

# ***Characterizing Facies Heterogeneity in Pleistocene Marine and Eolian Deposits, New Providence Island, Bahamas***

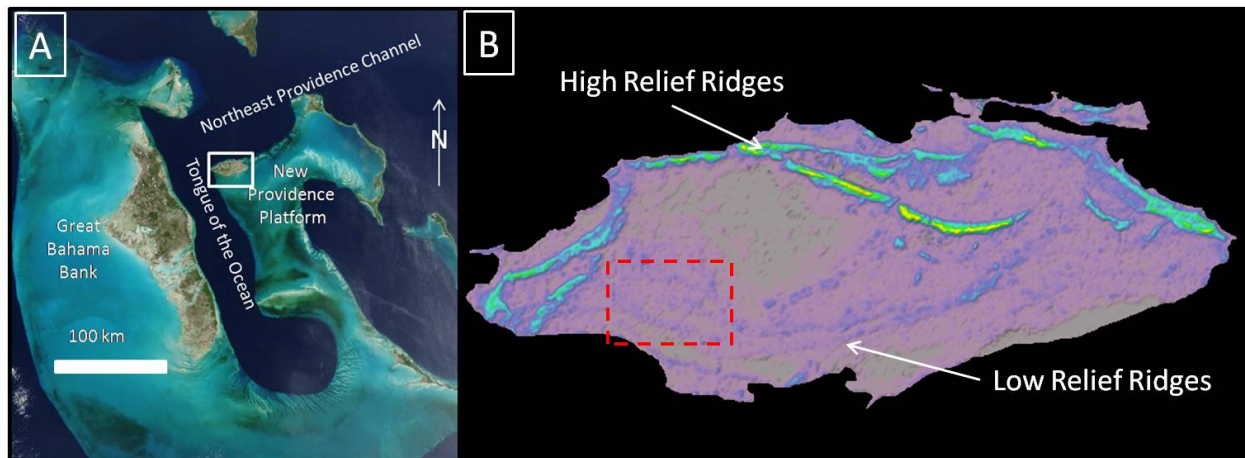
*Samuel B. Reid, Gregor P. Eberli, Donald F. McNeill and Klaas Verwer*

## **Background and Purpose**

New Providence Island is formed by vertical and lateral successions of subtidal, beach, and eolian deposits during several Pleistocene sea level highstands (Garrett and Gould, 1984; Hearty and Kindler, 1997). As a result, the ~200 km<sup>2</sup> island is a complex patchwork of facies of different ages but discrepancies remain concerning the timing of deposits in relation to Pleistocene sea level highstands. For example, Hearty and Kindler (1997) proposed that during MIS 7, eolianites built to higher relief than those during MIS 5e. But, sea level during MIS 7 was ~-17 m while it was ~+5 m during MIS 5e (Haddad et al., 1993). In addition, there is documentation that the last highstand MIS 5e experienced fluctuations of the sea level in the order of 10 – 15 m. Similar fluctuations can be expected within older highstands. New Providence Island potentially has the record of these fluctuations in the laterally accreted eolian and beach ridges. This aim of this project is to relate the island stratigraphy to the Pleistocene highstands and the fluctuations within the highstands while at the same time document and explain the facies heterogeneity and the accretionary history of New Providence Island.

## **Scope of Work**

This project will refine the documentation of the complex facies heterogeneity of juxtaposed ages, environments, and compositions on New Providence Island using the working hypothesis that the island formed through vertical and lateral accretion of marine and eolian deposits during the last three Pleistocene sea-level highstands (MIS 5, 9, and 11). Detailed stratigraphy both in outcrop and subsurface will be used to map out deposits across the island. This mapping, combined with detailed petrography of all units, will create a depositional and



*Figure 1. (A) Map of the Bahamas; white square shows the position of New Providence Island. (B) False color image of elevation across New Providence Island; red box indicates location of proposed GPS survey.*

diagenetic history of New Providence Island. Radiometric dating techniques will give the precise timing of deposition that is needed to relate the deposits to Pleistocene sea level changes. The beach facies within each one of the stratigraphic packages will provide an anchor point for the amplitude of sea level in each of the highstands.

## Project Description

In a first phase of fieldwork, facies and ages were mapped (Fig. 2). These maps show the lateral relationships of environments of deposition across New Providence Island, documenting facies heterogeneity with juxtaposed ages, compositions, and environments across a relatively small area. This year's fieldwork will focus on the detailed description of key outcrops. The Serenity Outcrop on the northwest side of New Providence Island shows prograding back-beach dune ridge systems, likely from MIS 5e. Bedding geometries of this outcrop will be mapped at high resolution to illustrate the internal facies architecture of such ridges. In addition, beach ridges to the south that show a punctuated sea level fall probably at the end of MIS 5e will be surveyed precisely using GPS measurements to assess the magnitude of each sea-level drop and thus the ice buildup associated with each subsequent ridge. Discontinuities in the eolian dunes at Collins Avenue, Travellers Rest, and the Queen's Staircase in northern New Providence will be carefully examined for paleosol development, as they may be evidence for sub-orbital-scale sea level fluctuations within MIS 5e suggested by Thompson and Goldstein (2005).

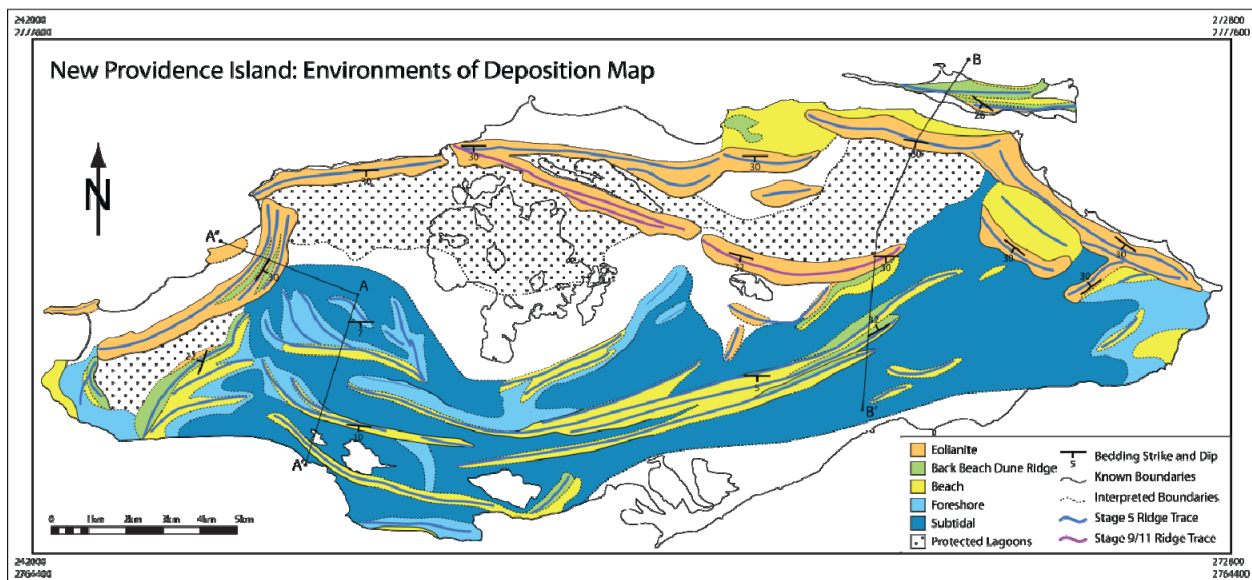
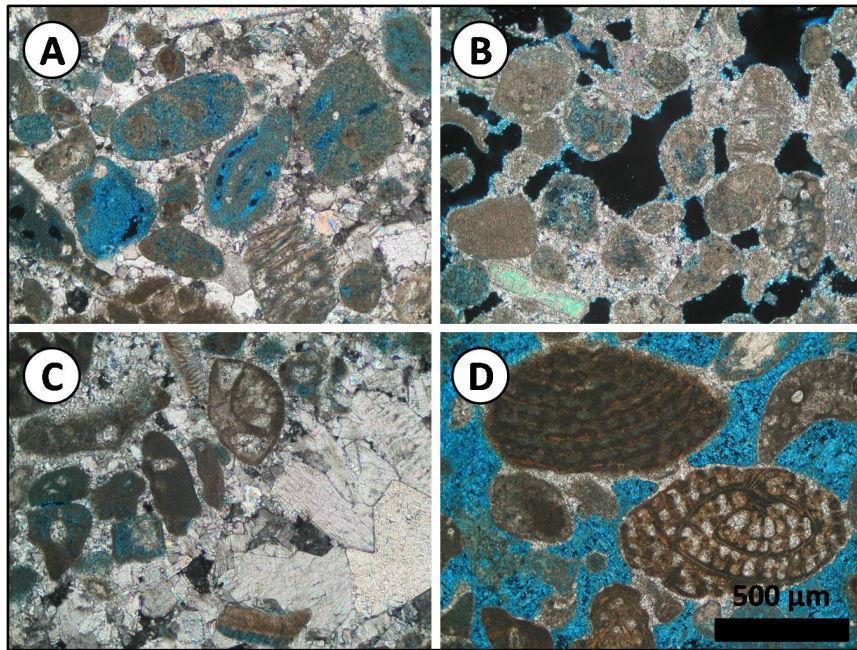


Figure 2. Map of environments of deposition across New Providence Island based on phase one of fieldwork.

Dating of the different ridges will be crucial for unraveling the sequence of depositional events on New Providence Island. Fossil shell samples have been collected from multiple locations across New Providence for U/Th dating. Initial tests show that the shells of land snail *Cerion sp.* can also contain enough Uranium for U/Th dating. Additionally, another dating method that may be employed involves plotting the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios from marine fossils on the

LOWESS fit for the marine Sr-isotope record in order to get numerical ages (McArthur et al., 2001).

In addition to the description of geometry and sedimentary structure within each ridge, thin section analysis is performed to document the composition and diagenetic histories of the different facies (Fig. 3). Of particular interest is the variable meteoric overprint of the different Pleistocene ridges. A cement stratigraphy is attempted and compared to the ages and relative succession of the ridges. Additionally, porosity and pore types will be classified to better understand the reservoir potential of these facies.



*Figure 3. Thin section photomicrographs displaying variations in composition and cementation. (A) Skeletal peloidal grainstone with partly dissolved grains. (B) Grainstone with early marine cement and interparticulate and microporosity (in the grains). (C) Skeletal grainstone with abundant blocky spar. (D) Skeletal grainstone with meniscus cement.*

In addition to >20 short cores (<1 m) from New Providence Island, two sets of long cores are available for interpretation. Multiple ~30 m cores from Clifton Pier (Aurell et al., 1997) are available to the University of Miami for correlation with outcrop stratigraphy. In addition, four cores up to ~20 m are available from the western end of Arawak Key near Nassau Harbor which will require retrieval from the Bahamas for study at the University of Miami. These two sets of cores will be used to create a 3D model of facies heterogeneity across New Providence Island.

### **Deliverables**

- Traditional outcrop mapping, core descriptions, and petrographic analyses will provide a comprehensive documentation of facies heterogeneity in 3D across New Providence Island.
- Detailed sedimentologic and petrographic description of the laterally accreting dune ridges.
- Documentation of the juxtaposition of facies of different ages based on the radiometric dates within the Pleistocene.
- Precise assessment of the down-stepping beach ridges to provide the magnitudes of the punctuated sea level fall leading into the last major glaciations.

## **Expected Results**

The results of this project will provide much-needed information on the instability of sea level highstands and the resultant temporal and spatial facies heterogeneity within a grainstone facies. In addition, detailed documentation of each facies type will provide a useful bank of information that can be used to identify similar deposits in the subsurface.

## **References**

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