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Low Field Nuclear Magnetic Resonance to Monitor Bio Mineralization Processes in Porous Media

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Low-field nuclear magnetic resonance (NMR) is a non-invasive measuring technique and an excellent tool for determining properties of materials with high magnetic susceptibilities such as rock cores and natural sediments. NMR is sensitive to parameters such as pore size, pore fluid changes, and permeability that are of interest to engineering applications such as subsurface fracture sealing and CO₂ sequestration by bio mineralization. Using a 2MHz Rock Core Analyzer, NMR relaxation and diffusion measurements are utilized to monitor changes in porous media during biofilm growth and bio mineralization. T₂ relaxation measurements are used to monitor changes in pore size distributions as well as chemical changes at the surface of pore walls due to microbially-induced mineral precipitation. T₂ relaxation measurements are also used to track changes in the total porosity of the system. The spatial distribution of relaxation rates throughout the length of the sample are determined using T₂ profiles, and signal intensity profiles provide a means to characterize the spatial heterogeneity as well as a way to monitor the progress of the bio mineralization process as the signal intensity decreases due to calcite precipitation. Diffusion measurements are performed to detect restricted diffusion as calcite begins to occupy the pore space. The application of bio mineralization as a fracture sealing agent as well as the ability of calcite to form in the pore space of a porous media is investigated using the above measurement techniques.

References

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