AAPG Datapages/Search and Discovery Article #90285 © 2016 AAPG Gulf Coast Association Geological Society, Corpus Christi, Texas, September 18-20, 2016

Chemofacies and Stable Carbon Isotope Analysis of the Cenomanian-Turonian Eagle Ford Formation: Sedimentation and Water Mass Evolution in the Maverick Basin, Southwestern Texas

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ABSTRACT

The Late Cretaceous Eagle Ford Formation represents marine deposition on the South Texas Shelf during late Cenomanian and Turonian time. The lower Eagle Ford (LEF) is a marl and limestone succession containing elevated %TOC (average TOC ~3.5%, maximum of 6.5%). The Upper Eagle Ford (UEF) is a comparatively organic-lean (average TOC ~1%) interval consisting of limestones and marls. A 600-foot-longcore containing the Eagle Ford shale in its entirety was recovered from the Maverick Basin, South Texas. Mineralogical results were generated at a 2-foot interval using x-ray diffraction (XRD), and high-resolution (2-inch sampling interval) chemostratigraphic results were generated using a handheld Bruker TRACER IV–SD x-ray fluorescence (XRF) analyzer. The chemostratigraphic record, supplemented by insights from XRD, TOC, and core description, is evaluated using a hierarchical clustering analysis (HCA) technique in order to quantitatively (1) identify the dominant end member geochemical facies compositions, (2) evaluate the chemical facies in terms of their relative elementalrankings, (3) elucidate linkages between lithofacies and chemical facies, and ultimately, 4) interpret the history of depositional and paleohydrographic conditions during accumulation of the Eagle Ford shale succession in the Maverick Basin. The HCA of the Maverick Basin core identified five unique clusters that account for 89% of the chemical facies variability in the core. The majority of samples from the Buda Limestone, and chemically similar limestones occurring throughout the Eagle Ford succession account for 19% of chemical facies observed, and they are best characterized as Mn-enriched limestones. The affinity of Mn in the carbonates is probably indicative of diagenetic overprinting that occurred during calcite recrystallization. The dominant limestone samples from the UEF interval account for 26% of the chemical facies identified in the entire succession, and are characterized by enrichments in Sr and U. The euxinic marls that dominate the LEF interval account for 19% of the chemical facies in the succession. These marls are characterized by enrichments in redox-sensitive trace elements (Mo, V, Ni, Zn, Cu, As, and U) and S. The euxinic marl is also the chemical facies with the highest %TOC concentrations. Almost 15% of the succession is characterized as oxic marl, with low/indeterminable redox-sensitive trace elements, and enrichments in elements associated with siliciclastic detritus (Zr, Al, Ti, K, and Rb). Approximately 10% of the succession is characterized as high-Ca oxic marl, with detrital enrichments in Rb, K, and Cr. The average %Ca for the oxic marl and high-Ca oxic marl is 19% and 26%, respectively. Evaluating the content of %Ca for each chemical facies is important, as calcite is a dominant mineral phase in the succession. When integrated with traditional core description, the aforementioned chemical facies provide additional insights into depositional components and the mean hydrographic conditions in the basin over time. A stable isotope record of bulk organic carbon was also reconstructed. The record includes a well-defined oceanic anoxic event (OAE–2) that initiates just below the LEF–UEF transition and evolves through the lowermost UEF. The record also includes a precursor to the OAE–2 that has been called the Mid-Cenomanian Event (MCE). Integration of results provides a strong record of regional paleo-marine evolution in the context of global change.