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Relaxometry in soil science

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NMR relaxometry is a sensitive, informative and promising method to study pore size distribution in soils as well as many kinds of soil physicochemical processes, among which are wetting, swelling or changes in the macromolecular status. Further, it is a very helpful method to study interactions between molecules in soil organic matter and it can serve to study the state of binding of water or organic chemicals to soil organic matter. The method of Relaxometry excite the nuclei of interest and their relaxation kinetics are observed. The relaxation time is the time constant of this first order relaxation process.

Most applications of relaxometry concentrate on protons, addressing water molecules or H-containing organic molecules. In this context, 1H-NMR relaxometry may be used as an analysis method to determine water uptake characteristics of soils, thus gaining information about water distribution and mobility as well as pore size distribution in wet and moist samples. Additionally, it can also serve as a tool to study mobility of molecular segments in biopolymers. Principally, relaxometry is not restricted to protons. In soil science, relaxometry is also applied using deuterium, xenon and other nuclei to study pore size distribution and interactions.

The relaxation time depends on numerous parameters like surface relaxivity, diffusion and interactions between nuclei as well as between nuclei and the environment. One- and two-dimensional methods address the relation between relaxation time and diffusion coefficients and can give information about the interconnectivity of pores. More specific information can be gained using field cycling techniques.

Although proton NMR relaxometry is a very promising method in soil science, it has been applied scarcely up to now. It was used to assess changes in molecular rigidity of humic substances. A very recent study shows the potential of NMR relaxometry to assess the pore size distribution of soils in a fast and non-destructive way. Recent studies investigated wetting and swelling processes in soil samples, as well as the formation of microbial biofilms in soil the formation.
This contribution gives an overview of current applications and the potential of NMR relaxometry in soil science with special emphasis on proton NMR relaxometry.

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