Quaternary Glacioeustatic Sea-Level Highstands from the Bahamas: The Karst Signature

Joan R. Mylroie and John E. Mylroie
Department of Geosciences
Mississippi State University
jem2@msstate.edu

ABSTRACT

The Bahamian Archipelago, because of the young age of its surficial rocks, 100% carbonate geology, and tectonic passivity, has long been used as a test of Quaternary glacioeustatic sea-level highstand position and chronology. With the exception of Mayaguana Island, which displays slight vertical rotation to the south exposing much older units, fossil coral reef U/Th dates from the archipelago all fall within the MIS 5e time window, ~120 ka. It has been argued that older corals formed either below modern sea-level elevation (MIS 7), or have been taken below modern elevation by isostatic subsidence of 1 to 2 m per 100 ka (MIS 9, 11, etc.). Flank margin cave position, on average at 0 to 6 m elevation, and a scattering of stalagmite dates less than 120 ka, supports a MIS 5e origin interpretation for the caves. In contrast, some caves, primarily in the southern Bahamas, display phreatic dissolution at elevations up to 17 m above sea level, and a stalagmite from Conch Bar Cave on the Caicos Platform was recently dated by U/Th to 266 ka. These observations suggest a lack of subsidence, or perhaps mild uplift, in the southern Bahamas. If so, where are the pre-MIS 5e fossil corals and related subtidal deposits? An often overlooked aspect is the karst denudation rate. Work on Guam in the western Pacific discovered 5 m of landscape denudation of a MIS 5e reef, extrapolating that rate of 5 m per 100 ka to the Bahamas (and accounting for climatic differences) suggests that those older reefs are entirely denuded, and that the remaining sea-level signature is preserved only in remnant flank margin caves, formed within the eolian high ground topography, which allowed survival to the present.

OBSERVATIONS

North and Central Bahamas:

1. All fossil corals date to MIS 5e (115-124 ka)
2. Flank margin caves mostly at 0 to 6 m asl
3. Caves contain stalagmites of ages <120 ka

Southern Bahamas and Turks & Caicos:

1. All fossil corals date to MIS 5e (115-124 ka)
2. Flank margin caves commonly up to 12 m asl or higher
3. Caves contain stalagmites with ages up to 266 ka

THE QUESTION

1. The cave data suggest pre-MIS 5e uplift in the southern Bahamas
2. Where are the pre-MIS 5e fossil coral and related lagoon deposits?

Figure 1: Google image of the Bahamian Archipelago

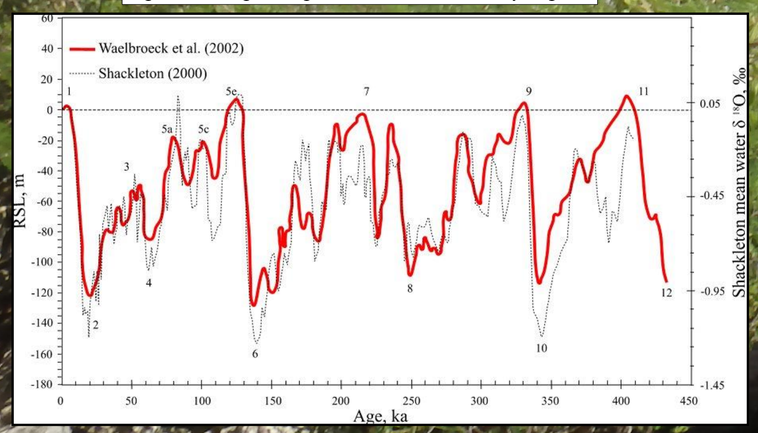

Figure 2: Glacioeustatic sea level curve for the last half-million years (Lascu, 2005)

Background Image: Goatarooter Cave, Cat Island, Bahamas

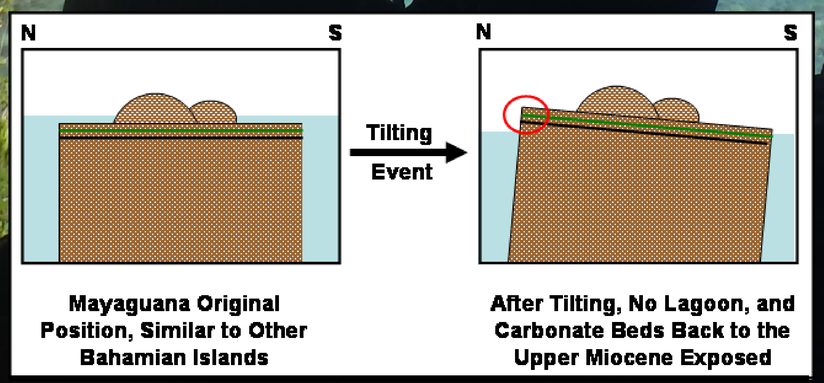

Figure 3: Slight tilting of Mayaguana Island brought carbonate rocks from the Pliocene and Miocene above sea level, and left no platform lagoon.

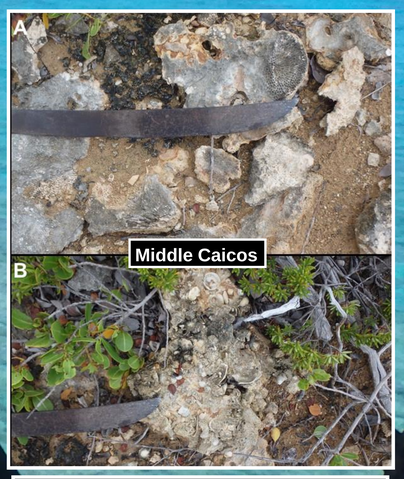

Figure 4: MIS 5e subtidal facies at 2 m asl. A - Fossil coral. B - Fossil molluscs.

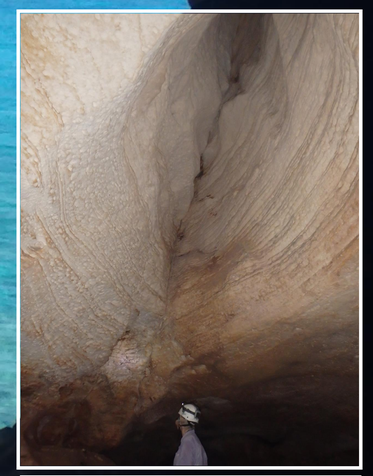

Figure 5: Jointing in an eolianite with phreatic development up to 14 m asl, Conch Bar Cave, Middle Caicos.

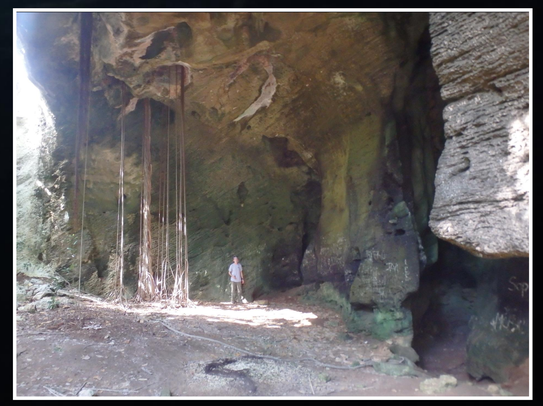

Figure 6: Phreatic surfaces above 14 m asl, Indian Cave ceiling, Middle Caicos.

Figure 7: Karst denudation on Guam. Above left, high cliffs of Plio-Pleistocene Marianas Limestone rising above the on-lapping low terrace of MIS 5e Tarague Limestone. Above right, the apparently flat depositional plain of 120 ka MIS 5e Tarague Limestone.

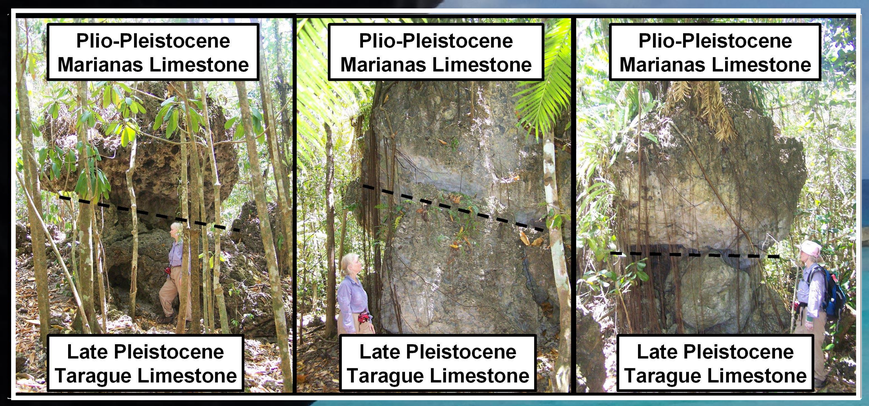

Figure 8 : karrentisch of Plio-Pleistocene Marianas Limestone boulders resting on top of Tarague Limestone pedestals, indicating meters of denudation since MIS 5e, ~120 ka.

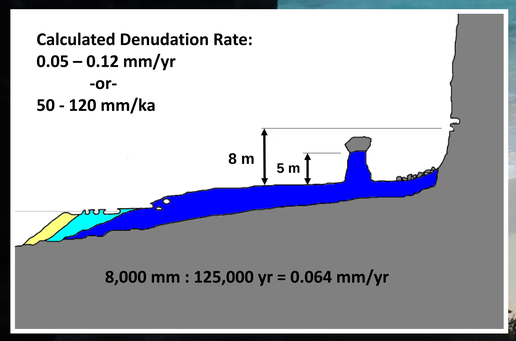

Figure 9: The Guam data, utilizing both karrentisch and coastal notches (likely breached flank margin caves), indicates denudation of meters per hundred thousand years.

For the Turks and Caicos, the presence of MIS 5e fossil corals and subtidal deposits below 4 m asl indicates minimal uplift in the last 120 ka.

Stalagmite U/Th ages older than MIS 5e, and flank margin caves at up to 17 m asl indicate uplift before MIS 5e, with loss of pre-MIS 5e fossil corals and subtidal deposits to karst denudation of up to 10 m.

Background image, Mudjin Cave, Middle Caicos Island

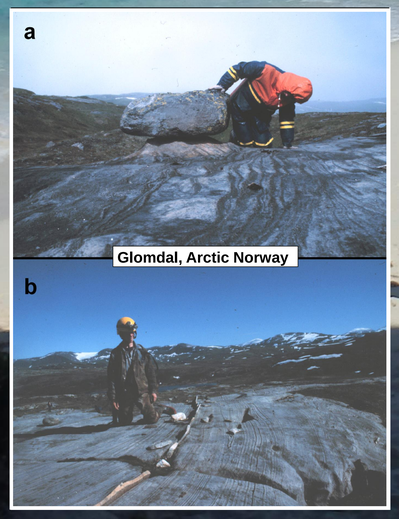

Figure 10: Karst denudation indicators from high latitude environments. A - Granite boulder on Cambro-Ordovician marble, forming a karrentisch. B - Quartz vein protruding above a marble surface. Both sites indicate about 30 cm of denudation since ice left the area ~8,000 years ago.

References Cited

Kindler, P., Godefroid, F., ands Samankassou, E., 2008, Pre-Holocene island geology of the Caicos and Mayaguana (Bahamas) platforms: similarities and differences In: Morgan, W. A., and Harris, P. M., eds. Developing Models and Analogs for Isolated Carbonate Platforms Holocene and Pleistocene Carbonates of Caicos Platform, British West Indies, SEPM Core Workshop 22, p 211-220.

Lascu, I., 2005, Speleogenesis of large flank margin caves of the Bahamas, Masters Thesis, Department of Geosciences, Mississippi State University, Mississippi State, MS, 218 p.

Carew, J. L., and Mylroie, J. E., 1995, Quaternary tectonic Stability of the Bahamian Archipelago: Evidence from fossil coral reefs and flank margin caves: Quaternary Science Reviews, v. 14, p. 144-153.

Miklavič, B., Mylroie, J. E., Jenson, J.W., Randall, R. H., Banner, J. L., Partin, J. W., 2012, Evidence of the sea-level change since MSI 5e on Guam, tropical west Pacific: Studia Universitatis Babeşs-Bolyai, Geology, Special Issue 2012, 30-32.

Smart, P. L., Moseley, G. M., Richards, D. A., and Whitaker, F. F., 2008, Past high sea-stands and platform stability: evidence from Conch Bar Cave, Middle Caicos, In: Morgan, W. A., and Harris, P. M., eds. Developing Models and Analogs for Isolated Carbonate Platforms-Holocene and Pleistocene Carbonates of Caicos Platform, British West Indies, SEPM Core Workshop 22, p 203-210.

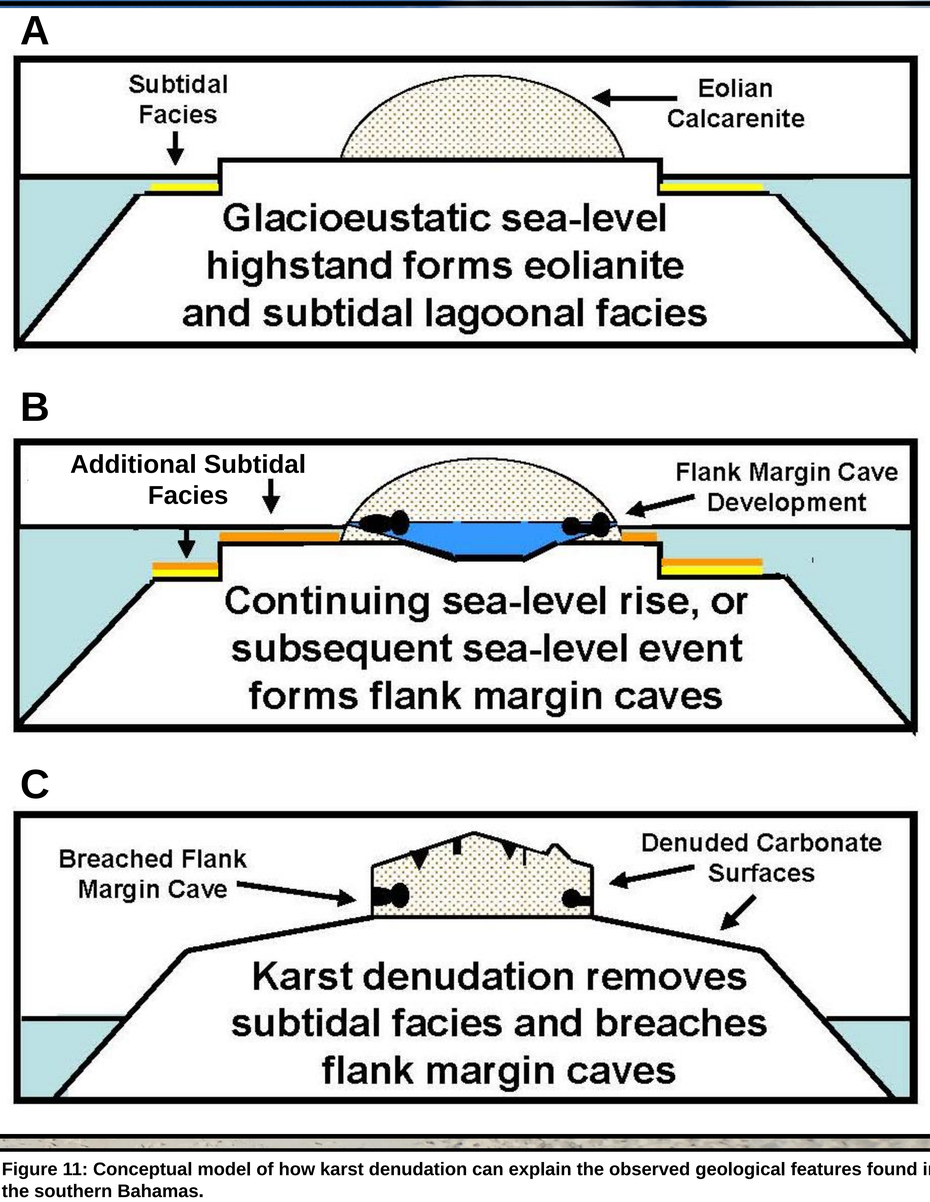

Figure 11: Conceptual model of how karst denudation can explain the observed geological features found in the southern Bahamas.

A – During a sea-level highstand prior to MIS 5e, platform flooding creates subtial facies and produces beach sand that becomes an eolian calcarenite.

B – If the same highstand continues to a higher elevation, or during a subsequent sea-level highstand, subtidal facies are deposited at higher elevations, and a fresh-water lens forms within the eolian calcarenite, and flank margin caves are produced.

C – During glacioeustatic sea-level lowstands (or during highstands that fail to flood the platform), karst denudation is active. The lagoonal subtidal facies of the previous highstand(s) are removed, and the flank margin caves are breached and exposed for access.

Platform uplift to bring the flank margin caves to elevations up to 17 m asl occurred after event B. Past glacioeustatic sea-level highstands at elevations of 17 m asl should have left a similar cave elevations across the entire Bahamas. The restriction of these high-elevation caves to the southern Bahamas implicates uplift.

CONCLUSIONS

Karst processes, by creating flank margin caves in the subsurface, preserve a record of former sea-level position that those very same karst processes remove from surface outcrops.

Acknowledgements: Nancy Albury, John Jenson, Michael Lace, and Blaz Miklavic for outstanding field assistance