

Stratigraphic and Geochemical Evaluation of a Shallow Drill Core of the Lewis Shale in the Eastern Washakie Basin, Wyoming

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Abstract

The U.S. Geological Survey collected a 620 ft shallow, continuous core of the Maastrichtian Lewis Shale in the summer of 2022. The Cow Creek 1-21 core was drilled on the east side of the Washakie Basin, approximately 60 miles southwest of Rawlins, Wyoming. The Lewis Shale, which produces natural gas in the eastern Greater Green River Basin (GGRB), was deposited in a small embayment during the last transgressive/regressive cycle of the Cretaceous Western Interior Seaway. The Lewis Shale in the Cow Creek 1-21 core is nearly 90% mudstone and captures multiple flooding surfaces, including a regional, high gamma ray interval, informally known as the Asquith marker. Detailed subsurface mapping of the Asquith marker reveals that the high gamma ray interval is up to 30 ft thick in the deepest parts of the paleo-basin and thins to the north, west and south toward the paleo-shelf. Regional mapping also indicates that the Asquith marker comprises a mix of transgressive sediments as well as the distal portions of multiple clinothems that prograded into the basin during the regressive phase of Lewis deposition. Five higher-order flooding surfaces were identified in the core and were regionally correlated throughout the subsurface is the eastern GGRB. In addition to detailed stratigraphic analysis of the core, a preliminary geochemical dataset was collected on ~70 samples from the Asquith marker interval. Mineralogy and bulk organic geochemistry were used to determine source rock quality, kerogen type, and mudstone bulk composition. The total organic carbon (TOC) content ranges from ~1 to just over 5 wt. % (average TOC: ~3 wt. %). The Hydrogen Index and Tmax values from programmed pyrolysis indicate a mixture of oil- and gas-prone kerogen in the samples, which was further delineated by applying multivariate curve resolution to the S2 peak in the sample pyrograms. Mineralogical analysis based on Fourier transform infrared spectroscopy (FTIR) indicates that the rocks are dominated by clay minerals, mainly illite, with some quartz and calcite, as well as rare apatite. The geochemistry data indicating a mixed kerogen type in the Asquith marker align with the regional stratigraphy, illustrating how these two data sets can complement one another and be integrated to understand the evolution of a potential source interval within the Lewis petroleum system.