Systematic Variations of Stratal Geometry and Rock Properties within Mudstone Parasequences at the Bedset Scale — Insights Into Heterogeneity at the Landing-Zone Scale

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Abstract

A key question for all mudstone-hosted resources is how much of the lateral variation in rock properties was set by original depositional architecture. Our examination of more than 10 km of mudstone sections in outcrops and cores revealed complex bedset-scale geometries within marine river-, wave-, and tidally dominated shelfal parasequences: not only simple downlap of compound bedsets, but also toplap and onlap. The occurrence and relative amount of downlap, toplap, and onlap at the bedset scale results in three distinct and recurrent internal stratal architectures within such parasequences. Foreset-dominated/sigmoidal parasequences have vertical stacking expressions with finest grained strata and highest gamma-ray directly above their basal flooding surface, overlain by relatively simple, serrate patterns of decreasing gamma ray and coarsening upward. Laterally, bedsets thin mostly by downlap directly onto the basal flooding surface; many basal and uppermost bedsets are concordant. This parasequence expression appears to record progradation that is relatively simple and progressive following the basal transgression. Bottomset-bypass parasequences have finest-grained textures and highest gamma ray a short distance (0.6-1.5 m) above the basal flooding surface, atop a distinctive basal bedset. Bedsets at the top of these parasequences are concordant with the overlying flooding surface. This expression records a more complex mode of progradation, with what appears to be a “two-step”

transgression: internal bedset-scale downlap below and onto the basal bedset indicates sediment bypass in the bottomset zone. Topset-bypass parasequences have their finest-grained textures and highest gamma-ray values directly above the basal flooding surface, overlain by a simple, serrate pattern of coarsening and decreasing gamma ray upward. However, their uppermost intervals contain two or more thick amalgamated bedsets of equal to subequal development, giving it an appearance of progradation to aggradation at the bedset scale. Most bedsets thin laterally, mostly by downlap directly onto the basal flooding surface. The uppermost bedsets tends to thicken in the direction of progradation—probably recording significant bypass and aggradation along the top of the parasequence profile (toplap). The relative abundance of these parasequence expressions is influenced by lower-order stacking patterns: bottomset-bypass parasequences are more common in retrogradational parasequence sets, whereas topset-bypass parasequences are more common in progradational parasequence sets.