Reservoir-Scale Architecture of Deepwater Slope, Base-of-Slope, and Basin-Floor Fan Depositional Environments: The Upper Miocene Urenui and Mount Messenger Formations, Taranaki Basin, New Zealand

Jonathan R. Rotzien

Basin Dynamics

ABSTRACT

Modern outcrops of the Urenui and Mount Messenger formations provide a field mapping opportunity to characterize deepwater slope, base-of-slope, and basin-floor deposits that represent petroleum reservoirs at depth in the Taranaki Basin, North Island, New Zealand. This includes observations of the sub-bed-scale sedimentology, lithofacies, stratigraphic architecture, and key stratigraphic surfaces. Analysis from recent field mapping campaigns (2009–2019) yields the following insights. (1) In the roughly 400 km^2 area, maximum grain size decreases from shelf to basin floor. However, sand grain size increases within channel-fill from slope to basin floor, yet remains consistently fine to very fine grained in the splays, levees, and overbank areas. Net-to-gross overall increases from slope to basin-floor environments, though channel-fill varies. (2) Paleocurrent direction is dominantly NW for the Urenui Formation, NE for the upper Mount Messenger Formation, and ranges from NE to WNW for the lower Mount Messenger Formation. (3) Lateral spacing of slope channels and gullies is about 4–9 km, with minimum width estimates of 250–650 m and depths exceeding 30–40 m. Channel bases routinely extend beneath outcrop level, and are eroded at the top of the cliffs. Channel evolution follows a five-stage process: erosional scour, drape, onlap, fill, and abandonment regardless of position along the proto-slope. Channel-fill is conglomerate- and mudstone-prone along the slope, sandstone- and mudstone-prone at the base of slope, and sandstone-rich at the basin floor. (4) Stratigraphic stacking patterns aren't well expressed along the upper and middle slope. However, fining-upward cycles in splay and overbank environments is well-developed at the base of slope. In the channel-fill, channel margins show strong upward coarsening, and near the axis, upward fining. At the basin floor, compensation-stacking

Rotzien, J. R., 2019, Reservoir-scale architecture of deepwater slope, base-of-slope, and basin-floor fan depositional environments: The upper Miocene Urenui and Mount Messenger formations, Taranaki Basin, New Zealand: GeoGulf Transactions, v. 69, p. 607–608.

patterns are interpreted to represent stronger dependence on the development of splays. (5) The conglomerate typically exhibits variations on Lowe $R_{(12)3}S_3$ to $R_3S_{(3)}$ intervals deposited by both traction and suspension from high-density turbidity currents and rare debris flows. From upper slope to basin floor, the sandstone deposits are typically variations on Bouma $T_{(a)bcde}$ with rare S_1 intervals, with some turbidites exceeding 2–3 m in thickness. The lack of thick structureless sandstone (i.e. Bouma T_a/ Lowe S_3) intervals is somewhat unexpected and may be a result of the uniformly fine to very fine grain size, lack of sharp changes in gradient, or overabundance of low-density turbidity currents causing deposition via traction. Though it can be difficult to translate primarily two-dimensional outcrops along cliffs to three-dimensional petroleum reservoir architecture, outcrop mapping over such a large area is useful to provide a benchmark on reasonable deepwater siliciclastic petroleum reservoir architecture, identify critical unknowns, and guide predrill predictions in analogous fine-grained, litharenite targets globally.