

Introduction to Carbonate Sequence Stratigraphy

The diagram illustrates a carbonate sequence stratigraphic unit. At the top, a Type 1 Sequence Boundary (SB) is shown. Below it is the Sequence Mounding Surface (SMST). The unit is divided into a Lowstand Systems Tract (LSW) and a Lowstand Systems Tract (LSF).

Lecture Outline

- Definition of a Depositional Sequence
- Concept of Accommodation Space and Relative Sea Level
- Stratal geometries
 - Important stratal bounding surfaces
 - Stratal packages
- Systems Tracts
 - Lowstand Systems Tract
 - Transgressive Systems Tract
 - Maximum flooding Surface
 - Highstand Systems Tract
- Recognition of Sequence Boundaries

Definition of a Sequence

- A relatively conformable, genetically related succession of strata, bounded by unconformities or their correlative conformities.

The diagram shows a sequence of strata bounded by a sequence boundary. A correlative conformity is also shown, representing a surface of non-deposition or erosion. A legend on the left identifies various stratal geometries and surfaces.

“Relatively Conformable”

- A succession of strata that has only short breaks in time, diastems.
- The duration of diastems within the succession of strata is much less than bounding unconformities.

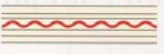


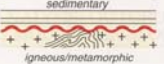
“Genetically Related Succession of Strata”

- Deposited in response to similar overall regional depositional drivers.

“Bounded by Unconformities or their Correlative Conformities”

- Unconformities – surface of non-deposition or erosion
- Generally indicates missing rock record of an interval of time
- Forms a **time line or chronostratigraphically significant surface** with which to correlate between stratigraphic sections.
- Sequence boundary unconformities must be of regional extent, not local.

4 Types of Unconformities:

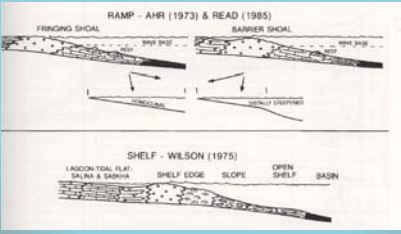
- Disconformity = hiatus + erosion**
 An unconformity in which the bedding planes above and below the break are essentially parallel, indicating a significant interruption in the orderly sequence of sedimentary rocks, generally by a considerable interval of erosion ..., and usually marked by a visible and irregular or uneven erosion surface of appreciable relief.
 
- Paraconformity = hiatus ± erosion (no discernible erosion)**
 An obscure or uncertain unconformity in which no erosion surface is discernible ..., and in which the beds above and below the break are parallel.
 
- Angular unconformity = hiatus, erosion, and tilt**
 An unconformity between two groups of rocks whose bedding planes are not parallel or in which the older, underlying rocks dip at a different angle (usually steeper) than the younger, overlying strata.
 
- Nonconformity = top of basement rocks**
 An unconformity developed between sedimentary rocks and older igneous or metamorphic rocks that had been exposed to erosion before the overlying sediments covered them.
 

Recognition of Disconformities/ Paraconformities

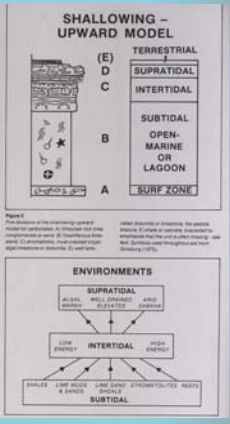
- 1. Missing biostratigraphical zones
- 2. Subaerial exposure of subtidal facies
- 3. Evidence of major erosion or down-cutting
- 4. Surfaces of corrosion or mineralization
- 5. Non-Waltherian facies shifts

Walther's Law

- Facies that occurred in laterally adjacent environments will also occur superposed in vertical succession in a conformable sequence.

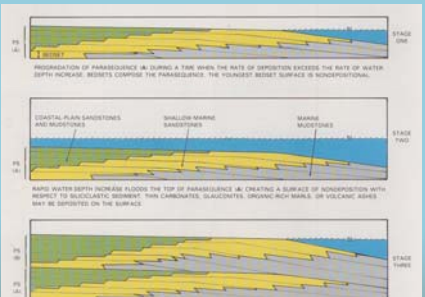


Shallowing Upward Cycle



Parasequence

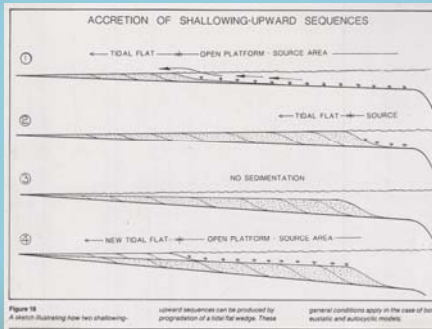
- Shallowing upward facies progression bounded above and below by marine flooding surfaces.



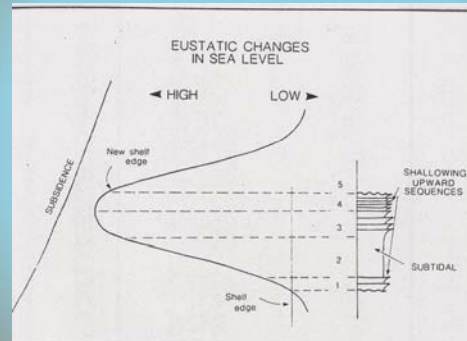
Parasequence Formation

- 1. Autocyclic Model
- 2. Eustatic Sea-level Fluctuations
- 3. Tectonic yo-yoing

Autocyclic Model



Eustatic Sea-level Cycles



Concept of Accommodation Space and Relative Sea Level

Accommodation Space Definition:
Space to deposit sediment in.

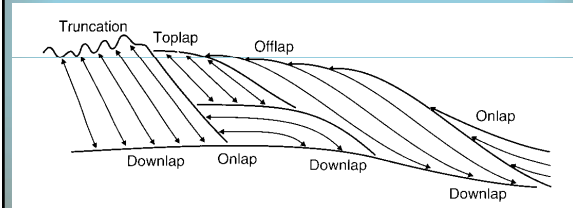
Controls:

1. subsidence and uplift - tectonism
2. eustasy - glacio-eustasy vs tectono-eustasy
3. sediment supply-climate, tectonism, eustasy

Relative sea level: whether the upper line or top of accommodation space moves up or down or is static

Stratal Geometries

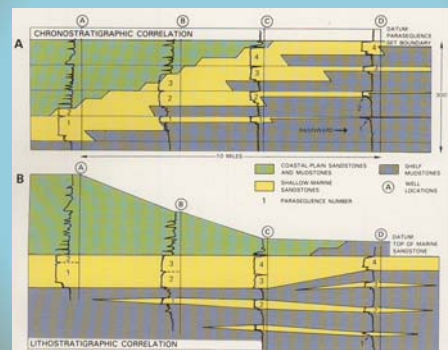
Stratal Geometries- strata are bounded by bedding planes (micro-disconformities)

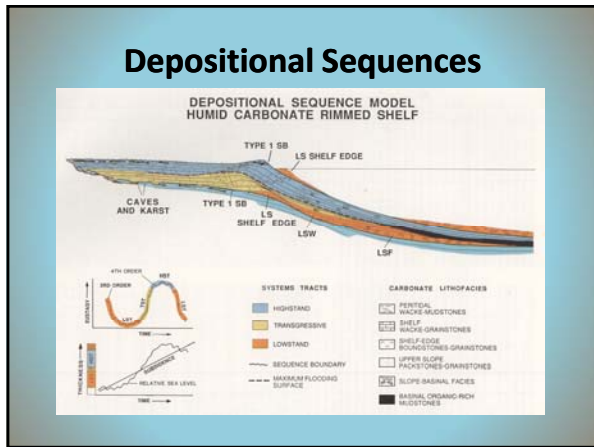
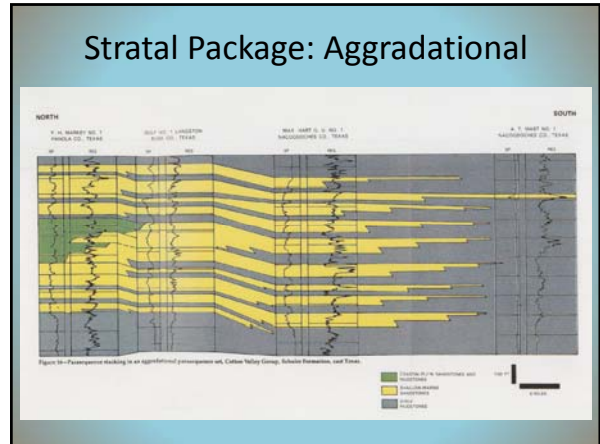
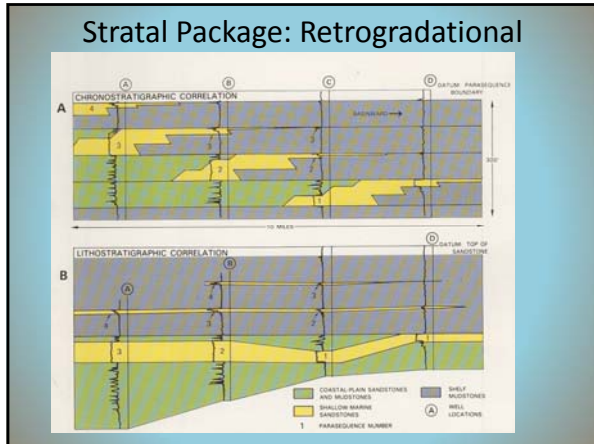


Stratal Packages

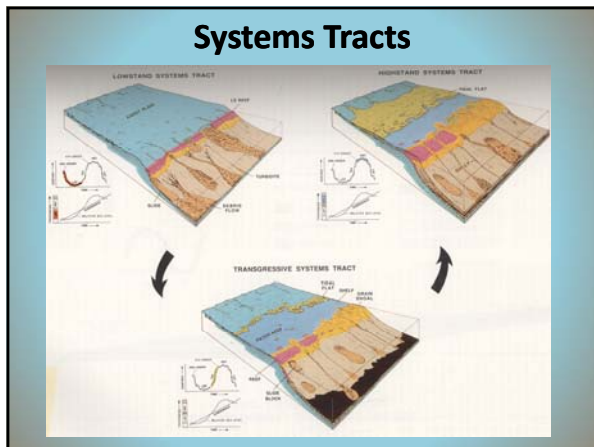
- **progradational**-basinward outstepping of strata; may show downlap or offlap stratal surfaces.
Forms in response to a relative fall in sea level or increase in sediment supply.
- **retrogradational**-shoreward backstepping of strata; may show onlap, downlap, and toplap.
Forms in response to a relative rise in sea level or decrease in sediment supply.
- **aggradational**-vertical accretion of strata; may show toplap.
Forms in response to relative sea level rise = sedimentation rate

Stratal Package: Progradational





- ### Systems Tracts
- **Definition-** linkage of contemporaneous depositional systems.
 - **Systems tracts are defined on the basis of:**
 1. types of bounding surfaces
 2. stratal geometry
 3. position within sequence
 - Use Walther's law to predict what facies should be lateral equivalents. Those facies should occur in vertical succession. If they don't and facies shift in a non-Waltherian manner, than an unconformity exists and a sequence boundary forms.



- ### Lowstand Systems Tract (LST)-
- Deposited basinward of shelf margin and overlies type 1 sequence boundary. No correlatable strata generally on the shelf.
 - Shows nice onlap stratal terminations; may be progradational (deltaic or fluvial facies) or retrogradational (submarine fans)

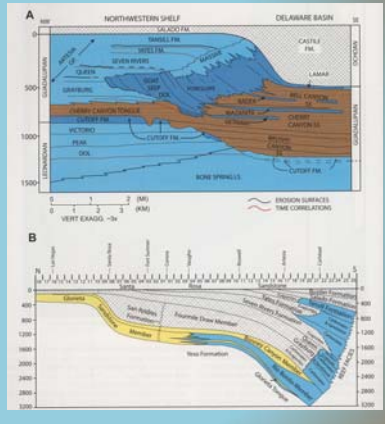
Transgressive Systems Tract (TST)-

- Deposited on the slope progressively **onlapping** onto the former shelf.
- Forms backstepping or retrogradational parasequences.
- The strata progressively thin basinward because of decrease in sediment supply and starvation forming a **condensed section**- thin hemi-pelagic or pelagic deposition at very slow sedimentation rates.
- **Base = Transgressive flooding surface (TS)** - The first transgressive surface above the lowstand systems tract.
- **Top = Maximum flooding Surface (mfs)**- Maximum water depth of sequence, maximum accommodation space.

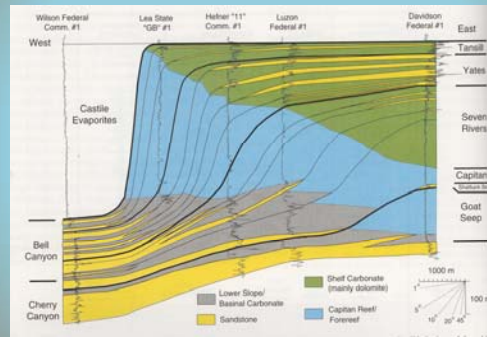
Highstand Systems Tract (HST)

- Relative sea level rise slows resulting in aggradation and then begins to fall.
- Shoreward accommodation space begins to fill causing the system to prograde.
- The prograding system then downlaps the TST and the mfs. Often shows offlap at the shoreward termination of the stratal unit.
- The upper surface of the highstand systems tract is a type 1 or type 2 sequence boundary.

Permian Reef Sequence Stratigraphy



Capitan Reef



Capitan High Frequency Cycles

