Deep Sea Coral Mound Geomorphology & Orientation on Stetson Mesa, Blake Plateau

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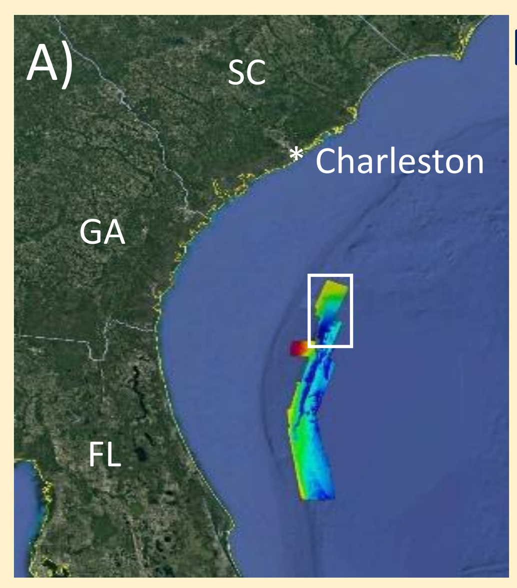
NOAA Ship Okeanos Explorer

ABSTRACT

NOAA Office of Ocean Exploration and Research (OER) collected multibeam sonar data on the Southeast U.S. Continental Margin in May 2014 during mapping cruise EX1203. The NOAA Ship *Okeanos Explorer* obtained bathymetric data 160 km east of Georgia's southeast coast in 600 to 900 m of water, along the western edge of the Blake Plateau, in an area directly beneath the main axis of the Gulf Stream. The purpose of this study is to characterize the geomorphology of recently discovered deep coral mounds with respect their shape, slope, and orientation, for comparison with the geomorphology of other seabed features in the region. Information gathered will be supplemented with ROV dives from the NOAA OER *Windows to the Deep 2018* Expedition Ex1806.



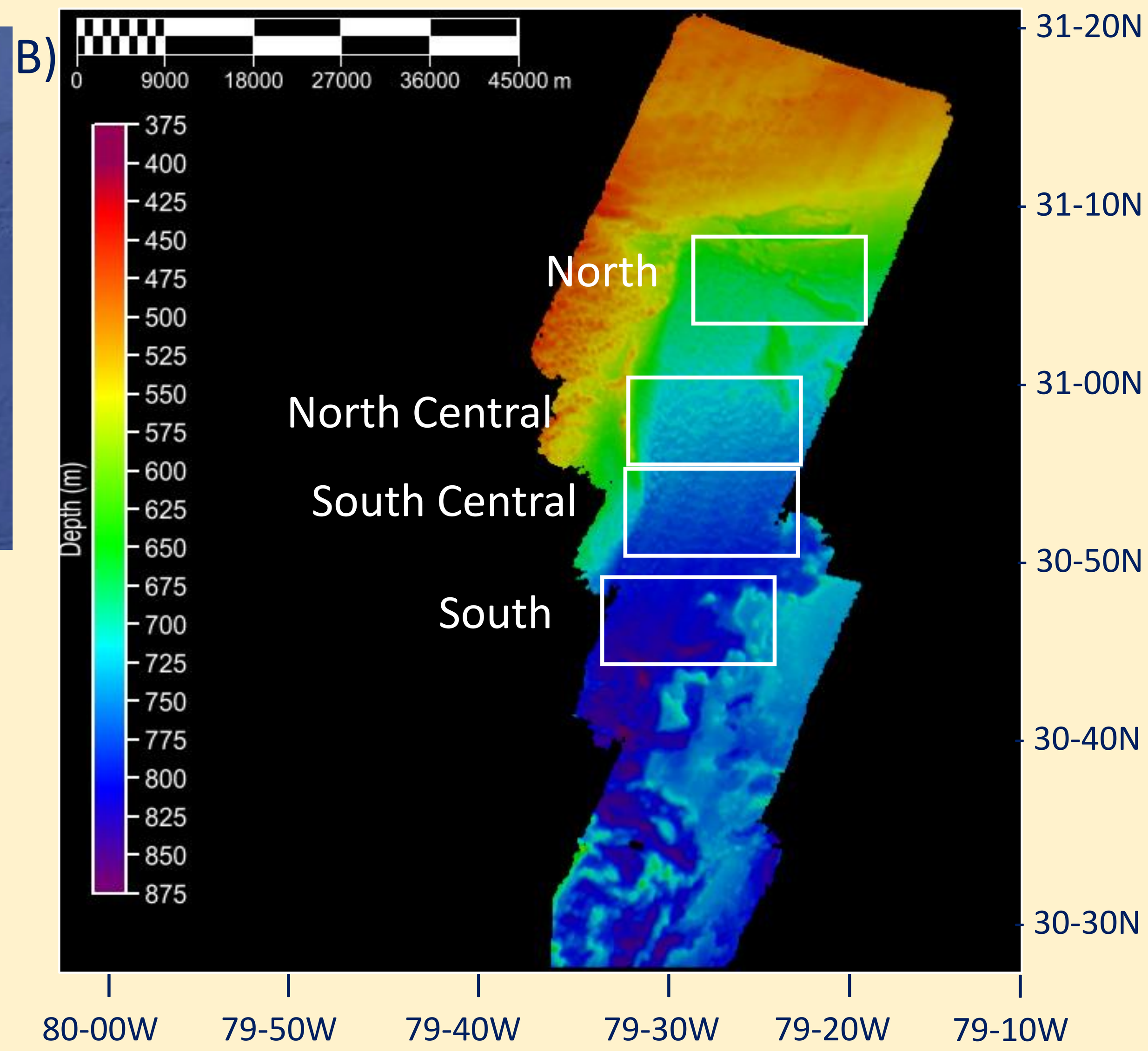
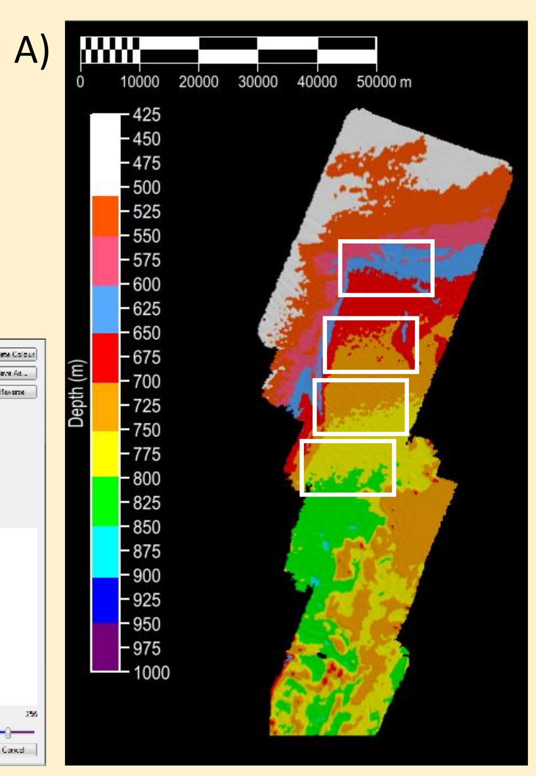


Figure 1. A) Google Earth Image of Stetson Mesa study surface located in the Atlantic Ocean, 220 km east of the Georgia-Florida state line.
B) CUBE BASE surface of the Stetson Mesa with 15m resolution. The four focus areas (A-D)each cover 200 km² and are labeled as Area A, Area B, Area C, Area D.

Figure 2. A) Classified surface CUBE gridded 10m with an unblended 50m interval color scale with B) key.



BACKGROUND

Stetson Mesa is located off the southeastern coast of the United States directly east of Florida and Georgia on the western edge of Blake Plateau, and lies directly beneath the Gulf Stream. Forty-five km east of the continental shelf break where the depth of the seafloor quickly drops to 500 m, Stetson Mesa gradually continues its descent to 1,000m (NOAA 2017). Deep-sea corals can be found worldwide and are some of the longest-living and slowest growing organisms on earth. These invertebrates are needed for deep-sea reef and coral community building (Fögel, 2014). Reef structures consist of intact dead colonies supporting the living corals on topographic highs (Brooke 2013). *Lophelia pertusa* is the dominant reef-building cold-water coral in the NE Atlantic with the ability to form expansive mounds up to 300 m high (Susan, et al., 2006) and in water between 4 and 12 °C (Freiwald et al., 2004). These mounds are commonly found between 200 and 400 m (Ross Howell 2013) where no light reaches the sea floor. Based on samples and HD video gathered by the ROV *Deep Discoverer* during the NOAA OER *Windows to the Deep 2018* expedition, mounds present in Stetson Mesa were verified to be comprised of dead skeletal debris of the cold-water stony coral *Lophelia pertusa*, with abundant live coral communities at mound crests. The purpose of this study is to use bathymetric maps to measure mound shape and orientation, and assess relationships of geomorphology to depth differences, and proximity to the Gulf Stream.

METHODS

- Multibeam sonar data were collected by NOAA OER during EX1203 by the NOAA Ship *Okeanos Explorer.*
- Data were post-processed using CARIS HIPS & SIPS 11.0 to generate a 10m CUBE gridded .
- Depth was classified using 50 m intervals to choose study areas.
- Study sites of 4 km² were selected within 50m of the depth-classified study areas.
- Deep-sea coral mounds were identified within each site using classified slope surfaces. Only isolated mounds were included.
- Measurements of mound shape were determined by taking the length and width at 10 m below the shallowest point.
- Orientation was determined by the heading of the "length" axis of the mound.
- A shape index of Length/Width was generated, where a value of 1 would indicate a circular shape, and larger values indicate elongated oval shape.
- The shape index was compared to orientation.

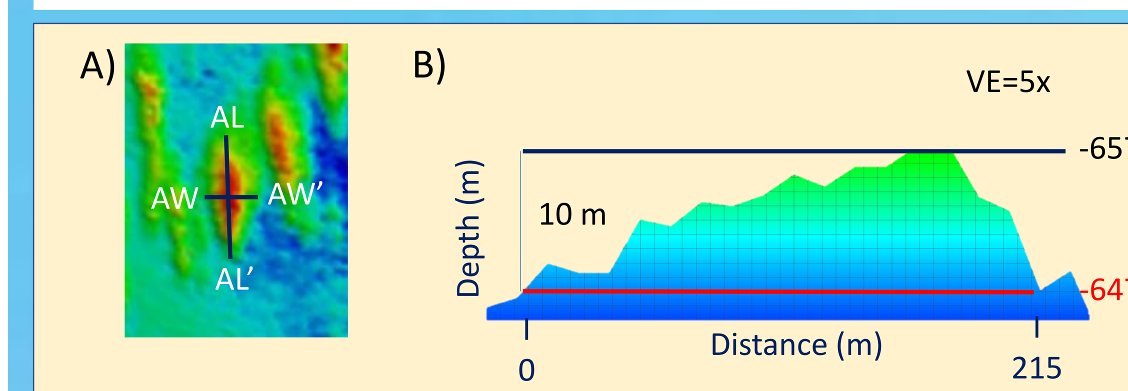
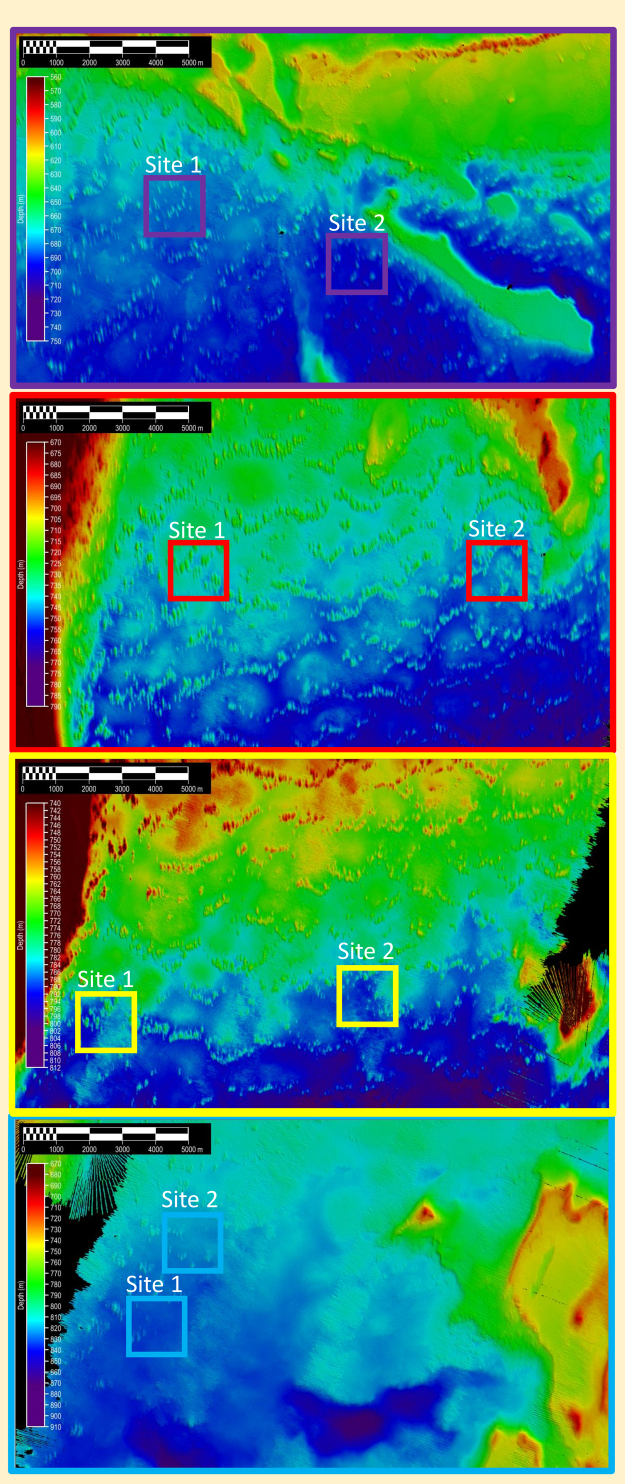


Figure 3. Example of how mounds were measured. A) Length and width profiles were made. B) The distance measurement for length and width (red line) was made 10 m from the shoalest point (black line).

Figure 4. Bathymetry (10 m resolution) of four study areas showing Sites 1 and 2 for each.



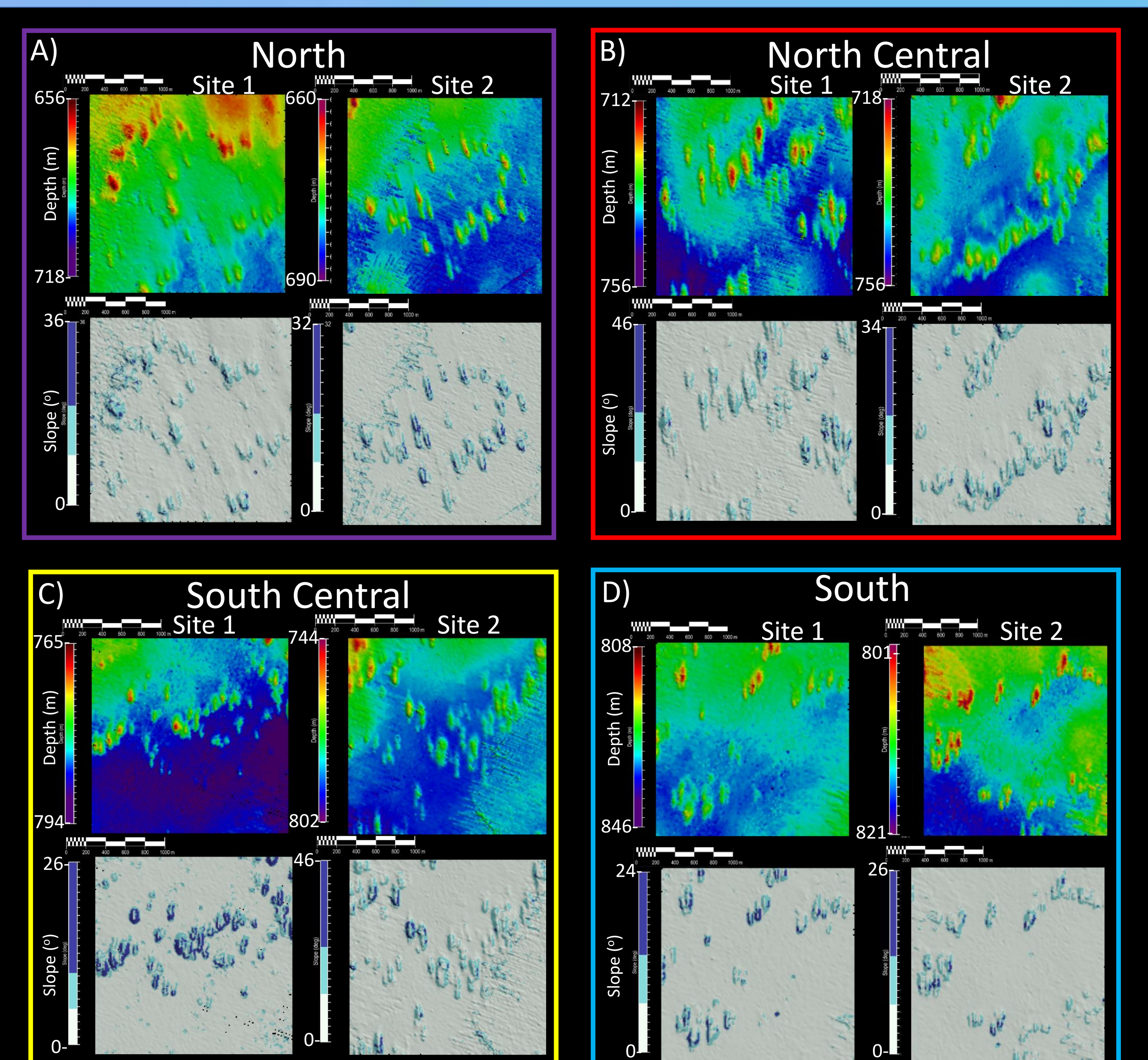
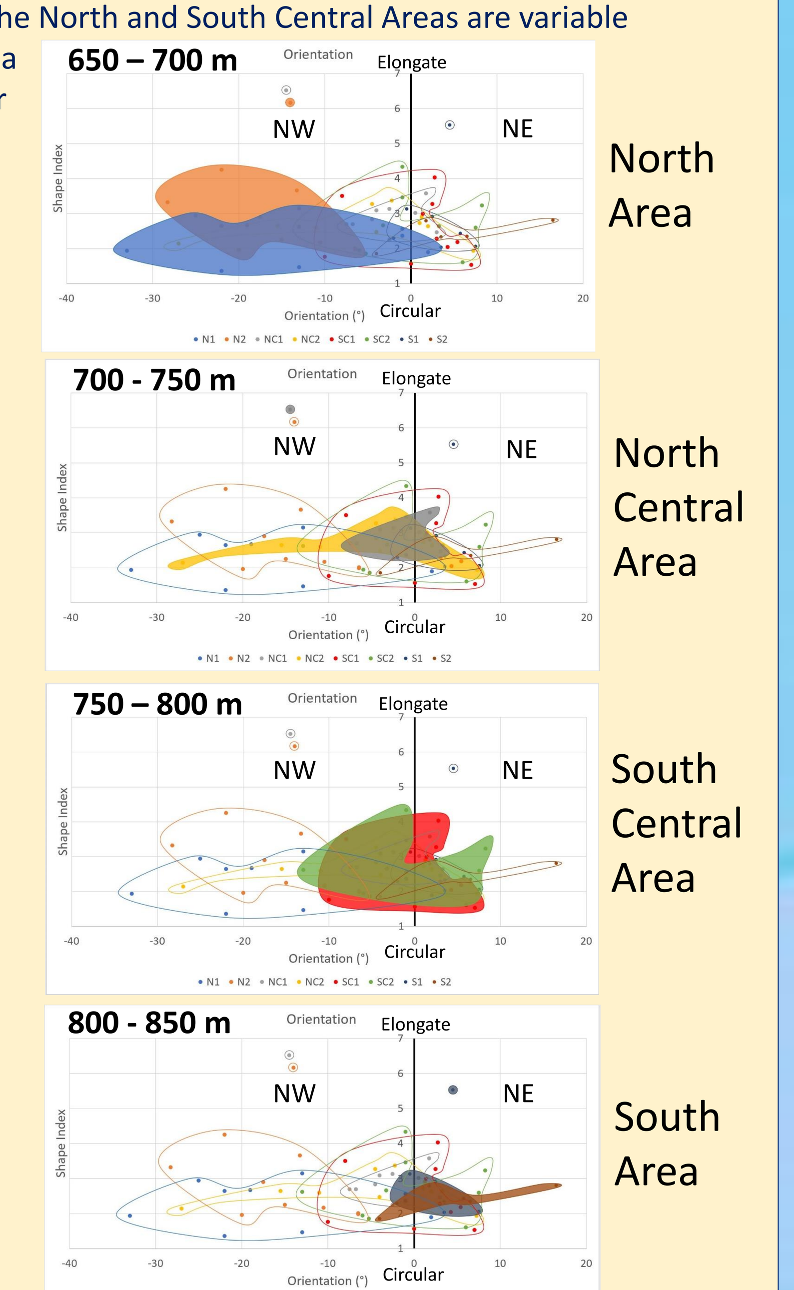


Figure 5. 4km² bathymetric and slope surfaces of A) North Area CUBE gridded at 10m resolution. B) North Central Area CUBE gridded at 11m resolution. C) South Central Area CUBE gridded at 12m. D) South Area CUBE gridded at 14m resolution. Note different depth scales.

Figure 6. Individual graphs comparing orientation of mound to the mound shape index, highlighting sites within each area. Study areas are within intervals of 50 m. As depth increases mound orientation shifts from NW to NE. Mounds in the North and South Central Areas are variable in shape, whereas North Central and South Area Mounds are less variable, and are more circular than elongate.

Table 1: Mound axis measurements made from profiles (Fig. 3), and orientation.

North Area, Site 1					North Area, Site 2				
Mound #	Length (m)	Width (m)	Orientation (°)	Shoalest Point (m)	Mound #	Length (L)	Width (W)	Orientation (°)	Shoalest Point (m)
1	146.60	75.65	327.00	657.00	1	189.18	87.08	349.50	665.00
2	212.86	156.59	338.00	668.00	2	289.29	46.92	346.00	666.00
3	156.20	59.07	338.00	682.00	3	215.00	95.37	345.00	665.00
4	195.58	73.27	341.00	679.00	4	140.68	70.00	353.50	668.00
5	159.49	108.84	347.00	676.00	5	228.85	53.77	338.00	663.00
6	171.60	90.46	2.00	664.00	6	199.03	59.96	331.75	666.00
7	181.74	70.93	359.00	678.00	7	205.00	56.00	346.75	667.00
8	185.90	78.61	359.00	679.00	8	207.50	105.88	340.00	669.00
9	223.64	71.03	347.00	664.00	9	162.08	81.50	353.50	669.00
10	192.57	65.36	335.00	665.00	10	204.28	70.30	342.50	669.00
North Central Area, Site 1					North Central Area, Site 2				
Mound #	Length (m)	Width (m)	Orientation (°)	Shoalest Point (m)	Mound #	Length (L)	Width (W)	Orientation (°)	Shoalest Point (m)
1	113.34	46.00	3.00	716.00	1	155.96	47.66	355.50	723.00
2	204.56	75.95	352.50	715.00	2	187.93	75.90	356.00	729.00
3	219.00	61.15	1.75	714.00	3	166.21	57.08	1.25	726.00
4	283.17	43.44	345.50	719.00	4	167.02	86.14	7.25	728.00
5	175.03	77.80	357.50	723.00	5	275.36	81.55	357.75	733.00
6	227.39	73.57	356.00	719.00	6	156.00	58.98	344.50	730.00
7	143.22	45.71	357.50	718.00	7	121.73	44.60	1.00	725.00
8	247.30	87.14	355.50	718.00	8	196.01	75.34	349.00	728.00
9	188.67	62.50	0.50	732.00	9	208.00	78.71	2.00	729.00
10	201.67	74.77	353.25	719.00	10	145.06	67.60	333.00	729.00
South Central Area, Site 1					South Central Area, Site 2				
Mound #	Length (m)	Width (m)	Orientation (°)	Shoalest Point (m)	Mound #	Length (L)	Width (W)	Orientation (°)	Shoalest Point (m)
1	169.00	77.28	5.40	769.00	1	156.50	58.70	356.75	762.00
2	169.29	56.62	1.40	771.00	2	104.33	53.49	354.00	769.00
3	110.32	62.39	350.00	770.00	3	182.62	52.69	359.00	773.00
4	161.68	105.12	7.00	768.00	4	196.94	60.94	8.25	754.00
5	166.75	81.63	4.25	770.00	5	151.91	57.62	3.25	775.00
6	156.04	44.48	352.00	767.00	6	185.91	70.97	347.00	771.00
7	253.33	62.86	2.75	774.00	7	229.00	88.12	7.50	769.00
8	203.16	62.08	2.50	771.00	8	107.41	66.92	6.00	758.00
9	148.41	94.85	0.00	775.00	9	221.41	51.03	359.00	767.00
10	152.34	66.61	3.00	773.00	10	175.09	94.44	354.75	763.00
South Area, Site 1					South Area, Site 2				
Mound #	Length (m)	Width (m)	Orientation (°)	Shoalest Point (m)	Mound #	Length (L)	Width (W)	Orientation (°)	Shoalest Point (m)
1	248.80	122.01	3.50	811.00	1	181.06	97.50	356.00	800.00
2	199.82	82.17	5.75	817.00	2	158.37	56.69	1.75	798.00
3	207.84	100.76	7.50	819.00	3	255.37	90.93	16.50	800.00
4	216.22	74.12	2.50	818.00	4	193.33	82.17	6.50	802.00
5	187.15	59.76	359.50	810.00	5	221.83	95.10	3.50	801.00
6	207.81	90.42	358.00	814.00	6				
7	245.87	44.46	4.50	820.00	7				



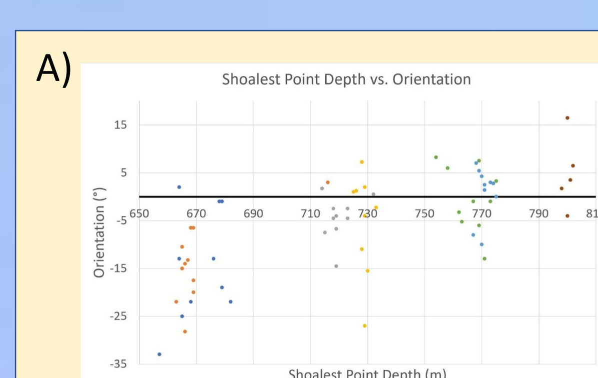
RESULTS

- The mound shape index showed no relationship to mound shoalest point (Fig. 7B).
- A weak relationship exists between mound shape index and orientation: As the mounds shape index lowers, the orientation shifts clockwise (Fig. 6).
- Comparing shoalest point depth to orientation showed an orientation shift clockwise from northwest to northeast orientation, as mound depth increased. This shift is seen from the North Area to the South Area (Fig. 7A).
- Mounds mostly were found falling within the 1-5 shape index range, or circular to moderately elongate.
- As the study sites increased in depth, mounds became smaller and less abundant (Fig. 7 & Table 1).

DISCUSSION and CONCLUSIONS

The purpose of measuring deep sea coral mound shape and orientation within Stetson Mesa was to find a relationship that can help us predict and understand more about its deep sea coral mounds. Mound shape was variable across the study region, ranging from slightly to moderately elongate, and rarely was the length more than 5x the width (Fig 6.). However, shape was found to be similar (moderately elongate) within the South and North Central areas. From the data collected there is no relationship present between the shoalest point and shape (Fig. 7B).

However, along the path of the Gulf Stream's northward flow mounds become more abundant, larger and shift from a northeast orientation in the south to a northwest orientation in the north (Table 1, Figure 6 & 7A). The depth variability at this location may also cause a shift in the Gulf Stream, which would result in changes to mound orientation. The Gulf Stream's velocity, temperature, and abundance of nutrients and food likely play a strong role in mound shape and orientation. To properly categorize mound shape and orientation with respect to depth, further research must be done for different regions, and should include water column characteristics which may affect deep coral growth.



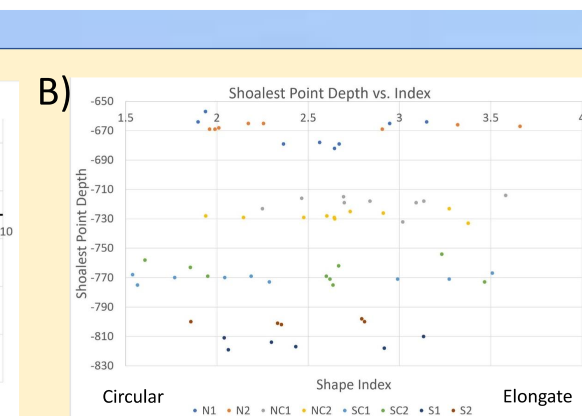


Figure 7. (A) Mound Shoalest Point compared to Orientation and (B) Shoalest point compared to Shape Index.

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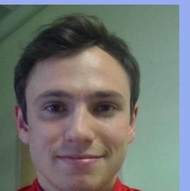

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