Comparison of Scarp Ridge Mounds on the Southern Blake Plateau to Identify Potential Deep Sea Coral Reefs

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Abstract

This study was to compare three sites within the Southern Blake Plateau- Western Scarp, Eastern Scarp, and Southern Scarp- using data from the NOAA expedition Windows to the Deep 2019 (EX1903) aboard the NOAA ship *Okeanos Explorer*. Dive footage collected by the ROV *Deep Explorer* (EX 1907) was used to ground truth the Eastern and Western Scarps and to identify potential areas of deep sea coral colonies. Multibeam bathymetric data, slope, backscatter intensity, and aspect were used to compare the areas. The Western Scarp was found to have high bathymetric similarities to the Southern Scarp, and is likely an additional area of deep-sea coral colonies, while the Eastern Scarp has fewer similarities and therefore is not concluded to be a likely area of coral colonies.

Methods

- Multibeam sonar data were collected by NOAA OER on the NOAA Ship *Okeanos Explorer* using a Kongsberg EM302 during EX 1903.
- Dive footage was acquired by ROV *Deep Explorer* on EX1907 and frame-grabs from high definition video were used to ground truth sonar data.
- CARIS HIPS and SIPS 11.2 was used to process raw multibeam sonar data and create CUBE BASE surfaces at 50 m and 20 m resolutions.
- 3D images and profiles were generated, slopes were measured, and backscatter intensity was classified.
- Slope and backscatter intensity data were collected along the line of each scarp edge to represent the slope and backscatter intensity associated with each study area.
- Slope and intensity data were plotted against each other to identify potential correlations in the data.
- Slope, intensity, and aspect data were visually compared to further identify potential correlations in the data.

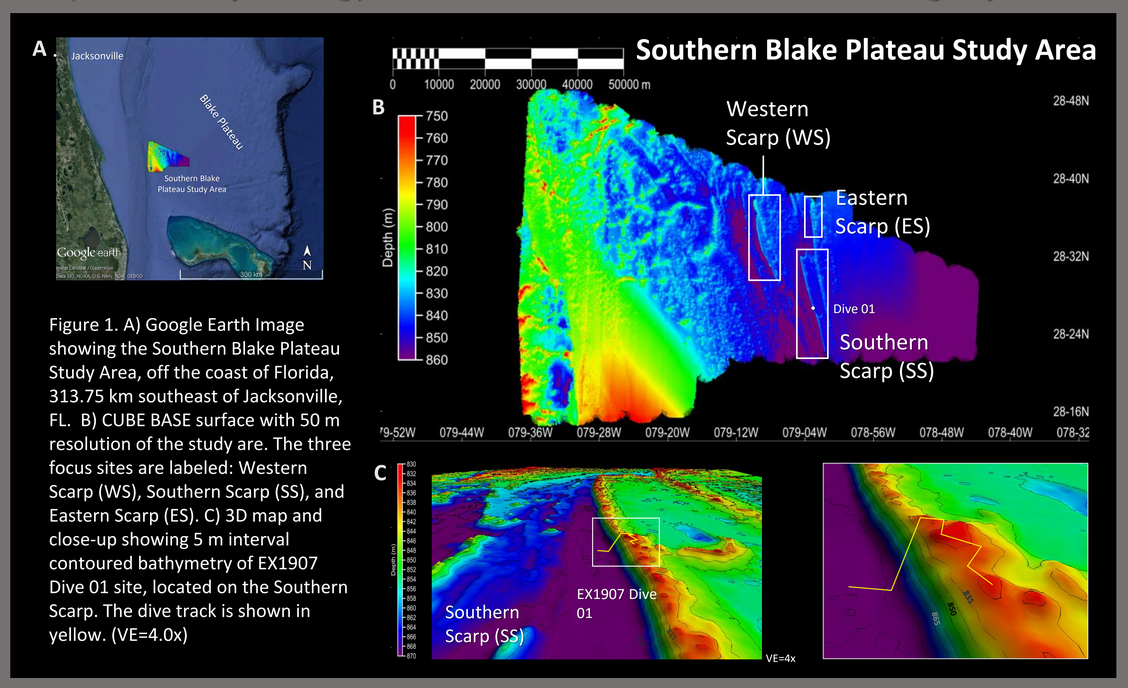


Figure 1. A) Google Earth Image showing the Southern Blake Plateau Study Area, off the coast of Florida, 313.75 km southeast of Jacksonville, FL. B) CUBE BASE surface with 50 m resolution of the study are. The three focus sites are labeled: Western Scarp (WS), Southern Scarp (SS), and Eastern Scarp (ES). C) 3D map and close-up showing 5 m interval contoured bathymetry of EX1907 Dive 01 site, located on the Southern Scarp. The dive track is shown in yellow. (VE=4.0x)

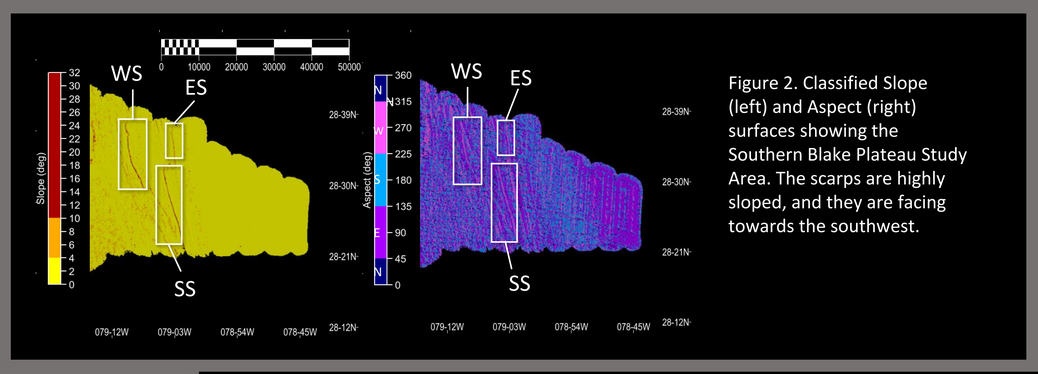
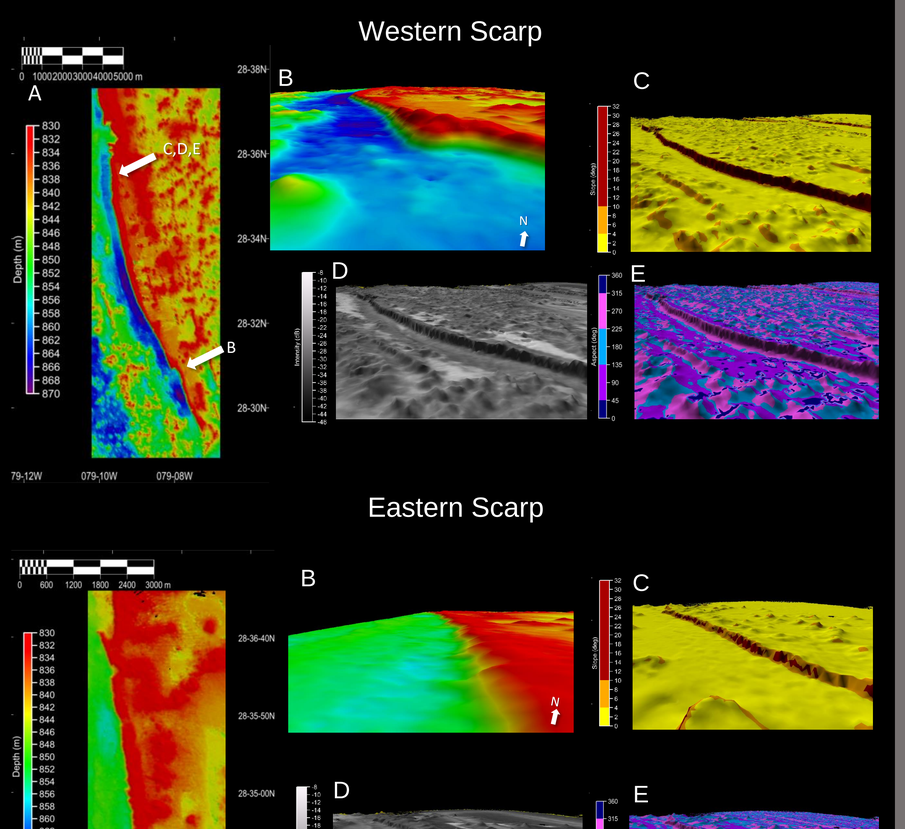


Figure 2. Classified Slope (left) and Aspect (right) surfaces showing the Southern Blake Plateau Study Area. The scarps are highly sloped, and they are facing towards the southwest.

Background

The NOAA Ship *Okeanos Explorer* conducted a series of mapping expeditions off the Southeastern United States coast during the Windows to the Deep 2019 and 2019 Southeastern U.S. Deep-sea Explorations expeditions. Multibeam sonar data were collected on cruises EX1903 and EX1906, and additional dive footage collected by ROV *Deep Discoverer* was acquired on EX1907. Bathymetric data from EX1903 revealed a large area of mounds and small scarps in an area known as the Stetson-Miami Terrace. This area of scarps and mounds is referred to as the Southern Blake Plateau. ROV dive footage from EX1907 dive showed large frameworks of stony coral rubble with an abundance of living *Lophelia pertusa,* as well as other invertebrates such as feather stars, sea urchins, and glass sponges along a scarp on the Southern Blake Plateau. Scientists previously inferred that areas of high intensity and high slope are the most likely to host deep-sea coral colonies. A previous study done by Bieri and Sautter (2019) and DiTommaso and Sautter (2019) used backscatter and slope data to identify potential areas of coral growth on the Blake Plateau. However, they concluded that these methods are not always reliable, particularly where coral mounds are examined. The purpose of this study is to compare three large elongate ridges between 6 and 20 km in length oriented southwest found in the Southern Blake Plateau. Both the Eastern and the Southern Scarps are relatively straight, while the Western Scarp is curved (fig. 1). ROV dive EX1907 on the Southern Scarp observed a field of dead coral rubble covered in ferromanganese crust at the scarp's base. As the dive progressed vertically, the coral framework became denser and abundance of invertebrates increased. The dive was used as a basis to determine the likelihood of coral growth on two additional scarps that have not been explored. Backscatter intensity, aspect, and slope were examined and compared among the three scarps.

Figure 3. The three study sites are each illustrated with 20 m resolution 2D bathymetry (A) and 3D bathymetry (B), 3D slope (C), 3D backscatter intensity (D), and 3D aspect surfaces. (VE=2.0X) All bathymetric surfaces are shown at the same depth range.



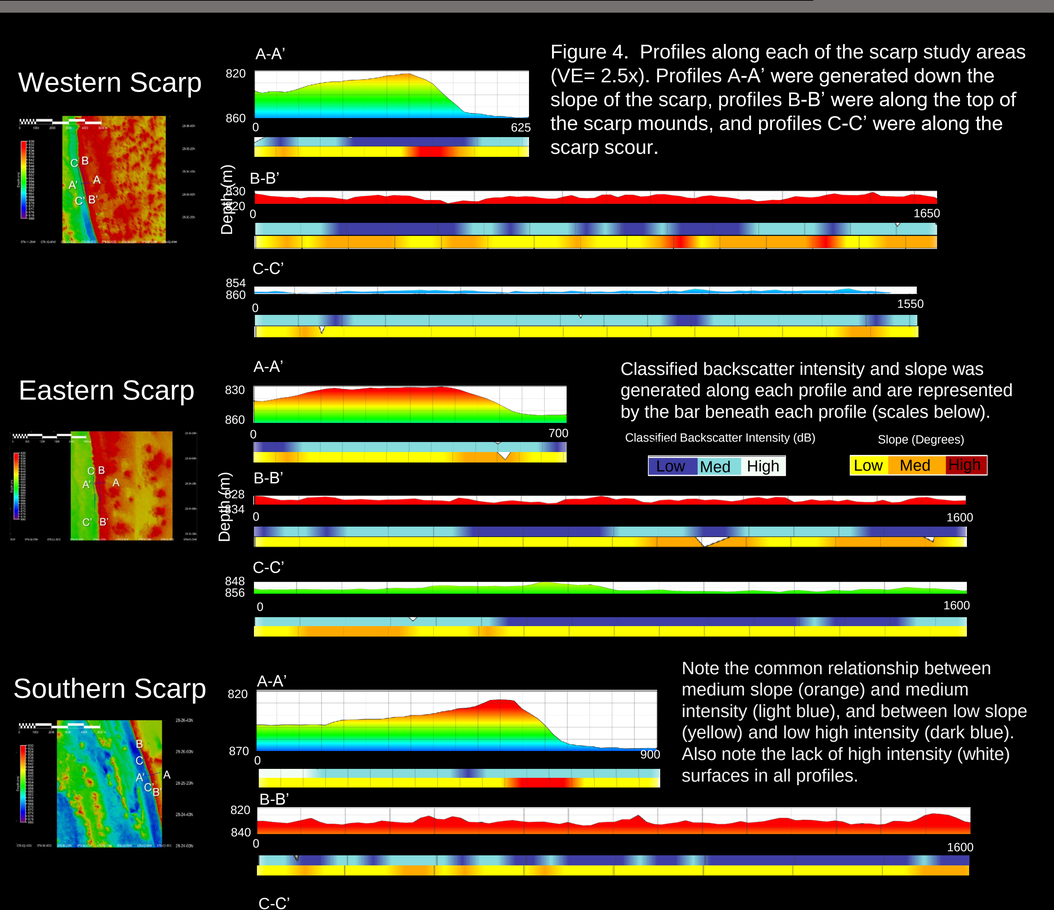


Figure 4. Profiles along each of the scarp study areas (VE= 2.5x). Profiles A-A' were generated down the slope of the scarp, profiles B-B' were along the top of the scarp mounds, and profiles C-C' were along the scarp scour.

Classified backscatter intensity and slope was generated along each profile and are represented by the bar beneath each profile (scales below).

Classified Backscatter Intensity (dB): Low Med High

Slope (Degrees): Low Med High

Note the common relationship between medium slope (orange) and medium intensity (light blue), and between low slope (yellow) and low high intensity (dark blue). Also note the lack of high intensity (white) surfaces in all profiles.

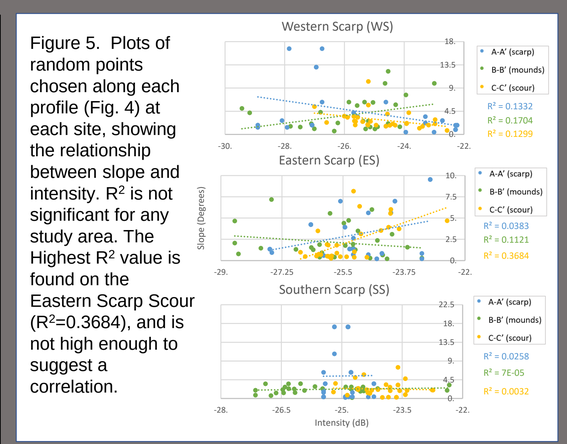


Figure 5. Plots of random points chosen along each profile (Fig. 4) at each site, showing the relationship between slope and intensity. R^2 is not significant for any study area. The Highest R^2 value is found on the Eastern Scarp Scour (R^2=0.3684), and is not high enough to suggest a correlation.

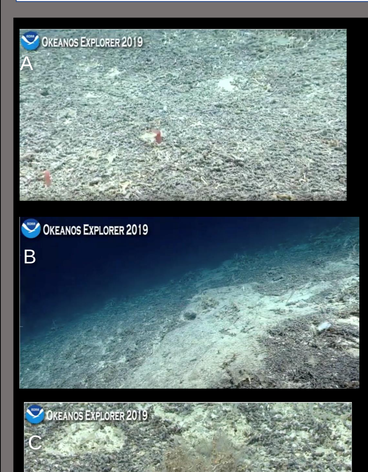


Figure 6. High resolution video footage from EX1907 Dive 01 at Southern Scarp showed A) coral rubble at the scarp base, B) thickening coral framework with exposed outcrops on the scarp face, and C) a group of *Lophelia pertusa* and other coral and sponge species.

Results

Scarps (A-A') – profiles drawn perpendicular to ridge trend, from beyond the ridge-scarp mounds to the scarp base

- Ridge scarps are found at 830-860 m (Fig 1).
- High and medium intensities were found beyond the scarp mounds at both the Western scarp (WS) and the Southern scarp (SS), but low intensity occurred beyond mounds at the Eastern Scarp (Fig 4).
- Medium intensity is observed on the tops of ES and SS mounds, while WS mounds show low intensity (Fig 4).
- Medium intensity is observed within the scour of WS and SS, but low intensity is observed in ES's scour (Fig 4).
- No significant correlation between slope and intensity was observed at any scarp (Fig. 5).
- SS's dive video shows coral rubble in the scarp scour. The scarp face contains a higher coral framework density, but still few live corals. Dense living coral colonies were seen on the scarp mounds (Fig 6).
- WS and SS have relatively narrow mounds while ES has relatively broad, wide mounds (fig 4)

Ridge Scarp Mounds (B-B') – profiles drawn parallel to the ridge, along mounds

- Medium backscatter intensities are observed primarily at the base of the mounds on WS and SS, but ES exhibited primarily medium intensity everywhere on the mounds (Fig 4).
- On the WS and SS, medium intensities show a slight visual association with medium/high slopes, while on the ES, medium intensities and low slope have a slight visual association.
- No mounds have a significant correlation between slope and intensity (Fig 4 and 5).

Scours (C-C') – profiles drawn parallel to the ridge, within the scour

- Medium intensities are observed in most of the scarp scour of WS and SS, while on ES shows medium intensity in the shallow portions of the scour, and low intensities in the deep portions (Fig 4).
- WS and SS have a visual association between low slope and medium intensity, while medium intensities and medium slope have a visual association on ES.
- There is no significant correlation between slope and intensity at any scour (Fig 4 and 5).

Discussion and Conclusions

Overall, the mounds and scours of the Western and Southern scarps share a similar backscatter intensity and slope, while the Eastern and Southern scarps have very few similarities (fig 4). The Western and Eastern Scarps seem to share no resemblance in intensity or slope (fig 4). WS and SS also share a similar shape, while ES is much different. A-A' profiles show SS and WS have a longer area beyond the mounds, and the mounds are relatively narrow. ES has a much less extensive area beyond the mounds and a much more broad width of the mound.

Just as Bieri and Sautter (2019) and DiTommaso and Sautter (2019) concluded, no significant correlation exists between areas of high intensity and high slope in the Blake Plateau. This study confirmed that the 3 ridge scarps in the Southern Blake Plateau exhibited different combinations of intensities and slope, none of which were significantly correlated (fig 5). WS and the SS study sites each had medium intensity and medium slopes on the mounds, and low slope and medium intensity in the scours, suggesting WS has a high potential of having deep sea coral colonies due to its strong similarity to SS. High resolution dive video on the Southern Scarp revealed coral colonies on the mounds of the ridge (fig 6). ES shows fewer similarities to the Southern scarp, so therefore is much less likely to have deep sea coral colonies (fig 4).

All ridges are oriented strongly to the southwest. The orientation may be from the Gulf Stream running directly over the Southern Blake Plateau, scouring the bottom through erosion. Because the Gulf Stream runs in the southwest-northeast direction, it would account for the ridges being oriented strongly in the same direction.

Acknowledgements

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