Geomorphologic Characterization of Seabed Features in the Central Region of the Blake Plateau, Southeast U.S. Continental Margin

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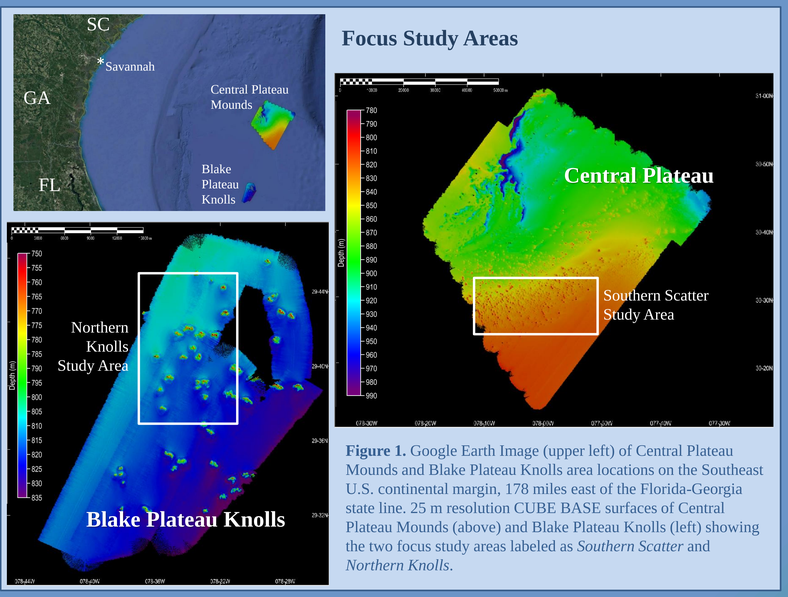


Focus Study Areas

Figure 1. Google Earth Image (upper left) of Central Plateau Mounds and Blake Plateau Knolls area locations on the Southeast U.S. continental margin, 178 miles east of the Florida-Georgia state line. 25 m resolution CUBE BASE surfaces of Central Plateau Mounds (above) and Blake Plateau Knolls (left) showing the two focus study areas labeled as *Southern Scatter* and *Northern Knolls*.

ABSTRACT

As a follow up to the NOAA Office of Ocean Exploration and Research's (OER) *Windows to the Deep 2018* expedition, the NOAA Ship *Okeanos Explorer* conducted *Windows to the Deep 2019*, on the Southeast U.S. Continental Margin during May-July of 2019. Scientists collected multibeam sonar data containing backscatter to expand the breadth of bathymetric areas that are mapped in high-resolution on the Blake Plateau. This study evaluates the geomorphology of individual seabed high intensity features (HIFs) found when examining the backscatter intensity of individual mounds that lie in two newly mapped areas, the Central Plateau Mounds and the Blake Plateau Knolls. These sites lie approximately 240 km east of the Florida coast and are approximately 850 m deep. Both sites are located to the northeast of the Gulf Stream, and do not lie directly beneath the Gulf Stream's current. The ROV *Deep Discoverer* dove on selected sites within each area to collect high-definition video. High abundances of coral, sponges, and other marine organisms were observed at both sites. Similarly, both the Central Plateau Mounds and the Blake Plateau Knolls contained relatively unconsolidated substrate on which coral mounds and debris had accumulated. The purpose of this study is to provide insight into the complex structure and potential extent of benthic communities by classifying benthic substrate. In examining high return intensity features at both the Central Plateau and Blake Plateau Knolls, an overall positive relationship between mound width and HIF length was observed. Additionally, HIFs showed similar orientations within each area of study.

BACKGROUND

The Blake Plateau, located on the Southeast U.S. Continental margin, is a broad and flat area that lies between the continental slope and abyssal plain (Laughton et al., 1978). In recent years, the NOAA Office of Ocean Exploration (OER) has conducted many mapping expeditions on the Blake Plateau, collecting critical rudimentary data on unknown deep water areas that are considered among the least explored along the U.S. East Coast (NOAA, 2019). The Central Plateau Mounds (Fig. 1), a newly mapped area lying approximately 322 km off the Florida coast where water depths range approximately 770 to 970 m, was mapped during Leg 1 of EX1903 (NOAA, 2019). Cold-water coral mounds composed of *Lophelia pertusa*, the dominant reef-building coral in the NE Atlantic were discovered in the area. Another newly mapped area, the Blake Plateau Knolls (Fig. 1), lying approximately 164 km off the Florida coast was mapped during EX1903 Leg 2 (NOAA, 2019). *Lophelia pertusa* mounds were discovered in this area as well, previously thought to be completely flat (Sautter et al., 2019). Dive 04, performed by the ROV *Deep Discoverer* at one of these mounds displayed relatively unconsolidated substrate surrounding the coral mound structures. Despite the presence of unconsolidated substrate, backscatter intensity generated from the multibeam sonar data at both the Central Plateau Mounds and the Blake Plateau Knolls revealed features around mounds that reflected a high intensity return, indicating consolidated substrate may be present. The purpose of this study is to characterize and compare these high intensity seabed features found in both study regions based on their area, orientation and other measurements, as well as attempt to determine factors responsible for such geomorphologic variations.

Methods

- Multibeam bathymetric and backscatter intensity data were collected by NOAA OER during EX1903 Legs 1 and 2 using a Kongsberg EM302 multibeam sonar system aboard the NOAA Ship *Okeanos Explorer*.
- Data were post-processed using CARIS HIPS & SIPS 11.2, generating CUBE 15 m BASE and 15 m SIPS Mosaic surfaces, as well as 3D images, bathymetric and backscatter intensity profiles.
- Classified Backscatter Intensity was used to identify three individual HIFs within each of two study areas, *Southern Scatter* and *Northern Knolls* (Fig. 2).
- Super-Classified Backscatter Intensity profile bands were generated, locating areas of highest return along each bathymetric profile (Fig. 2).
- Quantitative data were collected using CARIS HIPS & SIPS 11.2 and Google Earth. Measurement methods are illustrated in Figure 3.
- Three additional sites in each study area were measured based on orientation and length (Fig. 4).

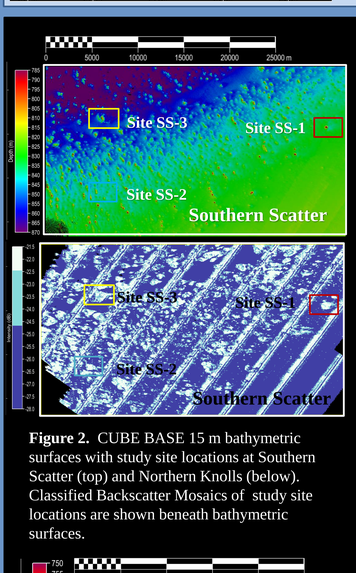
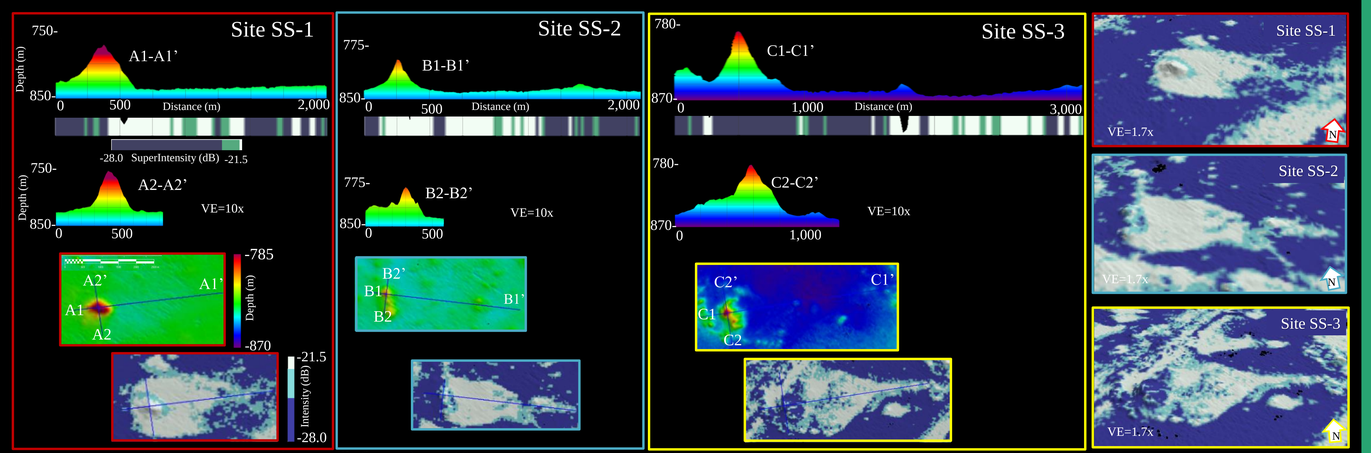
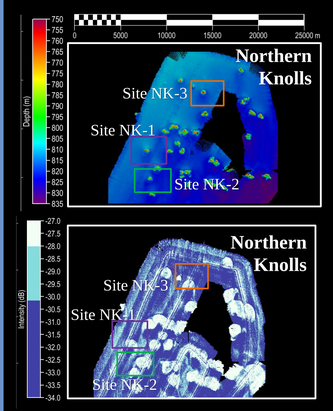
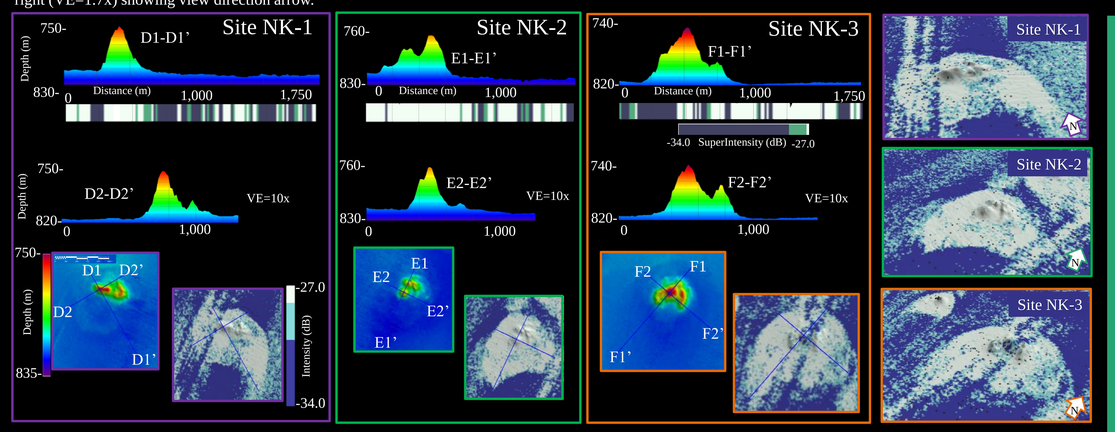


Figure 2. CUBE BASE 15 m bathymetric surfaces with study site locations at Southern Scatter (top) and Northern Knolls (below). Classified Backscatter Mosaics of study site locations are shown beneath bathymetric surfaces.



Profiles at Southern Scatter (top) and Northern Knolls (bottom), VE=10x. Lengthwise bathymetry profiles shown with super-classified backscatter intensity. Legends shown for Site SS-1 represent Sites SS-2 and SS-3, and legends for Site NK-1 represent Sites NK-2 and NK-3. Profile reference images in bathymetry and classified backscatter included for each site. 3D images of all sites in classified backscatter included at right (VE=1.7x) showing view direction arrow.





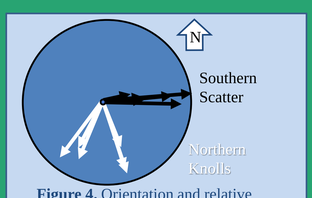


Figure 4. Orientation and relative length of six features from each study area. See Table 1.

Measurement System

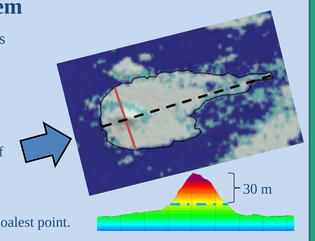
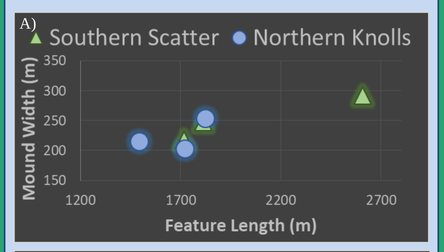


Figure 3. Measuring techniques created for classification of HIFs (top) and mound geomorphology (bottom). Parameters of measurement described below.

Feature Length- (dashed black line) length of high intensity feature transversing shoalest point of mound.
Feature Width- (red line) width of feature intersecting shoalest point of mound perpendicular to feature length.
Area- (black polygon) area covered by feature (km^2)
Heading- (arrow) orientation
Mound Width- (dashed aqua line on profile) measured 30 m below shoalest point.

	1-1' Heading (deg)	2-2' Heading (deg)	1-1' Length (m)	2-2' Length (m)	HIF Length (m)	HIF Width (m)	Mound Width (m)	Feature Area (km^2)	HIF Shape Index
SS-1	81.45	351.40	1856.47	718.28	1717.16	803.39	218.13	0.77	7.87
SS-2	96.45	6.55	1992.54	544.75	1811.66	658.26	247.75	0.72	7.31
SS-3	81.20	351.10	2955.37	1077.24	2607.45	1342.15	291.90	1.81	8.93
NK-1	150.00	60.03	1907.41	1147.37	1722.40	1196.83	201.94	1.32	8.53
NK-2	204.30	115.50	1550.31	1100.70	1495.27	1198.58	214.34	1.00	6.98
NK-3	221.00	130.00	1832.96	1299.77	1826.01	1412.23	253.54	1.32	7.20

Figure 5. A) Mound width versus feature length, and B) mound width versus feature width. Data are shown in Table 1.



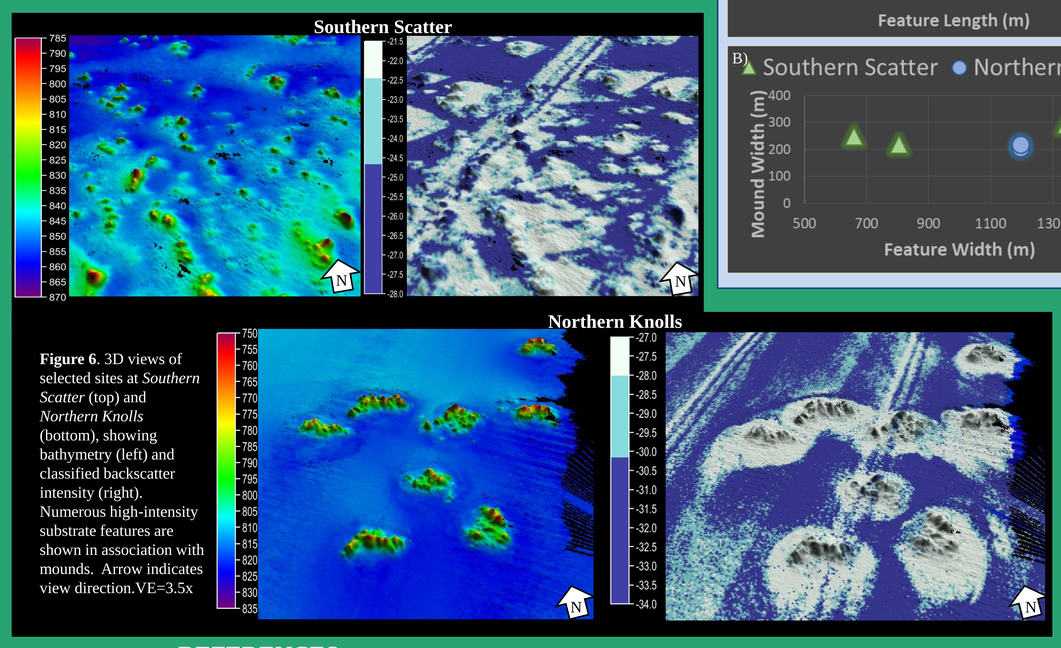


Figure 6. 3D views of selected sites at *Southern Scatter* (top) and *Northern Knolls* (bottom), showing bathymetry (left) and classified backscatter intensity (right). Numerous high-intensity substrate features are shown in association with mounds. Arrow indicates view direction.VE=3.5x

RESULTS

- A visible relationship exists between increasing mound width and increasing HIF length for all sites at Southern Scatter, and sites 2 and 3 at Northern Knolls (Figs. 2 & 5A, Table 1).
- Southern Scatter sites exhibit scoured mound bases, and super-classified backscatter indicates consolidated substrate is present in high concentrations behind these scours (Fig. 2)
- High intensity features at Northern Knolls vary considerably, in orientation, mound morphology, and length. Super-classified backscatter at these sites was unpredictable. (Fig. 2).
- The HIF Shape Index (ratio of HIF length to mound width) for SS-Sites 1-3 and NK-Sites 1-3 ranged between 6.98 and 8.93, indicating similar elongation in HIF geomorphologies (Table 1).
- Super-classified intensity locations along lengthwise profiles were also visibly more uniform at Southern Scatter (Fig. 2).
- Observed HIF heading angles are similar, differing no more than 21° for sites at Southern Scatter, and 76° at Northern Knolls (Fig. 4, Table 1).
- No association was observed between HIF width and mound width (Fig. 5B).
- No conclusive relationship was found between HIF length and orientation (Fig. 4, Table 1).
- No affiliation between super-classified high return intensity and location along lengthwise profiles is consistently apparent at any site (Fig. 2).

DISCUSSION

Deep water sediments of the Blake Plateau are characteristically fine oozes or silts (Brothers et al., 2013). As mentioned previously, Dive 04 of EX1903 L2, conducted at the Blake Plateau Knolls found coral buildup on relatively soft or unconsolidated sediment (NOAA, 2019). Amassing and interpreting data on backscatter intensity features found at two newly mapped study areas was intended to contribute to pre-existing knowledge of benthic substrate processes. Associations between these HIFs' geomorphic characteristics and possible controls resulted in observed increasing HIF length with increasing mound width (Table 1 & Fig. 5A). However, this association was only consistent at Southern Scatter, where feature orientations were also remarkably similar (Fig. 4 & Table 1). Site 1 at Northern Knolls, which differs in orientation from sites 2 and 3, also differs from this observed trend (Figs. 2 & 5A, Table 1). Evidence of such a relationship leads to a possible conclusion that deep sea currents with differing dominant directions may be present in these areas. Unlike previously mapped areas on the Blake Plateau, such as Stetson Mesa, neither the Central Plateau Mounds nor the Blake Plateau Knolls lay directly beneath the Gulf Stream Current, yet elongated HIFs are not found at Stetson Mesa. Despite their location with respect to the Gulf Stream, HIF elongation indicates such a prevalent current may still be influencing these areas, and responsible for HIF morphology in relation to mounds. In order to properly characterize these benthic features, further research must be conducted in areas with similar backscatter return intensities. Predictions in substrate classification must be verified by ground-truthing, and dives should be conducted at areas where high intensity features are abundant, such as in the Central Plateau Mounds.

ACKNOWLEDGEMENTS

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