the basis of the results from these experiments and corresponding numerical pore scale simulations of NMR relaxation (Nuclear Magnetic Resonance; see also Mohnke et al SSS23) and SIP (see also Volkmann et al MPRG7) we aim at an interpretation scheme for combined NMR and SIP measurements in order to assess structure, state and thus transport properties of fully and partially saturated soils.