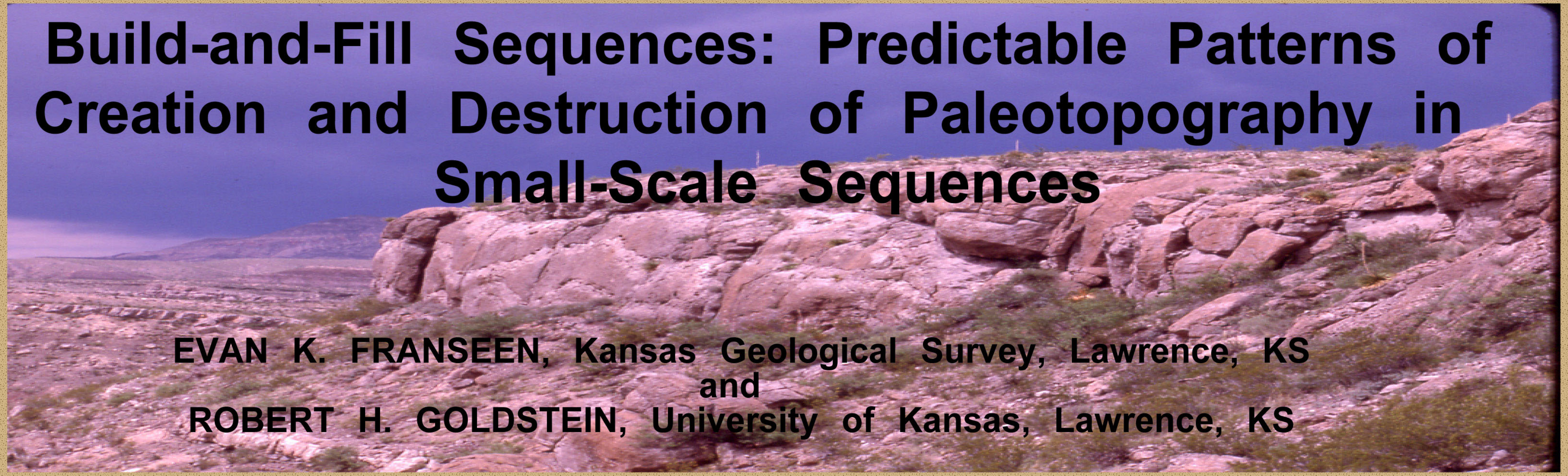


Build-and-Fill Sequences: Predictable Patterns of Creation and Destruction of Paleotopography in Small-Scale Sequences

EVAN K. FRANSEEN, Kansas Geological Survey, Lawrence, KS
and
ROBERT H. GOLDSTEIN, University of Kansas, Lawrence, KS

PURPOSE

- To evaluate controls on small-scale sequences (up to tens of m) deposited during ice-house periods 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:
  * Form in the build-and-fill zone.
  * Build relief into underfilled accommodation during sea-level rises.
  * Tend to smooth out paleotopography during sea-level falls (accommodation limited).
  * Consist of associations of reservoir/non-reservoir facies that build and fill relief.

IMPLICATIONS

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 paleohighs.

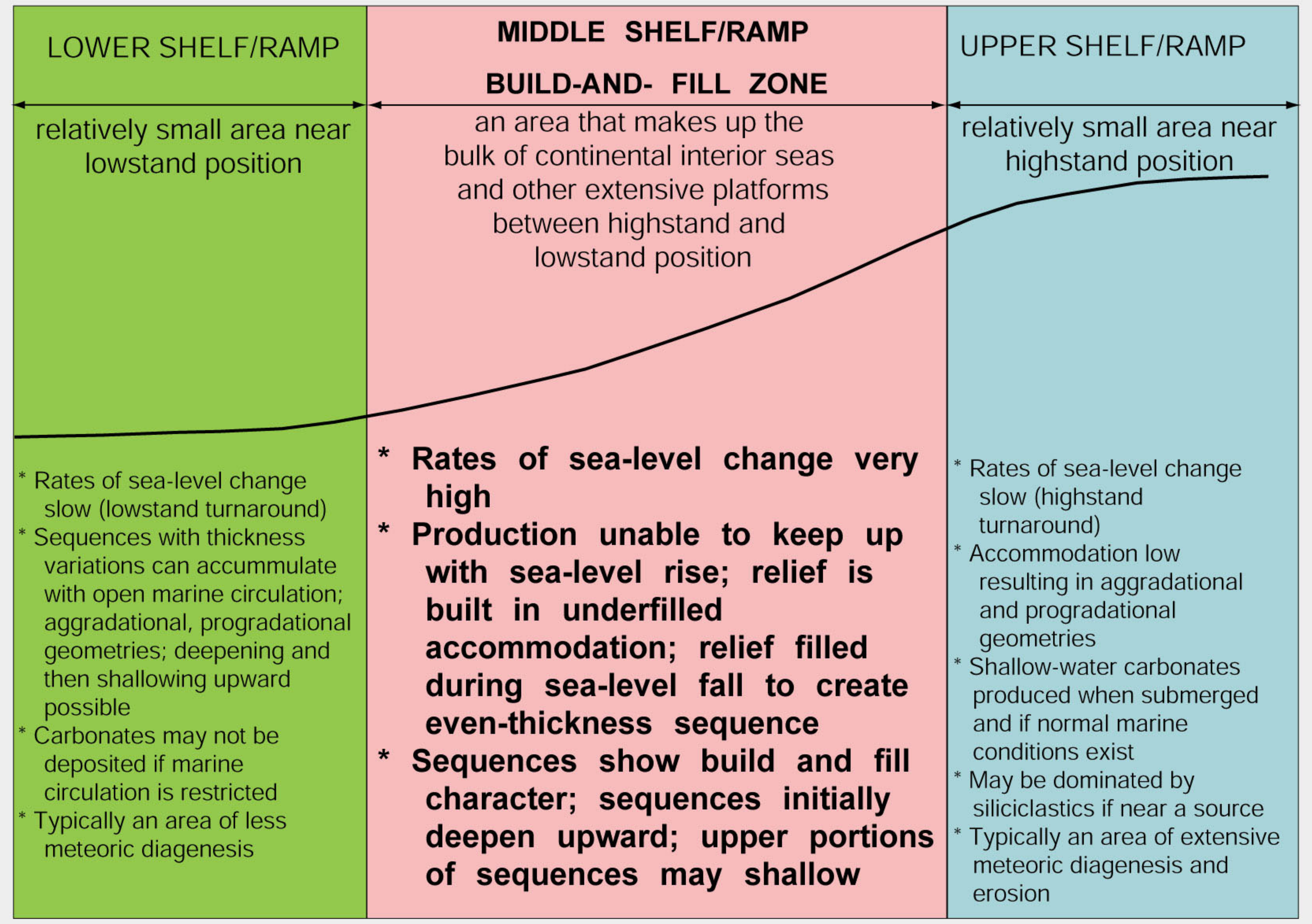
Siliciclastics can fill or build relief.

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

WHAT IS A BUILD & FILL SEQUENCE?

1. An entire sequence - either all carbonate, or mixed siliciclastic-carbonate
2. Laterally extensive in its distribution, but thin and of even thickness
3. Sequence is thin compared to amplitude of sea level change
4. Sequence tends to drape paleotopography when examined as an entire unit
5. Sequence is capped by a surface of subaerial exposure
6. There is a topographic relief building phase
7. There is a topographic relief filling phase

BUILD-AND-FILL ZONE



MAJOR CONTROLS ON BUILD-AND-FILL SEQUENCES

1. Icehouse conditions - times of high amplitude and high frequency sea-level fluctuations

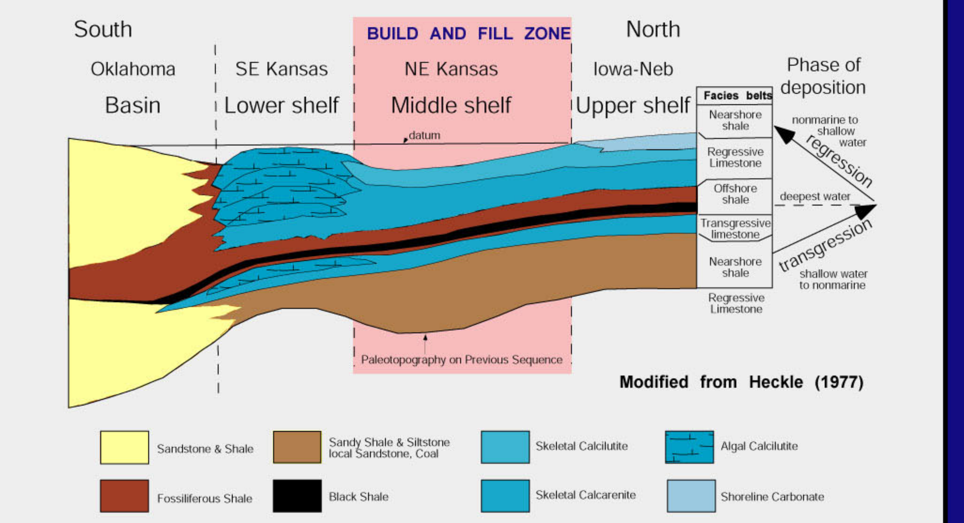
2. A perturbed system in which carbonate productivity is lower than optimum
   * Too many nutrients, stratified systems, cool water?
   * Re-colonization time/lag time allowing systems to fall behind
   * Energy considerations may be important
     -Wide ramps/shelves - prevent effective ooid production
     -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

EXAMPLES OF SETTINGS

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

Pennsylvanian Midcontinent Setting



Gondwana glaciation created high frequency-high amplitude sea-level fluctuations with amplitudes ~80-100+ m

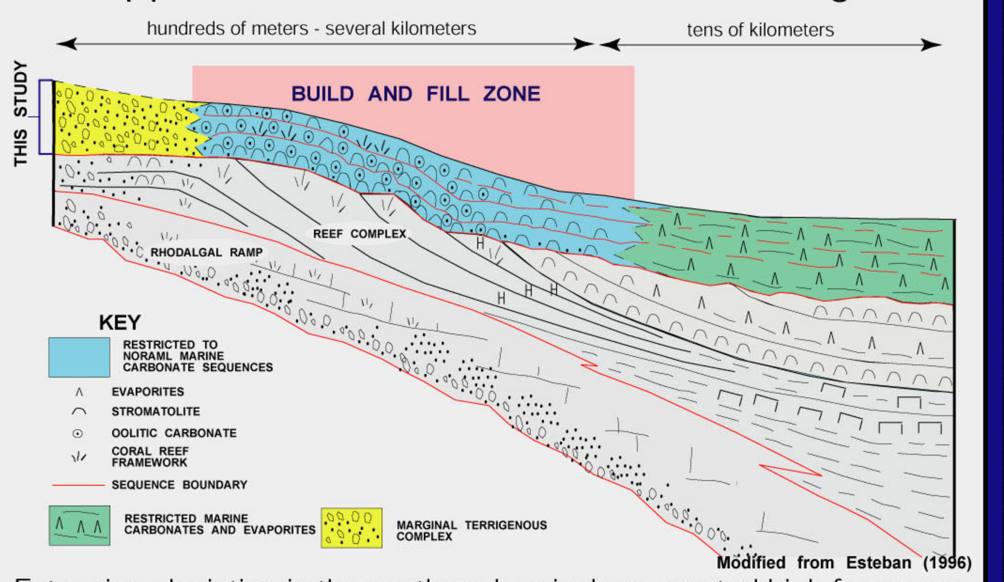
High frequency sequences were deposited on a broad, gently tilted shelf bordering the rapidly subsiding Anadarko basin

Estimated durations of sea-level fluctuations are ~100-400 ka

Area was a semi-enclosed basin with a restricted connection to the open ocean

Similar sequences and facies associations occurred in S New Mexico, Paradox areas

Upper Miocene Mediterranean Setting



Extensive glaciation in the southern hemisphere created high frequency -high amplitude sea-level fluctuations with amplitudes ~75-100 m

The study area is characterized by highly variable gentle and steep sloped substrate. Sequences accumulated on gently sloping substrates

Estimated durations of sea level fluctuations are 25-100ka

Mediterranean area was a restricted basin. High frequency sequences were deposited just after, and perhaps concurrently with evaporite deposition in the main basin and sub-basins