Facies Characterization and Chemostratigraphy of Upper Bakken Shale, Williston Basin

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Abstract

Recent exploration success and historical production from the Upper Bakken Shale (UBS) highlights its future resource potential. This emphasizes the need for comprehensive characterization of the UBS with respect to its facies and internal stratigraphic framework. This paper integrates results of thin-section petrography with the organic and inorganic geochemical analyses to characterize the facies, and to identify the laterally correlatable chemostratigraphic units of the UBS. Using these findings, this paper also addresses various gaps and inconsistencies in the current understanding of the prevailing sedimentary processes and depositional conditions for the organic-rich UBS. In this study, handheld X-Ray Fluoroscence (XRF) analyzer was used for elemental concentration data acquisition of sixteen well cores at 6-inch intervals. Thirteen well cores were described, and thin sections from five wells were examined. The cores used in this study were spread over both basin margin and basin depocenter areas. Six lithofacies, F1 through F6, were identified in the UBS from core descriptions and thin-section petrographic studies. 95% of the UBS consists of three main facies: siliceous mudstone (F1), massive to finely laminated silt-bearing mudstone (F2) and, macrofossil-bearing silt-rich mudstone (F4). Based on trends of major and trace element concentrations obtained from the XRF data, three regionally correlatable chemostratigraphic packages (Sub-units 1a, 1b, and Unit-2), were identified in the UBS. The elemental concentration data were also used as proxies to understand lateral and temporal variations in the detrital and biogenic sediment influx, and to determine the paleoredox conditions of the basin during deposition. Based on the results of this study it was proposed that influx of silt-size detrital sediments have multiple sources, especially during the

deposition of Unit-2. Along with eolian silt from the northeast, some detrital silt was derived from the southern basin margin. Redox conditions varied both temporally and laterally during the deposition of the UBS. Sub-units 1a and 1b were deposited in a persistently euxinic condition in most locations across the basin. Unit-2 was deposited in a much less reducing condition, which varied from sub-oxic to intermittently euxinic. The maximum flooding surface was located in Sub-unit 1b, below the Uni-2 and Sub-unit 1b contact.