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Depositional Environments and Reservoir Morphologies of Channel Sandstones

Channel sandstones are deposited in fluvial channels, fluvial-dominated deltas, submarine channels, and channel-dominated submarine fans on shelves and slopes of many basins. Excellent models of these channel-sandstone depositional environments and reservoirs are in Upper Pennsylvanian and Lower Permian sediments of the eastern shelves and slopes of the west Texas Permian basin. In dip-trending paleodrainage systems on superimposed alluvial plains, sandstone reservoirs are in single and multiple strike-oriented point bars in meander belts, and longitudinal and transverse bars in braided belts. By differential compaction these sandstone belts may produce oil where they drape over buried paleotopographic features such as reefs, structures, and sandstone bodies. Conversely, reservoirs may be found in these buried features by recognizing diversions in the trend of overlying sandstone belts. Oil and gas in sediments adjacent to channels may be trapped by nonpermeable channel-fill barriers. Seismic cross sections of meander belts can clearly show convex-downward bases.

Stratigraphic traps are in thin distributary-channel and delta-plain sandstone facies of shelf-elongate deltas on shelves. Shelf-margin lobate deltas have reservoirs in thick distributary-channel, delta-plain, and delta-front sandstone deposits.

"Packages" of fine-grained, lenticular turbidites can be correlated in submarine channels and fans. Stratigraphic cross sections reveal levees that trap oil in turbidites. Many slope-sandstone facies have been stratigraphically miscorrelated by hundreds of feet with lower sandstone formations.

Regional and local models of shelf and slope channel-sandstone systems and reservoirs and the subsurface methods that reveal them should aid research, production, and exploration geologists. This paper is an attempt to bridge the gap between research and applied geology by describing how the depositional environments of channel sandstones are recognized in the subsurface and how oil and gas are trapped in these sandstones.

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Intraslope Basins on Active Diapiric Continental Slope: A Key to Sand-Body Geometry in Ancient Submarine Canyons and Fans

The hummocky bathymetry of the continental slope off Texas and Louisiana is the result of active diapirism. Most of the diapirs originated from Louann Salt (Middle to Upper Jurassic) mantled by Tertiary shale; some may be completely shale. Except for the local outcrops of the shale, the diapirs are covered by younger sediments. The irregular bottom topography directly influences the path of bottom-hugging transport such as debris flows and turbidity currents.

Three types of intraslope basins have been recognized in this area of hillocks and depressions. The blocked-canyon intraslope basin, for example, Gyre Basin, was formed when an upward-moving diapir blocked a canyon at the time it had little or no active bottom transport, thus preventing the canyon from maintaining a continuous thalweg. The thalweg could be reactivated when the upcurrent part of the canyon filled to the level of a spill point. Seismic reflection profiles over such a basin show sets of onlapping reflections on the diapir flanks alternating with draping sets of reflections. The former reflections are interpreted as deposits from debris flows and turbidity currents; the latter represent mainly hemipelagic sedimentation.

Interdomal basins, for example, Orca Basin, were formed where upward-moving, coalescing diapirs surrounded a section of sea bottom that remained at or near its original depositional depth. In these basins, only draping seismic reflections resulting from pelagic and hemipelagic deposition are present.

The third type of intraslope basin—collapse basin—was formed by tensional collapse due to an extension of sediments over the top of a diapir. Solution of near-surface salt may also have been a forming mechanism. Continuous draping reflections, interrupted by faults and graben structures, are present on seismic records.

The sequences of sets of semitransparent reflections overlain by parallel reflections, as present in blocked-canyon basins, are interpreted to reflect variations in sediment input on the basis of sea-level variations. A rapid lowering of sea level enabled rivers to transport large volumes of coarse silt and sand over the shelf to the heads of submarine canyon systems on the upper continental slope. This rapidly deposited sediment was highly underconsolidated and unstable and was easily removed by slumping, debris flows, and turbidity currents. The bottom-hugging gravity flows transported sediment across the continental slope onto deep-sea fans on the rise. The material deposited in the canyons by these processes is recognized on reflection records as a set of semitransparent reflections. When the sand and silt supply ended, transport by mud-carrying turbidity currents may have continued for a time and may be present on the seismic records as less distinct, onlapping parallel reflections. During the succeeding rise and high stand of sea level, bottom transport completely ceased and pelagic and hemipelagic deposits slowly blanketed the sea floor, producing more distinct parallel reflections.

The weight of the sediment deposited on the flanks of diapirs causes a loading effect which, in turn, influences the movement of salt. In blocked-canyon basins, this diapiric movement has permitted the sediment facies to be repeated. Several examples of recent upward motion of salt are known, for example, protruding basalt on Alderdiche Bank and sand overlying caprock atop a diapir directly southwest of Gyre Basin.

Identification of these types of intraslope basins and an attempt to map the distribution of blocked-canyon basins may reveal the major canyon systems that were opertive on this continental slope. Probably only a few such canyon systems were opertional; therefore, a better understanding of all processes involved must be obtained prior to further studies of sand-body geometry and reservoir characteristics in an area strongly influenced by diapirism.

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Petroleum Source Beds: Environment of Deposition and Stratigraphy

Measurement of organic carbon content, alone, is insufficient to identify potential oil source beds because terrestrial OM (Organic Matter), oxidixzed planktonic OM, or reworked OM from a previous sedimentary cycle can create misleadingly high levels of organic carbon in marine sediments. Consequently, the presence of an oil-prone organic facies, as iden-