Integrating Stable Isotope Chemostratigraphy and Detailed Mudstone Lithofacies in Unconventional Reservoirs: An Example From the Ordovician Pt. Pleasant Shale, Appalachian Basin, USA

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Abstract

The era of horizontal well technology has allowed for expanded exploration from unconventional reservoirs, yet challenges remain in trying to understand source-to-sink relationships of these complex depositional systems. In many unconventional basins, there is a significant number of conventional cores that provide critical information on reservoir properties and fluids. The use of inexpensive stable isotopic studies as a regional correlation tool remains an underutilized analytical technique in many unconventional basins. New stratigraphic and carbon isotope records from Upper Ordovician strata in the eastern U.S. provide fresh insights into regional stratigraphic and depositional relationships between deep water Utica/Pt. Pleasant strata and outcrops in southwestern Ohio. We collected 1007 samples from six cores for carbon isotope analysis (at 1 foot/0.3-meter intervals) from the deeper water (outer platform) portion of the study area to construct a composite section. This isotope record was combined with detailed lithofacies and stratigraphic correlations to generate a robust regional understanding of the deep-water platform setting that was compared to shallow-water carbon isotope records from the study area. Coeval stratigraphic sections from these shallow-water settings are punctuated by periods of non-deposition and erosion. As such, comparing stratigraphically

incomplete sections on the shelf to more complete deep platform sections allowed for better understanding of regional relationships between subaerial unconformities on the shelf and their correlative conformities in the deeper platform. The importance of characterizing different mudstone facies related to depositional process is that it permitted us to develop a depositional model. This depicts a structured platform that underwent localized uplift creating an intraplatform slope composed of lean mudstone to the north of an intraplatform sub-basin composed of prolific mudstones to the south. Finer stratigraphic correlations frame this depositional transition and show thickness variations that support the southward deepening and thickening of the source rock interval. This regional framework ultimately led to the delineation of the most productive reservoir interval within a thick sequence of mudstones, corroborated with production data. The results from this study suggest that relatively inexpensive stable isotopic studies from basinal settings can be combined with core and outcrop data to construct a robust regional stratigraphic and depositional framework. This data can be used to help identify sweet spots within unconventional play fairways.