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STATUS: Ongoing long-term research; initial concepts developed
TIMING: Ongoing; targeted projects of 2-4 years upon funding
FUNDING: Seeking sponsors

Purpose
Concepts on cycles, cyclothsems, and cyclostratigraphy in carbonate and mixed carbonate/siliciclastic systems have been developed and debated for years, but much remains to be learned, and current sequence stratigraphic models do not adequately address the nature and controls on formation of these types of strata. Our work is focused on systems in the geologic record where thin sequences (10’s of meters thick) are prevalent, drape topography, and maintain similar thickness throughout wide geographic areas, but have a complex internal architecture of building and filling relief. Many of these form important reservoirs and our goal is to develop a detailed understanding of controlling factors for development of better predictive models to better maximize exploration/exploitation efforts.

Project Description
Our intial phase of study has been through projects targeting build-and-fill nature in icehouse carbonate-dominated systems of the Pennsylvanian, Permian, and Miocene (e.g. Mckirahan et al., 2003; Washburn and Franseen, 2003; Franseen and Goldstein, 2004, Emry et al., 2006; Franseen et al., 2007; Fairchild et al., 2008; Lipinski et al., 2008). The systems we are targeting exhibit thin sequences (10’s of meters thick) that maintain similar thickness throughout wide geographic areas, despite having a complex internal architecture. Our initial results indicate that “build-and-fill sequences” develop in settings in which carbonate productivity is less than optimal, leading to underfilled accommodation and incipient drowning during rises, and subsequent fill of low areas, typically during highstand or falling sea level. Fine-grained siliciclastics and adverse paleoceanographic conditions may inhibit carbonate productivity and lead to build-and-fill sequence development.

In icehouse systems, the build-and-fill zone develops in medial positions on broad shelves/ramps, and in inner platform/lagoon positions on high-standing rimmed platforms. Icehouse build-and-fill sequences result from the interaction of high-amplitude, high-frequency sea-level fluctuations with paleotopography and sediment dispersal processes. In greenhouse systems, the build-and-fill zone appears to develop only in inner platform/lagoon positions on high-standing rimmed platforms, where sea-level fluctuations and relatively shallow water interacts with paleotopography in areas of suppressed carbonate productivity.

The systems studied to date indicate that given accommodation in the build-and-fill zone, topographic highs may be favored areas to build relief by boundstone and grainstone. The fill phase may be favored by limited accommodation. Localized deposition of delta-
like siliciclastics may modify relief in paleo-low areas, given a paleotopographic focus. Where shallow-water conditions intersect complex topography, currents may be focused, depositing grainy carbonate and siliciclastic facies in lows. If energies are too high along topographic highs, boundstone/wackestone/packstone facies may accumulate (fill) in the topographic lows where current energies are weaker.

The second phase of study has included additional field studies and extensive literature search, to gain a better understanding on prevalence of build-and-fill architecture in the rock record, ranges of build-and-fill character, and controlling factors that result in build-and-fill. The preliminary results indicate that build-and-fill architecture occurs: 1) throughout the rock record, 2) in icehouse, greenhouse, and transitional systems, and 3) in middle portions of shelves and ramps, and interior portions of rimmed platforms that experience highest rates of sea-level change between sea-level highstand and lowstand positions. Examples identified from our studies and in literature are direct analogs for producing subsurface reservoirs.

The proposed third phase will further test and refine the conceptual model towards a predictable model and will work with KICC sponsoring companies to identify subsurface targets in which documentation of build-and-fill systems can aid in reservoir characterization.

**Deliverables**

Deliverables for the project include maps, stratigraphic sections, cross sections, copies of theses, copies of presentations, and quantitative data on the various projects and systems that have been completed to date, and those that are currently being studied or will be studied in the future. Current deliverables also include the current conceptual model of build-and-fill sequences, and literature review of outcrop and subsurface systems (including reservoirs) that show characteristics of build-and-fill.

**References**


Miocene, SE Spain; American Association of Petroleum Geologists Annual Convention Abstracts Volume, p. 122


**Figure 1**: Location of build-and-fill zone in ramps and rimmed platform settings.
Figure 2: Example of phylloid algal facies building and filling relief in the Permian of New Mexico.