Depositional Environments of the Joulters Cays Area*

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Depositional Environments

Field Guide to Some

Carbonate Rock Environments

Florida Keys and Western Bahamas

New Edition

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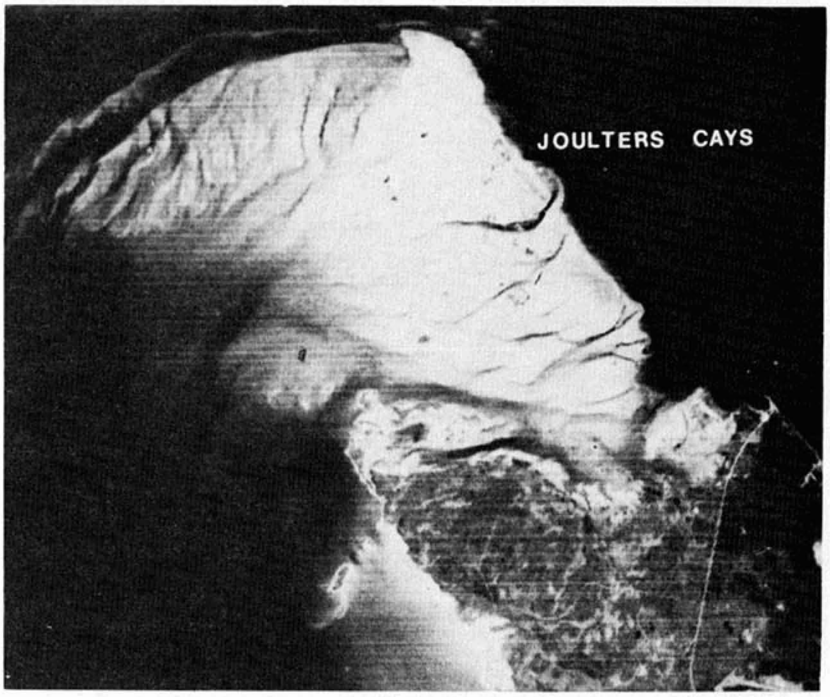

Figure 5.20. Landsat I (Band 5) scene of northern Andros-Joulters Cays area, Great Bahama Bank. NASA.

sand complex development for the Joulters Cay area compared to other areas.

The following unpublished data was furnished by P. M. Harris for the 1977 edition of this Guidebook. It briefly describes essential elements of the ooid sand complex of the Joulters Cays area together with pertinent adjacent marginal areas. Figures 5.20 through 5.23, also provided by Harris, illustrate his remarks.

DEPOSITIONAL ENVIRONMENTS OF JOULTERS CAYS AREA
by
P. M. Harris

Sediments on the windward platform margin of Great Bahama Bank, north of Andros Island, appear to be unique among sand accumulations in the Bahamas. Accumulation nearly to sea level has occurred over a large portion (greater than 375 km^2) of the Joulters Cays area.

Several distinct major depositional environments are recognized in the Joulters Cays area.

Environments within the ooid sand complex are:

1. the marginal sand shoal and tidal sandbar
2. the stabilized sand flat
3. tidal channels, and
4. islands.

Environments marginal to the ooid sand complex are:

1. the platform margin shelf
2. the open platform interior, and
3. the restricted platform interior.

Marginal Sand Shoal and Tidal Sandbar

The marginal sand shoal trends NW-SE and is continuous for approximately 24 km parallel to the shelf break in slope. It has a maximum width of little more than 1 km, but in most places is only hundreds of meters wide. To the north, tidal sandbars and channels trend E-W to NE-SW and extend greater than 30 km to the west onto the shallow platform. The shoal and bars make up the windward margin of the ooid sand complex—that part most affected by easterly winds and wave-dominated currents.

Water depths are shallow along the length of the shoal; the shallowest places are commonly exposed at low tide. Only on the shallow parts of the shoal are currents sufficient to keep ooids in near-constant motion.

Only those organisms adapted to living in a moving substratum are found on the shoal—a few infaunal annelid worms, burrowing mollusks, and echinoderms.

Sedimentary structure of this mobile sand environment are large-scale transverse ridges, or megaripples, with complex patterns of small-scale ripples superimposed upon them. Submarine cemented layers are present within the sediment of the shoal. Sand shoal and sandbar sediment is texturally a very well-sorted medium sand, with less than 3

Figure 5.21. Aerial photograph view looking northwest, Joulters Cays. (A) The Inner Platform Margin Shelf, where ooid-skeletal sand supports a *Thalassia*-stalked green algae covering. (B) The Marginal Sand Shoal, intertidal rippled ooid sand. (C) One of the three islands making up the Joulters Cays. (D) The Stabilized Sand Flat, where ooid-pellet-skeletal sand is stabilized by algae and grass. Photo and description courtesy of P. M. Harris.

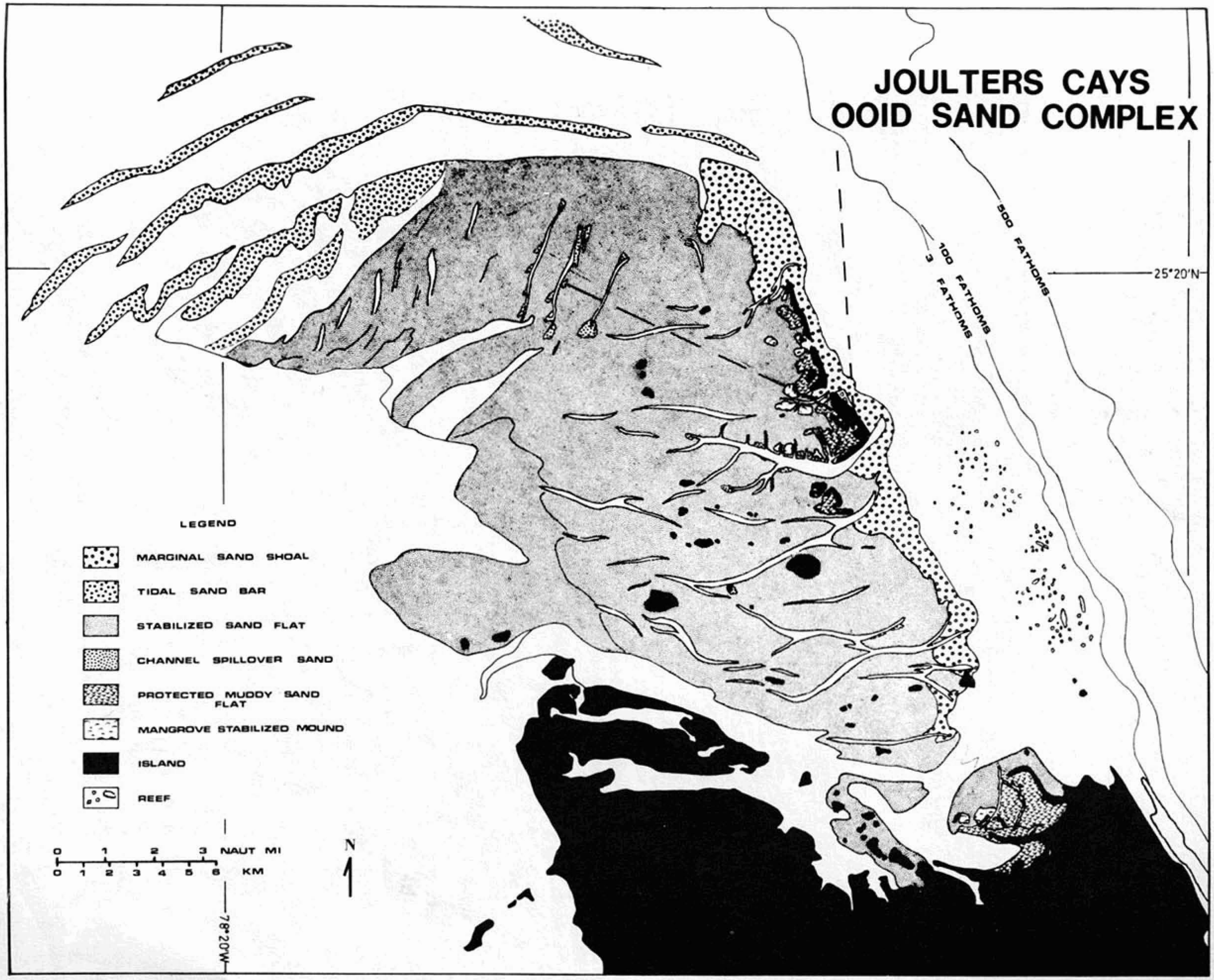

Figure 5.22. Map showing depositional environments recognized within the sand complex. Map and description courtesy of P. M. Harris (1976–research-in-progress). **Note:** Dashed "V" indicates approximate view of aerial photo showing in figure 5.21.

Figure 5.23. Rippled ooid sand of marginal sand shoal at low tide, Joulters Cays. Photograph courtesy of P. M. Harris.

percent mud. Compositionally the sediment is greater than 85 percent ooids, with the ooids having a well-defined oriented cortex.

Stabilized Sand Flat

The stabilized sand flat covers the greatest area (300 km^2) of any environment in the ooid sand complex. The sand flat lies bankward of the windward marginal sand shoal and tidal sandbar and extends westward for approximately 15 km where it gradually changes into platform interior environments. The sand flat is protected from easterly wave and storm turbulence by the marginal sand shoal and bars.

Water depths are shallow subtidal (generally 1 m or less) to intertidal. The sand flat is "stabilized" by the seagrass (*Thalassia*) and stalked green algae (*Penicillus, Rhipocephalus, Udotea,* and *Halimeda*) and by a covering of mucilagenous blue-green algal scum or mat. Both epifauna and infauna are abundant.

The sediment surface is generally smooth and flat with scattered burrow mounds. Burrowing by shrimp, crabs, and annelid worms results in recognizable organic sedimentary structures.

Compositionally the sediment is greater than 50 percent ooids. Other grain types are Foraminifera, pellets, and aggregate grains. The ooids are generally micritized, that is, much of the ooid cortex has been disrupted by endolithic algae. Texturally the sediment is a moderately sorted fine to coarse sand with approximately 20 percent mud.

Tidal Channels

The channels extend part of the way through the sand shoal and through the sand flat. They shallow at both ends with the bankward end often terminating in a lobate sand fan. The channels are up to 6 m deep at their seaward end, where rock is often exposed or covered by a thin sediment veneer. A depth of 3 m is common through most of their length. The channels are hundreds of meters wide at their widest points to tens of meters wide toward their bankward ends.

Both bottom and sediment type are quite variable in the tidal channels. Generally, they have a grass-covered poorly-sorted muddy sand bottom. The amount of grass covering and percentage mud increase toward the bankward end where up to 40 percent mud is often found. Sand waves are common in the channel bottom closer to the sand shoal, and a rock bottom is common toward the seaward end.

Channel spillovers or levees are found along the channel banks. The sand waves, channel sand spillovers, and terminal lobate sand fans indicate the channels are pathways by which ooids are being transported bankward by strong tidal currents.

Islands

Twenty-nine islands are scattered throughout the ooid sand complex. An additional fifteen or so are present in the areas marginal to the complex. The islands are of various sizes, shapes, and origins. The largest islands and probably the most important in the development of the sand complex are the Joulters Cays themselves.

The Joulters Cays are three islands lying on the NW-SE trend of the marginal sand shoal for a length of over 6 km. South Joulters Cay is the largest of the three islands. Barely a km wide at the widest point, the island is an impressive series of sand ridges and interdune lows. The sedimentary structures and geometry of the ridges indicate a beach-dune origin. The dominant grain type in the island sediment and rock is ooids. The sediment is a medium to coarse grained well-sorted ooid sand.

Based on the condition that the sand grains are in (that is, no major neomorphism has taken place), the limited amount of cementation that has occurred, and preliminary C^{14} dating, the Joulters Cays are young Holocene in age. For this reason, they must figure prominently in the development of the sand complex during the Holocene.

Immediately bankward and adjacent to the Joulters Cays and a few of the other islands is a protected muddy sand flat. The area is intertidal to supratidal; ponding of both salt and fresh water occurs. The muddy sand flat is an accumulation of mud and ooid sand that is extensively burrowed by shrimp and crabs. In the higher portions, blue-green algal mats cover the surface.

Smaller mangrove-stabilized islands, or sand and mud mounds, are found bankward of the Joulters Cays.

Platform Margin Shelf

Of the environments marginal to the ooid sand complex, the most seaward is the platform margin shelf. The shelf seaward of the sand complex lies to the north of the Andros Barrier Reef but numerous luxuriant patch reefs are present.

The shelf slopes gently seaward from depths of 2 to 3 m at the seaward end of the sand shoal for a distance of 5 to 6 km to depths in excess of 6 m where the slope increases greatly. To the north, the platform margin shelf grades into the platform interior. Much of the oceanic wave and swell action are dampened across the platform margin shelf.

The outer platform shelf is a deeper open area with a thin veneer of skeletal sand over a rocky bottom. Gorgonians, sponges, and small boulder-type corals are common. A thicker accumulation of skeletal sand (but still less than 1 m thick) is found on the inner platform shelf. *Thalassia* and stalked green algae are abundant.

Patch reefs, built nearly to sea level, are scattered throughout the southern half of the shelf. Sediments accumulated near the reefs are rich in coral, coralline algae, and mollusc debris.

Sediment typical of the platform margin shelf away from a reef is a micritized skeletal-aggregate sand. Less than 5 percent mud is present.

Open Platform Interior

Gradational between the platform margin shelf and more restricted platform interior is an open platform margin.

Tidal sandbars from 1 to 3 m deep and intervening channels up to 6 m deep are present. The sand is primarily an ooid-aggregate-pellet sand that is mobile on the shallow bars and stabilized in lower areas by *Thalassia* or by cemented layers.

Restricted Platform Interior

The restricted platform interior is the most bankward environment. It changes gradually toward the east into the stabilized sand flat and to the north to the open platform interior sandy deposits. Water depths range from two to three meters in the east to about 5 meters toward the west. The bottom is burrowed and covered by a brownish organic scum and scattered *Thalassia* and stalked green algae. The distance from the platform margin and increased water depth result in decreased competency of the bank waters and accumulation of mud.

The sediment ranges from a peloid-foraminifera muddy sand at the western boundary of the stabilized sand flat to a pelleted sand and mud toward the west.

Conclusion

The lateral distribution of different depositional environments and the sediments that are accumulating there reflect physical, chemical, and biological controls on sedimentation.

Physical controls are tidal currents, wave-induced currents, and preexisting bedrock topography. The chemical control is cementation by both submarine and meteoric waters. Biological controls are algae and grasses that stabilize the sediment by their binding ability and burrowing organisms that change sediment texture and produce organic sedimentary structures.