Sedimentology of the Joulters Cays Ooid Sand Shoal, Great Bahama Bank*

P.M. (Mitch) Harris[1]

Search and Discovery Article #60017 (2009)
Posted March 24, 2009

*Adapted from unpublished Ph.D. Dissertation, University of Miami, Coral Gables, FL, 1977, 452 p.

[1]ETC, Chevron, San Ramon, CA, USA. (MitchHarris@chevron.com)

Abstract and Table of Contents

Dissertation (70 mb)
Appendices (Article #60017a)

Abstract

The Bahamas are a mecca for modern ooid sands, like those that repeatedly occur in the geologic record. What is known of the development of these platform margin sand accumulations during the rapid Holocene rise of sea level comes from only three areas, characterized by bars and channels. Bar and channel morphology is an early stage in growth of ooid sand complexes; not all ooid sands are in bars and channels. Ooid sands in the Joulters Cays area are built-up nearly to sea level over a large extent. The sediment record of such an area needs to be examined by coring to better understand development of ooid sand accumulation. This examination of the sedimentology of the Joulters Cays ooid sand shoal is such an attempt, hopefully providing insight into environments, grain types, sediment distribution, facies anatomy, growth history, and diagenesis of ooid sand accumulations, that will enable us to better understand the sediment record of the Bahamas and apply the record to ancient oolite deposits.

Environments and Sediments

The Joulters Cays ooid sand shoal, on the margin of Great Bahama Bank north of Pleistocene Andros Island, is an intertidal to shallow subtidal stabilized sand flat, 400km^2, that is penetrated partially by tidal channels and fringed on the windward eastern and northeastern borders by mobile sands. Islands up to 6 m above MSL are aligned along the seaward side of the shoal; other islands are scattered throughout the sand flat. Variation in sedimentary environments is produced by a gradient in grain agitation from the ocean-facing margin to the interior of the sand shoal. Superimposed on this broad pattern are local variations in environment related to tidal channels, islands, sand bars, and grass-covered bottoms.

Surface sediments of the sand shoal and surrounding area reflect the sedimentary environments. Shoal sediments are primarily non-skeletal sands formed within the shoal. Ooid sand forms a narrow belt fringing the sand flat on its windward margin; the sand flat is a bankward spread of predominantly altered ooid sand, with aggregate sand bars and fine peloid and fecal pellet sand grass-covered channels. Fine peloid and fecal pellet sand is most common to the west of the shoal in the platform interior and to the north in open platform margin channel sediments surrounding altered ooid sand bars. Skeletal sand is most common to the east of the shoal in the outer shelf and to the south in Lowe Sound. The weight percentage mud exceeds 10% only in tidal channel and stabilized sand flat sediments from dense grass-covered bottoms.

Anatomy and Growth

Environments and sediments are used to develop and integrate facies anatomy from 60 cores. Coring has documented six facies: skeletal grainstone, ooid grainstone, mixed ooid grainstone to packstone, mixed fine peloid packstone to grainstone, pellet wackestone to packstone, and lithoclast packstone; In section, there are two basic parts to the sand shoal: (1) an ooid fringe up to 4.5 m thick on the eastern and northeastern margins of the shoal; and (2) a more widespread sequence of scattered lithoclast packstone and/or pellet wackestone to packstone up to 1.5 m thick at the base, mixed fine peloid packstone to grainstone up to 5.5 m thick in the middle, and mixed ooid grainstone to packstone up to 3 m thick at the top. The sequence shows an upward increase in grain size, percentage of ooids, and grain support fabric. Isopachs show the northern and western “wrap around” trend of the sand shoal is a result of accumulation of mixed ooid grainstone to packstone and ooid grainstone. The relief of the sand shoal over the surrounding sea floor is the result of contributions by different facies in differing amounts throughout the area, but in broadest terms the relief is a result of ooid sands in one facies or another. The theme of facies geometry is a windward margin fringe of ooid grainstone bordering a sand shoal comprised of two opposing sediment wedges: an upper bankward-thinning wedge of mixed ooid grainstone to packstone overlying a seaward-thinning wedge of mixed fine peloid packstone to grainstone that is the thickest part of an inter-platform sheet.

Topography of the underlying limestone has influenced shoal geometry; i.e., the part of the shoal greater than 3 m thick extends to the north and west around an enlarged Andros Island defined by a 3 m depth contour. The interpretive history of sand shoal deposition indicates limestone topography influenced shoal development by initially localizing marginal sand shoal formation and structuring bankward sand transport, but sediments created a syndepositional topography having greater influence on shoal development. The history of deposition occurs in three stages: bank flooding (from 4-5,000 years B.P.)-platform interior deposition began; sand shoal formation (from 3-4,000 years B.P.)-platform interior extended over submerged extension of Andros Island and ooid formation and accumulation were initiated; and sand shoal development (the last 3,000 years)-growth of marine sand belt established size and physiography of the sand shoal, changing platform sediments from mixed fine peloid muddy sands to ooid sands, a result of increased agitation produced by a combination of topography building and rising sea level. The vast nearly intertidal sand flat formed, with an average rate of sediment accumulation of 1 m per 1,000 years, by reworking of active shoal sands and spit-like tidal sand bar accretion in the open platform margin to the north. Islands have formed during the last 1,000 years.

Diagenesis

Cemented shoal sediments are not facies controlled. Marine cementation has produced intraclasts and crusts that are cemented with acicular aragonite and micrite. Sands exposed to fresh water are rapidly cemented by calcite. On south Joulters Cay, ooid and mixed ooid sands in the vadose and upper phreatic are moderately and poorly cemented. Vadose zone cements, a patchily distributed spar most common in grain-contact positions, change in a 1 m interval across the water table to upper phreatic zone cements, a uniform rim of rhombohedrons surrounding each grain. The change in cement style is abrupt and distinctive and, if preserved, could be used in identifying paleo-water tables in limestones. Mixed fine peloid sands in the lower phreatic zone are poorly cemented and uncemented. The source of cement calcium carbonate is small-scale dissolution of ooids in nuclei, within lamellae, and commonly in a micron-thick layer around the grains.

Conclusions

The development of the Joulters Cays ooid sand shoal provides one possible scenario for the evolution of the bar and channel pattern seen elsewhere; the bar and channel topography is extinguished and filled in, and ooid sands are mixed with other sediments by burrowing.

Table of Contents