Great Bahama Bank – Part II: Mapping Depositional Facies on a "Flat-Topped" Isolated Carbonate Platform*

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Please refer to companion article, entitled "**Great Bahama Bank – Part I: Evaluating Water-Depth Variation on a 'Flat-Topped' Isolated Carbonate Platform**," Search and Discovery Article #50960 (2014).

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Abstract

Great Bahama Bank (GBB) stands behind many of the models used to illustrate depositional -facies variation across flat-topped, isolated carbonate platforms, which have long served as subsurface analogs at a variety of scales. We have used Landsat TM imagery, a refined bathymetric digital elevation model, and seafloor sample data compiled into ArcGIS and analyzed with eCognition to develop a depositional facies map (Figure 1) that is more robust than previous versions.

For the portion of the GBB lying west of Andros Island, the facies map was generated by pairing an extensive set of GPS-constrained field observations and samples (n=275; Reijmer et al., 2009) with computer and manual interpretation of the Landsat imagery (see Figure 2). Twenty-one samples collected by the National Coral Reef Institute immediately north and south of Andros provided additional control points for the mapping. Approximately 35,000 km^2 of the GBB platform are within or along the margin of the 308 control points; so there are ~0.001 control point/km^2 or ~1 control point/100 km^2.

For the remainder of the platform, where we lacked such rigorous ground-control, the Landsat imagery was segmented into lithotopes - interpreted to be distinct bodies of uniform sediment - using a combination of edge detection, spectral and textural analysis, and manual editing (see Figure 3). The facies map was then developed by assigning lithotopes to facies classes on the basis of lessons derived from the portion of the platform for which we had rigorous conditioning.

Of particular importance are the detailed and generalized distributions of muddier lithologies and grainier lithologies shown by Figure 4 relative to that of previous maps. GBB is essentially a very grainy platform with muddier accumulations only in the lee of substantial island barriers. In this regard, Andros Island which is the largest island on GBB, exerts a direct control over the muddiest portion of GBB. Mudstones, wackestones, and mud-rich packstones cover 8%, 5%, and 14%, respectively, of the GBB platform top. By contrast, mud-poor packstones, grainstones, and rudstones account for 20%, 45%, and 3%, respectively. Of the 45% of the platform-top classified as grainstone, only 3% is composed of "high-energy" deposits characterized by the development of active sandbar complexes.

The diversity and size of facies bodies are broadly the same on the eastern and western limb of GBB as shown on the perspective views in Figure 5 (A is north-looking; B is south-looking), though the narrower eastern limb, the New Providence Platform, hosts a higher prevalence of grainstones. The northern half of the platform hosts a more heterogeneous facies mosaic than the south half, a difference likely related to the greater prevalence of islands. The most abrupt lateral facies changes are observed leeward of islands, areas which also hold the highest diversity in facies type.

The influence of Andros Island over mud accumulation is evident in the maps comprising Figure 6. There is a clear trend that the widest portion of the platform, which lies to the south of the TOTO, lacks islands, and hosts the most continuous expanses of grainstone. The prevalence of rudstone increases from north to south in step with an increase in water depth.

Further interrogation shows the breadth of the grainy fairways on the platform top is double that of the mud-rich (Figure 7). Grainy sedimentary bodies are highly interconnected, whereas mud-rich bodies are more isolated.

The depositional facies map should facilitate better use of this isolated carbonate platform as an analog for both exploration- and reservoir-scale facies analysis, serve as a template for better characterizing the platform at all scales, and highlight future research areas where "ground-truthing" is needed to further investigate facies patterns.

Reference Cited

Reijmer, J.J.G., P.K. Swart, T. Bauch, R. Otto, L. Reunig, S. Roth, and S. Zechel, 2009, A re-evaluation of facies on Great Bahama Bank. I: new facies maps of western Great Bahama Bank: International Association of Sedimentologists, Special Publication. 41, p. 29-46.

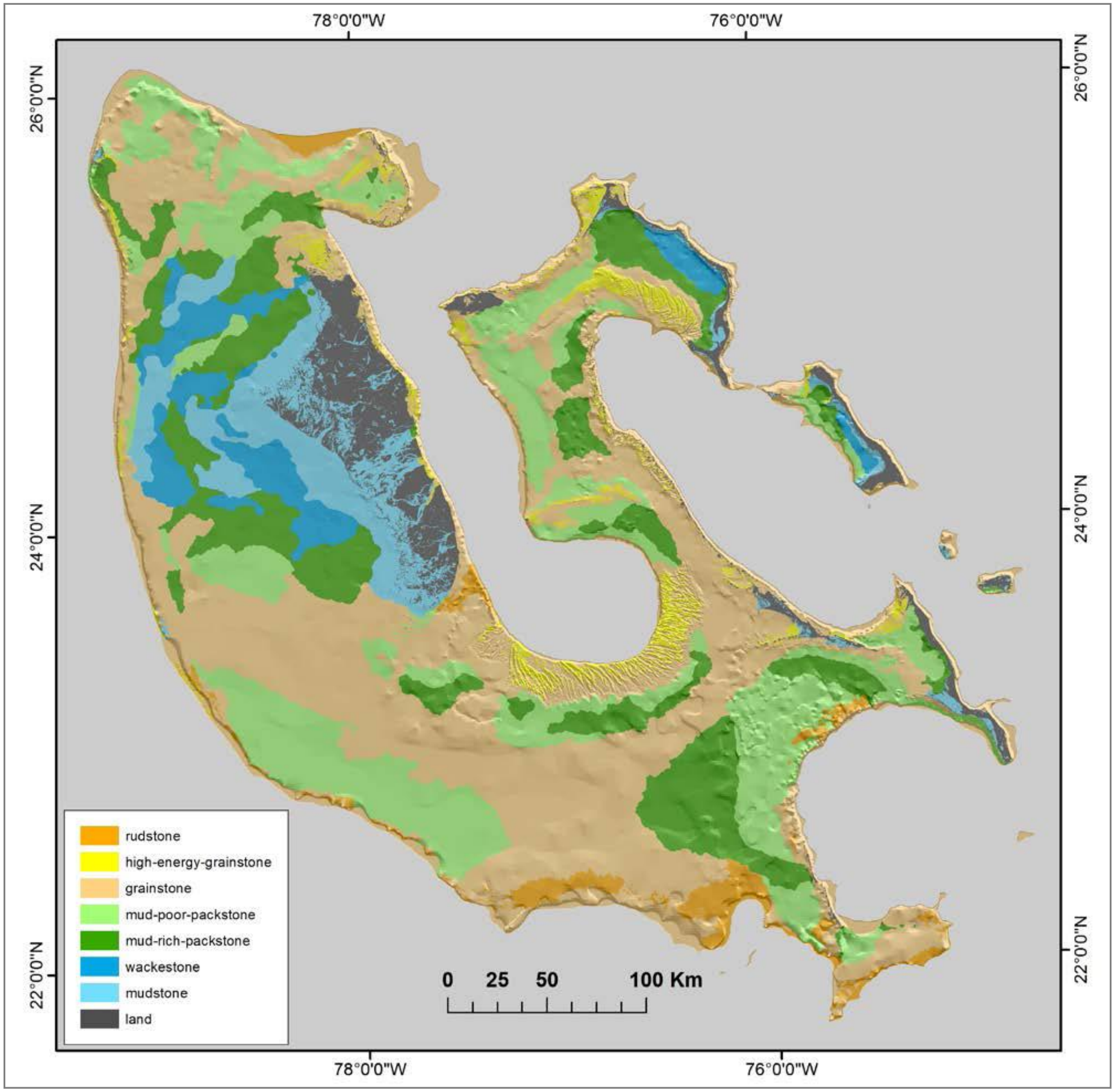

Figure 1. Depositional facies map of Great Bahama Bank (GBB) prepared from Landsat TM imagery, a refined bathymetric digital elevation model, and seafloor sample data and compiled into ArcGIS and analyzed with eCognition.

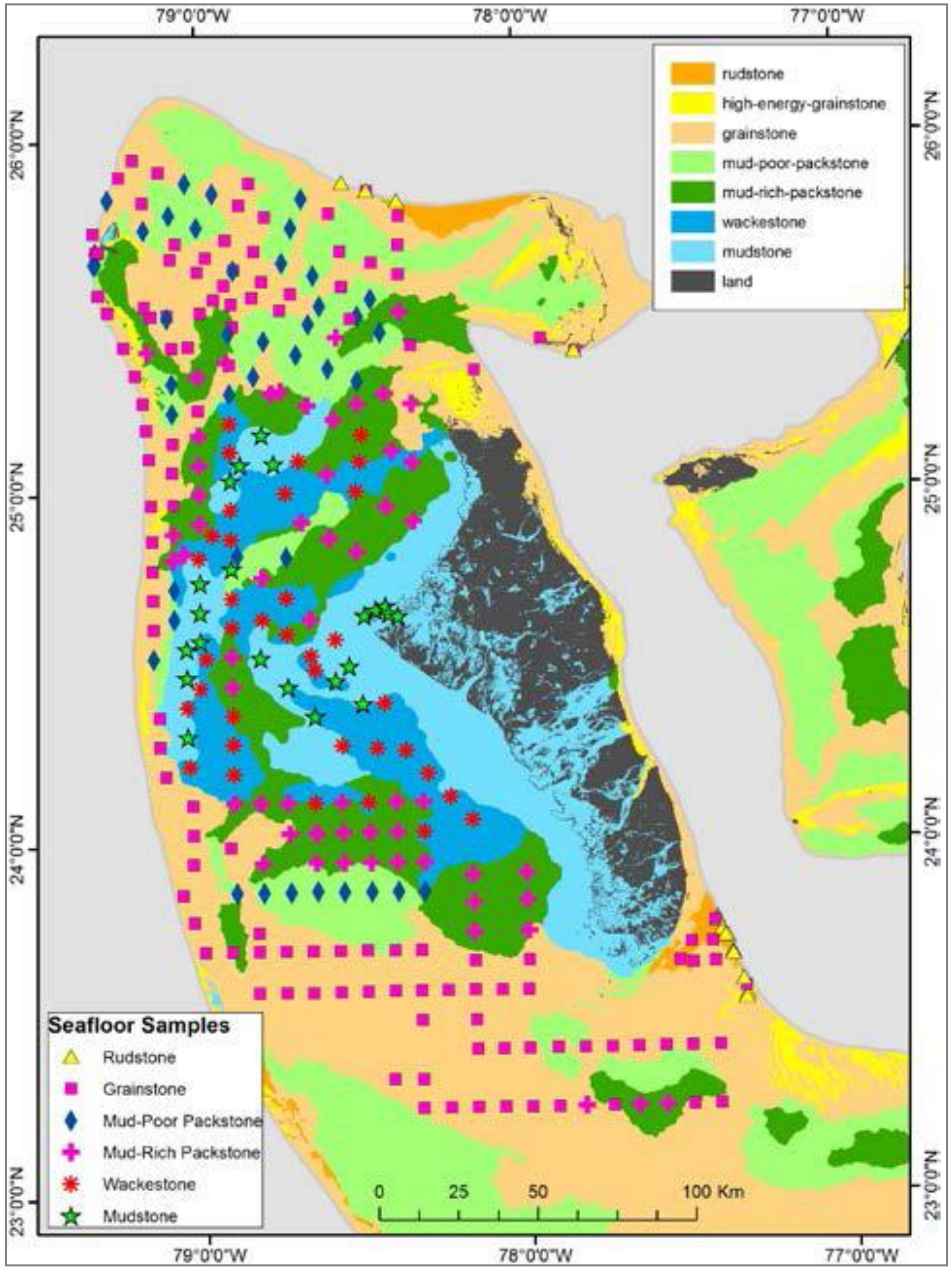

Figure 2. Distribution and lithotypes of seafloor samples in the areas west, north and south of Andros Island.

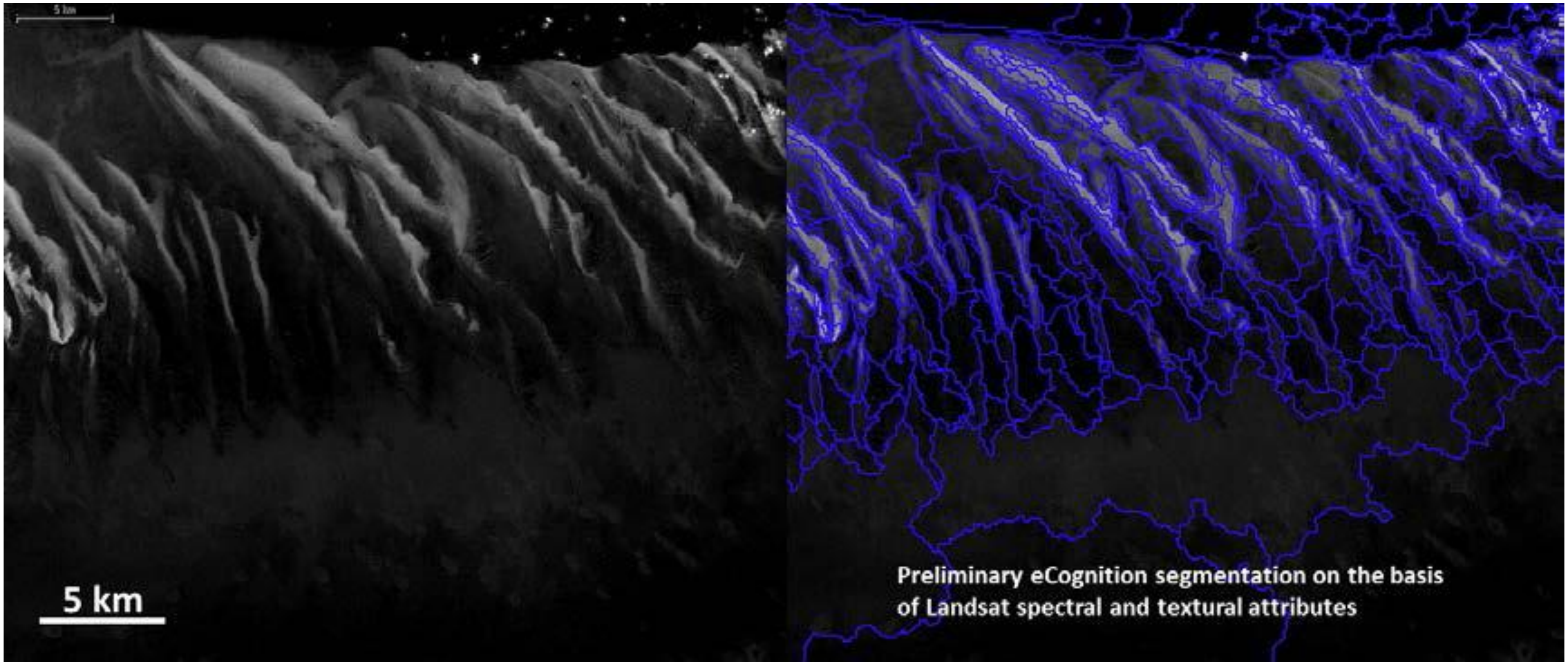

Figure 3. Example of facies map developed by preliminary eCognition segmentation on the basis of Landsat spectral and textural attributes, with manual editing.

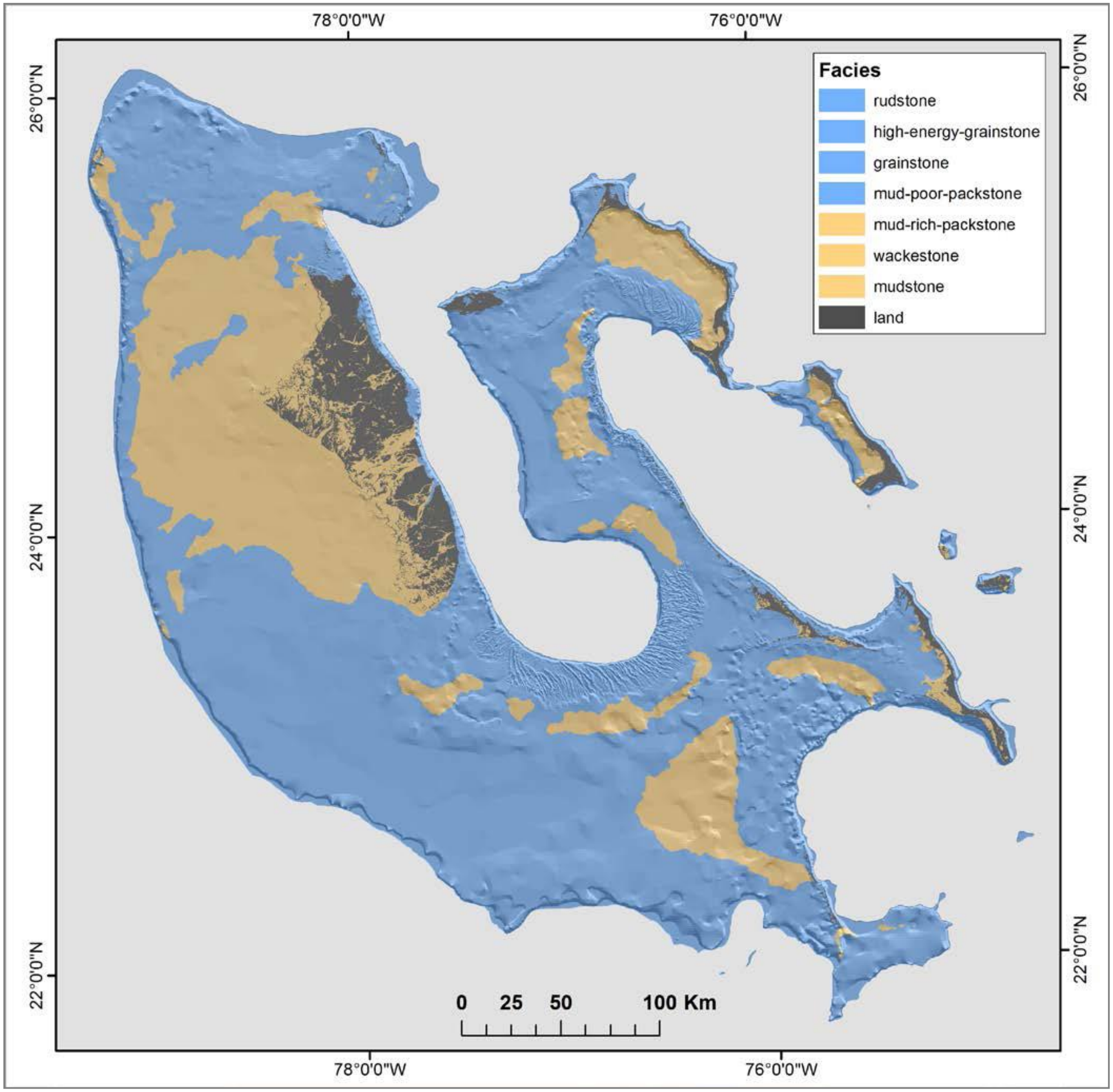

Figure 4. Depositional facies map of GBB, showing detailed and generalized distributions of muddier and grainier lithotypes.

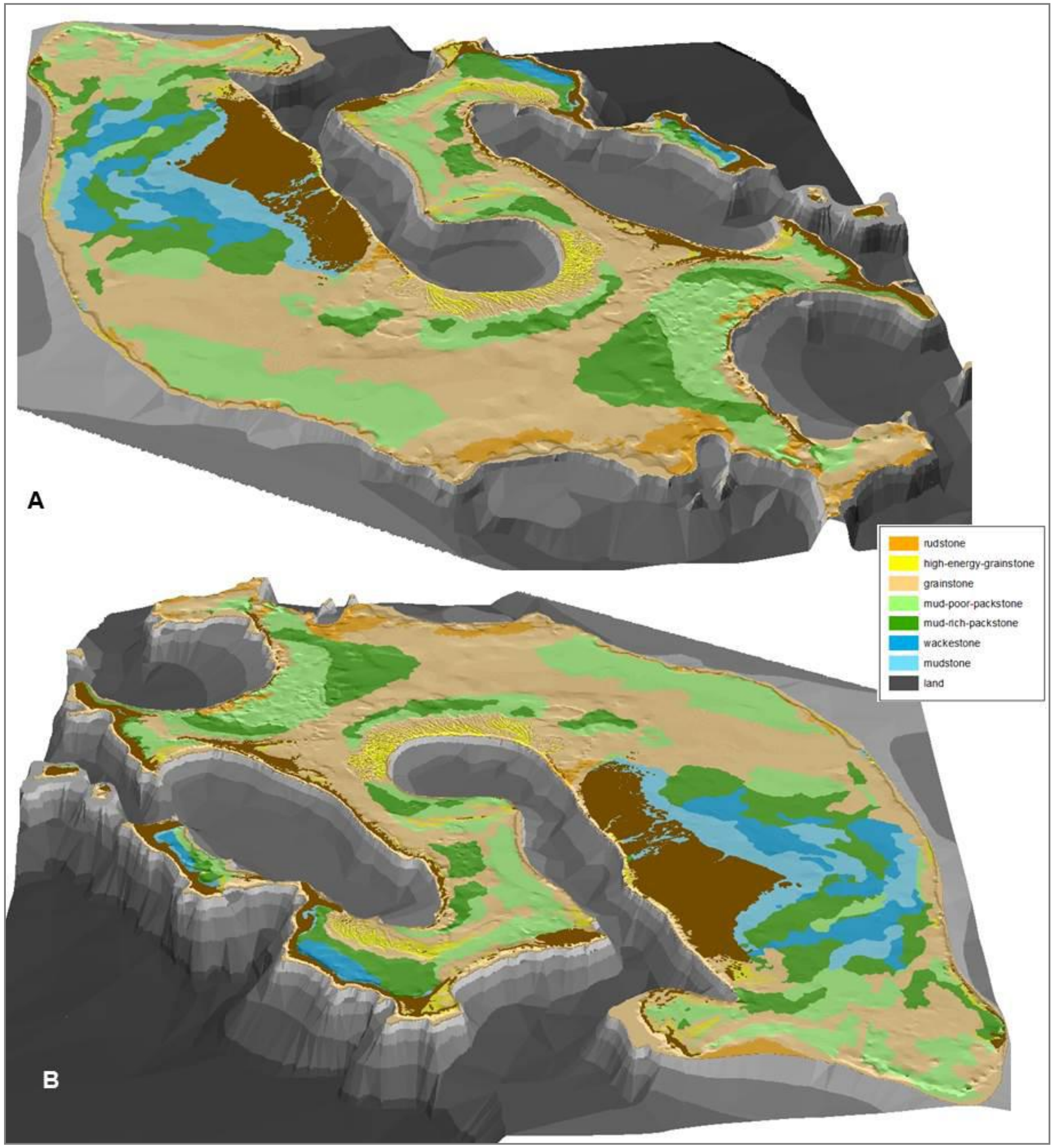

Figure 5. Perspective views of the diversity and sizes of facies bodies of GBB. A is north-looking; B is south-looking.

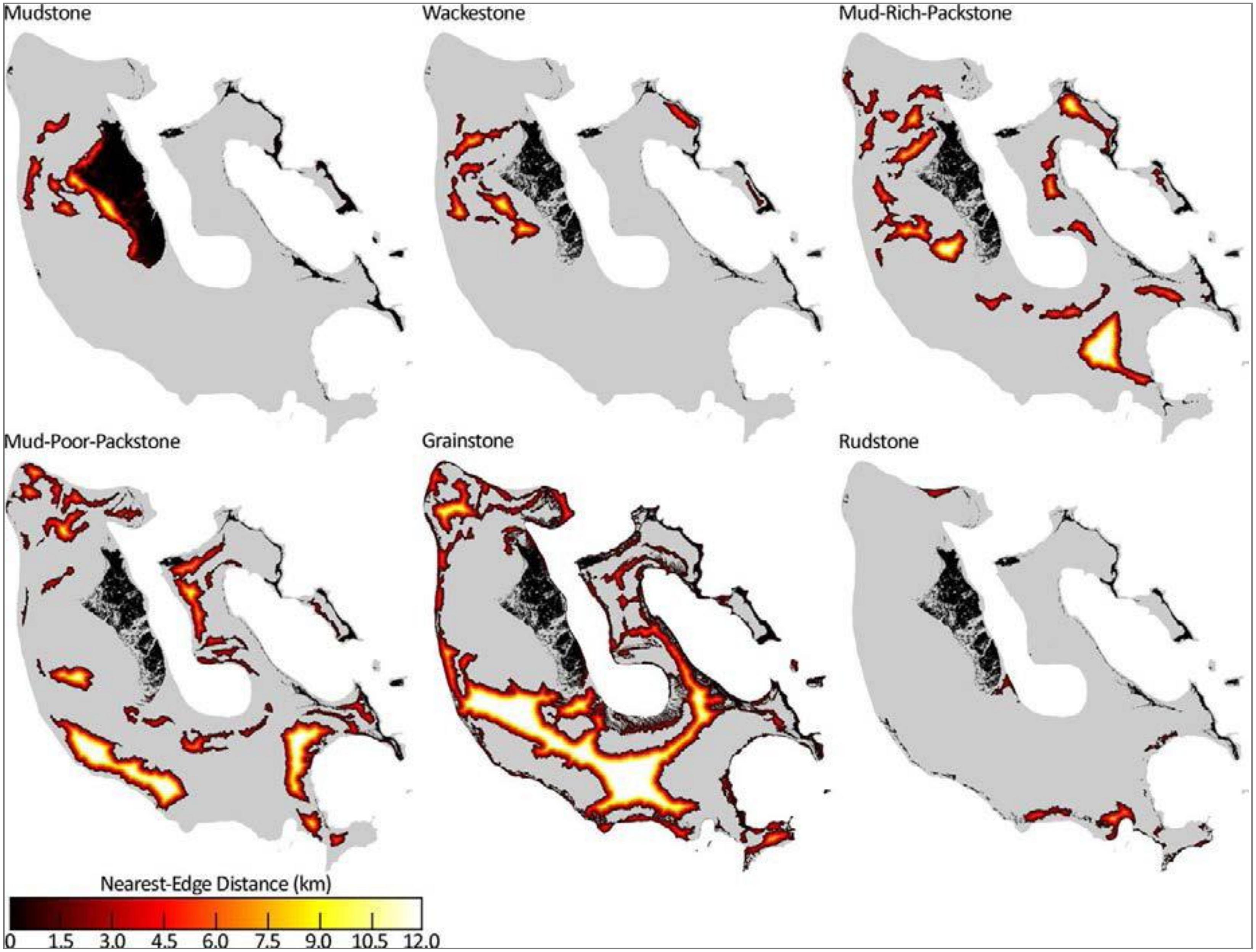

Figure 6. Maps of the distribution of lithotypes of GBB, showing the influence of Andros Island over mud accumulation. Area south of the TOTO has the most continuous expanses of grainstone.

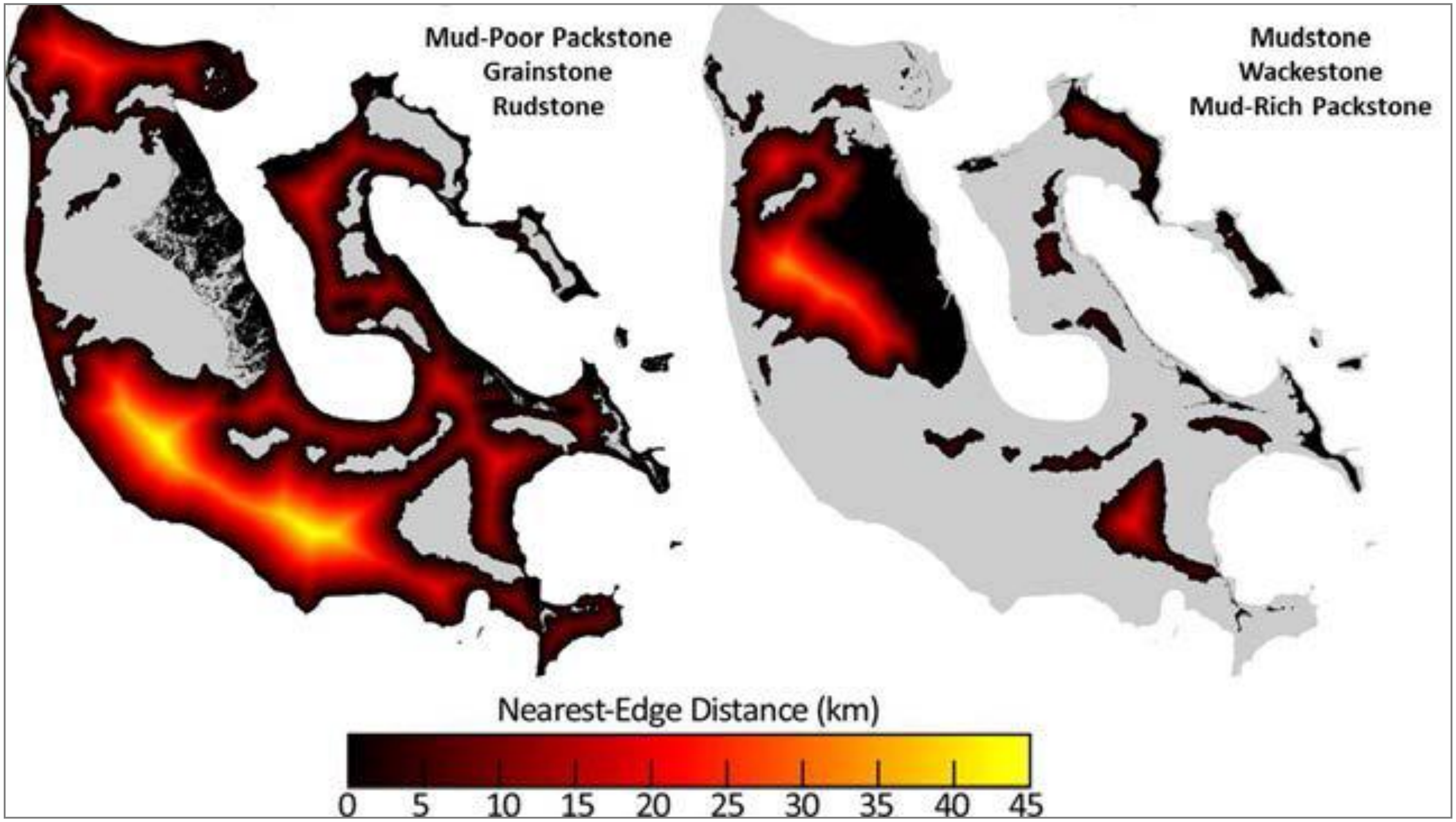

Figure 7. Maps of GBB showing grainy and mud-rich bodies, with the fairways of the former twice that of the latter. Grainy bodies are more interconnected than mud-rich bodies.