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Introduction
Advances in our understanding of siliciclastic deposition in deep-marine settings has occurred through the collection and interpretation of a variety of data sets from modern and ancient (outcrop and subsurface) depositional systems, laboratory experiments, and numerical modeling. Research on deep-water sandstones within the petroleum industry has traditionally relied on interpretation of subsurface systems with conventional exploration data (2D and 3D seismic, well logs, cores) and descriptions of outcrops of ancient systems. More recently, use of experimental and numerical modeling is on the rise (e.g. Hoyal et al., this vol.). Work in each sub-discipline has yielded significant results in the areas of stratigraphic, facies, sediment transport and deposition models of deep-water sandstones. However, there are many limitations to these data sets and results. Fundamental questions remain about how to best integrate and utilize these results to develop a comprehensive understanding of deep-water deposition. Most of the difficulties result from the disparate nature of the data types and the differences in scale and resolution of the observations being made.

It has been long recognized that study of latest Pleistocene and modern systems provides important clues for understanding of deep-water reservoirs. In the past few years, geotechnical developments have produced an opportunity to study late Pleistocene deep-water deposits in a new way. High-resolution, shallow imaging 3D seismic techniques can provide near outcrop-scale stratigraphic information in 3D. New rotary borehole drilling systems designed for collecting continuous cores within the first few hundred meters below the sea floor are now available commercially. As part of an ExxonMobil research project we have designed and executed a field program to take advantage of this technology in the East Breaks area of the western Gulf of Mexico (Figure 1).

The East Breaks Deep-Water Program
The survey area selected is an intra-slope basin located within the Texas continental slope in approximately 1500-m water depth (Figure 1). The basin represents the terminal portion (Basin 4) of a well-known chain of four Pleistocene intra-slope basins often referred to as the Brazos-Trinity Intra-Slope System. The program was designed to occur in two phases. The first phase, conducted in 2001, included the acquisition of a large (200 km², 14 OCS blocks), short-offset (100m, 6 cable array), ultra-high resolution (200 Hz peak frequency, 20-750 Hz bandwidth) 3D seismic survey (EBHR3D). A 30 in³ air gun source was used. The data have a 0.5 ms sample rate and trace spacing is 6.25 meters. Vertical resolution is estimated at 1-2 meters and imaging of the approximately 250 m of basin fill is excellent (Figure 2). The second phase is designed to “ground-truth” the seismic data through coring and logging of the upper levels of basin fill and is not presented here.

Stratigraphic Evolution of Basin Fill; Contrasting Reservoir Styles
Based upon previous research on this portion of the slope, the fills of these basins generally exhibit a three step evolution including, in chronological order: a) a “ponded” fill stage, b) a “perched” fill stage, c) a complete bypass stage (Beaubouef and Friedmann, 2000). These phases in basin filling and spilling and are associated with an evolving accommodation profile as each basin is filled with sediment. Early in its history the basin effectively acts as a pond and deposition is limited to the deepest portions of the bathymetric depression. Ultimately, as the basin continues to fill accommodation decreases and the basin enters the perched slope-filling phase. At this time, the depositional profile is more like a ramp and deposition is offset from the initial basin center and occurs close to the feeder channel. Deposition in Basin 4 was arrested in the perched stage of filling and there has been no bypass or significant post-depositional erosion of the basin fill. Therefore, a complete depositional record of basin filling can be evaluated.
In this presentation we will focus on the contrasting reservoir styles that occur during this evolution. In particular, we will highlight the differences between sand-rich units deposited during the "ponded" and "perched" phases of basin filling (high amplitude units in figure 2). We observe a change from the older, flat-lying, onlapping sequences (ponded), to the basinward tapering wedge of the uppermost unit (perched) that downlaps the older sequences. The difference between these deposits includes their: 1) positions and extents within the basin, 2) external form and map patterns, 3) stacking patterns and 4) internal architectures (Figure 3). The ponded units are best described as confined sheet complexes. They are restricted to the deepest portion of the basin and exhibit "bullseye" isochron patterns. They have uniform seismic amplitude characteristics, reflection continuity suggests they are comprised of layered sheets and no channels are observed within them. Stacking patterns appear aggradational. To varying degrees these units have been truncated by younger mass transport complexes. By contrast, the perched unit (the "Upper Fan") is aerially widespread, exhibits a fan-like map pattern and contains extensive channel systems (Beaubouef et al., this vol.). Strong down-and across-fan seismic facies variations indicate significant lithofacies changes and are accompanied by rapid thickness changes. Additionally, the upper fan shows a progradational depositional pattern. A stratigraphic evolution occurs in which early sheet-like deposition gives way to progressively more channelized facies as the system(s) build basinward. This progradation occurs through the successive off-lap of lobate packages and is associated with the extension of a distributary network of channels into the basin. At the mouths of the distributaries we find channel terminus lobes that resemble those found in river deltas in many ways (Beaubouef et al., this vol.). They exhibit a stratigraphic evolution similar to that observed for the entire fan, but at a much smaller scale. These lobes are of variable size and thickness and consist of small-scale, fan-like bodies (fans within fans).

Preliminary Numerical Modeling Results
The three dimensional behavior turbidity flows over the seismically defined bases of the perched and ponded deposits was modeled numerically. For both cases, the turbidity flow was assumed to have medium concentration (5%) and a height of 48 m, based on the levee height near the inlet. An inlet velocity of 20 m/s was calculated from these values and an assumed feeder channel slope of 1.8 degrees. We believe that the calculated velocities are unrealistically high, but that important insights can be gained from these results. A comparison between the results of the two cases reveals significant differences. These differences include the rate at which the flow decelerates as well as the general flow behavior inside the basin. These differences will have a significant effect on depositional behavior and shed light on the observed differences between the ponded and perched units.

The primary difference between the perched and ponded cases is the rate at which the turbidity flow decelerates. Because of the high slope of the ponded case, the flow accelerates downstream of the inlet. Furthermore, the flow does not decelerate significantly until the flow interacts with the high adverse slope at the end of the basin. In this case, a hydraulic jump forms at the distal end of the basin and migrates nearly half way up the inlet slope. Even though a hydraulic jump forms in this case, velocities are maintained downstream of the jump. In the perched case, a shorter and much gentler slope results in significant flow deceleration prior to the slope break. A hydraulic jump forms at the slope break that rapidly decelerates the flow. The combined effects of further flow expansion and friction rapidly reduce this velocity to low values at the distal end of the basin. A significant difference is also observed in the flow behavior of the two cases. The gentle slope and rapid flow deceleration observed in the perched case results in a rapid flow expansion and deceleration. In contrast the flow in the ponded case rebounds off the distal end of the basin and establishes a counterclockwise rotation centered near the slope break at the base of the inlet slope. The primary result of this flow recirculation is that a deposit forms in the low velocity region at the center of the basin.

Conclusions
From the seismic data we observe distinctly different reservoir styles between the ponded and perched fill. From the numerical modeling we observe differing behavior of the same turbidity current simulated for the ponded and perched cases. Although preliminary, the results of this study combined with those of previous studies point out that there are both extrinsic and intrinsic controls on the stratigraphic evolution in confined slope basins. The extrinsic controls (related to shelf edge delivery systems) affect the types, volumes and frequencies of sediment gravity flows entering a basin. The intrinsic controls (bathymetry, accommodation profiles) affect the positions, extents, and stacking patterns of
depositional sequences. Importantly, both types of controls can impact internal architecture of turbidite reservoir units within the sequences.

References Cited
Hoyal, D.C.J.D. and others, *this volume*. Sedimentation from jets: A depositional model for clastic deposits of all scales and environments.

Figure 1. Maps showing late Pleistocene paleo-geography and depositional setting of study area (Basin 4).
Figure 2. Dip-oriented seismic line from EBHR3D illustrating "Ponded" and "Perched" fill units. The high amplitude units (Lower, Middle, Upper Fans) represent sand-rich, turbidite dominated intervals. The low amplitude units represent mud-rich debris flow deposits and mass transport complexes (MTC).
Figure 3. Maps showing illustrating differences between "Ponded" and "Perched" basin filling units. On the left are isochron maps showing the thickness and extents of the Lower Fan and Upper Fan. On the right are the thickness contours superimposed on TWT (color) of the basal surfaces of these units. Note: a) the shallowing of the basin through time b) the relative conformity of thickness and bathymetric contours in the "Ponded" case, and c) the disconformity between thickness and bathymetric contours in the "Perched" case.
Figure 4. Preliminary results of numerical modeling for turbidity current flow in the "Ponded" and "Perched" cases. Shown are velocity and concentration profiles from 3D numerical simulations for each. In both cases the characteristics of the turbidity current released from the inlet is the same. The observed differences arise from the different bathymetric profiles derived from 3D seismic mapping.