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Modeled Restoration of the Cretaceous "Shelf Edge" in the Northeastern Gulf of Mexico: Reservoir Facies Implications

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The evolution of the Gulf of Mexico petroleum system began in the middle Mesozoic with intra–cratonic rifting and associated synrift deposition. By the early Tertiary, salt-lubricated passive margin extensional tectonics and neritic through abyssal marine deposition dominated the region. Extensional tectonics continues to shape the modern Gulf, evidenced by the growth of salt domes and movement of the Sigsbee salt sheet. Between the rifting and salt tectonic phases of Gulf history it is likely that seafloor spreading modified the basin. The extent of this modification has been much debated. During this intermediate tectonic phase an imputed mantle plume rotated Yucatan away from North America. It also would have initiated thermal subsidence and created the modern relief of the Gulf basin which established key prerequisites for Tertiary tectonic and depositional styles. Although the details of post-rift, pre-Tertiary tectonics remain speculative, regional thermal subsidence is implicit in most models. The locus of this post-rift subsidence is constrained to lie seaward of the high, stable continental crustal blocks resting on Paleozoic foundations. Although the transition zone between thermally subsided crust and stable crustal blocks appears to be marked by a steeply tilted post-rift unconformity surface, the evolution of this boundary is not well understood. The Cretaceous "shelf-edge" flexure/escarpment feature, described also as the "Florida escarpment" and "Lower Cretaceous reef", tracks the transition zone in the northeastern Gulf. Because it is underlain by thick under-explored but drillable Cretaceous section the transition zone constitutes an important objective for explorationists. The seismic line selected for this modeling experiment (tracing—Fig. 1, left) transects the Main Pass/Viosca Knoll area. The implications of strong differential thermal and sediment load induced subsidence for facies and reservoir development that arose from the modeling are significant. Structural restoration converts apparent Late Cretaceous-Early Tertiary downlap into onlap (Fig. 1, left-right), consistent with the low energy character of post-MCSB chalks and shales (Eagle Ford through Midway). After an Early Cretaceous restoration (Fig. 1, right) the onlapped Lower Cretaceous unit resembles a carbonate buildup, possibly a Sligo-Stuart City equivalent barrier reef. A Late Jurassic structural restoration (not illustrated) reveals probable Knowles-equivalent reefal expansion between the Cotton Valley and top Jurassic horizons, centered beneath the southern margin of the Sligo reef. Implied Lower Cretaceous reef facies seaward of the mapped "shelf-edge" in the northeastern Gulf suggest that potentially large porous reservoirs, stratigraphically trapped up-dip by low energy, fine grained, back-reef facies remain untested.

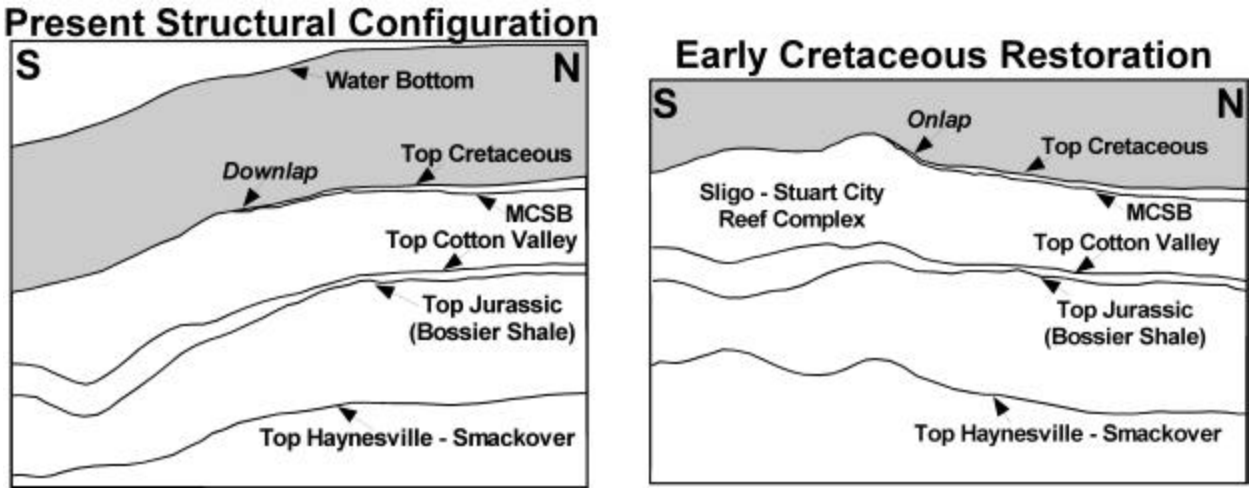

Figure 1. Stratigraphic interpretation of a north-south seismic line in southeastern Main Pass-Viosca Knoll (left). The Early Cretaceous restoration (right) was created by adjustment of the stratigraphic surfaces to a modeled paleo-geoidal surface, which removes the effects of differential thermal and isostatic subsidence.