MODEL FOR UNSTABLE SHELF DELTAS – A SEQUENCE CONDUCIVE TO ACCUMULATION OF GIANT GAS FIELDS; EXAMPLE FROM SOUTH LAKE ARTHUR FIELD

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In the south Louisiana onshore, exploration emphasis has now shifted to deeper plays in interdomal areas as the majority of the domes have been discovered. Unstable shelf deltas develop in such areas. Several discoveries have been made during the past few years and a giant one is South Lake Arthur Field. This field ideally fits the unstable shelf delta model.

Unstable shelf deltas are deeply buried structures of very large magnitude in which thick reservoir sandstones have been deposited on extensive organic rich prodelta shales (excellent source rocks). Deposition of reservoir sandstones generates the trapping structures — growth fault and rollover anticline. The sequence is sealed on top by large thicknesses of shales rich in marine organisms.

In the unstable shelf delta sequences, rapid deposition of sands on large prodelta shale platforms triggers a series of chain reactions that are self sustaining and supportive — initiation of growth fault, development of rollover anticline, geopressuring of sediments, shale movement and diapiric activity around the sand depocenter and finally the abandonment and bypassing of the area by major distributary channels initiating marine transgression, reworking of the older deltaic sands and deposition of thick marine shales on top of the sequence.

Unstable shelf deltas build in localized basins on the part of the shelf that "GIVES" actively, through combined effects of subsidence, shale compaction and shale flowage. They develop in stratigraphic units where a strong regressive episode of deposition is immediately followed by a large marine transgression.

South Lake Arthur Field is a giant gas field discovery with potential reserves in excess of a trillion cubic feet of gas. More than 25 wells have been drilled in the field and both the log and the seismic data display the typical unstable shelf delta sequence — 400 to 800' thick reservoir sandstones of "Miogyp" (Oligocene) age — sandwiched between greater than 2000' of prodelta shales at the bottom and 4000' or more of transgressive marine shales at the top. Production is between the depths of 16,000 to 18,000'. The field is bounded by an arcuate down to the basin fault on the north and is surrounded by shale and salt diapirs all around it.

Productive "Miogyp" sands were deposited in three separate depositional episodes. Lower and Middle "Miogyp" members are thick in the middle part of the field and are dominantly of distributary mouth bar origin — rapidly deposited, poorly sorted, and very shaly. The Upper "Miogyp" sands were developed by the reworking of older "Miogyp" delta sands. They are clean, better sorted, and are elongated along depositional strike.

Lack of knowledge of the unstable shelf delta model combined with structurally emphasized interpretation hindered the recognition, proper development, and accurate mapping of this field. Maps made without the depositional model erroneously used faults to explain variations of interval thicknesses, shale out of sands and anomalies of gas/water levels. In excess of 200 faults were mapped in the field with a map looking like a bowl of fettucini. Utilizing the unstable shelf delta model and the understanding of the depositional sequences, all variations of data could be mapped as a simple east–west trending anticlinal structure with a bounding arcuate fault on the north and no other internal faulting. Other similar features exist, not only on the south Louisiana shelf but in deltaic basins all around the world.

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