Laboratory Analysis of Newcastle/Muddy Outcrop Samples as Analogs to Bell Creek Field, Powder River County, Montana

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The Plains CO_2 Reduction Partnership led by the Energy & Environmental Research Center (EERC) has conducted laboratory analysis on Cretaceous Newcastle/Muddy formation outcrop samples as a preliminary characterization activity for an upcoming carbon dioxide (CO_2) enhanced oil recovery project in the Bell Creek oil field. The reservoir produces from a combination of delta and barrier bar lithofacies with porosity on the order of 24% and permeabilities of 900 mD. Newcastle/Muddy rocks were deposited along the continental slope and into the submerged Cretaceous interior seaway as a series of offshore bars, barrier bars, deltas, and channels cutting into the eroding Cretaceous Skull Creek shale. Continued uplift during tertiary time exposed Newcastle/Muddy rocks along the edges of the Black Hills of South Dakota and Bear Lodge mountains of Wyoming while simultaneously burying the interior basin to depths of 4500 ft. at Bell Creek.

Three outcrops representing different depositional environments were visited and sampled by EERC personnel. Collected rocks were submitted to the EERC's Applied Geology Laboratory for analysis including porosity, permeability, profilometry, x-ray diffraction, thin-section analysis, unconfined compressive strength, and non-steady-state CO_2 to water relative permeability testing. Relative permeability of supercritical CO_2 to water is of particular interest for application in dynamic simulations. Two deltaic and one barrier bar facies have been tested using a custom designed in-house apparatus and methodology. Relative permeability was measured using a non-steady-state-style test with saturations determined via mass balance.

Testing was assigned and conducted with the goal of maximizing the information recovered from each sample while, at the same time, operating with a minimal amount of material. This study represents a wealth of characterization information that may be obtained from a relatively small volume of sample; a situation that may be common in future projects in areas for which few cores are present and/or are difficult to obtain.