PLEISTOCENE AND HOLOCENE CARBONATE SYSTEMS, BAHAMAS

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

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INTRODUCTION - GEOLOGIC SETTING OF THE BAHAMA ISLANDS

The Bahama Archipelago is an arcuate system of carbonate platforms, commonly capped with low islands, located to the east and south of the continental margin of North America (Fig. 1). The archipelago extends for a distance of some 1,400 km (870 mi.), from Little Bahama Bank to the north (27.5° N latitude), off the coast of Florida, south to the Turks and Caicos Islands, Silver Bank, and Navidad Bank (20° N, south of area of Fig. 1), offshore from the island of Hispaniola. Water depths on these banks normally are less than 10 m, but the banks are separated by inter- or intra-platform, deep-water basins and troughs with depths of up to 4,000 m.

These shallow-water banks are underlain by thick sequences of carbonate rock; drill hole data reveal a thickness of at least 5.4 km (Meyerhoff and Hatten, 1974), and other data suggest thicknesses of up to 10 km in the southeastern Bahamas. It appears that shallow-water carbonate sedimentation on the banks has kept pace with the subsidence of the Bahamian continental margin platform since Early Jurassic time (Mullins and Lynts, 1977).

Indeed, the shallow-water banks of the Bahamas truly are "carbonate factories." The products are a diverse array of carbonate sediments formed by both physical and biogenic processes and deposited in a spectrum of environments ranging from lakes and dunes to deep-sea basins. The environments on and adjacent to the banks and the rates of carbonate production have been in a considerable state of flux with changing sea levels since the onset of Pleistocene glaciations. Today, as eustatic sea level continues its slow but steady rise, the banks of the Bahamas are thought to be either tectonically stable or subsiding slowly.

A longstanding debate concerns whether the Bahamian platforms are underlain by oceanic or continental crust. Mullins and Lynts (1977) reviewed carefully the large body of geophysical and geologic literature on this subject. They favored an interpretation of a basement of originally pre-Triassic continental material that was pervasively intruded by mafic and ultramafic rock during rifting of North America from Africa and South America in Late Triassic time. In a sense, this was a compromise position with the result being formation of a crust of intermediate density that would have geophysical properties somewhat similar to oceanic crust. More recently, Ladd and Sheridan (1987) have shown that seismic reflection profiles in the northwest Tongue of the Ocean area suggest deposition on thinned continental crust, whereas the areas of the central and southeast Tongue of the Ocean and Exuma Sound appear to have been built on oceanic crust.

The origin of Bahamian banks and basins also has been a topic of considerable debate and disagreement. Again, two quite different concepts have been proposed. The "graben" hypothesis of Mullins and Lynts (1977) proposes strong fault control on the bank-basin pattern, with the

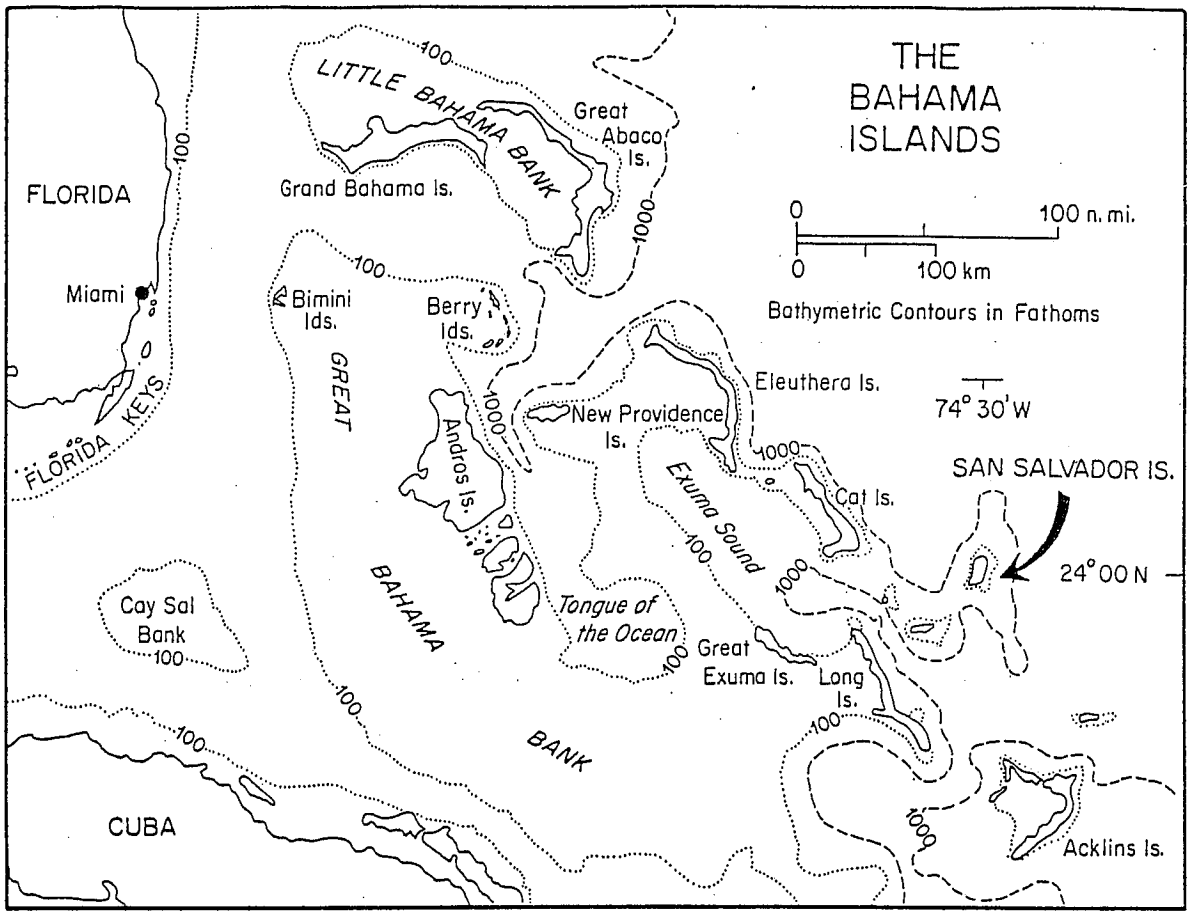

Figure 1. Location of San Salvador Island, Bahamas.

basins originating from grabens during the rifting stage of North Atlantic Ocean opening. By contrast, the "megabank" hypothesis of Myerhoff and Hatten (1974), Ladd and Sheridan (1987), and others holds that the Bahama platform was part of a more extensive, shallow-water carbonate bank that existed in Early Cretaceous time. Later drowning of the Bahamian platform and erosion by oceanic processes is thought to have produced the deep troughs that penetrate and subdivide the banks today. Austin and Schlager (1987) interpreted ODP Leg 101 drilling data as supporting the "megabank" hypothesis.

However, from a detailed seismic study of the northwestern Great Bahama Bank, Eberli and Ginsberg (1987) proposed origin by coalescense of three smaller platforms with significant bank progradation. They argued against the "megabank" hypothesis and proposed that the present bank-basin configuration results from progressive modification through time by segmentation events and incomplete coalescence. In sum, a final answer to the Bahamas banks-basins origin question is not yet available, and one can quickly conclude that much remains to be learned about the origin and development of the Bahamas.

THE ISLAND OF SAN SALVADOR

San Salvador is a small island, about 11 km wide by 19 km long (Fig. 2). The island is bordered by a narrow shelf with an abrupt shelf-edge break leading to a very steep slope. The topography of the island is dominated by arcuate ridges interpreted as representing successive stages of carbonate eolian accretion. Shallow lakes occupy the low inter-dune ridge areas. The island's shoreline is characterized by cliffed headlands of eroded eolianite; fine- to medium-grained carbonate sands form beaches between headlands, and Holocene beachrock is common.

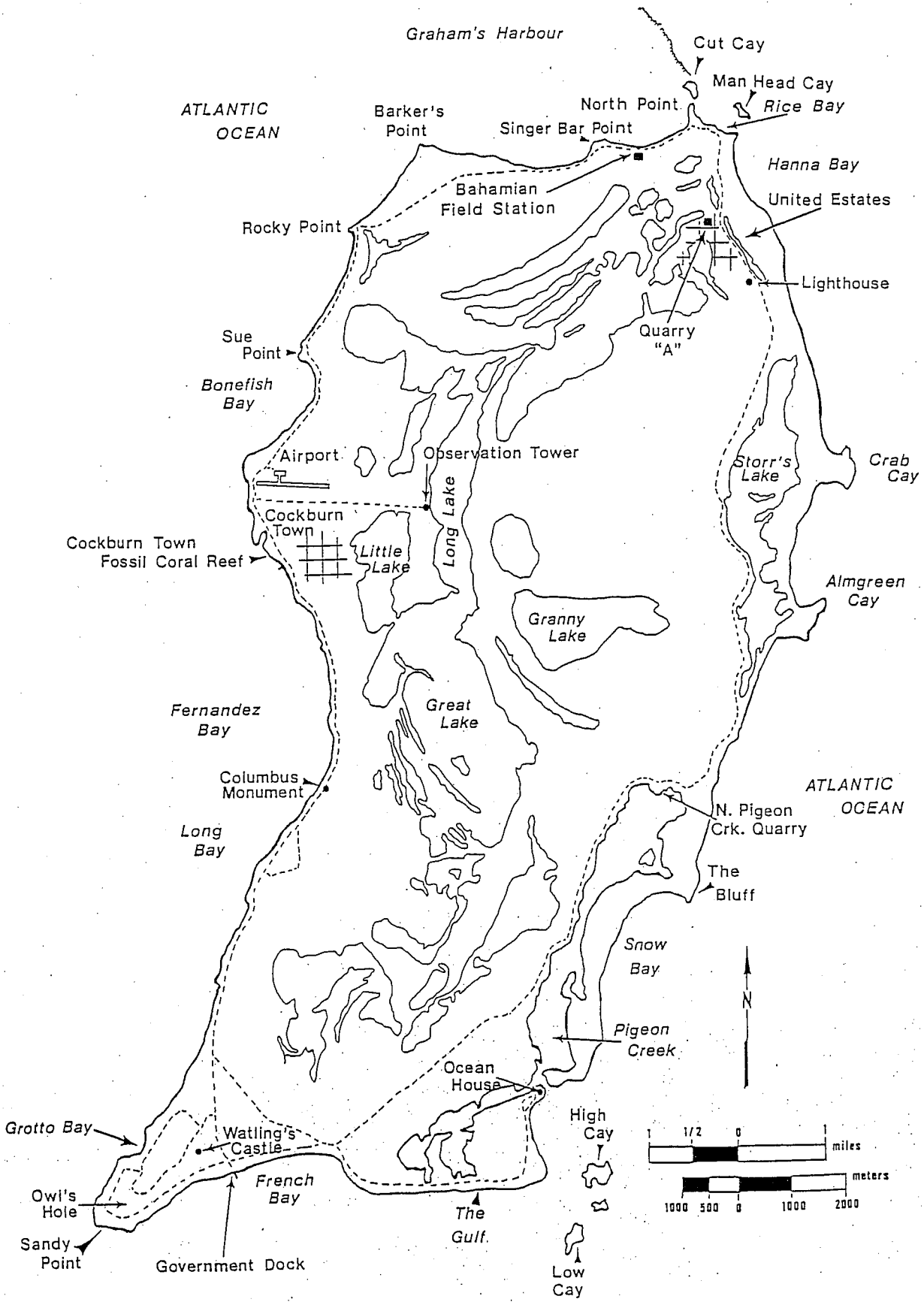

Figure 2. Index map to San Salvador Island.

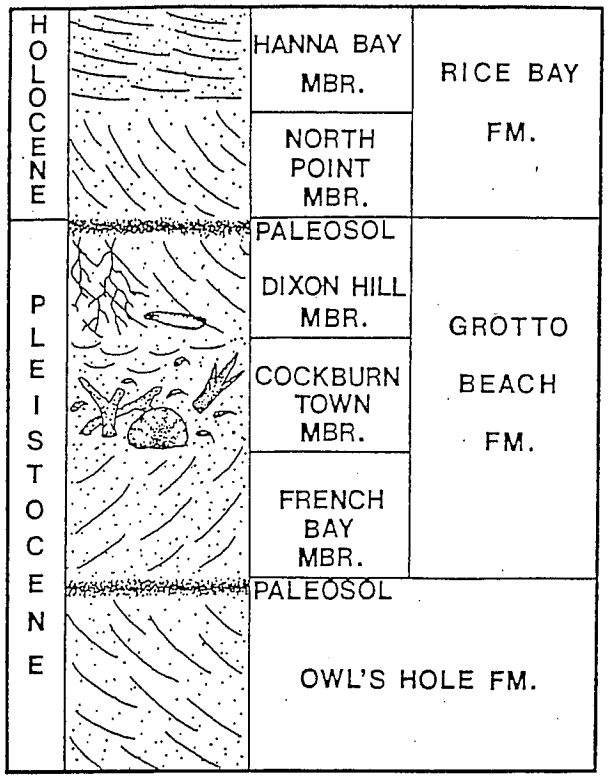

Figure 3. Stratigraphic column for San Salvador Island (after Carew and Mylroie, 1985).

Natural rock outcrops largely are confined to the coastal areas of the island. A dense vegetation cover restricts access to the island's interior, a karst surface with calcrete or caliche crusts, red soils, and solution phenomena, all of which further obscure charactersitics of the underlying rock. Road cuts and several quarries along the island's coastal highway also can 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 was presented by Carew and Mylroie (1985) and is shown in Figure 3.

KECK RESEARCH PROJECTS - 1988

With previous studies of the geology of San Salvador and the Keck Bahamas - '87 research reports as background, the Keck Bahamas Geology Research Group conducted four weeks of research investigations on San Salvador during June and early July, 1988. After several days of reconnaissance field trips for familiarization with the carbonate environments and rock record of the San Salvador natural laboratory, each of the eight student participants began to formulate their individual research project. Kathy White (Smith) conducted detailed field work on North Point and Man Head Cay to determine the effects of sea level change on the diagenesis of carbonate eolianites in coastal exposures. Her project was supervised by Prof. Brian White.

Under the direction of Prof. Roger Thomas, Lorrin Ferdinand and Tom Olszewski (both F&M) conducted field experiments and sampled arcoid and lucinoid bivalves respectively in order to determine the taphonomic histories of these two important molluscan groups. Celinda Brandt and Terry Lahm (both College of Wooster), with supervision from Prof. Mark Wilson,

investigated the effects of marine boring and microbioerosion on hard substrates from a number of intertidal to shallow subtidal sites around San Salvador.

Shannon Parsons (Beloit), with assistance from Profs. Carl Mendelson and Carol Mankiewicz, sampled shallow subtidal environments in the North Point and Pigeon Creek areas to determine the sediment contribution and distribution patterns of species of the marine calcareous green alga Halimeda. Nardos Fessaha (Smith) and Lisa Marrack (Williams) worked with assistance from Prof. Allen Curran. Nardos collected samples of fossil mollusks from Pleistocene beds at Quarry "A" and measured stratigraphic sections there in order to determine the paleodepositional history of the quarry units. Lisa donned snorkel and scuba gear frequently to sample sediments on and around patch reefs from five different areas off the San Salvador coast. Her goal is to determine what types and how much sediment is being produced by patch reefs and how different coastal settings may alter sediment production. The specifics of each student project are described in greater detail in the abstracts that follow.

Our research group is grateful to the Bahamian Field Station and its staff on San Salvador Island for full logistical support during the period of summer field work. We also thank the Keck Foundation for providing the funding for the Keck Geology Consortium which sponsored this project.

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