Monday, May 11, 2009

Westchase Hilton • 9999 Westheimer
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $28 Preregistered members; $35 non-members & walk-ups

To guarantee a seat, you must pre-register on the HGS website and pre-pay with a credit card.
Pre-registration without payment will not be accepted.
You may still walk up and pay at the door, if extra seats are available.

Lesli J. Wood, *Bureau of Economic Geology*
In collaboration with L. Moscardelli, R. Torres-Vargas, J. C. Bermúdez, G. López-Leyva, and D. Dunlap

Source-to-Sink Study of Shelf-to-Shelf Edge to Slope Depositional Systems and Reservoir Character in Offshore Eastern Mexico

Recent estimates of the hydrocarbon potential in eastern Mexico are approximately 55 billion barrels of oil equivalent (BOE) produced and 44.5 billion BOE in reserves. Comparatively, the U.S. Gulf of Mexico is estimated to have produced 138 billion BOE (plus proven) and that there are 73 billion BOE undiscovered. However, the U.S. Gulf of Mexico has over 1,300 producing fields, 42,000 producing wells offshore, and untold numbers of wells drilled. By contrast, the eastern Mexico regions of the Gulf of Mexico are underexplored, with vast regions of the shallow and deep water inadequately tested by exploration wells. This condition sets the stage for great opportunity in a variety of settings.

The Quantitative Clastics Laboratory at the University of Texas at Austin undertook a significant scientific research project to examine a large region (approximately 10,000 square kilometers) of the eastern offshore Mexico shelf and slope in partnership with Instituto Mexicano del Petroleo (IMP) and Petroleos Mexicanos (PEMEX) in hopes of applying ideas from seismic geomorphology to better understand the processes, sources, and sinks for sediments moving along the eastern Mexico margin. Some of the primary sedimentary systems examined included, shelf sands, shelf edge deltaic systems, slope systems, and mass transport prone systems and deposits.

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Shelf Sands

Answering the questions of origin and nature of shelf-deposited isolated sandstone bodies has important implications due to their significance as worldwide hydrocarbon reservoirs. Increased knowledge can be brought to paleoclimatic and paleooceanographic models to increase the accuracy of infill drilling during exploration and development programs. Purported production increases of nearly 40% in some fields worldwide have been attributed to these models.

A seismic geomorphologic study was undertaken to examine some examples of shelf sands located in the eastern offshore Mexico. Logs from gas producing wells showed several cycles of stacked coarsening-upward sands and intervening heterogeneous shaley units. Horizons mapped with 3D seismic provide good stratigraphic control, although several large faults partition the shelf into individual producing blocks and thus complicate the region's seismic geomorphic analysis. Within blocks, seismic geomorphic images show that intervals characterized by higher log gamma ray response appear to contain channelized deposits, while those intervals characterized by lower gamma response in logs appear to contain bar forms. Bar forms are interpreted here to represent the **highstand** component of sequences. Mapped from plan form geomorphic images, these bars appear to be about 1000 to 2000 meters wide and more than 10 kilometers long, similar to those found today immediately offshore. Further seismic geomorphologic analysis shows that the intervals of bar development are separated by channelized intervals with both low sinuosity, 250-meter-wide channels trending perpendicular to relict bar orientations, and smaller, approximately 150- meter-wide, back barrier channels trending obliquely or parallel to swales formed by relict bars. These channelized intervals are finer-grained, based on gamma log interpretation (since they are likely draining back-barrier, mud-dominated regions), and are interpreted to represent the **lowstand** component of these cycles.

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This interpretation differs significantly from previous interpretations of these units but, nevertheless, is a plausible explanation of the occurrence of fine-grained channeling within this system. These units should be accounted for in production and development since they have the potential to form heterolithic production barriers and baffles.

Shelf Edge Deltas and Slope Deposits

Several large deltaic clinoform packages characterize the margin in the south half of the eastern shelf. In an attempt to assess the nature of these packages and how they may relate to reservoirs downslope, four key surfaces were mapped across an extensive area to isolate the individual primary packages (each containing multiple clinoforming events), and those surfaces were carried over the shelf-break and slope region into the easternmost extent of the data. This allowed us to assess the relationships between clinoform architecture and deep-water morphologies.

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The shelf is characterized by a period of progradation and late-stage sediment bypass during a significant lowstand, followed by aggradation and limited downslope sedimentation. The system filled the accommodation space at the shelf-break and downslope and became retrogradational, before a new phase of sedimentation at the shelf caused significant oversteepening and failure downslope. These later mass-transport deposits incised deeply into underlying deposits.

Shelf-edge faults exerted a strong influence on the location of deep-water fans. In addition, a deep-seated structural high in the easternmost regions of the study area influenced gravity deposits, forcing them around the high to the north until the feature was buried. Amplitude extractions through the lowermost fan interval (immediately overlying the lowstand surface) show a series of fans issuing from the gateways provided by the faults that splayed off the shelf. Smaller, approximately 200 meter-wide, channels can be seen as well as larger lobe developments that cross-cut one another.

Farther south, significant high amplitude debris flows can be imaged in older margins, buried among a myriad of channelized slope deposits.

Mass Transport Deposits

Significant volumes of mass transport material appear to have been shed from the southern Lankuasa shelf-edge of eastern offshore Mexico during the late Tertiary. A significant surface which bounds the base of this mass-transport complex-rich section has been mapped up onto the shelf and appears to separate a significant period of progradational clinoform development from a period of aggradational clinoform development. However, variations in clinoform architecture in the strike direction are still speculative and require more investigation prior to finalizing these interpretations. One obvious feature on the distal shelf is a large down-to-the-east normal fault that appears to curve westward marking the updip terminus of aggradational clinoform development. The fault obviously played a role in accommodation development and deposition of aggradational architecture, but its motion and planform view are rather enigmatic. The mass-transport complexes downslope from the shelf-break appear to be "shelf-attached" systems similar to those seen in other regions of the world (Moscardelli and Wood, 2006) and likely contain significant volumes of sandy material. A large canyon, which can be seen in the southern portions of the mapped survey, likely fed sediments directly eastward. A major failure occurred on the shelf-break, resulting in significant basinward dislocation of large clinoform packages. The failure is marked at the break by clinoform truncation, large, cuspate (cookie-bite) scars, and loss of significant volumes of upper slope sediments into eastern depocenters. Semblance images along the basal mass transport complex surface show dense cats-claw scours and major truncation of older, underlying upper slope and delta topset, foreset, and toeset architectural elements. Some of these "erosional remnants" may provide exploration opportunities. Cretaceous mass-transport deposits form the major reservoir in the Cantarell Field of offshore Mexico. Additional opportunities may lie in the final resting place for these Tertiary-age, sandy, shelf-attached mass transport complex deposits.

The deeper regions of this area are known as the Mexican Ridges. These gravity-failed systems of shale-cored, thrusted ridges form a bathymetry on the seafloor that enhanced the influence of current-driven processes in the region during the Tertiary and resulted in reworking and development of thick packages of contourites and sediment waves. In addition, gas hydrate occurs in very specific locations where deep faults feed gas to near-surface regions and state changes cause it to freeze into clathrates.

The development of several new plays such as those in the deep-water Wilcox Group, Tertiary carbonates in the deep Gulf of Mexico, and conventional mini-basin province of the Burgos Basin that bridges the transboundary regions between Mexico

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and the United States illustrate the importance of understanding the opportunities that lie south of the border. ■

Biographical Sketch

Dr. Lesli J. Wood is a Senior Research Scientist and Lecturer at the Bureau of Economic Geology at the University of Texas, Jackson School of Geosciences. She holds a Ph.D. from Colorado State University (1992), and an M.S. degree from the University of Arkansas (1988).

Dr. Wood has served as President of the Gulf Coast SEPM, national Secretary-Treasurer of SEPM, and SEPM Technical Chair for the 2002 AAPG/SEPM Conference. She is also a member of AAPG, GCSSEPM, GSA, and the Geological Society of Trinidad and Tobago.

She spent five years in industry with Amoco Production Company before moving to the University of Texas where she directs the Quantitative Clastics Laboratory Industrial Associates program. Her current research emphasizes education through research, with former students currently employed in academe, government, and industry around the world. Her research interests are in outcrop characterization of clastic reservoirs, studies of worldwide large deltaic systems, quantitative seismic geomorphology, shale diapirism and mobile shale basin development, the distribution and influence of gas hydrates on margin development, and the morphology of deltas on Mars. She has authored numerous papers on these subjects and presented hundreds of lectures and posters at society meetings, universities, and public venues.