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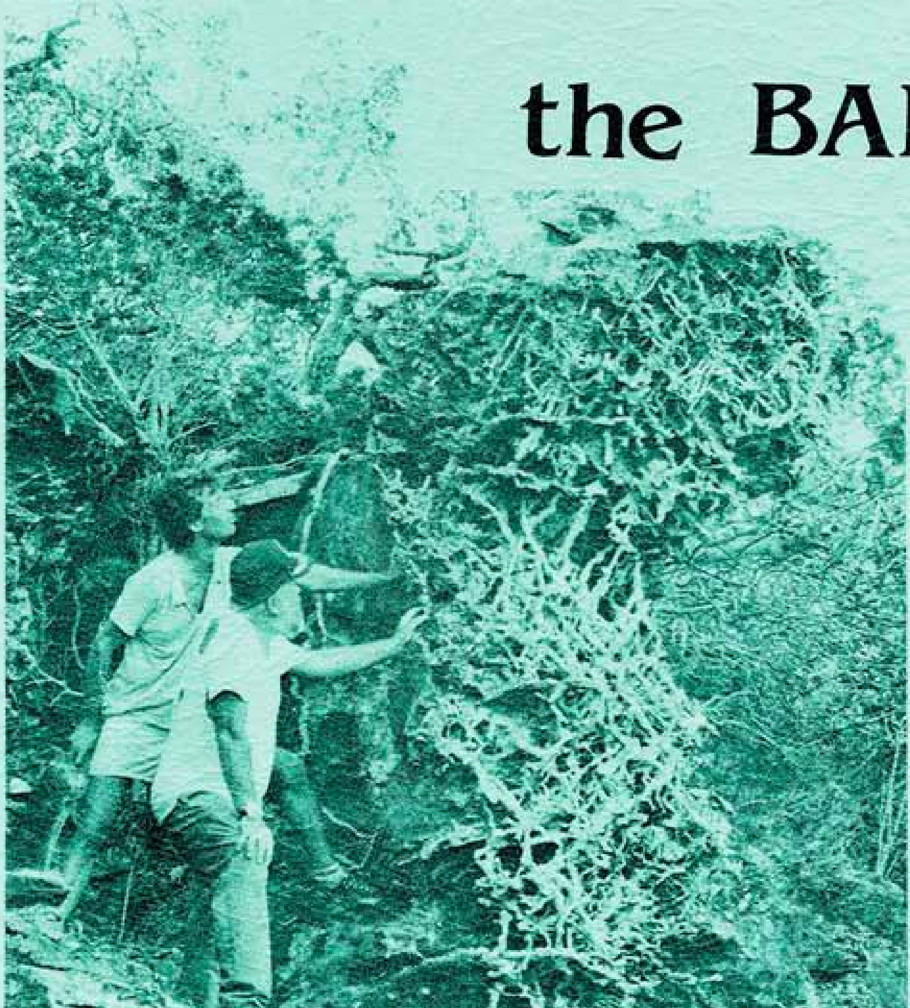

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PETROLOGY OF EOLIAN CALCARENITES, SAN SALVADOR ISLAND, BAHAMAS

Thomas Hutto
Department of Geology
University of Georgia
Athens, GA 30602

James L. Carew
Department of Geology
College of Charleston
Charleston, SC 29424

Abstract

Petrographic analyses of more than 75 thin sections from more than 100 eolianite localities on San Salvador, Bahamas reveals that petrographic criteria alone are insufficient to determine the interrelationships among the dune suites with regard to time of genesis. However, petrographic information combined with degree of karstification, amino acid racemization dating of *Cerion* from various localities, and constraints on dune genesis suggest at least three times of major eolianite deposition. This is consistent with data from New Providence Island (Garrett and Gould, 1984). We suggest approximate ages for these three phases of deposition of 125 ka-80 ka, 70 ka-10 ka, and 10ka.

Introduction

San Salvador Island, on the eastern margin of the Bahama Islands trend, is separate from the Great and Little Bahama Banks and entirely surrounded by water of greater than 1800 meters depth. The land area consists mainly of Holocene-Pleistocene eolianites that vary from transverse to parabolic dunes. Many of the dunes coalesced to yield eolianites with lengths of up to 8 km and heights over 38 m. Their shape and areal distribution reflect varying wind directions and stands of Pleistocene sea level.

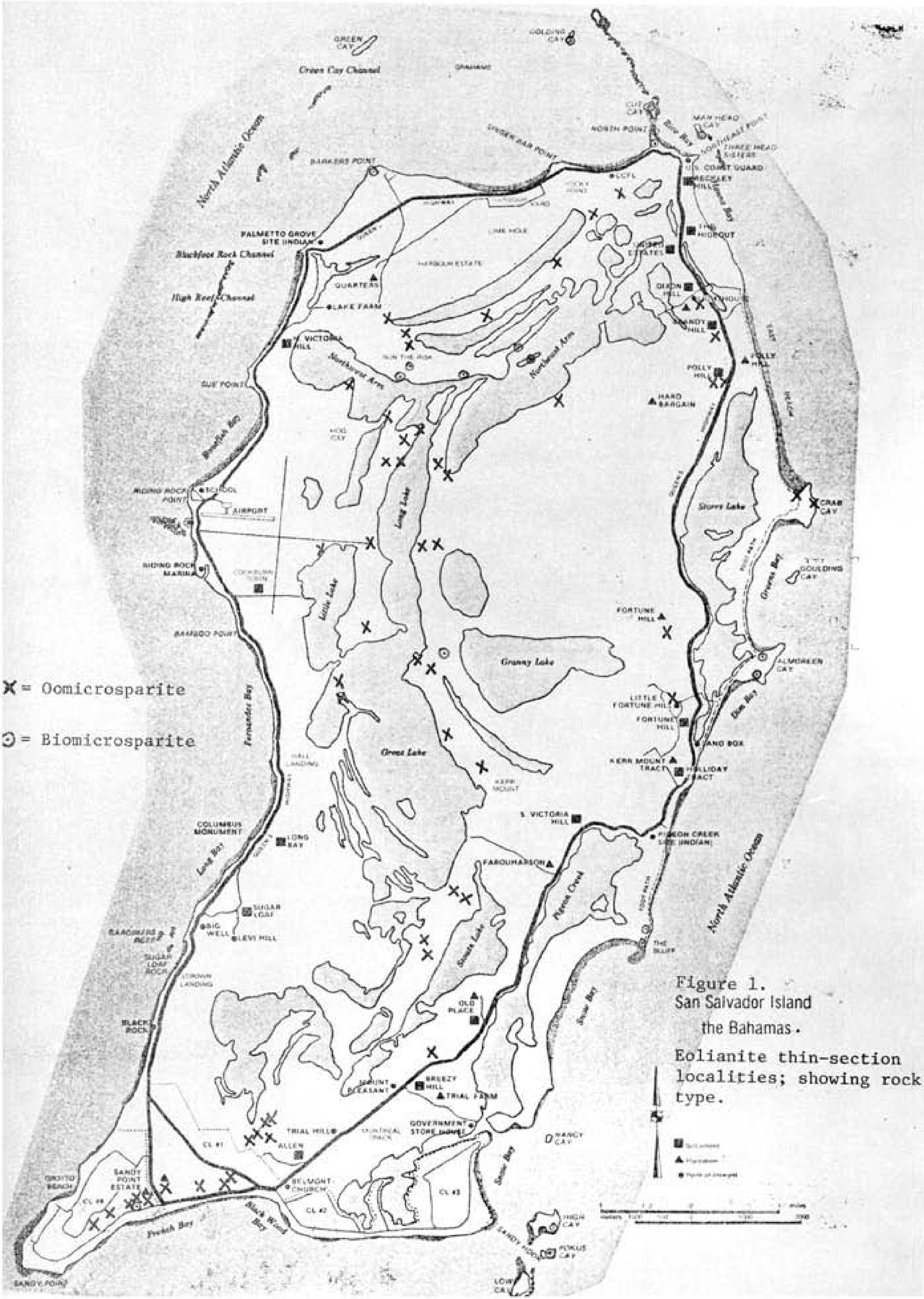
Samples were collected, and thin sections from approximately 75 localities were cut. They show that the eolianites are well sorted, and contain primarily ooids, skeletal fragments, and pellets. Ooids predominate in all but a very few thin sections.

Petrographic Study

Thin sections from approximately 75 localities can be divided into two categories (Figure 1). The first, oomicrosparites, represent 76% of the sample localities. The eolianites at those localities are composed of 90% ooids cemented by a meniscus of microspar and occasional equant spar. All cement is low Mg calcite. The remaining allochems are predominantly bioclastic material that are well sorted. The ooids vary in size from 0.05 mm to 0.3 mm, and average 0.2 mm. The great majority are equant, but some are slightly oblate. They often have a nucleus of micrite which may have been a pellet or small intraclast. The amount of coating varies from those that are superficially coated with but a few layers to those that are well coated. A strong resemblace to modern Joulter's Cay ooids is apparent (Figure 2).

The second group of eolianites is composed of biomicrosparites (including some oolitic biomicrosparites), and are compositionally much more variable than group one. They are predominantly an admix of skeletal grains, ooids and pellets, with skeletal grains being generally dominant (Figure 3). While highly variable the average grain size of these rocks is 0.3-0.5 mm.

Although the same ridge normally contains petrographically similar deposits, compositional similarity



X = Oomicrosparite

⊙ = Biomicrosparite

Figure 1.
San Salvador Island
the Bahamas.
Eolianite thin-section localities; showing rock type.

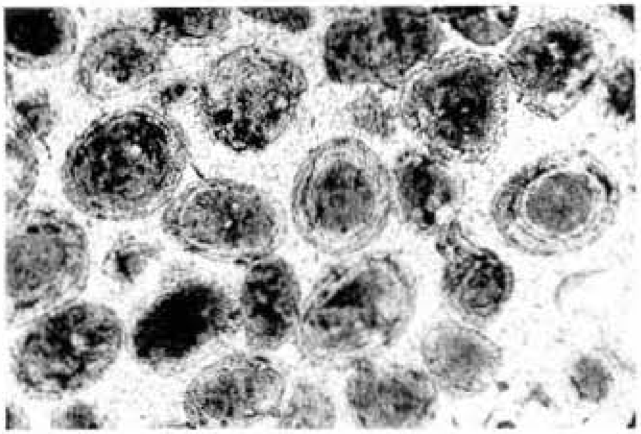


Figure 2a. Photomicrograph of a thin-section of Joulers Cay oolites in epoxy. x50,

Figure 2b. Photomicrograph of a thin-section of upper eolianite in Watlings Quarry. (Locality 60). x50. Note similarity between 2a and 2b.

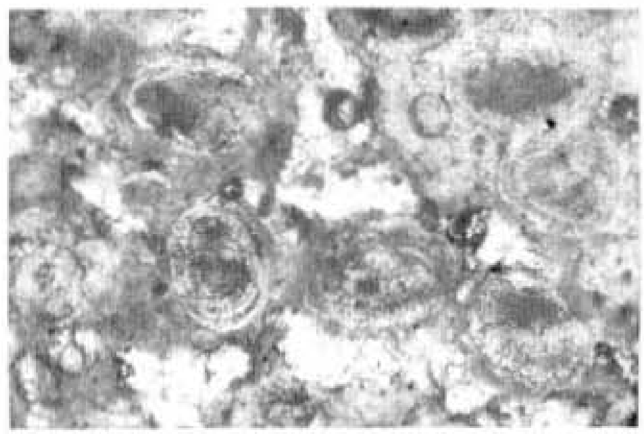


Figure 3a. Photomicrograph of a thin-section of eolinate ridge on High Cay. (Locality 55). x50.

3b. Photomicrograph of a thin-section of eolianite ridge north of Great Lake. (Locality 107). x20.

between eolian ridges cannot be used as evidence for coeval formation, as similarities and differences are also related to varying sediment sources. Consequently, formation of ooid shoals at different stages of Pleistocene history will result in petrographically similar eolianites being formed at different times. Conversely, eolianites formed concurrently with one another, but built by either different paleowinds or different sediment sources, can be petrographically dissimilar. However, some general trends are revealed petrographically.

Samples from many offshore cays, North Point, and modern dunes reveal a preponderance of skeletal material. Although ooids are present in amounts varying to as much as 50% of a sample, they are neither as generally well developed nor in as great an abundance as found in most rocks of the interior of the island. Furthermore, modern beach and shallow offshore sediments also contain a preponderance of skeletal material (Sims and Bergstrand, 1984).

These factors indicate that conditions favorable to ooid formation in great quantities are not currently found on the shallow shelf surrounding San Salvador. However, the appropriate conditions have been present in the past as demonstrated by the preponderance of oomicrosparite found in interior eolian ridges. Consequently, it is reasonable to assume that greater submergence of the island is necessary to provide greater area of shoaling for ooid formation. Therefore the interior island eolianites must have formed during, and as sea level fell from, high stands, thus exposing previously shallow ooid shoals to eolian processes.

Moreover, sea level must not have covered significant parts of the island in Holocene times as demonstrated by the youthful cays and modern dune and beach sediments.

Generally then, petrographic evidence is not a highly useful criterion for determining dune suites that formed concurrently. However, it is useful in providing clues about the Quaternary history of sea level stands as related to ooid formation.

Discussion

Three different generations of eolianites are presently recognizable (Figure 4). Based on the occurrence of modern dunes in close correlation with the beach, and the relatively rapid cementation of carbonate sands (MacKenzie, 1964), we believe that dunes begin their accretion adjacent to the littoral zone, and probably receive more sediment as sea level falls slightly. Surface inspection of interior and some marginal eolianite ridges reveals a calcrete layer of fairly uniform lithification on nearly all ridges irrespective of age. Within dune interiors, the youngest generation of dunes is slightly lithified to unlithified, and older generations of dune formation often exhibit a greater degree of lithification. However, these generalizations combined with the nearly omnipresent calcrete layer make degree of lithification alone an unreliable criterion for determining a deposit's age.

Generation one eolianites are the oldest. Formation probably conincided with the still-stand and fall of sea level from its approximately +6 m high at 125 ka. Under these conditions most, if not all, of the island would be awash (Garrett and Gould, 1984). Such conditions would be ideal for oolite formation. As sea level dropped, bars that with time became beaches probably emerged. Adjacent to the beaches and fed with beach sediments, dunes began to grow. As sea level continued to drop, further accretion of the original dunes took place and new dunes emerged to form sets of predominantly oolitic dunes as are seen surrounding Long Lake, South Granny Lake, and areas north of Northeast Arm (Figure 4). The resultant dunes must have been completed under conditions of sea level lower than present, as can clearly be seen from their drowned apearance at today's sea level. With continued fall in sea level, other dune ridges formed away from the center of the island. For example, Lighthouse Ridge was in place and lithified before 70 ka, as Lighthouse Cave must have been forming no more recently than that (Carew, et al., 1982; Carew and Mylroie, 1983; Carew, et al., 1984). A probable age of 85 ka for Lighthouse ridge eolianite seems reasonable (Carew, et al., 1984), and could be correlated with the Southampton Formation of Bermuda which has been dated at 85 ka by amino acid racemization (Harmon, et al., 1983). Because of similarity in shape and areal distribution, it seems reasonable to include Fortune Hill ridge, ridges west of Pigeon Creek, and ridges northwest of Allen Settlement in this grouping of pre-70 ka eolianites (see Figure 4).

Following the formation of the eolianites noted above, a second generation of dunes were accreted and lithified into

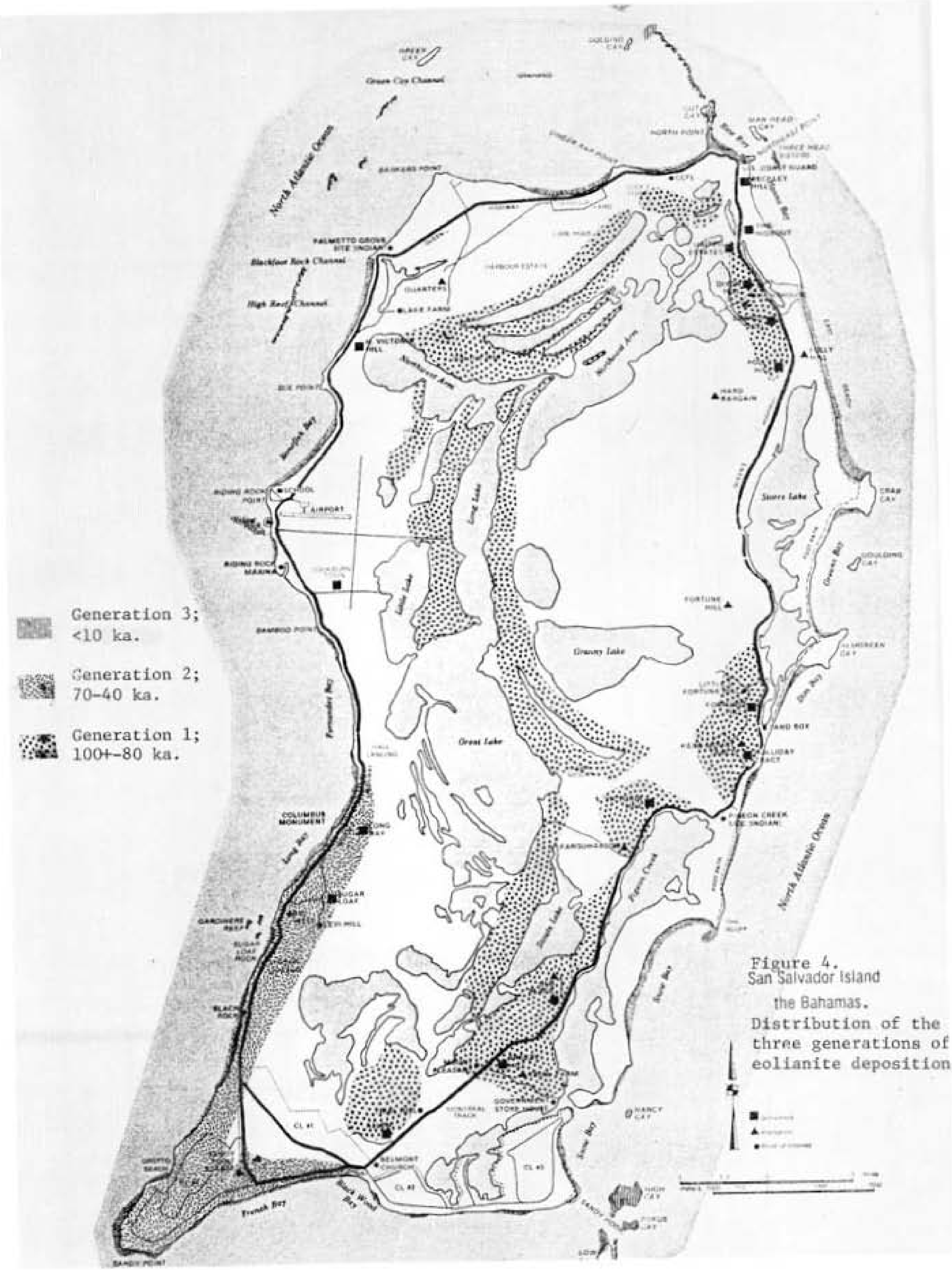


Figure 4.
San Salvador Island
the Bahamas.
Distribution of the three generations of eolianite deposition.

eolianites. These include ridges on Sandy Point and their linear extensions up the west side and along the south end of the island (see Figure 4). This assertion is based on the occurrence of Cerion dated by amino acid racemization at approximately 10 ka along French Bay (Carew, 1983) and other Cerion dated at approximately 70 $\pm$ 2 ka collected under the basal paleosol in Watling's Quarry (Carew, et al., 1984). Consequently, the overlying eolianites must be between approximately 85 ka and 10 ka. These ridges, which presently occur slightly inland of and parallel the present coast, are moderately to well lithified. Their degree of lithfication considered along with the occurrence of large (8 m deep) vadose freshwater solution shafts along their crest (Mylroie, 1983), denotes an age greater than that of the younger eolianites which are discussed below. These eolianites may have been formed coincident with the high sea level at approximately 40 ka - 50 ka proposed by Carew and Mylroie (Carew, et al., 1982; Carew and Mylroie, 1983; Carew, et al., 1984).

The youngest generation of dunes include: White Cay, Catto Cay, Cut Cay, North Point, High Cay, Nancy Cay, and Middle (Pokus) Cay (see Figure 4). These slightly lithified to unlithified eolianites seem to have been formed when sea level was lower (at approximately the present edge of the bank), due to their proximity to the bank edge, and their bedding that dips steeply below present sea level. The lack of significant lithification combined with a lack of significant karstification and paleosol crust indicates their relative youth. As sea level is generally accepted to have been at -120 m at approximately 18 ka the appropriate conditions for the development of these dunes were available during the rise of sea level from that low stand to its present elevation.

Summary

The eolianites on San Salvador Island all appear to have formed since the widely accepted high stand of sea level at 125 ka. The many similarities in paleoenvironmental conditions during Pleistocene sea level changes and the limited range of allochem composition preclude petrographic evidence as a highly useful criterion for determining the relative time of formation of dune suites, although some broad trends are revealed from the petrography. Criteria such as degree of karstification, lithification, and areal distribution of eolianites considered with dates provided by amino acid racemization of Cerion make possible a division of the island's eolianites into three basic suites, to which might be assigned the approximate age ranges of 125 ka to 80 ka, 70 ka to 10 ka, and 10 ka respectively. This three-fold subdivision would match well the scenario developed for New Provdence Island by Garrett and Gould (1984).

Acknowledgments

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