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Cover photo: *Diploria strigosa*, the common brain coral, preserved in growth position at the Cockburn Town fossil coral reef site (Sangamon age) on San Salvador Island. Photo by Al Curran.

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PRELIMINARY INVESTIGATION OF A PLATFORM MARGIN LAGOON-TIDAL FLAT COMPLEX, BLACKWOOD BAY, SAN SALVADOR ISLAND, BAHAMAS

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ABSTRACT

Preliminary investigation of a lagoon and tidal flat complex in Blackwood Bay, San Salvador Island, Bahamas suggests that the complex is the result of a catastrophic storm deposit. The lagoon and its associated tidal mud flat are immediately adjacent to a fringing reef and open abyssal marine waters, an unusual occurrence in the Bahamas. The presence of a smoothed spur and groove topography on the fore-reef slope, a *Millepora*-bound boulder rampart at the reef crest, an eroding lagoonal sand sheet partially stabilized by *Thalassia*, and coral rubble spillover lobes on the landward margin support the storm model. Detailed analysis of sediment samples from this area is currently underway to test further the storm model.

INTRODUCTION

Blackwood Bay is located at the southern end of San Salvador Island in the eastern portion of a large embayment known as French Bay (index Map 2). Blackwood Bay is enclosed to the north and east by Pleistocene rock outcrops, to the south by a shallow-water fringing reef trending east-west along the margin of the platform. The bay opens to the west into French Bay. The reef, composed mainly of a boulder rampart encrusted with *Millepora* acts as an efficient barrier to wave energy and produces a quiet water, back-reef complex. Immediately seaward of the reef, the platform passes through spur and groove topography and plunges nearly vertically to abyssal depths. The presence of the "wall" accounts for the shallow marine, back-reef environment.

The back-reef complex has characteristics of both lagoonal and tidal flat environments (Fig. 1). The lagoon is a result of an indentation of the island shoreline enclosed by the reef. Water depth in the lagoon ranges from 0-3 meters. A prominent intertidal zone has developed along the coastal margin of the study area (Figs. 2a,b). The tidal flat at Blackwood Bay has characteristics similar to the intensively studies tidal flats of Andros Island (Illing, 1954; Newell and Rigby, 1957; Shinn and others, 1965; Shinn and others, 1969; Ginsburg, 1975; Hardie, 1977; Hardie and Ginsburg, 1977; and Shinn, 1983) as well as its own distinct features controlled by the location and setting on the platform margin.

This paper is a preliminary discussion of research in progress on this area. The initial data, presented here as a progress report,

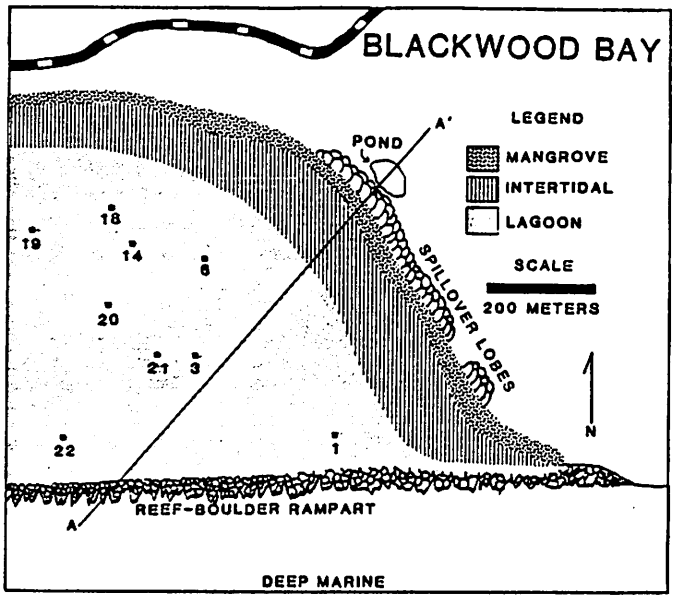


Fig. 1. Map of the Blackwood Bay region depicting major morphological features and sample locations discussed in the text. Line A-A' represents cross section shown in Figure 3.

Fig. 2a. Blackwood Bay, view from shore looking southeast. people are standing in the intertidal zone on Pleistocene bedrock capped with paleosol. Note the breaking waves at the reef-crest in the distance.

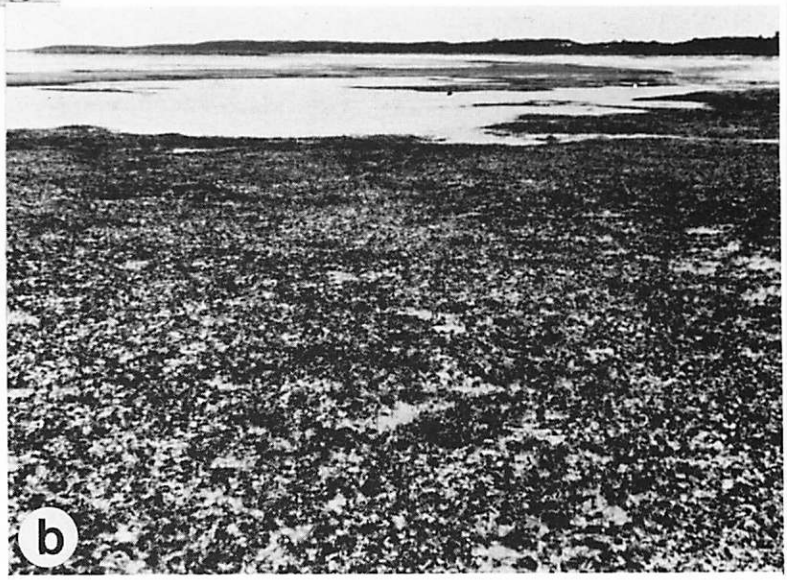
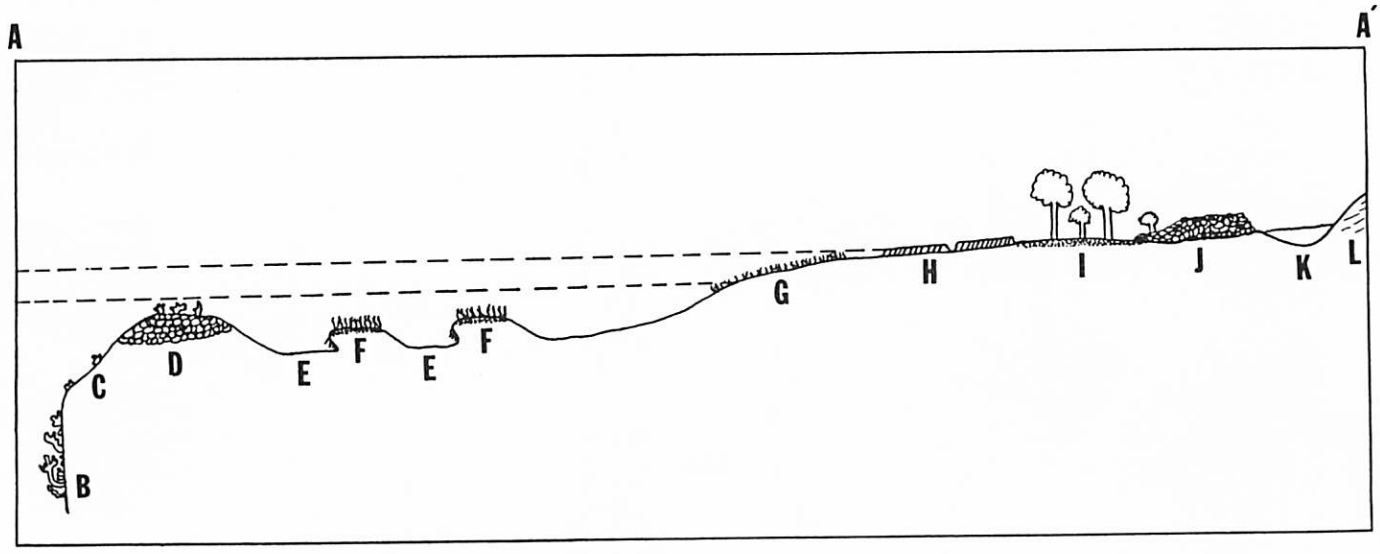


Fig. 2b. Blackwood Bay, view from shore to the west into French Bay. Exposed intertidal mud flat with *Thalassia* grass and abundant *Goniolithon* algae.



B VERTICAL WALL WITH ABUNDANT CORAL
C FORE-REEF SLOPE WITH SMOOTH SPUR AND GROOVE STRUCTURE
D REEF CREST WITH ENCRUSTING MILLEPORA BOULDER RAMPART
E SANDY INTERMOUND AREA
F THALASSIA MOUNDS
G INTERTIDAL ZONE
H PLEISTOCENE BEDROCK WITH PALEOSOL
I BLACK MANGROVE
J CORAL RUBBLE SPILLOVER LOBE
K POND
L PLEISTOCENE DUNE

Fig. 3. Generalized cross section A-A' (not to scale) showing subenvironments of the Blackwood Bay lagoon-tidal flat complex. See Figure 1 for line of section

have interesting implication for this lagoonal-tidal flat complex.

DESCRIPTION OF STUDY AREA AND RESULTS

Field work was conducted in January and May, 1986, and revealed the primary features of the study area. Figure 3, a generalized southwest to northeast cross section of these features, accompanies the following description. The near vertical fore-reef slope has excellent spur and groove structures. Isolated small hard corals, soft corals, and sponges inhabit the mostly smooth spur and groove topography. The reef-crest is a boulder rampart composed of coral rubble which has been bound by encrusting *Millepora*. The combination of *Millepora* and boulders form a barrier, producing quiet water conditions in the lagoon. Within the lagoon, there are two basic types of sedimentary features: mud mounds supported by dense growths of the seagrass *Thalassia*, and intermound areas that are bowl-shaped depressions containing mostly sand-sized debris. Sediment probing indicates that the thickness of the sediments in the intermound areas ranges from a few centimeters to one meter, and the mounds range from 0.5 to 1.5 meters thickness. The lagoon also serves as the subtidal zone for the tidal flat environment (see Fig. 1). The intertidal zone is a mudflat, containing abundant *Goniolithon*. Black mangrove trees inhabit the landward parts of the intertidal zone and are presently overgrowing older beach deposits. They are interspersed with outcrops of paleosol-covered Pleistocene bedrock and grade westward into actively forming beaches. Along the line of the section there are no active beach deposits, with the mangrove overgrowing a former beach. Inland of the mangrove, many large spillover lobes of coarse debris are present. These coalescing lobes are 1 to 2 meters high and 5 to 10 meters across and are composed of cobble- to boulder-sized reef rubble. At several locations along the coast, these spillover lobes lie adjacent to small ponds. One of these ponds is shown on the cross section.

In January, 1986, a reconnaissance trip was taken to Blackwood Bay. Twenty-two surface sediment samples were collected and nine of the samples were analyzed in detail (see Figure 1 for sample locations). Wet sieving was conducted for purposes of grain-size analysis (Fig. 4). Samples 18, 19, and 21 were collected from *Thalassia* mounds while samples 1, 3, 6, 14, 20, and 22 were collected from the intermound areas. As expected, the *Thalassia* mounds contained high percentages of silt and clay. X-ray diffraction of the sand-sized fraction from the mounds indicates that the composition is almost entirely calcite. However, the sand-sized fraction of the intermound areas contains nearly equal amounts of calcite and aragonite.

DISCUSSION

Three main questions have emerged from this preliminary work. They are: source of the lagoon and tidal flat sediments, source and distribution of the calcite and aragonite fragments and particles in the sediments, and origin of the *Thalassia* mounds.

The source of the sediments is thought to be one or a combination of the following: terrestrial; marine, (due to longshore currents); or *in situ* sediment production. A terrestrial source is unlikely due to lack of a production and transporting mechanism. Longshore drift is primarily to the west along the barrier reef, but often reverses during winter storms which approach from the northwest. The western margin of the study area is open to French Bay, which could be acting as a window for the seasonal influx of sediment. Currently, samples are being analyzed to determine if the sediments are being produced *in situ*. Foraminifera are extremely abundant in the samples along with *Halimeda* plates, *Goniolithon* fragments, and coral debris. It is possible that the sediments produced *in situ* are mixed with sediments transported into Blackwood Bay by longshore currents. The fore-reef slope is not considered to be a likely source because of the near vertical nature of the "wall" and very deep marine conditions adjacent to the lagoon.

The distribution of calcite may be related to biologic constraints. A high percentage of calcite is found on the *Thalassia* mounds compared to nearly equal amounts of calcite and aragonite found in the intermound areas. It is suspected that foraminifera are the more abundant sediment type on the mounds due to the favorable ecologic conditions

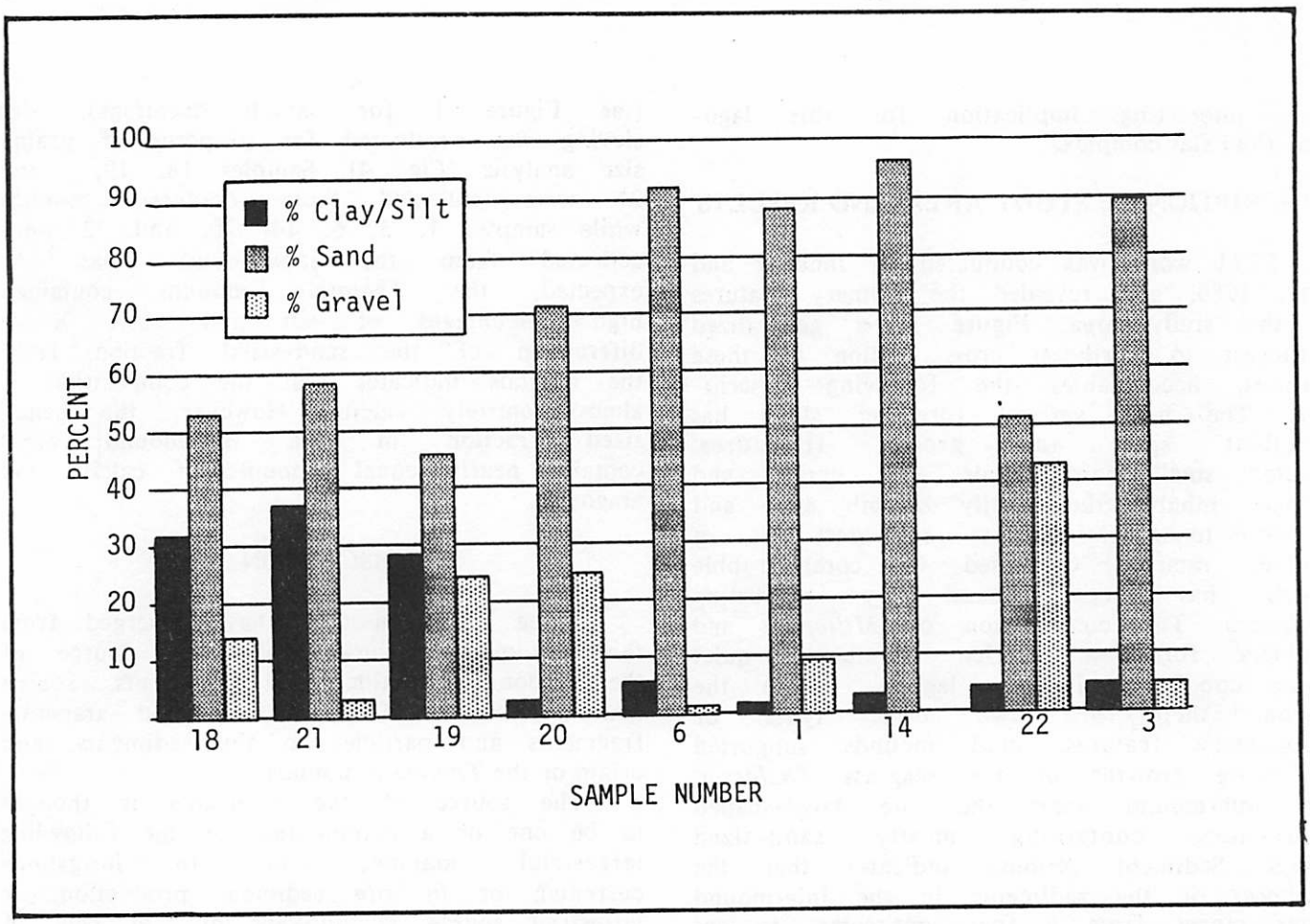


Fig. 4. Graphical representation of grain size analysis for samples collected in the lagoon. See Figure 1 for sample locations.

created by the presence of the *Thalassia*. The intermound areas have no *Thalassia* and therefore these foraminifera would not be as abundant. Another possible source of calcite could be from the re-working of Pleistocene material. The distribution and origin of calcite and aragonite is a major concern of the ongoing research.

Thalassia acts as an efficient baffle, trapping both coarse and fine grained sediment. Sand is trapped in the depressions in the bedrock floor of a lagoon, followed by establishment of *Thalassia* which increases trapping efficiency and results in upward mound growth. Sediment probing of mounds in Blackwood Bay, however, indicates a relatively uniform bedrock surface. Therefore, it appears that the origin of the Blackwood Bay mud mounds is not related to depressions in the bedrock.

A speculative description of the possible events based on the above observations is as follows. The present features of Blackwood Bay are the result of a catastrophic storm event striking from the south. This storm striped living and dead coral from the spur and groove topography of the fore-reef slope. The rubble was transported landward by the storm surge and formed the coral debris spillover lobes. The ponds landward of the spillover lobes may represent smaller, restricted portions of the pre-existing lagoon. A two meter core was successfully collected from one of these ponds for analysis. A coral sample from one of the spillover lobes was collected for C^{14} analysis in order to determine the relative age of the vent since the lobe cannot be older than the age of the coral rubble. The black mangrove trees seaward of the spillover lobes have apparently grown since the storm event. The storm surge also produced the boulder rampart on the reef crest, which is now being stabilized by encrusting *Millepora*. A storm event could also explain the present mound-and-hollow topography of the lagoon.

This storm model would suggest that the mounds, instead of building upward, are currently being destroyed by wave and storm activity. The mounds represent remaining portions of a storm-emplaced sand sheet stabilized by *Thalassia*. Exposed *Thalassia* roots along the perimeter of many mounds indicate that they are actively being eroded. Eleven cores and over 100 surface sediment samples have been collected from the lagoon and the tidal flat in order to test this hypothesis.

CONCLUSIONS

Preliminary investigations of Blackwood Bay suggest that one or more storm surges may have been responsible for the development of this lagoon-tidal flat complex that lies in such close proximity to the open marine environment. The smooth spur and groove of the fore-reef slope, the *Millepora* encrusted boulder rampart of the reef crest, and the coral rubble spillover lobes are all evidence of catastrophic storm activity. The lagoon and tidal flat may be unique because they are transitory, the topography being the result of a *Thalassia* stabilized storm deposit currently undergoing erosion. This would explain why features such as this platform margin lagoon and tidal flat are not more common in the Bahamas. The large number of surface sediment samples and core data under current analysis may provide an answer to the nature of the origin of the tidal flat and lagoonal deposits of Blackwood Bay.

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