Bathymetric Analysis of St. Croix Ridge, U.S. Virgin Islands

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ABSTRACT

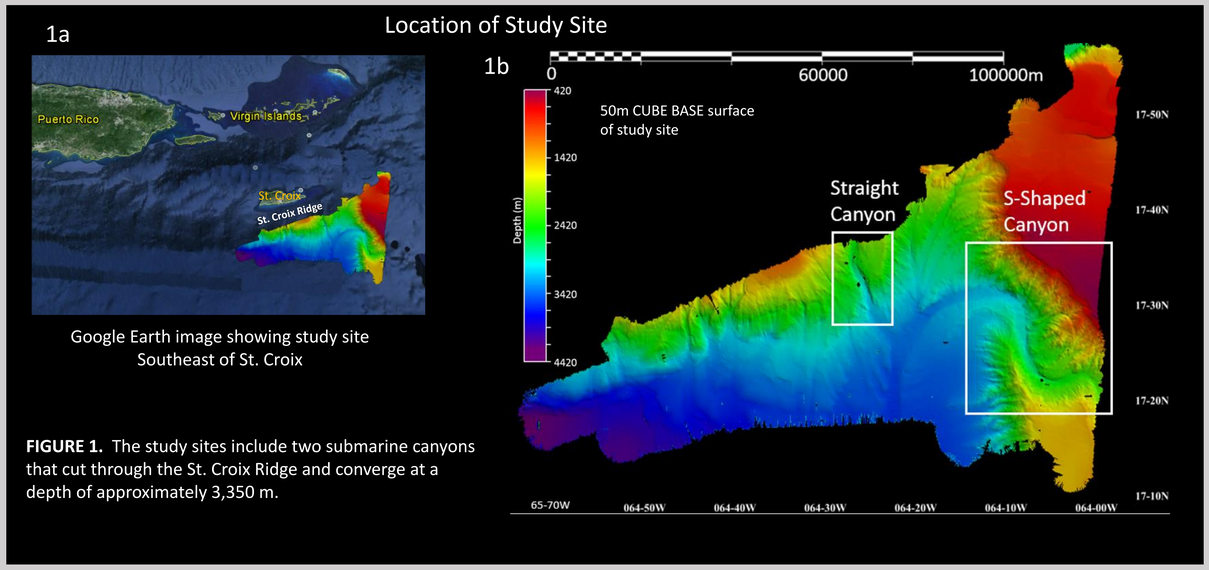
In early 2015, seafloor to the southeast of St. Croix, U.S. Virgin Islands was mapped using multibeam sonar data collected by a Kongsberg EM302 system on the NOAA Ship *Okeanos Explorer*. Bathymetry and backscatter data were post-processed with CARIS HIPS and SIPS 9.0 software to examine two submarine canyons which range in depth from 500 to 3,500 m. Both canyons cut through shallow ridges and converge in the deep ocean, and are approximately 36 and 70 km in length. Hard substrate is necessary for deep coral settlement, and hardground canyon walls are often sites for deep coral habitat. Bathymetric surfaces overlain with backscatter intensity imagery are used to identify areas of highest potential for deep coral habitat. Pinpointing these sites is essential to designating potential Marine Protected Areas and protecting the biodiversity of this region.

BACKGROUND

The St. Croix Ridge lies within the U.S. Virgin Islands in the Caribbean Sea. The areas of interest are located along the ridge, approximately 18 km southeast from the most eastern tip of St. Croix (Fig. 1a). A 70 km long, S-shaped submarine canyon – which will be referred to as "S-Shaped Canyon" – runs through the shallow (500 m depth) portion of the ridge and spills into the deep ocean at a depth of 3350 m (Fig. 1b), where it converges with a 36 km long "Straight Canyon." The canyons range in depth from 500 to 3,500 m. Deep corals often inhabit ridge systems and canyons (Armstrong et al., 2014) and can be found at depths up to 4,000 m near the equator (Roberts et al., 2006). Submarine canyons have steep topographic features that are associated with coral habitat (Baker et al., 2012). The purpose of this study is to identify high potential areas for deep coral habitat.

METHODS

- Data were collected by NOAA on the NOAA Ship *Okeanos Explorer* in February and March of 2015.
- Multibeam sonar, bathymetry and backscatter intensity data were collected using a Kongsberg EM302 system.
- CARIS HIPS and SIPS 9.0 was used to create a 50 m resolution CUBE BASE surface and 150 m resolution backscatter mosaic.
- Slopes of profiles were measured down the edge of a submarine canyon, and substrate was classified based on backscatter intensity.



Google Earth image showing study site Southeast of St. Croix

FIGURE 1. The study sites include two submarine canyons that cut through the St. Croix Ridge and converge at a depth of approximately 3,350 m.

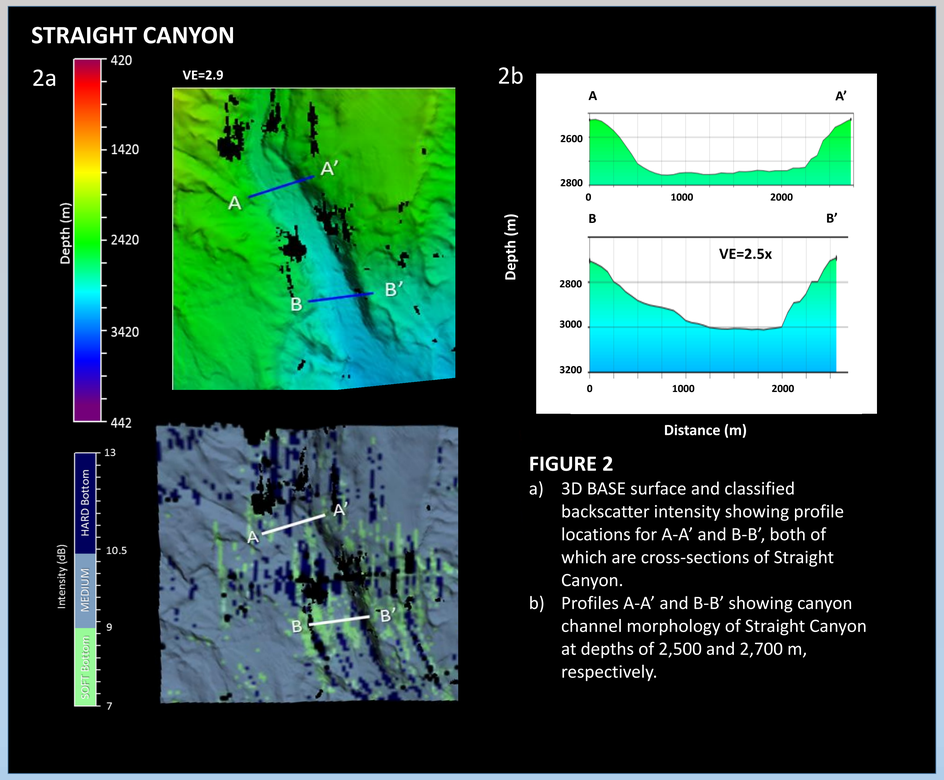


FIGURE 2

a) 3D BASE surface and classified backscatter intensity showing profile locations for A-A′ and B-B′, both of which are cross-sections of Straight Canyon.
b) Profiles A-A′ and B-B′ showing canyon channel morphology of Straight Canyon at depths of 2,500 and 2,700 m, respectively.

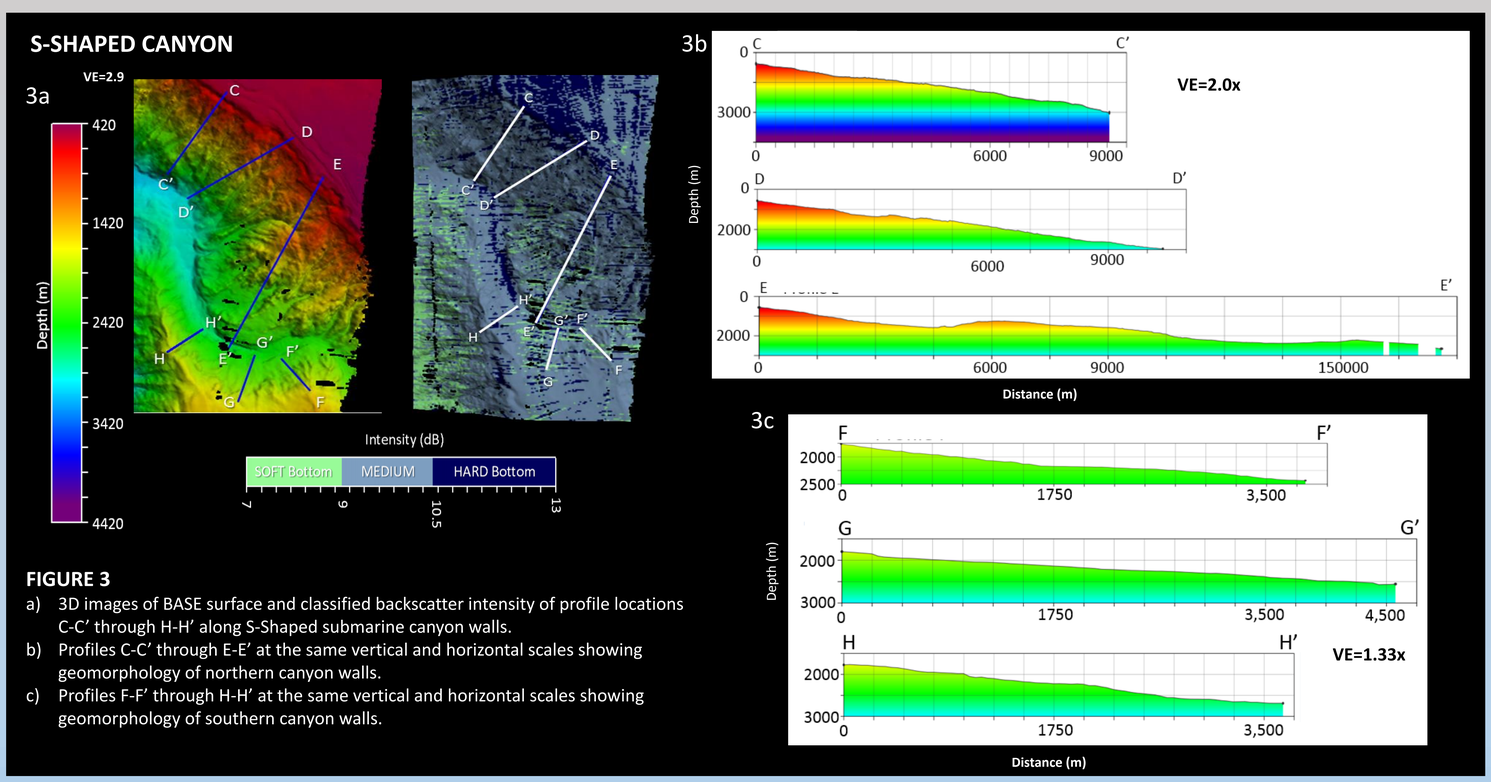


FIGURE 3

a) 3D images of BASE surface and classified backscatter intensity of profile locations C-C′ through H-H′ along S-Shaped submarine canyon walls.
b) Profiles C-C′ through E-E′ at the same vertical and horizontal scales showing geomorphology of northern canyon walls.
c) Profiles F-F′ through H-H′ at the same vertical and horizontal scales showing geomorphology of southern canyon walls.

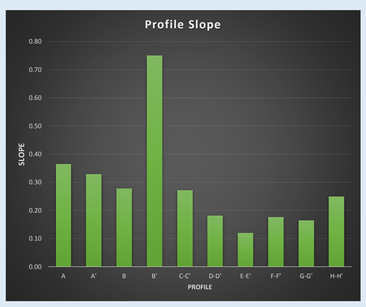
RESULTS

- While Straight Canyon's west and east sides of the A-A' profile location had similar slopes, the canyon's east side at B-B' (Fig. 2) was significantly steeper with a slope of 0.75 than the west side (Table 1, Fig. 2)
- The steepest canyon walls in S-Shaped Canyon (Fig. 3) were found along profiles C-C' (0.27) and H-H' (0.25) (Table 1, Fig. 4). The average slope in the S-Shaped Canyon is 0.19.
- The percent coverage of backscatter intensity between 10.5 and 13 dB (hard bottom) in the Straight Canyon was only 13% (Table 2, Fig. 5a), while the coverage in the S-Shaped Canyon was 21% (Table 2, Fig. 5b). Moderate hard-bottom substrate (between 9 and 10.5 dB) made up the majority coverage with 70% coverage in the Straight Canyon and 61% in the S-Shaped Canyon (Fig. 5).

Table 1. Slopes calculated for each profile shown on Figures 2 and 3.

Profile	Slope
A-A' west	0.36
A-A' east	0.33
B-B' west	0.28
B-B' east	0.75
C-C'	0.27
D-D'	0.18
E-E'	0.12
F-F'	0.18
G-G'	0.16
H-H'	0.25

Figure 4. Changes in depth and distance for each of the canyon walls measured using the profiles in Figures 2 and 3 (Table 1).



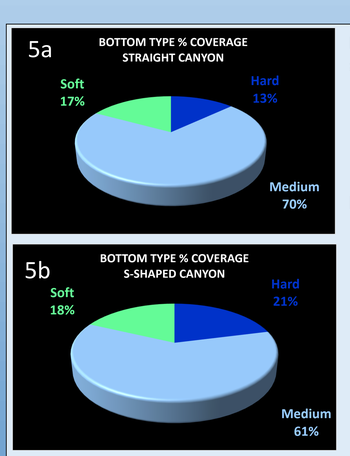
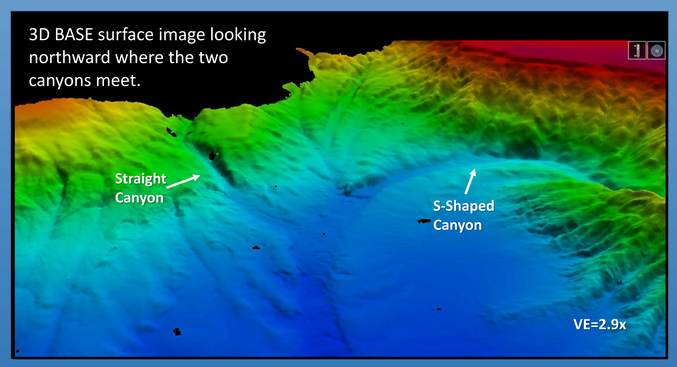


Figure 5

a) Percent coverage of bottom type in straight shaped canyon. Hard bottom makes up 13%. Refer to Table 2a for data.
b) Percent coverage of bottom type in s-shaped canyon. Hard bottom makes up 21%. Refer to Table 2b for data.

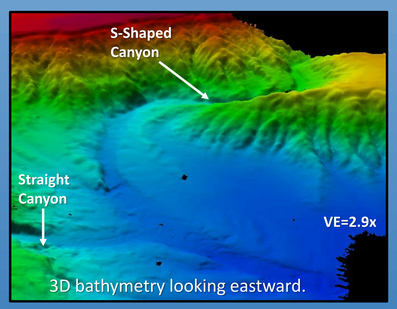
Table 2. Percent coverage of bottom types categorized using backscatter in both canyons.

Bottom Type	% Coverage Straight Canyon	% Coverage S-Shaped Canyon
Hard	13	21
Medium	70	61
Soft	17	18



DISCUSSION

Through observations and data collected from this research, profiles B-B' (specifically, the east side), C-C', and H-H' stand out as having the most essential characteristics for coral habitat, as they combine the proper low latitude depth range between 2000 and 4000 m (Roberts et al., 2006), steepness of canyon walls (ranging 0.25 to 0.75 slope), and hard substrate. Together these traits create excellent potential habitat sites for deep coral settlement and survival. Figure 6 illustrates areas with conditions most suitable for deep coral habitat. Continued research in this area with ROVs or manned submersibles would be useful to obtain visual images of the canyon walls. With more research and information, these areas could be designated for protection in order to preserve the fragile and biodiverse ecosystems found living with corals.



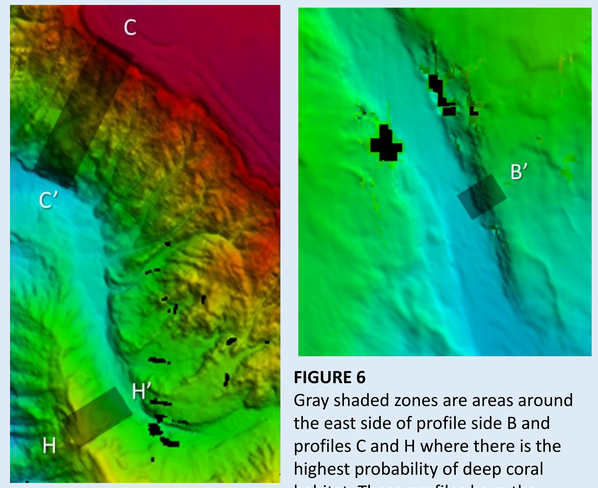


FIGURE 6
Gray shaded zones are areas around the east side of profile side B and profiles C and H where there is the highest probability of deep coral habitat. These profiles have the steepest slopes and highest percent coverage of hardground.

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