Growth of Fluvial Point Bars by Expansion, Translation and Rotation: Role in Governing Facies Architecture and Heterogeneity

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Abstract

As fluvial point bars evolve, they undertake expansion, translation, and rotation as the attitude of channel migration changes through various stages of bar development. This can lead to the partial erosion of deposits accumulated in earlier growth stages, and to the juxtaposition of complicated mosaics of scroll-bar units in planform. The associated migration of the in-channel pool zone may also result in variations in the dip azimuth and inclination of bar-accretion surfaces, and in the thickness of bar deposits. However, the relationship between transformation styles, rotational shifts of channel migration, and the resulting stratigraphic architecture and lithofacies distribution within point-bar bodies remains poorly understood due to limited outcrop or subsurface evidence that records such evolutionary history. To explore how complex expansion, translation, and multi-stage rotational shifts of channels may influence the morphology of resultant point bars in both plan-view and stratigraphic cross sections, a forward numerical stratigraphic model (PB-SAND) has been employed. The model simulates the 3D architecture of point-bar elements with complicated growth histories using a combined geometric and stochastic approach, constrained by quantified sedimentological analog data from real case-study examples stored in a database (FAKTS).The model has been applied to simulate complex bar-growth histories for both modern rivers and ancient successions. Results show how accretion geometries are significantly influenced by both expansion and translation, but also the magnitude and direction of rotation during bar development. Channels that undertake abrupt, angular shifts in migration direction tend to cause

the erosion of significant volumes of older bar deposits, and an overall increase in bar thickness in the direction of migration. The preservation of sand deposits is markedly controlled by the style of bar transformation, relative degree of downstream translation versus expansion, and the direction and magnitude of rotation associated with autocyclic controls that govern channel evolution at varying spatial and temporal scales. A detailed understanding of internal geometries and facies distributions in complex point-bar elements is important for prediction of both reservoir compartmentalization due to variation of bar thickness around a meander bend, and lithological heterogeneity associated with features such as counter-point bar deposits.

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