Exploring the Bathymetry, Geomorphology, and Seafloor Substrate off the Western Flank of Turneffe Atoll, Belize
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Abstract
Turneffe Reef is a carbonate platform and atoll within the Belize MesoAmerican Reef. The reef flank extends to depths of over 3000 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.

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 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 8 m 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). The profiles of Area 2 are less complex, with fewer structural elements compared to Areas 1 and 3. The backscatter intensity values in Area 1 are higher than in Areas 2 and 3, indicating a harder substrate. Areas of high backscatter and the average dimensions of the mounds are shown in Figure 4, below. The backscatter intensity values were calculated, and narrow linear length and width were measured and averages were calculated.

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 with 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 indicate 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 (Robarts et al., 2006). The linear length of the mounds can be determined, and the number of mounds can be calculated using profiles 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.

References

Acknowledgements
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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.

<table>
<thead>
<tr>
<th>Area</th>
<th>Average Depth (m)</th>
<th>Average Vertical Relief (m)</th>
<th>Average Linear Length (m)</th>
<th>Average Width (m)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>523.7</td>
<td>60.8</td>
<td>608.3</td>
<td>293.9</td>
</tr>
<tr>
<td>2</td>
<td>602.7</td>
<td>72.7</td>
<td>604.6</td>
<td>293.7</td>
</tr>
<tr>
<td>3</td>
<td>738.4</td>
<td>57.4</td>
<td>340.8</td>
<td>242.4</td>
</tr>
</tbody>
</table>

Figure 2. 3D images of each study area. Area 1, 2, and 3 have been measured, and averages were calculated.

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, Area of high backscatter from lengths ranging from 500 to 900 m. CARIS HIPS and SIPS 8.1 was used for post-processing bathymetry and backscatter data.

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 the profile of the longest angle of the structure. Width profiles are shown on the right.

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

Figure 5: Depth, Vertical Relief, Linear Length, and Width for 9 different structures in each area.

Figure 6: Area with low backscatter values indicating a softer substrate.