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OPTIMIZING RESOURCES

Low accommodation space tide dominated estuarine valley fill: early Albian, North Cactus Lake; McLaren reservoir - west-central Saskatchewan

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Abstract

Detailed well log correlation coupled with core interpretation illustrates the complex stratigraphic architecture of fluvial-estuarine valley fill comprising the North Cactus Lake reservoir. Occupying the deepest part of the incision (Tier 1) are massive sands (i.e. blocky well log profile) interpreted as braided stream deposits. These sediments have not been sampled by core. Superjacent to these are meandering stream deposits (Tier 2) consisting of both point bar and abandoned channels facies. The extent of meandering stream deposits, beyond that of underlying braided stream deposits, coupled with intraclasts derived from the valley wall indicate substantial broadening of the valley by stream migration. In the deepest portion of the channel meandering stream sediments are superseded by interbedded cross-bedded sandstones and thin structureless mudstones. Thin mudstones layers deposited in the highest energy portion of the channel are interpreted as fluid muds deposited during salt wedge intrusion into the base of the channel. Latterly equivalent to these channel base sediment, along the northern margin of the valley, are tidally influenced point bar sands. Silty and carbonaceous debris rich layers within these well sorted sands may signify tidal modulation of unidirectional current flow. The tidally influenced fluvial point bar accreted laterally, to the south, over channel base sediments. Increasing tidal influence on point bar growth is recorded by decrease in grain size (indicating a reduction in ebb current velocity) and periodic deposition of thin mudstone beds (suggesting slack water settling of fines). Jointly the channel base sand and point bar sand comprise the third sedimentary tier of the valley fill. The final phase of valley fill (tier 4) consists of inclined heterolithic stratification filled channels that cut to a deeper level and truncate preceding point bar sands. Deposition of muddy IHS in the late stage channels records deposition within the turbidity maximum. The transition from to fluvial influenced point bar sedimentation to tidally dominated point bar sedimentation implies transition from the straight tidal fluvial portion of the estuary to the meandering portion of the estuary. Stratigraphically distinct IHS filled channels, at the top of the valley fill succession, can be discriminated by differences in reservoir fluids, reservoir fluid contacts and direction of point bar accretion. The occurrence of stratigraphically distinct IHS filled channels, containing evidence of tidal current deposition, are interpreted as mutually evasive flood and ebb channels. Tidal flat sediments, capping tidally influenced point bars sands as well as occurring along the margins of the valley, are stratigraphically equivalent to late stage tidally dominated channels and jointly comprise the uppermost tier (Tier 4) of the valley fill.

The bulk of sediments filling the North Cactus Lake McLaren paleo-valley are upstream derived. Loss of stream gradient during rise in relative sea level resulted in a vertical transition from braided stream (Tier

1) to meandering stream (Tier 2) deposition. This transition was coupled with a marked broadening of the valley. Onset of tidal influence transformed the meandering fluvial channel into the straight tidal fluvial channel with deposition of tidally influence point bars along its margins (Tier 3). As transgression proceeded and tidal influence increased ebb dominance diminished and ebb and flood currents adopted mutually exclusive pathways. This transformation occurred at the turbidity maximum in the meandering portion of the estuary. The heterolithic channel fill was sourced from both upstream and downstream. Increasing tidal range within the tide dominated portion of the estuary resulted in mantling of pre-existing point bars and channel margins with tidal flat sediments concomitant with IHS channel fill (Tier4).

Stacking of braided stream – meandering stream –tidally influenced point bar sands create relatively homogeneous reservoirs typically in excess of 20 metres thick. Late stage muddy IHS filled channels creates permeability barriers that segment the valley fill into separate reservoirs.