Analysis of Potential Deep Coral Habitats within Submarine Canyons on the Northeastern Portion Glover's Reef Atoll, Belize

Hayley Brashier and Dr. Leslie Sautter

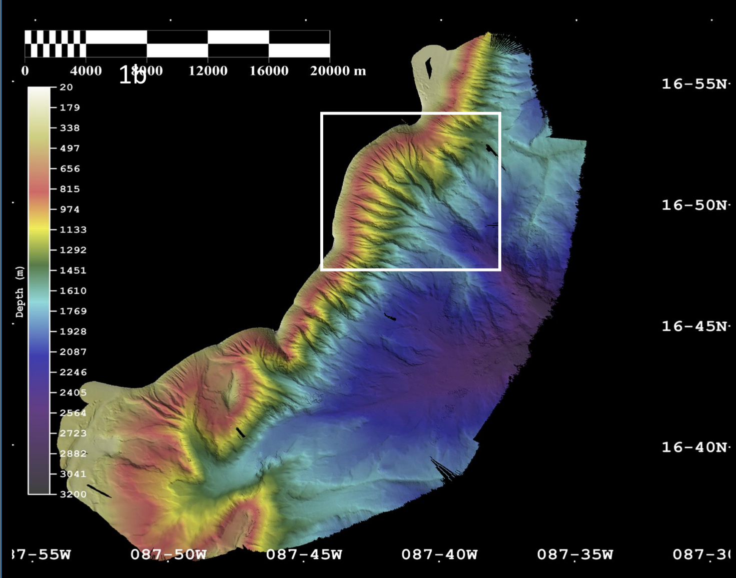
Department of Geology and Environmental Geosciences, College of Charleston


E/V Nautilus

ABSTRACT

Glover's Reef Atoll is a part of the Mesoamerican reef system found 45 km to the east of the Belize mainland. Deep-sea coral habitats have the ability to support many different species and promote biodiversity in deep-sea environments. Multibeam sonar data were collected by NOAA and the 2014 Corps of Exploration in August 2014 on the E/V *Nautilus* using a Kongsberg EM302 transducer. Submarine canyons on the northeastern end of Glover's Reef Atoll, Belize reside at depths ranging from 900 m to 1900 m, and contain potentially suitable habitats for deep-sea coral reef ecosystems. Sonar data were post-processed using CARIS HIPS 9.0, creating 2D and 3D bathymetric images to determine possible locations of deep-sea habitats. Submarine canyons of Glover's Reef contain a variety of different seafloor substrates, classification of which was done by using backscatter intensity. The angles and steepness of Glover's reef submarine canyons were measured to determine if a certain slope is more favorable for the success of deep-sea coral environments.

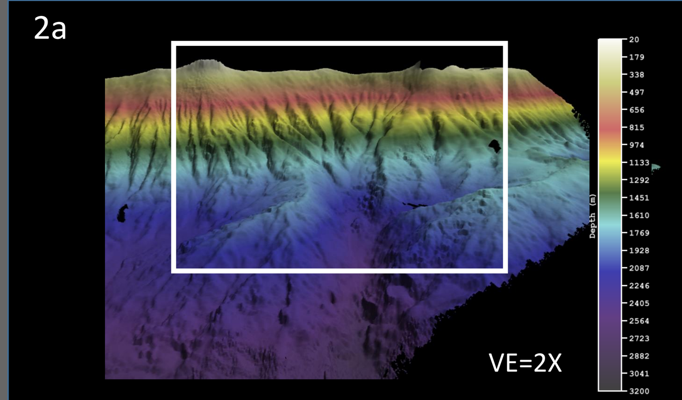
Figure 1a. Glover's Reef Atoll is part of the Mesoamerican reef system which lies aproximately 45 km east of Belize.
Figure 1b. CUBE BASE surface with a 20 m resolution of Glover's Atoll, showing the study area.



BACKGROUND

Glover's Reef Atoll is part of the Mesoamerican Reef system, and sits 45km to the east of Belize. In 2014, NOAA scientist Dr. Peter Etoyner (NOAA Center for Coastal Environmental Health and Biomolecular Research) collected multibeam sonar data of Glover's Reef Atoll, which concentrated on finding potential suitable habitats for deep-water corals in the area (Etoyner et al., 2015). The study site resides at approximately 900 to 1700 m water depth on the Northeastern side of the atoll. Scientists have determined deep-sea corals thrive in water temperature ranging from 4 to 12℃. These corals thrive in areas with high geomorphological diversity, similar to that of Glover's Reef Atoll (Roberts et al., 2006). With the use of multibeam sonar data, the area was found to be dominated by submarine canyons, which may provide suitable coral habitat. The data collected during this exploration could allow scientists to better determine smaller locations for further research with an ROV.

Deep-sea coral known as "Christmas tree" coral, *Antipathes dendrochristos.*



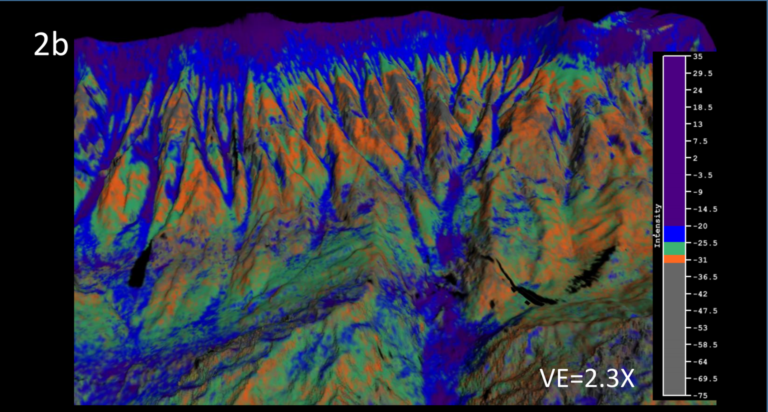


Figure 2a. 3D image of Glover's Reef study site's bathymetry. White box shows area in 2b.
Figure 2b. 3D draped image of classified backscatter intensity on bathymetry of the study site.

METHODS

- Multibeam data were collected by NOAA and the 2014 Corps of Exploration in August 2014 aboard the Ocean Exploration Trust's E/V *Nautilus,* by NOAA Marine Biologist, Dr. Peter Etoyner, using a Kongsberg EM302 system to create bathymetric and backscatter intensity images.
- CARIS HIPS 9.0 was used to create a 20 m CUBE BASE surface of the study site, and CARIS BASE Editor 4.1 was used to create slope maps.
- Classified backscatter images were used to determine relative substrate hardness within the area.
- Profiles of inter-canyon ridges were created to measure canyon slopes and sinuousity.

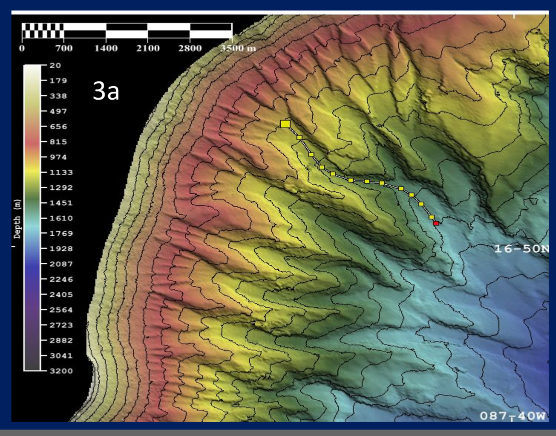
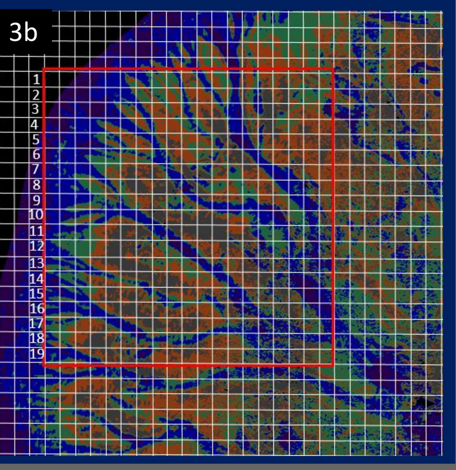
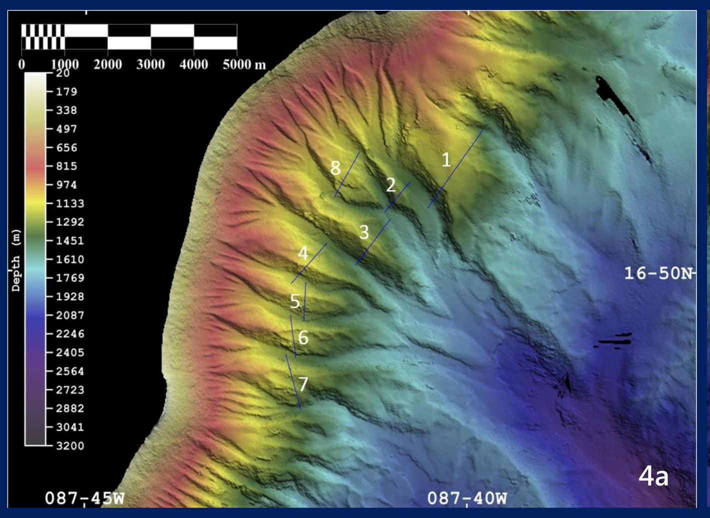


Figure 3a. Bathymetric image with 100m contour intervals used to measure sinuosity of the submarine canyons using the ruler tool.
Figure 3b. Classified backscatter intensity image with grid overlay to determine percent of each substrate class.



SLOPE RESULTS

Profile lines of the eight inter-canyon ridges were used to determine the morphology and slope of each submarine canyon wall (Fig. 4a). Ridge 1 has a total South side slope of 23.1° with certain segments of the canyon wall having a slope up to 60° (Figs. 4c,d,&e). Ridge 1 is both the tallest at 600m and widest at 2200m making it the largest ridge in the study site (Figs. 4b&e). Ridge 2 is the shortest site with a larger Southern side slope compared to the Northern slope. Ridge 2 features an escarpment like feature on its Northern side. Ridge 6 has two mounds on the South side of the slope (Fig. 4d). Ridge 3 had the highest total South side slope with a value of 26.7°. Ridge 4 had the smallest South side slope at 9.1° with a larger slope on the North side of 19.5°. The eight adjacent submarine canyons within the study site have low sinuosity with the most sinuous submarine canyon in the study to be adjacent to Ridge 8, with a sinuosity value of 1.13 (Table 1).
All but Ridge 4 inter-canyon ridges in the study area have greater slopes on the South side compared to the North side slope. All of the canyons are relatively straight in morphology, and not very sinuous (Fig. 4f).



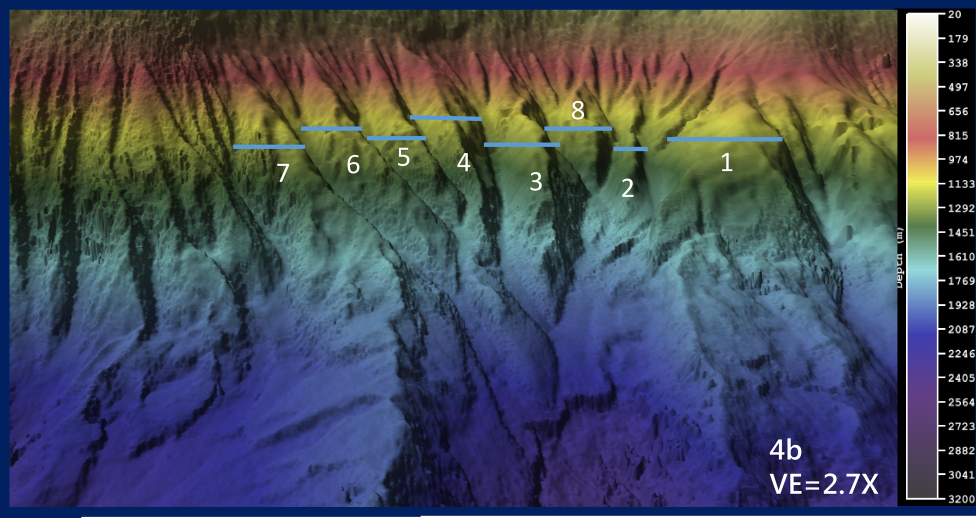


Figure 4a. CUBE BASE surface showing profile lines of the 8 inter-canyon ridges used in the study.
Figure 4b. 3D bathymetry of the study site with 2.7x vertical exaggerated to enhance the slopes of each of the canyon walls.

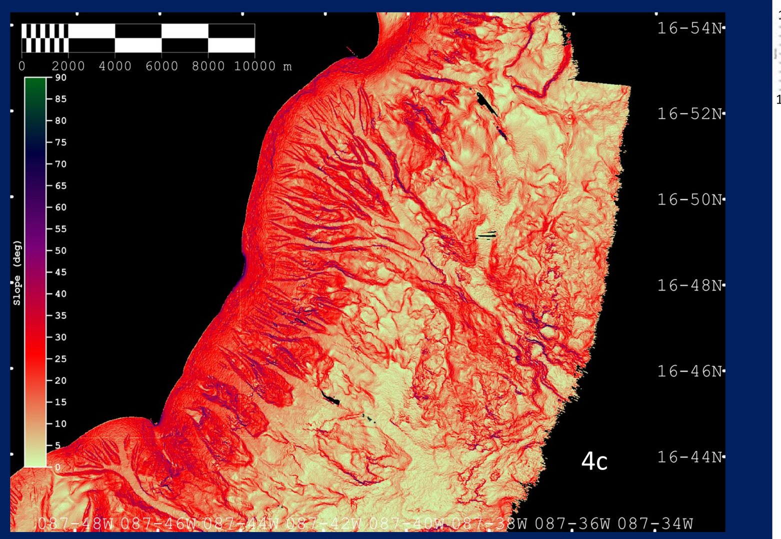


Figure 4c. Slope map of study site created using BASE Editor to determine areas of potential deep-sea coral habitats.

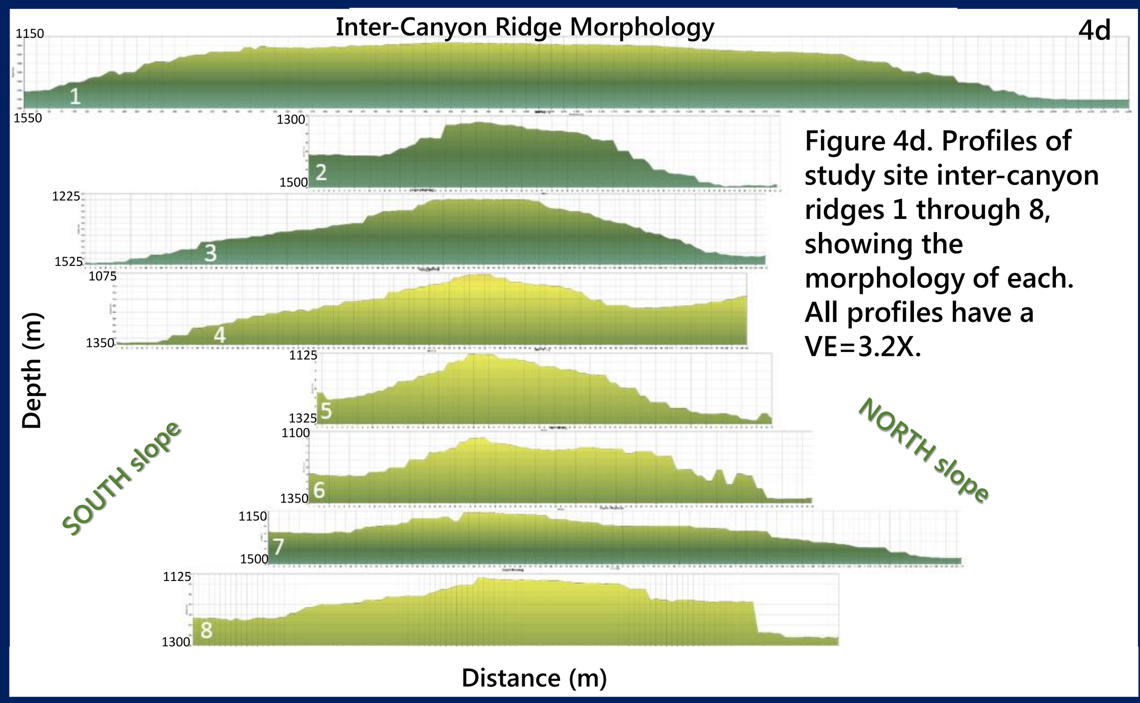
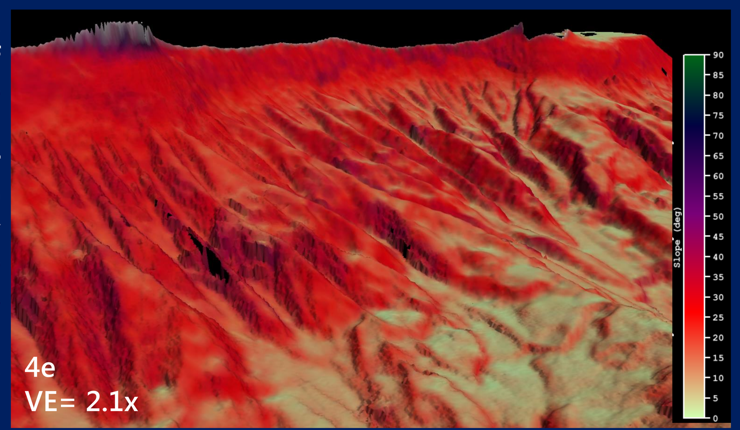


Figure 4d. Profiles of study site inter-canyon ridges 1 through 8, showing the morphology of each. All profiles have a VE=3.2X.

Table 1. All measured values of each the 8 inter-canyon ridges.

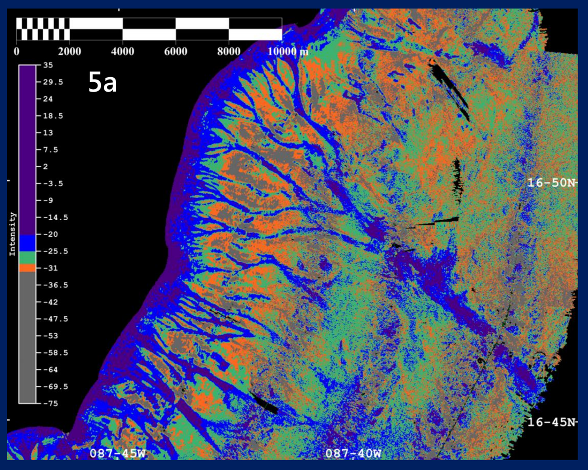
Inter-Canyon Ridge	Depth Range (m)	Relief of Ridge (m)	Profile Distance (m)	North Side Slope (deg)	South Side Slope (deg)	Sinuosity
1	1000-1600	600	2200	12.08	23.11	1.08
2	1300-1500	200	925	16.97	20.36	1.04
3	1200-1600	400	1350	20.67	26.66	1.01
4	1000-1400	400	1250	19.51	9.06	1.03
5	1000-1400	400	900	13.92	18.11	1.05
6	1000-1400	400	1000	9.09	21.40	1.03
7	1000-1500	500	1350	14.58	17.82	1.05
8	1100-1300	200	1200	10.58	17.85	1.13

Figure 4e. 3D image of the slope surface draped over bathymetry to more clearly see the slope of the canyons and inter-canyon ridges.



BACKSCATTER RESULTS

Substrate character of the study site was split into four different categories; hard, medium hard, medium soft, and soft (Figure 5a). Hard substrate made up the least area in the study site with only 8%. Medium hard and medium soft substrate made up a total of 53% of the study area, and soft substrate made up the most of the study site area with 40% coverage (Fig. 5b). The substrate in the thalweg of the submarine canyons is found to have the highest concentration of hard substrate with the highest intensity returns from the backscatter data (Fig. 5c). Lower intensity returns were generally on the side slopes of the submarine canyons, while the weakest intensity returns and softest substrate were mostly found on the tops of the inter-canyon ridges (Fig. 5d). There are some areas on the ridges and sides of the canyons where a higher intensity hard substrate can be found.



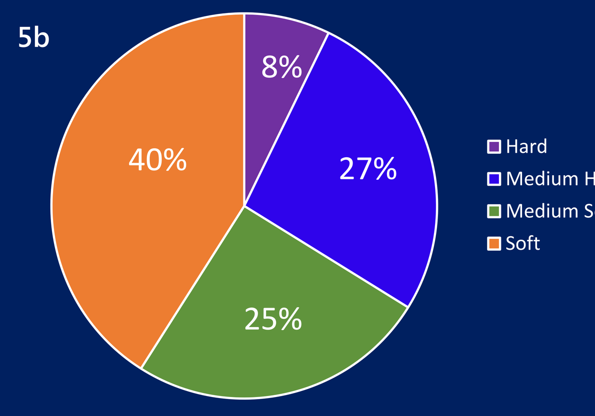
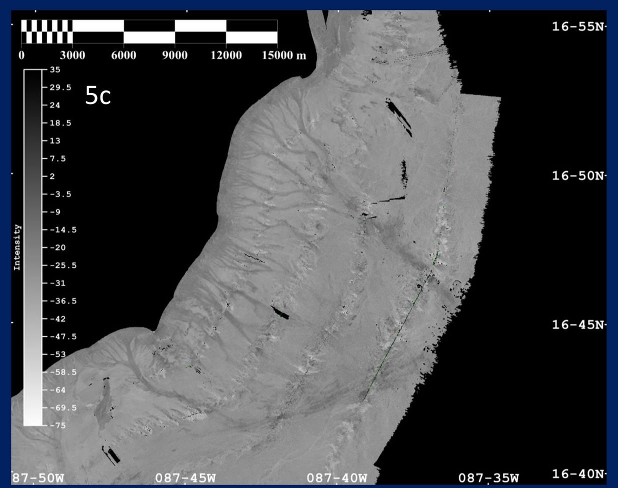


Figure 5a. Classified backscatter intensity image focusing on locations for potential deep-sea corals.
Figure 5b. Percent of each substrate class; hard (35 to -20.25 db), medium hard (-20.25 to -25.56 db), medium soft (-25.56 to -29.65 db), and soft (-29.65 to -32.25 db).



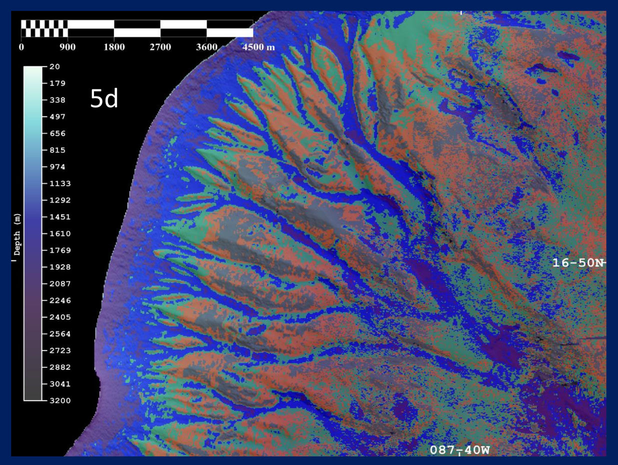
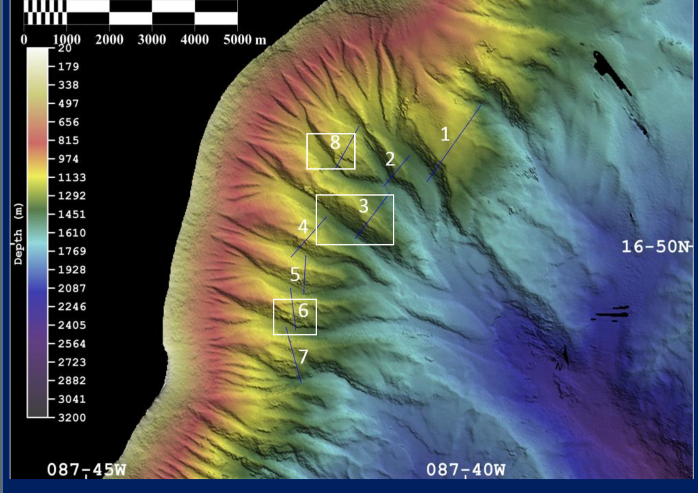


Figure 5c. Backscatter mosaic image showing the full study site of Glover's Atoll. These images show the intensity of returns helping to determine substrate character of the site.
Figure 5d. Classified backscatter intensity image draped over the bathymetric 2D image to more easily notice the trend in sedimentation of the study site.

DISCUSSION

Relatively hard substrate was found in the highest concentrations in the thalweg of the submarine canyons, while there are some areas on the walls of the inter-canyon ridges where a high intensity return was recorded. Hard substrate areas can be condusive to potential deep-coral habitats (Hoyland, 2008). While areas with relatively hard substrate in the thalweg may not be condusive to deep-sea coral environments due to turbidity in the area, there are areas lining the canyon walls that could potentially harbor deep-sea coral habitats. Backscatter intensity calculates the intensity of return to give an idea of how hard the substrate on the bottom, but these returns that are medium hard could be areas where deep-sea corals already exist. Relatively hard substrate, steep slopes, and depths up to 3000m make ideal habitats for deep-sea corals (Roberts et al., 2006). Carbonate mounds have also been found to create suitable habitats for deep-sea corals. Slopes of the inter-canyon ridges were all found to be relatively steep, with most slopes averaging greater than 10°. Specific sites within the study area were chosen for potential future ROV dives in order to determine deep-sea coral reef species abundancy and diversity (Fig. 6).

Figure 6. Suggested areas selected for future ROV dives include the inter-canyon ridges and slopes at sites 3, 6, and 8. Based on slope and substrate character, these areas are potentially suitable habitats for deep-sea coral.



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