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Paleoceanography of Late Paleozoic and Mesozoic Basins of Texas, USA: Insights from Mudrock Geochemistry

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Stratigraphic changes in the bulk geochemistry of mudrocks provide constraints on the hydrography and water-column processes that occurred in Late Devonian, Carboniferous, and Cretaceous marginal marine seas on the southern edge of Laurentia (North America). The Late Devonian Woodford Formation, preserved in a core from the Permian Basin of West Texas, provides a trace element-based (Mo, U) record of large-scale shifts in the paleo-redox state of bottom waters and sediments that trend upward from mildly restricted and anoxic, to oxic, then back to mildly restricted but with increased organic carbon preservation. Increases in silica (biogenic), and nickel and zinc (nutrients) in the uppermost zone suggest high levels of biogenic productivity, or increased preservation.

A similar upward stratigraphic pattern of trace element enrichment-depletion-enrichment is observed in the Early Carboniferous Barnett Formation, preserved in the same West Texas drill core. However, the range of enrichment is heavily diminished when compared to the underlying Woodford Formation, suggesting either a weakening of the driving forces associated with enrichment, or an increase in the level of basin restriction. Previous work on the Barnett Formation of West (Permian Basin) and North-Central (Fort Worth Basin) Texas has suggested that diminished levels of redox-sensitive trace element enrichment are most likely associated with enhanced basin restriction, potentially associated with partial basin closure to the open ocean (toward the south).

A core from Central Texas that preserves the Late Carboniferous Smithwick Formation, which is underlain by and separated from the Barnett Formation by the Marble Falls Formation, represents largely homogeneous fine-grained silt and clay deposition in an oxic/suboxic marine environment. What is most interesting about these mudrock strata is that they are punctuated by abrupt intervals (5-15 cm) of high-Mn-Mg-Ca siderite deposition/growth, the origins of which have not yet been determined. The Smithwick Formation represents the final mudrock deposition episode before basin filling by course-grained clastics and latest Carboniferous-Permian structural deformation along the Ouachita Thrust-Fold System immediately to the East.

The Late Cretaceous (Cenomanian-Turonian Boundary) Eagle Ford Formation represents mixed carbonate-siliciclastic mudrock deposition. Oscillating enrichment in both molybdenum and uranium, as recorded in a drill core from South Texas, defines a series of enhanced anoxia episodes superimposed on a more protracted episode of basin anoxia. It is unclear if basin restriction or an increase in productivity is responsible for the redox-sensitive trace element enrichment, however, the Mo- and U-enrichment interval may correspond to a global Ocean Anoxic Events (OAE), thereby suggesting that basin restriction did not play a role. The Paleozoic and Mesozoic Texas mudrocks will be compared and discussed in terms of modern anoxic environments, and in terms of their significance as regional paleoenvironmental archives.