GEOMORPHOLOGIC ANALYSIS OF THREE NEW ENGLAND SEAMOUNT SITES IN THE NORTH ATLANTIC #4368

Jacob S. Stock and Dr. Leslie R. Sautter

Department of Geology and Environmental Geosciences, College of Charleston

stockjs@g.cofc.edu and SautterL@cofc.edu

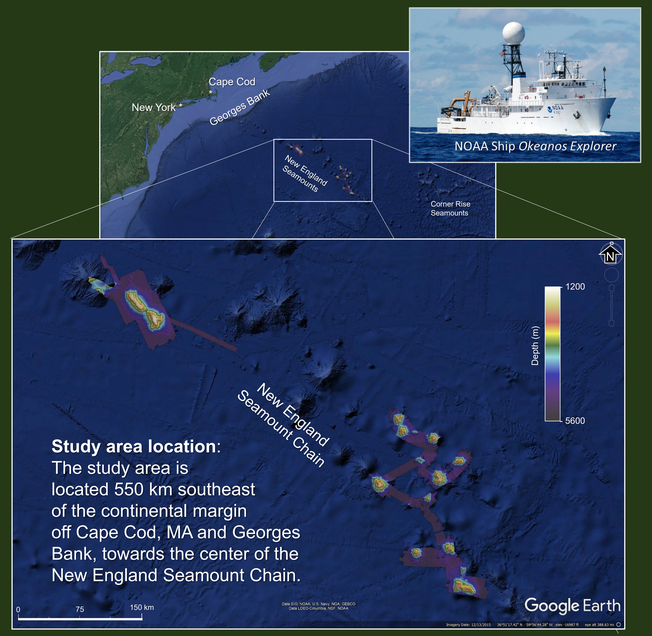
BACKGROUND

The New England Seamounts are a chain of extinct submarine volcanoes that reach from 50 km southeast of Georges Bank and extend east for over 1000 km creating the largest seamount chain in the North Atlantic Ocean. These unique bathymetric features resulted from volcanism as the North American Plate moved west across the Great Meteor hotspot approximately 80 mya (Shank, 2010). These features eventually cooled and contracted, then sank well below the sea surface. Seamounts that once grew to extend above sea level before being eroded flat by wave action are called guyots.

Seamounts often provide substrate necessary to support complex benthic habitats. Hard substrate, steep slopes, and accelerated bottom water flow attract many deep-sea coral species that need to attach to the seabed, and which also attract numerous species of fish and many invertebrates (Etnoyer, 2010). During the *2021 North Atlantic Stepping Stones: New England and Corner Rise Seamounts* expedition (EX2101), the NOAA Ship *Okeanos Explorer* collected multibeam sonar data of the New England Seamounts to acquire critical baseline information about previously unknown and poorly understood deepwater areas off the northeast U.S. coast. The purpose of this study is to use bathymetry, slope and classified backscatter intensity data to identify possible deep-sea coral habitat locations, and other benthic habitats likely to contain high biodiversity.

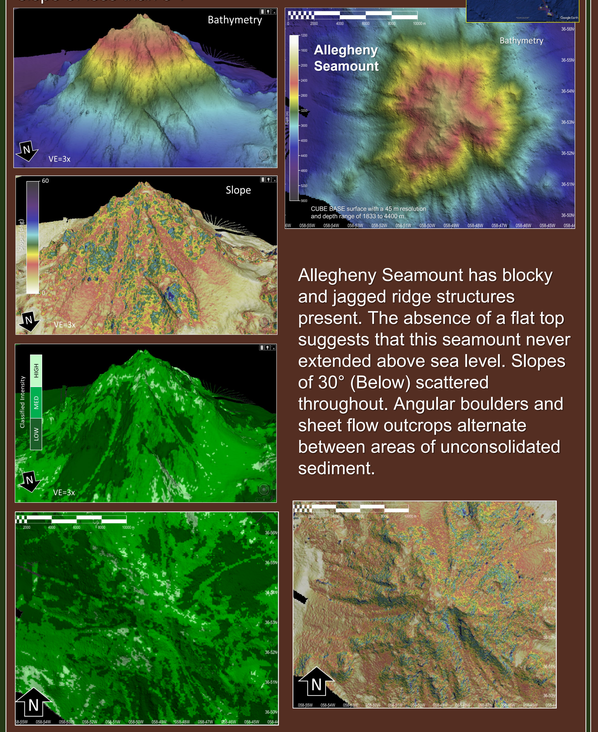
METHODS

- The NOAA Ship *Okeanos Explorer* collected raw multibeam data utilizing a new EM304 multibeam echosounder during EX2104 (June to July 2021) and EX1404 (August 2014).
- CARIS HIPS & SIPS 11.3 was used to post-process sonar data.
- The ROV *Deep Discoverer* was used during EX2104, Dives 12,15,16, and 17 to collect critical baseline information about dive site substrate and benthic biodiversity.
- 2D and 3D bathymetry and slope surfaces as well as classified backscatter intensity mosaics were generated. Depth profile cross sections were taken to better compare seamount geomorphology.
- Quantitative linear regression analysis was used to compare slope and intensity data between dive sites.
- Classified backscatter intensity mosaic was generated over the entire study area in order to compare intensity values among locations.



Allegheny Seamount

The geomorphology and substrate of this seamount are the most varied of the sites studied. Canyons and ridges surround Allegheny's seamounts conical shape and extend to its 4400 m base before tapering to a slope of less than 5°.

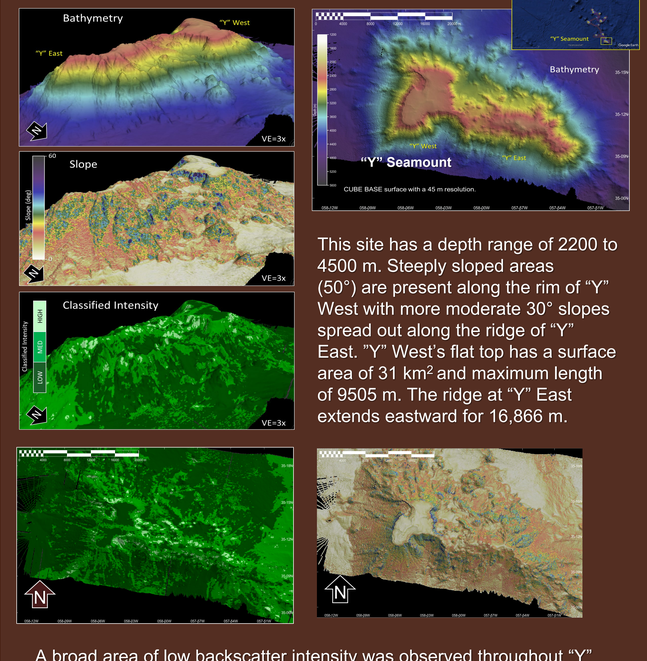


Allegheny Seamount has blocky and jagged ridge structures present. The absence of a flat top suggests that this seamount never extended above sea level. Slopes of 30° (Below) scattered throughout. Angular boulders and sheet flow outcrops alternate between areas of unconsolidated sediment.

Classified backscatter intensity (above) shows most high-intensity areas concentrated near Allegheny's peak, indicating possible hard substrate in these locations. Greater water depths are associated with an increased amount of unconsolidated sediments.

"Y" Seamount

This seamount was nicknamed by NOAA scientists who described the location as partly resembling the letter y. "Y" Seamount is a flat-topped guyot on its western summit (here referred to as "Y" West) and dips at its center to an elongated, narrower eastern ridge ("Y" East). The western side may have formed first and was subsequently eroded flat by wave action before the eastern ridge had developed. This theory is consistent with the path that the North American Plate took as it moved west over the Great Meteor hotspot during the formation of the New England Seamounts.

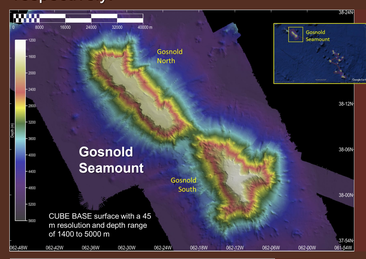


This site has a depth range of 2200 to 4500 m. Steeply sloped areas (50°) are present along the rim of "Y" West with more moderate 30° slopes spread out along the ridge of "Y" East. "Y" West's flat top has a surface area of 31 km^2 and maximum length of 9505 m. The ridge at "Y" East extends eastward for 16,866 m.

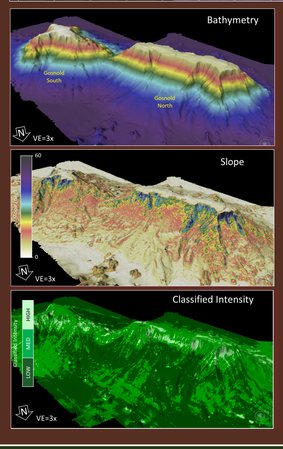
A broad area of low backscatter intensity was observed throughout "Y" West's flat summit. These data suggest that unconsolidated sediments may be present at this location. High intensity substrate is seen along the upper flanks of "Y" East and off the rim of "Y" West indicating hard substrate in these areas.

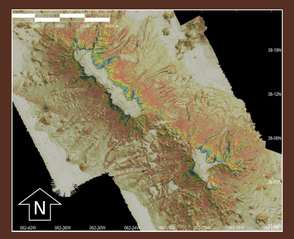
Gosnold Seamount

Gosnold is a twin-peaked guyot separated by a depressed saddle area. For this study, Gosnold's peaks are referred to as "Gosnold North" and "Gosnold South". Each area had an associated ROV dive to ground-truth sonar data. Those dives are EX2104-Dive16 and EX2104-Dive17 for the north and south peaks, respectively.



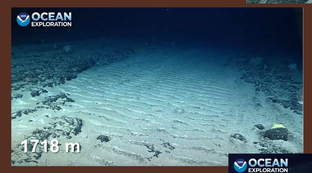
Gosnold North's flat-top has a surface area of 63.2 km^2 and a maximum length of 28.3 km. It is 46.8% larger and noticeably more elongated when compared to Gosnold South which has a surface area of 29.6 km^2 and a maximum length of 13.3 km. Steeply sloped areas (50°) shown on slope surfaces (below, blues) are concentrated just over the edges of the seamounts flat-top.



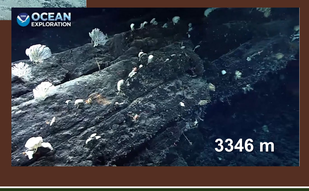


Areas of high intensity (light green) frequently occur on Gosnold North's flat-top within sloped areas of less than 5°. High intensity also associated with steep areas located on seamounts flanks and indicate that hard substrate may be present.

Numerous sponge and coral species growing on hard substrate. This confirms that the high intensity values found on Gosnold North's flat top act as good indicators of hard substrate.



Sediment on Gosnold North's flat top with undulating ripples suggesting unidirectional current present.



Sheet flow lavas on Allegheny Seamount provide substrate for a diverse benthic habitat consisting of sponges, corals, and sea stars of varying species.

DISCUSSION and CONCLUSIONS

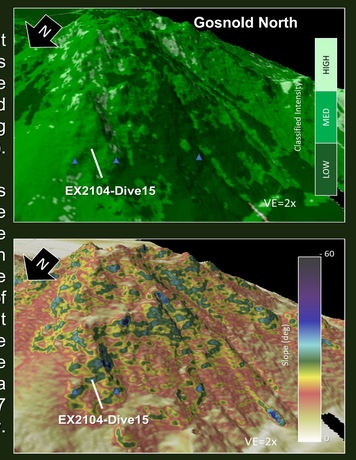
Data collected from the bathymetric surfaces revealed weak to no correlation found between slope and intensity values, and therefore are poor indicators for seeking areas of biodiversity in deep-sea environments in this study location. However, concentrated benthic habitats observed during ROV dives are associated with areas of hard substrate (i.e., high intensity surfaces). Thus, slope, depth, and intensity values from dive location will be used in conjunction with geomorphology to identify potential areas of benthic habitat.

Gosnold North

Possible deep-sea coral habitat locations were chosen from areas with similar intensity and slope values to where concentrated benthic habitats were found during EX2104-Dive17).

Strong unidirectional currents present on the summit plateau are indicated by undulatory/cuspate ripples. All sites are located on Gosnold North's flat top where organisms can take advantage of any O_2 rich waters being brought from this current. Water depth here is shallowest (1714 m) among the study sites examined and may be a contributing factor to EX2104-Dive17 having the highest biodiversity.

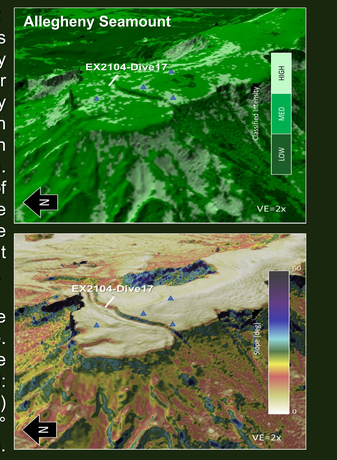
All site locations are indicated by a blue triangle. The following criteria were used:
Intensity: -11.6 dB (+/- 1.0)
Slope: 3.3° (+/- 1.0)
Depth: 1714.5 to 1782.8 m.



Allegheny Seamount

Although this seamount has a lower biodiversity compared with other locations studied, Allegheny has a relatively high biodiversity for seafloor with depths below 3300 m. Dipping sheet flow layers of varying thickness were present hosting biodiverse communities throughout EX2104-Dive15.

All site locations are indicated by a blue triangle. The following criteria were used:
Intensity: -12.6 dB (+/- 2)
Slope: > 23.6°
Depth: 3336.5 to 3446.6 m.



Summary

When identifying possible deep-sea coral habitats with sonar data, the traditional practice of locating areas of high slope and intensity should not be used. Individual site locations are too complex and varied to be generalized in this way. Gosnold North's flat-top having high intensity values directly contrasted the broad area of low intensity found on the flat-top of "Y" West supporting this conclusion. Instead, ROV dives should be used to ground-truth these data, and then criteria should be developed for a select area.

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