Nano-Petrophysical Studies of Avalon-Bone Spring-Wolfcamp and Dean-Sprayberry-Wolfcamp Shale Systems

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Abstract

The Permian Basin, including Delaware and Midland Basins, has been producing the most tight oil over the past several years. The research on nano-petrophysics, namely the study of rock properties, fluid (gas, liquid hydrocarbon, and formation water) properties, and the rock-fluid interactions within mudrocks with a predominant presence of nano-sized pore space, has been receiving much attention because of its implication in the steep initial decline and low overall recovery of hydrocarbon production from the mudrocks. This study work with a range of mudrocks in both Delaware and Midland Basins with a disparate difference in the geological characteristics. This presentation discusses various approaches to nano-petrophysical studies of the mudrocks, including pycnometry (liquid and gas), pore and bulk volume measurement after vacuum saturation, porosimetry (mercury injection capillary pressure, low-pressure gas physisorption isotherm, nuclear magnetic resonance cyroporometry), imaging (field emission-scanning electron microscopy), tomography (CT, focus ion beam-scanning electron microscopy), small-angle neutron scattering, and the utility of both hydrophilic and hydrophobic fluids as well as fluid invasion tests (imbibition, diffusion, vacuum saturation) followed by laser ablation-inductively coupled plasma-mass spectrometry imaging of different nm-sized tracers. Overall findings indicate that the unique characteristics of low pore connectivity and Dalmatian wettability, further implicated by the entanglement of nano-sized molecules in nanopore space, of these mudrocks, which could lead to a limited matrix-feeding of hydrocarbons to the stimulated fracture network and producing wellbore.