Investigating the potential of unconventional resources in the Midland Basin: a comprehensive chemostratigraphic analysis of a Cline Shale core (Wolfcamp-D)

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ABSTRACT

Basinal mudrocks assigned to the Wolfcamp Formation in the Midland Basin, the Eastern sub-basin of the Permian Basin, are prolific producers of oil and gas in West Texas. To gain improved insights into these fine-grained systems, high resolution chemostratigraphic (XRF) data has been integrated with core descriptions, organic richness (TOC) data, and well log analysis in this study to outline a sequence stratigraphic framework, as well as reconstruct paleo-redox and ancient water-mass conditions within the Cline Shale (Wolfcamp-D) from a core in the Midland Basin. This study revealed the presence of three chemo-stratigraphically distinct (third-order) depositional sequences within the Cline Shale, herein termed Lower, Middle, and Upper Cline from the base up.

The Lower Cline is highly enriched with carbonate minerals and dominated with argillaceous and carbonate mudstones. The Middle Cline is characterized with its high clay content dominated by argillaceous mudstones and carbonate siliceous mudstones, while the Upper Cline is dominated by elevated levels of silicate minerals and siliceous mudstones. The three units have been correlated across the basin with their interpreted third-order systems tracts.

Superimposed onto the third-order cyclicity within the Middle and Upper Cline, are potential fourth-order cyclicity with interpreted lowstand and transgressive/highstand deposits. The interpreted lowstand deposits exhibit elevated levels of nickel, titanium, zirconium, and sulfur, accompanied by covariant trace metal trends where uranium and vanadium closely track each other alluding to their highly reducing conditions. The interpreted transgressive/highstand deposits are characterized by high concentrations of phosphorous and, occasionally, calcium and divergent trace metal trends where the uranium concentration exceeds that of vanadium; suggesting suboxic conditions. The highest organic matter preservation is associated with the interpreted lowstand deposits, especially in the Upper Cline.

Optimal landing zones (20ft) are identified in the Upper Cline based on their high resistivity, total organic richness, elevated siliceous content, and reduced percentage of clay minerals. These zones have been correlated with several nearby wells. Although the current study is based on a single well, it has clearly shown the significance of high resolution chemostratigraphy with measurements on a cm-scale for heterogenous mudstones. The observed shifts in the chemistry of the sediments character and composition are distinct, with implications for sequence stratigraphic analysis, the reconstruction of ancient water-mass conditions, and the identification of sweet spots for hydrocarbon resources. The provided analysis lays a foundational basis for further studies in the region, serving as a critical data input for expansive regional research efforts.

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