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Two dimensional exchange NMR experiments of natural porous media with portable Halbach-Magnets

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The characterization of pore space and connectivity in soils of different textures is one topic within Cluster A, Partial Project A1. For this purpose low field mobile NMR became a powerful tool following the development of portable NMR sensors for well logging. By now there are numerous applications of mobile NMR in materials analysis and chemical engineering where, for example, unique information about the structure, morphology and dynamics of polymers is obtained, and new opportunities are provided for geophysical investigations [1]. In particular, dynamic information can be retrieved by two-dimensional Laplace exchange NMR, where the initial NMR relaxation environment is correlated with the final relaxation environment of molecules migrating from one environment to the other within a so-called NMR mixing time tm [2].
Relaxation-relaxation exchange experiments were performed with saturated and un-saturated soil samples at low and moderately inhomogeneous magnetic field with a simple, portable Halbach-Magnet. By conducting NMR transverse relaxation exchange experiments for several mixing times and inverting the results to 2D T2 distributions (similar to joint probability densities of transverse relaxation times T2) with the help of inverse 2D Laplace Transformation (ILT), we observed characteristic exchange processes: Soils consisting mainly of silt and clay components show predominantly exchange between the smaller pores at mixing times of some milliseconds. In addition, there exists also weaker exchange with the larger pores observable for longer mixing time. In contrast to that fine sand exhibits 2D T2 distributions with no exchange processes which can be interpreted that water molecules move within pores of the same size class. These results will be compared to the exchange behaviour under unsaturated conditions.

References:
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