Stratigraphic Heterogeneity of a Holocene Ooid Tidal Sand Shoal: Schooner Cays, Bahamas

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STATUS: Project in progress
TIMING: Seismic data acquisition completed; coring completed; results to be reported
FUNDING: National Science Foundation

Purposes
Oolitic sands form important reservoirs. The goal of this project is to develop actualistic models for stratigraphic heterogeneity within complex oolitic tidal sand shoal systems, by systematically examining well-constrained Holocene systems. Previous work has illustrated how variable processes lead to distinct bar morphology (e.g., flow-normal linear shoulder bars, parabolic bars, or flow-parallel tidal sand ridges). This project takes the next step, exploring if each bar type has a distinct internal stratigraphy, clearly assessing the relation between plan-view morphology and sedimentologic variability. Last year’s results illustrated relations between bar form and sedimentology on Lily Bank; this project expands to test these relations further by examining the tidal sand ridges of Schooner Cays, Bahamas.

Project Description
This study is part of a larger project to examine several oolitic sand systems. It builds upon results from Lily Bank (Sparks and Rankey, 2012, KICC annual review), by examining Schooner Cays ooid shoals. The 16 x 60 km marine tidal bar belt of Schooner Cays occurs at the northern end of Exuma Sound, a deep-water embayment on the eastern side of Great Bahama Bank (Figure 1A,B). The shoal is bound to the south by a slightly deeper outer shelf that includes a hard, rocky bottom; this is bordered to the north by a rock ridge. Platformward of the rocky ridge, geomorphic forms within the bar-and-channel belt include flow-parallel tidal sand ridges (more common to the east), parabolic bars, and flow-oblique shoulder bars with superimposed linear and parabolic bars (Figure 1). Individual flow-parallel sand ridges are up to 13 km long and 1.5 km wide. As they extend platformward, the crests of some ridges widen and include superimposed parabolic bars with intervening channels that, at their platformward extent, bend progressively to the north or west.

The fundamental hypothesis of this project is that oolitic bar forms, with different plan view morphologies and formed by distinct processes (Rankey and Reeder, 2011), include unique and distinct internal geometric and sedimentologic attributes. If this hypothesis is correct, it would suggest a close relation between plan-view morphology and stratigraphy, providing predictive insights on 3D variability and how bar forms (e.g., flow parallel versus flow normal) might be discerned from the stratigraphic record.

To explore this hypothesis, this project has three main objectives:

Describe the thickness and internal geometry of distinct bar forms on Schooner Cays. One hundred eighty line-km of high-frequency seismic (Chirp) data across the shoal include lines both parallel and perpendicular to strike of bar forms (Figure 1C). The lines image the Holocene section to the top of the Pleistocene. Standard seismic horizon interpretation
techniques facilitate observation and characterization of internal geometries and heterogeneities within the Holocene sediments. Seismic interpretation gives insight into of the elevation of Pleistocene bedrock, internal bar geometries (cross-bedding, truncation, downlap) and environmental interfaces, information useful to identify coring locations.

**Sedimentologic and Stratigraphic Characterization.** Vibracores from bars of different morphology (tidal sand ridges and parabolic bars) will be used to validate the Chirp data interpretations and understand the details of internal sedimentology and stratigraphy. To characterize lateral heterogeneity, numerous cores will be collected, parallel and perpendicular to the bar crests. The coring rig permits core penetration to in excess of four meters. Coring in this manner provides a means to explore the sedimentologic characteristics within and between different bar morphologies. Each core will capture and provide basic means for sedimentological characterization, including sedimentary structures, grain types and sizes, and facies successions.

**Integration and Comparison.** Collectively, the suite of Chirp data and cores will permit comparison of the stratigraphic record of ooid bar forms with different plan view morphologies. This evaluation of the sedimentologic character of different bar forms will form the basis for the explicit test of the hypothesis.

**Deliverables**

A central challenge in carbonate sedimentary geology is understanding three-dimensional variability, and how it might be predicted. Illustration, quantification and explanation of the origin and evolution of representative geometries within carbonate shoals represent important steps to addressing this fundamental challenge. Studying modern oolitic sand shoals, and the processes that affect their formation, will illuminate their internal geometry and linkages to plan-form morphology. If the hypothesis is validated, the results of this study will provide an important actualistic link between processes and stratigraphic product, essential for enhanced interpretation of the stratigraphic record and prediction of subsurface heterogeneity.

**References**


Figure 1. Location and setting of survey area. A) Location of Schooner Cays within the Bahamas, at the north end of Exuma Sound, a deep water embayment. B) Schooner Cays ooid shoals complex. C) Detail of focus area, and location of survey lines (yellow lines).