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Geochemistry and mineralogy of the Uteland Butte member of the Green River Formation, Uinta Basin, Utah

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The informal Uteland Butte member of the lower Green River Formation was deposited during a major transgressive phase of the early freshwater stage of Eocene Lake Uinta in the Uinta Basin and is the source rock for a successful tight-oil play in northeastern Utah. The thickness of the Uteland Butte interval varies from around 50 to over 300 feet across the basin and consists primarily of limestone, dolostone, and organic-rich mudstones and siltstones, with sandstone and ostracodal limestones in the lake margins. Immature outcrop samples from the eastern and western margins of the basin (White River outcrop; Willow Creek outcrop) along with immature cores (Petes Wash and Total PR-15-7c) were examined for comparison to cores from deeper in the basin within the unconventional petroleum play. The Uteland Butte samples were also compared to oil shale from the stratigraphically higher Mahogany zone (samples from the same and additional cores), which represents a later transgression and more saline phase of Lake Uinta. Lithologies within the Uteland Butte interval range from rare, organic-rich carbonate-lean mudstone (>4 weight % total organic carbon, TOC) to moderately organic-rich rocks (~2 to 4 weight % TOC) consisting of siliciclastic and clay minerals with some calcite to alternating highly dolomitic and calcareous samples with very low organic content (<1 weight %). The calcite- and dolomite-rich intervals in the Uteland Butte member alternate on the scale of one to several feet, which is similar to the alternating carbonate species in submillimeter-scale varves that make up the Mahogany zone. Hydrogen index (HI) values for the Uteland Butte interval of the Petes Wash core samples (~500 mg-hydrocarbons/g-TOC) were much lower on average than those of the Mahogany zone. Kerogens isolated from Uteland Butte outcrop samples had similarly high atomic hydrogen-to-carbon ratios (1.3 to 1.5) to those reported for overlying Green River intervals and slightly higher HI values (~700 mg/g) than the core samples. Overall, the organic matter in the Uteland Butte samples is predominantly Type I kerogen, but is present in lower concentrations and has lower petroleum-generating potential than the organic matter present in oil shales deposited during the brackish- to saline-lake phases of the Green River Formation.