

Basement Controls on Subsurface Geologic Patterns and Near-Surface Geology Across the Northern Gulf of Mexico: A Deeper Perspective on Coastal Louisiana

Stephens, Bryan P.¹ (1) Minerals Management Service, New Orleans, LA.

Of all the processes that have contributed to the depositional architecture and ongoing subsidence of the Mississippi Delta, tectonic subsidence is probably the least understood. Localized vertical movements in southeast Louisiana are, in part, manifestations of ordered, basin-scale structural patterns that have exercised a profound level of control on all subsequent geological processes including recent coastal environments and ongoing subsidence patterns.

The arrangement of structural elements across the northern Gulf of Mexico suggests the continental margin is segmented by northwest-southeast trending transfer fault zones related to Mesozoic rifting. Observations from a diverse collection of studies are used to document a framework of fourteen major transfer-fault delimited structural corridors, 25 to 40 miles in width, thought to be characterized by varying degrees of extension, crustal attenuation and tectonic subsidence. The corridors are more finely segmented by minor transfer fault trends which also exhibit regular and predictable lateral and vertical offsets that are reflected in the overlying Tertiary cover.

This study incorporates a seismic traverse from a recent proprietary offshore 3-D survey which images offsets in the basement surface corresponding to the transfer faults that trend into southeast Louisiana. Offshore examples illustrate the structural patterns resulting from the interaction of the basement structure, salt systems, and Tertiary faults and can be used as analogs for the subsurface of South Louisiana.

Several examples along the northern Gulf Coast from Florida to southwest Louisiana are used to examine the apparent relationship between the transfer-fault delimited structural corridors and coastal geomorphology. Vertical movements related to these subsurface geologic patterns appear to influence the spatial arrangement of Holocene coastal environments.

Recognition of the ordered arrangement of basement structures, faults and salt systems may provide new insights into the depositional architecture of the Mississippi Delta. Subsurface geologic templates can serve as useful analogs for understanding subsidence patterns and the emerging body of detailed subsidence measurements. Identification of areas of relative geologic stability may influence coastal restoration efforts.