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Nikki Strong[1], Chris Paola[2], Ben Sheets[3], Tom Hickson[4] (1) St. Anthony Falls Laboratory, Minneapolis, MN (2) St Anthony Falls Laboratory, University of Minnesota (3) University of Minnesota, Minneapolis, MN (4) St. Anthony Falls Laboratory, University of Minnesota

Chi Characterization of Alluvial Architecture

Observations from the subsiding-floor EXperimental EarthScape basin (XES) at St Anthony Falls Laboratory provide a full three-dimensional view of deposits of contained basinal depositional system. For alluvial systems, such observations show how difficult it is to interpret alluvial architecture unambiguously on the basis of cross-sectional information alone. In particular our study illustrates the dominant role of variations in the distribution of deposition along the system, i.e. mass balance, in controlling alluvial architecture. For example, a simple retrogradation in facies due to minor transgression leads to an upsection fining and reduction in channel density that could easily be mistaken for an increase in subsidence rate. The effects of shifts in mass balance can be accounted for via a simple coordinate transformation that maps downstream distance into a dimensionless distance defined as the fraction of all supplied mass deposited to a given point. We term this mass-normalized distance chi and find that transforming measured sections into this coordinate removes much, but not all, of the observed upward variability in architecture. For example, synthetic cross-sectional panels produced by stacking deposits formed at similar chi values show far less upward variability than actual sections, which by definition represent the same dimensional downstream distance but generally different chi values.