Comparing Deep-Sea Coral Mound Chains on the Southwest Blake Plateau, Southeast U.S. Continental Margin

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COLLEGE of CHARLESTON — DEPARTMENT OF GEOLOGY AND ENVIRONMENTAL GEOSCIENCES — BEAMS

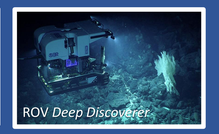
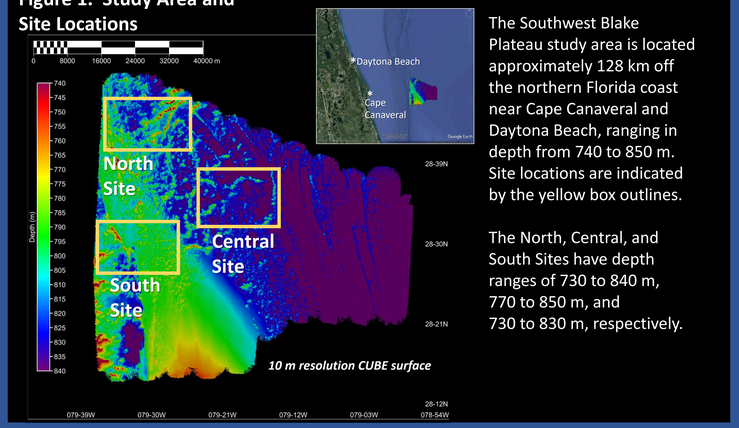


Figure 1. Study Area and Site Locations



The Southwest Blake Plateau study area is located approximately 128 km off the northern Florida coast near Cape Canaveral and Daytona Beach, ranging in depth from 740 to 850 m. Site locations are indicated by the yellow box outlines.

The North, Central, and South Sites have depth ranges of 730 to 840 m, 770 to 850 m, and 730 to 830 m, respectively.

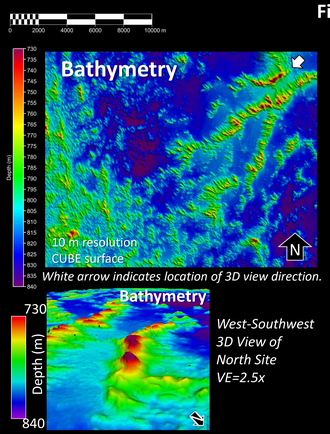
BACKGROUND

In 2019, NOAA OER led a bathymetric ocean exploration mission, 2019 *Southeastern U.S. Deep-sea Exploration* (EX1903-L1) during which the NOAA Ship *Okeanos Explorer* mapped an area in the Southwest Blake Plateau region. This area is often referred to as "Million Mounds" due to the high number of deep-sea coral mounds found in this region. The purpose of the NOAA expedition was to better understand and collect bathymetric data on this region of the U.S. continental margin. This region had been largely unexplored, and these expeditions contributed to a better understanding of the biota that live in this deep-water habitat (NOAA OER, 2019). Portions of the "Million Mounds" region are believed to be the largest *Lophelia pertusa* deep-sea coral reef habitat in U.S. waters (NOAA OER, 2019). This stony coral provides ideal skeletal framework within which many organisms live. As the coral dies and becomes part of the mound, it provides newer coral and other sessile invertebrates such as sponges hard substrate on which to attach and grow (NOAA OER, 2019).

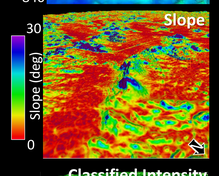
Three study sites within Million Mounds' southwestern portion are examined, referred to as North, Central, and South Sites (Fig. 1). All three sites contain one or more chains of connected coral mounds, classified as having multiple adjacent mounds which create a long chain (Horn and Sautter 2022). NOAA Ship *Okeanos Explorer* returned to this region for the expedition *Windows to the Deep 2021: Southeast U.S. ROV and Mapping* (EX2107), and deployed ROV *Deep Discoverer* to examine the area's geomorphology and biota (NOAA OER 2021). During EX2107-Dive14 the ROV provided ground-truth of a single coral mound in the southeast corner of the Central Site.

The purpose of this research is to compare geomorphologies of the three sites' coral mound chains in order to gain a better understanding of coral mound occurrences within different parts of this region of the Southwest Blake Plateau.

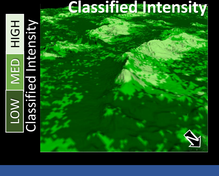
Figure 2. North Site



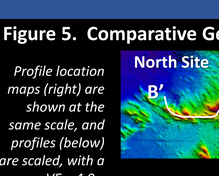
White arrow indicates location of 3D view direction.



West-Southwest 3D View of North Site VE=2.5x



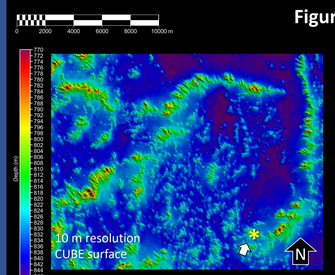
Coral mounds have greatest slopes (30º) on their flanks. Slope shows a change from 30º to 10º as the coral mounds approach the base of the mound.



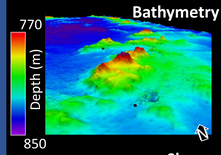
High backscatter intensity occurs on the northern side of coral mound chains. These mound chains also have a lower slope and larger coral base oriented northward which may explain the higher intensity.

Key features at North Site include 3 coral mound chains that converge in the site's northeast section. Individual mounds within the chains are oriented northwest-southeast, roughly perpendicular to the chains.

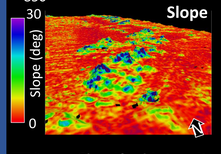
Figure 3. Central Site



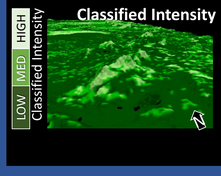
White arrow indicates location of 3D view direction.



EX2107-Dive14 is located on a coral mound, indicated by yellow asterisk, above.
North-Northeast 3D View of Central Site VE=2.5x



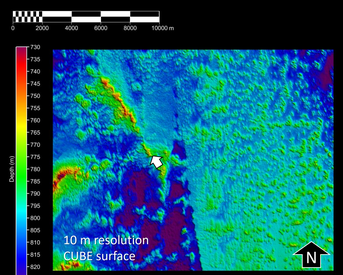
Narrow peaks occur on the mounds, indicated by the change in slope to 30º. The Central Site slope shows a large area of approximately 0º to 5º the base of the mounds.



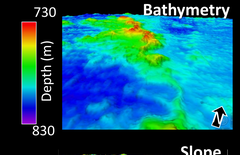
Central Site shows highest intensity at the peaks of coral mounds, suggesting harder substrate on which live *Lophelia pertusa* coral could live

Central Site is the easternmost site and has two long east-west coral mound chains, and one that is north-south. This site also contains other, smaller and more segmented chains in its western portion with mounds orientated northwest-southeast. The chain found in the eastern area of the site has mounds oriented west-east.

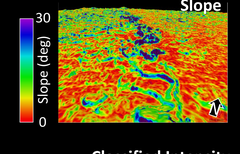
Figure 4. South Site



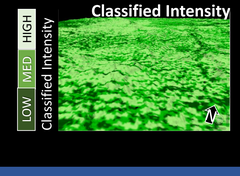
White arrow indicates location of 3D view direction.



North-Northwest 3D Views of South Site. VE = 2.5x



South Site chain slope shows steep flanks that change approximately 0º to 30º. Flanks create steps in the chain.

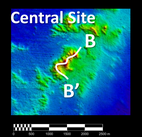


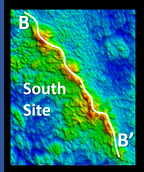
South Site has high intensity across most of the site, but is focused on the peaks of the coral mounds.

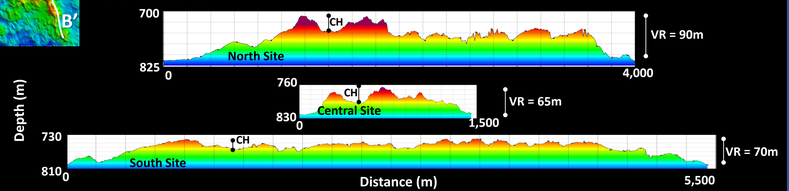
A 5.5 km long coral mound chain is located on the northwestern part of the site. A scarp splits the site and individual mounds occur on the flat region to the east. Hundreds of smaller individual mounds fill the eastern half, the reason this region is often referred to as "Million Mounds." The two South Site chains each have a broad base. The mounds are oriented northeast-southwest.

Figure 5. Comparative Geomorphologies

Profile location maps (right) are shown at the same scale, and profiles (below) are scaled, with a VE = 4.0x.



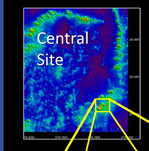




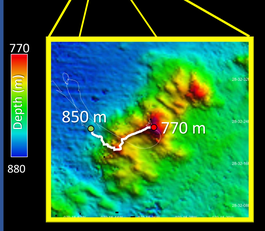
A representative example of a connected mound chain from each site shows a range of chain lengths and morphologies. Most chains in the North and Central Sites are oriented southwest-northeast, whereas those found in South Site are oriented northwest-southeast. Vertical relief from base depth to highest peak in the chain ranges 65 to 90 m. South Site contains the highest density of mound peaks within a chain with low-relief crests having crest height (CH) of only 22 m, whereas mounds of North Site and Central Site chains have fewer peaks but steeper crests and crest height of as much as 40 and 35 m, respectively.

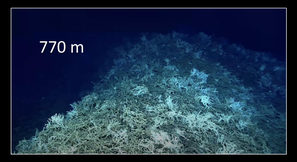
Figure 6. ROV Dive EX2107 – Dive 14

Dive location within Central Site, with NOAA OE dive track (white line), below.



ROV started at base of mound (green dot, depth 850 m) and moved up the mound's flank to its crest at a depth of 770 m (red dot).





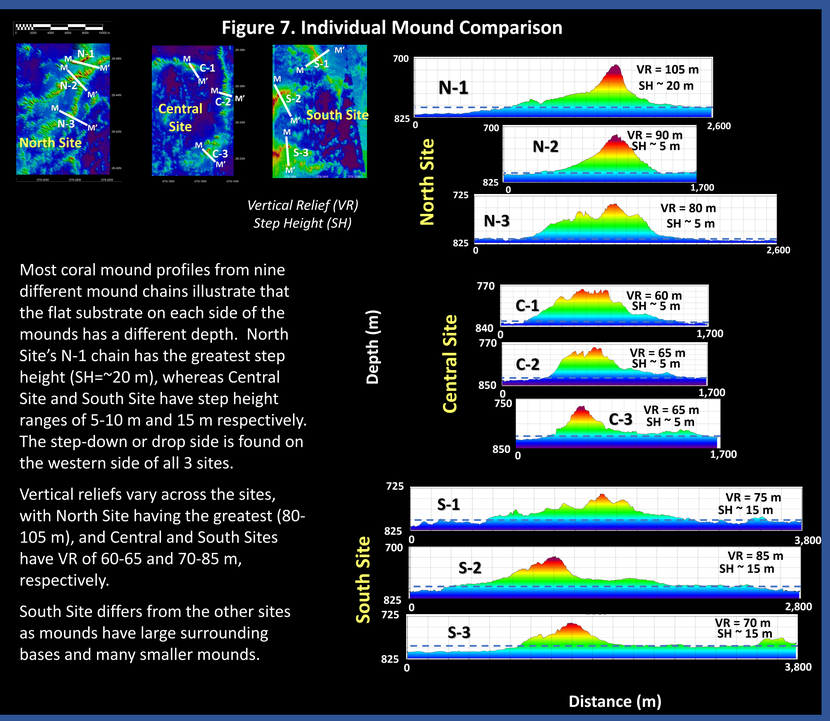
(above) Shoalest point of the coral mound shows steep slopes forming a ridge and abundant live *Lophelia pertusa* colonies.

(left) Coral rubble substrate at mound base and flanks allows for marine life like anemones to attach and survive.

METHODS

- Multibeam sonar data were collected on EX1903L1, June 2019 by NOAA Ship *Okeanos Explorer*, using a Kongsberg EM302 multibeam sonar.
- CARIS HIPS and SIPS 11.4 was used to generate high resolution bathymetric (CUBE) depth and slope surfaces at 10 and 20 m resolution.
- Classified backscatter intensity (dB) was generated using SIPS Mosaic Engine.
- Profiles were made along chained mounds and across individual mounds located within each chain.
- ROV *Deep Discoverer* captured HD video footage of a coral mound in the southwest of Central Site during EX2107-Dive14, November 2021.
- Coral mound orientation and vertical relief of individual mounds within the chains are compared among sites.
- Step Height was measured using methods of Hanley and Sautter (2022).

Figure 7. Individual Mound Comparison



Vertical Relief (VR)
Step Height (SH)

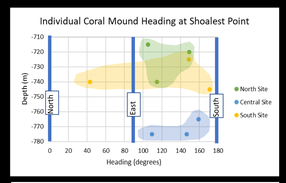
Most coral mound profiles from nine different mound chains illustrate that the flat substrate on each side of the mounds has a different depth. North Site's N-1 chain has the greatest step height (SH=~20 m), whereas Central Site and South Site have step height ranges of 5-10 m and 15 m respectively. The step-down or drop side is found on the western side of all 3 sites.

Vertical reliefs vary across the sites, with North Site having the greatest (80-105 m), and Central and South Sites have VR of 60-65 and 70-85 m, respectively.

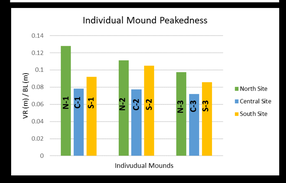
South Site differs from the other sites as mounds have large surrounding bases and many smaller mounds.

Figure 8. Individual Mound Orientation and Peakedness

Comparison of individual mound (Fig. 7) heading and shoalest point show that nearly all coral mounds measured have a compass heading between 100 and 180º (between east and south). The outlier at South Site (S-1) has mounds with a northeast heading. Orientation does not appear to be influenced by mound depth.



Individual mound peakedness was determined by dividing vertical relief (VR) by base length (BL). Individual mounds in the North Site (green bars) have an overall greater peakedness than the other two sites. Central Site (blue bars) has the lowest peakedness. This site also has the deepest shoal depths (see upper graph).



SUMMARY

Coral mound morphologies vary within chains across the North, Central, and South Sites. Central Site mound chains differ from North and South Sites in that they have the lowest base to peak vertical relief, deepest shoal depth, and lowest individual mound peakedness. Central Site's chain lengths are also shortest for the 3 sites. These observations from Central Site indicate that the coral mounds may be less developed than mounds found in the North and South sites, possibly due to their proximity to the Gulf Stream. Mounds occurring beneath the Gulf Stream's main axis (i.e., North and South Site mounds) likely have abundant food supply promoting growth of the mound-forming stony coral, *Lophelia pertusa*. Central Site mounds, are ~ 35 km east of these sites and may have slower growth because of suboptimal conditions for *Lophelia pertusa* growth. ROV Dive footage of a Central Site mound, revealed that the base of the mound is covered in stony coral skeletons (Fig. 6), however the mound crest has a high concentration of live *Lophelia pertusa* indicating suitable habitat conditions exist at present.

Another noticeable feature among the sites can be seen in the surrounding substrate's step height (Fig. 7). Step height is an indication that coral mounds have formed along a topographic feature such as a small scarp (Hanley and Sautter 2022). Seafloor currents may upwell against the step, supplying nutrients and food that could allow coral to grow more in these areas.

Results of mound morphology suggest that mounds examined at Central Site may either be forming more slowly, or they are younger than the other two sites. Additional research on this study area of the Southwest Blake Plateau could determine age differences in the coral mound chains and indicate if coral mounds are influenced by proximity to the Gulf Stream's main axis.

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