Regional Geochemical Variation as a Function of Competing Drivers — Anoxia, Primary Productivity, Dilution and their Implications for Organofacies Distribution within the Mowry Shale, Wind River Basin, Wyoming

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Abstract

The Lower Cretaceous Mowry Shale, exposed in the Wind River and Hanna Basins in southern Wyoming, was deposited in the foreland basin of the Sevier orogeny along the western margin of the Cretaceous Interior Seaway. Previous studies have broadly characterized the changes in organofacies throughout the basin, with total organic carbon (TOC) and Hydrogen Index (HI) increasing to the southeast based on subsurface data. In order to better constrain basin-wide trends, over 350 outcrop samples were collected from the Mowry Shale from Lander in the northwest corner to Hannah Basin in the southeast. Outcrops are up to 200 km apart, providing significant spatial coverage, and multiple bentonite layers one to three feet thick dissect the shale, providing important stratigraphic control across the study area. Rock-Eval Pyrolysis, X-Ray Fluorescence, and X-Ray Diffraction were used to constrain paleoenvironment through organic and geochemical variations. Rock-Eval pyrolysis indicate an increase from an average of 1.25% TOC near the western edge of the basin to 2.88% TOC in the Hannah basin to the east, consistent with previous subsurface datasets. Additional geochemical characterization as part of this study sheds additional light on the cause of this regional trend. Moving from west to east, an increase in the average Hydrogen Index (59 to 188), an increase in

carbonate carbon, and an increase in the amount of biogenic silica all indicate that conditions are becoming more open marine towards the Hannah Basin. Redox indicators confirm this; U, V, S and other elemental indicators and ratios derived from XRF analysis all show anoxia was greater to the west and more oxic conditions are present to the southeast. Additionally, detrital indicators such as Ti, La, Ga, and Sc all show enrichment to the west, further reinforcing a transition to a more open marine system moving southeast. All of these indicators show an increasingly open marine system to the southeast, in the same direction that TOC is increasing. This contradicts common source rock models, which assume that increased anoxia should equate to higher preserved organic material (OM). This dataset shows the importance of additional key constraints on preservation of organic material - primary productivity and dilution. We believe that negative correlation between TOC and anoxia is the result of higher primary productivity in the southeast portion of the basin, coupled with dilution of OM in the western portion through increased detrital input. These controls outweigh the changes in redox conditions, leading to this somewhat surprising correlation. The results of this study show the importance of considering a more complete conceptual model for the deposition and preservation of organic-rich facies, which can lead to better definition of regional trends and improved leasing and exploration decisions on a basin scale.