Implication of Unfilled Accommodation Space in Carbonate Depositional Systems for Cyclo-Stratigraphy*

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Abstract

Shallow-water carbonates are thought to fill the accommodation space in each high-frequency sea level change, but Holocene and late Pleistocene deposits show the geologic record to be much more complex, with examples exhibiting unfilled, irregularly filled, and overfilled accommodation space. Where filling occurs, it is often achieved with one facies, indicating that progradational patterns are likely the result of lateral stacking during subsequent sea level changes.

As an example, the present-day topography on Great Bahama Bank from platform-margin dune ridges to the subtidal platform interior is approximately 12 m, and in a few cases up to 20 m. Both muddy and grainy tidal flat systems locally fill accommodation space to mean sea level. High-energy beach-dune ridges locally overfill accommodation space. Cores through tidal flats document that the provenance does not change significantly during the filling of the accommodation space; i.e., the high-energy grainy tidal systems remain grainy even in their uppermost portions. Pleistocene cores from the platform interior rarely display a shallowing-upward trend, but exposure surfaces rest directly on subtidal facies, indicating that in this environment accommodation remained unfilled until sea level dropped. The lack of clear shallowing-upward trends in facies is common in the cores from the modern bank, indicating that facies boundaries move little during one high-frequency sea level cycle. Facies juxtaposition occurs more frequently in successive sea level changes.

Based on the Pleistocene-Holocene succession of Great Bahama Bank, we speculate that many depositional cycles in the rock record, for which a change in the provenance is reported, might in fact be two cycles. In addition, the topographic relief in each cycle might have been underestimated, which might have lead to miscorrelations of cycle tops.

Implication of Unfilled Accommodation Space in Carbonate Depositional Systems for Cyclo-Stratigraphy

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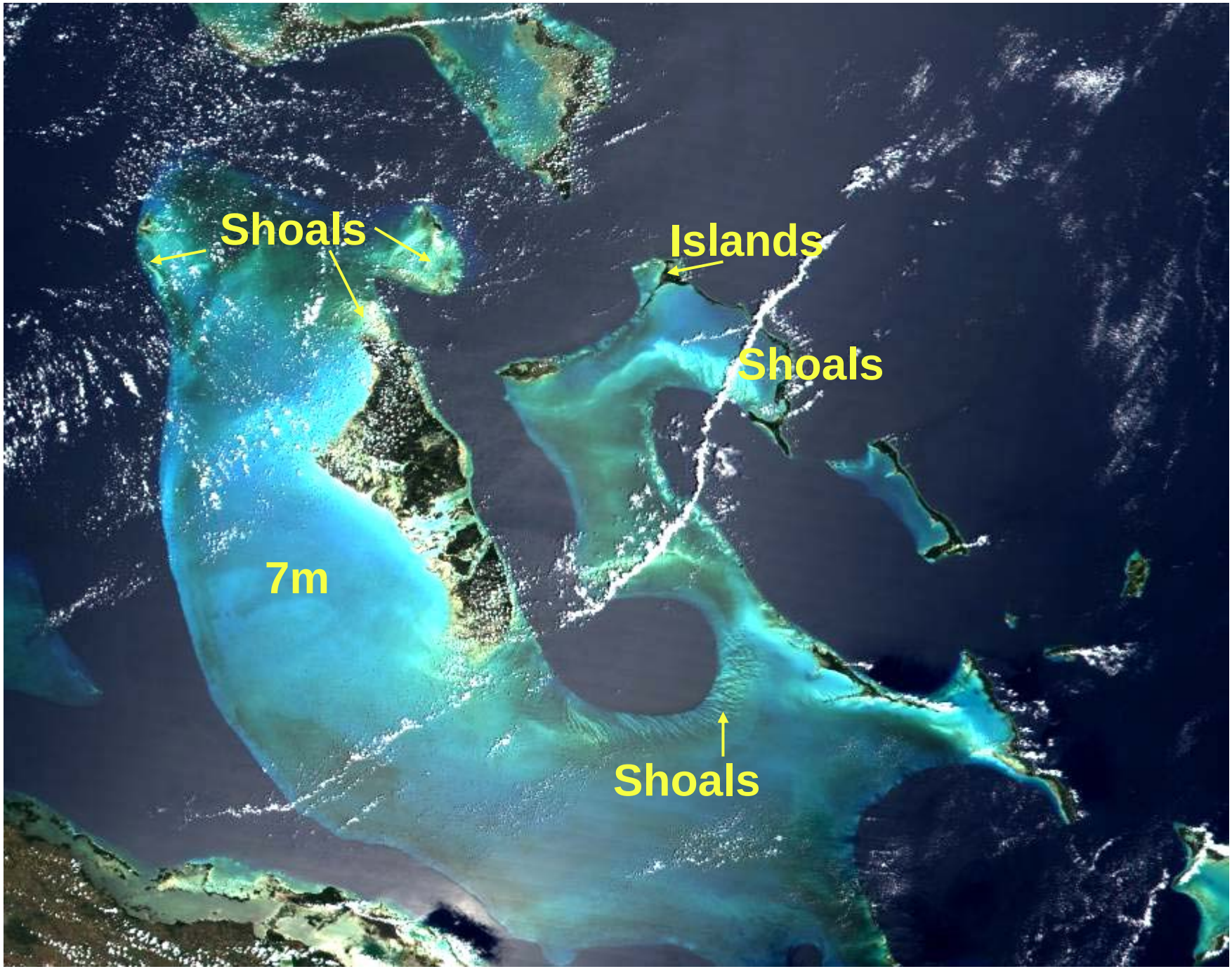
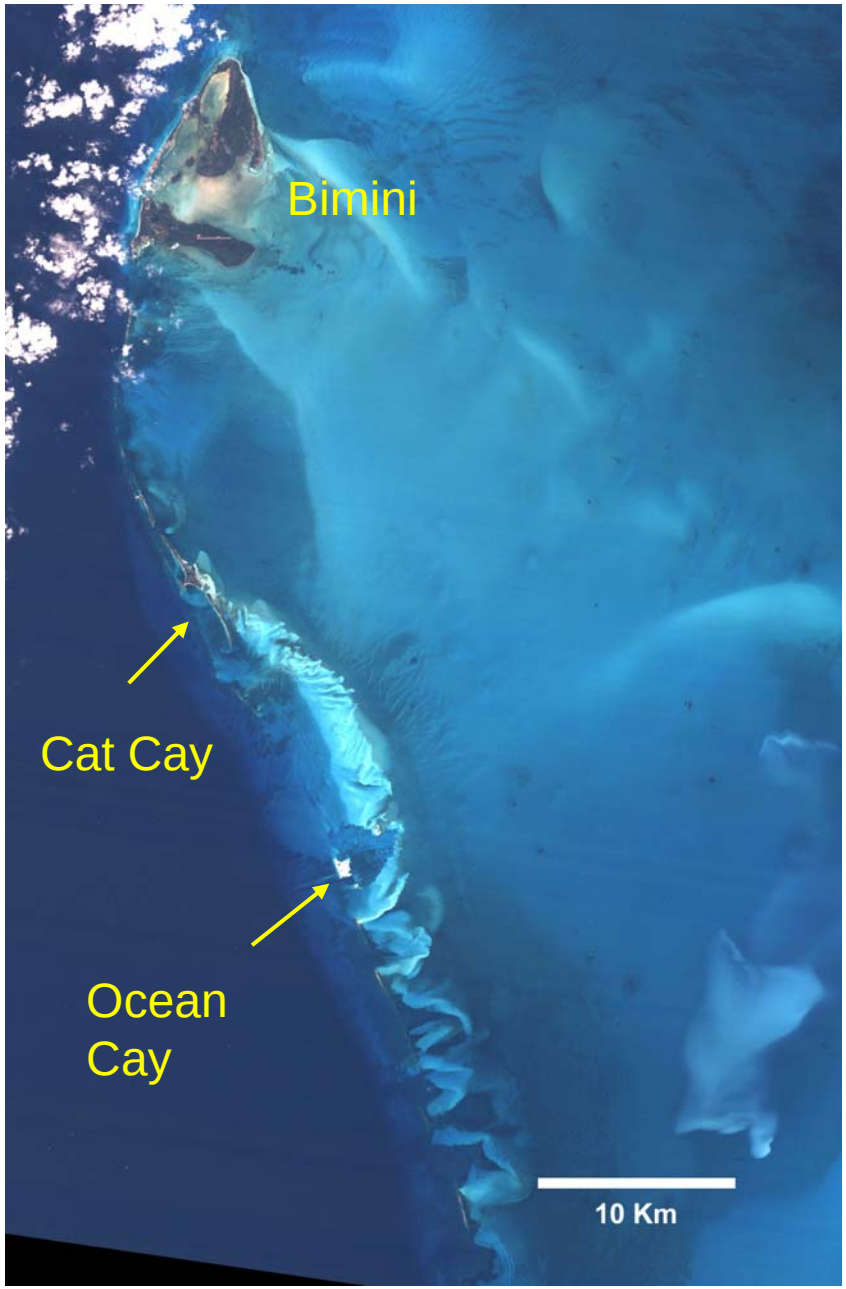
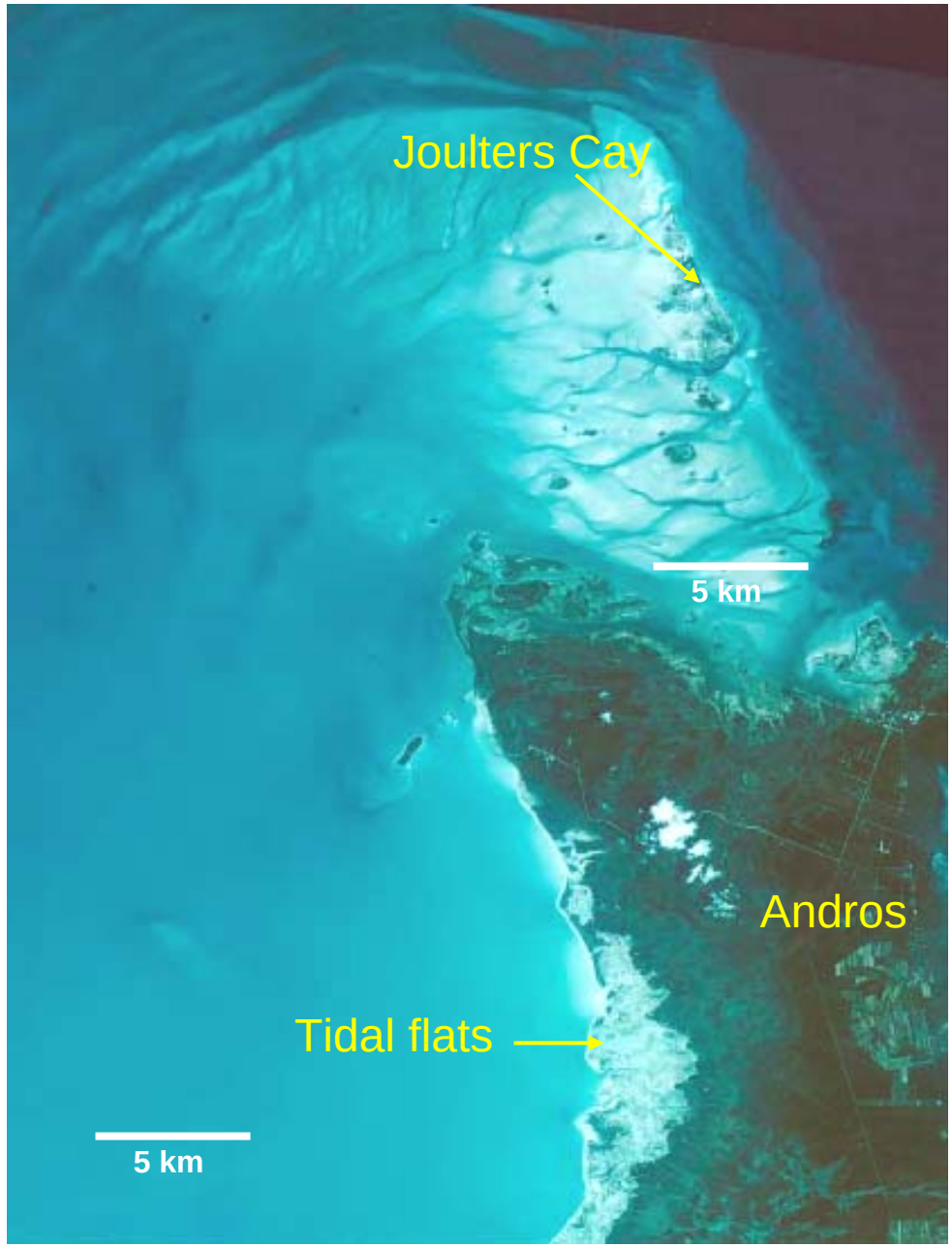
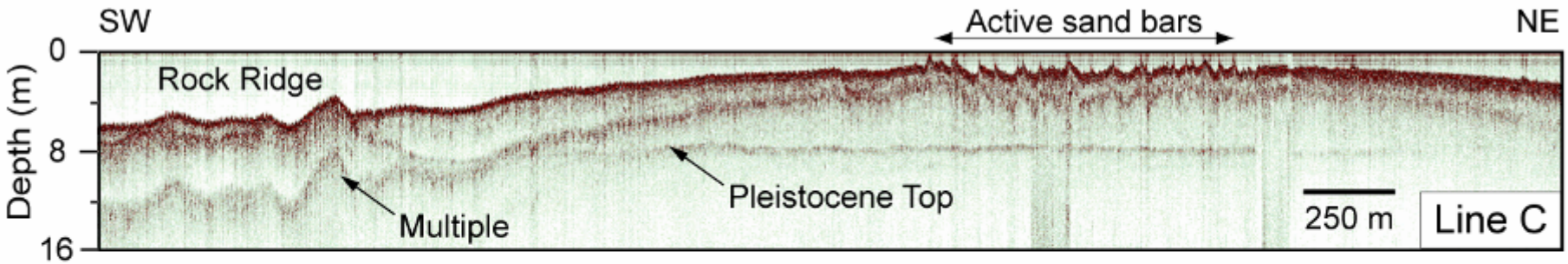

Shoals
Islands
Shoals
7m
Shoals





From Eduardo Cruz, 2007

Sand belt north of Ocean Cay



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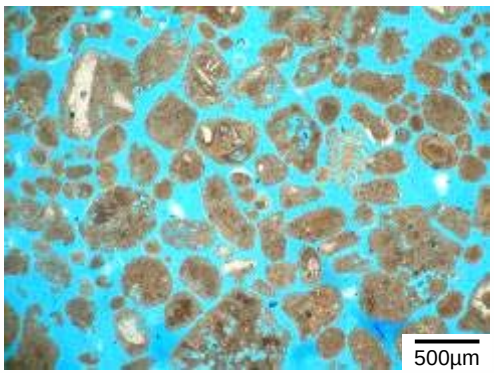
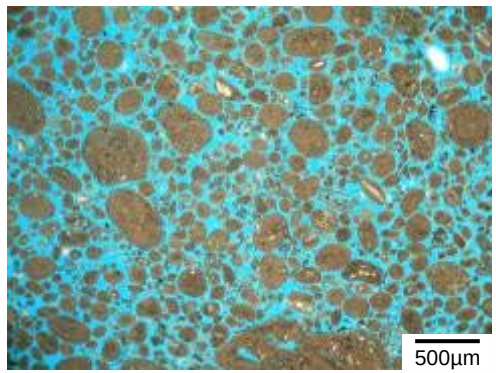
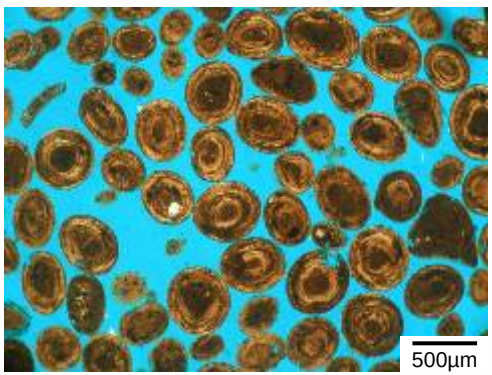
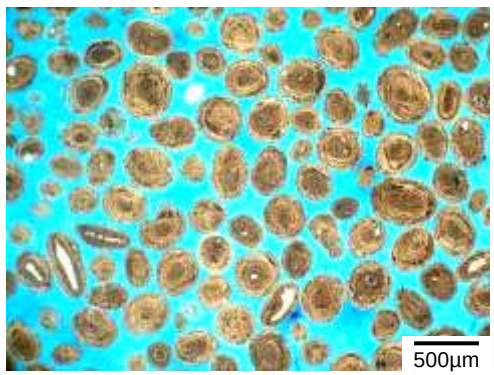
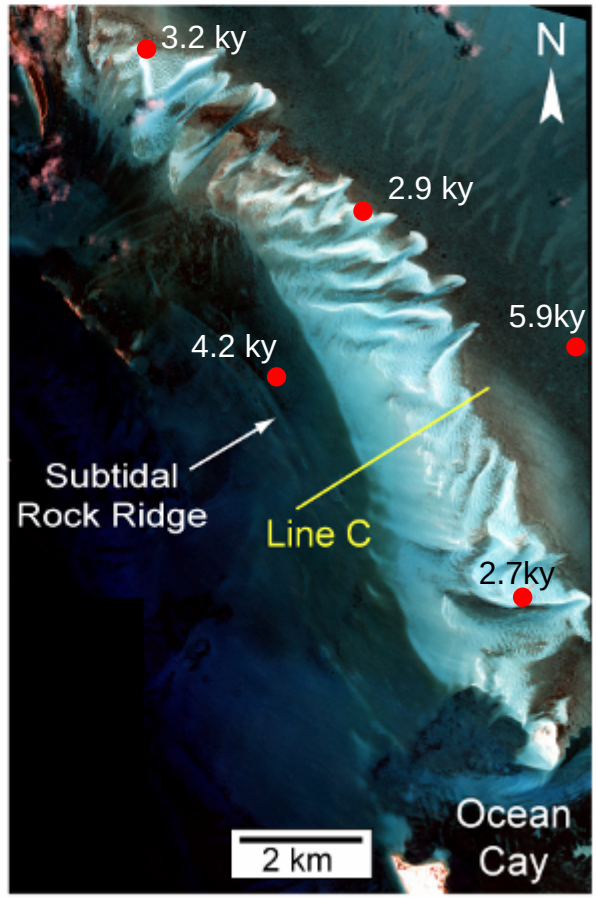




Active sand belt

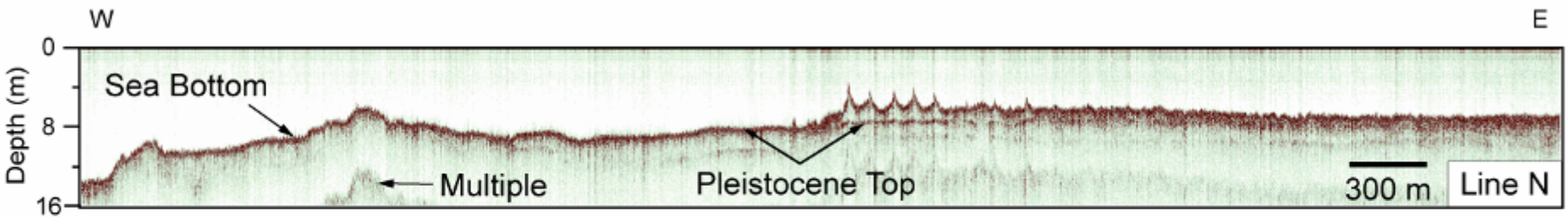


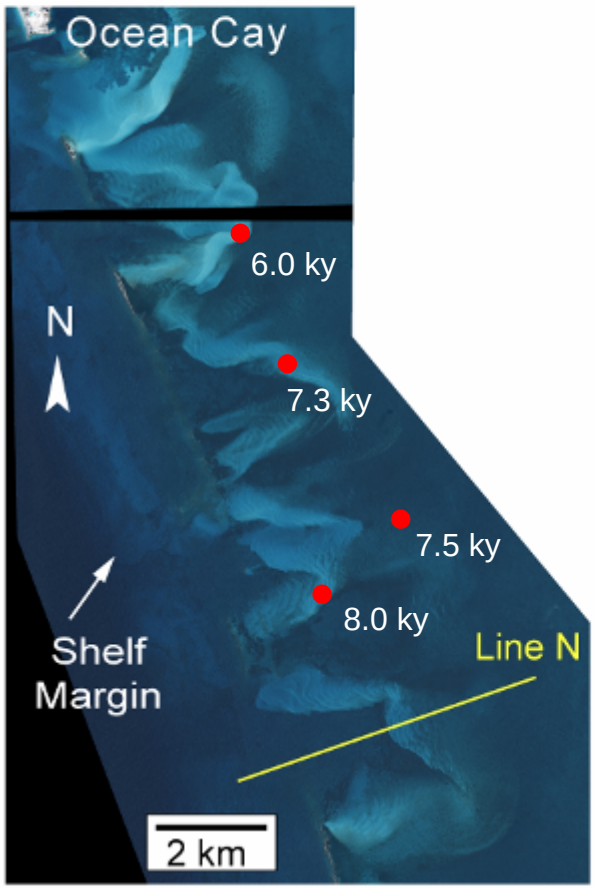




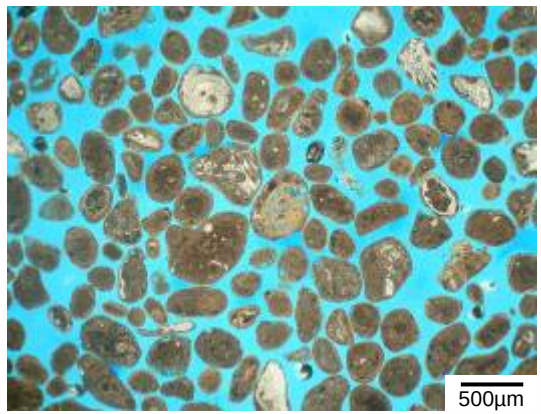
Cruz et al., 2007 CSL Meeting

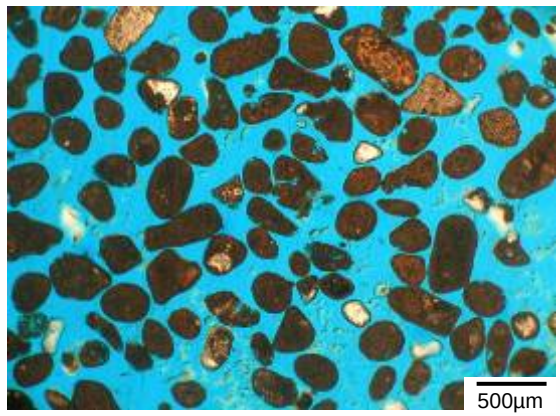
Tidal deltas south of Ocean Cay

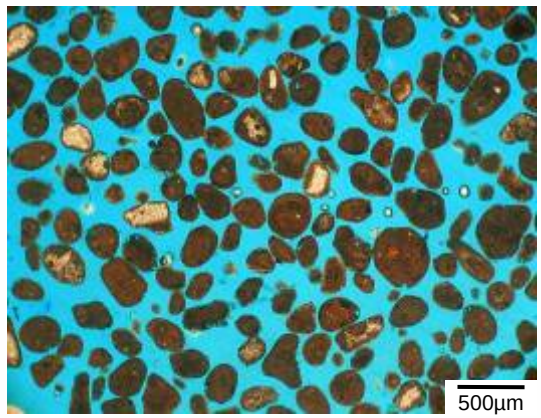




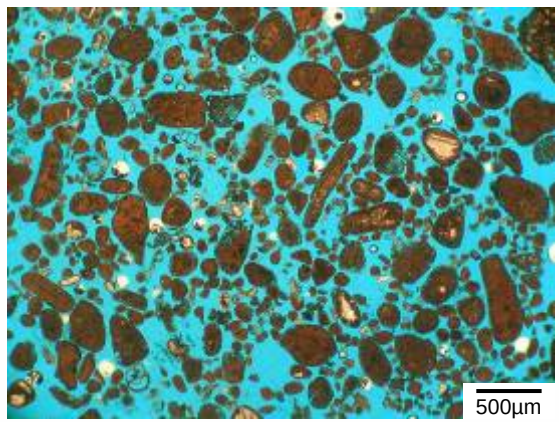
Sand Shoals





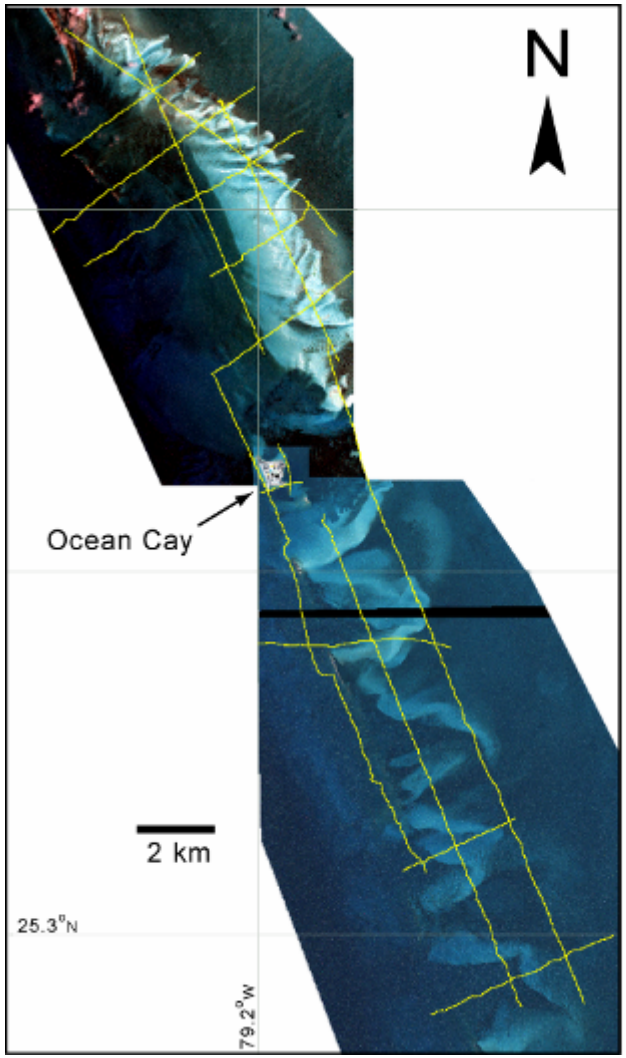


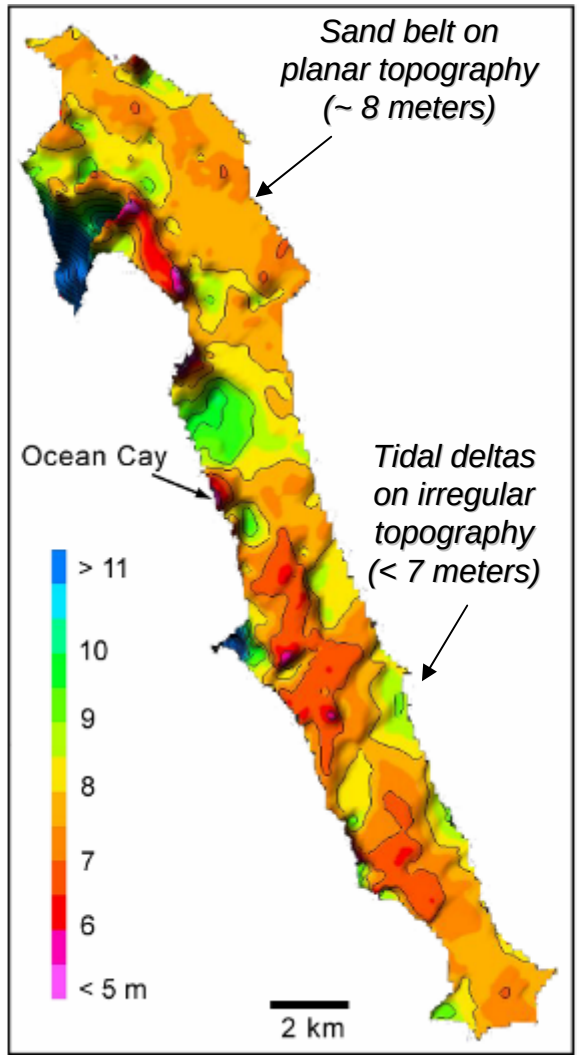
Stabilized area

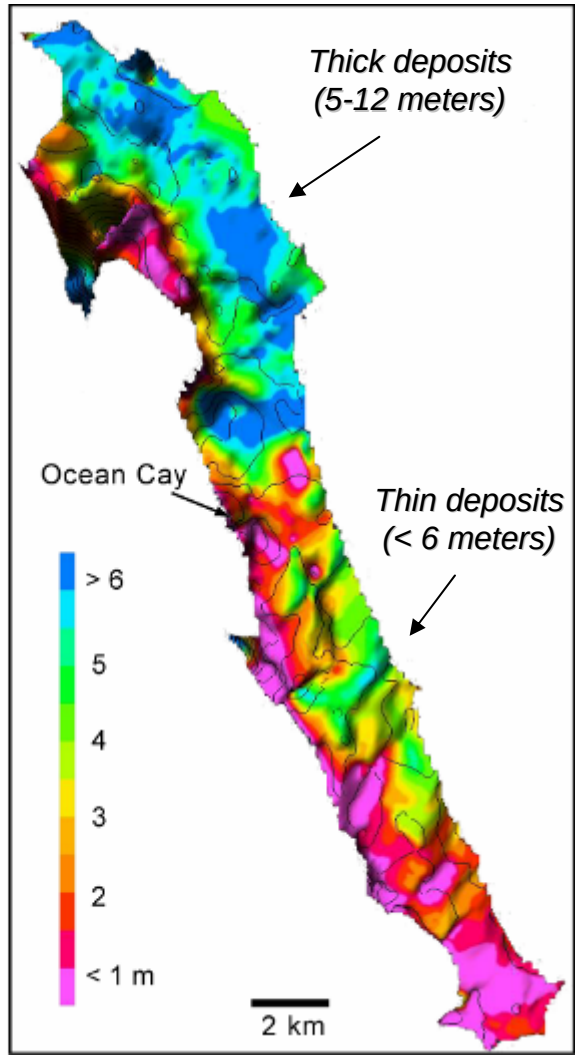


Cruz et al., 2007 CSL Meeting

Pleistocene Topography and Thickness of Holocene Deposits

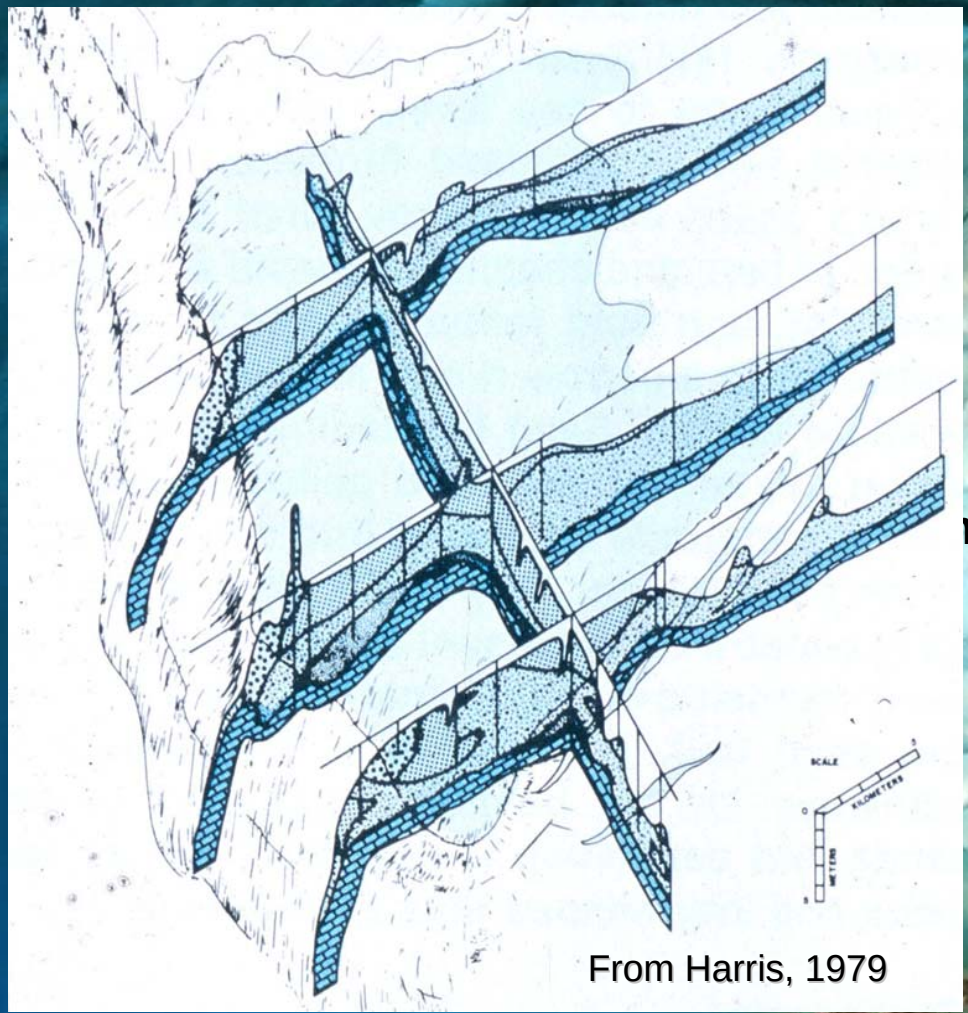






Cruz et al., 2007 CSL Meeting

Joulters Cays Ooid Shoals



TOTO

Active Shoal

-0.1 m

Holocene Islands

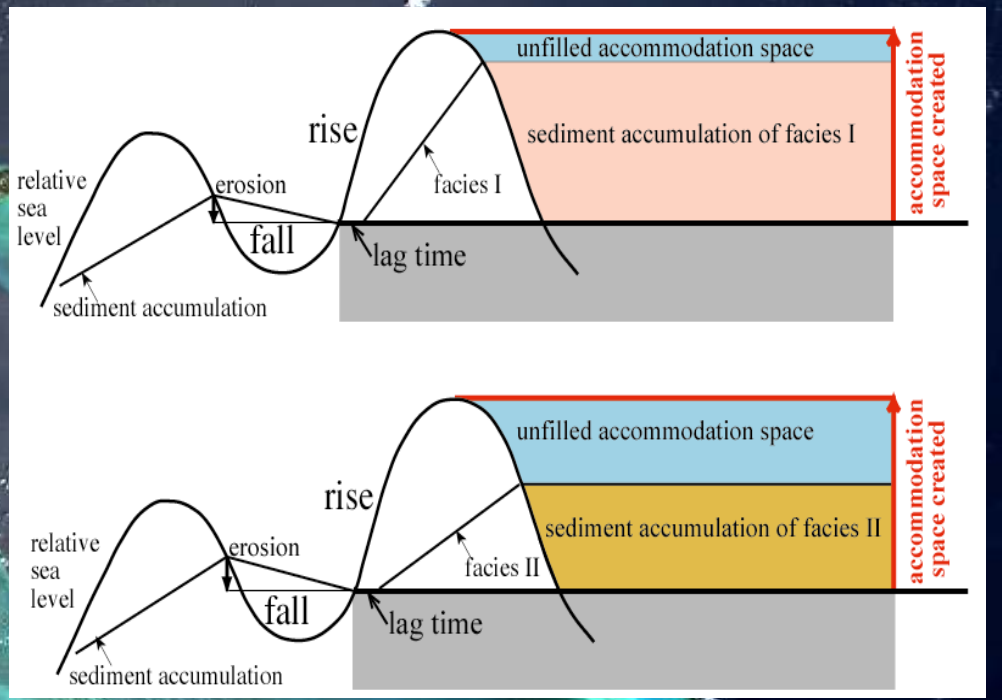
+4 m

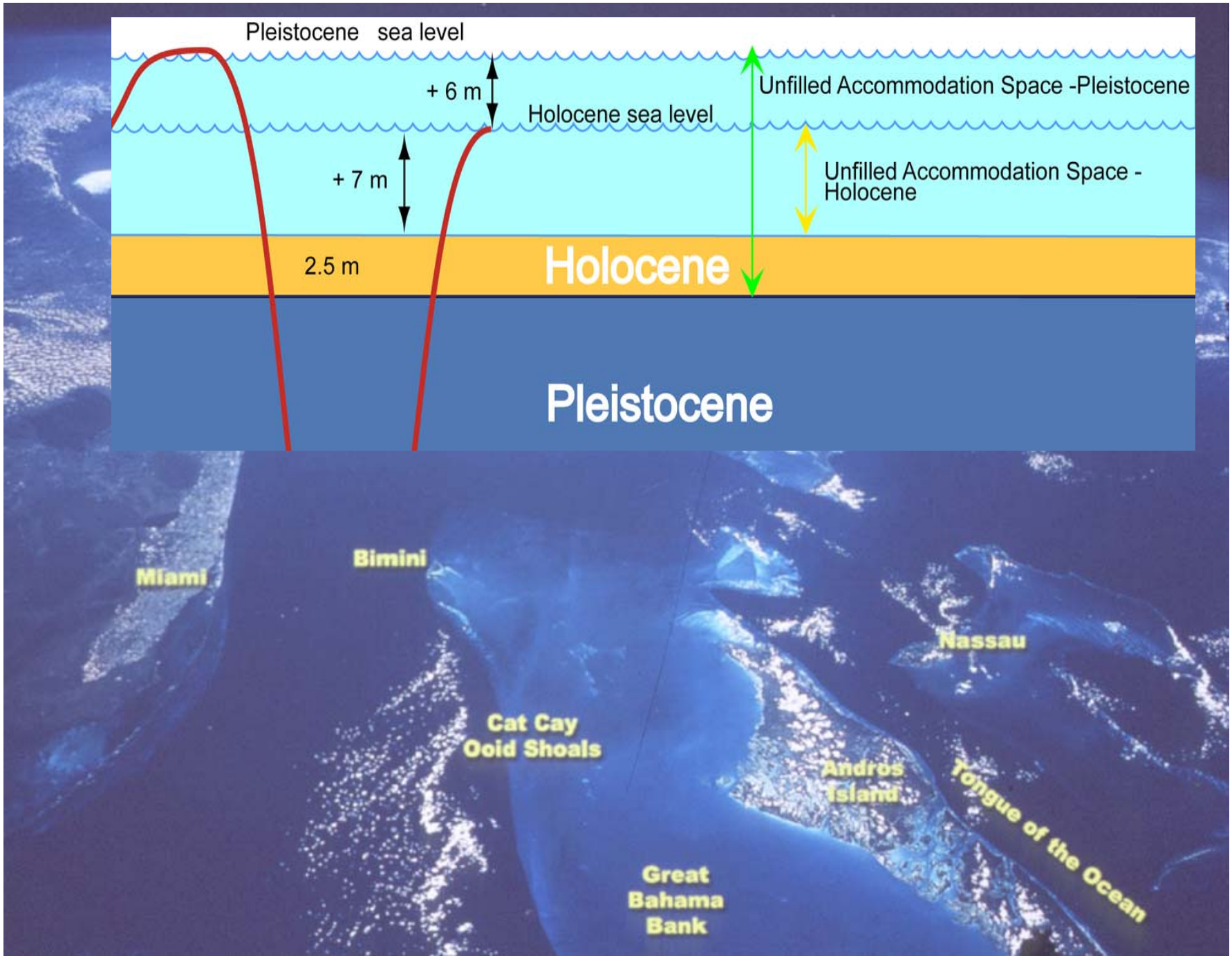
-5 m

5 km

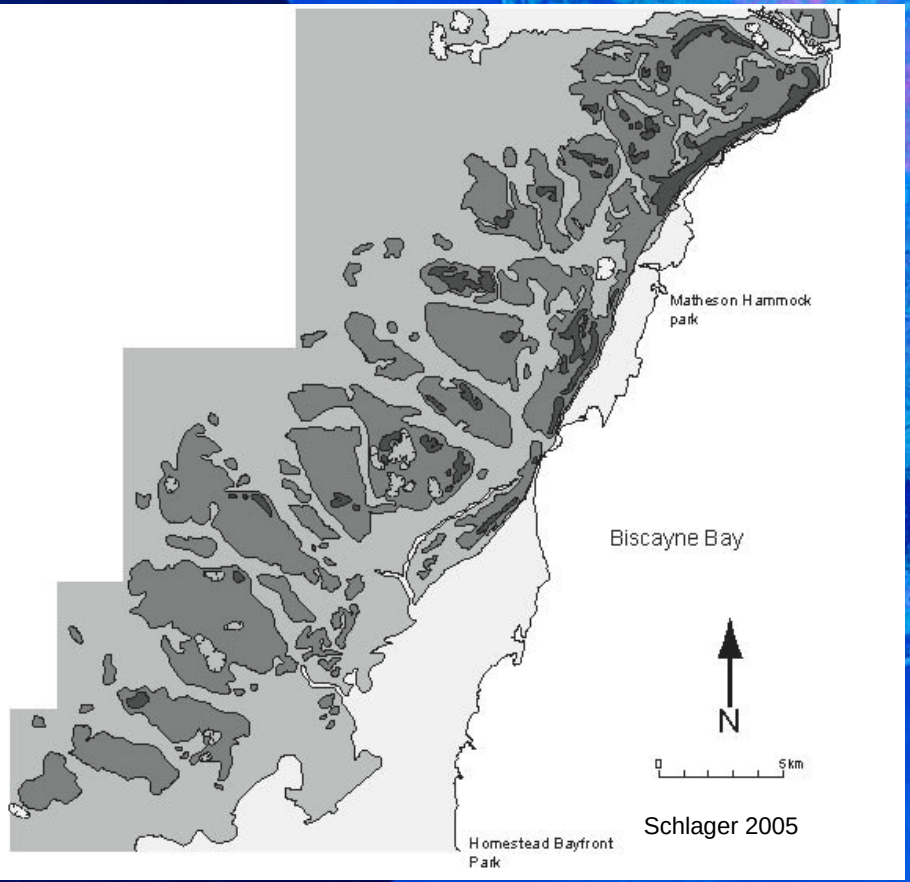
Joulters Cays: Overfilled Accommodation

Filling of accommodation space is facies dependent which is related to the energy distribution
creates topography
produces thickness variation within same cycle




Pleistocene sea level
+ 6 m
Holocene sea level
+ 7 m
2.5 m
Holocene
Pleistocene
Unfilled Accommodation Space -Pleistocene
Unfilled Accommodation Space - Holocene
Miami
Bimini
Nassau
Cat Cay
Ooid Shoals
Andros Island
Tongue of the Ocean
Great Bahama Bank

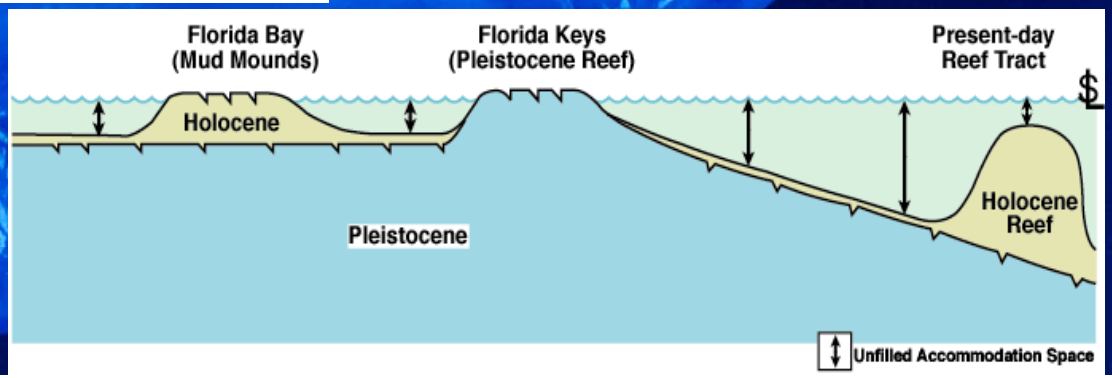
Preservation of topography

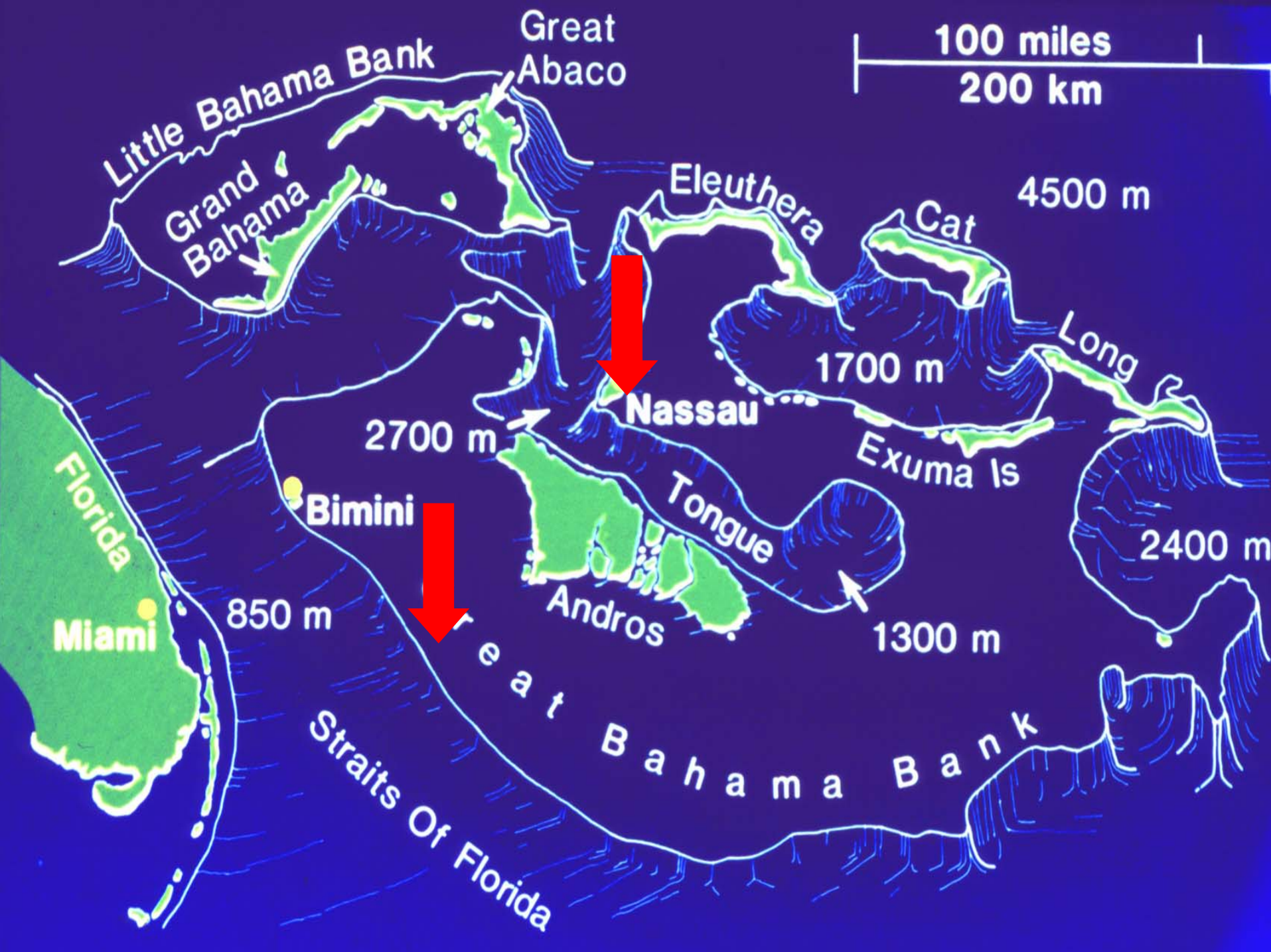


Schlager 2005

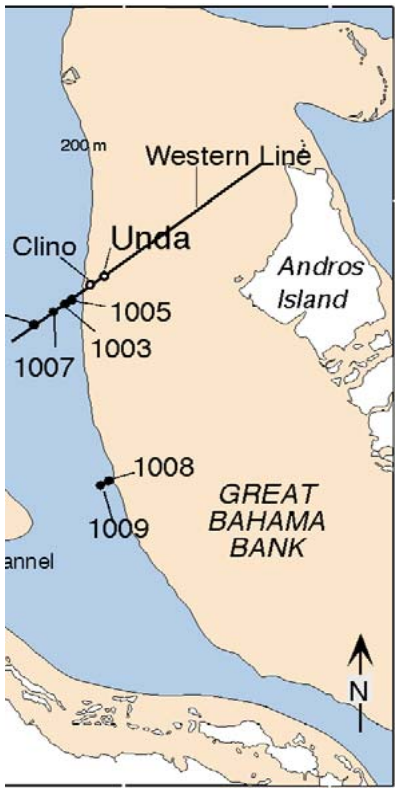
Miami Oolite

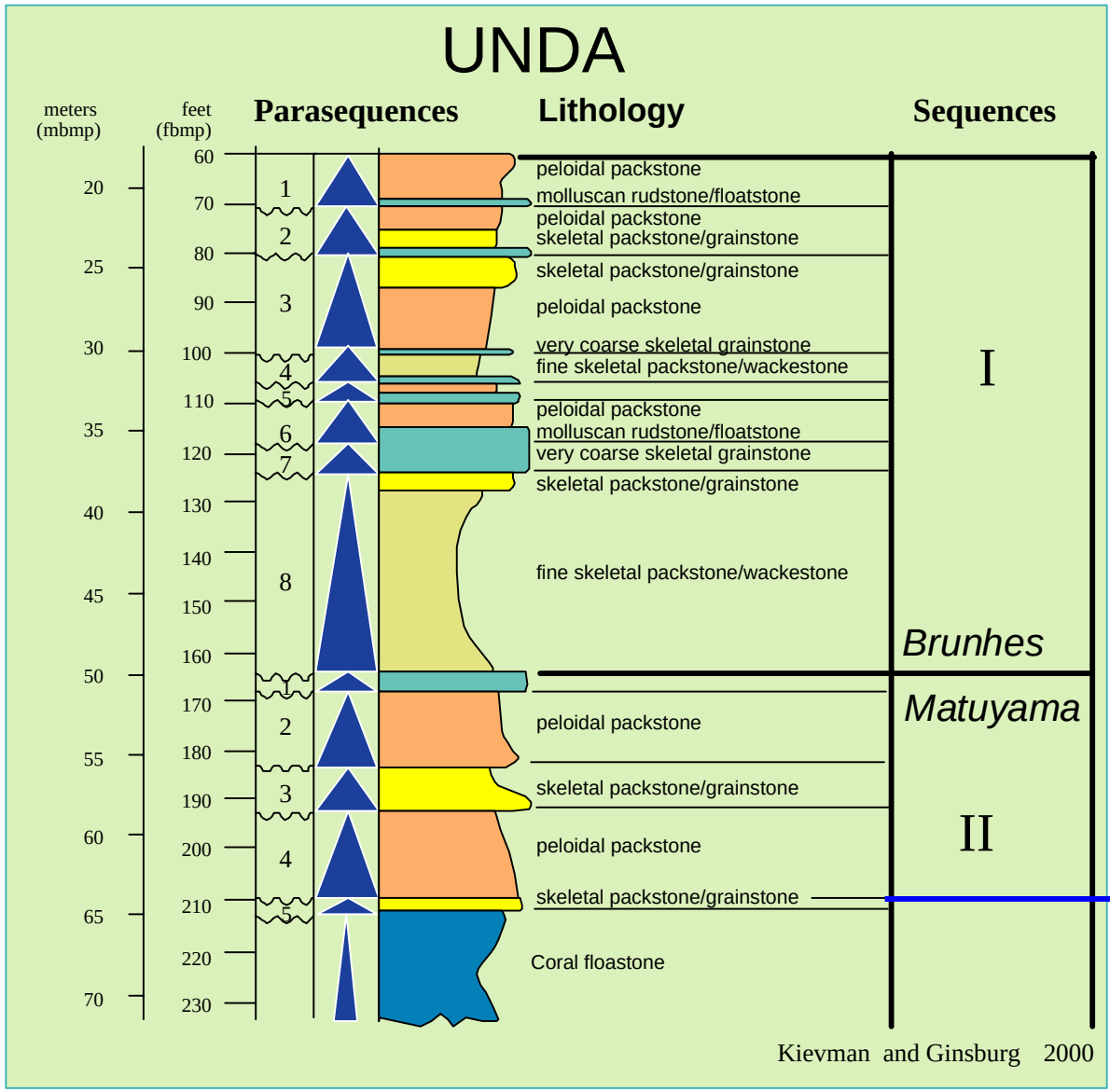
Florida Keys




Little Bahama Bank
Great Abaco
100 miles
200 km
Grand Bahama
Eleuthera
4500 m
Cat
Long
1700 m
Nassau
2700 m
Exuma Is
Florida
Bimini
Tongue
2400 m
Miami
850 m
Andros
1300 m
Great Bahama Bank
Straits Of Florida

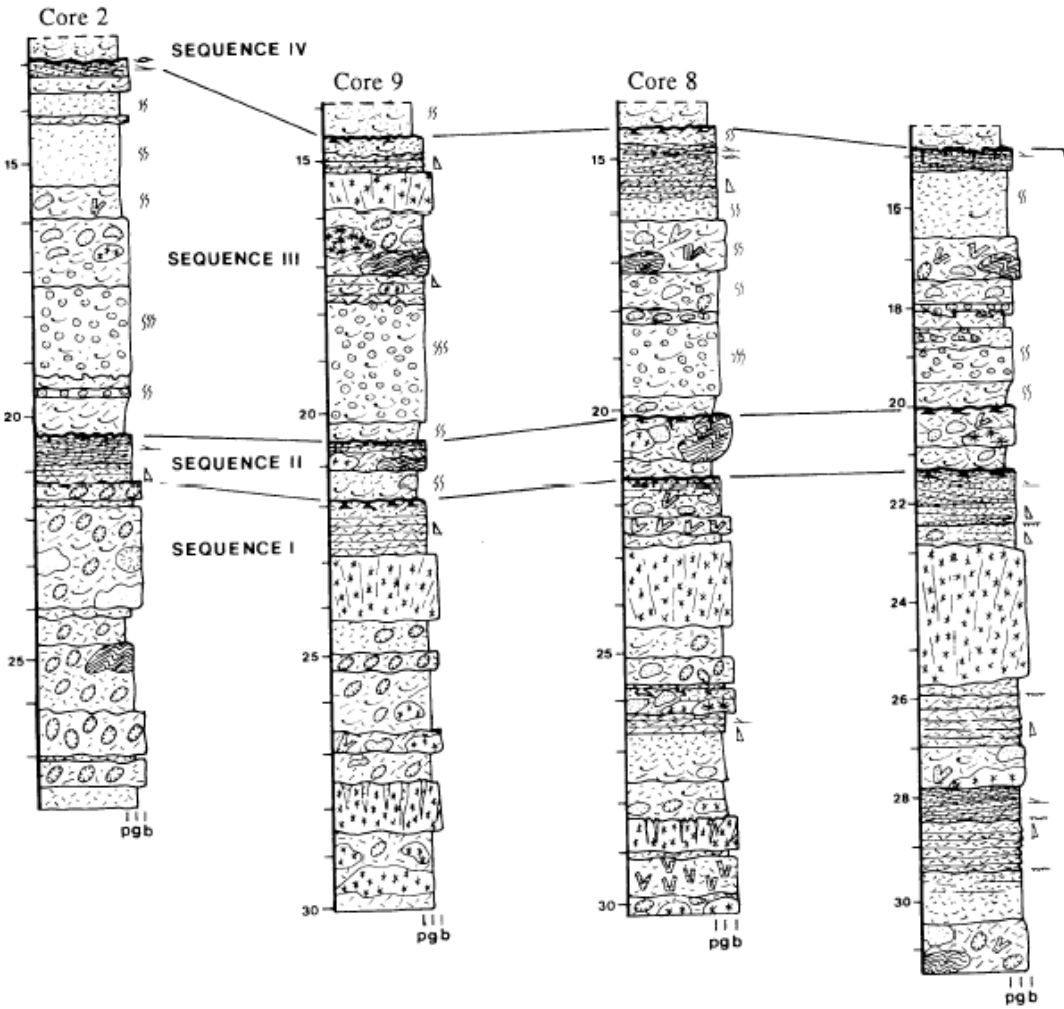
Facies and Cycles at Unda, western margin of GBB

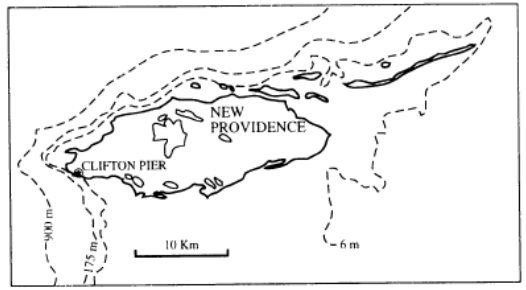


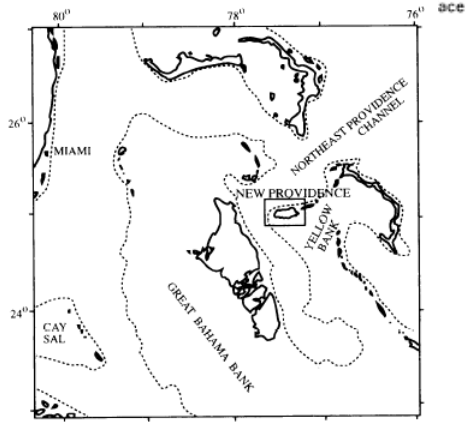


A) Unda (64.8 m)

Clifton Pier:

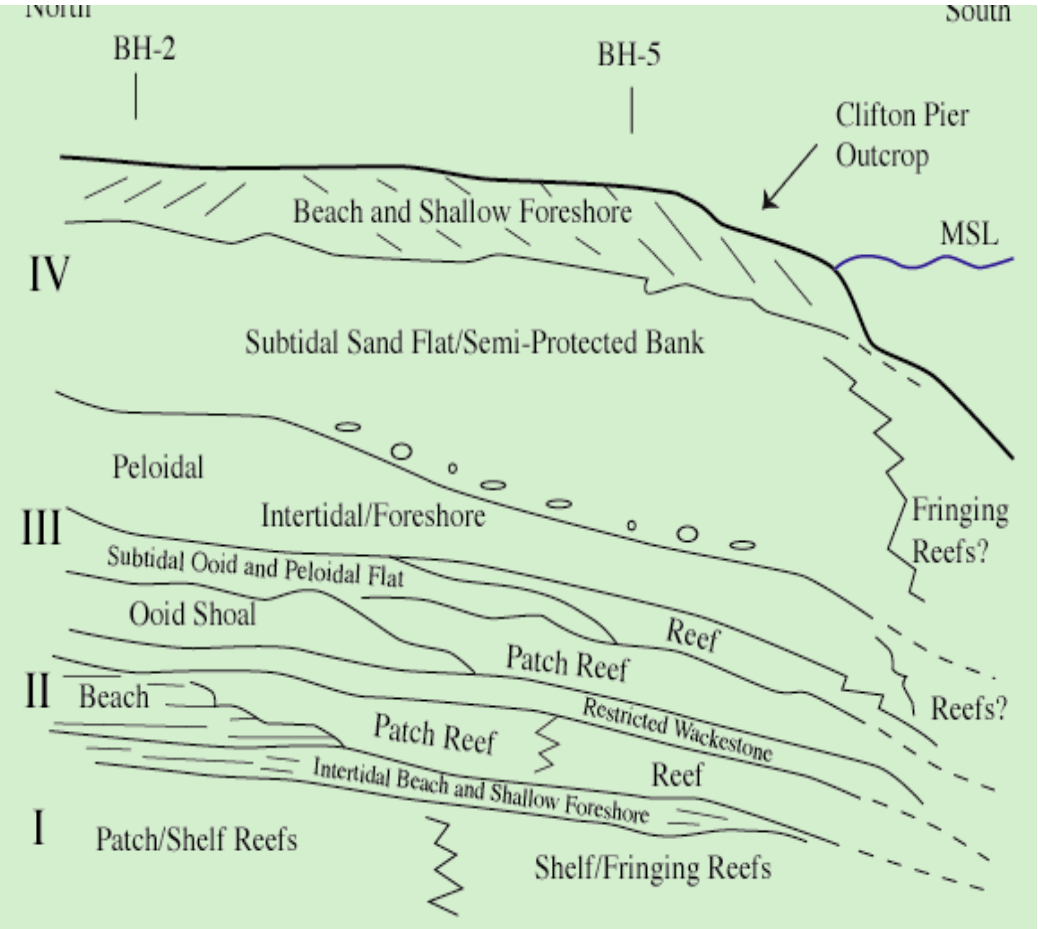


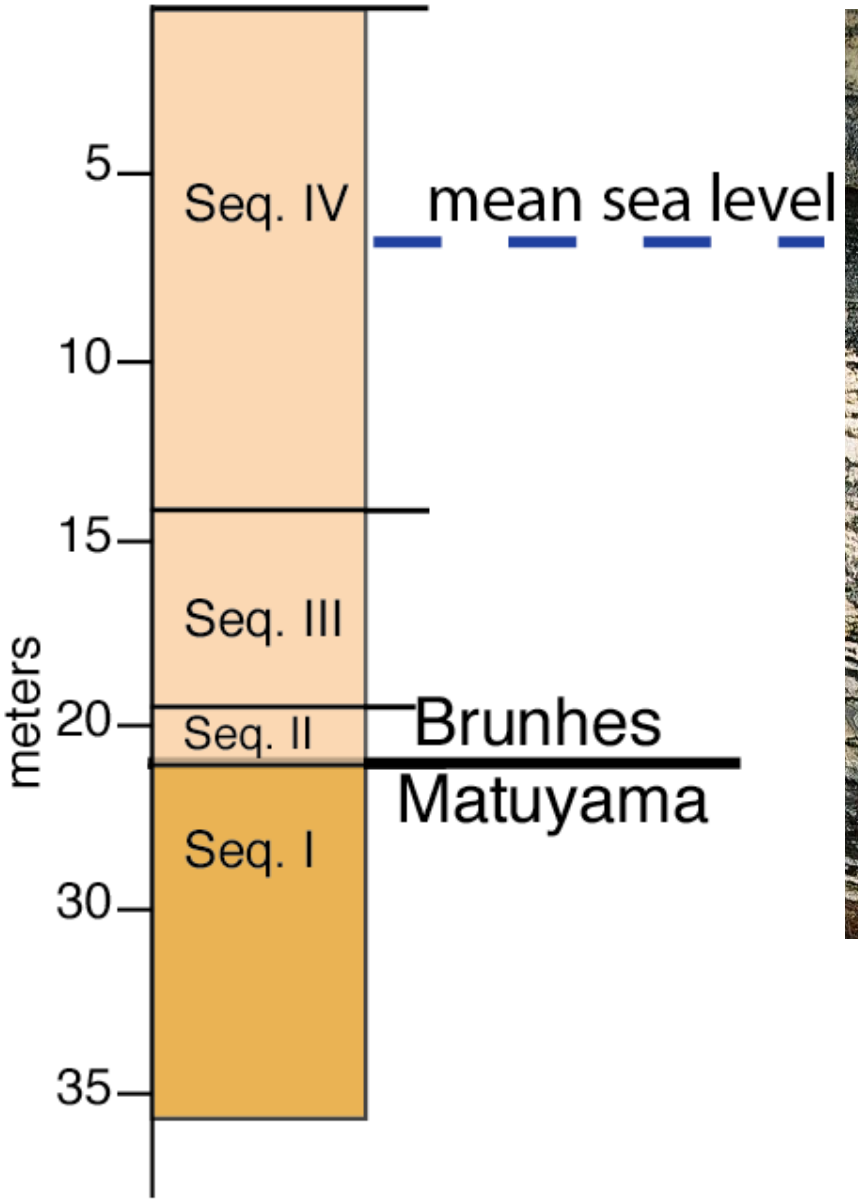




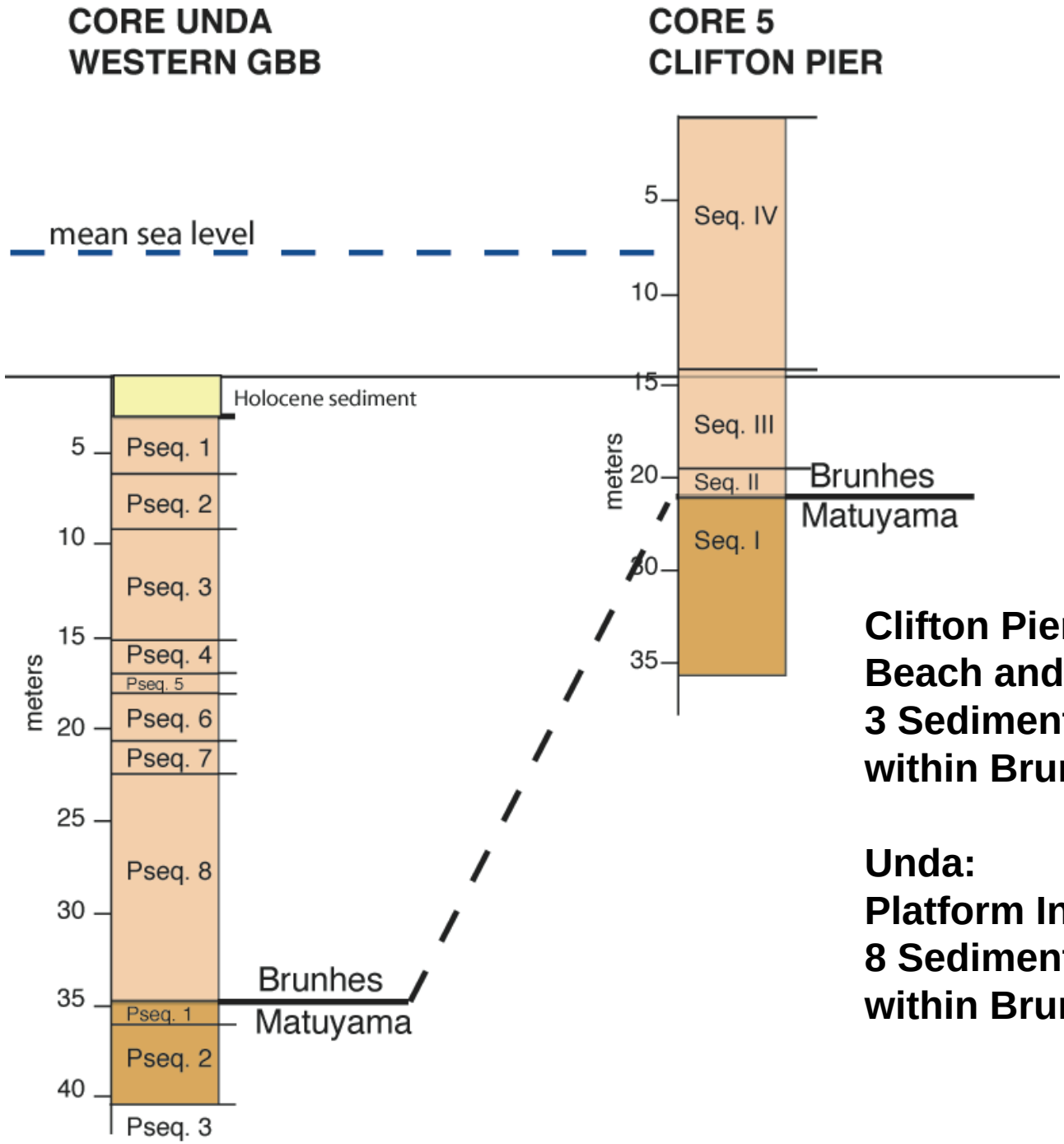
Aurell et al. 1995

Clifton Pier:
Beach and Reef Facies



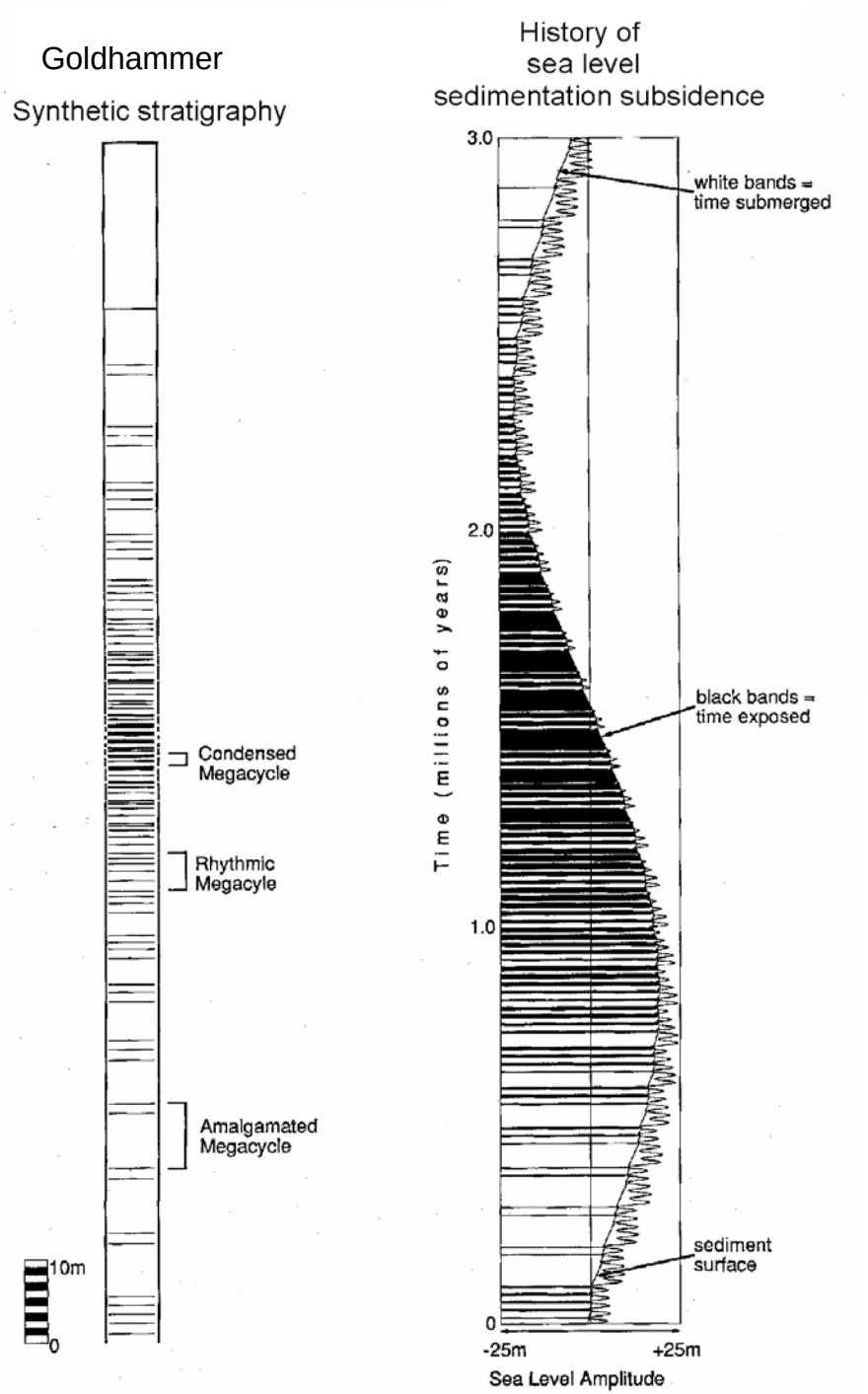


3 Sedimentary cycles within Brunhes



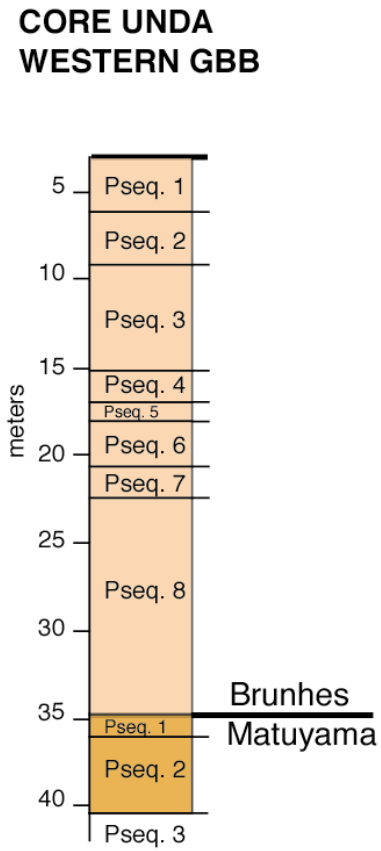
Clifton Pier:
Beach and Reef Facies
3 Sedimentary cycles within Brunhes

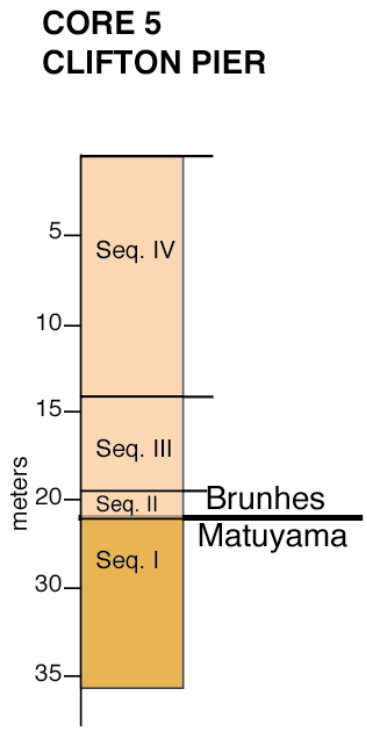
Unda:
Platform Interior
8 Sedimentary cycles within Brunhes



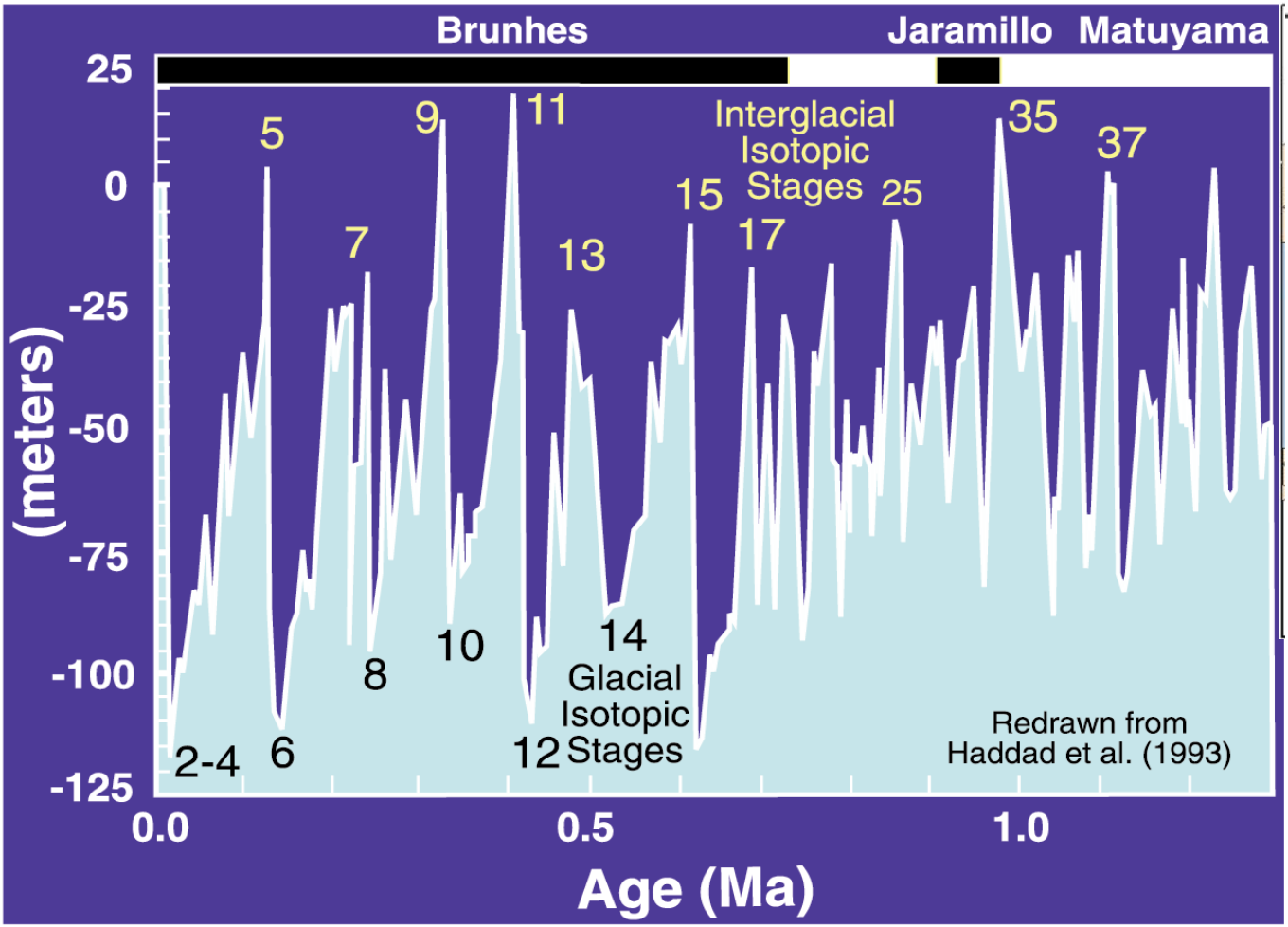
Missed beats

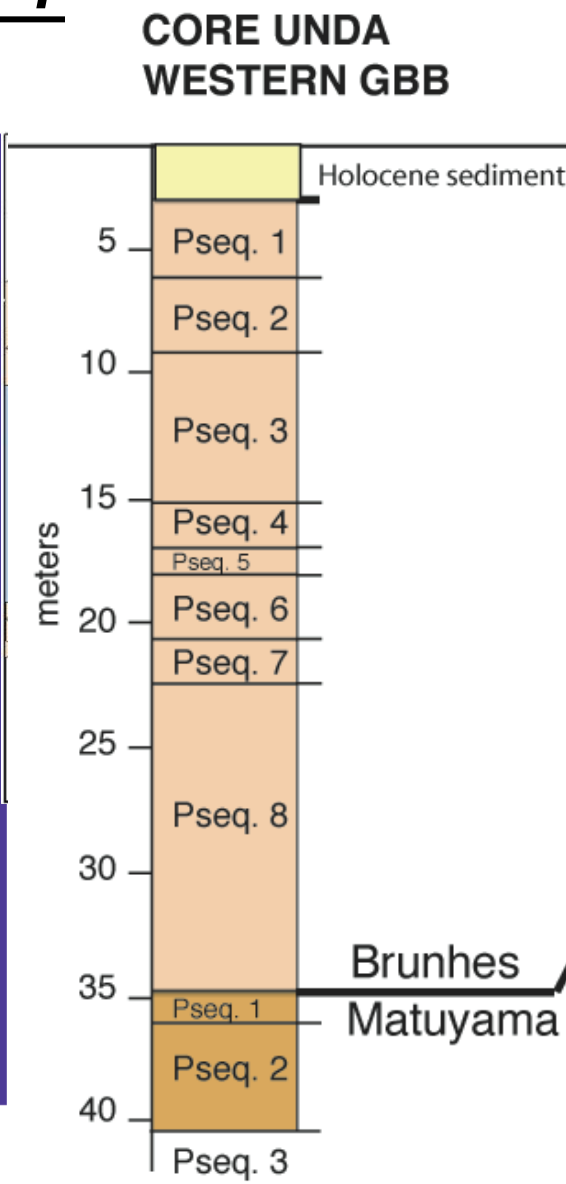
due to variable filling of accommodation space



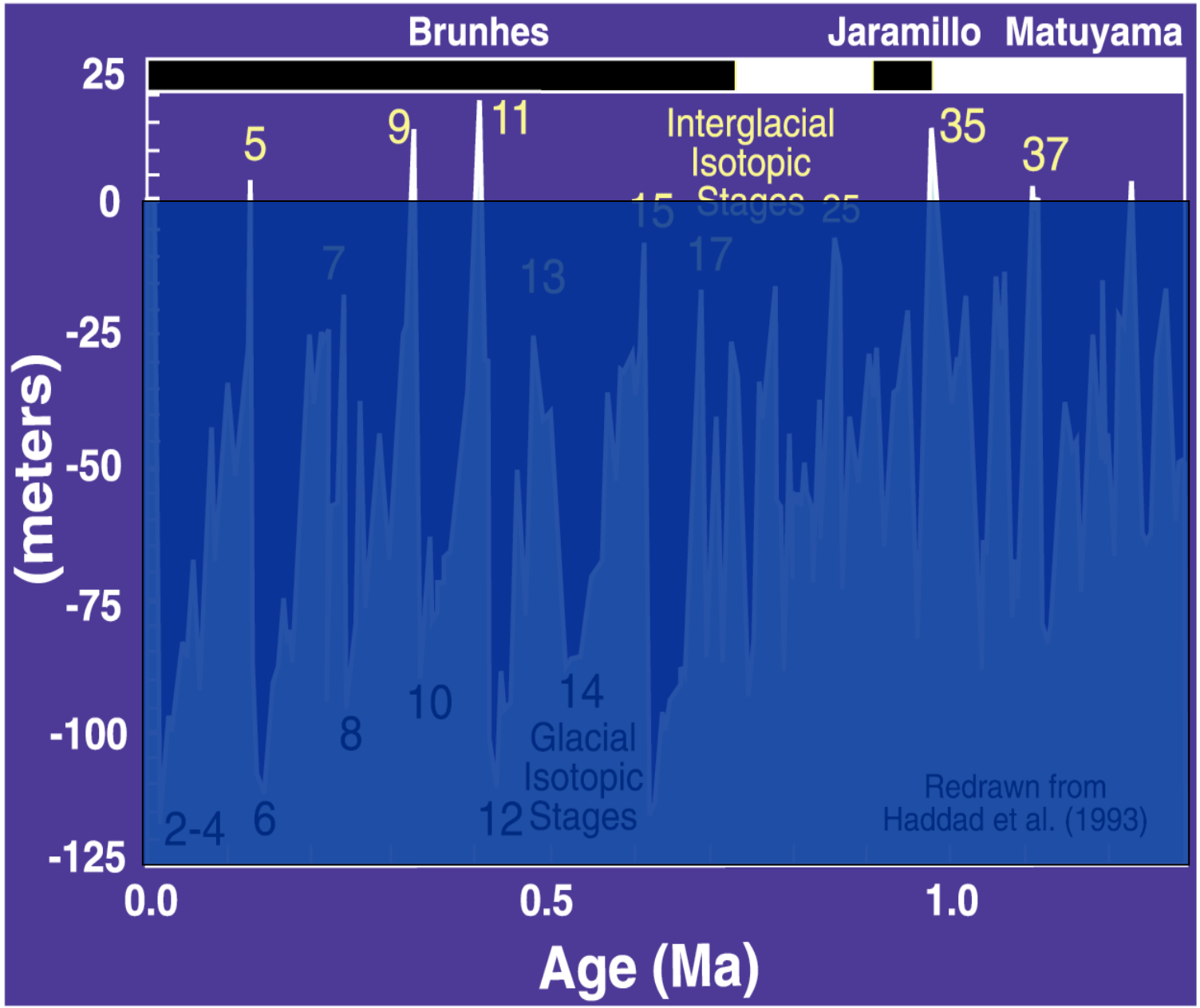


Cycle thickness versus sea level amplitude

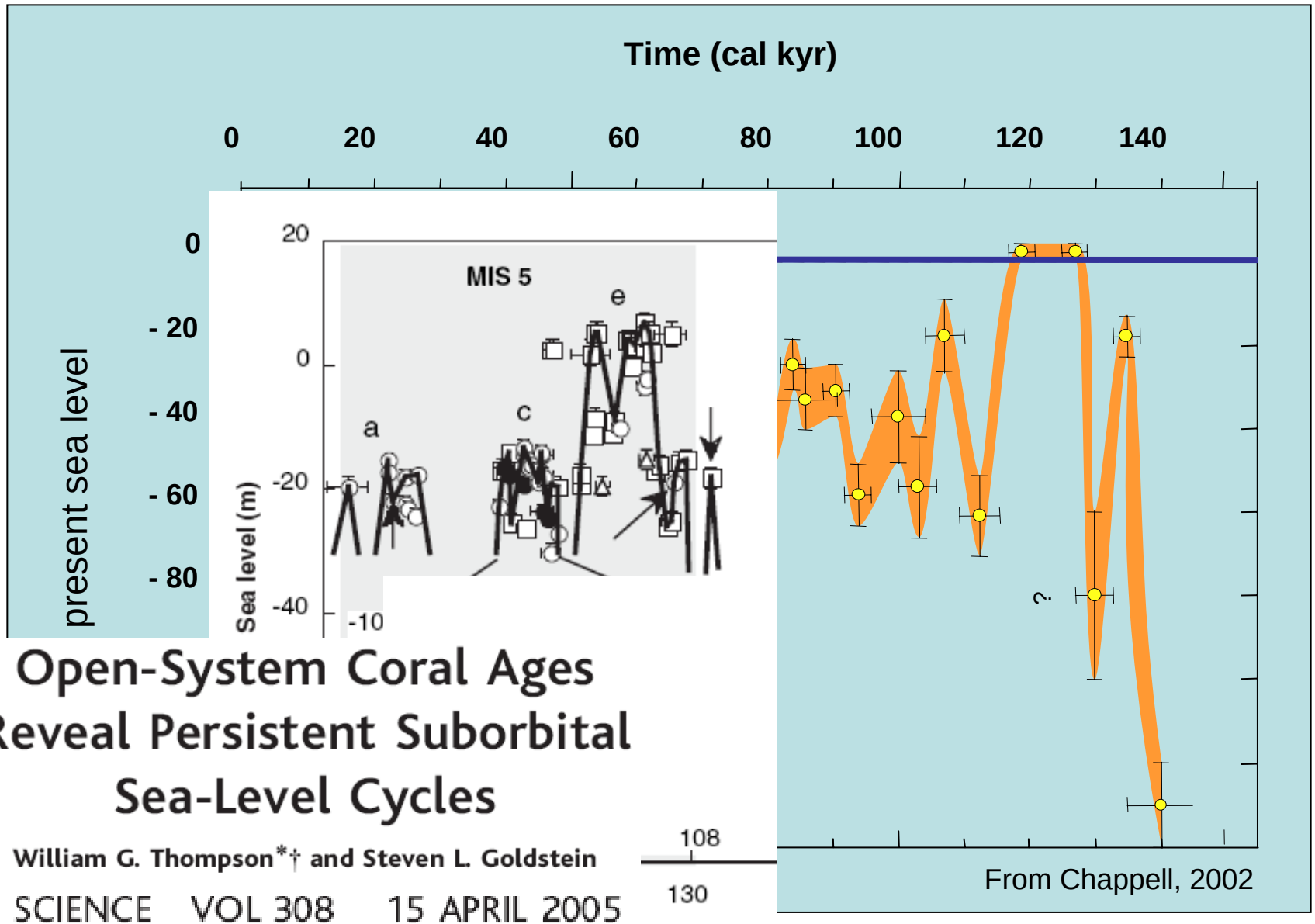




Cycle thickness versus sea level amplitude



Sea level curve for last 150 kyr



Open-System Coral Ages Reveal Persistent Suborbital Sea-Level Cycles

William G. Thompson*† and Steven L. Goldstein

SCIENCE VOL 308 15 APRIL 2005

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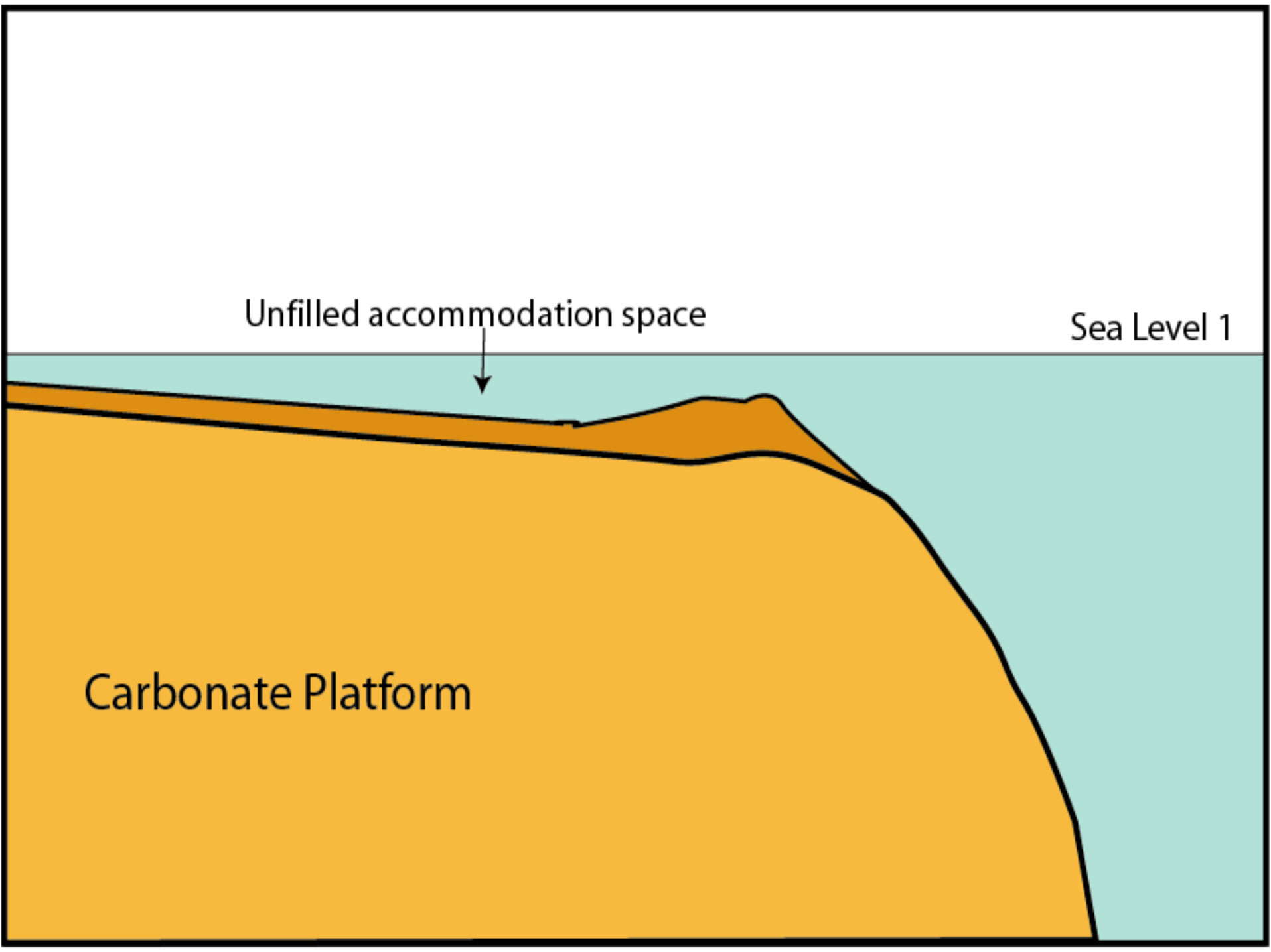
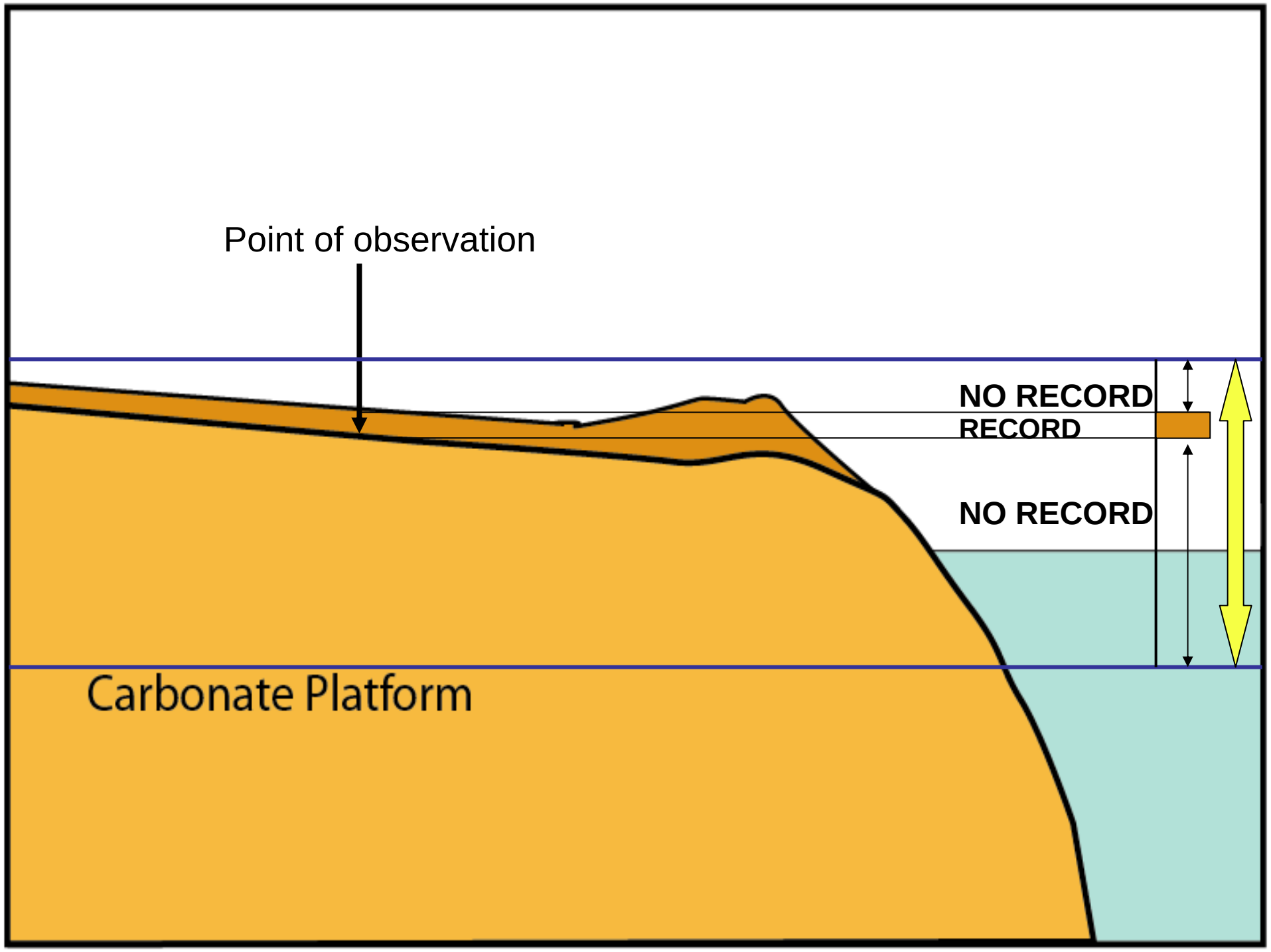
130


Unfilled accommodation space
Sea Level 1
Carbonate Platform


Point of observation
NO RECORD
RECORD
NO RECORD
Carbonate Platform

Conclusions

- Accommodation space is filled irregularly, mostly not completely filled but also “overfilled” in places
- Depositional topography creates
  - cycle thickness variations
  - missed beats
- In the Pleistocene cycle thickness is not reflecting sea level amplitudes
- Suborbital sea level fluctuations may produce meter scale cycles on a platform