Geomorphologic Characterization of the Richardson Hills Region of the Blake Plateau, Southeast U.S. Continental Margin

Jason Mueller and Dr. Leslie R. Sautter

Dept. of Geology and Environmental Geosciences, College of Charleston

ABSTRACT

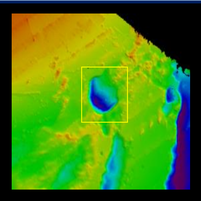
During May and July of 2018, the NOAA Office of Ocean Exploration and Research conducted the *Windows to the Deep 2018* expedition on the Southeastern United States Continental Margin, on board the NOAA Ship *Okeanos Explorer*. The expedition's goal was to explore and gather information of seafloor characteristics and identify potential deep-sea coral and sponge habitats. Multibeam sonar data collected during NOAA OER cruise EX1805 were used to produce bathymetric, backscatter intensity and slope surfaces of the seafloor. The purpose of this study is to characterize the geomorphology of a northern section of the Blake Plateau referred to as the Richardson Hills Region, located approximately 250 km east of Hilton Head Island, South Carolina. The study area consists of flat lying strata, scattered potential deep sea coral mounds, and prominent areas of small, shallow basins with steep scarps.

METHODS

- Multibeam sonar data were collected aboard the NOAA Ship *Okeanos Explorer*, using a Kongsberg EM302, during expedition cruise EX1805 in May and June, 2018.
- CARIS HIPS and SIPS 11.0 was used for post-processing raw sonar data, including refraction editing and creating surfaces.
- A 15m resolution CUBE bathymetric surface was created, as well as slope and aspect surfaces to characterize the geomorphology of three different study areas.
- SIPS backscatter intensity mosaics were manually classified.
- Cross-sectional profiles of prominent features were made for each study area.

Figure 3: BASIN

Figure 3a. BASIN Study Area location shown on a CUBE bathymetric surface with a resolution of 15m.



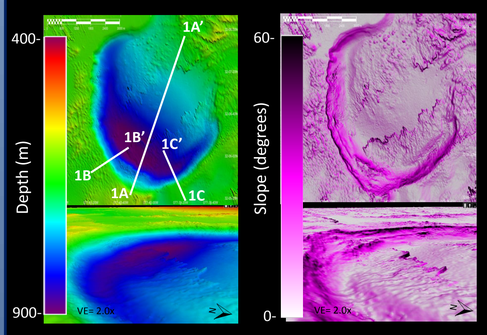


Figure 3b. BASIN Study Area 15m CUBE bathymetric surface. 2D and 3D surface of depth (left) and slope (right). Note the slope of the scarp face surrounding the basin.

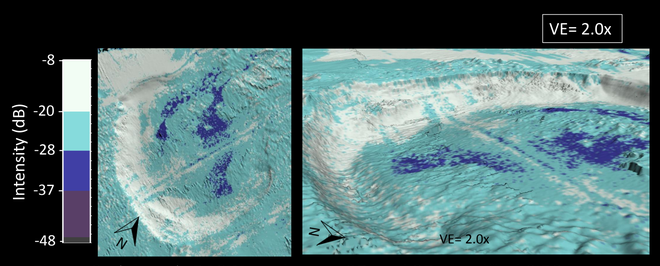


Figure 3c (above). BASIN study area 2D and 3D classified SIPS backscatter intensity surface draped on bathymetric surface. Note the difference in intensity of backscatter returns of the scarp face compared to the basin floor.

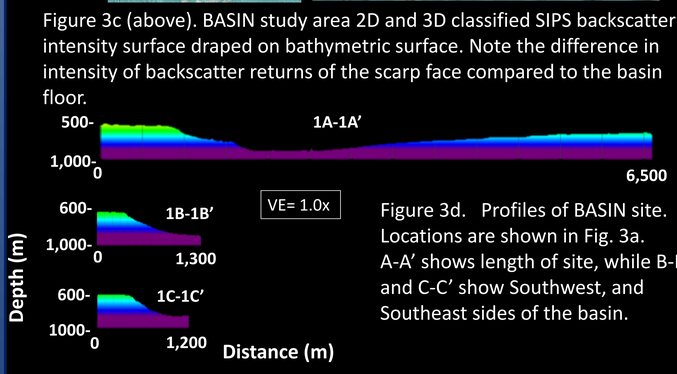


Figure 3d. Profiles of BASIN site. Locations are shown in Fig. 3a. A-A' shows length of site, while B-B' and C-C' show Southwest, and Southeast sides of the basin.

DISCUSSION and CONCLUSIONS

Studies have suggested that deep sea coral habitats are likely to have high intensity backscatter returns (Roberts et al., 2006) due to being located on areas with hard substrate. However, coral mounds at this study site on the Blake Plateau have significantly lower intensity of backscatter returns when compared with the surrounding strata, and agree with a study done by DiTommaso and Sautter (2019), suggesting that many of the deep sea coral mounds in this region are composed of highly rugose, porous dead coral framework structure, which results in higher scattering and lower intensity backscatter return when compared to the coral habitat on exposed rock (DiTommaso et al., 2019). The orientation of the coral mounds (Fig 4.) is likely caused by the prevailing direction of the Gulf Stream above the Richardson Hills Region (Fig 1b.). The scarp was likely caused by rifting. As the crust diverged, normal faults formed, and caused sections of the oceanic crust to subside (Juliani, 2019), which supports research of scarps completed by Byas and Sautter (2019). The Basin site shows potential to serve as a habitat for deep sea corals on the upper areas of the basin's west, south, and southeastern scarp faces, as these areas are likely to have hard substrate (Fig 3c), and steep slopes reaching ~50º which, according to Roberts et al. (2006), are favorable characteristics for deep sea coral habitats. In conclusion, the prominent geomorphologic features of the Richardson Hills Region of the Blake Plateau vary greatly, and are formed and influenced by different forces. Some of these features possess the proper characteristics to serve as a benthic habitat.

Figure 1.

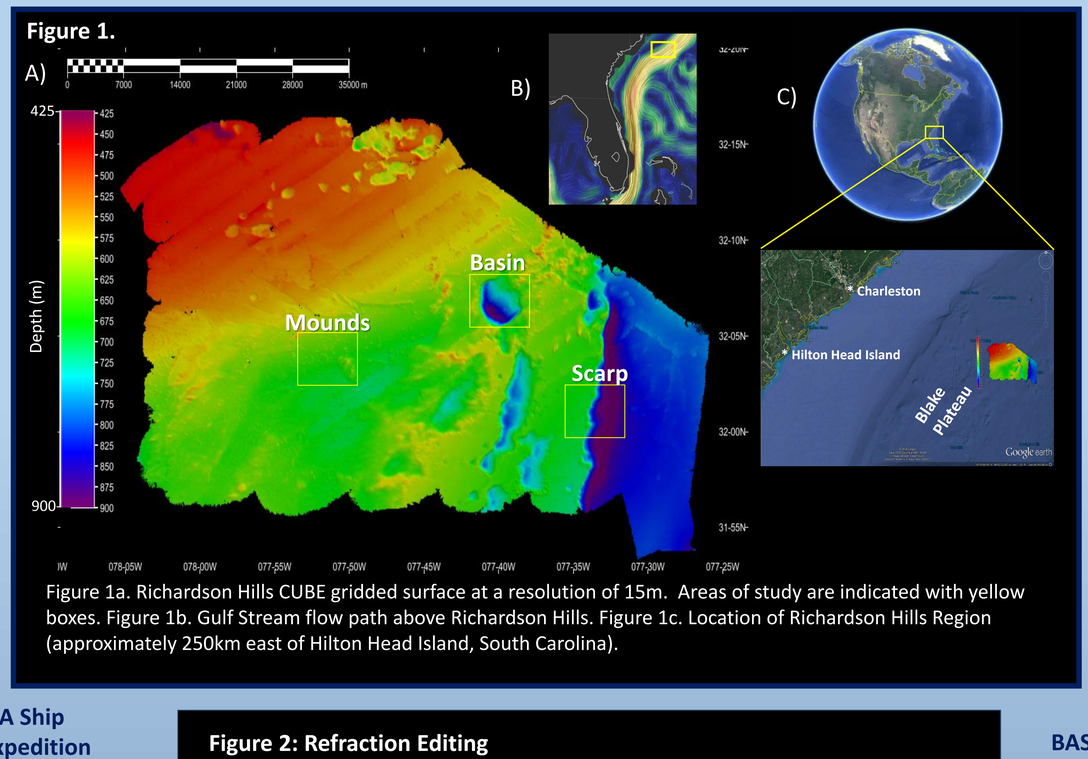


Figure 1a. Richardson Hills CUBE gridded surface at a resolution of 15m. Areas of study are indicated with yellow boxes. Figure 1b. Gulf Stream flow path above Richardson Hills. Figure 1c. Location of Richardson Hills Region (approximately 250km east of Hilton Head Island, South Carolina).

Figure 2: Refraction Editing

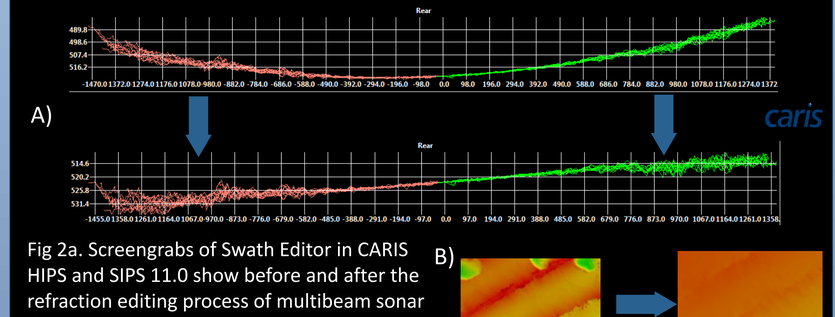
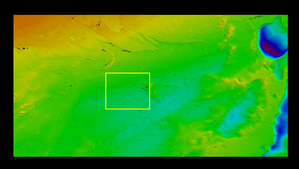


Fig 2a. Screengrabs of Swath Editor in CARIS HIPS and SIPS 11.0 show before and after the refraction editing process of multibeam sonar data.

Fig 2b. Screengrabs of 2D CUBE bathymetric surface with a resolution of 15m to show results of refraction editing on multibeam sonar data.

Figure 4: MOUNDS

Figure 4a. MOUNDS Study Area location CUBE bathymetric surface with a resolution of 15m.



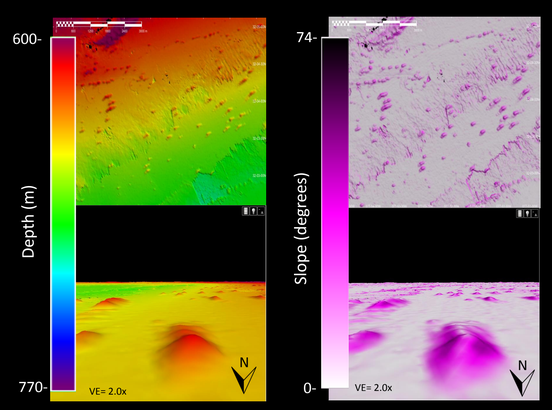


Figure 4b. CUBE bathymetric surface with a resolution of 15m. 2D and 3D surface of depth (left) and slope (right). Note the trend in orientation of the mounds.

Figure 4c. 2D and 3D classified SIPS backscatter intensity surface draped on bathymetric surface. Note the difference in intensity of backscatter returns from the mounds compared to the surrounding strata.

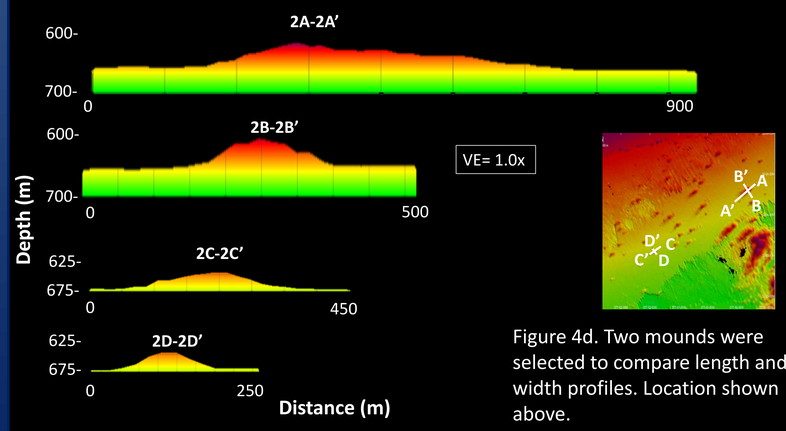
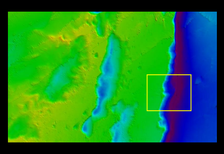


Figure 4d. Two mounds were selected to compare length and width profiles. Location shown above.

Figure 5: SCARP

Figure 5a. SCARP Study Area location CUBE bathymetric surface with a resolution of 15m.



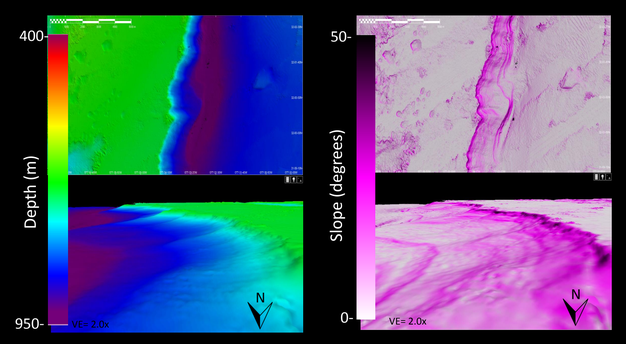


Figure 5b. SCARP Study Area CUBE bathymetric surface with a resolution of 15m. 2D and 3D surface of depth (left) and slope (right). Note the difference in slope of the top of the scarp face compared to the bottom of the scarp face.

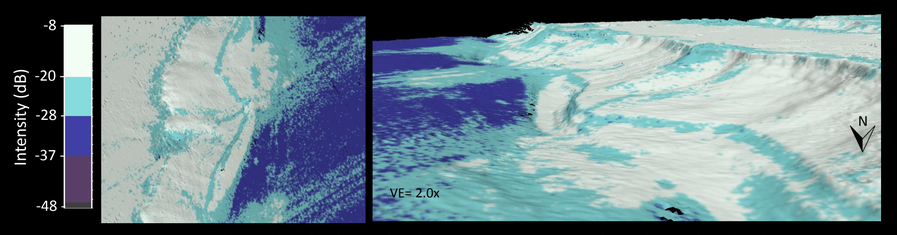


Figure 5c. 2D and 3D classified SIPS backscatter intensity surface draped on bathymetric surface. Note the intensity of backscatter returns on the scarp face compared to that of the flat lying strata below the scarp.

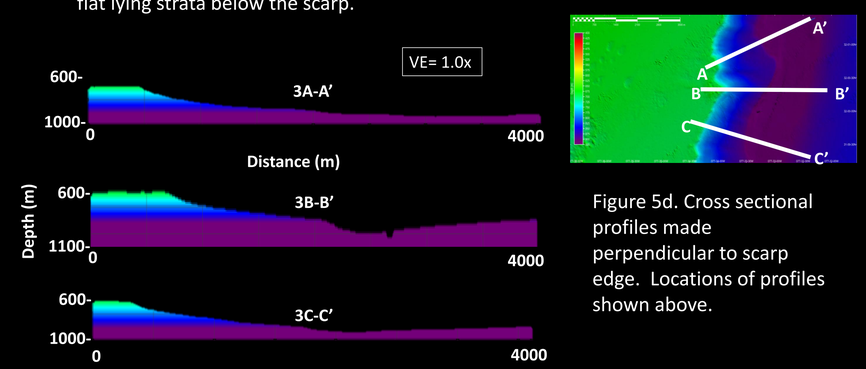


Figure 5d. Cross sectional profiles made perpendicular to scarp edge. Locations of profiles shown above.

BACKGROUND

The NOAA Office of Ocean Exploration and Research utilized the NOAA Ship *Okeanos Explorer* to conduct expedition *Windows to the Deep 2018*. During the months of May and June of 2018, *Okeanos* gathered multibeam sonar data during expedition cruise EX1805 to map the bathymetric surface of a region along the southeastern United States continental margin known as the Blake Plateau, an extensive, relatively flat feature formed during the Atlantic Ocean's formation (Dillon et. Al, 1988). Bathymetric maps were then used during cruise EX1806, on which *Okeanos* utilized ROV *Deep Discoverer* to acquire high definition video footage of biological systems, habitat and geomorphology on the plateau's seafloor, including deep sea coral mounds, and terraced rock areas with abundant benthic communities. One such area was the Richardson Hills region, located in the northwestern section of the plateau, about 250 km east of Hilton Head Island, South Carolina, where depths range from 400 to 950 m . Data gathered revealed seabed characteristics consisting mostly of flat lying strata, and also including shallow basins, steep scarps, as well as scattered deep sea coral mounds. The purpose of this study is to characterize the geomorphology of the prominent bathymetric features found in the Richardson Hills Region, including an examination of backscatter intensity to help identify areas of hard substrate which may serve as benthic habitat.

RESULTS

BASIN (Fig. 3)

- The Basin Site's deepest area is the southwestern-most point within the basin, reaching about 900 m in depth. The Basin's west, south, and southeastern sides are characterized by relatively steep slopes, the steepest points being about 50º. =However, the north, and east edges of the basin are much broader, with very gradual slopes of approximately 10º.
- Backscatter intensity was significantly greater on the scarp face of the basin than at the bottom of the basin.

MOUNDS (Fig. 4)

- Most of the mounds appear to be oriented southwest-northeast.
- Cross-sectional profiles show that mounds are relatively symmetrical.
- Most mounds have a slope of approximately 40º.
- There is no apparent order to the distribution of larger vs. smaller mounds.
- Backscatter intensity was relatively low on mounds as compared to the high intensities observed on surrounding flat-lying strata.

SCARP (Fig 5)

- The Scarp has a relief of nearly 350 m (600 to 950 m). The scarp's depths drop, in general, from the east, to west. After reaching its deepest point, the scarp gradually rises to depth of ~850 m, forming a valley that runs north to south.
- The scarp has a relatively uniform slope, where its steepest areas (~35º) are towards the top of the face. Towards the scarp's base, the slope becomes more gradual (<10º).
- Backscatter intensity was relatively high on the flat lying strata atop the scarp and on the scarp face when compared to the valley below.

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