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A Cenomanian-Age Deep Continental Shelf Record of Cyclical Anoxia, Gulf of Mexico, South Texas

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While many Cretaceous paleoceanographic reconstructions have focused on global-scale oceanic anoxia events (OAEs) like that which occurred at the Cenomanian-Turonian Boundary (CTB; also known as the Bonarelli Event), we focus on defining paleoceanographic changes that occurred prior to the CTB interval. Specifically, we present a chemostratigraphic record of mixed carbonate-siliciclastic sedimentation from what is interpreted to be a deep-shelf succession preserved in a drill core from Bee County, South Texas (Shell Oil Co. J.A. Leppard, #1). This succession unconformably overlies Albian strata and is believed to predate most of the Eagle Ford-age deposition of South Texas. Biostratigraphic constraints define the ∼140-foot thick succession as mostly lower Cenomanian, with approximately 30 feet of middle-upper Cenomanian, unconformably overlain by ∼20 feet of Campanian strata. A suite of 105 total organic carbon (TOC) values range from 1% to 6% in the Cenomanian strata, and from ∼0.5% to 3.5% in the Campanian strata.

A chemostratigraphic record for the drill core was generated using a suite of 830 major and trace element analyses obtained at an average sample spacing of two inches. Stratigraphic changes in the major element composition are generally reflective of bulk mineralogical changes, largely interpretable in the context of changing facies. Lower Cenomanian strata are dominantly calcitic (60+/-12% $CaCO_3$), middle and upper Cenomanian strata are less calcitic (42+/-12% $CaCO_3$), and Campanian strata are slightly higher than those of the lower Cenomanian (62+/-7% $CaCO_3$). The silicon/aluminum ratio (%Si/%Al) is generally low throughout the section (∼4), indicating very minor quartz inputs. Whereas the bulk major element geochemistry dominantly reflects changes in a simple two-component (calcite and clay mineral) depositional system, trace element signatures reveal exceptionally large, cyclical variations throughout the lower Cenomanian interval. Whereas redox-sensitive trace elements (RSTE) such as nickel (Ni), copper (Cu), and zinc (Zn) record periods interpreted to be reflective of anoxia, the dominant signatures of anoxia/euxinia are best defined by vanadium (V) and molybdenum (Mo). Eight stratigraphically distinct episodes of lower Cenomanian-age anoxia are defined by Mo enrichment factors (EF-Mo) higher than 100; and furthermore, several of the enriched intervals are defined by multiple peaks, indicating an oceanographic process that generates a pattern of redox-driven cyclicity in the sediments. It is hypothesized that the cyclicity is a manifestation of the paleo-oxygen minimum zone (OMZ) impinging on the deep shelf. However, the RSTE pattern could represent a very high-resolution record of the Middle Cenomanian Event (MCE), documented in similar age strata preserved in the Mediterranean region. Further biostratigraphic work and the identification of similar RSTE variations in nearby strata may elucidate if the observed features reflect vertical and lateral shifts in the OMZ of the proto-Gulf of Mexico, or if they are more reflective of changes in global oceanographic conditions that ultimately lead toward conditions are the CTB.