M.S. Thesis Abstract

Sedimentologic, stratigraphic, and diagenetic analysis of microbialite-bearing lacustrine rift sequence within the Lower Cretaceous Yucca Formation, Indio Mountains, West Texas

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This study sedimentologically, stratigraphically, and diagenetically analyzed strata of the upper member of the Lower Cretaceous Yucca Formation in the Indio Mountains, West Texas in order to develop an outcrop-based analog model for similar facies that form major hydrocarbon reservoirs in the Pre-salt rift basins of the South Atlantic margin. The lower Cretaceous strata of the Indio Mountains were deposited in rift basins that formed along the eastern margin of the Chihuahua Trough under similar greenhouse climate conditions as the South Atlantic basins. Eleven lithofacies are recognized from the upper member of the Yucca Formation to the base of the overlying Bluff Mesa Formation. The lithofacies are: 1) siliciclastic channelized sandstone and conglomeratic sandstone, 2) carbonate-clast channelized conglomerate, 3) polymict-clast channelized conglomerate, 4) burrowed fine-grained sandstone containing localized lenses of thrombolite, 5) fine-grained sandstone containing carbonate septarian concretions, 6) calcite radial fans, 7) stromatolitic bindstone, 8) dolomudstone, 9) sandy oyster-rich packstone, 10) lime mudstone and 11) fossiliferous packstone. These eleven lithofacies were further grouped into four depositional facies associations: 1) fluvial channel, 2) lacustrine littoral, 3) marginal marine and 4) normal marine open shelf. The upper member of the Yucca Formation comprises eleven cycles of interstratified lacustrine and fluvial facies associations. Cycles consist of an upward shallowing and coarsening lithofacies progression from 1) lacustrine fine-grained sandstone containing localized thrombolite lenses; to 2) lacustrine massive fine-grained sandstone containing irregular carbonate septarian concretions and localized calcite radial fans; to 3) lacustrine stromatolitic bindstone; to 4) lacustrine dolomudstone, capped by 5) fluvial channel facies with a basal lag commonly containing clasts of the underlying lacustrine facies including stromatolite, carbonate concretions, lime mudstone and lithic clasts of sandstone or siltstone. Not all facies are present in every cycle and the spatial and temporal variations of lithofacies within cycles are attributed to the interplay between rift tectonics and climate. The cyclic repetition of lacustrine to fluvial depositional systems is attributed to climate shifts from semi-humid to semi-arid where increased surface runoff during more humid conditions formed lakes. With increased aridity the lakes dried up and rivers developed across the basin. Cycles display a long-term trend of increase in average thickness and increase in dominance of lacustrine facies within a cycle. This trend is related in this study to long-term climate change to more humid/higher rainfall climatic conditions. In the Echo Canyon area of the Indio Mountains a series of normal fault-bounded uplifts and basins with minor syndepositional offset on faults of a few meters were identified. The subtle differences in bathymetry/topography generated by the faults significantly influenced lacustrine facies distribution. The stromatolitic bindstone and dolomudstone developed...
preferentially on syndepositional horst blocks, whereas the lacustrine fine-grained sandstone with calcite radial fans are only present within down-dropped grabens directly adjacent to faults. The faults acted as conduits for Ca-saturated waters that degassed upon reaching the surfaces along seeps resulting in calcite precipitation on the lake floor. No syndepositional faults were recognized in the Squaw Canyon area.\textsuperscript{1} Diagenetic alterations and paragenetic sequence are similar in the same facies between the Echo and Squaw canyons. Mineral replacements including dolomitization and silicification were identified in all lithofacies except for thrombolite and calcite radial fans. Furthermore porosity in all lithofacies (1 – 2\%) was reduced by cementation and replacement and was slightly improved by dissolution channels that formed in a relatively deep burial diagenetic environment. The only evident spatial variation regarding diagenetic features in the area was the localized presence of hydrothermally-derived saddle dolomites that are spatially associated with a Tertiary igneous dike in Squaw Canyon and normal faults in Echo Canyon.\textsuperscript{1} Stratigraphic cyclicity within the upper member of the Yucca Formation in the study area was dominantly controlled by climate fluctuation, whereas syndepositional faulting played an important role controlling local facies type within lacustrine facies association and lateral facies distribution.\textsuperscript{1}