Transgressive Events in the Lower and Middle Miocene of the Gulf of Thailand: Implications for Reservoir Characterization

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Abstract

The lower to middle Miocene, late syn-rift to early post-rift, sandstone-dominant succession in the Gulf of Thailand hosts many important petroleum reservoirs and is traditionally viewed as nearly all fluvial deposits with minor estuarine sediments. However, recent studies indicate that marine strata are far more common than previously recognized. The succession includes shallow marine shale and relatively common, thin “coals” previously interpreted as floodplain swamp deposits and used extensively for stratigraphic correlation based on their wireline log signatures. Conventional cores from 9 wells across 200 km of the Pattani Basin integrated with biostratigraphic and petrographic data, indicate that the "coals" actually comprise three distinct facies, two of which are marine. Based on well log to core calibration plus log correlation of 157 wells, each of the three facies also has a different wireline signature and areal distribution. Shallow marine coaly mudstones are 0.6 - 5.0 m thick, laminated clayey siltstones with interbedded thin coals. They have gradational contacts with various adjacent tide-dominant sandy facies and burrows, organic matter and inner neritic foraminifera are common. Their log signature features low resistivity and moderately high-density values that can be correlated regionally. The third coaly facies is non-marine coaly mudstones, which are 0.2 - 0.6 m thick that have gradational upper and lower contacts with floodplain deposits. Plant debris is abundant and thin coal beds are common.

The geographic and stratigraphic distribution of the coaly mudstones indicates that there were multiple minor transgressive events, plus at least two significant marine transgressions, within the fluvial-dominant lower and middle Miocene succession. Many of the sandstones stratigraphically adjacent to the shallow marine and marginal marine coaly mudstones are tide-dominant or strongly tide-influenced, which affects reservoir characterization significantly because the tidal sand bodies are smaller with very different geometries from fluvial sandstones, and porosity and permeability generally are lower in the tidal sandstones. Many of the transgressive successions include abundant fining-upward, stacked channel sandstones previously interpreted as braided stream, meandering river or distributary successions. The sedimentary character of the channel fill varies considerably; some feature increasingly marine conditions upward from near their base while others have only minor marine influence near the top of the channel sand, although all become finer-grained and exhibit increasingly lower-energy sedimentary structures upward. Near the paleo-shoreline, distributaries were filled with a strongly marine succession that is similar to progradational tidal point bar successions except that marine influence increases upward. Further upstream, marine indicators first appear much higher in the succession and the stratigraphic column closely resembles fining-upward fluvial point bar successions deposited by meandering rivers.

Proximal channel-fill successions exhibit much less fining-upward and resemble braided stream deposits. They can include relatively fine sandstones that look like sandy braided stream deposits except they have minor marine influence and grade laterally upstream into coarse, often pebbly sandstones with minimal, if any, marine influence. Accurate reservoir characterization requires careful determination of the depositional

setting because the sedimentary character of the channel fill determines sand body size, shape and thickness as well as porosity and permeability.