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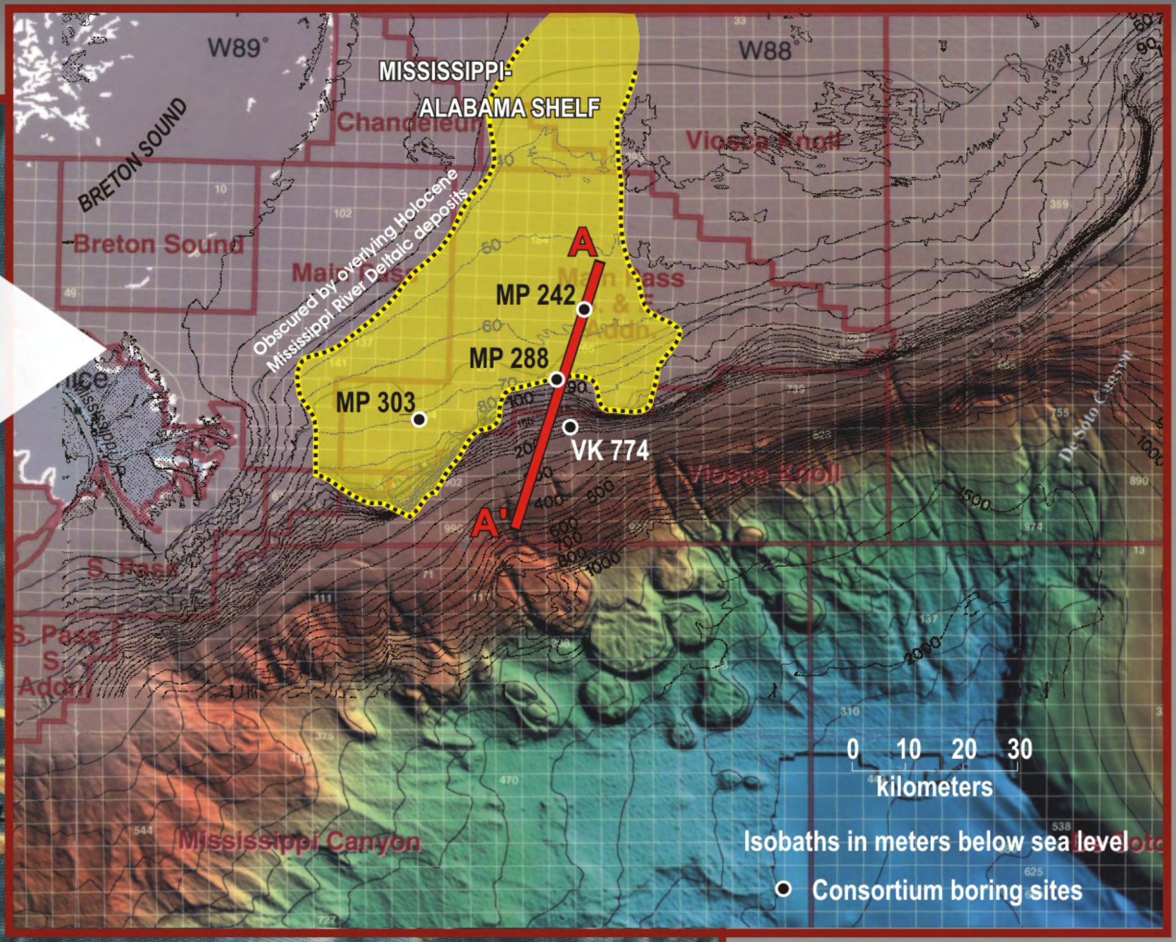
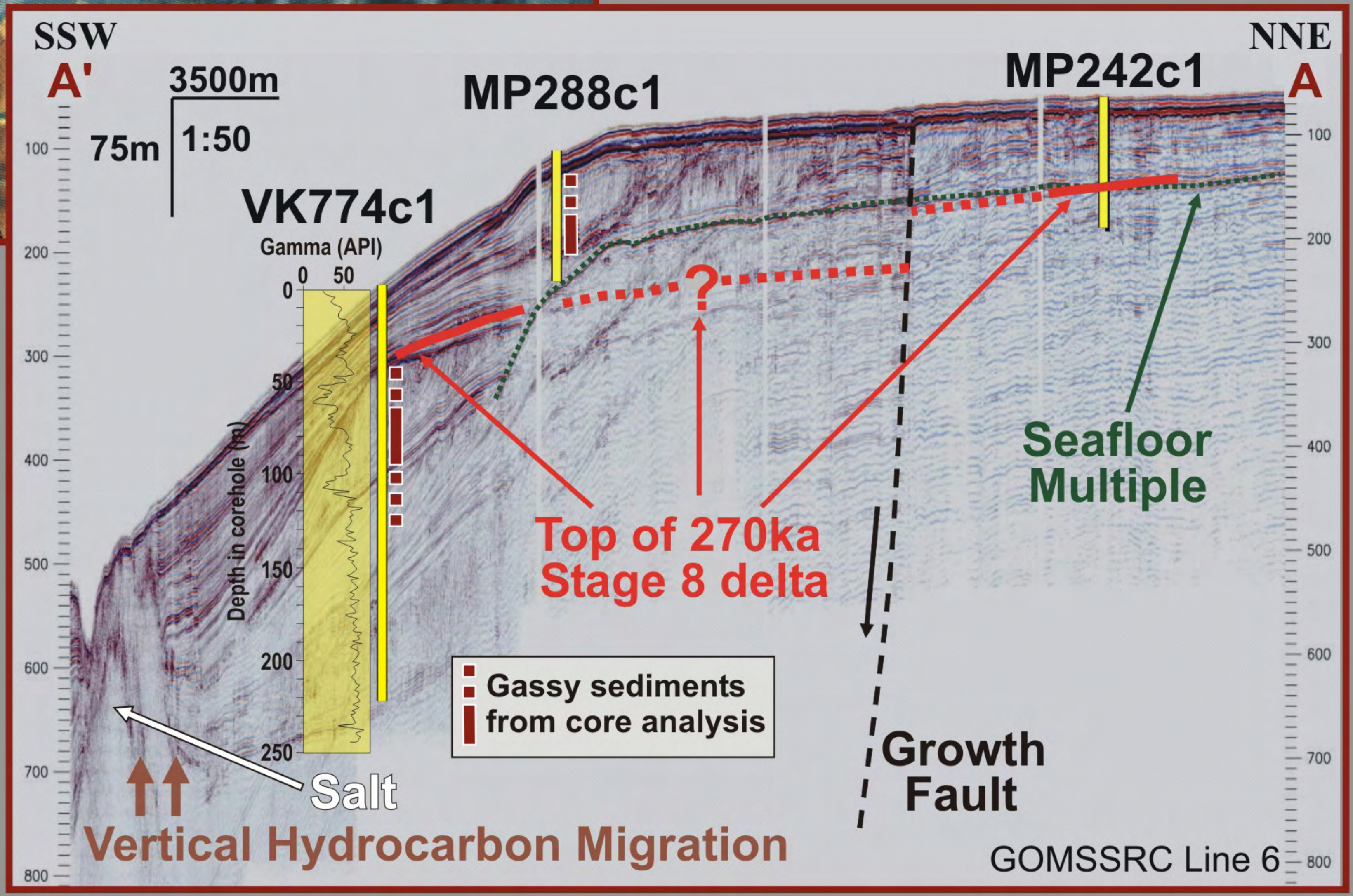
Study Area Location



Bathymetry at the shelf-edge east of the modern Mississippi River delta highlights localized convex seaward protrusions of the contours defining shelf-edge deltas of various scales. The Lagniappe delta is identified in yellow. As suggested from cores through the Lagniappe delta, these deltas are probably coarse grained and exhibit slump and turbidite deposits at the bases of steep clinoforms. Although slope channels or canyons do not connect to all shelf-edge deltas, many well-defined slope channels are present on the eastern Gulf's continental slope. These channels frequently merge down-slope with well-defined channel-levee and slope fan systems.

The shelf-edge of the northern-northwestern Gulf of Mexico is dominated by localized deltaic depocenters that are compensationally stacked and laterally offset (Suter and Berryhill, 1985; Anderson et al., 2003; Roberts et al., 2003). The Lagniappe delta, highlighted in this Figure, is but one of many such falling-to-lowstand deltas that have prograded the shelf edge and provided coarse sediments to down-dip deep water sites of deposition. In addition to direct fluvial input of sediment to deep water, most shelf margin deltas exhibit evidence of slope failure on a variety of scales.



Abstract

Seismically imaged clinoform sets in the northeast Gulf of Mexico define deltas that prograded to the shelf edge during periods of lowered sea level. Two shelf margin deltas, one associated with marine isotope stage 2 (~19 kaBP), and one associated with marine isotope stage 8 (~270 kaBP) are especially well imaged and have been cored by research boreholes. The architecture of this delta complex is calibrated to corrected radiocarbon age, marine isotope stages, biostratigraphic markers, paleoecologic water depth estimates, and sediment properties. The clinoform tops of the younger delta lie at about -90 m water depth, covered only by a thin veneer of transgressive deposits, while the clinoform tops of the older delta lie beneath 185 m of water and 50 m of sediments, downthrown ~145 m to a shelf edge growth fault.

Using this high-resolution dataset we are investigating how growth faulting affects the post depositional geometry and sourcing of shelf margin sand bodies, a major and very prolific reservoir type in the northern Gulf of Mexico. While located near the surface these sand bodies are relatively leaky, receiving large volumes of fluids from downdip sources, via linked thin distal turbidite beds. Fortuitously, the stacking relationship of growth faulted shelf-edge deltas places the leaky portions of older deltas beneath thick accumulations of vertically sealing prodeltaic strata related to middle shelf deltas of intermediate age. Further, it appears that the overlying prodeltaic strata are prevented from transmitting fluids laterally updip into coeval, and potentially leaky, middle shelf deltaic facies by displacement on the growth fault.

As permeable wedges of deltaic sediment move downward along the growth fault, fluids and gases trapped within these reservoirs are transported into the gas hydrate stability zone. With continued cycles of deltaic deposition and simultaneous fault displacement, reservoirs containing gas hydrate are transported below the base of the hydrate stability zone. Hydrate dissociation occurs when this happens. The transport of gas downward along the fault and through the gas hydrate stability zone (GHSZ) has several implications for reservoir preservation and charging. Quantities of gas that might have been lost to the water column by updip migration through shallow subsurface permeable units are retained in reservoir sands. Retention of gas hydrates in the reservoir sands preserves porosity and permeability. The formation of gas hydrate allows the reservoir to be supercharged with gas (1:160 volumes). Dissociation of gas hydrate below the GHSZ frees large volumes of gas creating an overpressured reservoir environment which forces gas up the fault possibly charging reservoirs on the both the upthrown and downthrown sides. At this point, a potentially economic shallow gas reservoir has been produced by the growth fault-gas hydrate conveyor belt. Most shelf margin delta reservoirs that contain mixtures of biogenic and thermogenic gas can be explained by the linked processes outlined in this model.

Acknowledgments

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