Facies Anatomy and Diagenesis of a Bahamian Ooid Shoal*

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Abstract and Table of Contents

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Abstract

The Bahamas are a mecca for modern ooid sands, like those that repeatedly occur in the geologic record. Our understanding of these ooid accumulations during the rapid Holocene rise of sea level comes from areas that are characterized by bars and channels. Not all ooid sands, however, are in bars and channels. Ooid sands in the Joulters Ooid Shoal are built-up nearly to sea level over a large extent, restricting water exchange between the seaward and bankward sides of the shoal and limiting present-day mobile sands to the shoal's windward margin. The sediment record of such an area needs to be examined by coring to better understand development of ooid accumulations. Hopefully this study will expand our concept of the environment of accumulation, which is what we see in the geologic record.

Environments and Surface Sediments

The Joulters Ooid Shoal, on the margin of Great Bahama Bank north of Pleistocene Andros Island, is a sand flat, 400km^2, that is penetrated partially by tidal channels and fringed on the windward borders by mobile sands. Islands are aligned along the mobile fringe and scattered throughout the sand flat. Variation in environments is produced by a decrease in grain agitation from the ocean-facing margin to the interior of the 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 shoal and surrounding area reflect the environments. Shoal sediments are primarily non-skeletal sands formed within the shoal. Ooids coincide with the narrow windward fringe of mobile sands, but the sand flat is an extensive bankward spread of altered ooids that are mixed with other grain types and mud. The sand flat is clearly not a present-day site of ooid formation.

Anatomy and Growth

Environments and surface sediments are used to develop and integrate facies anatomy from cores taken throughout the Joulters Ooid Shoal and surrounding area. Coring has documented six facies: skeletal grainstone, ooid grainstone, ooid packstone, fine-peloid packstone, pellet wackestone, and lithoclast packstone. In section, there are two basic parts to the shoal: (1) a windward ooid fringe and (2) a more widespread sequence of lithoclast packstone and/or pellet wackestone at the base, fine-peloid packstone in the middle, and ooid packstone at the top. The sequence shows an upward increase in grain size, percentage of ooids, and grain support fabric. The trend of the shoal and its relief over the surrounding sea floor are the result of accumulation of ooid sands in one facies or another. The basic theme of facies geometry is a fringe of ooid grainstone bordering a shoal comprised of two opposing sediment wedges: an upper bankward-thinning wedge of ooid packstone overlying a seaward-thinning wedge of fine peloid packstone. The lower wedge is the thickest part of an inter-platform sheet.

The topography of the underlying limestone has influenced shoal development by initially localizing ooid formation and structuring bankward transportation, but sediments created a syndepositional topography having greater influence on shoal growth. The growth history occurs in three stages: bank flooding—platform interior deposition began; shoal formation—ooid formation and accumulation were initiated; and shoal development—growth as marine sand belt established size and physiography of the shoal, changing platform sediments from muddy fine-peloid sands to ooid sands, a result of increased agitation produced by a combination of topography building and rising sea level. The vast sand flat formed by reworking of mobile sands and spit-like tidal bar accretion. Islands have formed during the last 1,000 years. The resulting facies patterns are products of changes in the environment of accumulation during the Holocene.

Diagenesis

Marine cementation occurs on stable bottoms of the Joulters Ooid Shoal. Intraclasts and crusts, cemented both with acicular aragonite and micrite, punctuate the facies forming relief of the shoal. The crusts can commonly be traced across facies boundaries. Sands exposed to fresh water are rapidly cemented by calcite. On south Joulters Cay, ooid sands in the vadose and upper phreatic zones are cemented, while sands in the lower phreatic zone are uncemented. Vadose cements, a patchily distributed spar most common in grain-contact positions, change in a 1 m interval across the water table to upper phreatic 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. The source of cement calcium carbonate is small-scale dissolution of ooids occurring within nuclei, within lamellae, and commonly in a micron-thick layer around the grains.

Conclusions

The development of the Joulters Ooid Shoal provides one possible scenario for the evolution of the bar and channel physiography seen elsewhere. The shoal-generating physiography has been erased, as bar and channel topography was extinguished and filled in and ooid sands were mixed with other sediments by burrowing. The resulting accumulation—a belt of ooid grainstone bordering a belt of ooid packstone that becomes increasingly muddy with depth—is one that is common in the geologic record. Understanding the development of facies patterns of the Joulters Ooid Shoal should prove valuable in our interpretation of ancient accumulations.

Table of Contents