Potential Deep-Sea Coral Habitats Within the Corner Rise Seamount Chain, Northwest Atlantic

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#2744

BACKGROUND

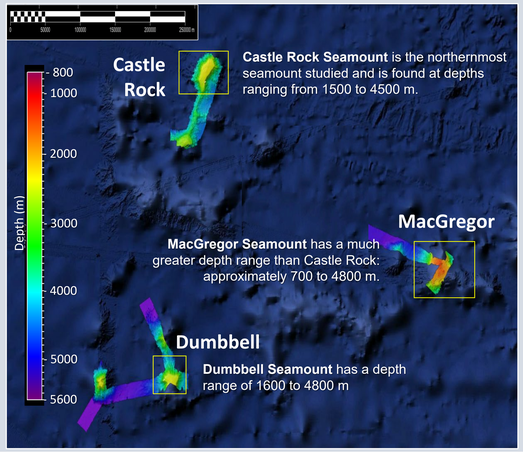
Corner Rise Seamounts are a group of approximately 20 seamounts located more than 1,500 km east of the northeastern U.S. continental margin and 615 km east of the New England Seamount Chain. Both seamount chains were formed by volcanic activity over a mantle plume hotspot that formed the Monteregian Hills southeast of Montreal, Canada, beginning 140 million years ago (Lapointe, 2020). Along with the New England Seamount Chain, the Corner Rise Seamounts make up a chain that extends from the Mid-Atlantic Ridge to the United States' northeastern continental margin, as seen in the figure below. These seamounts are comprised of a series of submerged volcanic islands stretching across a surrounding flat plain of abyssal mud where depths reach to more than 5000 m (NOAA, 2021). The seamounts' flat tops indicate that they are guyots, which are seamounts that grew above sea level and were eventually eroded flat by waves (Kelley, 2021). Not much was known about the Corner Rise Seamounts (CRS), as the area had not been mapped or explored in great detail. However, in 2021 the NOAA Ship *Okeanos Explorer* undertook the EX2104 mission from June 30 to July 29 to discover more about these seamounts. Mission goals related to the CRS included improving knowledge of unexplored areas, locating and characterizing deep-sea coral and sponge communities, and enhancing predictive capabilities for identifying vulnerable marine habitats and marine minerals (NOAA, 2021). Expedition results revealed that some of these seamounts have a wide range of deep-sea coral communities such as *Chrysogorgia, Iridogorgia,* and *Metallogorgia* corals (NOAA, 2021), along with many other taxa. There were also areas observed that exhibited high diversity and high densities of sponges (NOAA, 2021).

The purpose of this study was to (1) use multibeam sonar data along with ROV footage collected on the expedition to analyze the region, (2) evaluate the relationship between the area's geological attributes and their ability to support communities of coral and other marine life, and (3) determine potential deep-sea coral habitats within other areas of the Corner Rise Seamounts.

Figure 1. Study Area and Site Locations

The Corner Rise Seamounts study area is located approximately 1,500 km east of the U.S. continental margin and 615 km east of the New England Seamount Chain.

A total of 3 seamounts were examined in this study (below), referred to as Dumbbell, Castle Rock, and MacGregor. Castle Rock and Dumbbell are each comprised of two distinct volcanic features.



METHODS

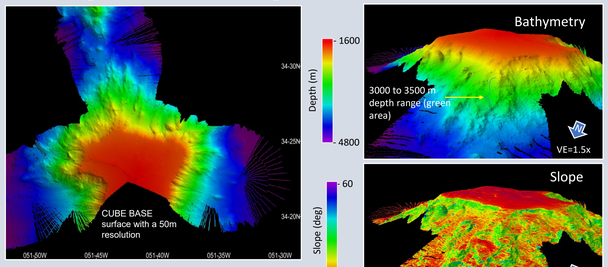
- Bathymetric surveys were conducted by NOAA OER on the NOAA Ship *Okeanos Explorer* with a Kongsberg EM302 multibeam sonar system. Data collection dates for expedition EX2104 were July 7, 9, and 11, 2021.
- Frame-grabs of high-definition video collected by ROV *Deep Discoverer* were used for seafloor ground-truthing along the dive track for each site. ROV dives used included EX2104-Dive04, EX2104-Dive06, and EX2104-Dive08.
- CARIS HIPS and SIPS 11.3 software was used to process raw multibeam sonar data and render CUBE BASE surfaces at 50 m resolution.
- 2D and 3D images and profiles were generated, slopes and distances of each site were measured, and backscatter intensity was classified.
- Intensity and slope data were collected at random points along the ROV dive paths to represent the slope and intensity associated within each focus area and linear regression was performed.

NOAA Ship *Okeanos Explorer*

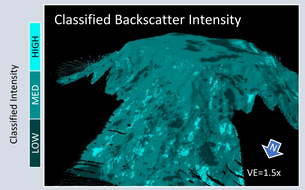
ROV *Deep Discoverer*

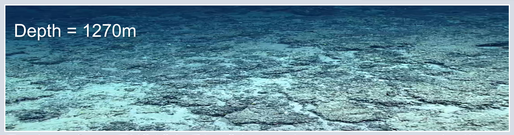
Figure 2. Dumbbell Seamount

This flat-topped seamount, or guyot, is approximately 3.5 km tall and is composed of steep ferromanganese-encrusted rocky slopes, low-relief rock pavements, and slopes covered with variable thicknesses of sediment both biological and volcanic in origin (NOAA 2021).



Dumbbell Seamount has a broad top with an east-west width of 17.1 km. The top has an area of 48.2 km^2. The seamount ranges in depth from 1600 to 4800 m. There is also a lower sloped area that ranges 3000 to 3500 m near the seamount base.



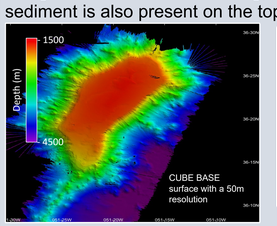


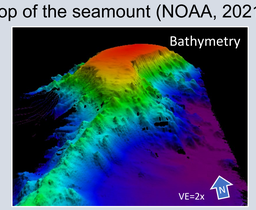
Footage from EX2104_Dive04 showing carbonate crust with ferromanganese patina.

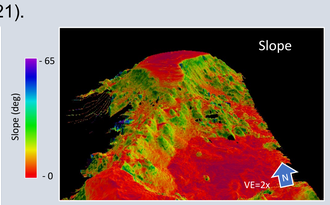
Higher backscatter intensity occurs randomly on deeper parts of the slopes of the seamount. High intensity areas also occur on the eastern flank directly below the rim, as well as on the ridges.

Figure 3. Castle Rock Seamount

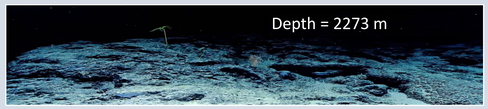
This seamount is approximately 3 km tall and has steep sections of exposed lava flow morphologies, along with a series of alternating, low-relief rock and sedimented areas. Thicker and more extensive sediment is also present on the top of the seamount (NOAA, 2021).



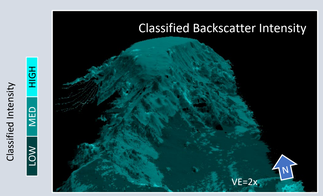




Castle Rock Seamount has an elongated flat top area at a depth of approximately 1500 m. The top has a 93.2 km^2 area Flank slopes are less than 10° to a depth of 2000 m, then increases to 35° by 3000 m and are steepest between 2600 and 3300 m.



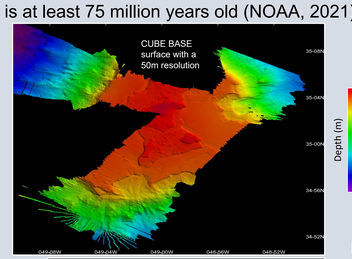
Footage from EX2104_Dive06 showing ferromanganese crusts and biogenic sediment.

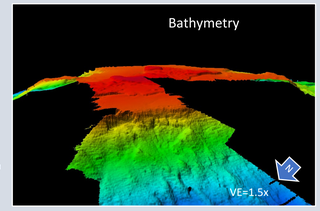


Higher backscatter intensity occurs mainly on the mid-slope areas, with small patches on the flat top area.

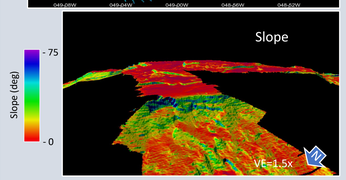
Figure 4. MacGregor Seamount

This seamount is approximately 4 km tall and its flat top is covered by a thin layer of coarse, biogenic sediment, indicating sustained strong currents were preventing the volume of sediment accumulation that might be expected for a feature of this age, which is at least 75 million years old (NOAA, 2021).

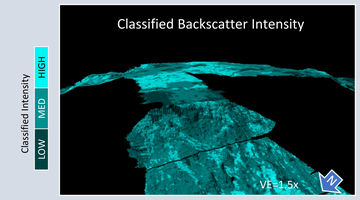




MacGregor Seamount has the greatest vertical relief (4100 m) of the 3 sites, ranging in depth from 700 to 4800 m. The flat top has an area of 85.5 km^2.



There are some areas on the rim edge with slopes between 20° and 30° degrees, but overall, this is a very flat site, with slopes between 0 and 10°. Towards the northwest area of the seamount, there is a cliff face that has a steep drop from 1500 to 2500 m with slope approaching 70° in some parts.

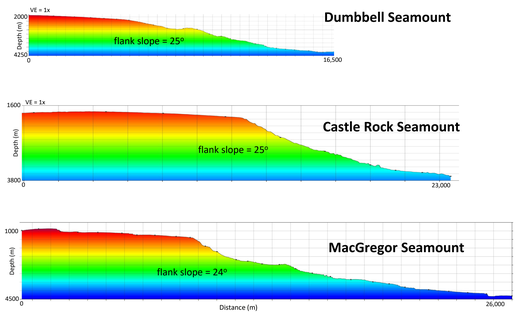


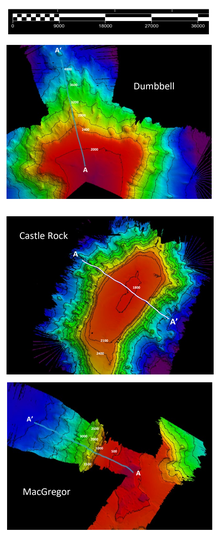
Higher backscatter intensity occurs mostly on the steep slope leading up to the flat top area of the seamount. There are more high intensity areas on the top of the seamount, indicating hard substrate.

Footage from EX2104_Dive08 showing thick ferromanganese crust with a layer of accumulated biogenic sediments.

Figure 5. Comparison of Flank Geomorphologies

Due to lack of bathymetric data, attaining full longitudinal profiles of each seamount was not possible. Thus, flank profiles are compared.



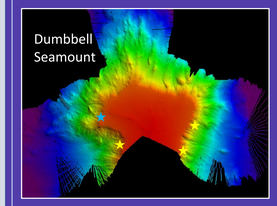


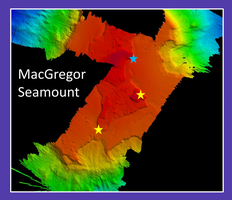
All three seamounts have distinct features that make them areas of interest. **MacGregor** has the greatest vertical relief of 4,100 m, ranging in depth from 4,800 to 700 m. **Castle Rock** has a smoother flank than other seamounts.

Dumbbell has the shortest flank, around 16,500 m. All three seamounts have flat tops of varying areas that range between 48.2 and 93.2 km^2, with slopes ranging 0 to 10°. Flank slopes are similar (~25°), but with varying changes in gradient.

DISCUSSION and CONCLUSIONS

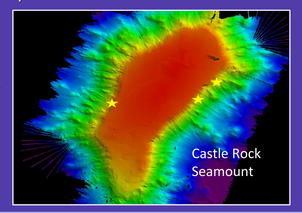
After analyzing substrate hardness, slope, and depth for corals observed on the HD video collected by ROV *Deep Discoverer*, potential locations for future ROV dives were identified for each Corner Rise Seamount site. These dive locations have substrate characteristics similar to where deep-sea corals were observed. Pinpointing these potential dive sites will save significant time and money for future exploration in this region. ROV dive sites from EX2104 are indicated with blue stars. Potential deep-sea coral habitats are indicated with yellow stars.





For **Dumbbell Seamount** (left), potential deep-sea coral habitat locations were identified between 2250-2412 m with high backscatter intensity and a slope between 15 and 35°. **Castle Rock Seamount** (below) habitat locations were selected if they were at depths between 2082-2331 m, had medium to high classified backscatter intensity, and slopes between 8 and 45°. Selected habitat locations ranged from 939-1272 m for **MacGregor Seamount** (left) with medium to high classified backscatter intensity and slopes between 0 and 60°.

Overall, deep-sea coral habitats were found in areas with higher slope. For example, a large wall of coral skeletons and living corals was observed on Dive 04 at Dumbbell Seamount. The wall was steep and in close proximity to a current flowing through the area. Corals were able to use the current to filter water and capture food particles. The same situation was observed on Dive 08, as many corals were growing on a steep carbonate wall. Corals were also found on the flat top of MacGregor Seamount near a sponge 'garden', but not in as high quantity abundance. Based on the ROV dive footage and characteristics of the sites, deep-sea corals prefer to grow in relatively steep locations, such as cliff faces or walls, on hard substrate.



ACKNOWLEDGEMENTS

We would like to thank the College of Charleston BEAMS Program and the College of Charleston Department of Geology and Environmental Geosciences. We are also grateful to CARIS, Google Earth, and the participants of the NOAA *Okeanos Explorer* expedition EX2104.
Support to attend this meeting was generously provided by the Matt Christie BEAMS Support Fund.

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