Wednesday, January 30, 2008

Petroleum Club • 800 Bell (downtown)
Social 11:15 a.m., Lunch 11:45 a.m.

Cost: $30 with advance reservations, $35 for walk-ins, space available ($15 for Emeritus and Honorary).

The HGS prefers that you make your reservations on-line through the HGS website at www.hgs.org. If you have no Internet access, you can e-mail reservations@hgs.org, or call the office at 713-463-9476 (include your name, e-mail address, meeting you are attending, phone number and membership ID#).

by ***Chris M. Edwards, Paul A. Dunn,***
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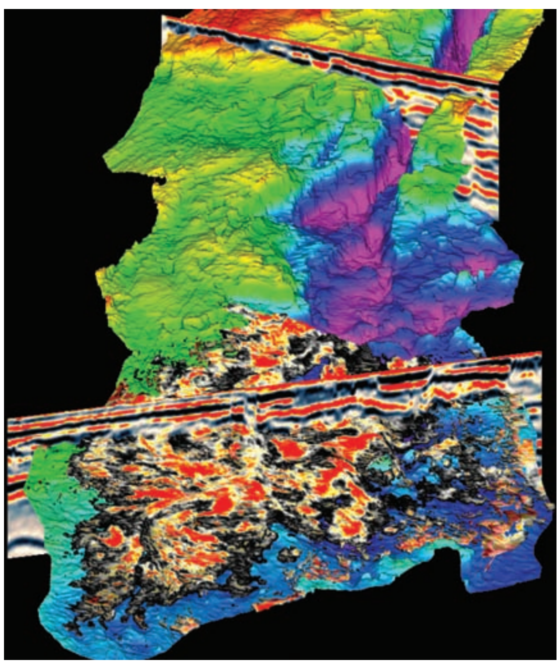
Temporal and Spatial Evolution of a Deepwater Turbidite Fan as Revealed by Ultra-High-Resolution 3D Seismic Data, East Breaks, Gulf of Mexico

Analysis of an ultra-high-resolution 3D seismic volume reveals new insights into the temporal and spatial evolution of a deepwater turbidite fan. The latest Pleistocene upper fan of the Trinity-Brazos slope system is located at the terminal end of a series of linked salt-withdrawal intraslope minibasins and constitutes a basinward-tapering wedge of sediment deposited by turbidity currents. This accumulation reaches a maximum thickness of approximately 260 feet (80 meters) and represents a late Pleistocene analogue to deepwater-fan hydrocarbon reservoirs in the Gulf of Mexico. An ultra-high-resolution 3D seismic volume (200-Hz peak frequency) covering the fan was acquired to identify key stratal elements associated with the growth and evolution of the fan. Seismic resolution is estimated at 3–7 feet (1–2 meters) and provides 3D imaging of bedset-scale stratigraphy that outcrop analysis or conventional, industry-standard seismic data cannot. Because it is commonly the sub-seismic stratigraphic elements that exert a strong influence on production behavior, a better understanding of their distribution is essential for effective hydrocarbon recovery.



Interrogation of the volume reveals numerous channels and lobes that ornament the fan and are arranged into channel and lobe complexes bound at their base by erosional and highly composite surfaces. These surfaces display cross-sectional steer's-head morphology in proximal areas with erosional relief diminishing with distance into the basin. Surface dimensions measure up to 9 miles (14 km) in length and 3 miles (5 km) in width and erosional relief can exceed 80 feet (25 m). Sequential surfaces are offset both laterally and vertically, revealing a compensational stacking arrangement of lobes in the distal part of the fan and a complex cut-and-fill architecture in proximal zones. These relationships imply that only one channel-lobe complex is active at any one time during deposition of the fan and that successive complexes are deposited as a consequence of repeated avulsions at the head of the fan.

At least 12 channel-lobe complex avulsions have been identified that document the growth pattern and evolution of the fan as the system prograded. Early stages in the growth of the fan are characterized by predominantly sheet-like deposition. Incision associated with erosion at the base of channels is minor, and as a consequence, the steer's-head geometry of the channel-lobe complex bounding surface is only weakly defined. As progradation continues, the depth of erosion by channels increases incrementally and successive channel-lobe complex surfaces progressively evolve toward the characteristic steer's-head morphology with deposition occurring in a more organized manner via well-developed channels and lobes.

The internal fill of individual complexes is characterized by two principal architectures. First, the oldest part of the complex is represented by an aggradational terminal lobe that is located at the most down-dip extent of the complex and was deposited immediately after avulsion. Second, a series of landward-stepping reflections downlap onto the terminal lobe, indicating that a significant volume of sediment accumulated behind the terminal lobe by backfilling.

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Coincident with the backfilling process is a change in the plan-view geometry of the channel that feeds the lobe. Seismic coherency slices reveal a change in channel sinuosity and length from initially straight and long channels at the onset of avulsion toward shorter and more sinuous channels as the complex evolves.

Physical tank experiments using sediment-laden salt-water flows have revealed the tendency of the channel-to-lobe transition zone to migrate landward in a fashion analogous to that observed on lobes of subaerial alluvial fans and shallow water river deltas. The backstepping occurs when the flow interacts with the depositional topography created by the lobe, causing flow deceleration and deposition in the channel-to-lobe transition zone. Such behavior plugs the channel and eventually leads to flow diversion and avulsion. The fine-detail stratal architecture revealed by ultra-high frequency seismic data is not sufficiently captured in existing deepwater fan facies models and therefore our ability to predict reservoir performance has traditionally been limited. ■

Biographical Sketch

Chris Edwards graduated from University of Liverpool in 1999 with a BS in geology and then earned an MS from Royal Holloway, University of London, in basin evolution and dynamics. He then completed his PhD in stratigraphy at the University of Liverpool in 2004. He went on to hold postdoctoral positions at the University of Manchester and the University of Bergen, Norway in 2004.

In the early 2000s Dr. Edwards undertook frontier exploration projects on the mid-Norwegian Atlantic margin at BP Sunbury (UK) and Norge (2000, 2002) and developed new depositional models for ENI-Lasmo's Dacion Fields, Venezuela (2003). He joined Esso (UK) in January 2005 and is currently a senior geologist in the ExxonMobil Upstream Research Company, Integrated Reservoir Performance Prediction Division, in Houston. His current role focuses on developing and refining process-based depositional models for the interpretation of Quaternary depositional systems from high-resolution seismic volumes, integrated with outcrop analysis of ancient analogues and physical tank experiments. Whilst at ExxonMobil he has worked exploration issues associated with the deep-shelf Gulf of Mexico play and production issues arising from fluvial reservoirs in Chad. This talk is an extension of his presentation delivered at the 2007 AAPG annual meeting in Long Beach, California.