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

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INTRODUCTION

The fourth Keck Geology Consortium research project in the Bahamas was conducted on San Salvador Island during June, 1992. However, the really big news on San Salvador in 1992 wasn't Keck Geology but the celebration of the Columbus Quincentennial and the arrival of Club Med on the island. The Columbus expedition is known to have made first landfall in the "New World" somewhere in the Bahamas, and many scholars think that Long Bay, on the island's west coast, was the spot. The latter day "discovery" of the island by Club Med likely represents another major point of change in the island's human and natural history.

Our Keck research group consisted of ten rising senior geology majors, representing seven of the Keck Consortium colleges, four faculty supervisors as above, and a project assistant. During the time of the project, the group welcomed a stream of faculty visitors, including Odell Maguire (W&L), Carol Mankiewicz and Carl Mendelson (Beloit), Paul Myrow (Colorado), and Perry Roehl (Trinity). These visitors were of great assistance in aiding the students with formulating their research plans and initiating their research.

GEOLOGIC SETTING OF THE BAHAMA ISLANDS AND SAN SALVADOR

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, just south of the area of Fig. 1). 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 platforms are underlain by thick sequences of carbonate rock; drill hole logs from several exploratory wells reveal thicknesses of at least 5.4 km (Meyerhoff and Hatten, 1974), and other data suggest thicknesses of up to 10 km in the southwestern Bahamas. The platforms are tectonically stable, and it appears that shallow-water carbonate sedimentation on the banks has kept pace with the subsidence of the Bahamian platforms since at least Early Jurassic time (Mullins and Lynts, 1977).

These shallow-water banks of the Bahamas truly are "carbonate factories." The "products" are a diverse array of carbonate sediments formed by both organism secretion and physical processes. These sediments are and have been 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 the conditions of changing sea level since the onset of Pleistocene glaciations.

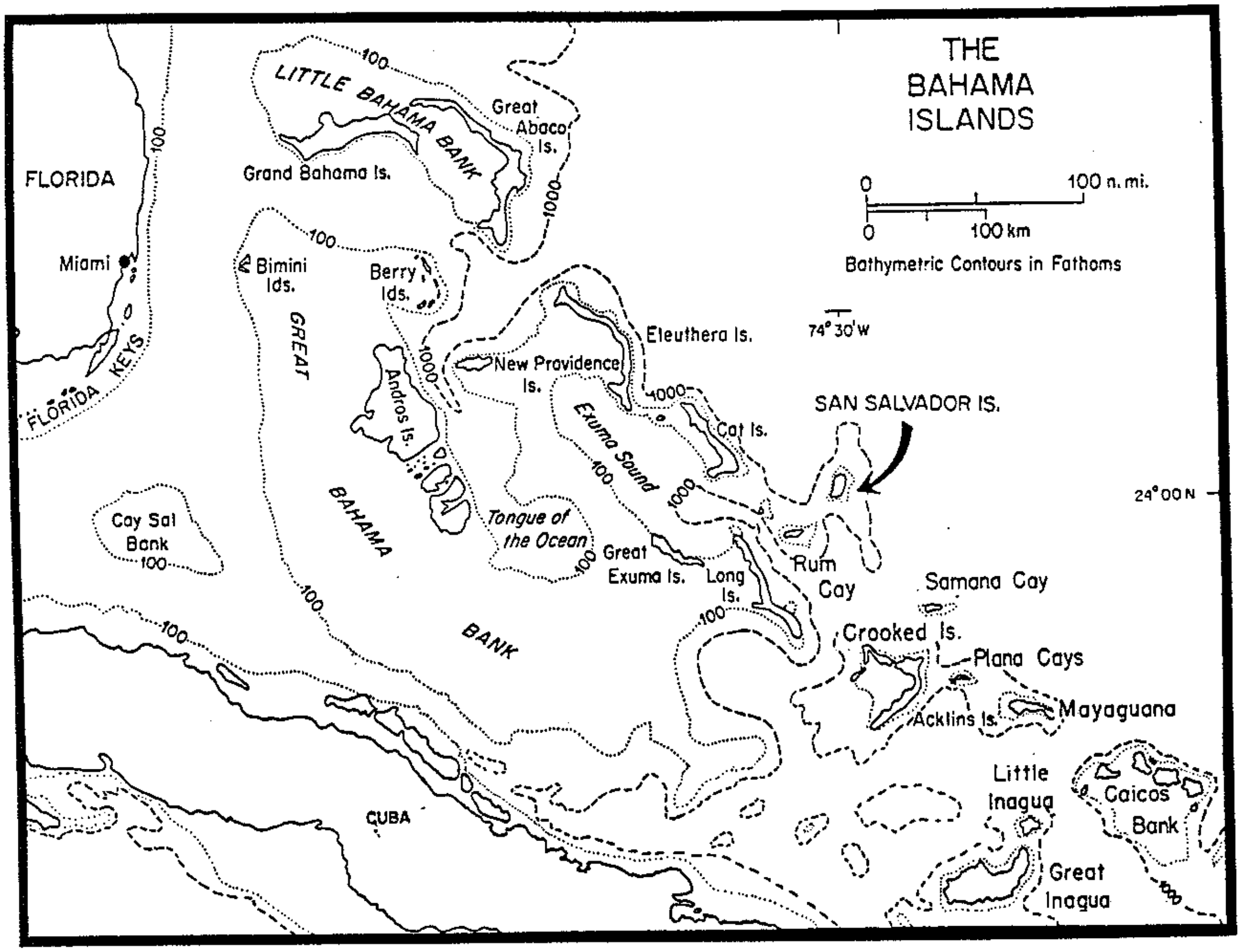

Figure 1. The Bahama Archipelago and location of San Salvador Island.

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 and a very steep slope. The topography of the island is dominated by arcuate ridges interpreted as representing successive stages of carbonate eolian accretion. Shallow hypersaline 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.

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 characteristics of the underlying rock. Road cuts and several quarries along the island's coastal highway also can provide good exposures for study. As a result of intensive geologic investigations by a number of workers over the past decade, the Pleistocene and Holocene bedrock geology of the island now is reasonably well known and has been summarized in a series of guidebooks. Some of the environments typically represented by these rocks are portrayed in the cross section of Figure 3.

KECK RESEARCH PROJECTS - 1992

With previous studies of the geology of San Salvador and the Keck Bahamas '87, '88, and '90 research reports as background, our group conducted four weeks of research investigations on San Salvador during June, 1992. After several days of reconnaissance field trips for familiarization with the carbonate environments and rock record of the island, each of the ten student participants began to formulate their individual research project.

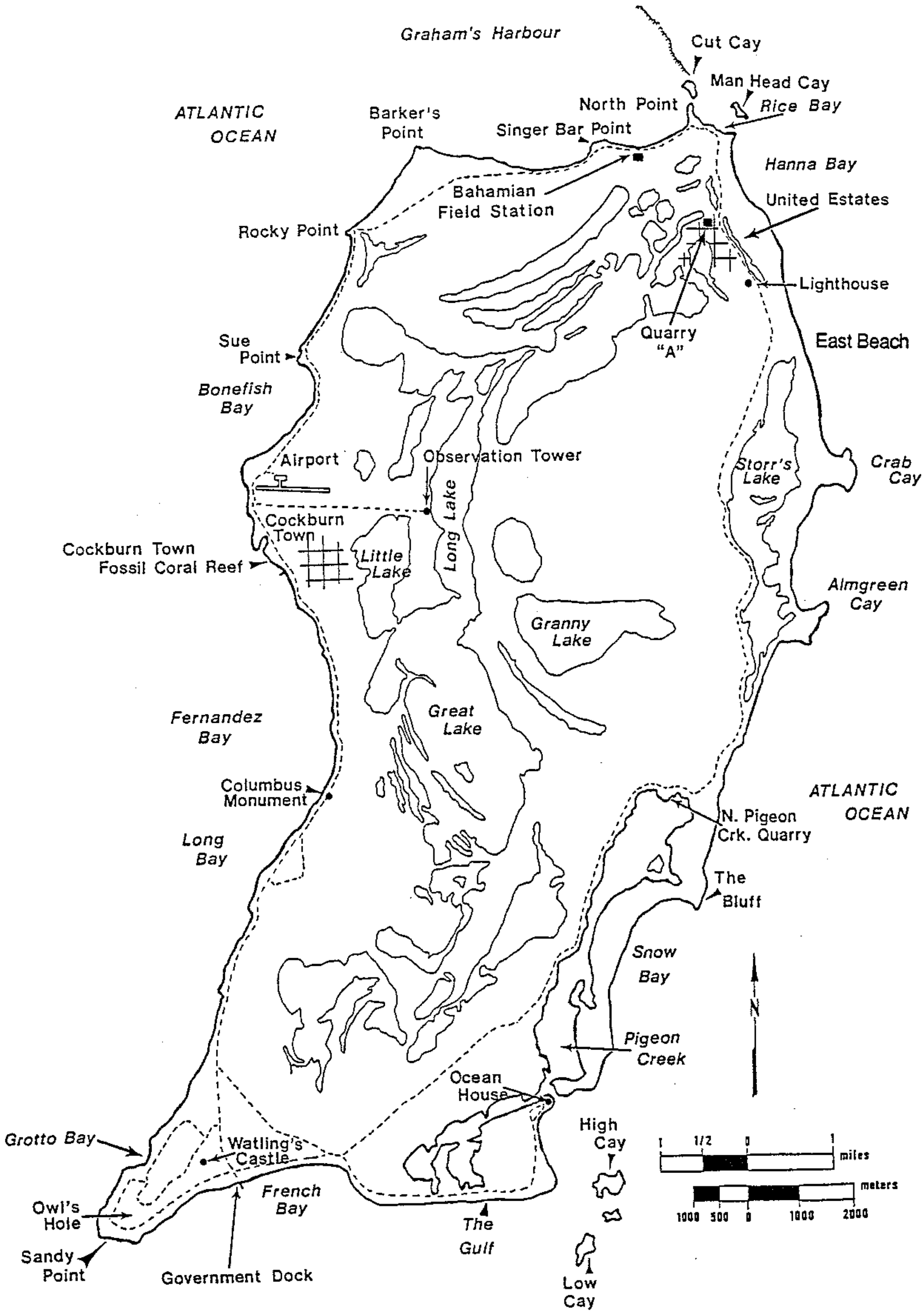

Figure 2. Index map to San Salvador Island.

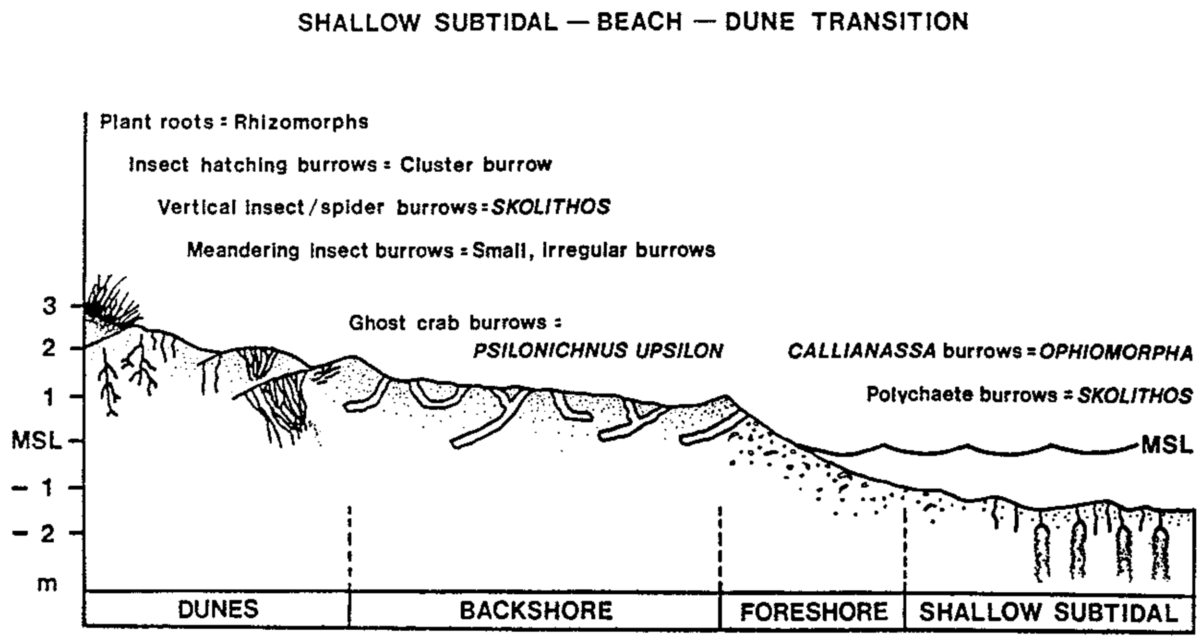

Figure 3. Depositional environments and ichnologic model for Bahamian calcarenites in the transition across an open coast from shallow subtidal to dunal settings. The shallow offshore might also include coral reefs on the open shelf and protected lagoonal areas elsewhere (Curran and White, 1991).

This year half of our projects had strong taphonomic themes, meaning that they were designed to investigate how the hard - part remains of organisms are affected by post - mortem physical and biologic processes and how such remains might become part of the rock record. The Bahamian setting is particularly good for such endeavors because the rock record provides readily accessible, close analogues to the modern environments. We had the added impetus of the expertise of taphonomist Ben Greenstein. Nicole Fraser (Smith) and Whit Swift (W&L) braved the waters of Bonefish Bay and Pigeon Creek to collect bottom samples along long transects for molluscan taphofacies studies, under the direction of Ben and with a visitor assist from Odell Maguire. Heather Moffat (Smith) also worked with Ben's supervision to sample extensively for a taphonomic comparison of Pleistocene and modern corals.

Julie Hohman (Wooster), with project design advice from Mark Wilson, collected a truly large number of the very heavy queen couch shells from two sites for a bioerosion and encrustation study. Much of the sediment of the Bahamas is generated by calcareous red and green algae. Kathryn Desmarais (Beloit), with assistance from Carol Mankiewicz and Carl Mendelson, designed a project to investigate the morphology of the red calcareous alga *Neogoniolithon* at three sites with different energy conditions to see if morphology may be related to offshore energy levels.

Rebecca Beavers (Williams) covered herself with sunscreen and continued the studies of the dynamics of the beach-dune systems at East Beach and Sandy Point begun in 1990 by Andrew Brill and Nick Loizeaux (both also Williams). We now have 2-1/2 years of data from these beaches. Lisa Greer (Colorado) and Durelle Smith (Smith) both chose to work on modern coral patch reefs in Fernandez Bay. With diving assistance from Davy White and the supervision of Al Curran, both designed projects to determine the baseline biologic and physical characteristics of these reefs.

Susan Jennings (Trinity) and Kathryn Riesenberg (Colorado) chose to work on rock record projects with direction from Brian White. Susan collected samples for a petrographic study and did further mapping at Sue Point, with assistance from Perry Roehl. This site was initially mapped as a Keck project in 1987 (published in 1989). Kathryn Riesenberg (Colorado), with help from Paul Myrow, collected rhzomorphs from several Pleistocene sites for a project designed to classify these highly variable and near ubiquitous forms. It was close, but Kathryn did survive in spite of encounters with "killer" thorns, jagged rocks, and out-of-control canoes.

In January, 1993, Becca Beavers, Lisa Greer, Heather Moffat, and Al Curran returned to San Salvador for an eight-day mini-workshop designed to collect seasonal data for the three student projects. Becca had some problems finding San Salvador (if you ask her very nicely, she *may* tell), but once that was resolved, we had an excellent week of further field work to finish successfully the data gathering for these projects.

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 funding to the Keck Geology Consortium which sponsored this project.

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Morphodynamics of Two Modern Carbonate Beach-Dune Systems on San Salvador Island, Bahamas

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INTRODUCTION

An understanding of the dynamic processes in the coastal zone is vital to developing a clear picture of the effects that small and large scale change can have on this system. Modern sediment dynamics can be detailed by following a series of profiles with baseline data. Two beaches on opposite ends of the island of San Salvador were chosen for comparison. East Beach and Sandy Point Beach are representative windward and leeward beaches with unique characteristics. Seasonal patterns are responsible for annual changes in East beach, but storm events provide the largest elements of change for these modern carbonate beach-dune systems at Sandy Point.

FIELD AREAS AND METHODS

East Beach is a windward beach located on the northeastern side of the island. It has a smooth undulating foreshore with a well-developed sequence of secondary dunes to the west. A 1 kilometer baseline was laid out in the primary dune and marked at 125 meter intervals in a series of nine profiles in June 1990 (Brill, 1991). In June 1992, these stations were located, and all nine profiles were surveyed by the stake and horizon method of profiling. All profiles originated in the primary dune and extended to 1.5 meters depth where possible (Figure 2). The time and date of all profiles were carefully recorded to allow for adjustment of all profiles to the Mean Level of Low Water (MLLW). Six profiles were extended to at least 50 meters offshore to better quantify the movement of sediment along East Beach. Depths offshore were measured with a weighted line and corrected to MLLW. All profiles from East Beach were reprofiled in January 1993. Elevations of the nine profiles were used to contour a topographic map of East Beach for June 1992 and January 1993 (Figures 1a and 1b). Sediment samples were collected along these six offshore profiles. All sediment samples were sieved and characterized according to the mathematic parameters of Folk and Ward (1957). Three carbonate sediment samples were collected for radiocarbon dating analysis. One sample from the foreshore will be used to provide baseline data for understanding the dates provided by samples collected from the secondary dune ridges behind East Beach. These dates will be used with their distance from the present foreshore to give an estimate for the rate of progradation of East Beach.

On the opposite corner of San Salvador, Sandy Point Beach comprises the southwestern point of the island. This leeward beach is free from most of the flotsam and jetsam that clutters the foreshore of East Beach and provides a remarkable contrast to East Beach. From rock headlands to the east, Sandy Point Beach wraps around the southwestern corner of the island and continues north until it ends at the cliffs at Grotto Bay. A 1.925 kilometer baseline was laid out in the dunes parallel to the shore in June 1990 (Loizeaux, 1991). Ten profile stakes were marked every 200 meters. This study area was expanded by the addition of seven more profile locations to better quantify the migration of sediment along this large area of beach. Two profiles were added to the southeastern portion of Sandy Point Beach to extend this study area 400 meters to the rock headlands to the east. Three profiles were positioned in the southwest on Sandy Point to allow for better control of the migration of the lobe of sand that comprises this point. Two profiles were added to the northern section in Grotto Bay to bring the total length of beach profiled to 2.4 km. Six offshore profiles were also completed on the northern section during June 1992 and January 1993. A swift current flowing around Sandy Point prevented completion of any profiles in the southernmost portion of the study area. All stations were profiled during June 1992 and January 1993. Unlike East Beach, the amount of change observed at Sandy Point after a southwesterly storm on June 21, 1992, did warrant another series of profiles on June 23, 1992. All profiles were performed using the same methods mentioned for East Beach and were also corrected to MLLW. Topographic maps were contoured for Sandy Point Beach for the beginning of June 1992, June 23, 1992, and January 1993 (Figures 3a, 3b, and 3c). Sediment samples were collected during the offshore profiling and later sieved in the lab. A sediment sample from the foreshore was also obtained from Sandy Point Beach to compare with the radiocarbon age obtained from the foreshore sample from East Beach. During all visits to each beach, careful field notes and pictures were taken to further document the change in these beaches.