OVERFILLING OF ACCOMMODATION IN A MODERN OOID SAND BODY A RECORD OF CLIMATE (STORM FREQUENCY) CHANGE

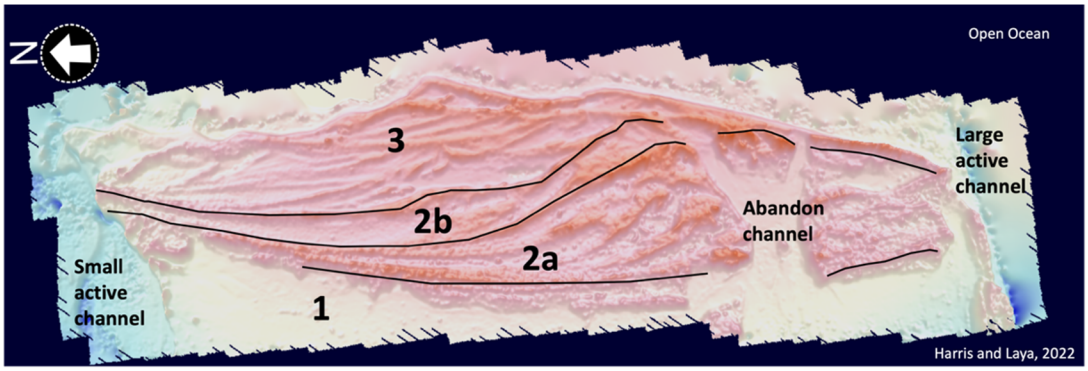
Paul (Mitch) Harris, Juan Carlos Laya[1], and Pete van Hengstum[2]
1) Department of Geology and Geophysics, Texas A&M University
2) Department of Marine and Coastal Environmental Science, Texas A&M University at Galveston

PROJECT OBJECTIVES

- Forward the hypothesis that the geomorphology of South Joulter Cay results from punctuated intervals of local hurricane activity impacting hydrodynamic and depositional conditions.
- Suggest a correspondence between island growth stages and periods of elevated storm activity documented from Millennial-scale Atlantic paleo hurricane compilations.
- Given the absence of a local paleo hurricane reconstruction from Northern Andros, the Joulters geomorphology may be informing local activity.

PROJECT RATIONALE

Our ongoing examination of South Joulter Cay, an important component of the large modern ooid sand body lying directly north of Andros Island on Great Bahama Bank, targets a better delineation of the processes and timing that formed the island (Harris and Laya, 2022; Laya and Harris, 2022). High resolution imagery, a DEM constructed from a drone survey, field evidence, and radiocarbon dating of ooids and meteoric cements forward the hypothesis that island geomorphology comprising ridges associated with three distinct island growth stages (Fig. 1) results from punctuated intervals of local hurricane activity over the last ~1800 years.



1. **Linear ridges:** "island" bounded by active channels; wide active ooid shoal in front tied to major channel to south

2a. **"Arcuate" ridges:** ebb tidal delta lobe "storm" deposits related to now abandon channel; internal complexity due to changing influence of the different channel branches

2b. **Arcuate longer ridges:** increasing importance of longshore currents and diminished importance of now abandoned channel

3. **Irregular cuspate ridges:** related to longshore currents and sediment from major channel to south; ridge patterns reflect pulsed sediment input, variation in longshores and coastline irregularities

Figure 1: Summary of morphological stages of growth of South Joulter Cay. Annotation shown on DEM constructed from high-resolution drone survey.

APPROACH

Indeed, millennial-scale Atlantic paleo hurricane compilations broadly inform hurricane-climate dynamics, which reveal centennial-scale intervals of elevated Atlantic hurricane activity relative to the instrumental period (Wallace et al., 2019, 2021a and b; Winkler, et al., 2020, 2021, 2023). The scenario for island development summarized on Figure 1 emphasizes active sand bars locally building to beaches and back-beach dune ridges forming repeatedly, with variations in dispersal of ooid sands driven by tidal channels, wind and wave energy, and longshore and storm-related currents. We suggest that intervals of elevated storm activity proximal to Joulters and delivering east to west energy and sediment transport are most likely to have played a role in island development, and radiocarbon dating (Fig. 2), although limited, suggests a correspondence between island growth stages and the periods of elevated storm activity documented from Bahamian storm compilation (Fig. 3). Given the absence of a local paleo hurricane reconstruction from Northern Andros and that local hurricane histories may deviate from basin-wide compilations, the Joulters geomorphology may be informing local paleo hurricane activity.

Figure 2: Satellite image of SJC showing location of samples recently submitted for radiocarbon dating to the Keck Carbon Cycle Ams Facility, Earth System Science Dept, UC Irvine. Separate aragonite ooid and calcite meteoric cement analyses should bracket age of ridge formation (ooid either older than ridge or same age, cement younger and likely still forming). Results improve on those of Harris (1977, 1979) wherein 9 lightly cemented surface rock samples, 4 rock samples collected vertically down a water well, and 8 samples from two rock cores were submitted to the University of Miami Geochronology Laboratory for age determination using a partial ooid dissolution method. Given these were bulk samples of large size (50 mg) so a mixture of diverse ooids and the younger meteoric cement, results must be viewed as a minimum age.

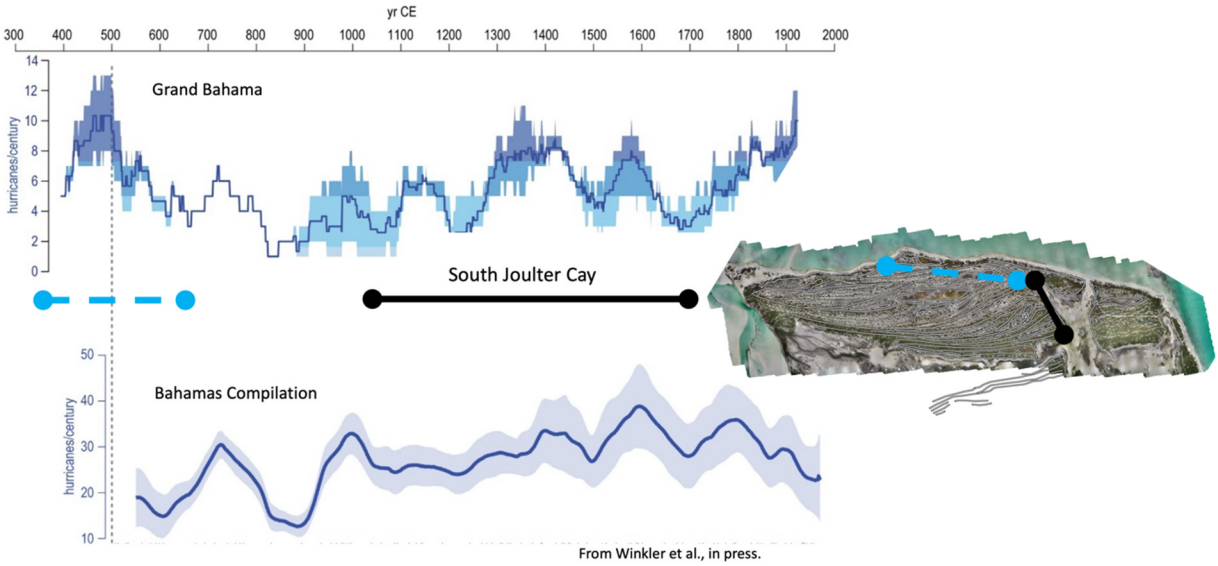


Figure 3: Latest estimates of timing for growth of South Joulter Cay from radiocarbon age dating of marine aragonite ooids and meteoric calcite cements allow for a comparison with paleo-hurricane records, both the latest Bahamas compilation as well as results from the closest site to the northern Andros area – Grand Bahama, derived from studies of cored storm deposits in blue holes from Winkler et al, in press.

SIGNIFICANCE

The scenario proposed here for island growth, an example of the overfilling of accommodation in a Modern ooid sand body, provides insight on the thickening and facies change to be expected locally within a high-energy depostional cycle. The storm aspect of island ridge growth is significant in that infrequent and short-lived events can produce localized "anomalies" that profoundly impact the sedimentary record well beyond the bounds of the island itself, a notion previously put forward by Purkis and Harris (2016) and Harris (2022). As a potential record of local paleo hurricane activity, the Joulters geomorphology may aid in refining the Bahamian storm compilation of others and further our inderstanding of millennial-scale climate change.

REFERENCES

Harris, P.M., 2022, Carbonate Islands – Their Origin and Relevance to Subsurface Studies. 2022 CSL Annual Review Meeting Abstracts Volume, pp. 23-26.

Harris, P.M. and Laya, J.C., 2022, Evolution of a Modern Ooid Sand Island (South Joulter Cay, Great Bahama Bank) and Implications for Subsurface Studies. Second SEG-AAPG International Meeting for Applied Geoscience & Energy (IMAGE), pp. 347-350. DOI:10.1190/image2022-3731200.1

Laya, J.C. and Harris, P.M., 2022, A Tale of Storm Deposition – Formation of South Joulter Cay, Great Bahama Bank. SEPM-CSPG Mountjoy III Conference.

Purkis, S. and Harris, P.M., 2016, The Extent and Patterns of Sediment Filling of Accommodation Space on Great Bahama Bank. Journal Sedimentary Research, v. 86, pp. 294–310.i https://doi.org/10.2110/jsr.2016.24

Wallace, E., Donnelly, J., van Hengstum, P., Wiman, C., Sullivan, R., Winkler, T., d'Entremont, N., Toomey, M., and Albury, N., 2019, Intense hurricane activity over the past 1500 years at South Andros Island, The Bahamas. Paleoceanography and Paleoclimatology, v. 34(11), pp. 1761-1783.

Wallace, E.J., Donnelly, J.P., van Hengstum, P.J., Winkler, T.S., Dizon, C., LaBella, A., Lopez, I., d'Entremont, N.E., Sullivan, R.M., Woodruff, J.D., Hawkes, A.D., and Maio, C., 2021a, Regional shifts in paleohurricane activity over the last 1500 years derived from blue hole sediments offshore of Middle Caicos Island. Quaternary Science Reviews, v. 268, 107126.

Wallace, E.J., Donnelly, J.P., van Hengstum, P.J., Winkler, T.S., McKeon, K., MacDonald, D., d'Entremont, N.E., Sullivan, R.M., Woodruff, J.D., Hawkes, A.D., Maio, C., 2021b, 1050 years of hurricane strikes on Long Island in The Bahamas. Paleoceanography and Paleoclimatology, v. 36, e2020PA004156.

Winkler, T.S., van Hengstum, P.J., Donnelly, J.P., Wallace, E.J., Sullivan, R.M., MacDonald, D., and Albury, N.A., 2020, Revising evidence of hurricane strikes on Abaco Island (The Bahamas) over the last 700 years. Scientific Reports, v. 10, pp. 1-17.

Winkler, T.S., Hengstum, P.J.v., Donnelly, J.P., Wallace, E.J., D'Entremont, N., Hawkes, A.D., Sullivan, R.M., Woodruff, J.D., and Maio, C.V., 2021, Oceanic passage of hurricanes across Cay Sal Bank in The Bahamas over the last 530 years. Marine Geology, v. 443, 106653.

Winkler, T.S., Hengstum, P.J.v., Donnelly, J.P., Wallace, E.J., Albury, N.A., D'Entremont, N., Hawkes, A.D., Maio, C.V., Roberts, J., Sullivan, R.M., and Woodruff, J.D., 2023, Paleooceanography and Paleoclimatology, v. 38, e2023PA0046623.