Geomorphology and Paleoecology of Holocene Coral Reefs from the SE Florida Shelf

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Introduction

The SE Florida shelf is a well studied coral reef region used in the development of West Atlantic/Caribbean sea-level curves and the examination of Pleistocene and Holocene reef geomorphology and paleoecology. The SE Florida continental reef tract and the better studied Florida Keys reef tract located further south are situated on the Florida shelf (Figure 1). Coral reefs variably accreted throughout both tracts during the Holocene to the present day.

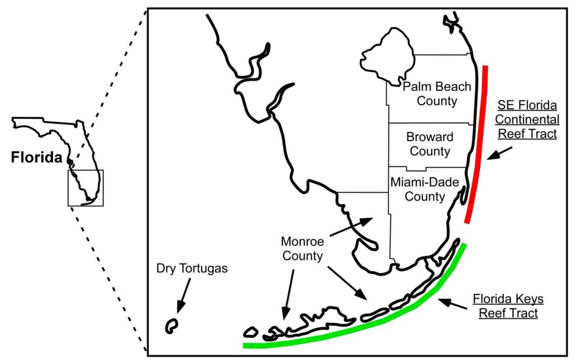

Figure 1: Map of the SE Florida and the Florida Keys reef tracts.

The SE Florida continental reef tract is a 125km long Holocene fringing/barrier coral reef complex, composed of three shore-parallel linear reefs ('outer', 'middle', and 'inner' reefs) and a nearshore 'ridge complex' of varying age (Figure 2). Fewer detailed geologic and stratigraphic descriptions exist in comparison to the Florida Keys reef tract, thus reef cores were extracted to further analyze internal composition, taphonomic characteristics, and Holocene accretion history. This was combined with the most recent LIDAR bathymetric data for analyses of reef geomorphology and bathymetry at cored locations.

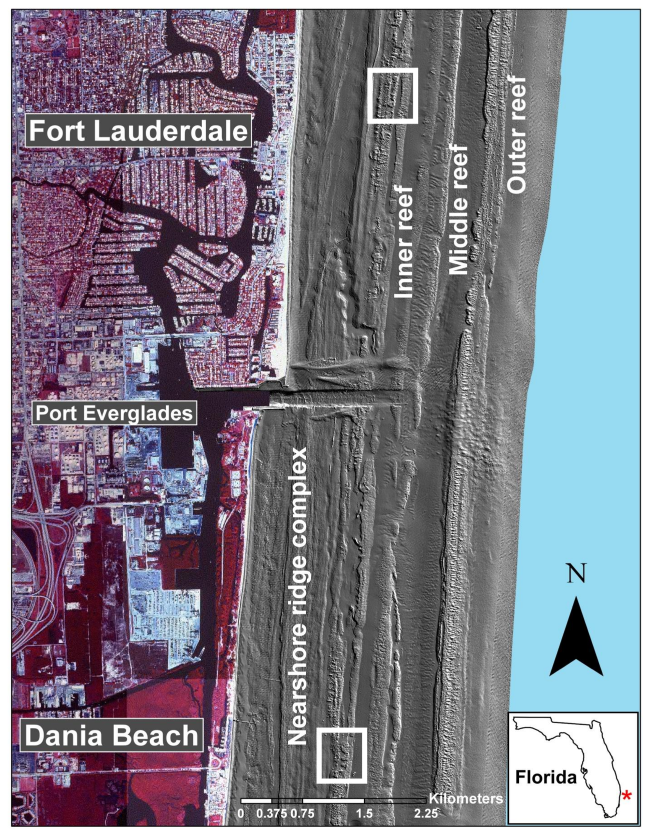

Figure 2: LIDAR bathymetric map of drilling sites (white boxes).

Methods

•Reef cores were extracted with a tripod-mounted submersible drill rig (Figure 3). The drill is hydraulically-powered from a surface vessel and utilizes a double-barrel wireline system for simplified core removal. Drilling was carried out by a small dive team with surface support.

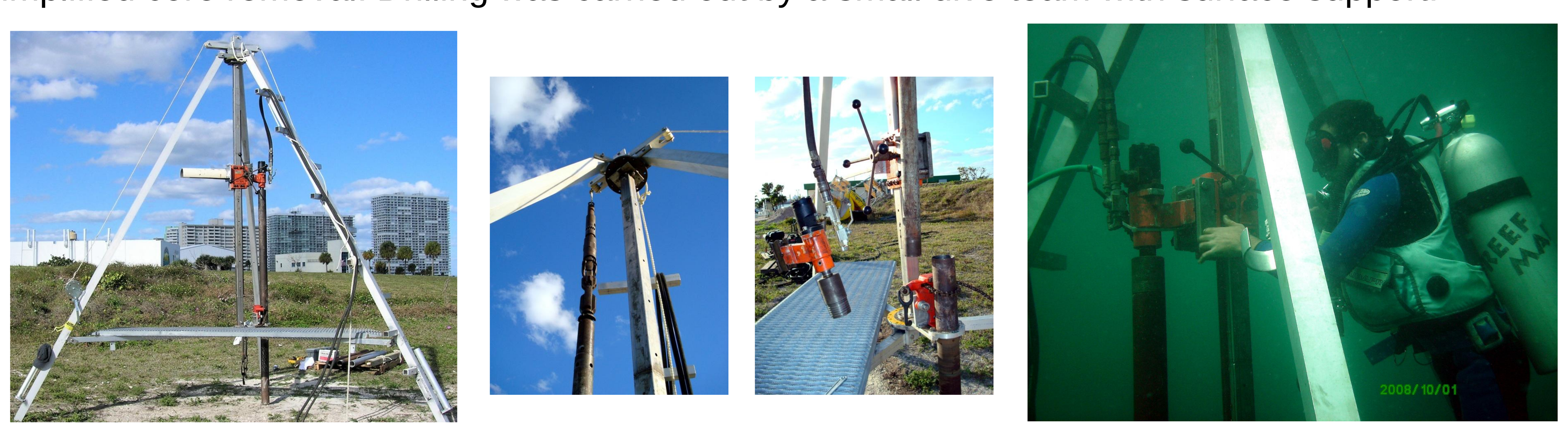

Figure 3: Images of tripod, drilling equipment, and underwater core-drilling

•Cores were photographed, slabbed, and analyzed for taphonomic characteristics (Figure 4). Taphonomic features were identified, digitally color-coded and pixel-counted to determine their percent contribution to slabbed core surfaces.

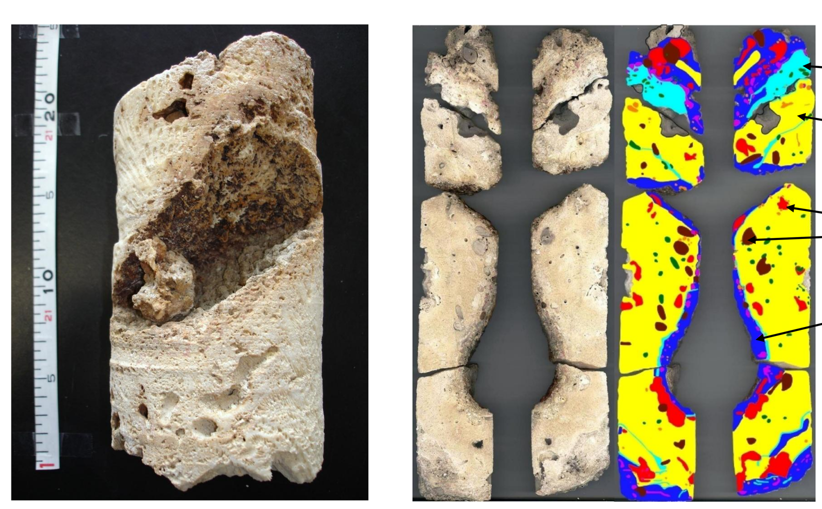

Figure 4: Coral reef core fragment prior to slabbing and analysis (far left) and slabbed core before and after color-coding for image analysis (left).

•Standard ^{14}C Radiocarbon aging and calibration of aragonitic coral samples (verified by X-Ray Diffraction analysis) was performed by BETA Analytic Inc (Table 1). Ages were used in paleoecological and reef accretion reconstructions and were integrated with LIDAR-derived bathymetric profiles at drilled reef sites (Figure 6).

Results

Core IR-1
Corals: *M. annularis*, *Siderastrea* sp., *Diploria* sp.
Dom. Framework: Massive coral rubble
Core length: ~0.45m
Core recovery: ~60%

Core IR-2
Corals: *M. annularis*, *Diploria* sp., *P. porites*
Dom. Framework: Massive corals
Core length: ~1.95m
Core recovery: ~52%

Core IR-3
Corals: *A. palmata*, *M. annularis*, *M. cavernosa*, *Diploria* sp., *Siderastrea* sp., *Dichocenia* sp.
Dom. Framework: *A. palmata* (~0.90m) & *Diploria* sp. (~1.00m) & mixed rubble (~0.30m)
Core length: ~2.20m
Core recovery: ~59%

Core IR-4
Corals: *A. palmata*, *M. annularis*, *Diploria* sp., *P. porites*, *Millepora* sp.
Dom. Framework: *A. palmata* rubble (~0.60m) & massive coral rubble (~0.50m)
Core length: ~1.85m
Core recovery: ~50%

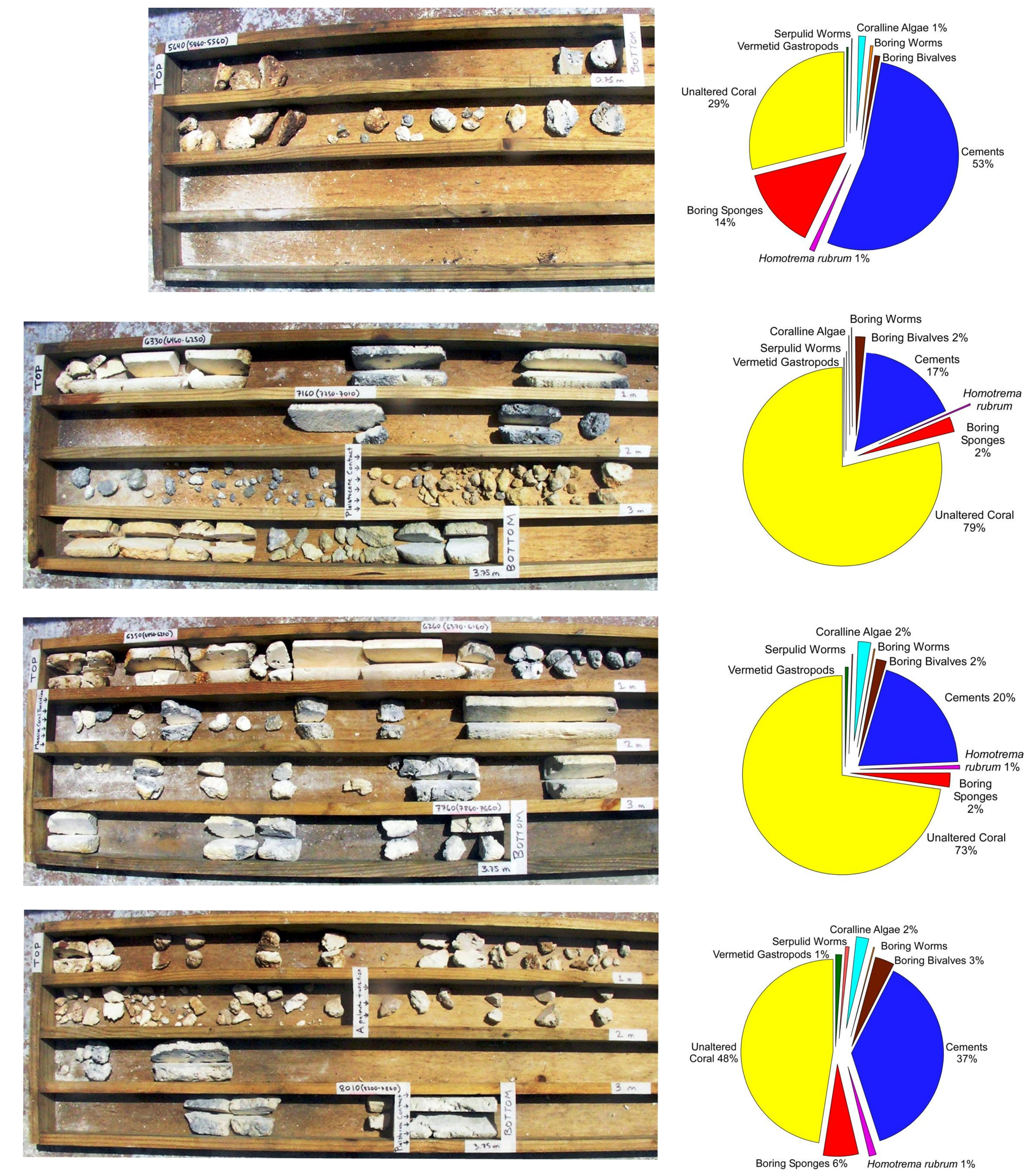

Figure 5: Cores (above left) and percentages of core components (above right).

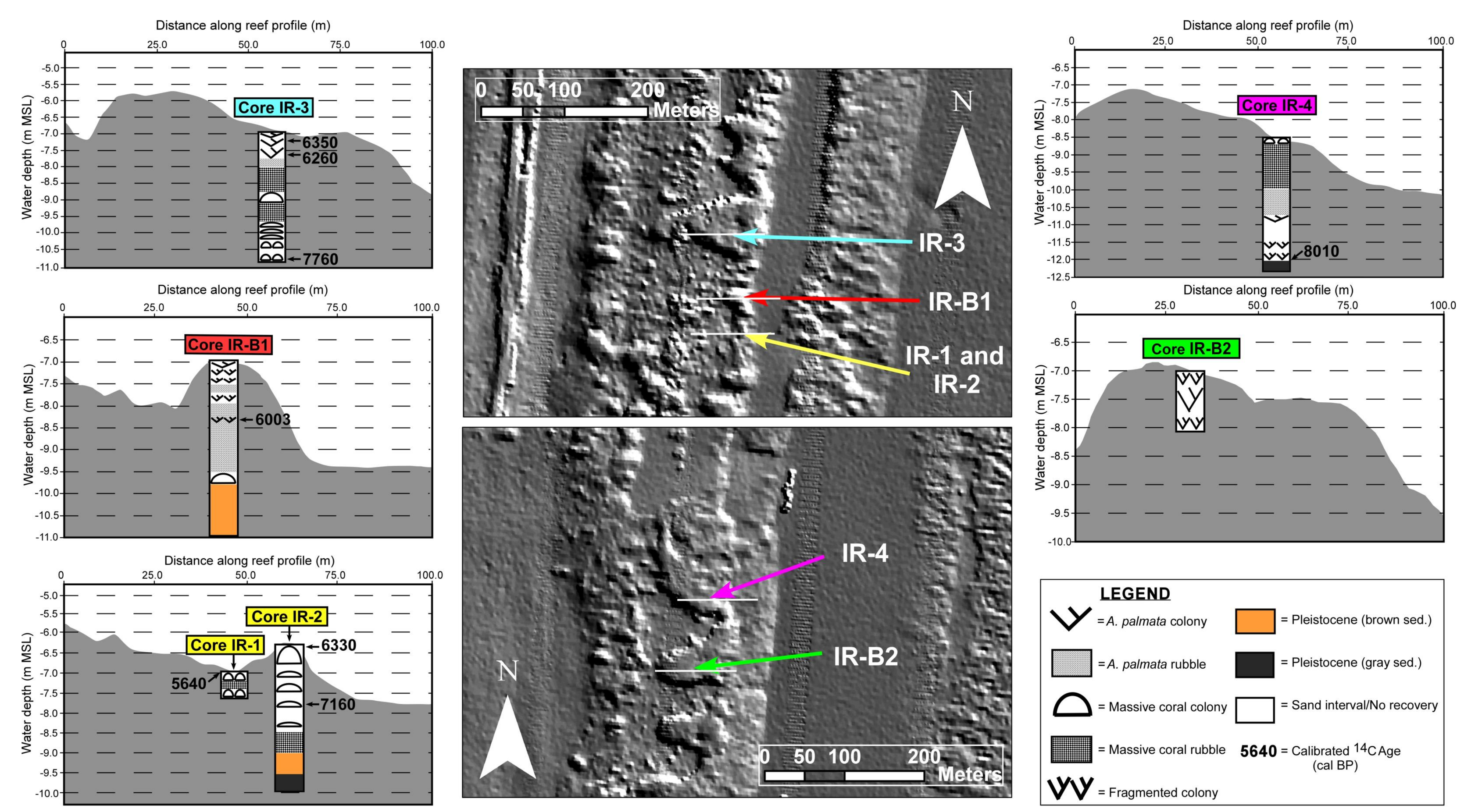

Figure 6: Interpreted inner reef profiles using LIDAR and cores (IR-B1 and IR-B2 from Banks et al (2007).

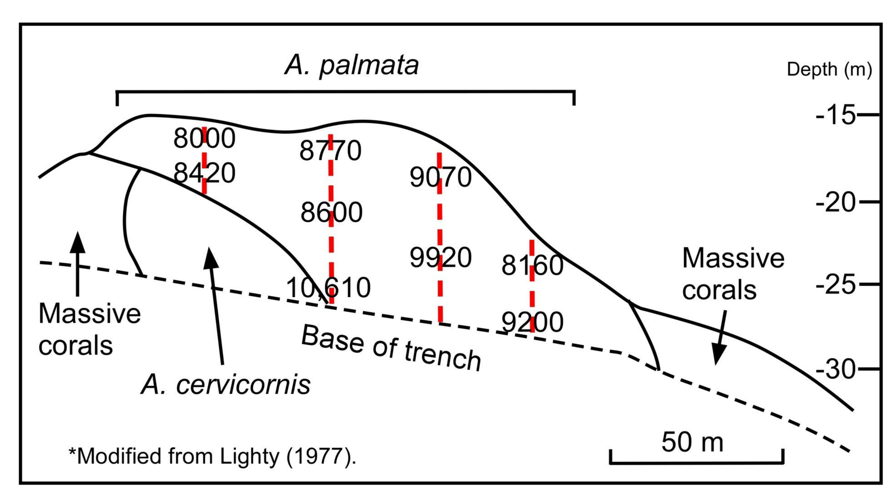

Figure 7: Outer reef profile and ages from a trench excavation.

Table 1: Inner reef ^{14}C Radiocarbon ages.

Core name	Coral & Position in core	Sample depth (m MSL)	Conventional ^{14}C age (yrs BP & range)	Calibrated ^{14}C age (calendar yrs)
IR-1	TOP *M .annularis*	-7.0	5,290 ± 70	5,640
IR-2	TOP *M .annularis*	-6.3	5,920 ± 60	6,330
IR-2	BOTTOM *Diploria sp.*	-7.7	6,610 ± 50	7,160
IR-3	TOP *A. palmata*	-7.3	5,930 ± 50	6,350
IR-3	MIDDLE *A. palmata*	-7.8	5,820 ± 60	6,260
IR-3	BOTTOM *Diploria sp.*	-10.8	7,290 ± 50	7,760
IR-4	BOTTOM *A. palmata*	-12.1	7,560 ± 90	8,010

Discussion

Results indicate that the outer reef accumulated from ~10.6–8.0 ka cal BP, the middle reef from at least ~5.8–3.7 ka cal BP, and the inner reef from ~7.8–5.6 ka cal BP. The outer reef is better developed than the inner reef, and the middle reef may not have any appreciable framework buildup. A lack of significant age overlaps and new data from this study confirm that outer reef to inner reef backstepping occurred a few hundred years after outer reef termination (Figure 8). Similar spatial and temporal scales of backstepping were reported from Puerto Rico and St. Croix.

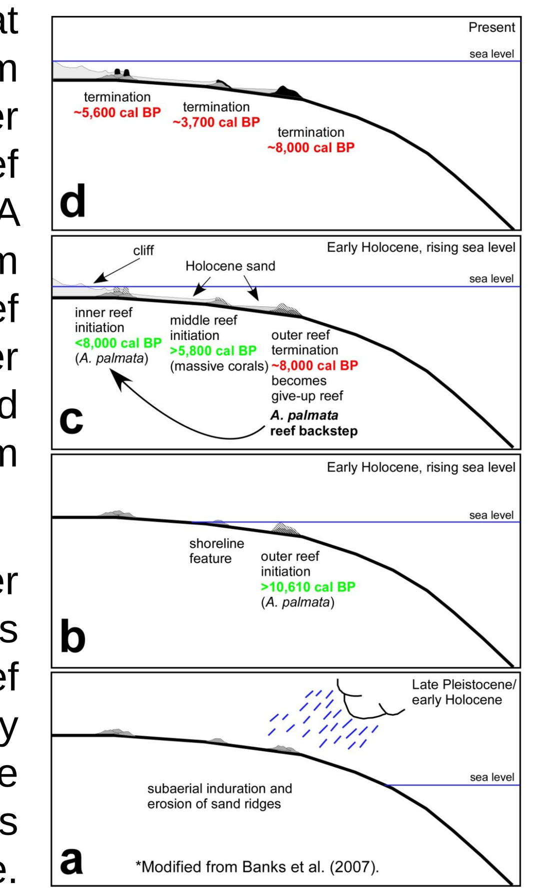

Figure 8: Accretion history of the SE Florida reef tract.

We observed that the Caribbean reef builder *Acropora palmata* was present but not always dominant during most of the Holocene on both reef tracts. Geomorphology was strongly determined by its dominance and length of presence, with the size and shape of reef bodies clearly reflecting its declining importance throughout the Holocene. Perceived gaps in reported ^{14}C ages are most likely artifacts of limited sampling and emphasize the need for more precise sampling and dating.

Dynamic local/regional reef terminations, backstepping, and re-initiation have occurred in response to sea-level rise and flooding of structures conducive for reef growth. Large-scale geomorphic and ecological changes to Florida's Holocene coral reefs occurred on at least centennial timescales.

Continuing Research

Drilling projects will continue on the deeper and less understood middle and outer reefs to further refine the overall accretion history and paleoecology of the SE Florida reef tract. In addition, analyses of Holocene climate and sea-level records will be performed to determine possible links to backstepping and eventual reef demise.

References

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