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Deepwater Exploration: Conceptual Models and Their Uncertainties

by G. Shanmugam, Mobil Exploration and Production Technical Center, Dallas

The common perception in exploration is that deep-water sands are predominantly a product of turbidity currents, and that submarine-fan models with channel/levee and lobe elements are the norm in both sedimentology and sequence stratigraphy. The reality is that, in many cases, deep-water sands are deposits of sandy debris flows, slumps, and bottom currents rather than turbidity currents.

Conventional submarine-fan models are not applicable in many cases. Examination of nearly 15,000 feet (4573 m) of conventional core from Paleogene deep-water sandstone reservoirs in the Gryphon Field (U.K. North Sea), Frigg Field (Norwegian North Sea), Faeroe Basin (west of Shetlands), and Edop Field (offshore Nigeria) reveal that these reservoirs are predominantly composed of deposits of sandy slumps and sandy debris flows. Classic turbidites are rare. Sedimentary features indicative of slump and debris-flow origin include sand units with basal shear zones, sharp upper contacts, slump folds, discordant, steeply dipping layers (up to 60°), glide planes, brecciated clasts, clastic injections, floating mudstone clasts, planar and random clast fabrics, inverse grading of clasts, and moderate-to-high matrix content (5 to 30 %). Cored reservoirs in the North Sea exhibit seismic (e.g., mounded forms) and wireline-log signatures (e.g., blocky motif) and stratal relationships (e.g., downlap onto sequence boundaries) indicative of basin-floor fans within a sequence-stratigraphic framework. Although basin-floor fans are predicted to be composed of sand-rich turbidites with laterally extensive, sheet-like geometries, calibration of long (up to 215 m) cored intervals with seismic and wireline log signatures through several of these basin-floor fans shows that these features are actually composed almost exclusively of slumps and debris flows with complex geometries.

In addition, coring of modern fans (e.g., Mississippi Fan, and Amazon Fan) reveals a complex distribution of facies, which is quite different from the conventional submarine fans dominated by depositional lobes (sheet turbidite sands) in the outer fan areas. These recent developments necessitate a paradigm shift from the routine use of turbidite-dominated submarine-fan models to debris-flow-dominated non-fan models.

Biographical Sketch

G. (Shan) Shanmugam is a Geological Scientist at Mobil Technology Company in Dallas which he joined in 1978. He received his M.Sc. in applied geology from the Indian Institute of Technology (Bombay), and Ph.D. in geology from the University of Tennessee (Knoxville). His publications (75 papers and 70 abstracts) cover a wide range of topics on petroleum exploration and production, including deep-water sands in the Norwegian Sea, North Sea, offshore Nigeria, offshore Equatorial Guinea, offshore Gabon, Gulf of Mexico, California, the southern Appalachians in Tennessee, and the Ouachita Mountains of Arkansas and Oklahoma; tide-dominated estuarine sands in Ecuador; development of secondary porosity in sandstones beneath erosional unconformities in Alaska and the Norwegian Sea; and oil generation from coaly source rocks in Australia.

Shan received the best paper award from the Nigerian Association of Petroleum Explorationists (NAPE) in November 1996 for his paper entitled "Deepwater Exploration: Conceptual Models and Their Uncertainties". ●