What does Holocene organic matter deposition in a Bahamian Bluehole reveal about internal basin environmental change?

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1. Introduction

- Blueholes and sinkholes are ubiquitous in the tropics, and their sediment preserve records of environmental change.
- **Problem Statement: There is a poor understanding of how environments in blueholes change during Holocene sea-level rise.**
- **Research Question:** How does sedimentary organic matter document paleoenvironmental change in Freshwater River Bluehole through the Holocene?
- Quantity and type of organic matter deposited are closely related to environmental conditions at time of deposition.
- Three main factors likely impacting organic matter accumulation: (1) primary productivity from the water, (2) hydrographic conditions in the bluehole which impact the rate of decomposition, and (3) Holocene sea-level.

3. Methods

- Sediment core FWRBH was collected by push core in 2014 and FRSH cores were collected in 2016 via Rossfelder-P3 Submersible vibracorer.
- Core samples progressed downcore in 1 cm increments.
- Loss-on-ignition (LOI) procedure used to determine organic matter weights: $\%OC_{LOI} = [(W_{dry} - W_{crucible}) - [(W_{550} - W_{crucible})]/[(W_{dry} - W_{crucible})*100\%$ (Santisteban et al., 2004).

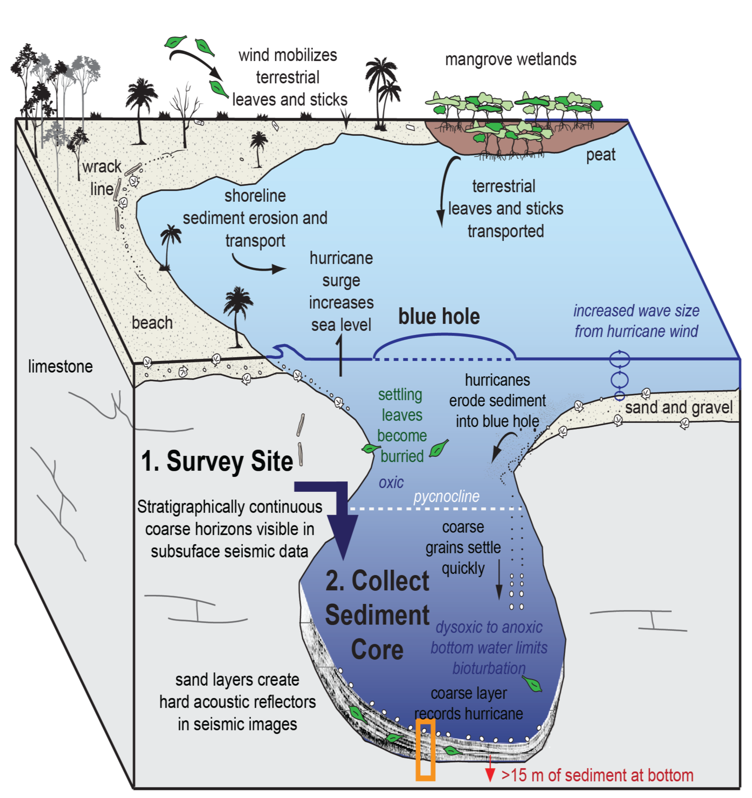

Figure 2. Diagram of the internal basin environment from which the sample cores were collected, as well as surrounding environmental features under which organic matter deposition occurs.

2. Study site: Freshwater River

Freshwater River Bluehole is located on the western banks of Great Abaco Island, The Bahamas. This entire margin is known, locally, as "The Marls", and although it is not a river, nor comprised of fresh water, it does have a lower salinity than the surrounding waters and a depth of just 5-8 m (van Hengstum, pers. com.) This study focused on 3 cores; FRSH-C3, FWRBH-C2, FRSH-C2.

The Bahamian archipelago spans over 30,000 km^2 (Carew and Mylroie, 1997). Carbonate platforms are the primary constituents of the islands (Nelson, 1852) which began formations in the late Jurassic (Mullins and Lynts, 1977).

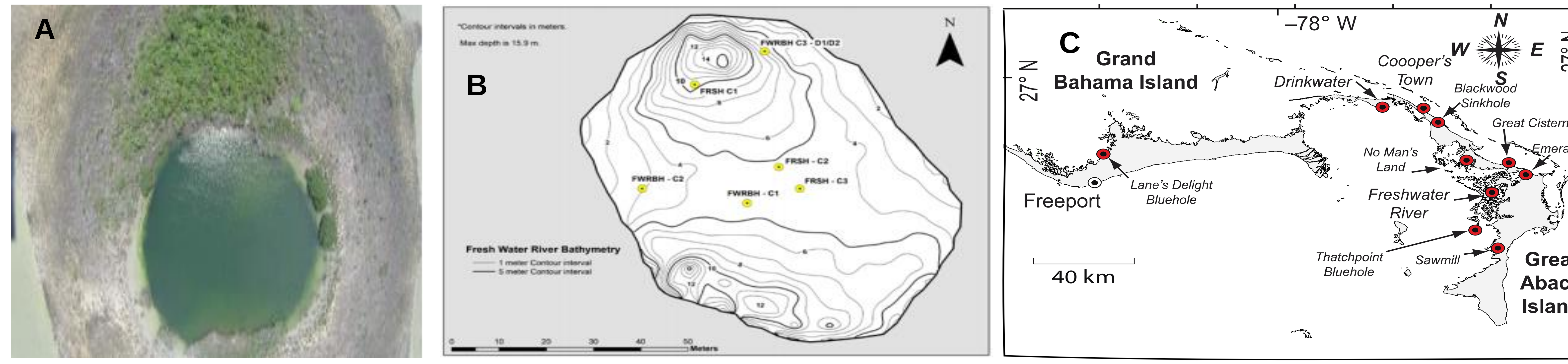

Figure 1. (A) Drone image of Freshwater River Bluehole. (B) Bathymetric map of Freshwater River Bluehole created using GPS and a single frequency Hydrolite® echosounder. (C) Geographic map of study site alongside other areas of research.

4. Results

Basal peat layer:

- Organic rich horizon referenced to sea-level data indicate depositional periods of drought.
- Contains only wood fragments indicating strictly terrigenous deposition.

Freshwater peat layer:

- Appearance of charophyte and Cyperaceae microfossils indicate presence of freshwater lens infilling from water table.

Marine marl layer:

- Presence of Hydrobidae microfossils indicate brackish to oligahaline depositional environment.
- Marl deposits indicate inundation from marine sources.

Sapropel layer:

- Indicator of primary productivity from marine environment documenting infilling from marine surroundings.

Organic matter graphs:

- Plotted alongside sea-level curve indicating sea-level was -8.3±1.2 mbsl at 8-7 ka
- Bulk deposition highlighted in red correspond to known periods of drought through Holocene sea-level data highlighted in blue.

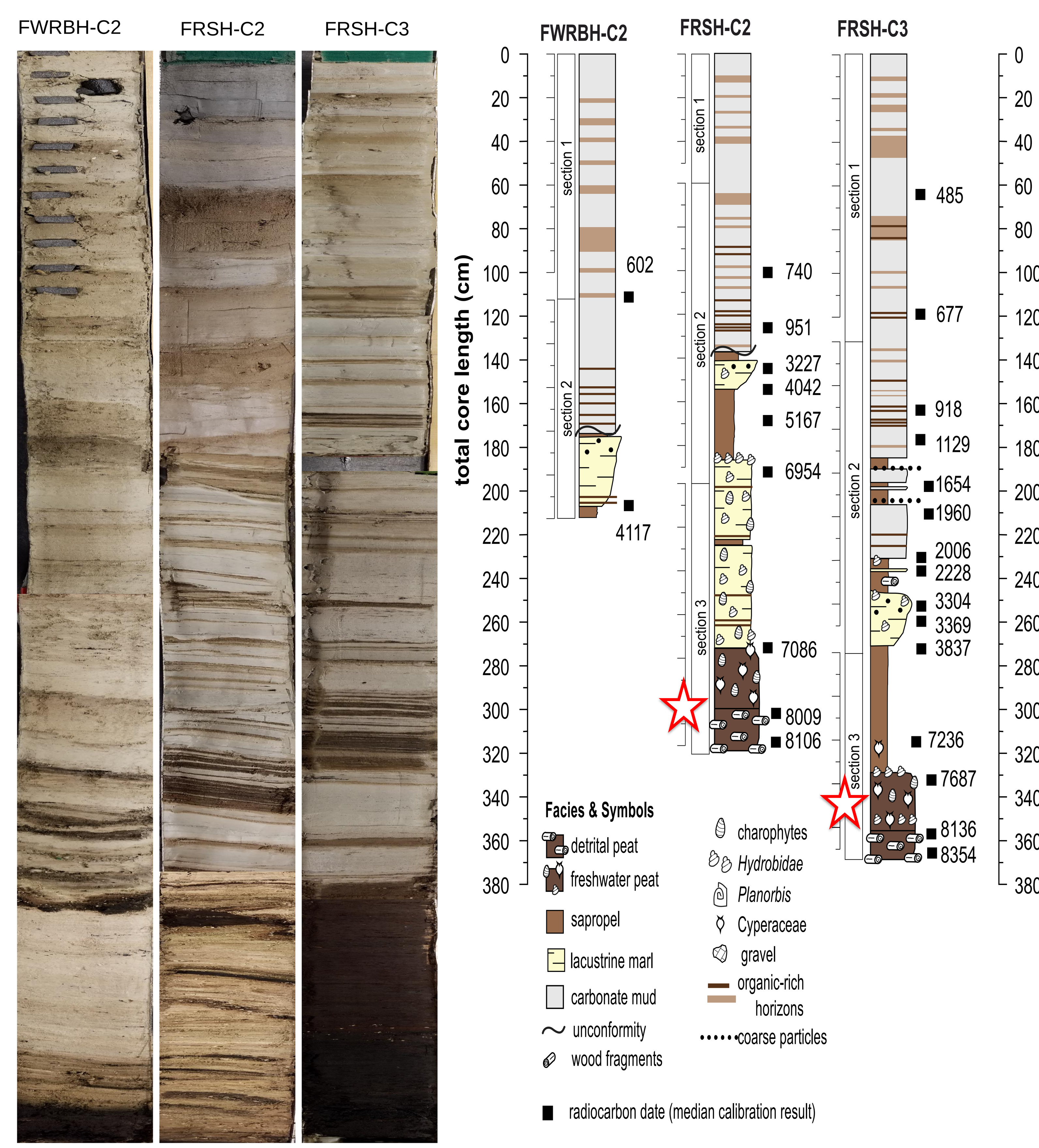

Figure 4. A) Photo images of sample cores with defined stratigraphic horizons. B) Pictorial diagrams of core components with radiocarbon dates (van Hengstum 2017).

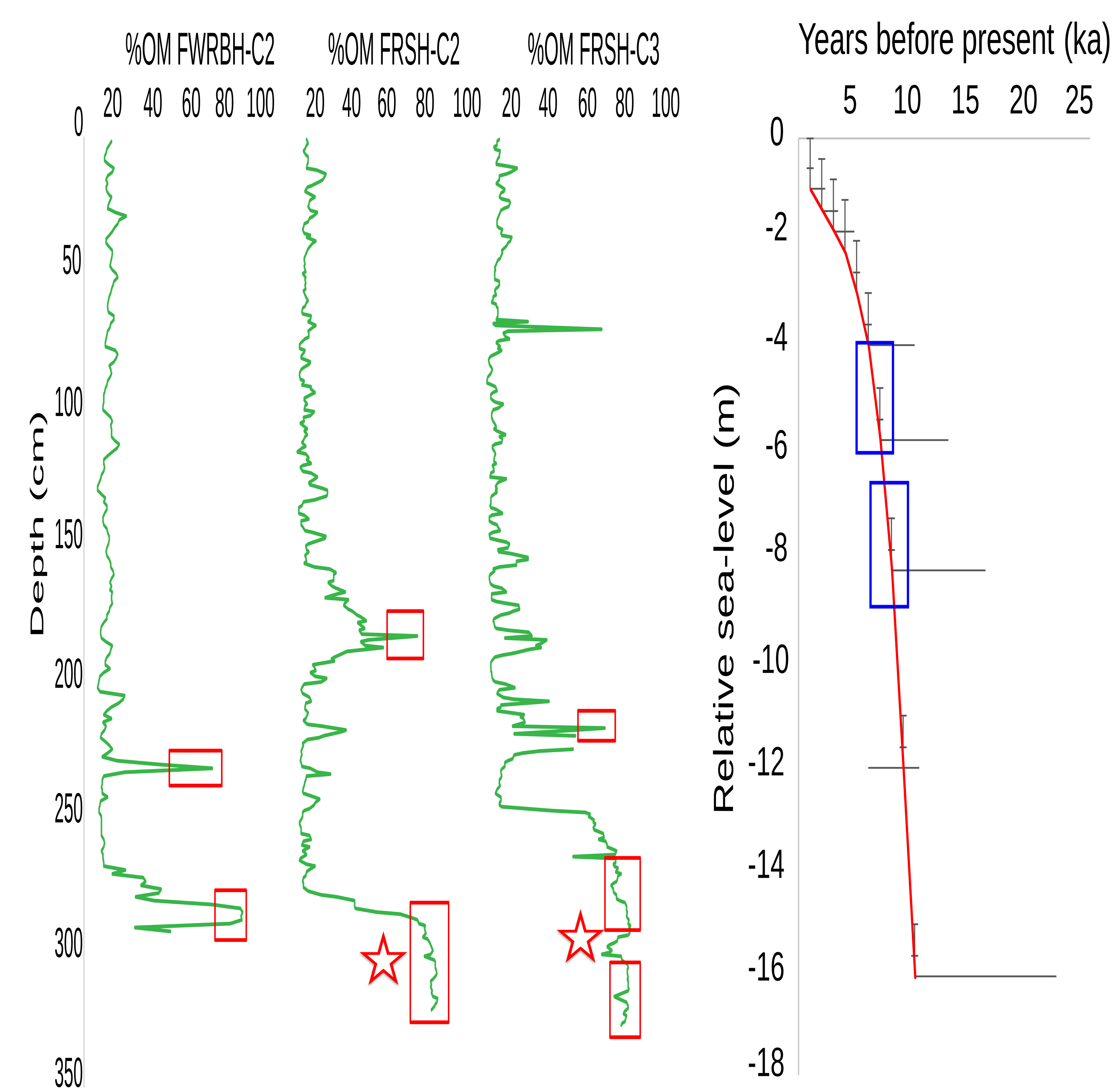

Figure 3. Organic matter content for sample cores plotted against a relative sea-level curve (Khan et al., 1997). Highlighted boxes show bulk of deposition corresponds to lowest sea levels between 4-6 and 7-8300 ka.

5. Broader Impacts

- The data obtained from this study can be used to determine how the environment in this area has responded to climate shifts and how it could potentially react in the future.
- A better comprehension of these periods and their driving factors can assist with current climate and sea-level studies for societal impacts.

6. References

Carew, J. L., Mylroie, John E. (1997). "Geology of the Bahamas." Geology and Hydrogeology of Carbonate Islands. Developments in Sedimentology 54: 91-139. Khan, N. S., et al. (2017). "Drivers of Holocene sea-level change in the Caribbean." Quaternary Science Reviews **155**: 13-36 Mullins, H. T., Lynts, George W. (1977). "Origin of the northwestern Bahama Platform: Review and reinterpretation.". Santisteban, J. I., et al. (2004). "Loss on ignition: a qualitative or quantitative method for organic matter and carbonate mineral content in sediments?". van Hengstum, pers. com.