Petrophysical Evaluation of the Cane Creek Unit of the Paradox Formation, Northern Paradox Basin, Utah

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Abstract

The Paradox Formation in the N. Paradox Basin, Utah, has a long history of sporadic hydrocarbon exploration whose development has been complicated by extensive salts interbedded with prospective clastic reservoirs spanning several thousand feet of section. The US Department of Energy funded Northern Paradox Basin study was designed to update characterization of the reservoir and investigate strategies to mitigate the difficulties imparted by the salt beds, focusing on the ~100' thick Cane Creek Shale (clastic 21). For characterization, the study team collected whole core over the Cane Creek Shale in the State 16-2 well, which was drilled in late 2020/early 2021. Unfortunately, the BHA became stuck at the completion of the coring operations and could not be retrieved. Therefore, wireline logging was unable it to collect data over the cored interval (logs were collected in the overlying clastic units in the Paradox Fm.). The core, however, was successfully recovered. Thanks to the presence of a legacy set of logs in the nearby State 16-42 well (~150 m distant), we were still able to conduct a petrophysical interpretation of the State 16-2. We did this by aligning the Gamma Ray (GR) logs of the State 16-42 well with the core GR from the State 16-2, and then basing the interpretation off those realigned logs, calibrated to the core data. The match between the core GR and log GR was excellent. Unfortunately, the log suite collected in the State 16-42 was not as extensive as what we had hoped to collect in the State 16-2, consisting of only basic Triple Combo and sonic logs, thus limiting the number of interpreted properties we could derive. This was particularly problematic given the complex lithology. To mitigate this problem, we conducted an unsupervised classification of the log data to subdivide the Cane Creek into 8 classes with expected similar (or dissimilar) material properties based on similar (or dissimilar) bulk log responses, and then calibrated our mineral model to major constituents in each class based on correlation to XRD data collected on the core. We also varied end member log responses and saturation equation exponents between the classes, as warranted, to derive a more robust interpretation of the porosity and fluid saturation across the Cane Creek interval. All classes were calibrated to core data. The resulting model was then applied to nearby wells with legacy logs by using supervised machine learning to identify the model classes using the log data from those wells so that the same class-specific models could be used. The interpretation shows an average hydrocarbon-filled pore volume (HFPV) of ~4.6% in two classes making up a combined ~50' of section in dominantly the Cane Creek B & C and an average HFPV of ~5.2% over ~18' in one class dominantly in the Cane Creek A. Other classes showed higher HFPV, but were much thinner, and the rest showed lower HFPV.