Stratal Elements of
Sequence Stratigraphy

Depositional Sequences

Lowstand Systems Tract

The LST contains a set of progradationally stacked parasequences, that is, parasequences that progressively build basinwards and that form a net shallowing-upward succession. The lowstand systems tract is underlain by a sequence boundary (sb) and overlain by the transgressive surface (ts), the first major flooding surface of the sequence. The LST is deposited during a slow relative rise in sea immediately following a relative fall in sea level.

Transgressive Systems Tract

The TST is built from a set of retrogradationally stacked parasequences, that is, a set of parasequences that progressively step landward and that forms a net deepening-upward succession. The TST is underlain by the transgressive surface (ts) and overlain by the maximum flooding surface (mfs), which records the deepest-water conditions within the sequence. The TST contains the most prominent flooding surfaces within the sequence. This systems tract forms during a relative rise in sea level that is rapid enough to outpace the rate of sediment accumulation.

Highstand Systems Tract

The HST contains a progradational set of parasequences, like the LST, but occurs in topographically higher setting, hence its name. The HST is underlain by the maximum flooding surface (mfs) and displays net upward shallowing to its upper bounding surface, the basal surface of forced regression (bsfr) or its correlative surface. The HST accumulates during a slow relative rise in sea level. Because the rate of sea-leve rise declines during the HST, coastal plain systems transition from mudstone-dominated with single-story fluvial channels in the lower HST to sandstone-dominated with multi-story fluvial channels in the upper HST. The HST is commonly capped by an unconformity at the sequence boundary (sb), which records prolonged subaerial exposure and erosion.

Falling-Stage Systems Tract

The FSST consists of a set of basinward-stepping and downward-stepping high-frequency sequences, each bounded below by a surface of forced regression. This is the only systems tract to have this unusual architecture. The base of the FSST is placed at the basal surface of forced regression (bsfr) and the top lies at the sequence boundary (sb). The FSST is the only systems tract to form during a relative fall in sea level, and as a result, it is typically thin. In many cases, it is eroded away entirely during subsequent subaerial exposure and formation of a sequence boundary. Because of its thinness and relative rarity, the FSST was originally not regarded as a distinct systems tract and was included as part of the late highstand systems tract.

Depositional sequences are relatively conformable successions of genetically related strata bounded by subaerial unconformities and their correlative surfaces. Depositional sequences may be composed of parasequences (see below), higher-order sequences, or a combination of the two.

Sequences are composed of a characteristic succession of four systems tracts (sets of all contemporaneous depositional facies), always in the same stratigraphic order: lowstand, transgressive, highstand, and falling-stage. Not all systems tracts may be present in any one area, but they will be present somewhere in the depositional basin, unless removed by erosion.

The three-dimensional architecture of a sequence – how facies, surfaces, and systems tracts are arrayed internally – varies markedly depending on rates of eustatic sea-level change and tectonic subsidence, the type and volume of sediment supplied, and the configuration of the shelf.

Surfaces of Forced Regression

Surfaces of forced regression are sharp erosional contacts that separate underlying deeper marine strata from overlying shallow subtidal facies, giving rise to the name "sharp-based shorefaces" (yellow lines, above). These surfaces form by wave erosion on a narrow zone on the inner shelf during a relative fall in sea level. They are best-developed within the falling-stage systems tract.

This surface may display features indicating the erosion of cohesive marine muds, including gutter casts and firmground ichnofacies. The surface is often overlain by a lag of shells and mud rip-up clasts.

Sequence Boundaries

Sequence boundaries are defined by unconformities that record subaerial exposure and erosion (red lines, above), correlative marine erosion surfaces (surfaces of forced regression), and correlative conformities. Sequence boundaries form from a relative fall in sea level.

In fluvially dominated areas, unconformities display erosion from downcutting rivers, which may form incised valleys or regional erosional truncation. Such unconformities are commonly mantled with siliciclastic pebbles. Incised valleys are commonly filled with fluvial to estuarine deposits. Between river valleys, subaerial unconformities are typically marked by paleosols and weathering horizons.

In carbonate settings, unconformities may be paleokarst surfaces with evidence of subaerial dissolution and diagenesis.

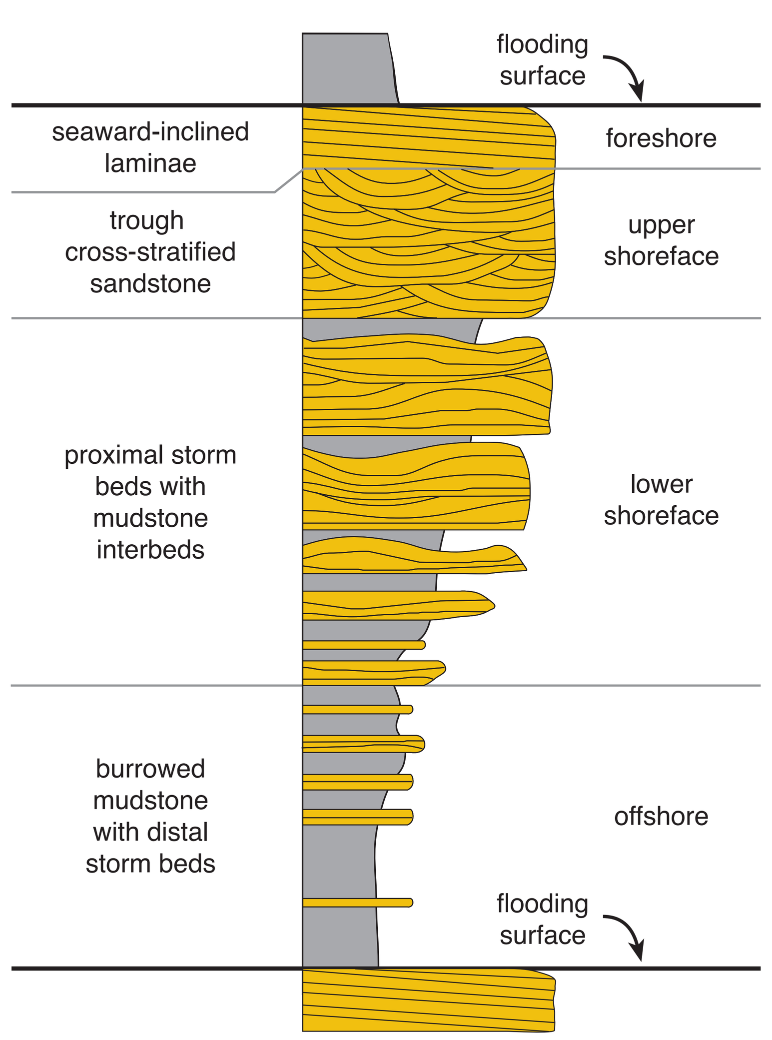
Major Flooding Surfaces

Most sequences are built from sets of parasequences, units bounded by marine flooding surfaces, at which relatively shallow-water marine and coastal strata are sharply overlain by deeper-water marine strata.

These surfaces are commonly zones of low sediment accumulation, or condensed sections. Condensed sections are best developed at the most prominent flooding surfaces (heavy black lines, above), such as those within the transgressive systems tract, beginning with the transgressive surface (ts) and ending with the maximum flooding surface (mfs).

Evidence of stratigraphic condensation may include thick accumulations of shells and other bioclastic material, including bones and teeth. These horizons are also commonly burrowed and bored with firmground to hardground ichnofacies. Authigenic mineralization of pyrite, phosphate, glauconite, and siderite may be present, as well as radioactive shale and layers of volcanic ash.

Early sequence stratigraphic studies referred to the maximum flooding surface as *the* condensed section, but there is now a realization that stratigraphic condensation could be best developed at any of the major flooding surfaces in the transgressive systems tract.



Parasequences

Parasequences are relatively conformable successions of genetically related beds or bedsets bounded by marine flooding surfaces and their correlative surfaces. Parasequences are commonly, but not necessarily, meters to ten meters thick and shallowing-upward. Facies transitions within parasequences obey Walther's Law, but transitions across the upper and lower bounding surfaces do not.

Parasequences are bounded, by definition, by flooding surfaces, which are surfaces across which there is stratigraphically abrupt deepening recorded in sedimentary facies (black lines in cross-section, above). Flooding surfaces may also display minor erosion and evidence of slow net deposition, including burrowed and bored surfaces, and accumulations of shells, authigenic minerals, mudstone intraclasts, bentonite, and radioactive shale.

Flooding surfaces record a rapid relative rise in sea level without deposition of sediment. Parasequences record a period of shoreline progradation under static to slowly rising relative sea level. Parasequences may be produced by eustatic sea-level changes, episodic earthquake-induced subsidence, and delta switching.

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