PORE-SCALE AND NMR CHARACTERIZATION OF UNCONVENTIONAL CARBONATE MUDROCKS

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ABSTRACT

In contrast to macropore to micropore-dominated pore systems in conventional carbonate reservoir facies, the majority of pores identified in carbonate mudrocks are within the micropore to nanopore size range. Recent work has shown that due to the highly irregular pore network in unconventional carbonates, expected relationships between pore geometry and laboratory-measured sonic velocity, which are well-defined in conventional carbonate reservoirs, are not readily apparent. Thus there is a need to develop proxies which can be used to petrophysically characterize the pore systems. We propose to use nuclear magnetic resonance (NMR) to develop one of such proxies. NMR transverse relaxation times (T2) provides direct information on porosity, pore size distribution, and permeability. Consequently, rock fabric — the spatial arrangement and orientation of grains and pores — has an implication on T2 distribution, making NMR particularly useful in the multimodal pore systems of conventional carbonate rocks. The objective of this study is to develop a geological-petrophysical characterization that integrates information from facies, pore architecture variation and NMR response in carbonate mudrocks from unconventional carbonate reservoir cores. The geological investigation will combine detailed facies and pore-type descriptions with multiscale image analysis (optical microscopy (OM), scanning electron microscopy (SEM), and micro-CT scanning) to obtain pore architecture data. The petrophysical investigation will include laboratory-measured porosity, permeability, NMR, and specific surface area (BET) measurements. To date, work on 'Mississippian Limestone' cores have classified the unit into petrophysically-significant facies groups defined by distinct porosity - permeability relationships, facies, and dominant pore types. In general, T2 curves in these facies groups show up to three peaks: varying by facies and attendant pore types. Understanding how NMR signals change between various facies, and the pore-scale control of these changes should inform the use of NMR both as a pore-scale characterization tool and as a logging tool for predicting carbonate mudrock reservoir units in the study area.

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