The Role of Islands in Influencing Carbonate Platform-Top Deposition*

Paul (Mitch) Harris[1] and Sam J. Purkis[1]

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[1]Center for Carbonate Research, University of Miami, Miami, FL (pmitchharris@gmail.com)

General Statement

Great Bahama Bank (GBB) is a useful Modern analog to aid subsurface interpretation, particularly in the correlation and modeling of depositional facies within high-frequency sequences (cycles) across a platform-top. Islands atop GBB primarily consist of exposed Pleistocene limestone (eolian, beach and locally subtidal deposits from previous MIS 5, 9, and 11 highstands) (Figure 1). Although numerous (n = 1430), islands occupy only 8% (or 8700 km^2) of the platform-top (Figure 2), nevertheless, islands have played a critical role in focusing and shaping the filling of accommodation space during the Holocene by significantly influencing the local environment (tidal currents, wave energy, wind transport, etc.) to localize high-energy grainy factories and shape their deposits around them. Islands also provide protection in their lee for mud accumulation.

Analysis and Results

Remote sensing, facies and water depth mapping allow a partitioning of GBB into water depth zones that serve as a proxy for accommodation filling (Figure 3; Purkis and Harris, 2016). The "filled" zone extends from sea level down to a water depth of -1.5 m, the "under-filled" zone captures terrain from -1.5 m depth to -6.0 m, and the "unfilled" zone extends from -6.0 m depth down to the -30 m contour of the platform-margin.

Analysis of accommodation filling relative to island location reveals that the likelihood of encountering filled accommodation decreases exponentially with increasing distance from islands, and the probability of encountering under-filled accommodation is 70% for the first 50 km offset from the islands (Figure 4).

Seventy percent of sediment in the areas of filled accommodation is rudstone, high-energy grainstone, grainstone and mud-poor packstone (Figure 5); thus there is a linear increase in the probability of encountering grainy facies (potential reservoir) and a corresponding decrease in the likelihood of encountering muddy facies (potential baffle) with increasing distance from islands (Figure 6). The most abrupt lateral changes of depositional facies across the platform-top are observed leeward of islands, areas that also hold the highest diversity in facies type.

Most islands are preferentially distributed along the eastern (windward) margin of GBB and align with the NW-SE strike of the margin; these islands, in turn, exert control on the shape and orientation of facies belts that develop in proximity to them. For this reason, regions of the platform that contain prevalent islands host facies belts that align with the principal axis of the platform, whereas for regions lacking islands, the facies belts adopt an E-W trend consistent with prevailing winds and currents (Figure 7).

References Cited

Harris, P.M., S.J.Purkis, J. Ellis, P.K. Swart, and J.J.G. Reijmer, 2015, Mapping water-depth and depositional facies on Great Bahama Bank: Sedimentology, v. 62, p. 566-589.

Purkis, S.J., and P.M. Harris, 2016, The extent and patterns of sediment filling of accommodation space on Great Bahama Bank: Journal of Sedimentary Research, v. 86, p. 294-310.

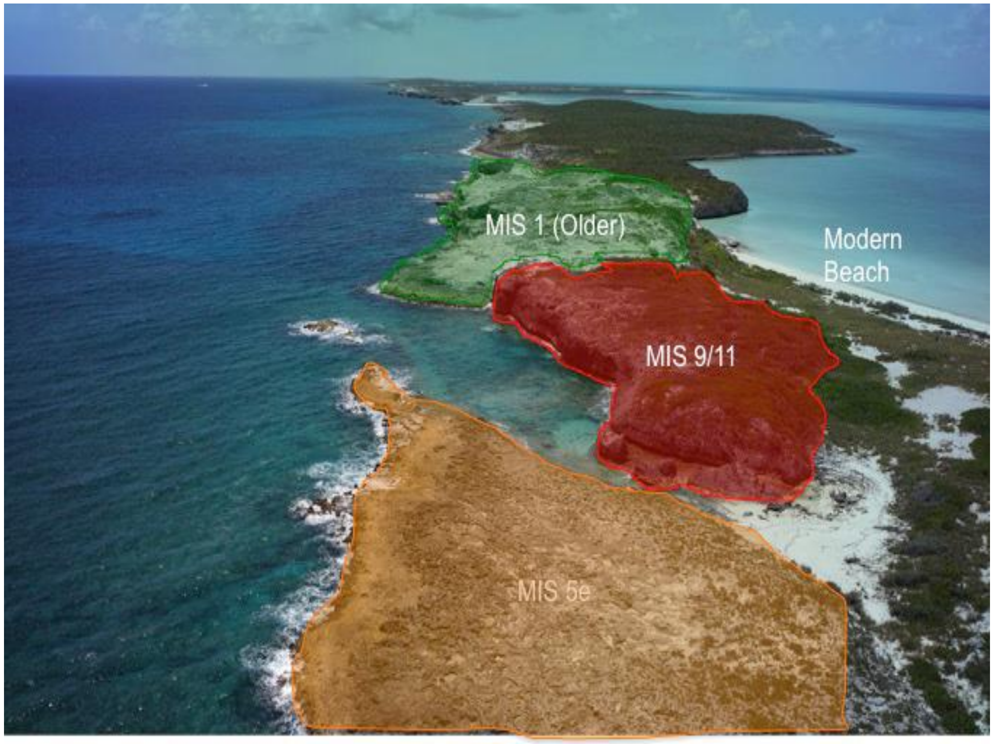


Figure 1. Oblique aerial view of islands in the Exumas portion of GBB, highlighting complex age relationships.

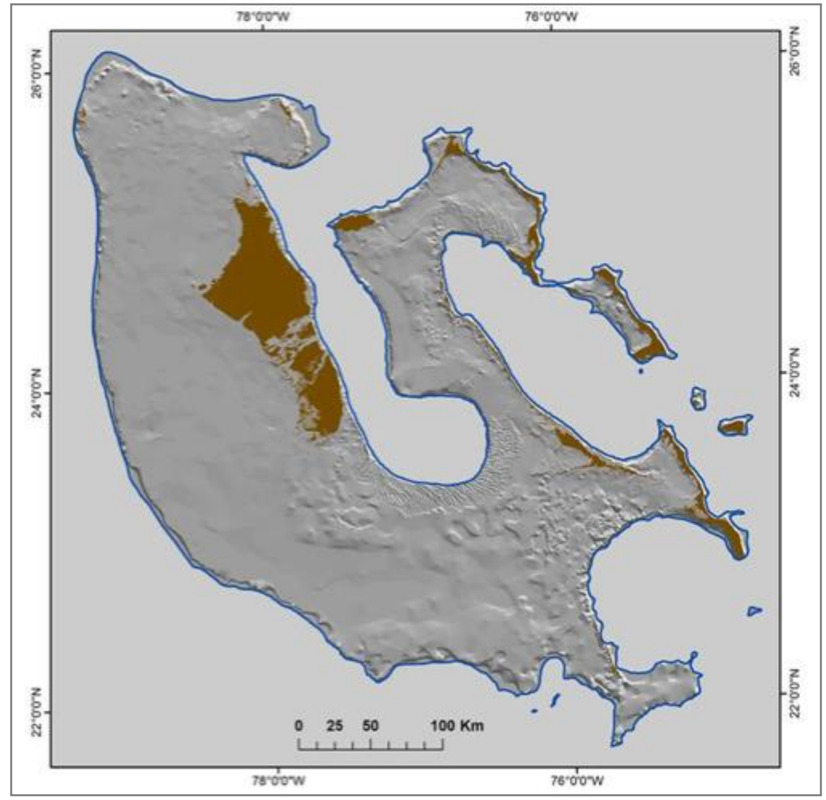


Figure 2. Islands shown in brown on shaded relief DTM of GBB (from Harris et al,, 2015).

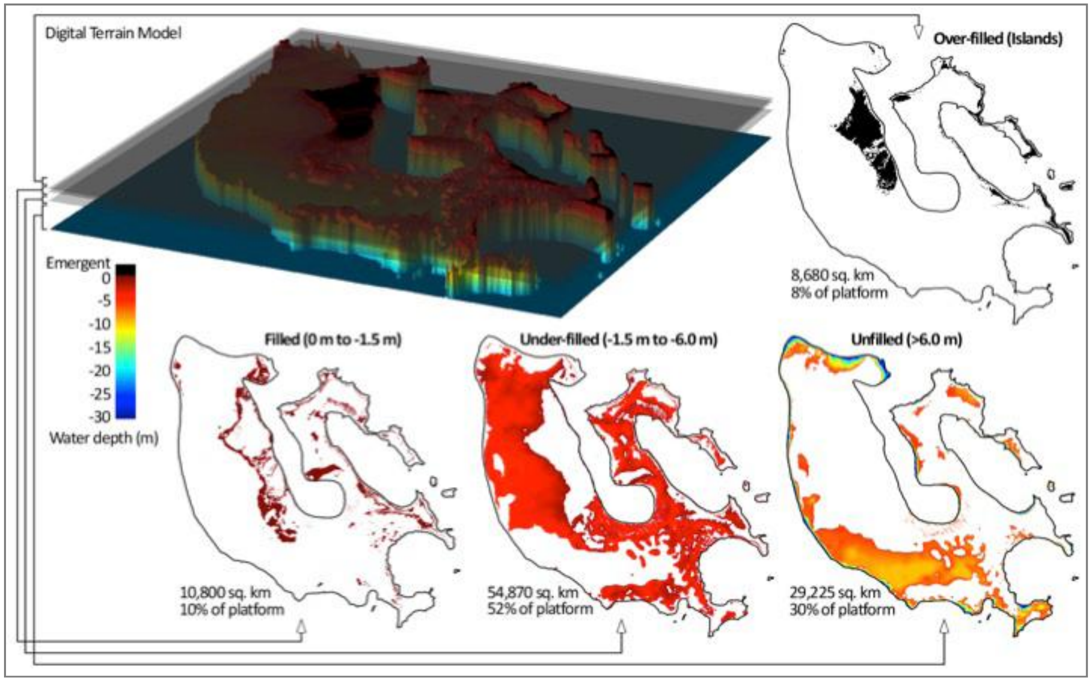


Figure 3. DTM and facies maps, from Harris et al. (2015), are interpreted to show patterns in filling of accommodation space across GBB.

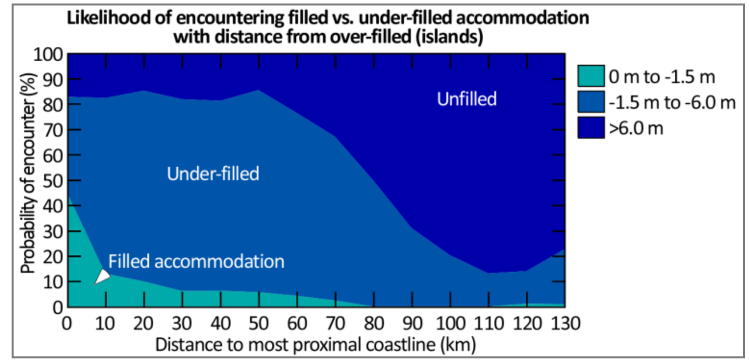
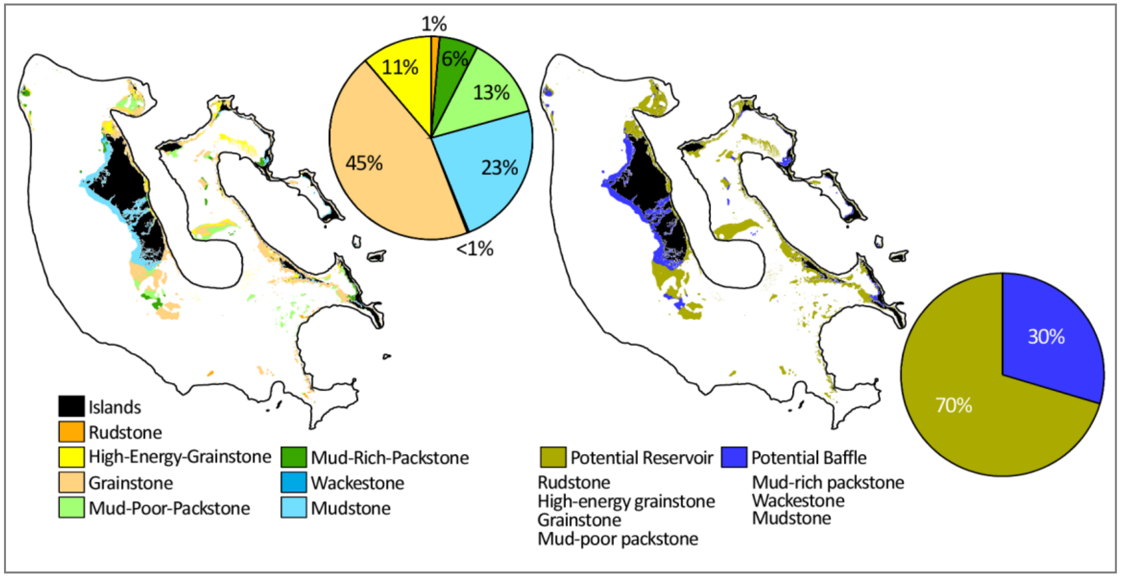


Figure 4. PDF showing variation in accommodation filling with respect to distance from islands.



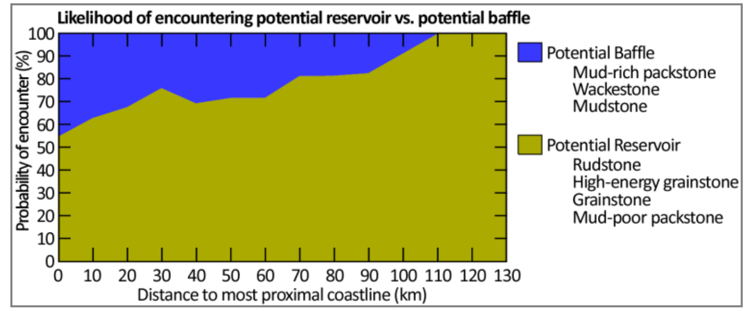


Figure 5. Maps of GBB showing sediment types in areas of filled accommodation space (left) and sediments grouped by primary-porosity character into potential reservoir and baffle (right).

Figure 6. PDF showing variation in grainy facies (potential reservoir) and muddy facies (potential baffle) with respect to distance from islands.

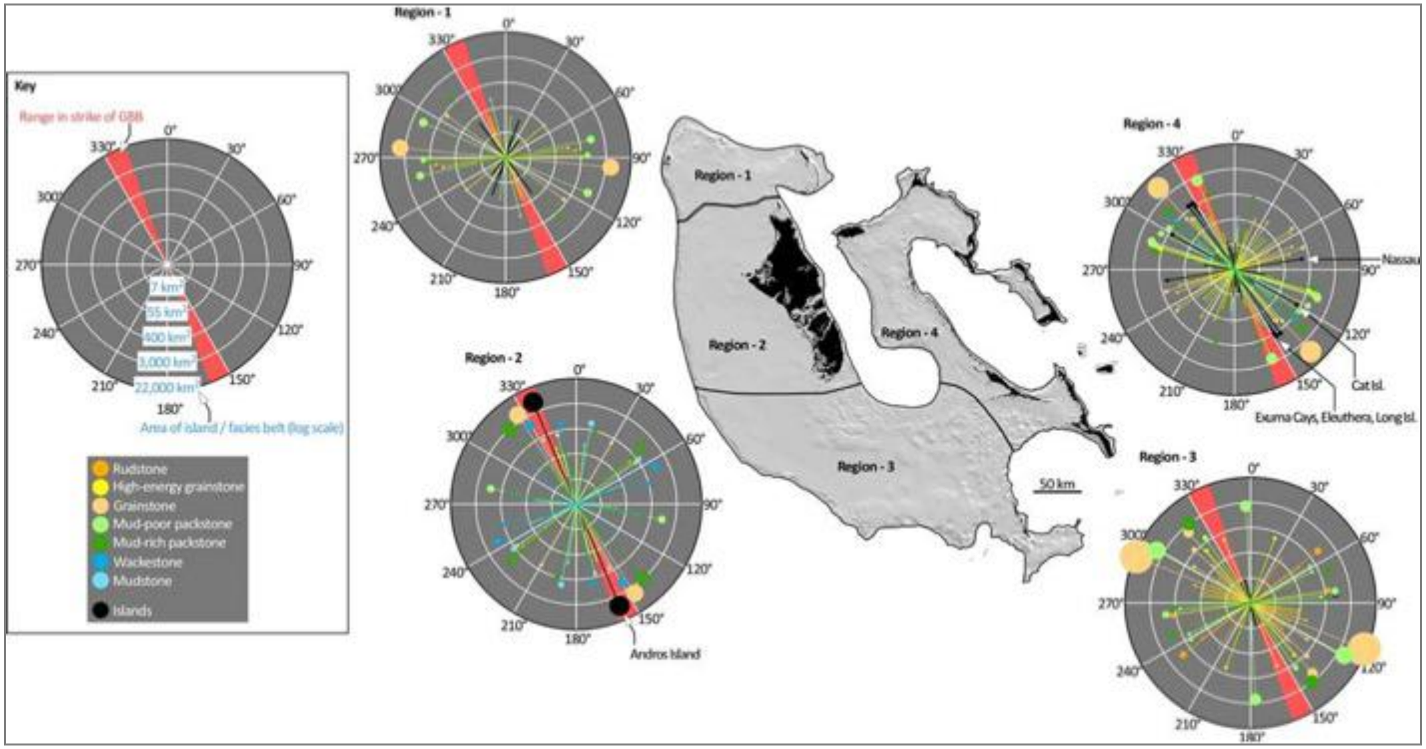


Figure 7. Analysis of facies orientations wherein GBB is subdivided into regions and the alignment of depositional facies are investigated with regard to island occurrence and platform-margin orientation.