Gulf of Mexico Basin Depositional Synthesis: Neogene Sequences, Depositional Systems, and Paleogeographic Evolution of a Small Ocean Basin

By

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A comprehensive industry-sponsored synthesis of the Cenozoic depositional history of the Gulf of Mexico basin has integrated well data from the onshore, shelf and upper slope areas with Feng's 1995 seismic stratigraphic interpretation of the deep basin. The overall scientific goals of this project are five-fold:

1) Create a digital geographic information system (GIS) data base containing information systematically tabulated from well logs, 2-D seismic lines, and published maps, papers, and other sources.
2) Test and refine sequence correlations between the continental margin (primarily well log data base) and the deep basin (primarily seismic data base).
3) Identify and map successive Cenozoic sedimentary supply and cross-slope transport axes to guide petroleum reservoir prediction in slope and deep basin exploration plays.
4) Document the temporal and spatial distribution of submarine canyons, slump chutes, and structural conduits that have focused sand transport from the shelf margin to the slope and basin floor.
5) Expand the broader understanding of slope depositional processes, facies associations, and paleogeographic evolution.

The first phase of the project has focused on the Neogene basin fill. Ten Neogene genetic stratigraphic sequences, recording major depositional episodes (depisodes) of the northern and northwestern Gulf basin, have been correlated throughout the basin (Fig. 1). For each sequence, interpretative data include thickness, lithofacies, depositional systems, and stratigraphic architecture. In addition, major stratigraphic features, including paleoshelf margins, local depocenters, depositional system outlines, mapped submarine canyons, and continental-margin embayments have been compiled from published sources and digitized. These data have been stored in a digital format (ARC/INFO™), which provides a "living" data base that can be continually updated as more information becomes available or as data are reinterpreted.

The preliminary results of this synthesis are summarized by a series of interpretative maps (e.g., Fig. 2) showing the depositional setting for each of ten sequences: Lower Miocene 1 (24-18.2 Ma); Lower Miocene 2 (18.2-16 Ma); Middle Miocene (16-12.8 Ma);

Upper Miocene (12.8-6.2 Ma); Miocene-Pliocene [*Bul. 1*] (6.2-4.9 Ma); Pliocene [*Glob. alt.*] (4.9-3.1 Ma); Pliocene [*Lent. 1*] (3.1-2.3 Ma); Pliocene [*Ang. B*] (2.3-1.6 Ma); Pleistocene [*Trim. A*] (1.6-0.55 Ma); and Pleistocene [*Sang.*] (0.55-0.27 Ma). The maps are supplemented by a series of regional reference margin well and deep basin seismic cross sections. Major observations from this synthesis include:

1. The early Miocene was characterized by relatively uniform progradation across the entire northern and northwestern Gulf, with major fluvial-deltaic sediment input along the Burgos, Rio Grande, Sabine, and Mississippi axes. Subregional, but short-lived embayments in the paleocontinental margin, likely created by massive salt evacuation, formed first along the western (Planulina embayment) and then eastern (Harang embayment) Louisiana margins. In the western Gulf, a sandy fluvial/deltaic axis built into the Burgos Basin, and sand-rich submarine fans aggraded on the basin floor.

2. The middle Miocene depisode records ongoing sand-rich supply into the western Gulf, abandonment of the Rio Grande axis, development of a middle Texas (Guadalupe) fluvial axis, and an eastward shift of the Mississippi axis to incorporate the Mobile axis. Thus, multiple fluvial/deltaic axes continued to nourish an extensive, largely prograding north and northwest Gulf continental margin. Sandy fan turbidites of the western Gulf floor were replaced by local muddy turbidite successions. In the eastern Gulf, a large muddy submarine fan developed at the margin of the deltaic depocenter and its east-flanking shore zone and sandy shelf. Deep geostrophic marine currents became active in the Gulf, and the first of a succession of mid-Miocene through Quaternary contourite drift deposits accumulated along the westernmost deep basin floor.

3. The late Miocene depisode records further waning of western and northwestern Gulf fluvial axes, and concomitant focus of sediment input into the combined Mississippi-Mobile axes. An extensive delta-fed slope and basin-floor apron extends beneath the deep central Gulf. The large submarine fan system, now sandy, continued to build on the eastern Gulf floor.

4. The uppermost Miocene-Pliocene *Bul. 1* sequence contains deposits of a single large delta system developed along the Mississippi and Mobile axes. The submarine fan, so prominent on the Miocene basin floor is replaced by a broad delta-fed apron across the highly progradational central slope and adjacent basin floor. A thin veneer of shore-zone and muddy shelf deposits comprise the northwest basin margin.

5. Early Pliocene through early late Pliocene deposits of the *Glob. alt.* sequence (Fig. 2) display a dramatic reduction in overall sediment input to the Gulf. Sediment input shifted modestly westward, and distinct Mississippi and Sabine fluvial axes are differentiated. An initial retreat of the western Sabine margin caused by a single megaslide nearly 100 miles in breadth was rapidly healed by apron offlap. However, the eastern margin, fronting the Mississippi delta system, experienced long-term retreat, leaving the shelf margin as much as 40 miles landward of its early Pliocene position. Retreat was

accompanied by slope retrogradation and bypass that nucleated a new, muddy submarine fan system seaward of the delta depocenter.

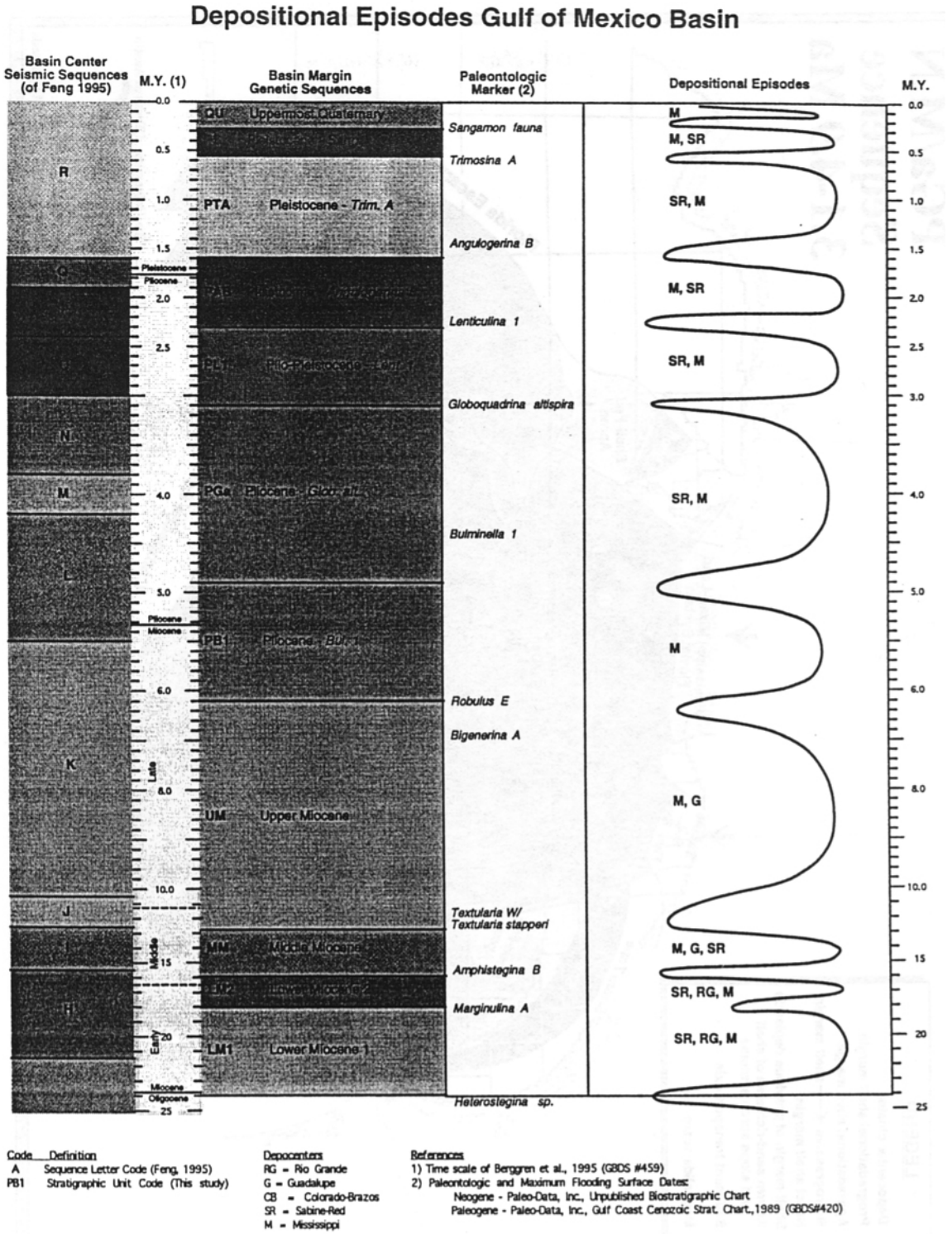
6. Renewed supply through a combined Sabine and Mississippi axis during late Pliocene reestablished margin offlap along a broad, sandy delta-fed apron. Along the eastern margin of the delta depocenter, much sandy sediment continued to bypass to the base of the slope, creating a second phase of relatively sandy fan system aggradation on the east-central Gulf floor.

7. The terminal Pliocene depisode continued to focus sediment into the central Gulf margin and adjacent slope and basin floor. Along the western front of the *Trim. A* deltaic depocenter, continental margin offlap by deposition of a sandy delta-fed slope apron system was renewed. However, the eastern margin of the depocenter displays a more complex history. Here rapid subsidence and foundering of the older delta platform caused slope retrogression and long-term margin retreat. A broad and lithologically diverse autochthonous slope apron extends out onto the basin floor. As delta progradation partially reconstructed the foundered margin in the later phase of depisode history, renewed supply of allochthonous sediment and continued slope bypass nourished a newly formed eastern Gulf fan system - the precursor of the Quaternary Mississippi fan system.

8. The 1.6 Ma Pleistocene history of the Gulf includes ongoing margin outbuilding in front of the combined central Gulf deltaic depocenter, progressive eastward migration of the axes of slope bypass to and deposition of the Mississippi fan, and creation of a second, sandy central basin fan at the mouth of the salt-controlled Bryant canyon.

Figure 1. Neogene depositional episodes of the Northern Gulf of Mexico sedimentary basin and their correlation to Feng's 1995 deep basin seismic sequences.

Figure 2. Interpretive depositional systems and paleogeography of the Gulf of Mexico basin during the early Pliocene depisode (Glob. alt. genetic sequence). Deposits of this episode are included in Feng's seismic sequences M and N, which are combined in this map.



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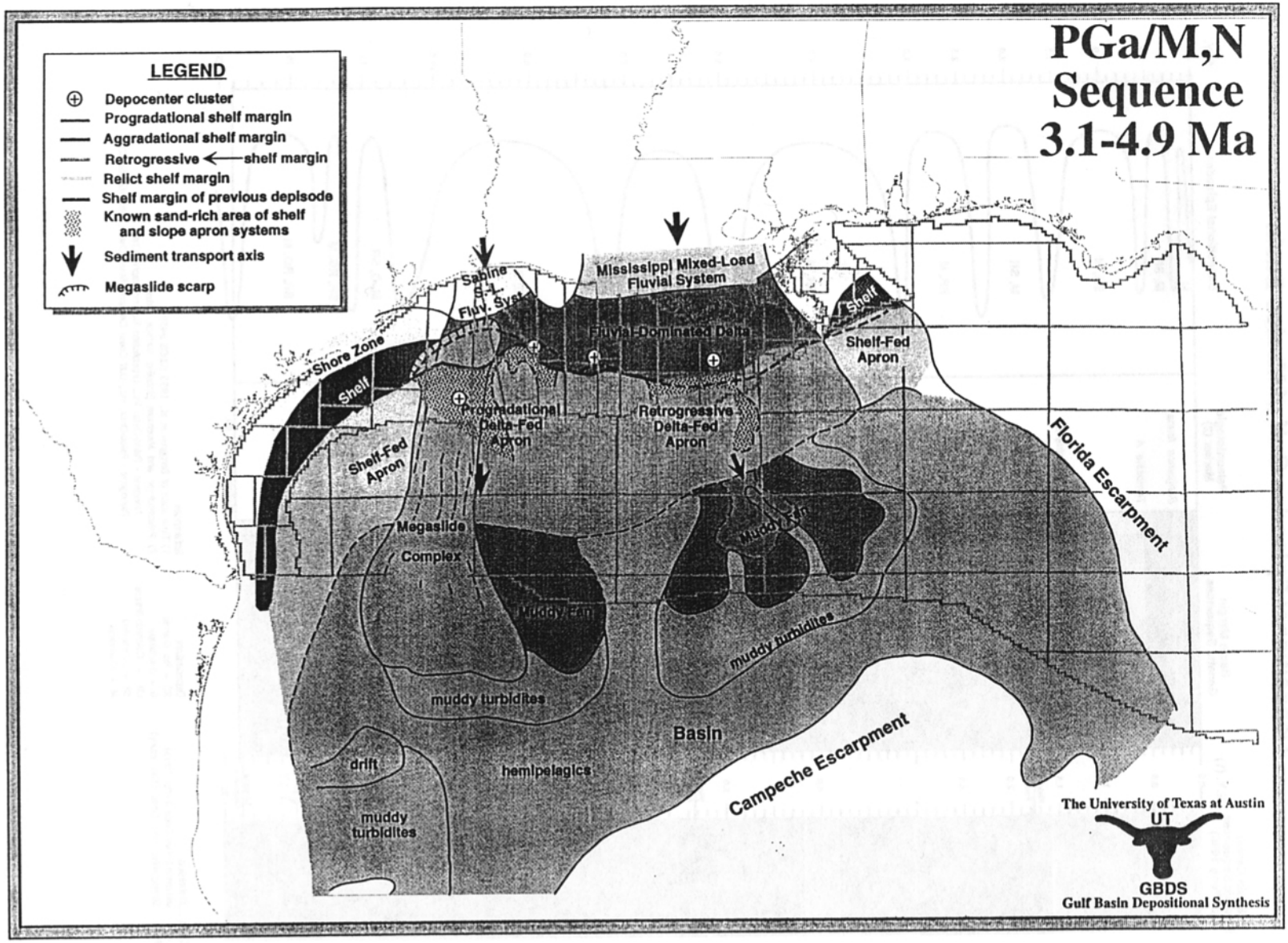

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