

Detailed Geochemical Characterization of the Lower Part of the Green River Formation in South-Central Uinta Basin, Utah

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Abstract

Lacustrine and fluvial-deltaic mudstones in the lower part of the Eocene Green River Formation in the Uinta Basin, particularly the informal Uteland Butte member (UB), represent the only significant oil production from an unconventional lacustrine petroleum system in North America. Since development of the UB by horizontal drilling and hydraulic fracturing, several other stratigraphic units with production potential have been identified and developed, including the underlying lacustrine Wasatch and the overlying Castle Peak and Carbonate Marker (Black Shale) units. Previous studies have presented results on immature UB mudstones from outcrop on the eastern margins, but data availability for core samples from more distal areas with low thermal maturity has been limited. To address this, samples were collected from a core drilled in the south-central region of the Uinta Basin (north of Nine Mile Canyon) for geochemical and mineralogical characterization. The Petes Wash well (U 13-06 GR), drilled by EOG Resources in 2007 was sampled roughly every foot between 5520 and 5650 feet. The sampled interval contained approximately 44 feet of upper UB mudstones, including C- and D-shale marker beds and dolomitic “pay zones” described in previous studies and another 52 feet of organic- and carbonate-rich lower UB mudstones split by 26 feet of sandstone and feldspar-rich siltstone that is unique to the south-central part of the basin. Total organic carbon (TOC) content of the upper interval of the core was between 1% and 4% in most samples (average 2.2%, n = 53) and, based on programmed pyrolysis parameters (hydrogen index, HI ~600 mg/g; Tmax ~450°C). The lower interval of the core is slightly more organic-rich (TOC 1% to 5%; average 2.4%, n = 53) with similar but somewhat higher HI values. The sandstone unit TOC values were less than 1% (n = 24) with HI-Tmax values indicative of a different organic matter source or poorer preservation conditions than for the over- and under-lying mudstones. Mineralogy of the lower sampled interval is dominated by dolomite and illite. The UB in the area where the core was collected contains a variety of carbonate phases, including calcite, Mg-rich calcite, dolomite, and rare ankerite, along with lower concentrations of quartz and illite. The sandstone unit contains mostly quartz and illite, but high feldspar concentrations were observed in the middle of the unit. Major element concentrations were consistent with the identified mineral phases. Evaluation of the total rare earth element concentrations, Si/Zr ratios, and trace metal enrichment factors indicate fluctuating detrital input and redox conditions through the sampled strata, implying highly variable conditions. These results highlight some of the variability in distal areas of the Uinta Basin tight oil lacustrine resource play.

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