# TESTING THE HYPOTHESIS ABOUT THE INFLUENCE OF GRAIN TYPE AND TEXTURE ON THE FORMATION OF POLYGONALLY CRACKED CARBONATE GRAINSTONES IN THE BAHAMAS

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## Introduction and Objectives

• Polygonal cracking commonly forms by drying of exposed muddy sediment. A similar desiccation feature can occur in Bahamian eolian and beach carbonate grainstones without mud (Glumac et al., 2011).

• The main objective of this study is to test the following hypothesis from Glumac et al. (2011):

***"The paucity of documented examples of polygonal fractures in mudfree carbonate deposits suggests that the formation of this unique sedimentary structure may require sediment that consists of well-sorted, well-rounded spherical sand grains, such as ooids, in areas subject to desiccation unlike the texturally and compositionally more heterogeneous skeletal and peloidal sediment."***

## Previous Work (Glumac et al., 2011)

Previous work (Glumac et al., 2011) documented polygonal sandcracks from Holocene eolian and beach backshore carbonate grainstone on Alligator Point, Cat Island, Bahamas and experimented with well-sorted, mud-free beach sand from Cat Island composed of well-rounded, fine to medium sand-size (100–400 μm) ooids.

In experiments on Cat Island beach sand, sediment surfaces cracked polygonally in the absence of mud or biofilms while drying at room temperature (Figure above on right) due to contraction generated by capillary effects related to surface tension attraction of interstitial water. Gravitational collapse of irregular open pores (Figure on left before drying) and repacking of sand grains due to loss of cohesion between particles caused by evaporation of water enhance the cracking process and appearance of polygons by providing space for cracks to expand. The polygons are held together by any remaining capillary moisture and associated meniscus cement, which precipitates as the sand dries.

## Materials and Methods

• Study of collected samples of polygonally cracked carbonate grainstone from three different locations on Exuma Islands, Bahamas (see locality map).

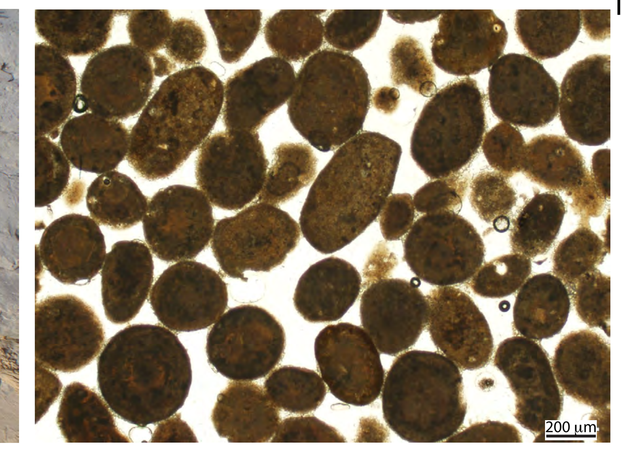
• Examination of petrographic thin sections of these deposits to document in detail their texture and composition. This work addresses whether size, shape and sorting of sand particles play a critical role in the formation polygonal cracking.

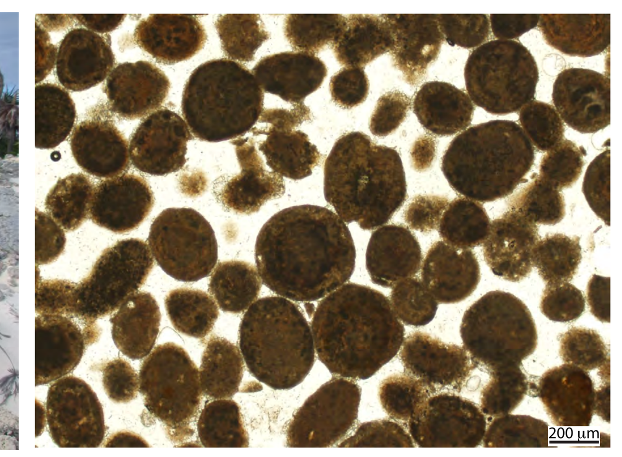
• From analyzing these deposits and documenting the characteristics of their particles, we can test the original hypothesis and potentially predict other cases where it might be possible to find polygonally cracked sandstones in the Bahamas and elsewhere.

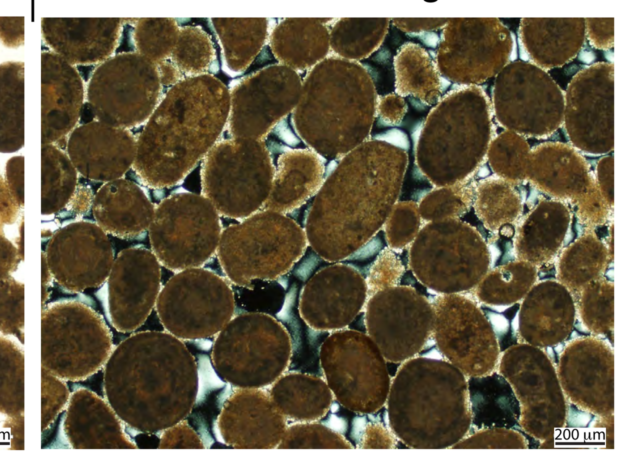
## Observations

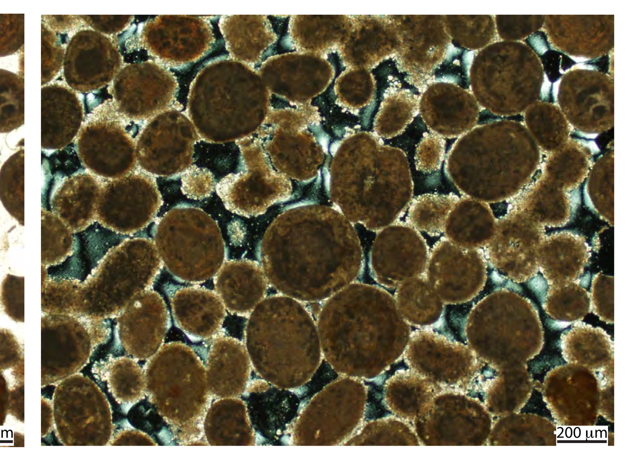
Plain Polarized Light View | Cross Polarized Light View

### Conch House Beach Site





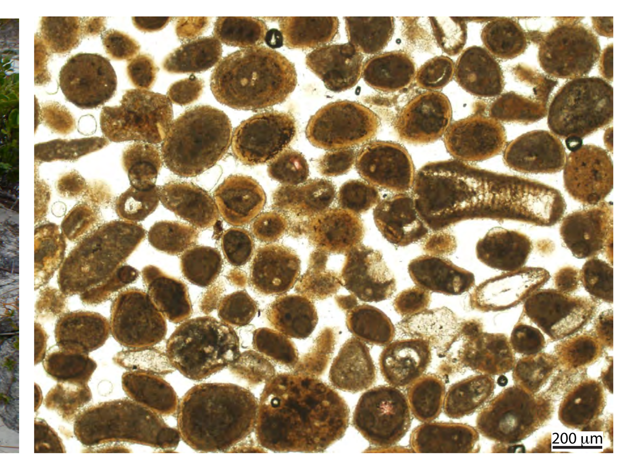


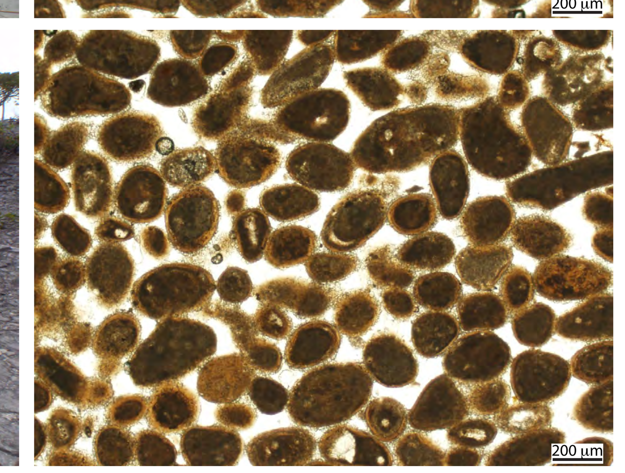


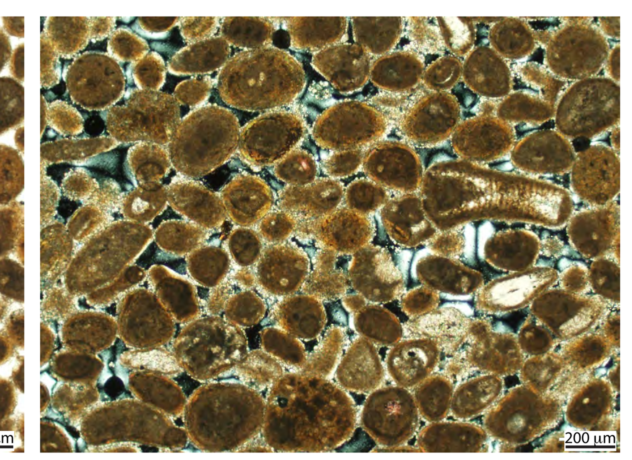
**Description**

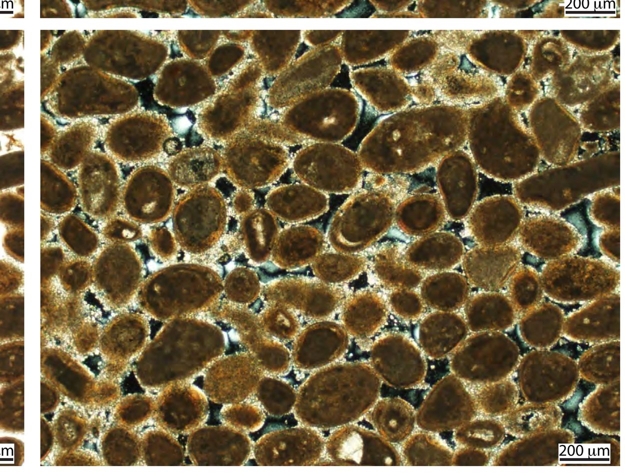
- Eolian ooid grainstone with very rare skeletal fragments (mainly mollusks, foraminifera and rare algae) and aggregate grains (i.e., grapestones composed of multiple ooids)
- Ooids of circular to elliptical shape; Dominance of ooid grains of fine to medium sand-size (mainly 200-500μm diameter); Rare skeletal fragments and aggregate grains reach coarse to very coarse sand-size (up to 1-1.2mm)
- Generally very well-sorted and well-rounded sand with very rare larger elongated skeletal fragments
- Some peloids and skeletal fragments are present as ooid nuclei, although extensive micritization of grains by microboring prevents positive identification of nuclei
- Highly porous deposit with thin isopachous rim and meniscus morphologies of fine-crystalline meteoric equant clear calcite cement
- Some very faint lamination

### Iva Bowe Beach Site



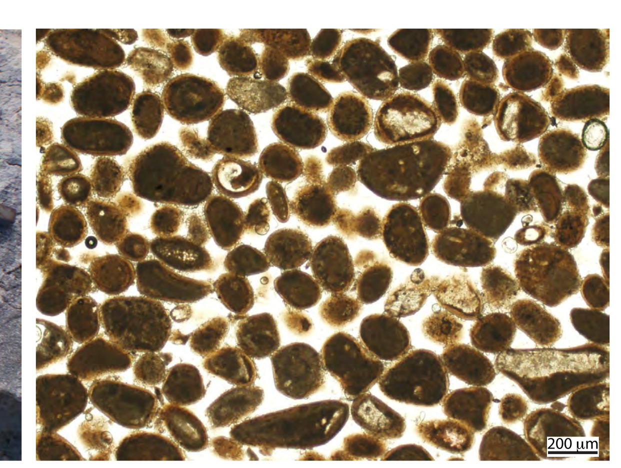


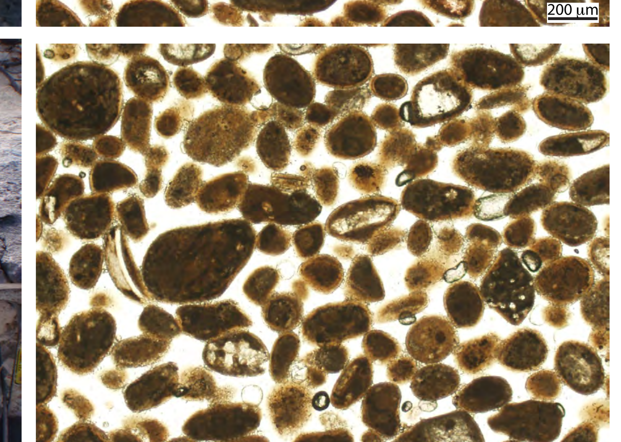


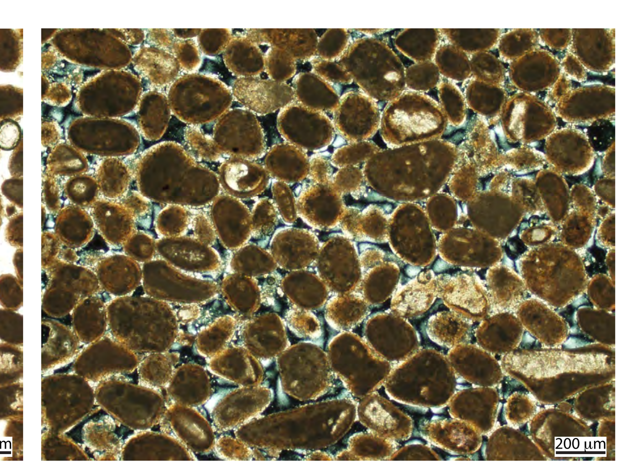


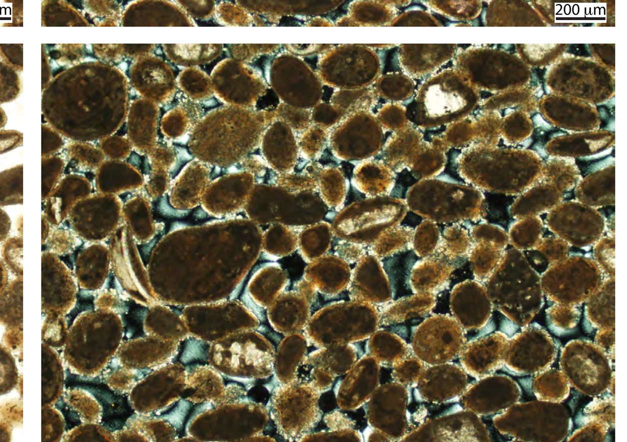
- Eolian ooid grainstone with common skeletal fragments (mollusks, foraminifera, algae; both thinly coated and uncoated) and very rare coated aggregate grains (composed of two or three ooids with a common cortex)
- Ooids are mainly fine to medium sand-sized (mainly 100-400μm diameter). Rare aggregate grains and skeletal fragments reach coarse sand-size (up to 800μm - 1mm in diameter)
- Moderately well-sorted with circular to elliptical ooids and sub-angular to rounded, semispherical to elongated skeletal fragments
- Skeletal fragments and peloids are dominant ooid nuclei
- Very loosely lithified by isopachous rims and menisci of fine-crystalline meteoric equant clear calcite
- Faint wind-ripple lamination

### Moriah Harbour Beach Site









- Ooid grainstone from beach backshore to eolian dune transition; some skeletal fragments (mollusks, algae, foraminifera), and rare aggregate grains (composed of multiple ooids or skeletal fragments) present
- Dominance of ooid grains of fine to medium sand- size (mainly 150-350 μm diameter). Rare skeletal fragments and aggregate grains reach coarse sand-size (up to 600-800 μm)
- Generally well-sorted and very well-rounded grains
- Ooid nuclei composed of peloids and skeletal fragments
- Extensive microboring and micritization of grains
- Very porous with some fine-crystalline meteoric equant clear calcite cement mainly with meniscus morphology
- Finely laminated

## Study Area


Map showing the location of Little Exuma and Exuma islands in the Bahamian Archipelago.


Map showing the location of Iva Bowe Beach on Exuma Island, Moriah Harbour Beach and Conch House Beach on Little Exuma Island, The Bahamas.

## Summary of Observations

• The samples examined were dominated by ooids of fine to medium sand- size (mainly 150-350 μm in diameter), with less common coarse sand composed of skeletal fragments and aggregate grains (500μm - 1.2mm).

• Sand grains were mainly well-sorted and very well-rounded ooids with thin cortices around nuclei of peloids or skeletal fragments.

• The sand also contained some skeletal fragments (mainly mollusks, algae and foraminifera) and aggregate grains or grapestones, which were uncoated or had a very thin surficial cortex.

• Grains were commonly heavily micritized by microboring, but there was no mud present in the matrix. Instead, the sand was loosely lithified by mainly clear, equant meteoric calcite cement with isopachous rims, and meniscus and pendant morphologies.

## Disscussion and Conclusions

• These observations generally support the hypothesis that homogeneous composition and texture are key factors for development of polygonal cracking in grainstones.

• However, there could be other controlling factors such as:

- air and sand moisture regime (i.e., composition and amount of fluids);
- temperature, duration and rate of wetting and drying;
- depositional processes that produce unique sedimentary structures and fabric, including grain packing and porosity within sediment.

• With future studies on comparing polygonally cracked versus uncracked grainstones as well as examining conditions under which polygonal cracking is currently occurring, it should be possible to evaluate these additional factors to better understand the formation of polygonal fractures in sand and to predict situations where it might be possible to find more modern and ancient examples.

## Acknowledgments

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## Reference

Glumac, B., Curran, H.A., Motti, S.A., Weigner, M.M., and Pruss, S.B., 2011, Polygonal sandcracks: Unique sedimentary desiccation structures in Bahamian ooid grainstone: Geology, v. 39, no. 7, p. 615-618.