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Back Cover: Dr. H. Leonard Vacher, University of South Florida, Keynote Speaker for the 12th Symposium and author of "Keynote Address – Plato, Archimedes, Ghyben Herzberg, and Mylroie", this volume , p. ix. Photograph by Don Seale.

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DEPOSITIONAL HISTORY AND DIAGENESIS OF A PLEISTOCENE CORE, ANDROS ISLAND, BAHAMAS

Karly A. Howerton and Cindy K. Carney
Department of Geological Sciences
Wright State University
Dayton, OH 45435

Mark R. Boardman
Institute of Environmental Sciences
Miami University
Oxford, OH 45056

ABSTRACT

A rock core retrieved from Andros Island in July of 2001 was evaluated. The core provides a record of changing depositional conditions and environments on Andros Island during the latest Pleistocene. This study seeks to interpret that record. The core is approximately 24.4 m in length and is composed of Pleistocene Lucayan Limestone. Core recovery varied from 25% to 100% with about 19.5 m of core obtained from the borehole. Analyses include a macroscopic and microscopic description of the core, XRD analysis, and initial interpretations of depositional and diagenetic history.

Nine facies were identified in the core. Facies 1 is interpreted as a bioturbated muddy lagoon with an abundance of skeletal grains including some corals. Facies 2 has characteristics of a high energy near shore environment and Facies 3 is a beach with sedimentary structures including beach bubbles and low angle laminations. An erosional surface marked by a thin paleosol is present at the top of Facies 3. Facies 4 and 5 are comprised of bioturbated lagoonal sediments. Facies 4 contains a coral rich boundstone that has been interpreted as a small patch reef. Facies 6 is a high energy beach containing low angle laminations and beach bubbles. The transition between Facies 6 and 7 may be another erosional surface, however no clear paleosol is present. Facies 7 is a moderate to high energy lagoon with abundant fossils, including corals, and no mud. Facies 8 has been interpreted as a bioturbated ooid-peloid sand flat or ooid-rich high energy lagoon with little mud and ooids present throughout. Facies 9 comprises laminated beach sediments with an abundance of ooids.

The facies identified within the Andros core reflect changes in sea level during the time of deposition. Three depositional packages (Facies 1-3, Facies 4-6, and Facies 7-9) have been recognized, separated by erosional surfaces. Mineralogy was determined for eighty-nine whole rock samples from the core. Samples in the upper depositional package contain high percentages of aragonite. The lower two depositional packages have low aragonite overall but individual samples are high. Cores drilled further to the north on Andros Island penetrated only the uppermost package of this core (Kostelnik, 2001; Fitzgerald, 1997). They are similar in lithology but contain additional paleosols-erosion surfaces not recognized in the southern core.

INTRODUCTION

The purpose of this study is to describe the composition and texture of a core taken from Andros Island, Bahamas, (Figure 1) and to evaluate its depositional and diagenetic history. The borehole was 24.4 meters deep and drilled through Pleistocene Lucayan Limestone (Beach and Ginsburg, 1980). Core recovery varied from

25% to 100% with about 19.5 m of core obtained from the borehole. The core was drilled near AUTEC (Atlantic Undersea Test and Evaluation Center) with the purpose of ground - truthing electrical resistivity imaging surveys.

This study, however, is concerned with depositional and diagenetic aspects of the core. Interpretations were used to correlate and compare this core with other cores drilled to the north on Andros Island (Kostelnik, 2001; Fitzgerald, 1997). Further investigations and dating of this core may also help to map sea level changes in the Late Pleistocene.

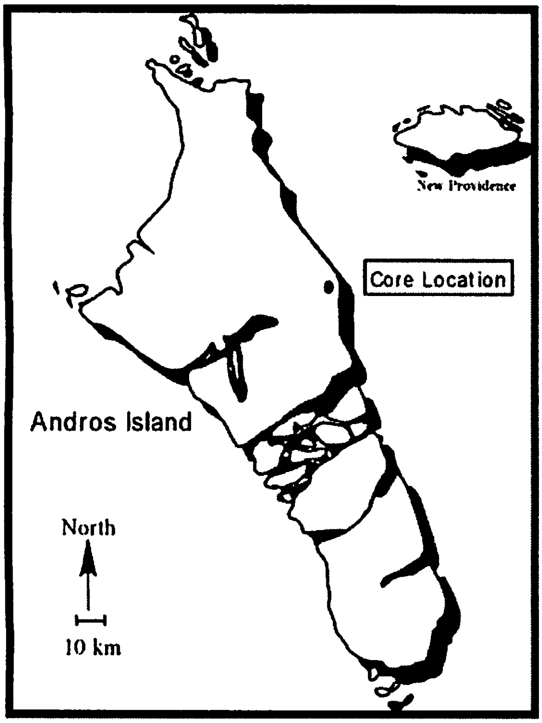

Figure 1. Location of the core sample taken from Andros Island (modified from Adams et al., 2001).

METHODS

Drilling took place on July 9, 2001 and July 10, 2001. The core location was south central Andros, and a mud rotary drill was used. The core was donated to the Wright State University Department of Geological Sciences by Golder Associates Inc. Using a hand lens and a binocular microscope, the core was described macroscopically and subdivided into units based on grain type, fossils, and sedimentary structures. Selected samples were then described microscopically. The thin section analysis included point counts (300 points per slide) of approximately 30 thin sections in order to obtain percentages of grains, mud, cement, and porosity. The analysis provided much more detail about the composition of the limestone and the post-deposition changes that have occurred. Percentages of ooids, mud, cement, and porosity were graphed. Eighty-nine whole rock samples were taken to Miami University to be analyzed using an X-Ray Defractometer (XRD). A graph of this data was used to evaluate aragonite to calcite transformations throughout the core sample.

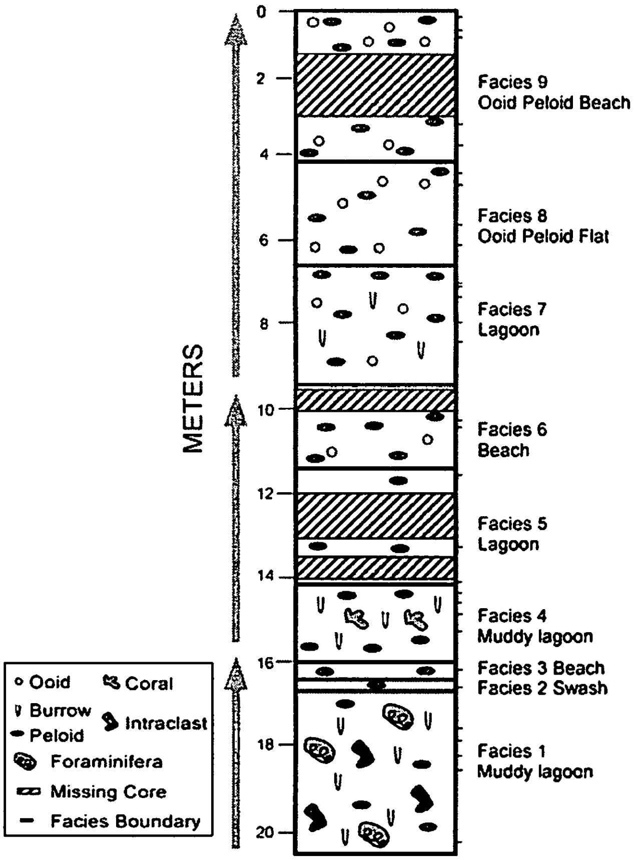

Figure 2. Stratigraphic column of the core. Location of thin sections shown by ticks on column.

Category (Average)	Facies 9	Facies 8	Facies 7	Facies 6	Facies 5	Facies 4	Facies 3	Facies 2	Facies 1
Algae	0.5	2.1	8.3	0.5	2.7	0.1	1.6	3.6	1.3
Foram	0.0	0.3	5.1	3.2	7.2	1.5	6.6	10.3	4.5
Coral	0.0	0.0	16.8	0.0	0.0	0.0	0.0	0.0	0.0
Mollusk	0.3	0.8	1.5	0.5	0.0	0.0	0.0	0.0	0.0
Gastropod	0.3	3.6	6.6	0.0	0.0	0.0	0.0	0.0	0.0
Ooid	5.6	4.4	0.3	0.7	0.0	0.0	0.0	0.0	0.0
Peloid	39.6	54.4	34.9	50.1	22.3	3.0	34.3	16.6	11.4
Intraclast	15.0	7.5	0.3	0.0	0.9	0.0	2.0	4.3	6.0
Mud ·	0.0	0.0	7.4	0.0	8.3	29.0	11.6	7.6	20.7
Cement	23.3	13.4	18.3	31.8	33.9	40.7	28	20.3	28.9
Porosity	13.7	14.2	11.1	11.8	23.4	25.5	15.6	37	11.9
Other	1.8	0.3	0.8	0.7	1.2	0.0	0.0	0.0	1.3

Table 1. Point Count Data. Data are percentages averaged for all thin sections in each facies.

RESULTS

Based on the macroscopic investigation, nine distinct facies, beginning at the bottom of the core, were identified within the core (Figure 2; Table 1). Facies 1, (Figure 3D, 4D) is a heavily bioturbated fossiliferous packstone. It is 4.7 m thick. Common skeletal grains include foraminifera, red algae, and mollusks. Non-skeletal grains include intraclasts and peloids. There are a few corals visible as well. Mud averages 21%. Cement averages almost 30% and porosity is 12%. Because of these characteristics, the facies was interpreted as a shallow, muddy lagoon. Facies 2 is a well washed fossiliferous packstone. The facies is 0.24 m thick and contains coarse sediments and fossil fragments that include foraminifera and red algae. There is 7.6% mud on average. Cement averages 20%. Porosity in Facies 2 is the highest of all the facies with an average of 37%. There are also many peloids and intraclasts. This unit has been interpreted as a high energy near shore environment, perhaps a beach swash zone.

Facies 3 is a peloidal packstone with peloids comprising most of the grains. The facies is approximately 0.6 m thick and show little to no bioturbation. Mud is present in small amounts. Samples from Facies 3 contain an average of 28% cement and have 16% porosity. Common fossils include foraminifera and red algae. Intraclasts are rare, but present. Beach bubbles and low angle laminations are present throughout this facies, which has been interpreted as a beach. A paleosol, characterized by dark greenish-brown micritic layers, occurs at the top of Facies 3 (Figure 3C) and marks an erosional boundary. Facies 4 is a heavily bioturbated peloidal packstone. This unit is interpreted as a muddy, low energy lagoon and is 2.2 m thick. Mud averages 29% and thus, is the highest in the core. Cement is 41% and porosity averages 25%. Peloids are abundant throughout and common fossils include foraminifera and red algae. Intraclasts and burrows are also present throughout this facies. Surprisingly, coral is also abundant in this facies and a 0.45 m thick coral boundstone, interpreted as a small patch reef, is found near the middle of the unit.

Facies 5 is 1.5 m thick and is a peloidal packstone. It is heavily bioturbated and contains foraminifera, red algae, and intraclasts. No coral is present. This facies is interpreted as a moderate energy lagoon with about 8% mud. Cement averages 34% and porosity averages 23%. Facies 6 (Figure 4C) is 1.8m thick. Beach bubbles and low angle laminations are present throughout. Cement averages 32% and porosity is 12%. This facies is a peloidal grainstone, and marks the first

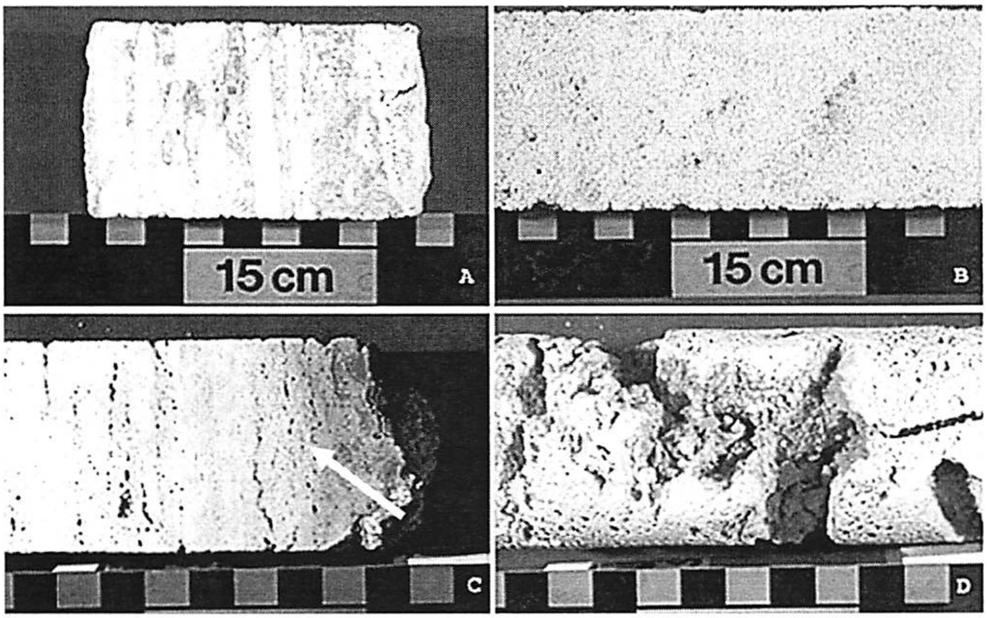

Figure 3. Core samples from top left:(A) facies 9, (B) facies 8, (C) facies 3 (paleosol shown by arrow), and (D) facies 1.

appearance of ooids and gastropods in the core. The ooids have all been partially micritized but laminations are still recognizable. Red and green algae are present but rare, as are foraminifera. This facies is interpreted as a beach, with no bioturbation and no mud. Facies 7 (Figure 4B) is 3.3 m thick and represents a transition back into a lagoonal setting. The rock is a well-washed peloidal packstone with low to moderate amounts of mud. Cement is 18% and porosity is 11%. Grains include foraminifera, red algae, ooids (micritized), mollusks, and abundant peloids, many of which are micritized ooids.

Facies 8 (Figure 3B) is a peloidal grainstone. The unit is 3.2 m thick. Ooids are common (up to 8%) in this facies and not all have been micritized. There is moderate bioturbation present and skeletal grains include foraminifera, and green algae. Non-skeletal grains consist of peloids (some are micritized ooids) and intraclasts. With the exception of peloids and ooids, all other grains are rare. Cement is 13%, porosity is 14%, and there is no mud. The area has been interpreted as an ooid/peloid sand flat or high-energy ooid/peloid.lagoon. Facies 9 is also a peloidal grainstone (Figure 3A, and 4A). It is 2.1 m thick. Laminations are present throughout this facies and ooids are common (up to 14%). No mud is present. This unit also contains foraminifera, algae, and rare mollusks. There is 23% cement and 14% porosity. This facies has been interpreted as a high-energy ooid/peloid beach.

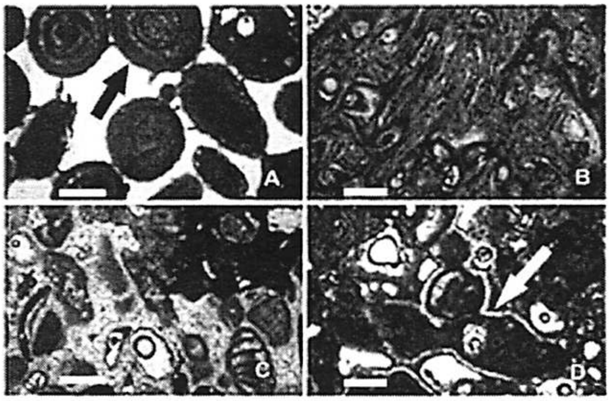

Figure 4. Photomicrographs from top left: (A) facies 9 (arrow is indicating an ooid), (B) facies 7, (C) facies 6, (D) facies 1(arrow is indicating cement) Scale bars are 0.5 mm.

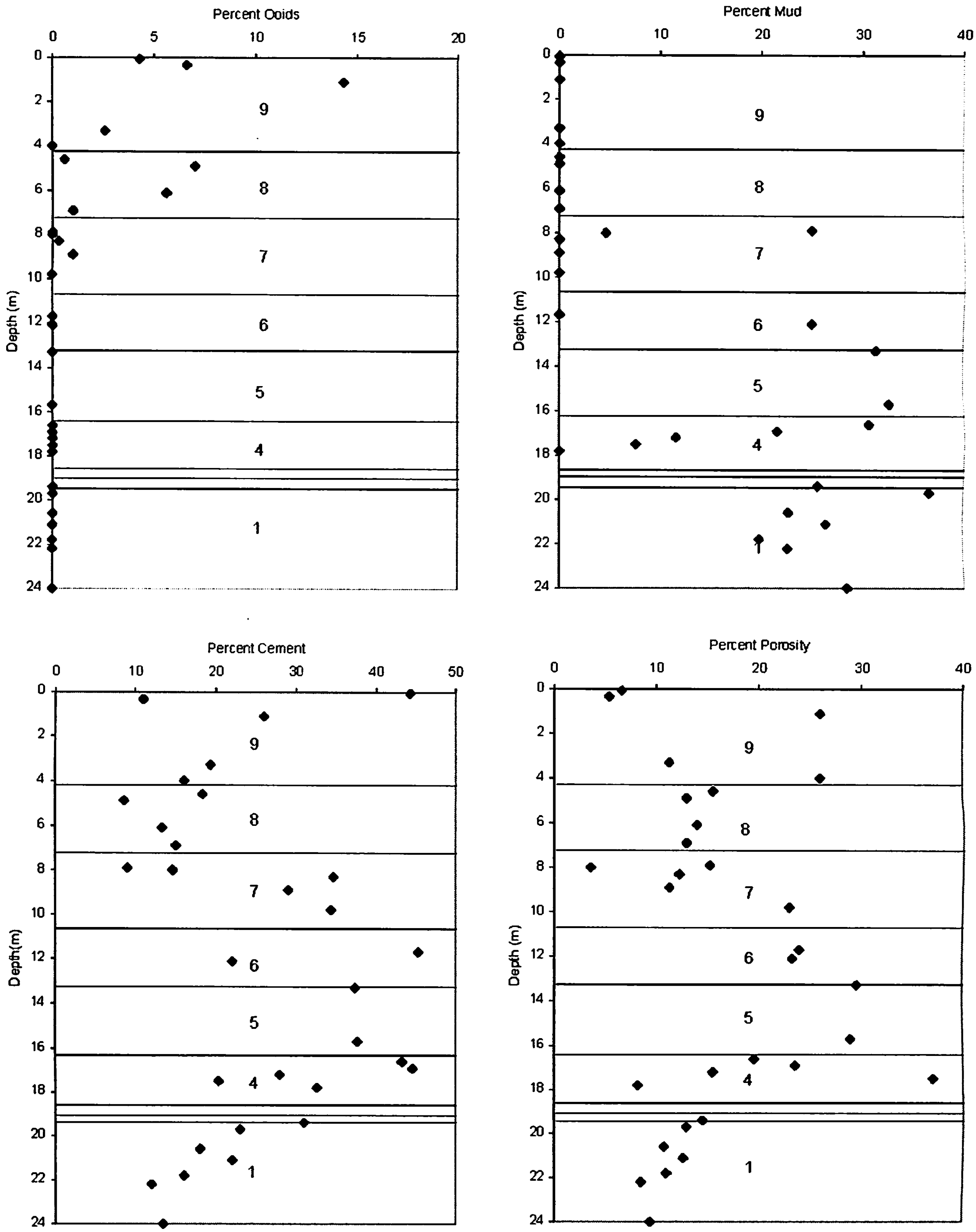

Figure 5. Percent vs. depth for various components. Facies (numbered 1-9) are marked for each.

TRENDS

Point count data were graphed to show the distribution of ooids, mud, cement, and porosity (Figure 5). Ooids are most abundant in the top portion of the core, and no ooids are present deeper than Facies 6 (about 13.4 m). Mud percentages increase towards the bottom of the core. Overall, there is more cement in the central portion of the core. Porosity varies but in general, is highest in the central portion of the core as well.

XRD analyses of aragonite show that the greatest amount of aragonite is found at the top of the core in Facies 8 and 9 (Figure 6). These are the youngest units and the most ooid rich. The sediments of Facies 8 and 9, therefore, had more aragonite originally and/or have been altered less than underlying facies. Facies 7 has samples with as much as 20% aragonite and a few samples in Facies 4 and 5 also contain some aragonite. Several samples in Facies 1 also have aragonite, the two samples with very high aragonite were taken from corals.

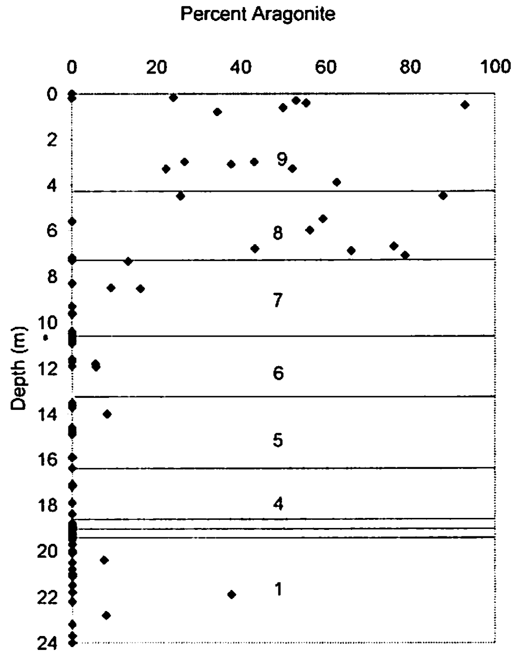

Figure 6. Percent Aragonite vs. depth. Facies (numbered 1-9) are marked

DISCUSSION AND CONCLUSIONS

The facies identified within the Andros Island core reflect changes in sea level during the time of deposition. Three depositional packages (Facies 1-3, Facies 4-6, and Facies 7-9) have been recognized, separated by erosional surfaces (see Figure 2). Depositional package 1 was deposited during a sea level highstand. A shallowing upward sequence comprising muddy lagoon to beach facies resulted. A drop in sea level marks the first erosional boundary at the top of Facies 3, where a clear paleosol (Bain and Foos, 1992; Boardman et al., 1995) is present. Depositional package 2 was deposited during a subsequent sea level highstand. A shallowing upward sequence comprising muddy lagoon to beach facies resulted.

After yet another sea level rise, depositional package 3 was formed. This also resulted in a shallowing upward sequence from lagoon to beach. However, during this highstand, conditions were right for ooids to form. Today, ooids form in agitated, high energy, marine environments such as Joulters Cays, Bahamas (Carney and Boardman, 1993). Cores from the northern portion of Andros penetrated only to depths equivalent to package 3 (Kostelnik, 2001). The upper 7.6 meters of these cores are ooid rich (Boardman and Carney, 1997; Carney et al., 2001) like the core described in this study. The northern cores contain additional paleosols-exposure surfaces not recognized in this core. A well developed paleosol occurs in the northern cores at the approximate depth of the boundary between Facies 7 (lagoon) and Facies 8 (sand flat) of the southern core. Although a change in lithology is noted in the southern core, no equivalent paleosol was observed. No attempt to tie packages in the core to actual sea level highstands was made. The uppermost facies may have been deposited during Stage 5 and may be of a similar age (125,000 ybp) to rocks exposed near Nichollstown on North

Andros (Neumann and Moore, 1975). However, at this time, no age dates are available for the core.

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