SEISMIC STRATIGRAPHY, SEDIMENTOLOGY, AND RESERVOIR POTENTIAL OF A LATE PLEISTOCENE SHELF-EDGE DELTA

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EXTENDED ABSTRACT

Evaluation of a 92 m continuous boring through a shelf-edge delta sequence, in Main Pass Lease Area, Block 303 (MP303), and high resolution seismic profiles on the outer Mississippi-Alabama shelf (Fig. 1), has led to a better understanding of the internal architecture of fluvio-deltaic systems during falling to low sea-level periods. The data set is the best available from any outer-shelf setting, and has resulted in the most detailed documentation to-date of a shelf-edge delta. Although only one boring is utilized, its high quality data form a very useful calibration point for the seismic grid. The resulting stratigraphic mapping supplies valuable knowledge about the lithologic character, stratigraphic position, distribution, and compartmentalization of reservoir facies in an outer-shelf setting.

The MP303 boring, drilled in 72 m water depth, was continuously cored (86% recovery) and gamma-ray logged. The entire core was X-ray radiographed, and photographed in color and black-and-white. Sediment samples at 1.2 m intervals underwent micropaleontologic, isotopic, and coarse-grain analyses. The study utilized over 4500 line kilometers of high-resolution, single-channel reflection seismic profiles. Optimum vertical resolution ranged from 2-3 m (mini-sparker and mini-sleeve guns) to less than 1 m (boomers).

The clinoforms of the landward-thinning delta wedge have prograded onto a shelf-wide, high-amplitude reflector (Surface 10, Fig. 2). This reflector is represented in the boring by a 4 m thick, nodular shell hash, with fauna indicative of a highstand in sea level. The deltaic clinoform wedge appears to be sand-rich. Steep clinoforms at the boring site correspond to the top half of the deltaic sequence, consisting of silty to clean, upper-delta front fine sands. Mapping of steep clinoforms indicate that delta sands are volumetrically the most significant reservoir facies on the outer shelf. The delta reservoir is compartmentalized into clinoform sets, interpreted as individual delta lobes. The lobes are separated by bounding surfaces interpreted as the result of lobe-abandonment periods. From data associated with the MP303 boring these surfaces appear to be composed of muddy facies. Within a clinoform set the best developed reservoir facies are most likely associated with the steep (up to 5°) clinoforms near the progradational centers (axes of diverging downlap), such as found at the boring site. A progradational center is interpreted as the depositional locus associated with an advancing feeder distributary. Each individual delta lobe may be comprised of one or more progradational centers related to distributary bifurcation. Stacking of clinoform sets indicate overall progradation from the NE to SW.

Paleobathymetric indicators suggest shoaling of at least 100 m within the ~10 m thick shelf-to-delta transition at the base of the delta sequence, and is evidence for a "forced" regression of Posamentier et al. (1992). Successively lower elevations of clinoform topsets from -40 m on the middle shelf to -118 m of the distal-most lobes, provide further support that the majority of the fluvio-deltaic system prograded during an overall falling sea level to glacial maximum (18 Ky) lowstand. The majority of the shelf-edge delta therefore belongs to the Falling State Systems Tract (FSST, Nummedal and Plint, in press). Deposition during turnaround of sea level appears to be represented in the distal-most lobes by a small volume of clinoforms which prograded with a strong aggradational component. These final clinoforms are assigned to the Lowstand Systems Tract.

The broad evacuation created by fluvial scour (~15 km wide, 20-25 m deep) is a NE to SW trending feature, which is filled with mainly medium to course sands

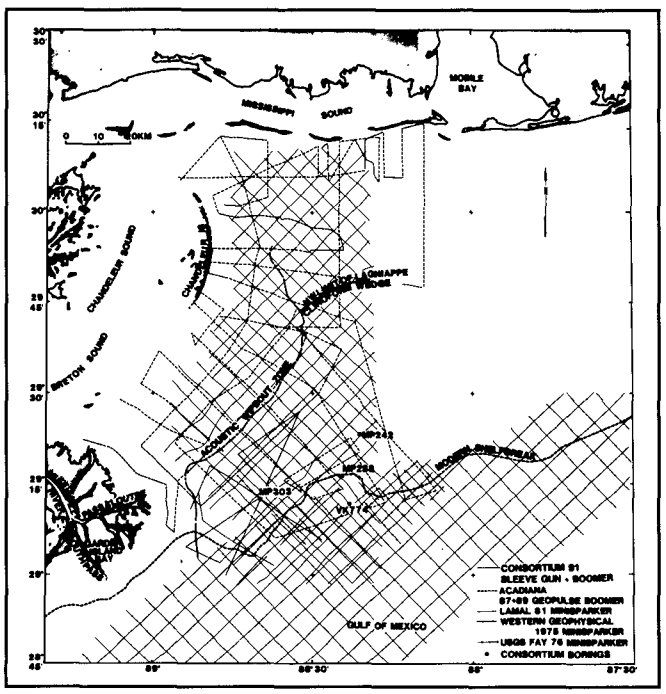

Figure 1. Track-line chart of high-resolution seismic data coverage and location of the Gulf of Mexico Shelf/Slope Consortium borings on the outer Mississippi-Alabama shelf. This study incorporates only the boring from the Main Pass Lease Area, Block 303 (MP303).

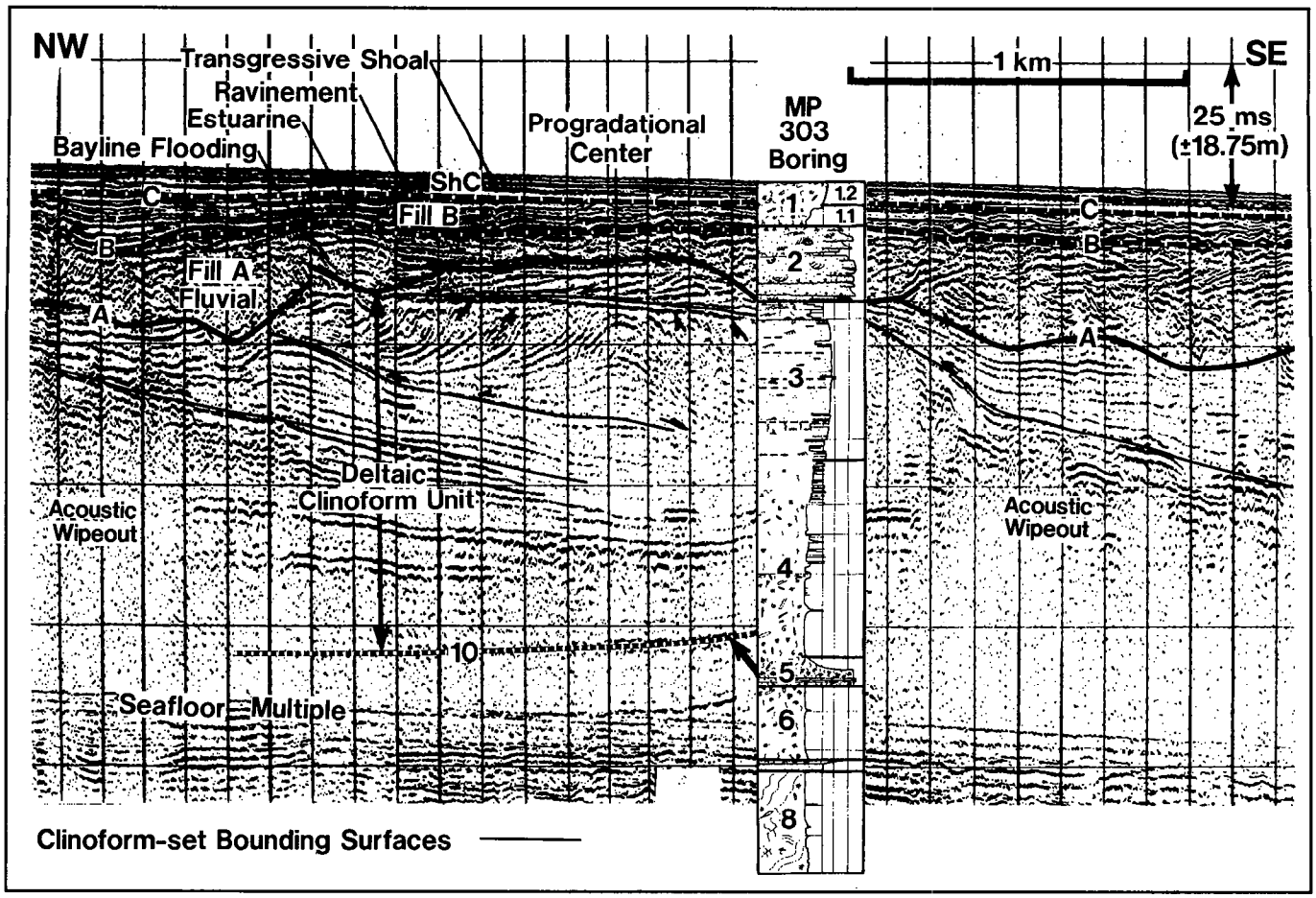

Figure 2. Tripple-plate boomer profile through the MP303 boring site. Depths in the 92 m boring are converted to two-way time assuming 1500 m/s sound velocity. Distinct lithological contrasts differentiate Units 1 to 8 in the boring. Unit 5 in the boring, the nodular shell hash, is correlated to the high amplitude reflector associated with Surface 10 (indicated by arrow). Deeper penetrating, but lower resolution, sleevegun and minisparker profiles imate Surface 10 more effectively. The upward coarsening deltaic succession in the boring, Units 4 and 3, correspond to the progradational-clinoform reflectors in the seismic profiles. Seismic unit Fill A corresponds to fluvial sediments of Unit 2 in the boring, and Surface A is the base of fluvial scour. Surface B is the bayline flooding surface, overlying Fill B corresponds to estuarine Unit 1.2. Surface C, the ravinement surface, is overlain by seismic unit ShC which is represented by transgressive marine sands (Unit 1.1) in the boring. Unit 6 in the boring contains Ericson zone X fauna (125-85 Ka), Units 5 to 3 contain Ericson zone Y fauna (85-12 Ka), non-marine Units 2 and 1.2 probably also belong to zone Y. Holocene Ericson zone Z fauna occur in Unit 1.1. At least two major sea level falls occurred during Ericson zone Y, the Lagniappe delta is associated with the latter of these - the glacial maximum at 18 Ky.

and gravel, and minor estuarine sandy silts at the boring site. The clean fluvial sands form the best quality reservoir facies. The combined fluvial and estuarine fill in this broad evacuation feature equates to approximately 9% of the volume underlying delta clinoform material. Delta reservoir facies have been removed where overridden by widespread fluvial scour on the middle shelf. Fluvial reworking during sea level lowering thus results in poor preservation potential of preceding highstand-delta deposits on the middle and inner shelf. This reworking provides remobilized sand-rich sediment for shelf-edge delta construction.

The fluvial-scour and associated interfluve surface is the most obvious contender for sequence boundary in this data set. This sequence boundary separates the underlying FSST (delta clinoforms) from the overlying LST (fluvial-scour fill and the small volume of delta material deposited during sea level turnaround). In interfluve regions the sequence boundary is amalgamated with the transgressive ravinement surface.

The fluvial deposits in the boring are capped by the bayline flooding surface, which is in turn overlain by estuarine deposits, the transgressive ravinement surface, and finally, submare shoal and thin sheet deposits. The estuarine and shoal deposits form the Transgressive Systems Tract. Submarine shoals are sandy but contain abundant shell material. Shoals are of the poorest quality, and volumetrically least important, reservoir facies.

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