The Role of Turbidites in Gas-Charging of Shelf-Edge Delta Sand Bodies: Lagniappe Delta, Gulf of Mexico

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ABSTRACT

During the falling sea level period prior to the latest Pleistocene glacial maximum (18–20 kya), rivers along the northern rim of the Gulf of Mexico migrated across the continental shelf and built deltas at the shelf edge. The best studied of these deltas, the Lagniappe Delta, constructed thick sand-rich, offset, and stacked shelf-edge clinoform sets (to ~30 m thick) that prograded across the outer shelf and onto the upper continental slope. The slope turbidite channel network that developed on the distal clinoform surface eroded headward to the shelf edge indicating that during the final stage of delta development, sediments were delivered directly to the continental slope. Truncated clinoforms and toe-set slump blocks suggest over-steepening and clinoform collapse resulting in down-slope transport of sand-rich sediments. Thinly laminated sand-rich turbidites form a distinctly laminated prodelta apron seaward of the shelf-edge clinoform sets. These sand-to-clay turbidites create effective capillary seals that prevent vertical hydrocarbon migration while allowing hydrocarbons to move laterally updip into the porous shelf-edge delta sand bodies. Strong acoustic impedance contrasts on high resolution seismic profiles in the lower parts of clinoform sets suggest the presence of bubble-phase gas. Also, observation of gas in the water column on acoustic records seeping from truncated clinoforms plus the occurrence of ^{13}C-depleted authigenic carbonates found in a core through a shelf-edge clinoform set suggest linkage between a deep petroleum system and the Lagniappe Delta. Growth faults and shallow salt bodies found on the slope seaward of the Lagniappe Delta focus vertical migration of hydrocarbons to the prodelta turbidites where lateral migration takes place. The gas hydrate stability zone plays a critical role in: (a) regulating the updip hydrocarbon migration through the prodelta turbidites and (b) triggering slope failures that can mobilize large volumes of sediment from the delta front, creating turbidity currents and debris flows that deposit sediment in ultra- deep water. These processes are modulated by sea level change. Gas hydrates decompose during falling-to-low sea level and stabilize during rising-to-high sea level.