geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Meander-bend migration style controls bar type and resulting heterogeneity

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Summary

In meandering rivers, meander-bend migration style imparts a strong control on the resulting depositional product, yet few studies have attempted to quantitatively characterize this relationship. This is partly due to the difficulty in: quantifying meander kinematics over sufficient time scales in active rivers; and, interpreting meander kinematics from ancient deposits. The rapid migration (>10 $m.yr^{-1}$) of the Mamore River in Bolivia has been documented in 32 years of Landsat imagery, which provides a unique opportunity to quantify meander-bend migration and the resulting depositional products. Linkages to the stratigraphic record are made using high-quality 3D seismic, well log, and core data from meander-belt deposits of the Cretaceous McMurray Formation in Alberta, Canada.

We analyzed a 200 km reach of the Mamore River channel belt, upstream of the confluence with the Amazon River. Mapped channel centerlines provided curvature values, while migration magnitude was measured between successive centerlines. We applied a “bar type index” (BTI) to channel centrelines to classify each meander bend into zones based on the local relationship between curvature and migration. The BTI differentiates between channel segments where a convex point bar or a concave counter-point bar will develop. Migration style was classified using an expansion index that differentiates between expansion and translation of a meander bend.

Our results quantify the distribution and preservation of bar zones in the context of meander-bend migration style. We find that migration style imparts a strong control on the preserved bar architecture and distribution of BTI values. Pure expansion of a meander-bend is rare, and it often takes place in conjunction with rotation. Depositional products of expanding meander bends are dominated by point bar deposits (positive BTI values) and have high preservation percent. Translation is common and preferentially preserves the downstream zones of bars, which results in a higher proportion of counter-point bar deposits (negative BTI values) and overall diminished preservation. In the Mamore River, well-developed counter-point-bar deposits account for 7% of the 250 km^2 total migrated channel area. We apply the results of our analysis to subsurface data from the McMurray Formation to inform interpretations of migration style in Cretaceous rivers. This new approach to analyzing meander development has significant implications for predicting heterogeneity in analogous fluvial meander-belt reservoirs.