

# Exploring the Bathymetry, Geomorphology, and Seafloor Substrate off the Western Flank of Turneffe Atoll, Belize

Rebekah Gossett and Dr. Leslie Sautter

Department of Geology and Environmental Geosciences, College of Charleston



## Abstract

Turneffe Reef is a carbonate platform and atoll within the Belize MesoAmerican Reef. The reef flank extends to depths of over 1000 meters and may provide habitat for critical deep coral species. Using multibeam sonar data collected by NOAA scientist Peter Etnoyer aboard the Ocean Exploration Trust's *E/V Nautilus*, variations in bathymetry, seafloor substrate, and geomorphology on the northwest flank of Turneffe Reef were examined in order to hypothesize the identity of rounded structures found along the reef margin at depths ranging from 500 to 900 m. CARIS HIPS and SIPS 8.1 was used for post-processing bathymetry and backscatter data, to determine variations in seafloor hardness and identify potential deep coral sites. Characteristics of the geologic structures surrounding Turneffe Reef provide insight as to how deep coral is supported, and to identify sites to investigate on future ROV missions.

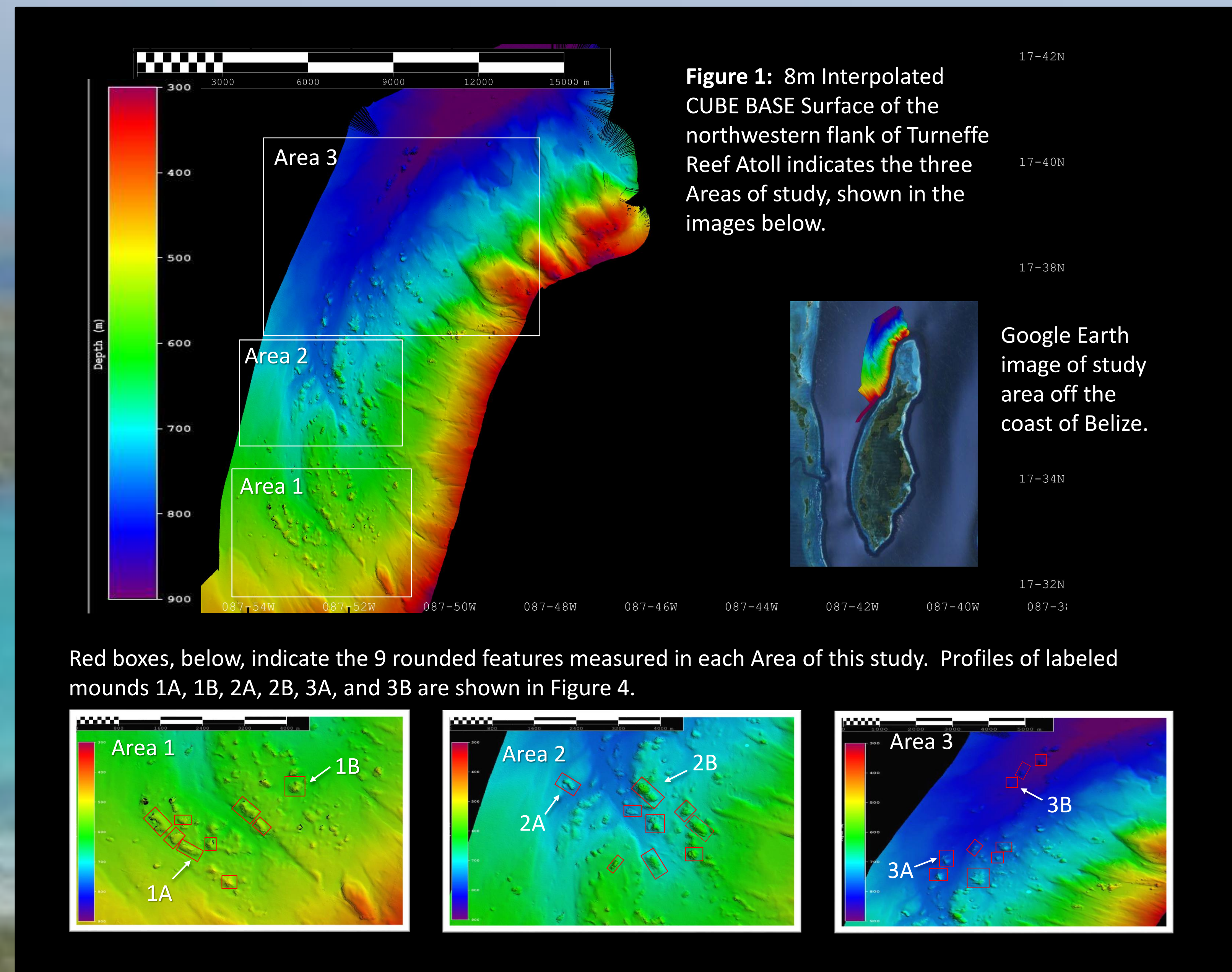


Figure 1: 8m Interpolated CUBE BASE Surface of the northwestern flank of Turneffe Reef Atoll indicates the three Areas of study, shown in the images below.

Google Earth image of study area off the coast of Belize.

Red boxes, below, indicate the 9 rounded features measured in each Area of this study. Profiles of labeled mounds 1A, 1B, 2A, 2B, 3A, and 3B are shown in Figure 4.

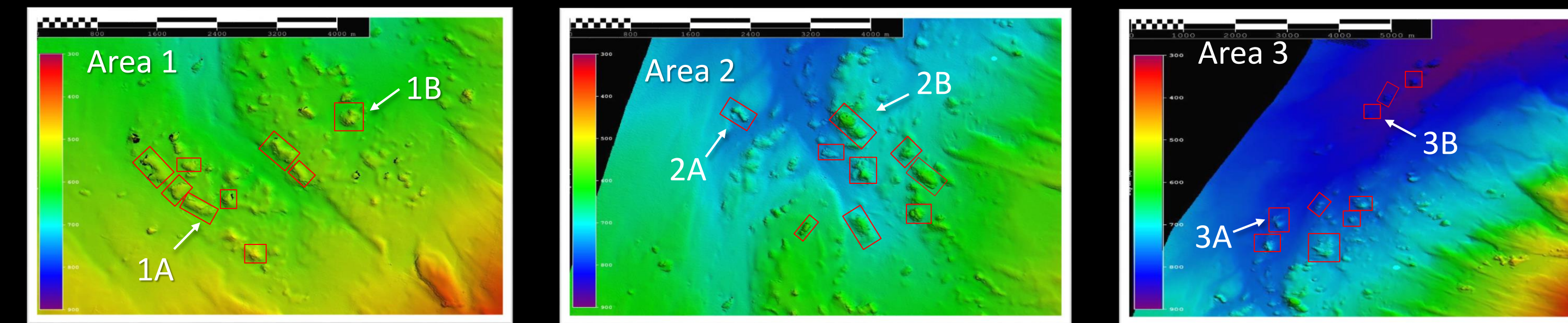


Figure 2: 3D images of each study area (V.E.=2.7x). Red arrows indicate some of the structures on which profiles were made, however not all structures are defined.

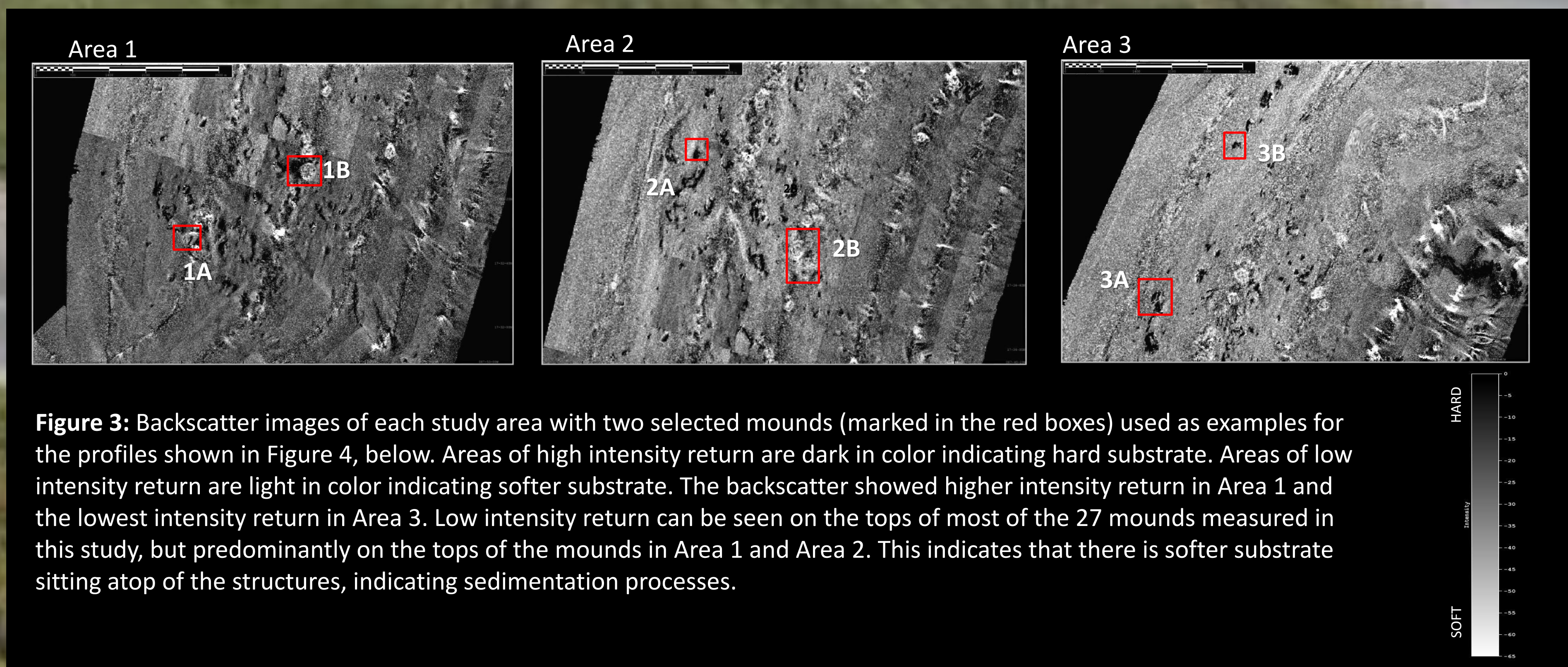


Figure 3: Backscatter images of each study area with two selected mounds (marked in the red boxes) used as examples for the profiles shown in Figure 4, below. Areas of high intensity return are dark in color indicating hard substrate. Areas of low intensity return are light in color indicating softer substrate. The backscatter showed higher intensity return in Area 1 and the lowest intensity return in Area 3. Low intensity return can be seen on the tops of most of the 27 mounds measured in this study, but predominantly on the tops of the mounds in Area 1 and Area 2. This indicates that there is softer substrate sitting atop of the structures, indicating sedimentation processes.

## Background

Turneffe Reef is one of three islands located on a fault ridge off the coast of Belize in Central America (McCloskey et al., 2013). An Atlantic atoll, Turneffe is a carbonate mound rising from depths over 1000 meters from the seafloor (Gischler et al., 1998). The fore-reefs of Turneffe may provide habitat for deep corals to thrive. Deep sea corals are potential sites for many organisms and offer more insight into the ocean's history. Deep corals can be preserved for long periods of time if they are protected. Patch reefs occur rarely off the Turneffe Atoll except on the north end (Purdy et al. 2003). The primary sediment found in Turneffe is predominantly carbonate with limestone Holocene facies underneath (McCloskey et al., 2013). Dr. Peter Etnoyer collected the data used and found that parts of Turneffe Atoll were unlikely for development of deep corals due to high sedimentation and little rocky outcrops past 500m depths. The purpose of this study is to explore the geomorphology and seafloor substrate off the western flanks of Turneffe Reef in order to identify geologic structures that might serve as deep coral habitat.

## Methods

- Data for this research were collected in August 2014 aboard the Ocean Exploration Trust *E/V Nautilus* by NOAA using a Kongsberg EM302.
- Raw data were processed using CARIS HIPS and SIPS 8.1 software.
- An 8 m interpolated CUBE BASE surface and a backscatter mosaic of the data were made to interpret the geomorphology and relative hardness of the seafloor substrate.
- BASE Editor 4.0 was used to make profiles of 27 of the rounded structures found on the seafloor at varying depths grouped, in 3 different locations based on surrounding structures and depth.
- Using profiles, the depth, vertical relief, linear length, and width of the structures were calculated and compared based on location.

## Results

The 8m CUBE BASE surface shows rounded and oblong mound structures along the seafloor located at depths from 400 to 900 m (Fig 1).

- The profiles of Area 2 were more even and rectangular than those of Areas 1 and 3 (Fig. 4).
- In Area 3, depth ranges of the structures measured were greater, ranging from 152 to 819 m.
- The structures in Area 2 had the highest vertical relief, averaging 72.2 m (Table 1).
- The structures in Area 3 had the lowest average vertical relief, length, and width at 57.4 m, 340.9 m, and 243.4 m, respectively, but a greater average depth of 738.4 m (Table 1).
- Backscatter showed the intensity values of the structures in Area 1 to be more negative (i.e., lower intensity) on the tops of the structures, indicating relatively soft substrate (Fig. 4).
- The intensity values on the top of the structures and surrounding seafloor in Areas 2 and 3 were higher (i.e., less negative) than that of Area 1, suggesting the substrate is harder (Fig. 3).

## Discussion and Conclusions

Deep corals are more likely to be found in hard bottom areas with rocky outcrops and hard-bottom exposure, as opposed to areas of high sedimentation (Etnoyer et al., in press). Examining backscatter images, an ideal location for coral would be darker in color as opposed to areas that are white or lighter. Area 3 is of particular interest due to the results of the backscatter and the average dimensions of the mounds. The backscatter intensity values indicated that the substrate is harder in this area than substrate in the shallower Areas 1 and 2. Compared to the other areas measured, Area 3 contains more suitable habitat for corals to thrive due to the depth and harder substrate although the number of mounds is much smaller in this area. In some scenarios, clusters of small carbonate mounds are believed to develop into large structures under the right conditions (Roberts et al., 2006). The soft substrate on the tops of the mounds found primarily in Area 1, may indicate some sort of sedimentation process where sediment is deposited on top of these mounds. This sedimentation could be linked to the larger size of the mounds in Area 1 if sediment were being deposited either more rapidly or in larger amounts, thereby building up the mounds. Based on the results of this study, the identity of these structures is inconclusive. However the rounded structures off the northwestern flanks of Turneffe Atoll could potentially develop into deep coral habitat over time.

## References

- Purdy, E., Gischler, E., and Lomando, A., 2003, The Belize margin revisited. 2. Origin of Holocene antecedent topography: *Int J Earth Sci*, doi: 10.1007/s00531-003-0325-z
- McCloskey, T., and Lui, K., 2013, Sedimentary History of Mangrove Cays in Turneffe Islands, Belize: Evidence for Sudden Environmental Reversals: *Journal of Coastal Research*, vol. 29.4, p. 971-983.
- Gischler, E., and Hudson, J., 1998, Holocene development of three isolated carbonate platforms, Belize, Central America: *Marine Geology*, vol. 144, p. 333-347.
- Roberts, J.M., Wheeler, A.J., Freiwald, A., 2006, Reefs of the Deep; The Biology and Geology of Cold-Water Coral Ecosystems: *Science*, v. 312, p. 543-547, doi:10.1126/science.1119861.
- Etnoyer, P.J., Brennan, M.L., Finamore, D., Hammond, S., Vargas, M., Janson, X., Tuzun, S., Wagner, J., Ferraro, D., Snyder, W., 2015, Exploration and Mapping of the Deep Mesoamerican Reef: *Oceanography*, (in press).

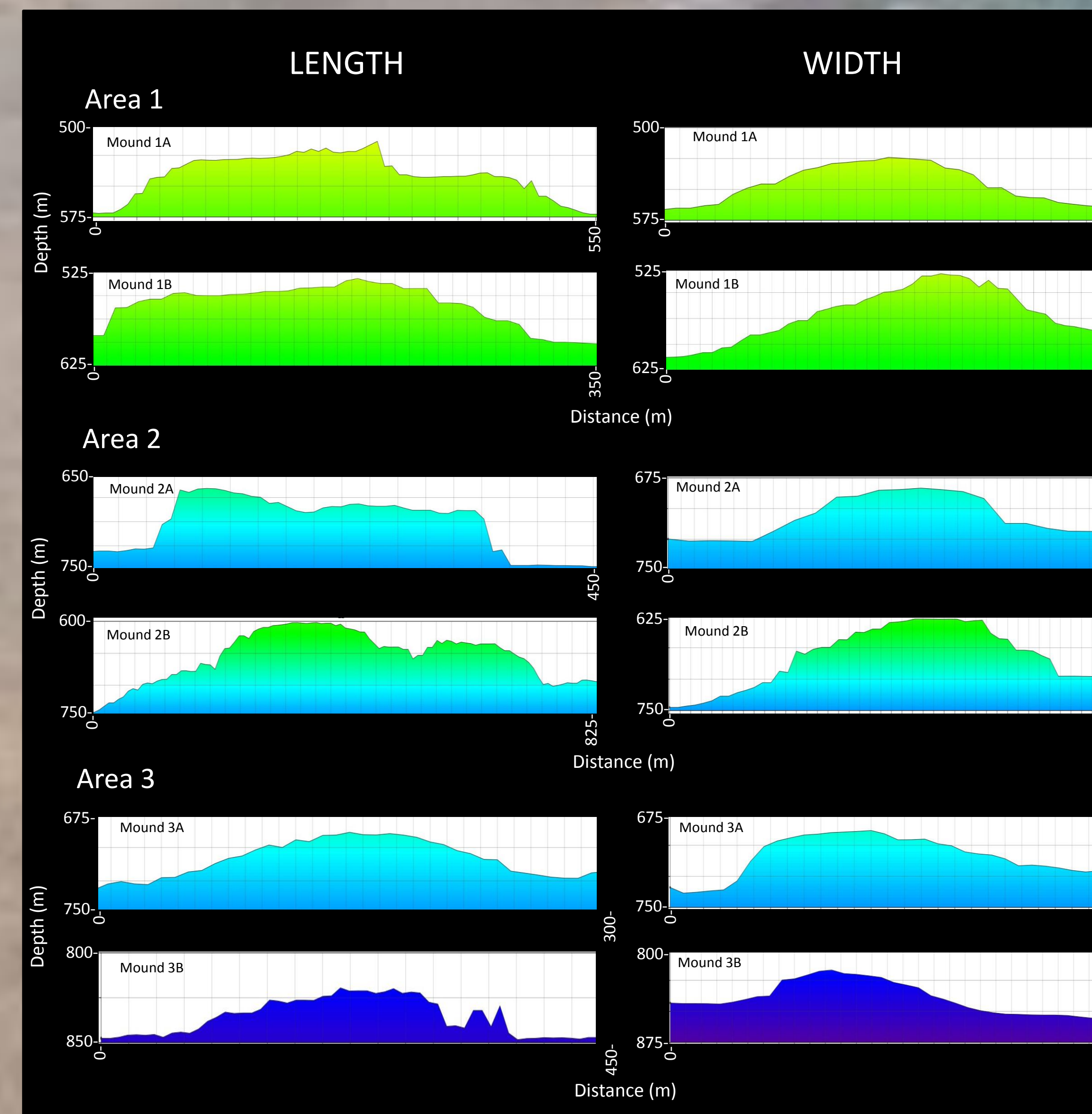


Figure 4. Examples of profiles of two structures from each of the three study areas. Profiles on the left were taken to measure linear length and to calculate the vertical relief. Many of the structures were oblong in shape while on others the linear length was determined from taking the profile of the longest angle of the structure. Width profiles are shown on the right.

Area	Average Depth (m)	Average Vertical Relief (m)	Average Linear Length (m)	Average Width (m)
1	522.7	60.8	438.2	279.2
2	639.1	72.2	409.6	250.7
3	738.4	57.4	340.9	242.4

Table 1. Average values for 9 different structures in each Area. Using profiles, the shallowest depth, vertical relief, linear length, and width was measured, and averages were calculated.

## Acknowledgements

We would like to thank NOAA and Dr. Peter Etnoyer for the data, CARIS for Academic Partnership, and the College of Charleston School of Science and Math.



Rebekah Gossett  
gossetrr@g.cofc.edu  
(803)-917-7744

