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# Low-Field Nuclear magnetic resonance characterization of Carbonate and Sandstone Reservoirs

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Laboratory measurements, i.e. gas ( $N_2$ ) porosity and permeability, time-domain nuclear magnetic resonance (NMR) including transverse relaxation time ( $T_2$ ) and diffusion coefficient, and thin section and scanning electron microscopy (SEM) analysis, were conducted to obtain petrographical and petrophysical descriptions of the Weber Sandstone and Madison Limestone at the Rock Spring Uplift, a potential carbon dioxide site in Southwestern Wyoming. The relationships between pore structures, such as pore geometry, pore-size distribution, pore network, and porosity/permeability were investigated. First, using thin sections combined with electronic microscopy for the description of pore structures, all samples are described in detail from the geological, petrographical and diagenetic point of view. Results show that within the Madison Limestone pore systems, pore types include intercrystalline, vuggy, moldic, or mixed (combination of all other pore types). Both moldic and vuggy pore types are associated with samples of high porosity and permeability. NMR relaxation time distributions show either bimodal or multimodal distributions. Large relaxation time components are associated with samples with large pores, whereas small components are dominated by small pores. Permeabilities predicted by the log mean of  $T_2$  shows a good correlation with gas permeability for Weber Sandstone samples. While for Madison Limestone samples, permeabilities predicted by NMR method are over- or underestimated when permeability is small due to pore coupling effect. In addition, short-time diffusion coefficients ( $D$ ) were measured by pulsed field gradient (PFG) NMR method using a series of gradient strengths, and diffusion coefficient distributions were calculated. We found that diffusion coefficient distributions are consistent with the corresponding  $T_2$  distributions for macropores. However, for micropores, diffusion coefficient peak vanished because of fluid-rock interaction and/or small value of brine saturated in. Furthermore, by comparing the dominant peak position of  $T_2$  distributions and their corresponding diffusion coefficient distributions, we predicted the surface relaxivity of different rock types. We found that surface relaxivities of Weber Sandstone samples can be well predicted, while for Madison Limestone samples, surface relaxivities are overestimated due to diffusive pore coupling effect.

## References

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