BAHAMAS PROJECT

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SAN SALVADOR ISLAND, BAHAMAS: A NATURAL LABORATORY FOR THE STUDY OF CARBONATE SEDIMENTS AND ROCKS

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Limestones and dolomites comprise about 15% of the sedimentary mass of planet Earth, and such rocks are particularly useful for the interpretation of past Earth surface conditions. This is because these rocks frequently contain physical and biogenic sedimentary structures and body fossils that can enable interpretation of ancient depositional environments and ecosystems. In addition, the chemical composition and textures of carbonate grains and their cements reflect the physical and chemical conditions that existed at the time of sediment formation and, if diagenesis has occurred, at later times. However, in the modern world, areas of shallow-water carbonate sediment formation are limited, owing primarily to the conditions of high continentality that have prevailed during Quaternary time and the paucity of low latitude epeiric seas.

The Florida Keys and the islands and shallow platforms of the Bahamas Archipelago are two of the most accessible areas for North Americans to study processes of modern carbonate sediment formation and deposition and for their comparison with carbonate rocks of Pleistocene and Holocene age. Indeed, the shallow-water platforms of the Bahamas truly are "carbonate factories," with the products being a diverse array of carbonate sediments formed by both physical and biogenic processes and deposited in a spectrum of environments ranging from dunes and lakes on the islands to deep-sea basins adjacent to the platforms.

San Salvador Island sits atop a small, isolated bank at the eastern edge of the Bahamas, about 630 km ESE of Miami (Fig. 1). The island is about 11 km wide by 19 km long and is bordered by a narrow, shallow shelf with an abrupt shelf-edge break leading to a steep continental slope that extends to near abyssal depths around the entirety of the island. Little is known of the subsurface geology of San Salvador; one well drilled to a depth of 168 m on the north coast of the island revealed a column of shallow-water, dolomitized limestones of undetermined age (Supko, 1977). Presumably San Salvador is underlain by a several kilometer thick sequence of shallow-water carbonates resting on a mixed continental-mafic basement similar to the conditions thought to exist beneath the larger Bahamian banks (Meyerhoff and Hatten, 1974; Mullins and Lynts, 1977). The banks of at least the northwestern part of the Bahamas are thought to be tectonically stable and slowly subsiding, perhaps at the rate of about 3 m/125,000 yrs. determined for Andros Island by Garrett and Gould (1984).

The topography of San Salvador is dominated by arcuate ridges reaching elevations of up to 45 m. These ridges are formed of carbonate eolianite and are interpreted as representing successive stages of eolian accretion. Shallow, hypersaline lakes occupy the low, interdune areas. The island's shoreline is characterized by cliffed headlands, with carbonate sands forming beaches between headlands; Holocene beachrock is common. Natural rock outcrops largely are confined to the

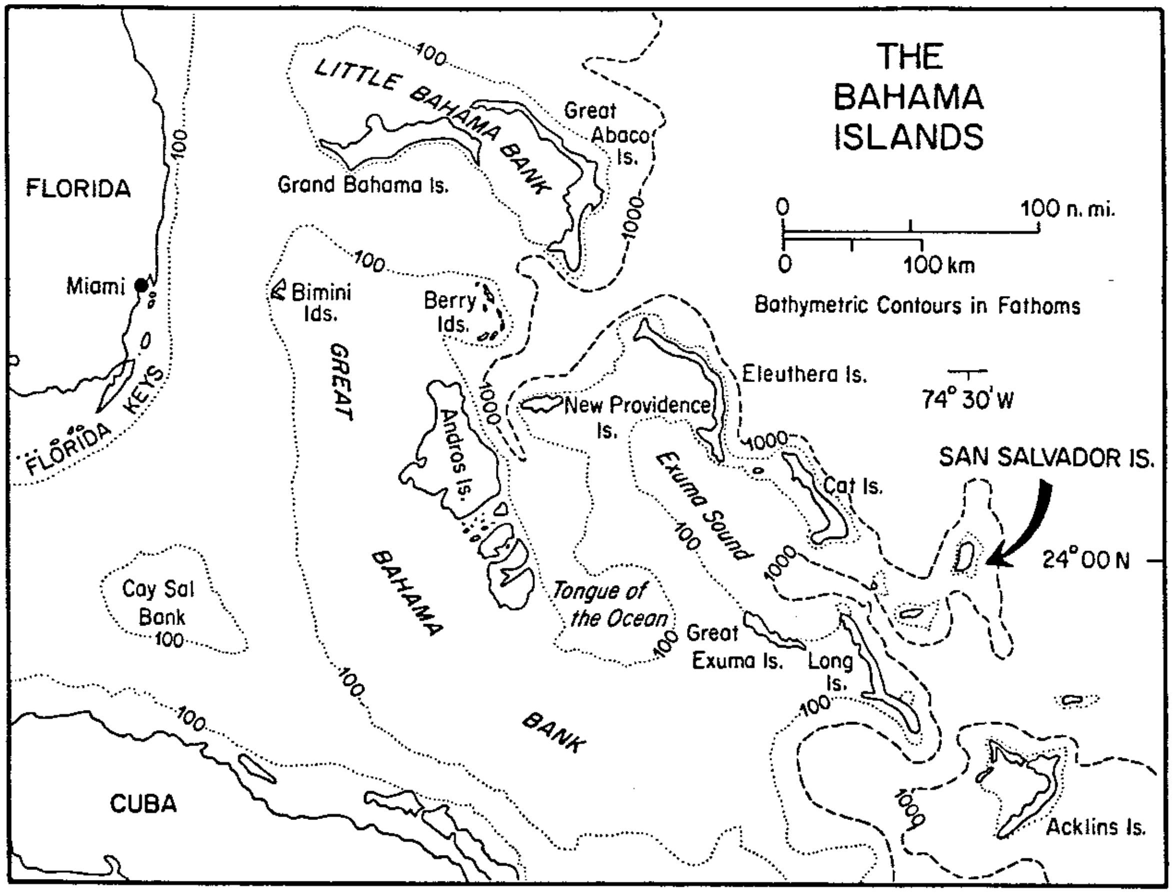

Figure 1. Location of San Salvador Island within the Bahamas Archipelago.

coastline. Dense vegetation restricts access to the island's interior, a karst surface covered by a calcrete crust and thin, red soils. Road cuts and several quarries along the island's coastal highway also provide good exposures for study.

Because San Salvador lies on a tectonically stable platform surrounded by deep water, the Pleistocene and Holocene rocks that are exposed on the island have particular significance as markers of Quaternary eustatic sea level change. Vertical facies changes are abrupt, allowing precise interpretation of former sea level positions. A comprehensive stratigraphy for San Salvador has been presented by Carew and Mylroie (1985) and is shown in Figure 2. The oldest unit that crops out on San Salvador, the Owl's Hole Formation, is believed by Carew and Mylroie to have a minimum age of 700,000 years.

Beginning in the early 1980's, Professors Allen Curran and Brian White and students from Smith College began geologic investigations on San Salvador. An initial project involved the detailed geologic mapping of the Cockburn Town fossil coral reef (Curran and White, 1985), an extensive reef of Sangamon age located on the west coast of the island. Analysis of vertical facies changes and the diagenetic sequence as revealed by thin section petrography showed that the Pleistocene facies are characterized by a shallowing upward sequence (White and others, 1984) similar to that portrayed in Figure 3. This sequence appears to be a common stratigraphic theme in at least the Pleistocene rock sequences of the Bahamas. More recently, White and Curran have investigated the physical sedimentary structures and trace fossils in the Holocene eolianites on San Salvador (White and Curran, 1988) and the recognition of facies transitions in Bahamian carbonates using trace fossil assemblages (Curran and White, 1987).

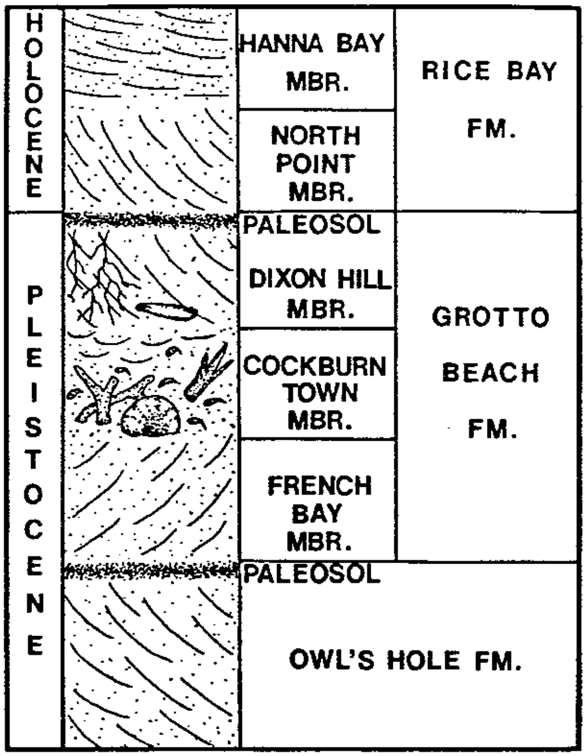

Figure 2. Stratigraphic column for San Salvador Island (after Carew and Mylroie, 1985).

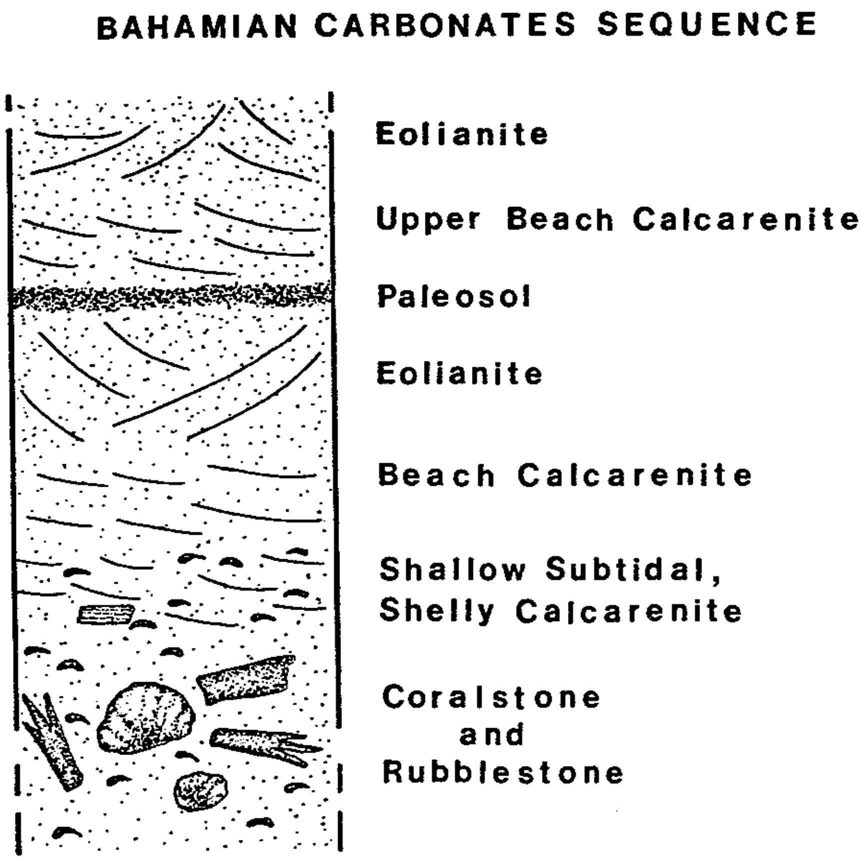

Figure 3. Model shallowing-upward facies sequence for Bahamian carbonate rocks.

With these studies as background, the Keck Bahamas Geology Research Group conducted four weeks of research investigations on San Salvador during June and early July, 1987. After several days of reconnaissance field trips for familiarization with the carbonates environments and rock record of the San Salvador natural laboratory, two research teams were formed. The "Construction Crew," headed by Professor White and including Doug Cattell (Colorado), Storr Nelson (Whitman), and Molly Stark (Smith), had as its goal the detailed geologic mapping and sampling of a large Pleistocene fossil coral reef at Sue Point. The research objectives were to expand on and supplement knowledge gained from earlier studies of the Cockburn Town fossil coral reef, particularly with regard to the diagenetic history of the various reef facies.

The "Fossils" team, directed by Professors Curran and Thomas and including Cara Davis (Pomona), Lorrin Ferdinand ((F&M), Daisy Hagey (Williams), Lynn Neal (Wooster), and Jennifer Schuster (Carleton) had more diverse goals, with projects ranging from the study of modern hardgrounds to the analysis of Pleistocene bivalve faunas. A central theme for this group of projects was the investigation of taphonomic processes in tropical marine, shallow-water environments, addressing questions of how the borings, shells, and tests of modern organisms might come to be preserved in ancient deposits. The specifics of each student project are described in detail in abstracts in this volume.

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A PETROOGRAPHIC STUDY OF THE DIAGENESIS OF THE SUE POINT FOSSIL REEF SAN SALVADOR, BAHAMAS

Douglas A. Cattell

INTRODUCTION

During the months of June and July of 1987 a survey was made of the Sue Point fossil reef on the northwest corner of San Salvador Island, Bahamas. Core samples were taken and petrographic analysis of the samples was completed. The following is a description of the facies defined by outcrop and sample study, and a discussion of the diagenetic sequence and history of the facies. Figure 1 is a schematic representation of the features described for each facies.

FACIES DESCRIPTION AND INTERPRETATION

Beach Rock Facies

This facies consists of well sorted and well rounded, creamy-white, bioclastic limestone with a grain size varying from 1.25mm. to 3.5mm in diameter. The allochems include foramanifera; algal flakes; and fragments of coral, echinoderms, bivalves and other molluscs. This facies also contains peloidal and ooid grains, the latter of which are rimmed with brown, micritic, aragonite cement. There are also intraclasts composed of two or more ooids, peloids, and/or bioclasts, with similar concentric aragonitic rims that coat the entire grain.

Cements are patchily distributed within this facies. Low-Mg calcite cements vary from thin rims on the surfaces of individual grains, to void spaces fully occluded with equant, sparry crystals. The cement within these voids exibits the classic coarsening-inward crystal size pattern.

This facies also contains intergranular micritic cement composed of low Mg-calcite that is long and sinuous in shape. Associated with this micritic cement are patches of whisker calcite. This too is low-Mg calcite, but it displays a much different crystal habit of long hair-like needles radiating from a central core. Both of these cement types form as a result of the biological activity of plants and fungi. These cements form as sheaths around roots and root hairs that upon organic breakdown remain as casts. The whisker calcite is a fast growing calcite polymorph associated with the rapid flux of CO_2 gas within the sediment resulting from the breakdown of the organic root material.

Coralstone

This facies is composed mainly of large in situ coral heads of Monastrea annularis and Acropora cervicornis. Some of the coralites in these heads are partially or completely filled with sediments consisting of ooids, peloidal grains, and bioclasts, as well as micrite and sparry calcite cement. The bioclasts in this sediment include broken coral fragments, bivalve fragments, and foramanifera. The distribution of sediment infill in some cases defines geopetal structures: early micritic cement is found within the sediment and late-stage sparry calcite cement is found above the sediment in some of the voids that were partially sediment-filled. The patchiness of late-stage cementation can be attributed to the irregular nature of vadose diagenesis.

Eolianite

This facies consists of very fine, well sorted and very well rounded, lithified sand (.0625mm. - 1.25mm.). This facies is carmel in color, darker than the beach rock facies. The eolianite is composed of ooids and a minor amount of bioclasts that include bivalve fragments, algal flakes, foramanifera, and coral fragments. This facies is composed of a series of normally graded laminae 0.2mm to 0.5 mm thick. Normal grading is common in eolian deposits and forms during progradation of dunes.

The eolianite facies is generally well cemented. Some whisker calcite is present but the majority of the cement is equant, sparry, low-Mg calcite. There is an inverse relationship between the size of the grains and the degree and style of cementation within the laminae. The laminae composed of large grains exibit more rim cements and less pore-filling cementation than the laminae of smaller grain size which are generally filled with equant crystals. This distribution is a function of the capillary action within the sediments at the time of cementation. Smaller grains