Build-and-Fill Sequences: Predictable Patterns of Creation and Destruction of Paleotopography in Small-Scale Sequences

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Purpose

- To evaluate controls on small-scale sequences
  (up to tens of m) deposited during ice-house
  conditions that maintain similar thickness
  throughout wide geographic areas despite
  draping topography and containing facies
  that both build and fill relief.

- Use Pennsylvanian, Permian and Upper
  Miocene examples to demonstrate various build
  and fill facies and architectures.

- Demonstrate that build-and-fill sequences:
  1. Form in the build-and-fill zone.
  2. Build relief into underfilled accommodation
     during sea-level rises.
  3. Tend to smooth out paleotopography during
     sea-level falls (accommodation limited).

- Consist of associations of reservoir/non-
  reservoir facies that build and fill relief.

Implements

- Expect build-and-fill sequences to develop during
  periods of high frequency-high amplitude sea-level
  fluctuations when carbonate production is not optimal.

- Build-and-fill sequences form in the build-and-
  fill zone, in middle ramp/shelf settings that lie
  between highstand and lowstand positions.

- Build-and-fill sequence architecture may be
  predictable given knowledge of the sea-level
  history, paleotopography, and controls on sediment
  production and dispersal.

- Many shallow-water carbonate facies fill low
  areas as opposed to building relief on paleohills.

- Siliciclastics can fill or build relief.

- Thealternation of building and filling processes
  during a single sea-level cycle produces a
  thin widespread sequence with complex
  internal architecture.

Build-and-Fill Zone

- Rates of sea-level change are high.
- Production unable to keep up with raised rate; relief is
  built in underfilled accommodation; relief filled
  during sea-level fall to create even-thickness sequence.
- Sequences show build and fill character; sequences
  may be deepening upward; upper portions of sequences may shallow

Examples of Settings

- Examples used come from the Pennsylvania of Kansas and New Mexico, Permian of New Mexico, and Upper Miocene of the Mediterranean Area (Spain)

Major Controls on Build-and-Fill Sequences

1. Icehouse conditions - times of high amplitude and high frequency sea-level fluctuations
2. A perturbed system in which carbonate productivity is lower than optimum
   - Too many nutrients, stratified systems; cool water?
3. Erosion controls (topography).
   - Re-colonization time/lag time allowing systems to fall behind
   - Energy considerations may be important
     - Wide ramps/shelves - prevent effective ooid production
     - An area behind a shelf margin high characterized by low energy and decreased productivity
3. Substrates not in highstand or lowstand positions
   - Intermediate shelf and ramp positions
   - Platform interiors that are not at the right elevation to be in shallow water during highstand or lowstand

Pennsylvanian Midcontinent Setting

- High-frequency sequences were deposited on a broad, gently sloping shelf bordered by the clastic wedge.Antecedent basin of Mississippian and Pennsylvanian ages
- Field site in the south-central Texas oil belt with high amplitude fluctuations with amplitudes: 75-100 m

- The study area is characterized by highly variable clastics and shallow marine carbonates. Sequences are characterized by gently sloping ramp and shelf environments
- Given the overall thicknesses of the sections, the depositional sequence is relatively high and rapid.

- Median durations of sea-level fluctuations are 25-30ka

Upper Miocene Mediterranean Setting

- High-frequency sequences were deposited on a broad, gently sloping shelf bordered by the clastic wedge. Sequences are characterized by gently sloping ramp and shelf environments
- Given the overall thicknesses of the sections, the depositional sequence is relatively high and rapid.

- Median durations of sea-level fluctuations are 25-30ka

- Mediterranean area a more restricted rise; high-frequency sequences are unlikely to be preserved, and perhaps only economically important sections have been identified in the nearby Atlas and Sardinian areas.