

Chemofacies Signatures of Sabkha-to-Nearshore Environments of the Upper Devonian Three Forks Formation, Williston Basin, USA

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ABSTRACT

Sabkha, tidal flat, and nearshore depositional environments preserved in late Devonian-aged strata of the Williston Basin record the regional response to sea-level variability, climate change, and tectonic forcings. A suite of eight cores covering all or portions of the Three Forks Formation were investigated for their lithological and geochemical stratigraphic changes in order to understand the overall evolution of sedimentary accumulation, and also to document the spatial variability in depositional characteristics across a large sector of the basin. Emphasis was placed on developing chemostratigraphic records from each core and assigning stratigraphically-defined chemofacies characteristics that have the potential to be traced across large portions of the basin. Major trends in Mg, Al, and S (elemental proxies for dolomite, clay, and anhydrite, respectively) define previously-characterized members/units, and potentially provide additional resolution for further refinement. For instance, in most of the cores the upper Three Forks is characterized by more dolomite-mudstone cycles than previously defined in the literature. And, the occurrence of anhydrite does not appear to be particularly uniform across the study area, at least in the upper Three Forks. Furthermore, it is hypothesized that thin intervals characterized by enrichments in Sr, Ba, Zr, and other trace elements may be correlated locally or across large parts of the Williston Basin. The approach of chemofacies analysis (grouping of elemental information) provides a more involved way of defining facies heterogeneity in the Three Forks, and is particularly useful when coupled with traditional core description and lithofacies assignments. Chemofacies trends may indicate the need for refinement of the paleoenvironmental model, which has traditionally been described as evaporitic to nearshore deposition, dominated by sabkha-like depositional conditions. The outcome of the study provides a valuable approach and insights that may be useful in studies of similar paleoenvironments in the Middle East and elsewhere.