# [PS]Building 3-D Perspectives of a Modern Carbonate Sand Body for Improved Visualization and Quantitative Interrogation of Spatial Patterns*

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## Abstract

A very robust bathymetric surface can be derived from satellite imagery in clear, shallow waters by establishing a relationship between pixel brightness and inferred water depth. This extrapolation of depth from a 2-D satellite image is powerful in that it can transform traditional facies maps into 3-D models. This visualization technique creates a unique opportunity for comparing facies relationships with various geobody morphometrics, therein providing quantitative inputs for property distribution or geological modeling.

We have experimented with a recently developed technology that creates a hologram from 3-D geological data. In particular, we are interested in visualization methodologies that may add value to field work and/or field trips that do not require electricity, are portable, rugged, and reusable. The area of interest for this project is the southern end of Tongue of the Ocean (TOTO) on Great Bahama Bank, where the broadest expanse of "high-energy" sands found in the Bahamas occurs. This sand body, extending parallel to the platform margin for 155 km and covering 3120 $km^2$, is characterized by narrow sandbars separated by wide, deep channels and a lack of islands. Individual sandbars extend onto the shallow platform on average 20 km but up to 27 km.

The base images for the hologram are a Landsat TM satellite image draped over the extrapolated bathymetric digital elevation model (DEM). The portion of the Landsat image defining the TOTO sand body is replaced by the high-resolution water-depth DEM, color-coded with hotter colors indicating shallower water (0-2 m). Two additional layers or "channels" are draped over the DEM, and are visible from only certain angles so they turn on and off depending on the viewer's position relative to the hologram. One of the channels is an attribute image derived from centerline spacing of the sand bars. The "centerline density" attribute is color-coded with hotter colors assigned to more closely-spaced sand bars; in this case the hottest colors (or highest density class) on the image indicate there is 1.4-1.5 km of centerline per $km^2$. The second channel displays an attribute image derived for sandbar shape called "form factor". The form factor varies between 0-1 with higher values indicating more rounded sandbar shapes. Viewing the hologram of TOTO sandbars color-coded with their form factor

visually reinforces the meaning of this morphometric parameter.

## Reference

Harris, P.M., J.M. Ellis, and S.J. Purkis, 2010, Delineating and quantifying depositional facies patterns of modern carbonate sand deposits on Great Bahama Bank: SEPM Short Course Notes, #54, 2 DVD-ROMs.

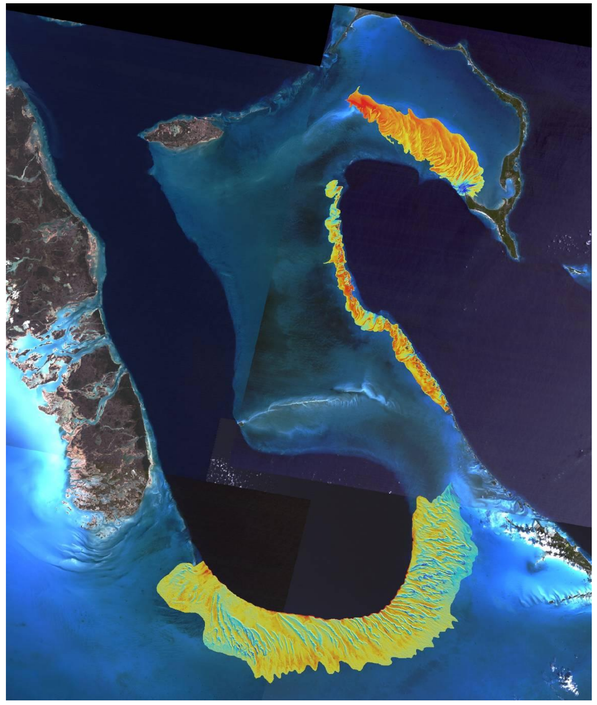
# BUILDING 3-D PERSPECTIVES OF A MODERN CARBONATE SAND BODY FOR IMPROVED VISUALIZATION AND QUANTITATIVE INTERROGATION OF SPATIAL PATTERNS

Paul M. (Mitch) Harris and Jerome Bellian (Chevron Energy Technology Company, San Ramon, CA, USA) and James Ellis (Ellis GeoSpatial, Walnut Creek, CA, USA)

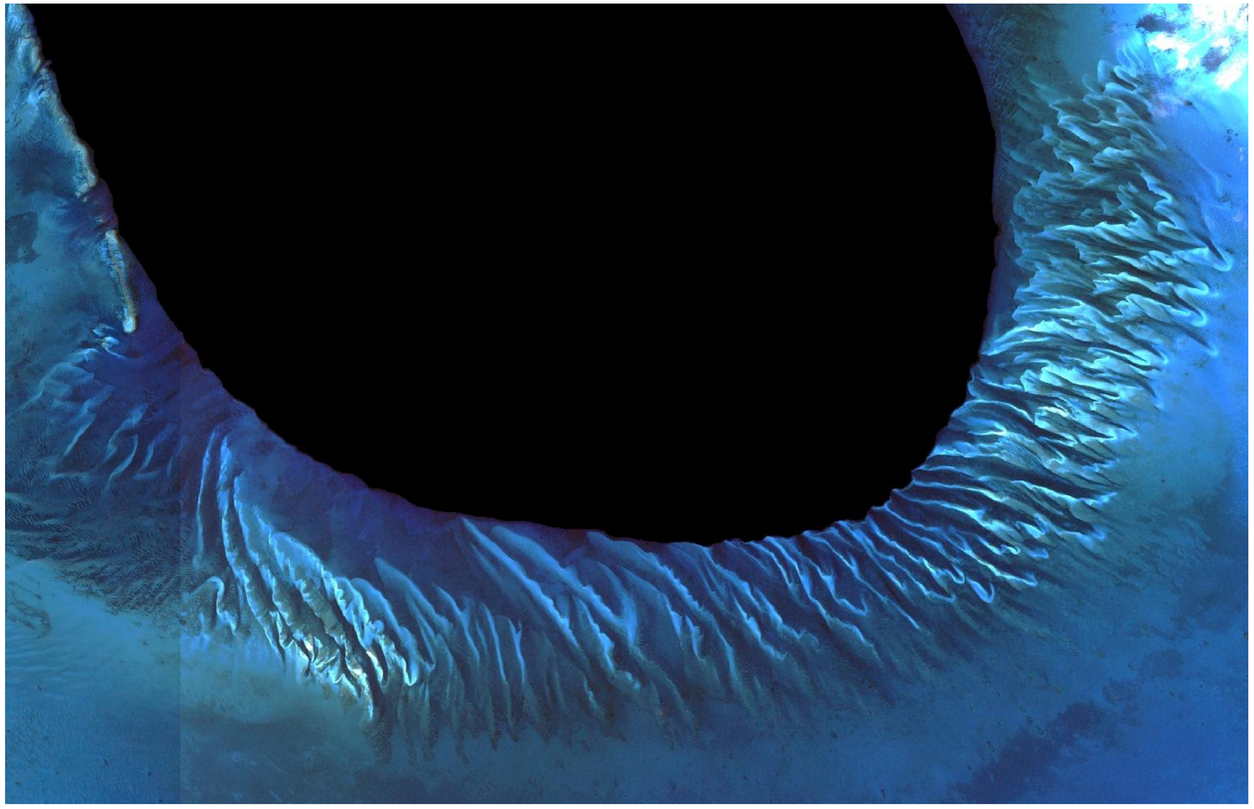
**A very robust bathymetric surface can be derived from satellite imagery in clear, shallow waters by establishing a relationship between pixel brightness and inferred water depth. This extrapolation of depth from a 2-D satellite image is powerful in that it can transform traditional facies maps into 3-D models. This visualization technique creates a unique opportunity for comparing facies relationships with various geobody morphometrics, therein providing quantitative inputs for property distribution or geological modeling.**

**We have experimented with a recently developed technology that creates a hologram from 3-D geological data. In particular, we are interested in visualization methodologies that may add value to field work and/or field trips that do not require electricity, are portable, rugged, and reusable.**

**As an example, we have created a hologram for the southern end of Tongue of the Ocean (TOTO) on Great Bahama Bank, where the broadest expanse of "high-energy" sands found in the Bahamas occurs. This area is one of the three modern carbonate sandbodies investigated by Harris, Ellis, and Purkis (2010) in SEPM Short Course Notes, No. 54.**



**The TOTO sand body, extending parallel to the platform margin for 155 km and covering 3120 km$^2$, is characterized by narrow sandbars separated by wide, deep channels and a lack of islands. Individual sandbars extend onto the shallow platform on average 20 km but up to 27 km.**



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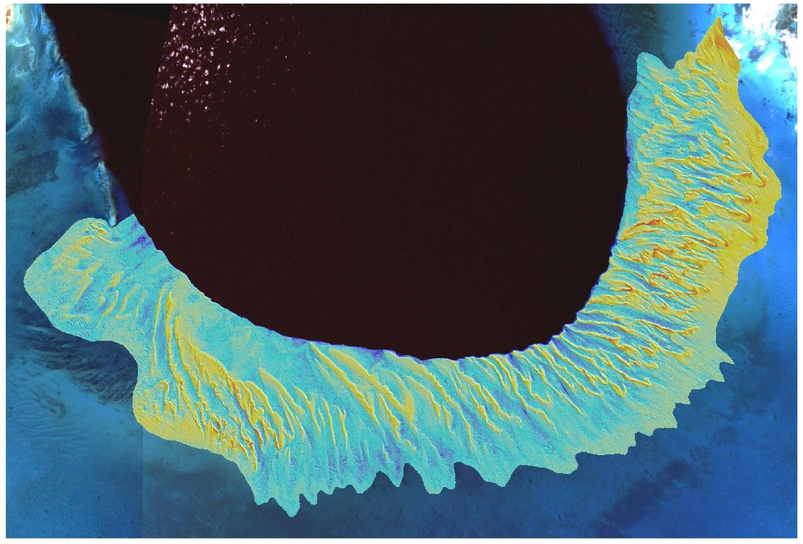
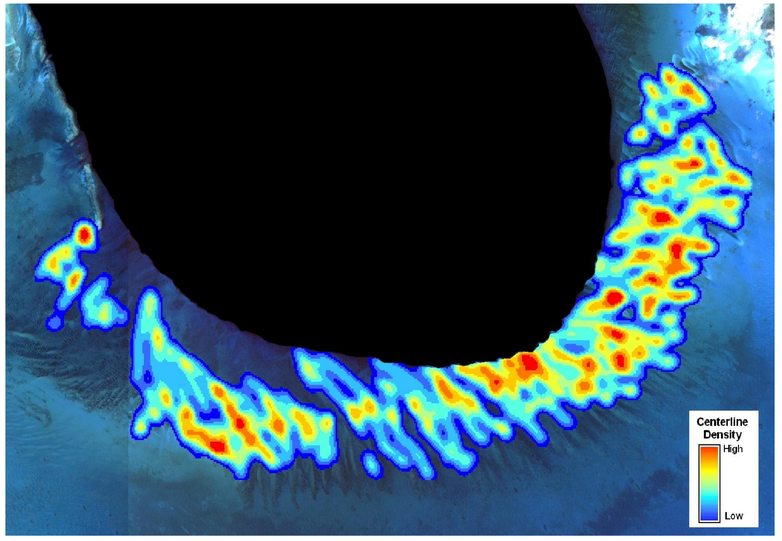
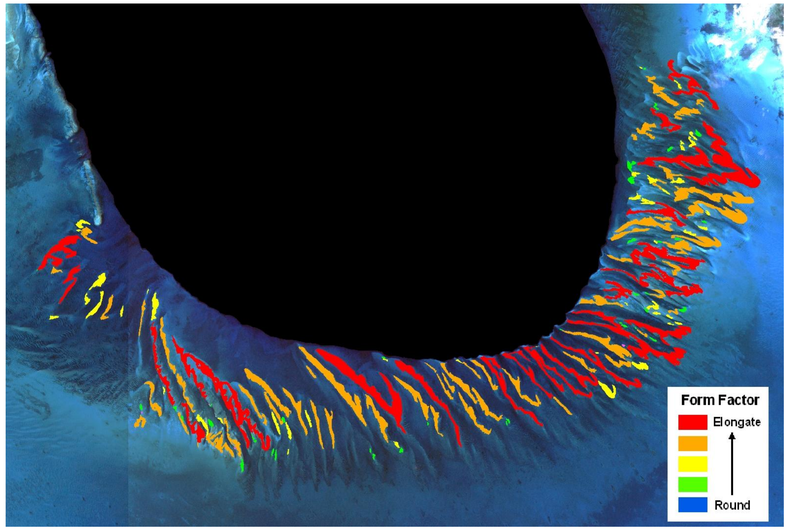
The base images for the hologram are a Landsat TM satellite image draped over the extrapolated bathymetric digital elevation model (DEM). The portion of the Landsat image defining the TOTO sand body is replaced by the high-resolution water-depth DEM, color-coded with hotter colors indicating shallower water (0-2 m). Two additional layers or "channels" are draped over the DEM, and are visible from only certain angles so they turn on and off depending on the viewer's position relative to the hologram.



One of the channels is an attribute image derived from centerline spacing of the sand bars. A centerline is drawn within each sand bar of the sandbody, and the colors indicate centerline density (or spacing between centerlines) wherein hotter colors indicate more closely spaced sand bars. The "centerline density" attribute is color-coded with hotter colors assigned to more closely-spaced sand bars; in this case the hottest colors (or highest density class) on the image indicate there is 1.4-1.5 km of centerline per km$^2$.




The second channel displays an attribute image derived for sandbar shape, where Form Factor is calculated for each sand bar within the sandbody and is indicated by colors draped on the DEM. The form factor varies between 0-1 with higher values indicating more rounded sandbar shapes. TOTO sand bars have low Form Factors quantifying the visual observation from imagery of the elongate nature of the bars. Viewing the hologram of TOTO sandbars color-coded with their form factor visually reinforces the meaning of this morphometric parameter.



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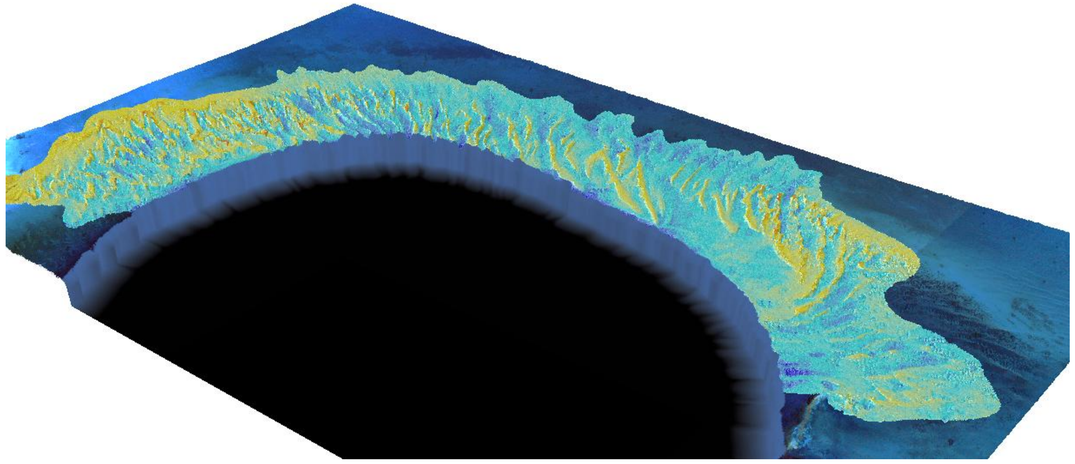
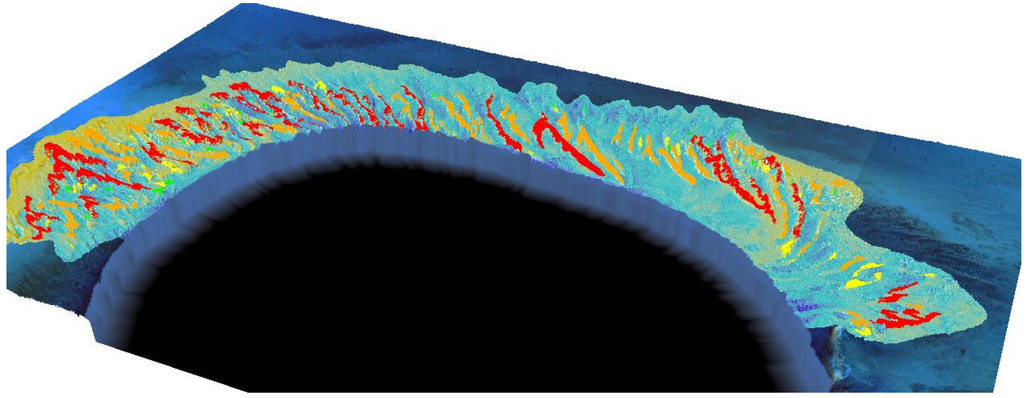
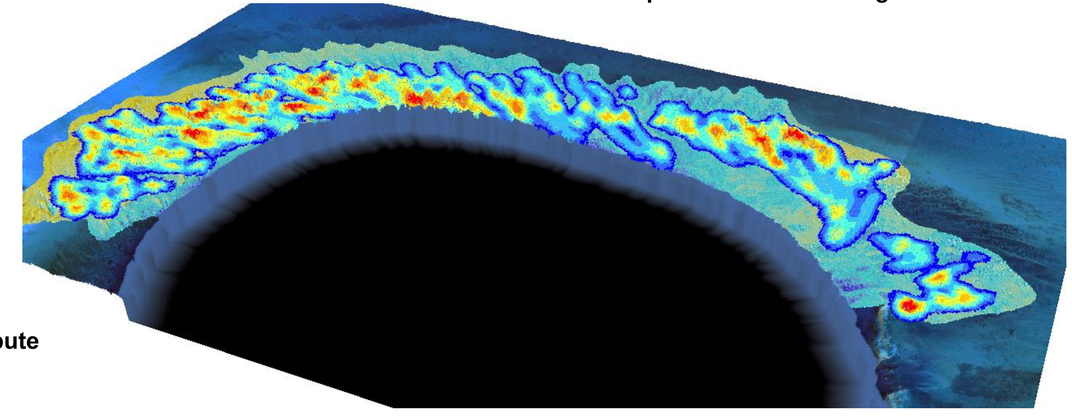
**View the hologram from different angles to see the attributes displayed over the base image.**
**Is this a visualization tool that may add value to your field work and/or field trips ?**



**Perspective view of the base images for the hologram (Landsat TM satellite image draped over the DEM)**



**Perspective view of the Form Factor shape attribute draped on the base image**



**Perspective view of the “centerline density” attribute draped on the base image**