# Geomorphology and Sediment Wave Analysis of the Southeastern U.S. Continental Margin Along Blake Ridge

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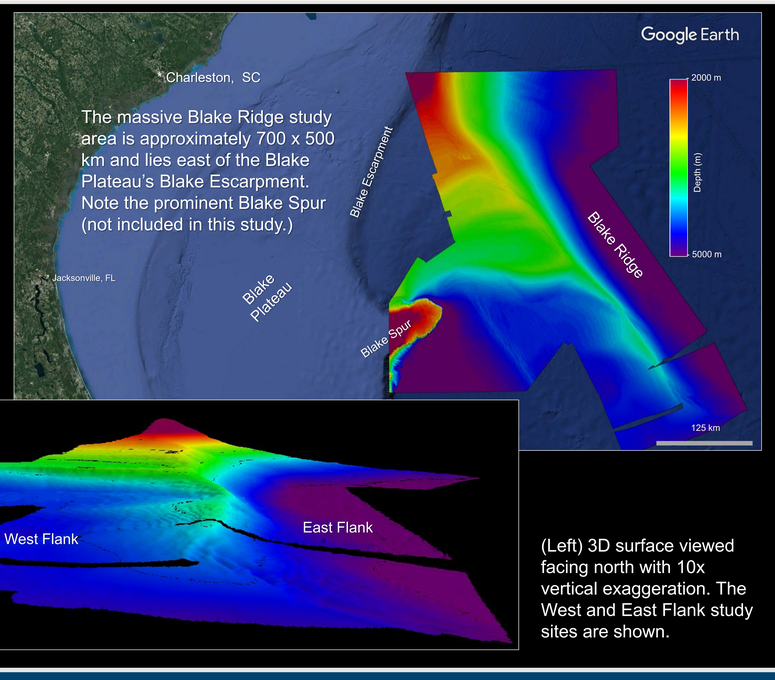
## BACKGROUND

NOAA conducted mapping expeditions off the southeastern United States coast during *Windows to the Deep 2018* (EX1806), and *Mapping Deepwater Areas off the Southeast U.S. in Support of the Extended Continental Shelf (ECS) Project* (EX1810) in 2018 aboard the NOAA Ship ***Okeanos Explorer*** . University of New Hampshire (UNH) conducted an earlier series of mapping expeditions in 2005 (PF0501 and PF0502) during *Atlantic Leg 5* on the US Naval vessel ***Pathfinder*** (T-AGS-60). These expeditions surveyed the Blake Ridge, a prominent feature east of and adjacent to the Blake Escarpment, where depths range 1000 to 5500 m, approximately 400 km off the coast of Charleston, SC. The purpose of this study is to collect information about Blake Ridge's flank geomorphology, and to study sediment waves at the ridge axis' deepest point to determine the bottom current direction.

## Figure 1. Study Area

(Above) The R/V *Pathfinder*

(Right) 200m resolution CUBE surface of the Blake Ridge study area in .kmz file format.

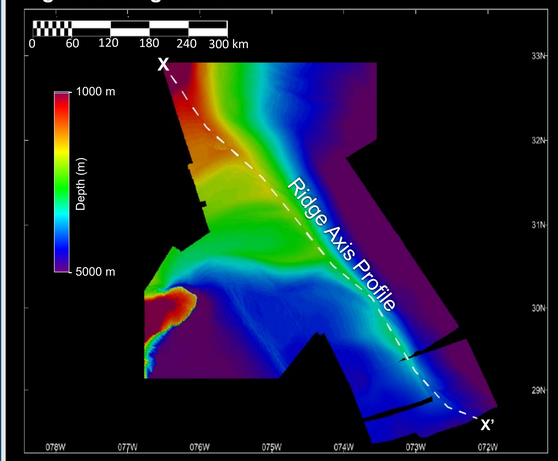



(Left) 3D surface viewed facing north with 10x vertical exaggeration. The West and East Flank study sites are shown.

## METHODS

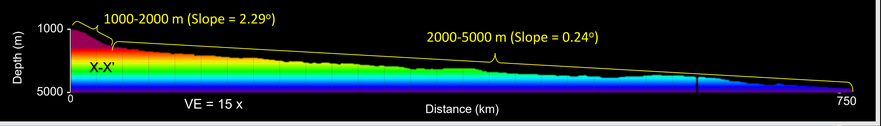
- Multibeam sonar data were collected by University of New Hampshire on ***Pathfinder*** using Simrad EM121A during PF0501 and PF0502.
- Multibeam sonar data were collected by NOAA OER on NOAA Ship ***Okeanos Explorer*** using Kongsberg EM302 during EX1806 and EX1810.
- CARIS HIPS and SIPS 11.3 was used to process raw multibeam sonar data and create one CUBE BASE surface at 200 m resolution.
- 3D images and profiles were generated, sediment waves were measured.
- Symmetry of K-K' and L-L' wavelengths determined by dividing West Base length by East Base length.

## Figure 2. Ridge Axis

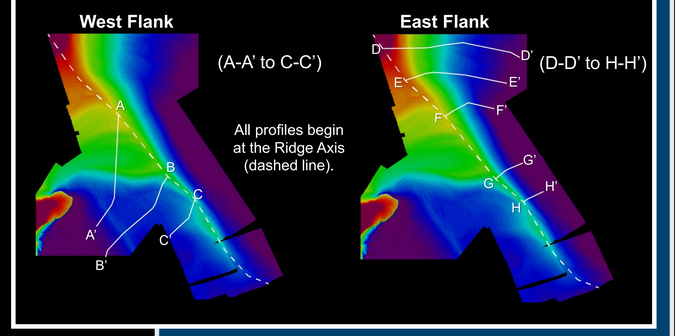



The depth of the Ridge Axis (X-X') ranges from 1000 to 5000 m with an overall slope of 0.36°.

(Below) Slope is significantly steeper between depths of 1000 to 2000m (2.29°) and lower from 2000 to 5000 m (0.24°).




## Figure 3. Flank Profile Locations

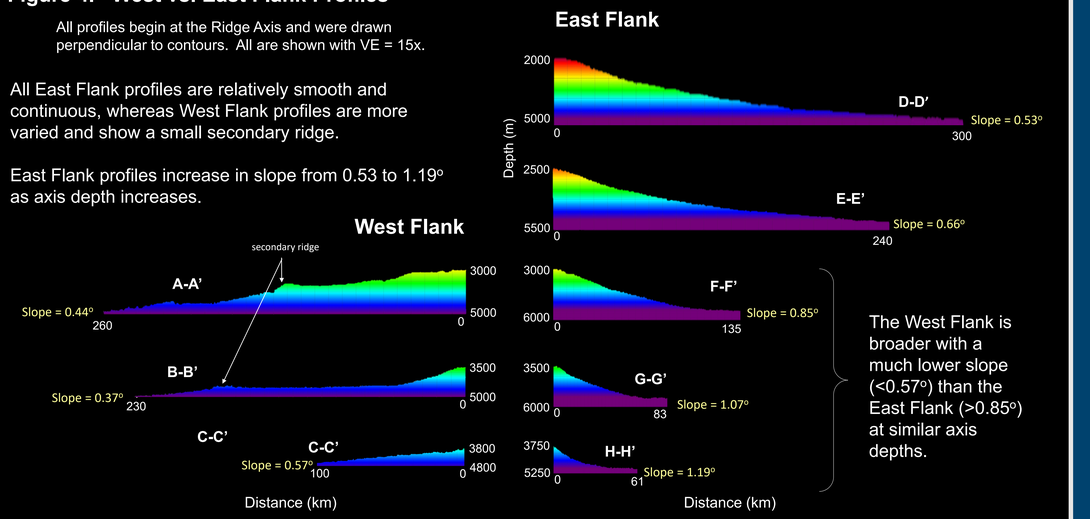



## Figure 4. West vs. East Flank Profiles

All profiles begin at the Ridge Axis and were drawn perpendicular to contours. All are shown with VE = 15x.

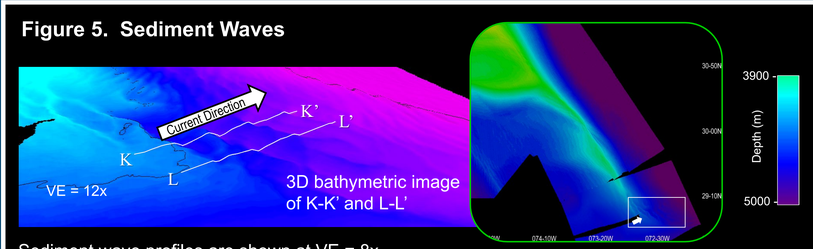
All East Flank profiles are relatively smooth and continuous, whereas West Flank profiles are more varied and show a small secondary ridge.

East Flank profiles increase in slope from 0.53 to 1.19° as axis depth increases.

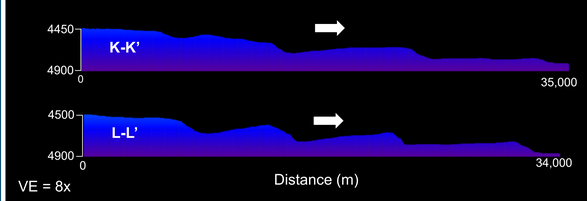



The West Flank is broader with a much lower slope (<0.57°) than the East Flank (>0.85°) at similar axis depths.

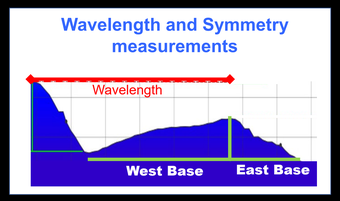
## Figure 5. Sediment Waves




Sediment wave profiles are shown at VE = 8x.



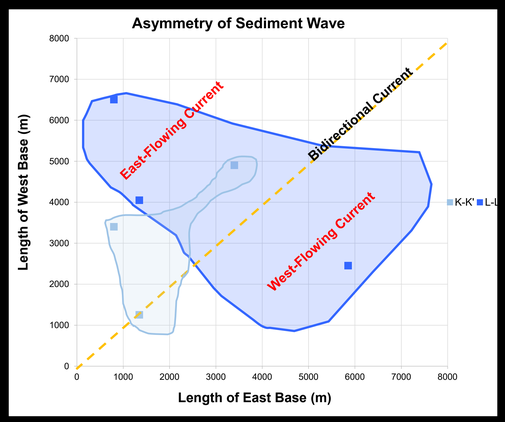

Massive asymmetric sediment waves are found at the of the ridge's East Flank. Their wavelengths range from 2075 to 9100 m. Their asymmetry and size indicate eastward bottom water currents




## Figure 6. Sediment Wave Analysis

Measurements were made of the west and east base lengths (see figure above) of each sediment wave from K-K' and L-L' (Fig. 5) (Dawson and Sautter, 2017). Equal lengths would indicate wave symmetry and a bi-directional bottom current flow, shown by the dashed line on the graph at right.

Sediment wave data indicate that all but one wave measured are the result of an east-flowing current.




## DISCUSSION and CONCLUSIONS

The purpose of this study is to collect information about the geomorphology of Blake Ridge, to compare both of its flanks, and to study sediment waves at the ridge axis' lowest point to determine the bottom current flow direction. Profiles drawn perpendicular to contours on opposite sides of the ridge axis illustrate the significant morphologic differences between the two flanks (Figure 4). Blake Ridges' sediment accumulation differs on each flank. West Flank has two tiers and has more variable topography and lower slopes compared to East Flank.

The Western Boundary Undercurrent (WBCU) may be the cause of giant sediment waves that occur at depths between 4000 and 5000 m along the East Flank. Asymmetric sediment waves here indicate an eastward current flow (Figures 5, 6). The WBUC may also bifurcate and flow down the West Flank, accounting for the flank's varied topography. Additional sediment wave analysis will provide insight on bottom water flow in the study area.

## REFERENCES

Dawson A. and Sautter L.. 2017. Geomorphological Analysis of Sand Waves at Lucifer Shoals, Ireland. http://oceanica.cofc.edu/beamsprogram/images/Photo%20Galleries/Posters/2017_SSM_US_Hydro/DawsonAlex_FinalPoster.pdf.

Raineault, N.A, and J. Flanders, eds. 2019. The E/V *Nautilus*, NOAA Ship *Okeanos Explorer*, and R/V *Falkor* 2018 field season. in: New Frontiers in Ocean Exploration: *Oceanography* 32(1), supplement,150 pp., https://doi.org/10.5670/oceanog.2019.supplement.01.

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