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Classification of syndepositional structural systems, northern Gulf of Mexico

Syndepositional structures form in response to sedimentary loading. In the northern Gulf of Mexico, deltaic and turbidite complexes comprising the sediment load cover tens of miles, and the resultant structures are of similar size. We have come to recognize that hydrocarbon-trapping structures are actually quite small components of larger scale structural systems. We define syndepositional structural systems as complexes comprising a number of different, but genetically related, structures that occur in generally repetitive and predictable patterns, linked causally with reservoir distribution and the nature of the unstable substrate being loaded. Three primary types of syndepositional growth-fault systems are observed in the northern Gulf of Mexico: shale-based detachment fault systems, salt-withdrawal mini-basin systems, and salt-based detachment (roho) systems.

Shale-based detachment fault systems are strike-linear gravity slides. Characteristically they exhibit a highly listric master expanding fault, a rollover anticline, a planar synthetic fault, a syncline, a planar antithetic fault, and a horst block. Compressional toe folds may be visible, but they are usually obscured by younger systems. The listric faults share a common sole plane, most often a locally thick transgressive shale. Deltaic progradation stalls at the head of the system. Sands tend to be stacked in the rollover or transported, as if on a conveyor belt, down dip along the fault ramp to form rotated wedges, while the synclinal region is typically filled with prodelta slope facies.

Salt-withdrawal amini-basin systems consist of large (12–20 miles), elliptical withdrawal basins. They consist of a deep turtle structure, a syncline, and a series of subsidiary faults and diapirs that outline the basin margin. In the slope region, tabular salt may obscure all or part of the underlying mini-basin.

Overall geometry of a mini-basin and the nature of the sedimentary fill within the basin vary considerably, depending on whether the mini-basin was loaded primarily in a shelf or in a slope environment. In mini-basins loaded by shelf deposits, the shelf margin characteristically coincides with the hinge faults rimming the basin, resulting in a section of stacked deltaic sands and shales that overlie massive prodelta shales. In mini-basins loaded with slope deposits, ponding of turbidites is generally continuous as long as there is salt withdrawing from the basin.

Salt-based detachment faults, or roho, are combination gravity slide and salt evacuation structures. Roho systems undergo two phases of evolution. Evacuation of salt from a starved mini-basin first forms an extensive salt wing, which is subsequently remobilized by deposition of upper slope and outer shelf sediments on the wing. The deposition initiates formation of a series of listric, down-to-basin faults that sole into remnant salt resulting primarily from salt evacuation into the edges of the wing. Growth faults of roho systems are generally a series of nested horseshoe-shaped faults along which deltaic sands and shales tend to be stacked. The listric normal faults grade laterally into strike-slip fault zones and dip-oriented salt diapirs, and the system has a complex toe thrust zone of salt and compressional structures at the down dip edge of the salt wing. Because of the two-phase evolution, roho separates two regions of discordant structure, a geopressured slope section below and a hydropressured shelf section above.

Biographical sketches

John F. Karlo has worked 20 years for various domestic and international divisions of Shell. Building on a background in tectonics and structural geology (Ph.D., S.U.N.Y. Buffalo and M.A., Univ. of Missouri, Columbia), his career has encompassed both large-scale regional synthesis and play definition and small-scale prospect evaluation as applied to greenfield exploration. He is an expert on the geological architecture of passive margins, particularly those with mobile substrates. Recently he has →

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been exploring for turbidites in deepwater basins of India, Brazil, and Nigeria.

Robert C. Shoup was born in St. Paul, Minnesota, where he attended Winona State University, receiving a B.A. in geology in 1978. After receiving his B.A. degree, Bob attended the University of Oklahoma in Norman, receiving an M.S. in geology in 1980.

Upon graduation, Bob was employed by Shell, mainly doing geological evaluation of the South Texas offshore. In 1983, he became a member of a team evaluating the tectonic and stratigraphic architecture of the Gulf of Mexico. After working onshore and international, Bob was transferred to China in 1993 where he was offshore team leader. At the end of 1995, he was transferred back to New Orleans, overseeing generation and evaluation of prospects in the eastern deep water of the Gulf of Mexico. After 18-plus years with Shell, Bob retired and is now working in Houston with Samson Offshore where he oversees all Gulf of Mexico exploration.

Bob is a Certified Petroleum Geologist and an active member of AAPG, HGS and NOGs. He has also been very active in the DPA, serving as editor of the DPA *Correlator* in 1993–1994, DPA Advisory Board member for the Gulf Coast, 1998–2001, DPA vice president in 1999, and vice chairman of the DPA New Orleans Year 2000 National Convention. In addition to this service, Bob has been a co-author or senior author of several publications and conducted short courses for the AAPG. □