RMS-SEPM talk October 2010

Recent Advances in our Understanding Incised Valley Systems utilizing examples from the Lower Cretaceous (Lakota equivalent) of the Western Canada Sedimentary Basin

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Jurassic to Lower-most Cretaceous fluvial to fluvial-estuarine incised valley reservoirs are the host to the most prolific hydrocarbon successions in the Western Canada Sedimentary Basin (WCSB). Production ranges from conventional oil and gas reservoirs of the Basal Quartz, Glauconitic, and Bluesky, to the equivalent Deep Basin tight gas deposits of the Nikanassin (Monach) – Cadomin - Bluesky succession, to the unconventional ‘‘supergiant’’ heavy oil deposits of the McMurray Formation. Recent studies undertaken on Lower Cretaceous (Lakota equivalent) WCSB incised valley systems have identified that in order to effectively exploit these resources that the most significant issue common to all units is the mapability of incised valley trends and internal facies architecture developed in LOW ACCOMODATION settings across the Basin.

Incised valleys systems (IVS) created during a relative sea level fall and back-filled during its subsequent rise constitute one of the most common scenarios of hydrocarbon-producing Cretaceous IVS reservoirs in the Western Canada sedimentary basin (WCSB). At the most general level, all valley fills can be classified as either "simple" or "compound," depending on whether they consist of a single depositional sequence or more than one sequence, respectively. Simple valley fills are most common in small valleys confined to low-gradient coastal plains (i.e., coastal-plain valleys), whereas compound systems are more common in larger incised-valleys that have their headwaters in a (mountainous) hinterland (i.e., piedmont valleys).

Any simple valley fill, or each sequence in a compound fill, can be subdivided longitudinally into three segments. Segment 1 is the most seaward part of the valley, lying between the lowstand and initial highstand shorelines; segment 2 is the middle section and corresponds to the dimensions of the estuary at the end of the transgression; and segment 3 is the most landward portion, lying landward of direct marine influence throughout its history. Estuarine deposits will be present in segments 1 and 2, but are absent, by definition, from segment 3. The idealized vertical succession of facies differs between segments 1 and 2 in relation to where the two segments lie with respect to the initial highstand shoreline (the shoreline location at the "turn-around" point between the transgressive and highstand systems tracts). In segment 1, estuarine deposits overlie lowstand and transgressive fluvial deposits and typically exhibit a transgressive stacking of facies. Estuary-mouth facies are typically partially to completely removed by wave or tidal ravinement as the shoreline backsteps, and the remaining estuarine deposits are overlain by marine sands and/or muds. In segment 2, open-marine deposits are absent because this segment lies landward of the initial highstand shoreline. In the ideal case, transgressive estuarine deposits overlie lowstand and transgressive fluvial deposits, and are themselves capped by a regressive estuarine succession that forms as the estuary fills at the beginning of the highstand. The maximum flooding surface lies near the middle of the estuarine succession and passes seaward into marine shales above the ravinement surface.

The WCSB is an ideal area for examining the changes between low and high accommodation due to the wealth of publicly available data. Detailed core, wireline log correlation, petrography, ichnology,

chemostratigraphy, 3-D seismic and production engineering analysis, organized into a systematic sequence stratigraphic framework, utilizing robust facies models and an understanding of underlying structural overprints and geopressure distribution, allows for a better understanding of fairway trends, compartmentalization, reservoir quality and production characteristics of incised valley reservoirs. This paper will utilize case studies from the key Lower Cretaceous producing reservoirs to demonstrate the complexity and opportunity that still exists, in the exploration for, and exploitation of, incised valley systems.

Back to the RMS-SEPM Luncheon Abstract Archive