



# CGS *virtual* Coastal Geology Field Trip 2020

## Long Bay's Changing Coast



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**Coastal Geosystems Research Lab**

**Coastal Carolina University**





# COASTAL PROCESSES FIELD TRIP: KIAWAH ISLAND, SEABROOK ISLAND, AND EDISTO BEACH STATE PARK

## FIELD TRIP LEADERS:

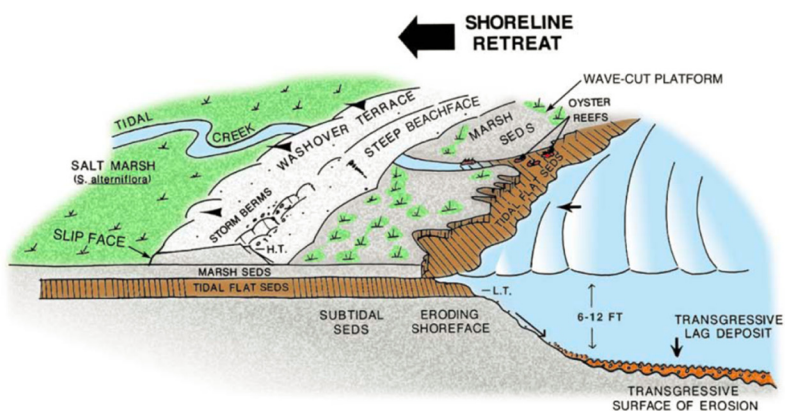
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RESEARCH PLANNING, INC. AND CAROLINA GEOLOGICAL SOCIETY



CGS 2010 CHARLESTON, SOUTH CAROLINA  
**FIELD TRIP GUIDEBOOK**  
 18-19 SEPTEMBER 2010





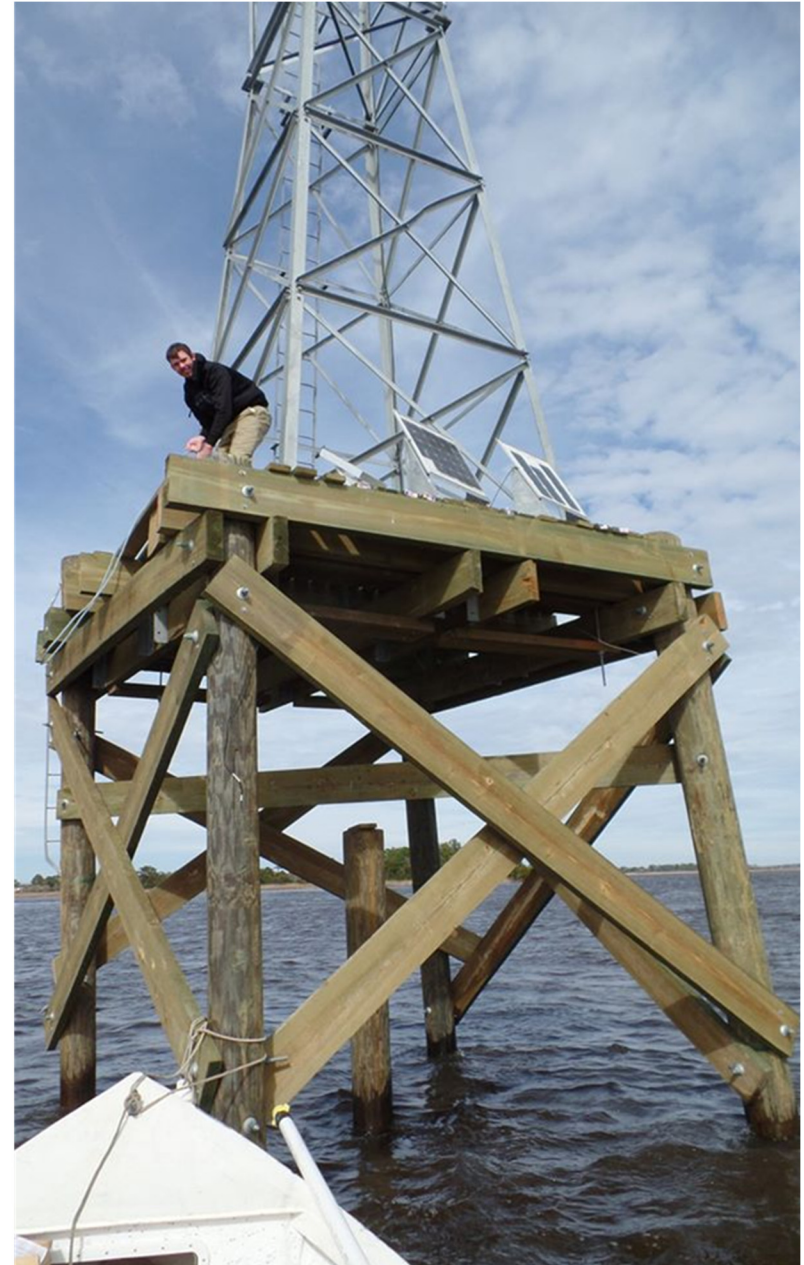
## How to learn about the geology in a coastal plain and offshore?

- Almost no outcrops
- Very high groundwater table
- No gradient
- Stratigraphy horizontal(?)





## Methods to Explore the Geology: **Monitoring**





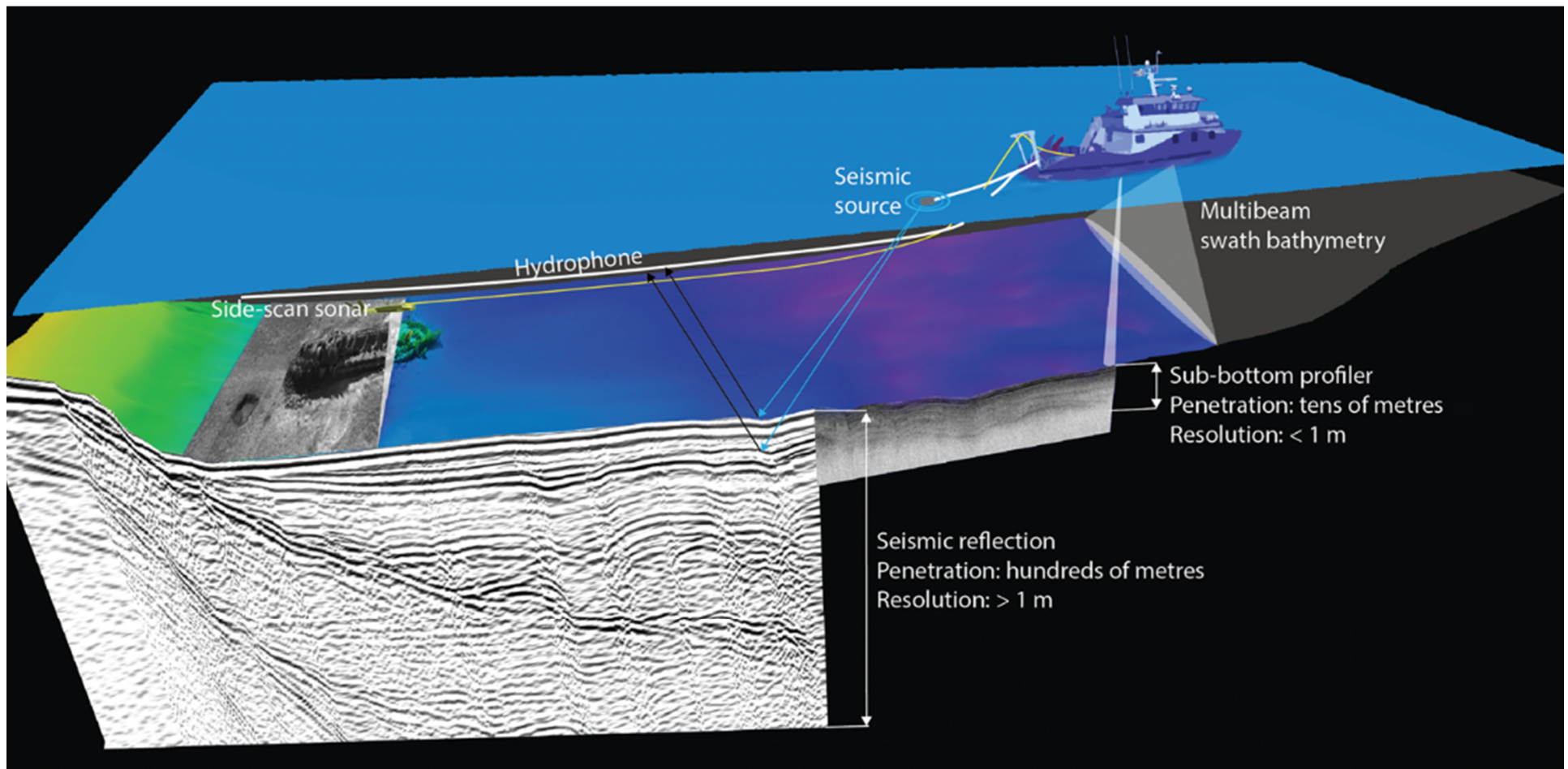
## Methods to Explore the Geology: Sediment Coring

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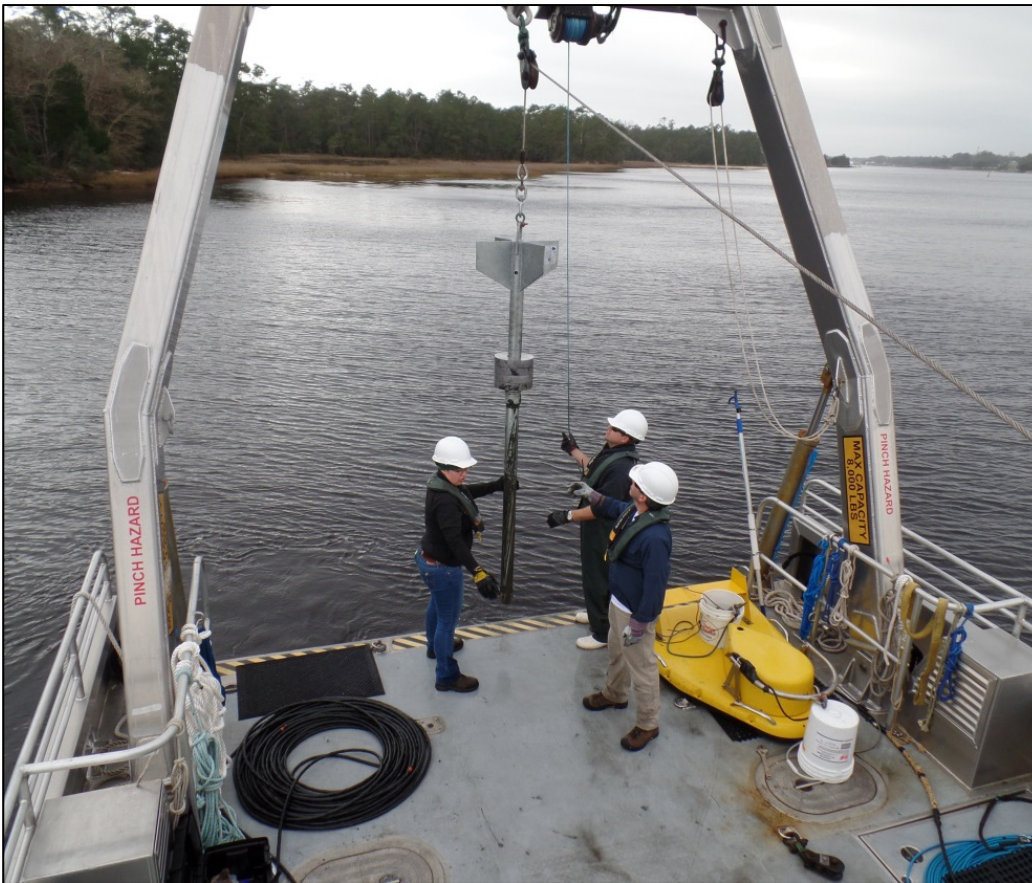


## Methods to Explore the Geology: Seismo-Acoustic Surveying

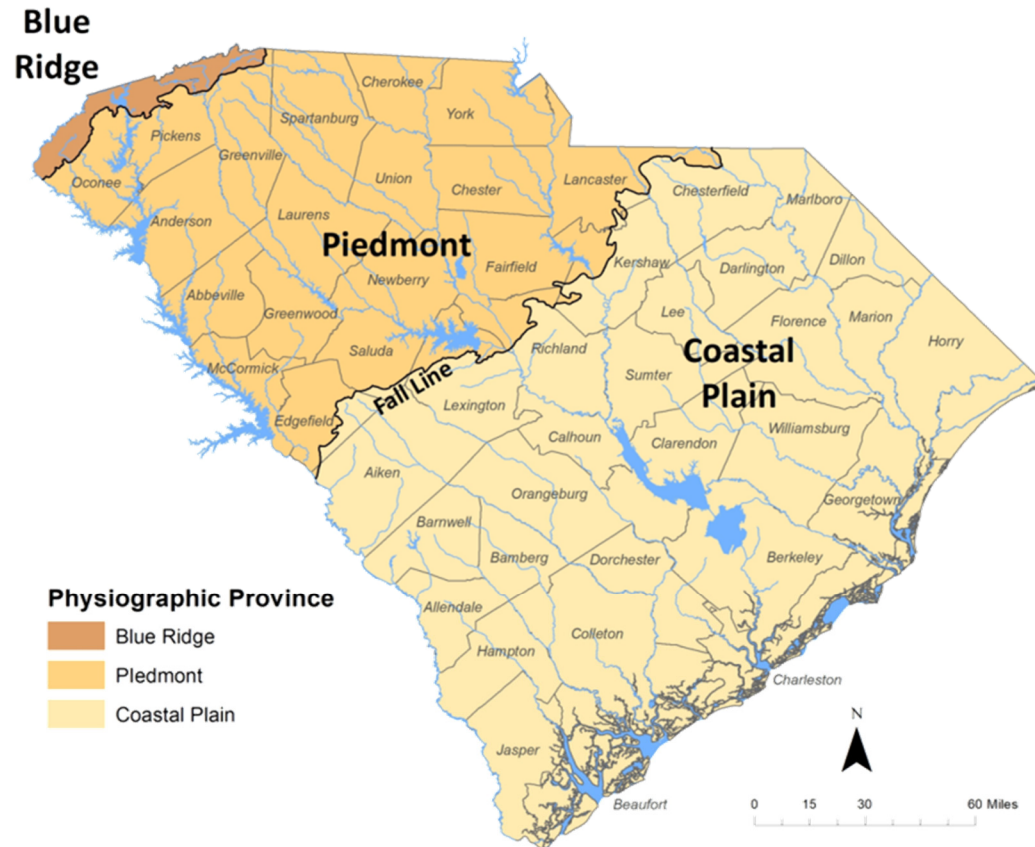




## Methods to Explore the Geology: **Shallow-Subbottom Sediment Echosounding**



## South Carolina's Coastal Plain



### Field Trip Outline:

- The Geological Framework Since the Cretaceous.
- Quaternary Coastal Architecture.
- Coastal Dynamics.
- ...in a Changing World.

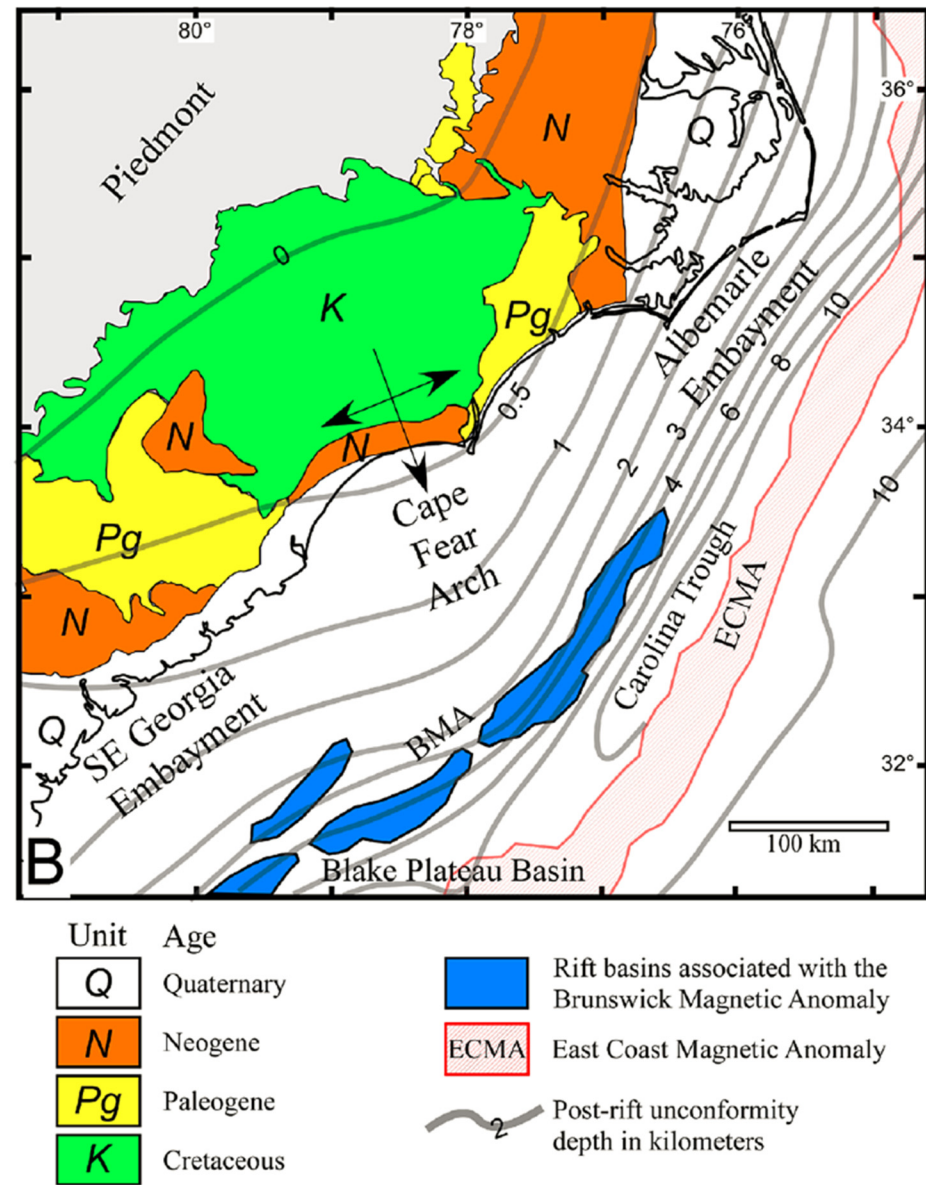


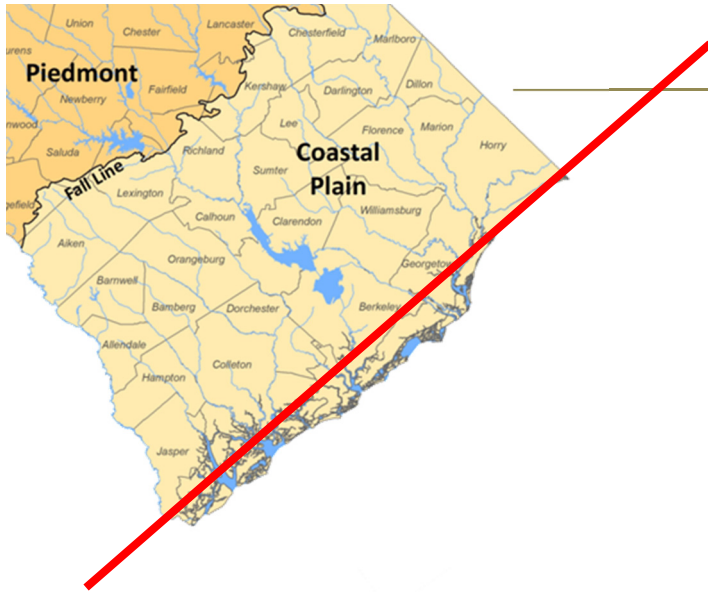


## Onshore-Offshore Stratigraphic Architecture

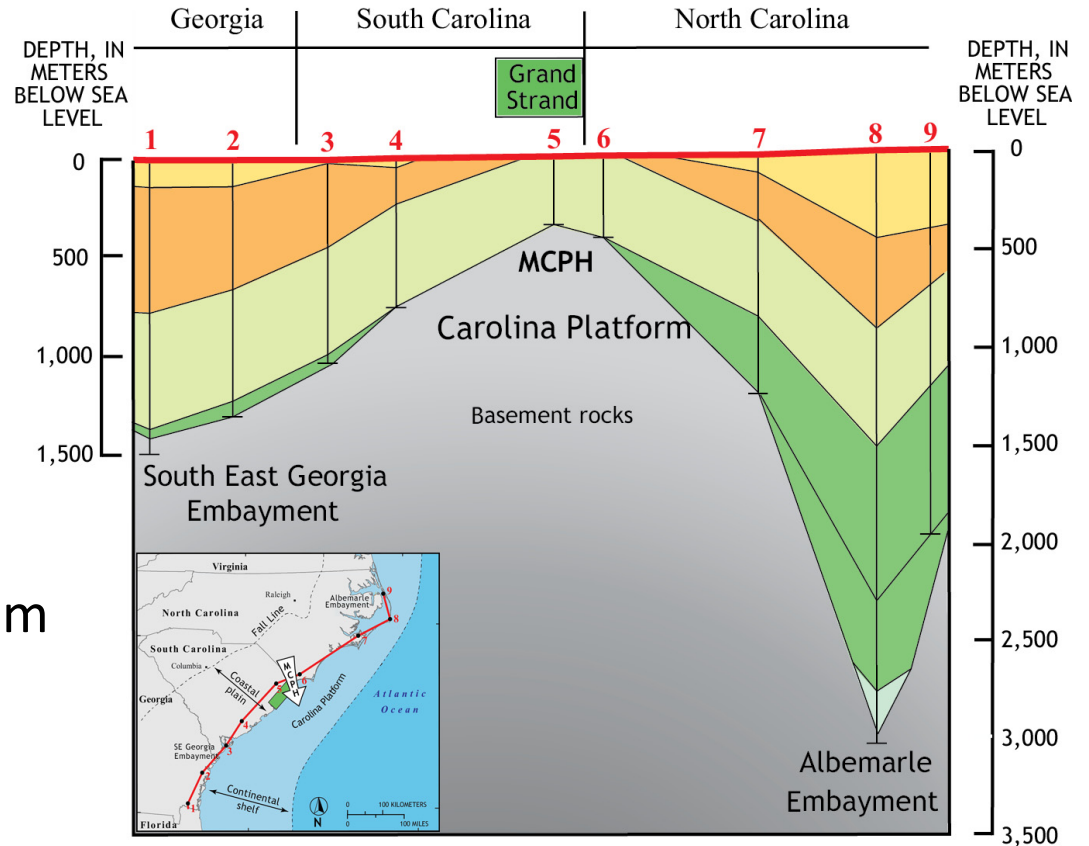
### The Geological Framework:

- High sedimentation rates from the Cretaceous until the Quaternary.
- Deltaic to shelf environments.
- Progradational cycles.





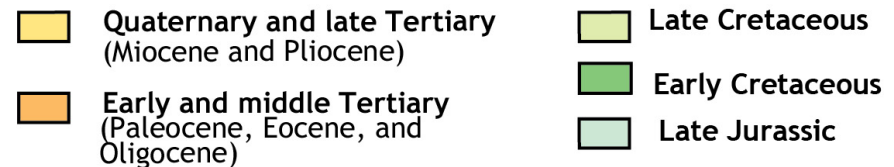
## Onshore-Offshore Stratigraphic Architecture



### The Geological Framework:

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#### EXPLANATION



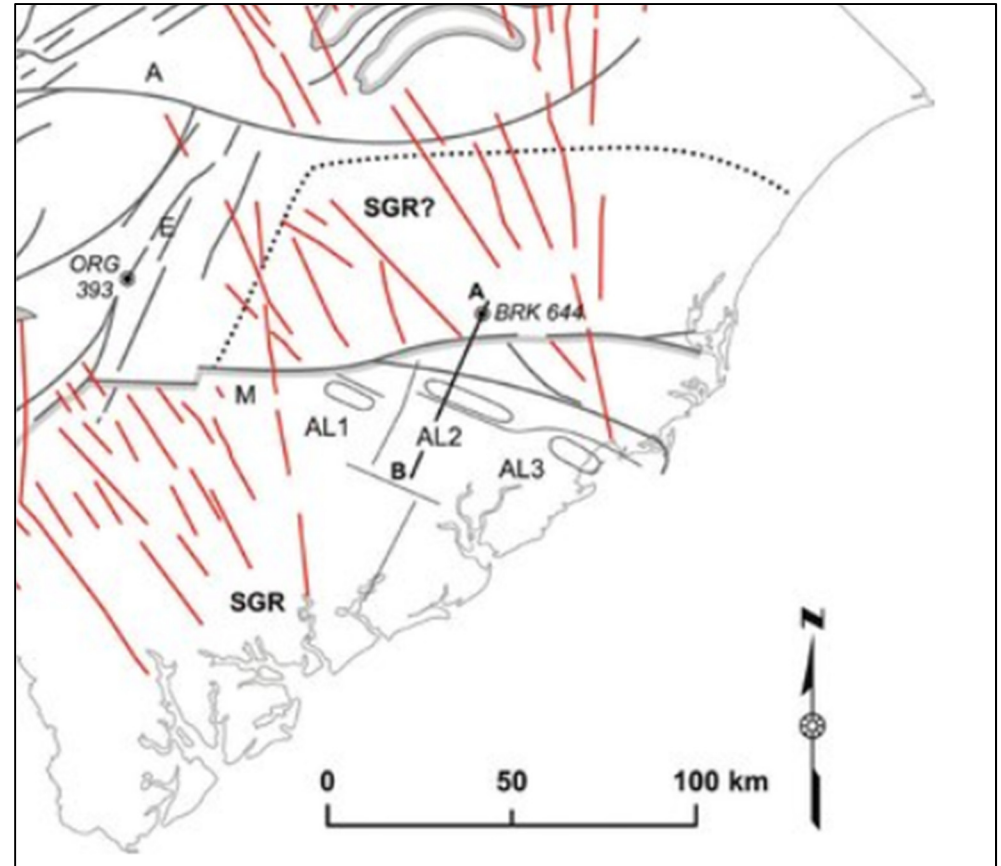


## Onshore-Offshore Stratigraphic Architecture



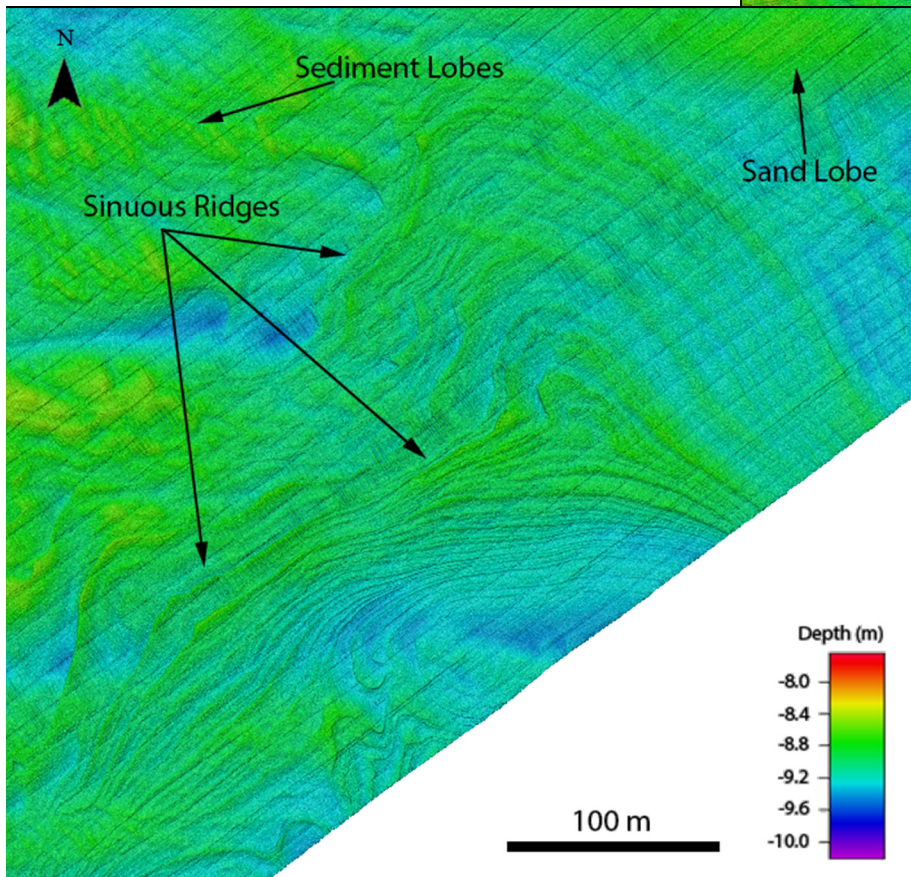
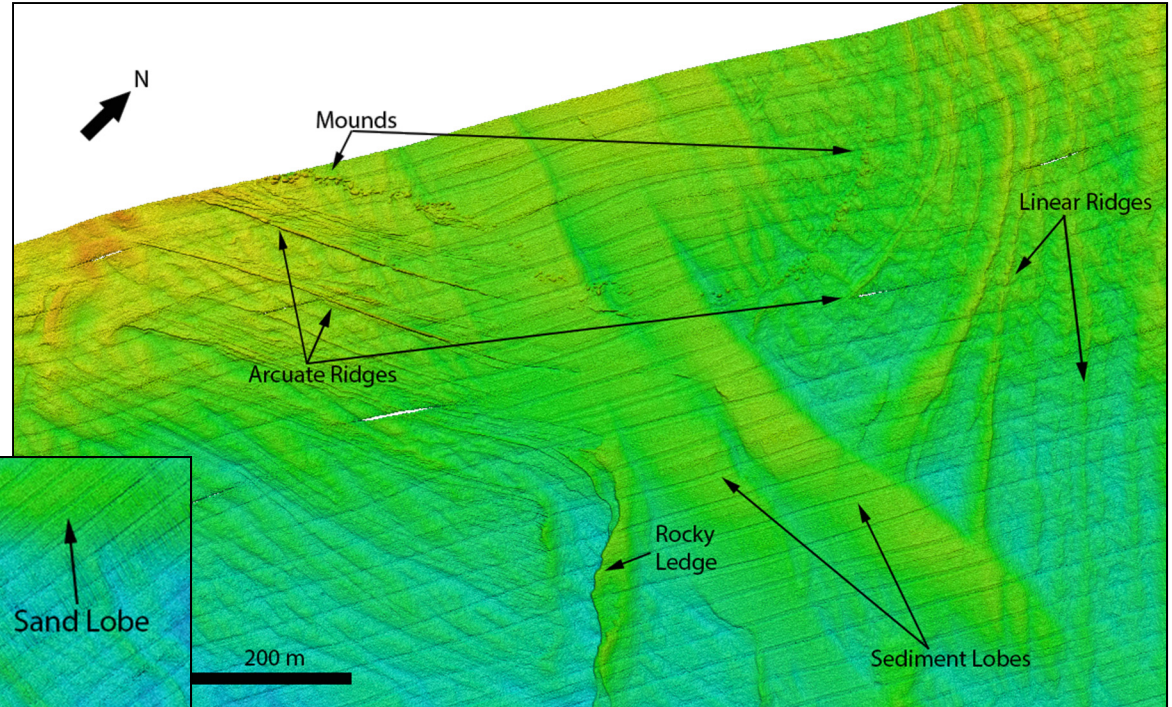
### The Geological Framework:

- Faults extend probably offshore.
- Coastal plain rivers may follow these fault zones.
- Dike systems perpendicular to the overall continental margin orientation.



**Gray: Faults**  
**Brown: Dikes**

## Onshore-Offshore Stratigraphic Architecture



### The Geological Framework:

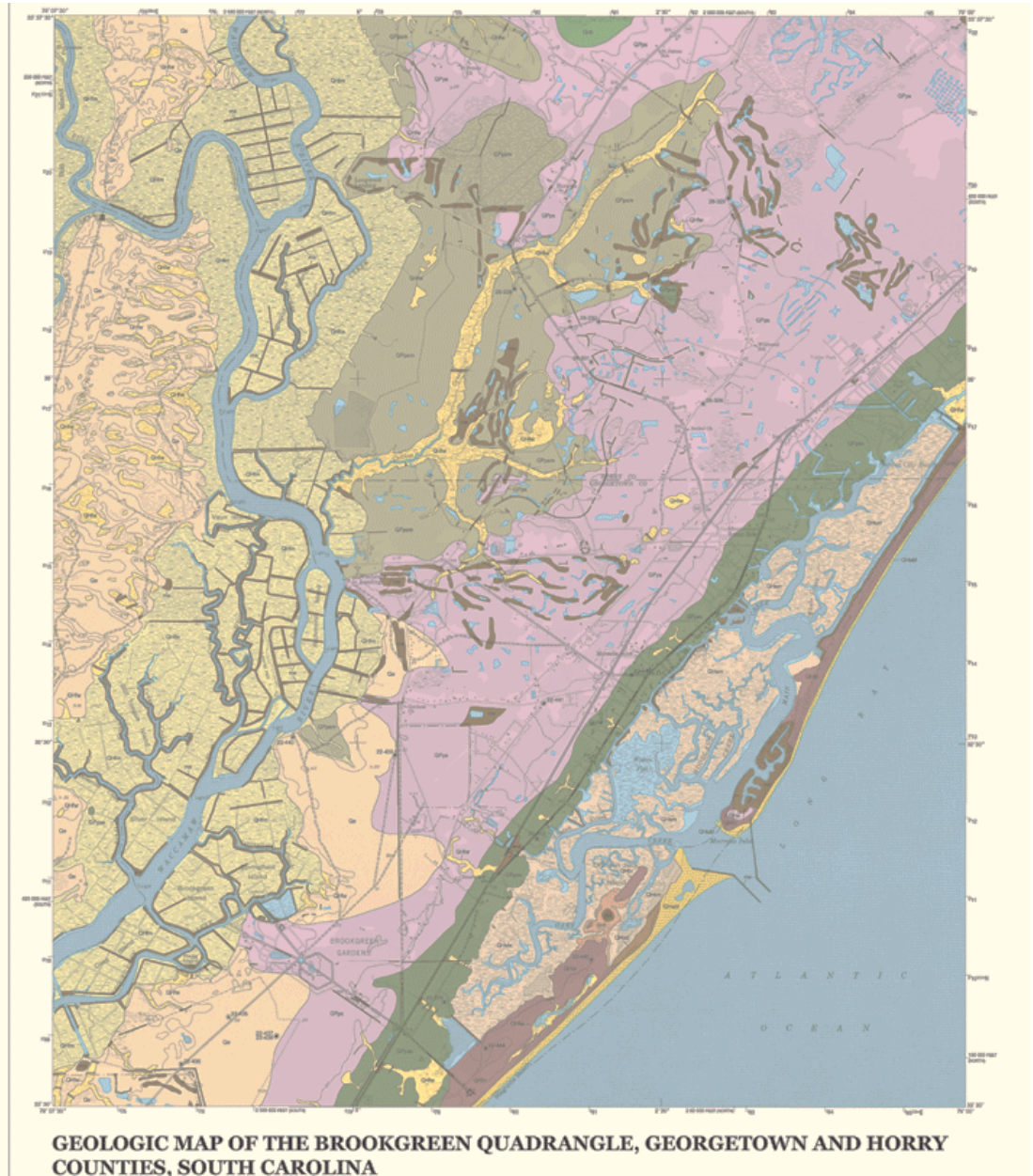
- The strata are tilted, folded, without clear orientation.
- When did this deformation happen?





### The Coastal Geology:

- Modern barrier island – marsh – lagoon systems.
- Fluvial and tidal wetlands.
- Sand ridge systems.

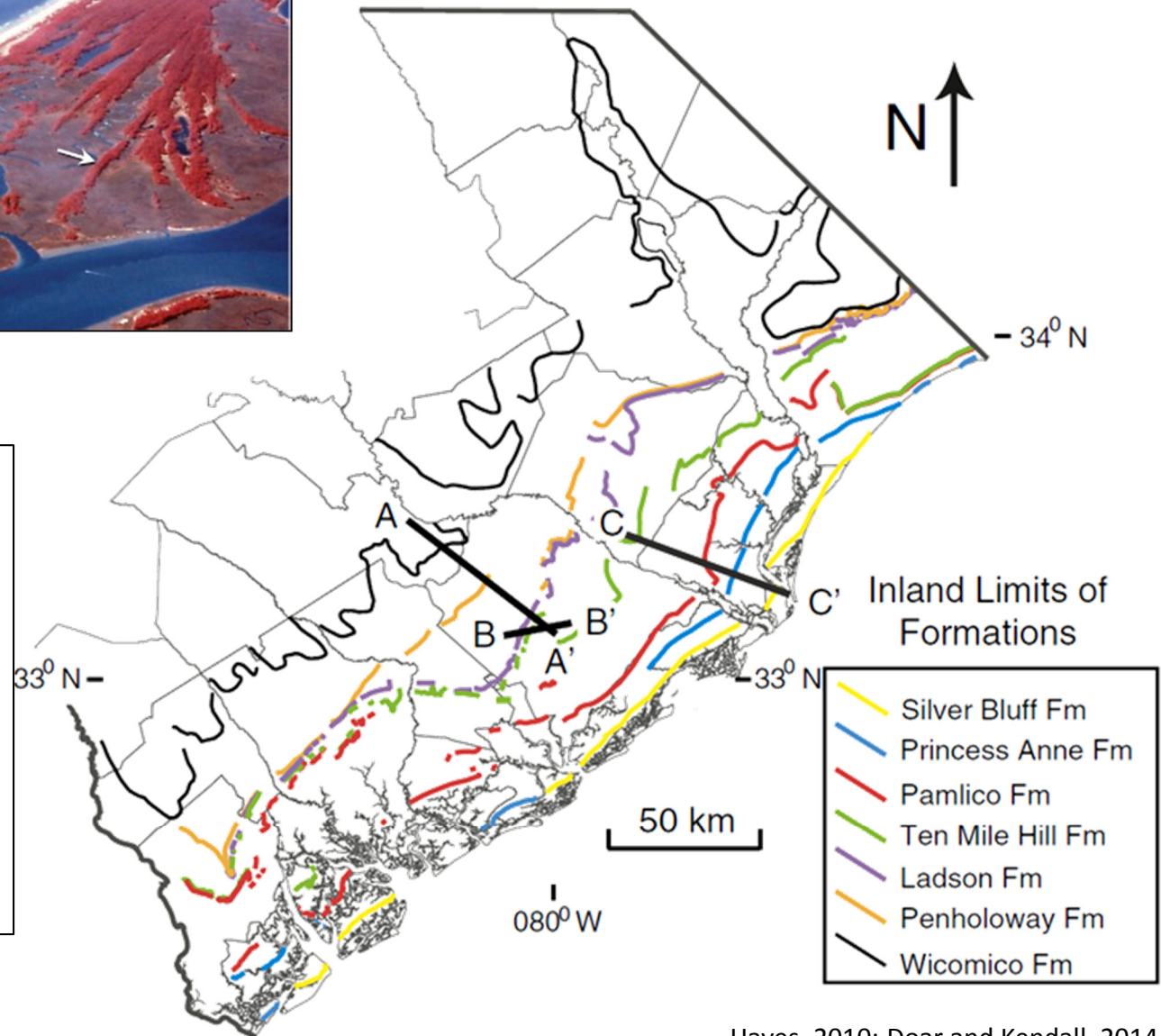


## Quaternary Coastal Architecture



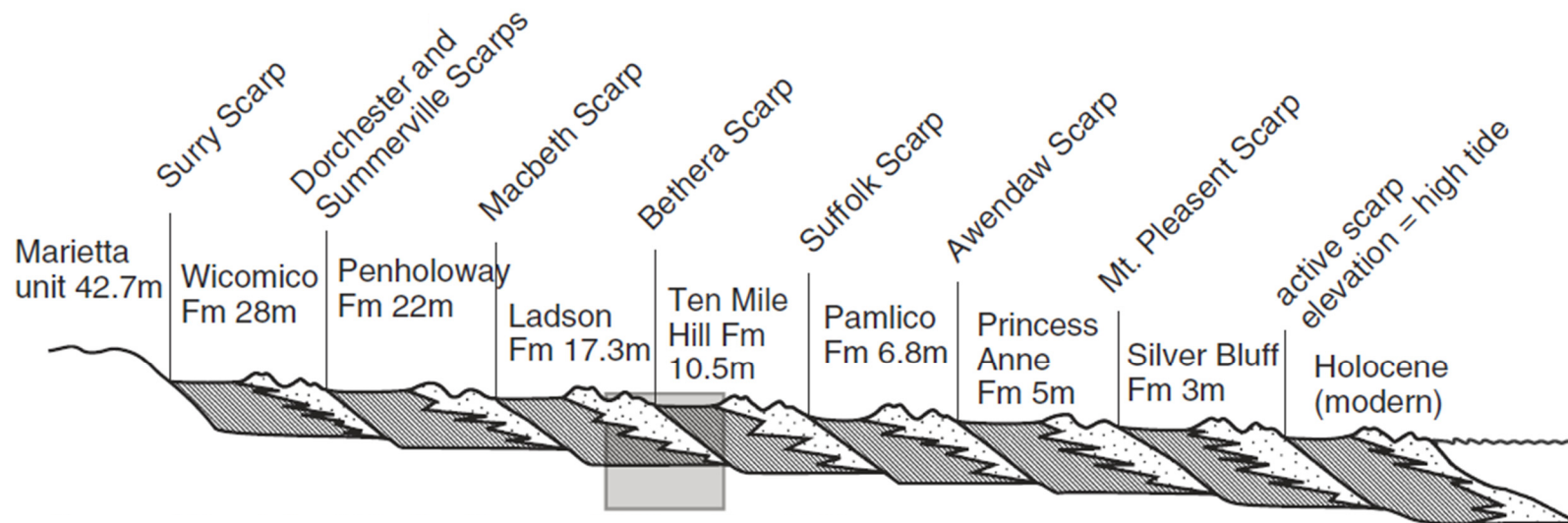
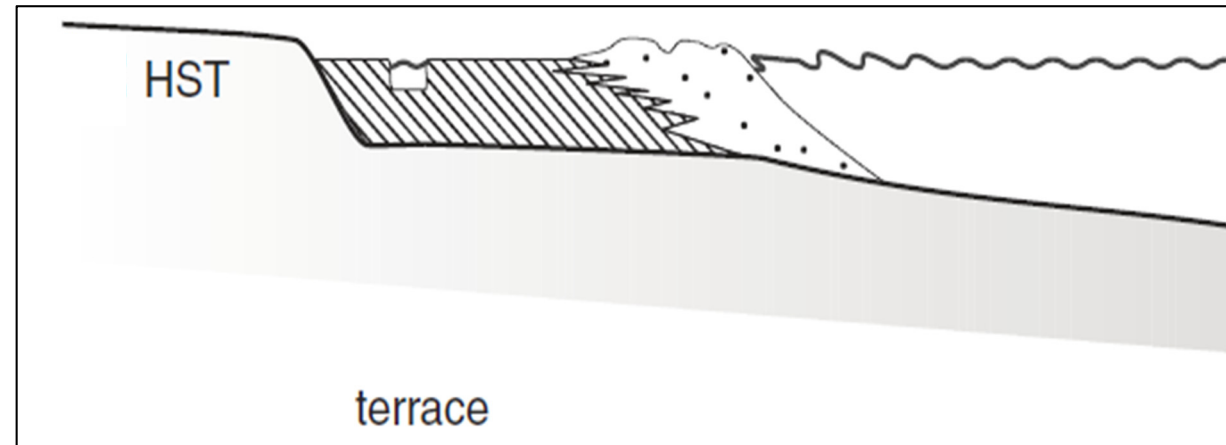
### The Beach Ridge Systems:

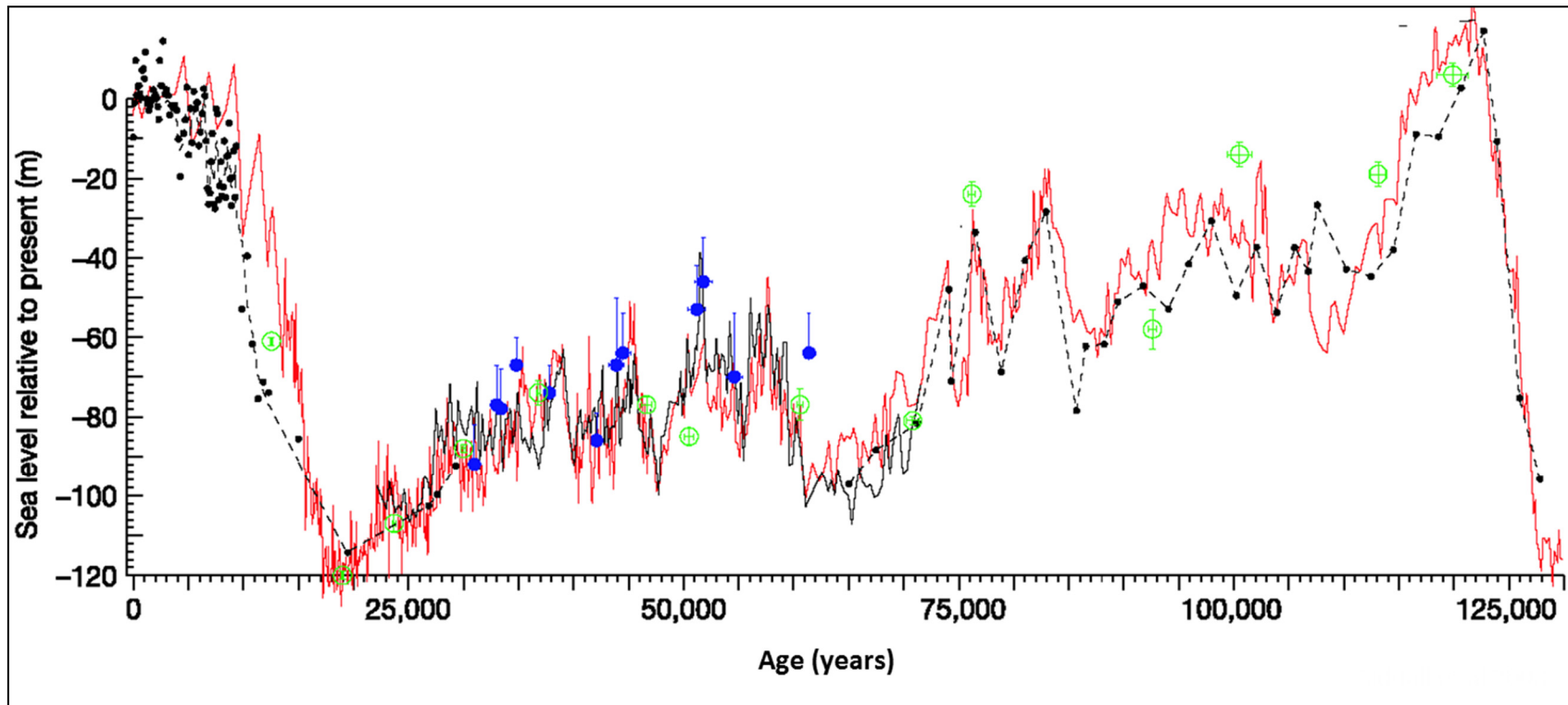
- Lines of old dune systems.
- Witnesses of old shorelines.





# Quaternary Coastal Architecture





### The Sea Level Cycles:

- Beach Ridge Systems developed during sea level highstands.
- The coastline was far off the modern coast during lower sea level = most of the time.

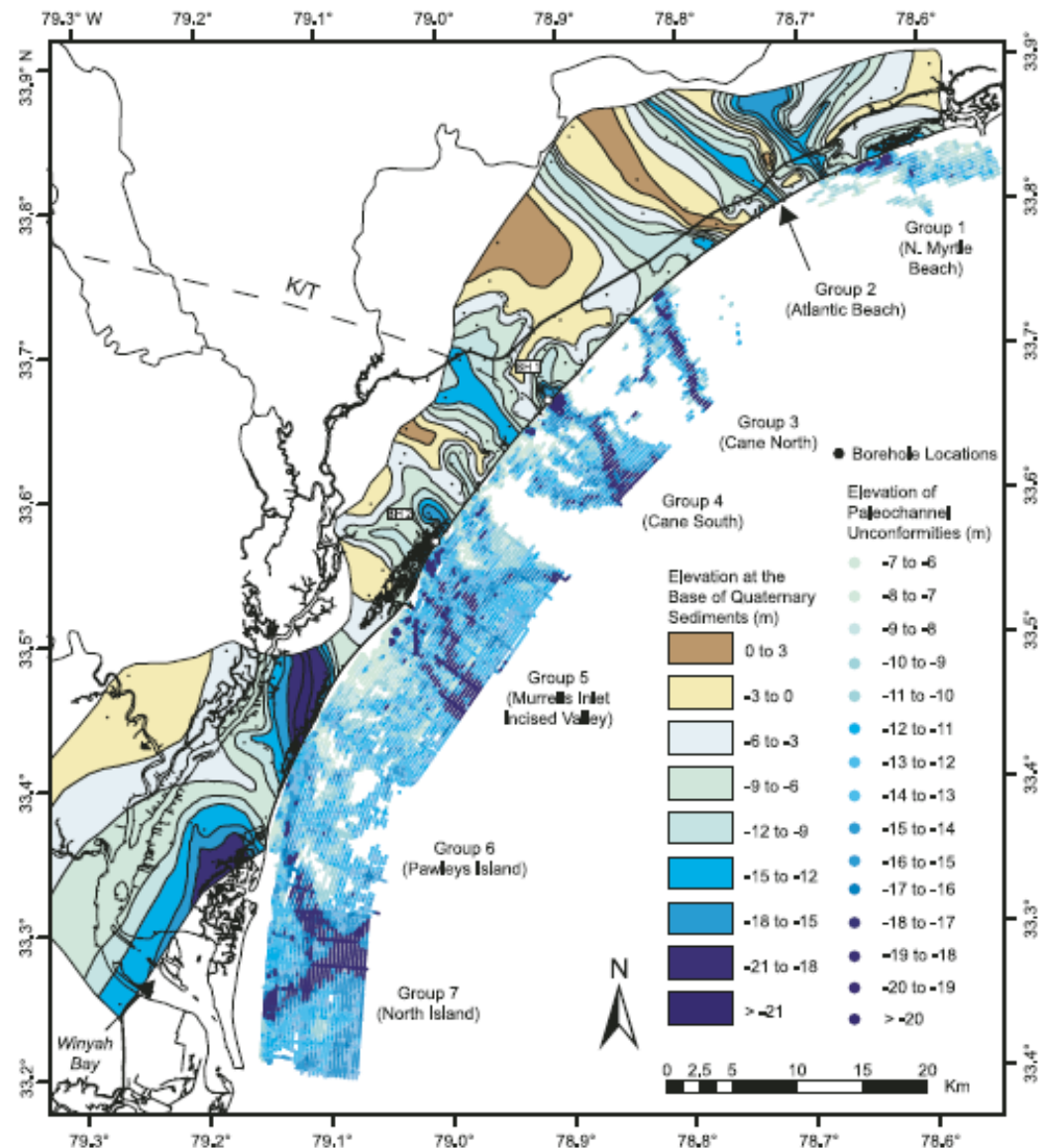




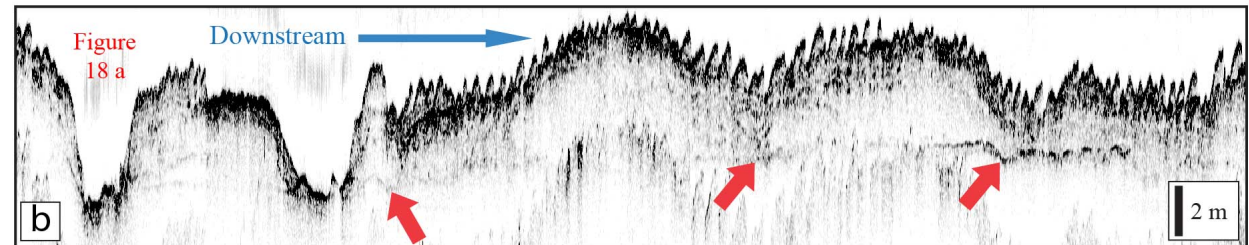
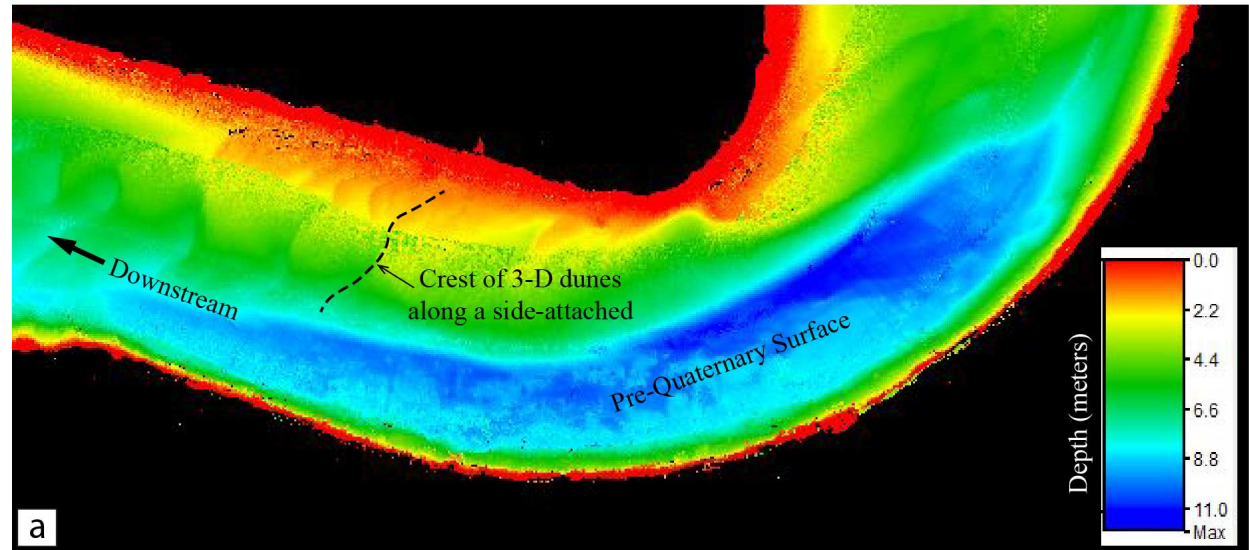
## Quaternary Coastal Architecture

### Thickness of Quaternary Deposits:

- Often less than 10 m.
- Only substantial inside paleo-channels.



## Quaternary Coastal Architecture



### The Thickness of Quaternary Deposits:

- Often less than 10 m.
- Easily erodible as (semi-)soft deposits.

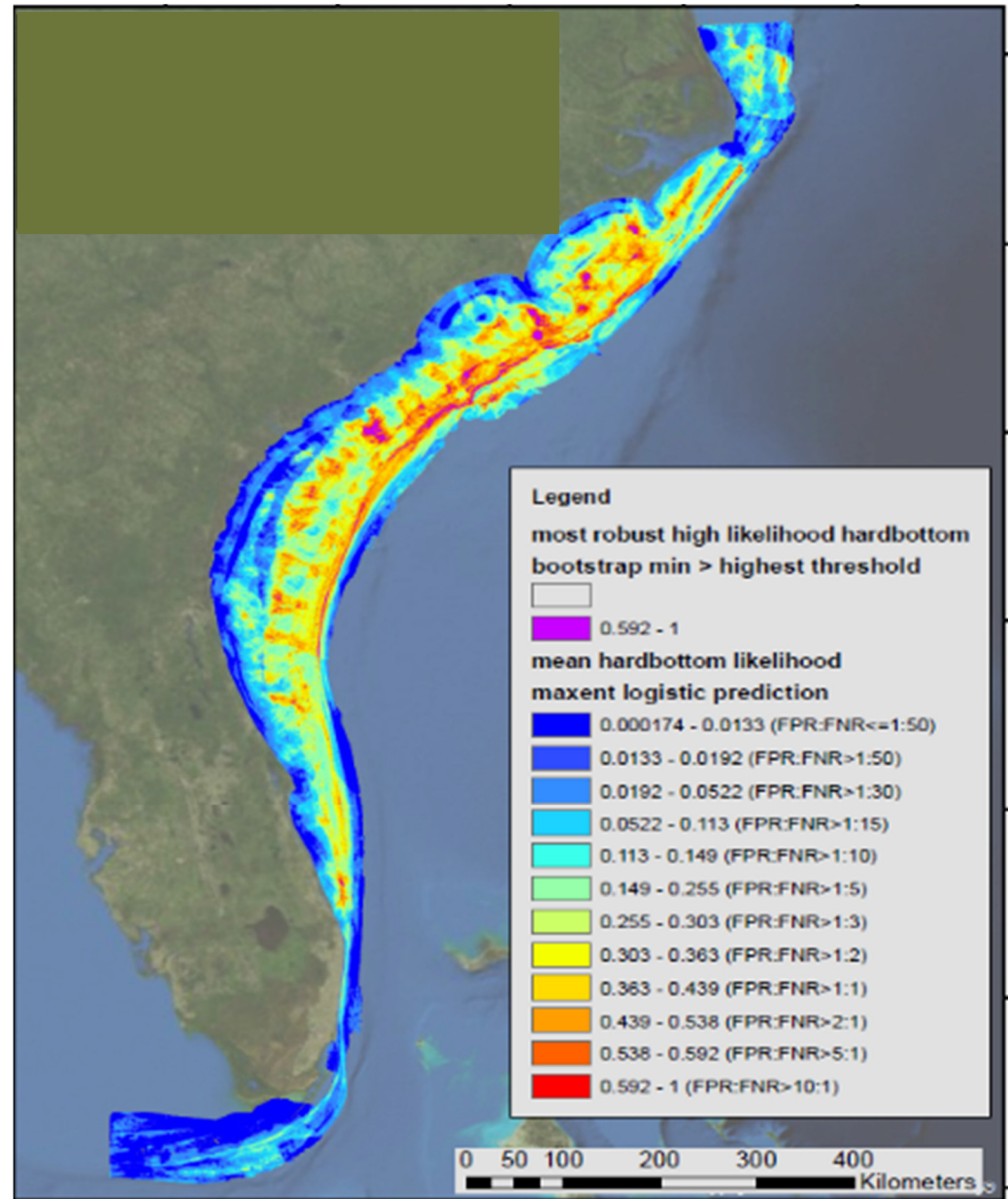


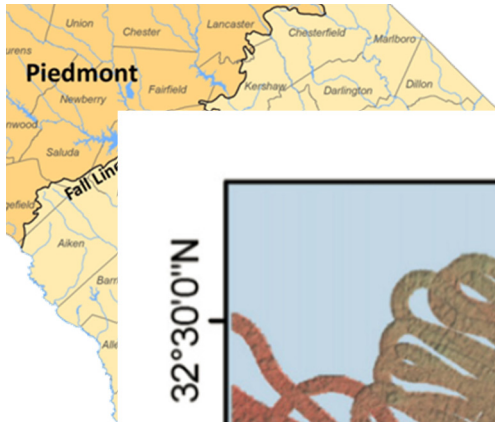




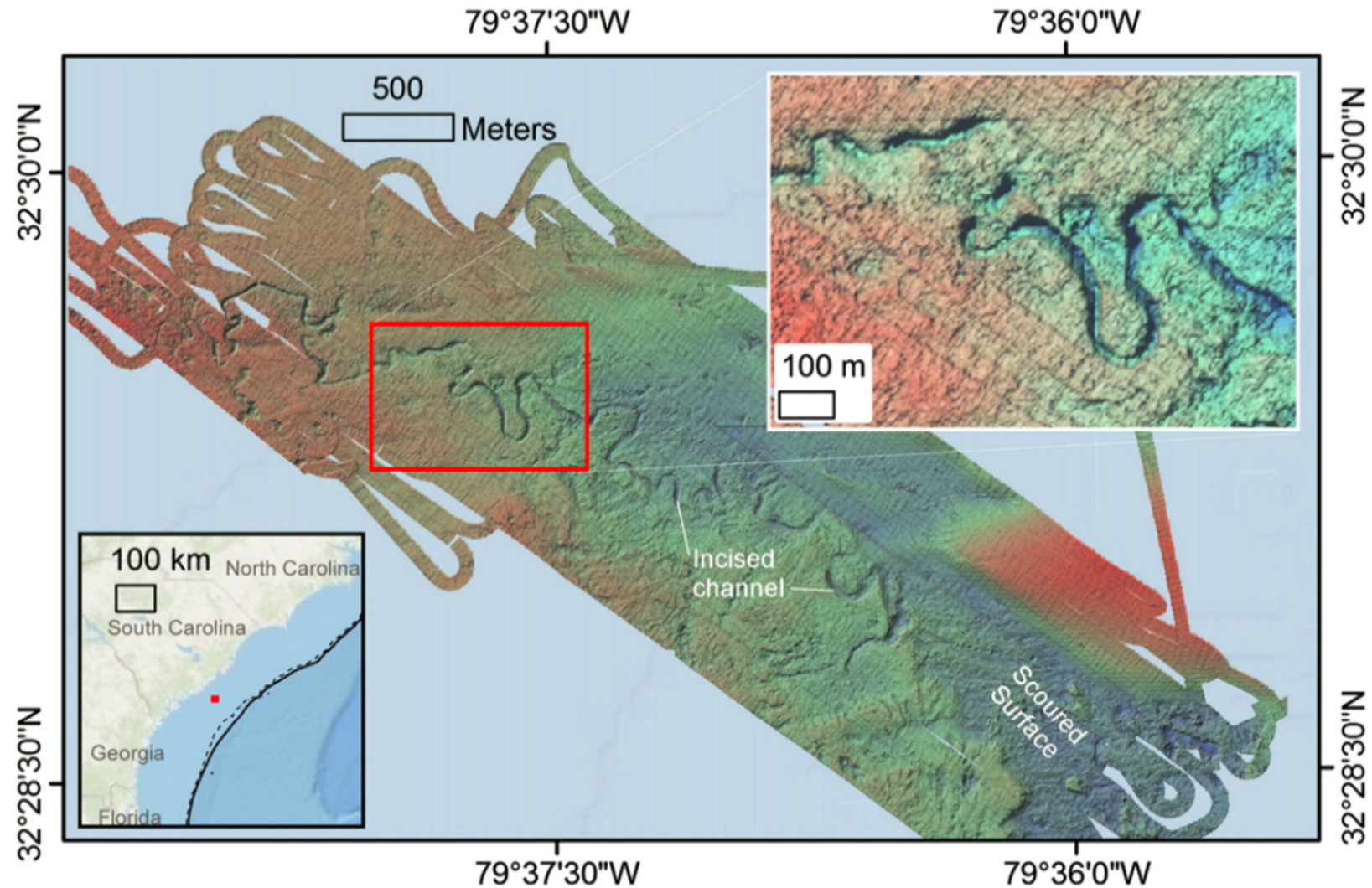
### The Thickness of Quaternary Deposits:

- Offshore sparse and patchy.
- Hardbottom = pre-Quaternary geology as great benthic habitat.





## Continental Shelf Geomorphology



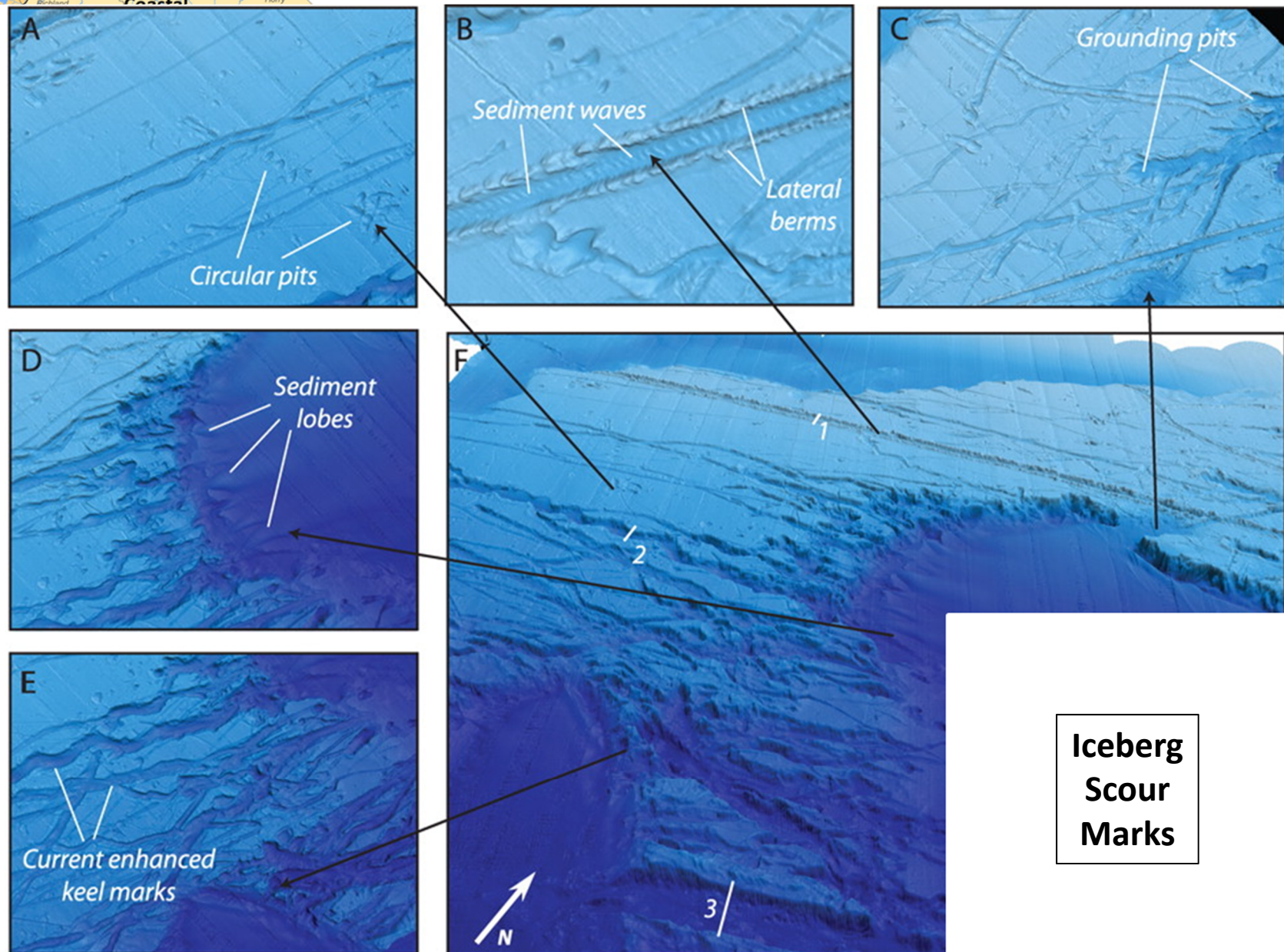
### Offshore Paleo-Landscapes:

- Sediment starvation characterizes our coastal ocean.
- Old fluvial and coastal systems preserved at the seafloor.





## Continental Shelf Geomorphology

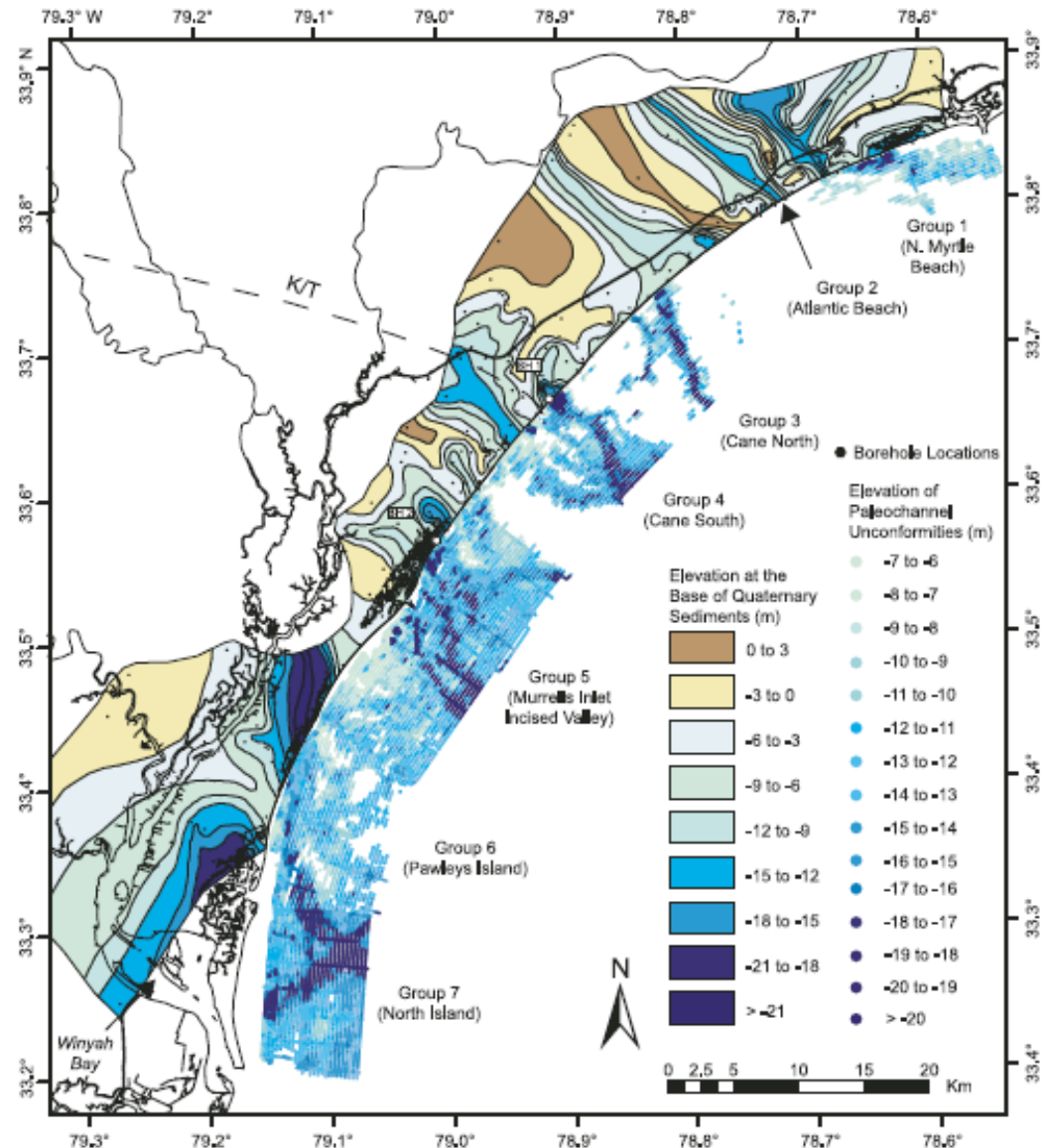




## Quaternary Coastal Architecture

### The Thickness of Quaternary Deposits:

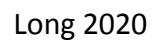
- Often less than 10 m.
- Only thicker inside paleo-channels.

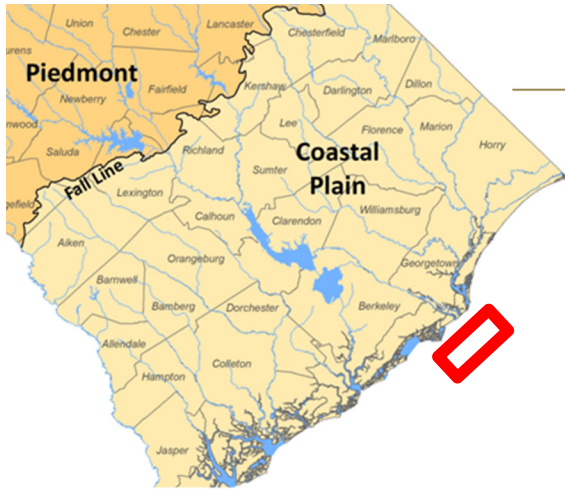




A map of South Carolina divided into two main regions: the **Piedmont** in the north and the **Coastal Plain** in the south. The **Fall Line** is marked as a boundary between the two regions. Major cities labeled include Union, Chester, Lancaster, Chesterfield, Marlboro, Dillon, Newberry, Fairfield, Kershaw, Darlington, Florence, Marion, Horry, Lexington, Richland, Sumter, Calhoun, Williamsburg, Aiken, Orangeburg, Georgetown, Bamberg, Dorchester, Berkeley, Allendale, Colleton, Hampton, and Jasper. A red arrow points to the coastal area near Berkeley.

- Gravelly base, sandy filling.
- Overlying old limestone formations.
  - *Position controlled by fault lines?*

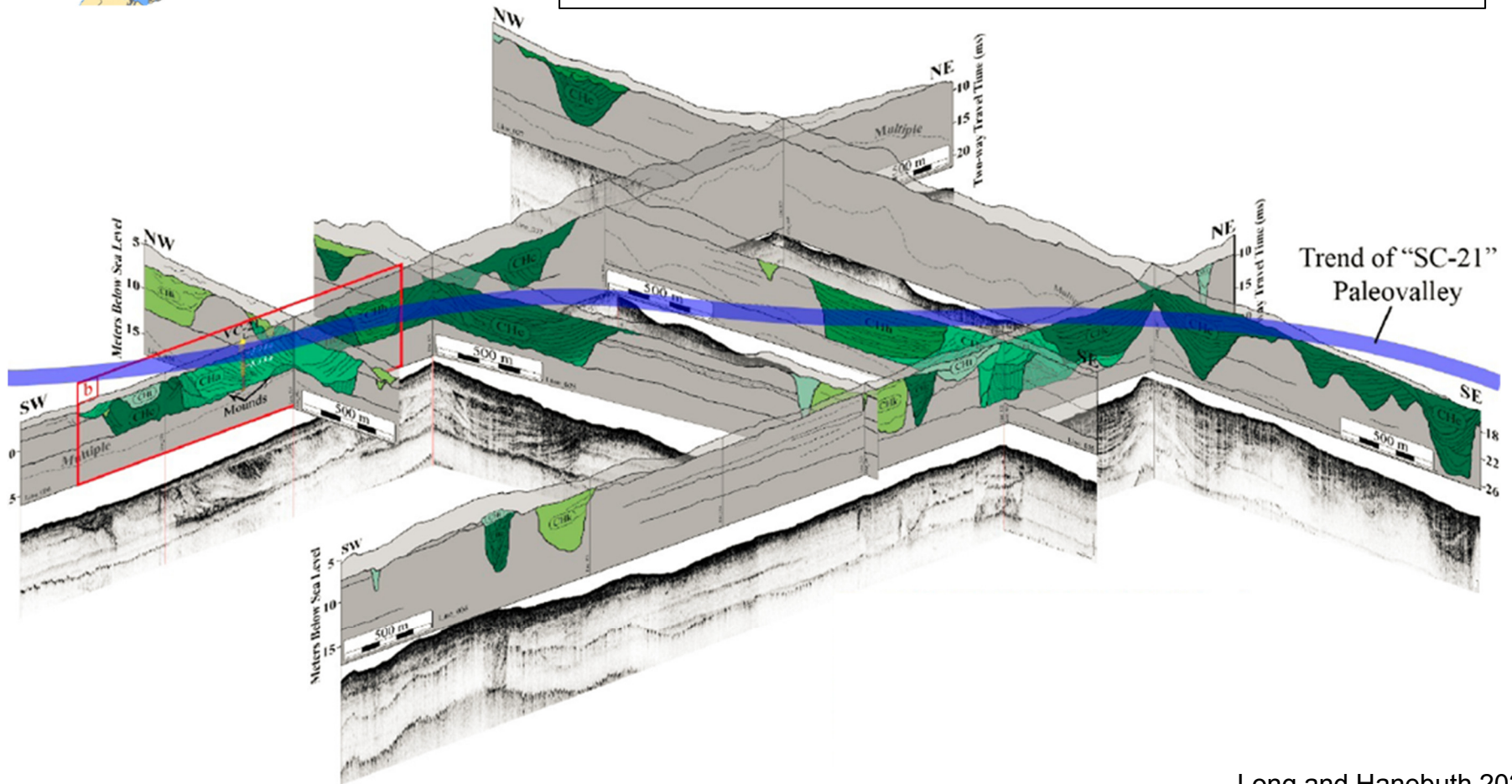




## Continental Shelf Paleo-Geomorphology

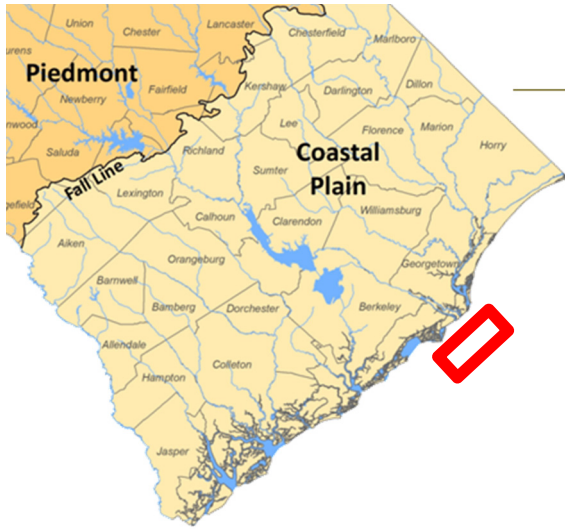
### Paleo-channel records – offshore:

- Substantial, locally confined deposits.
  - *Beach-quality sand resources?*
  - *Strategic-mineral resources?*
  - *Groundwater conduits?*



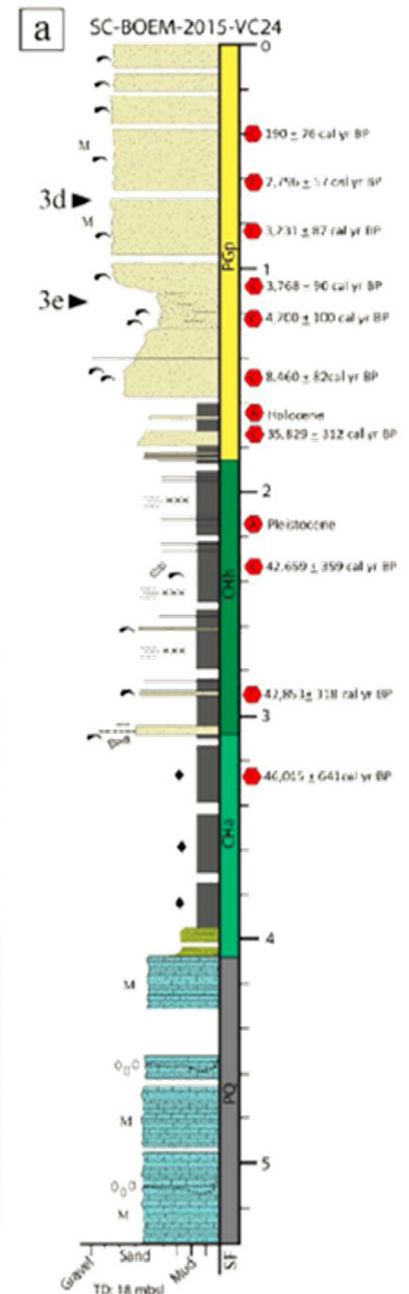
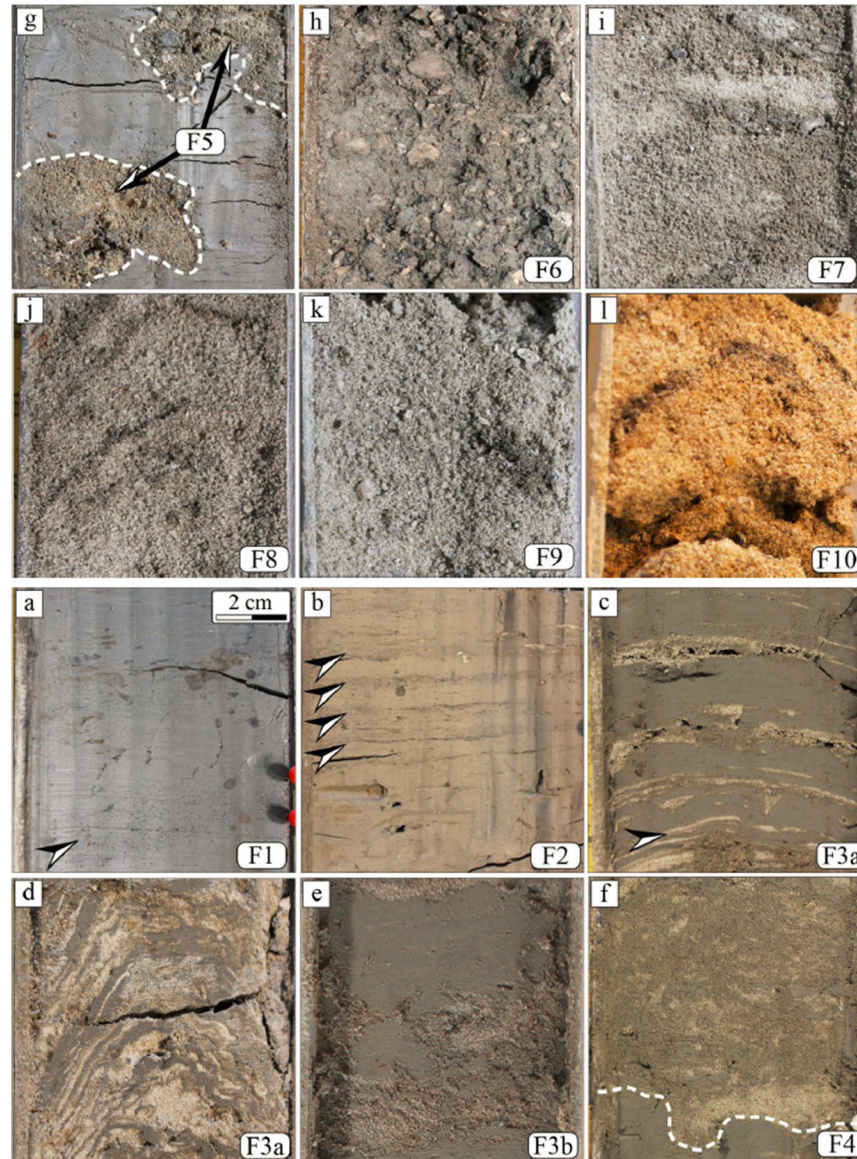


# Continental Shelf Sedimentary Records



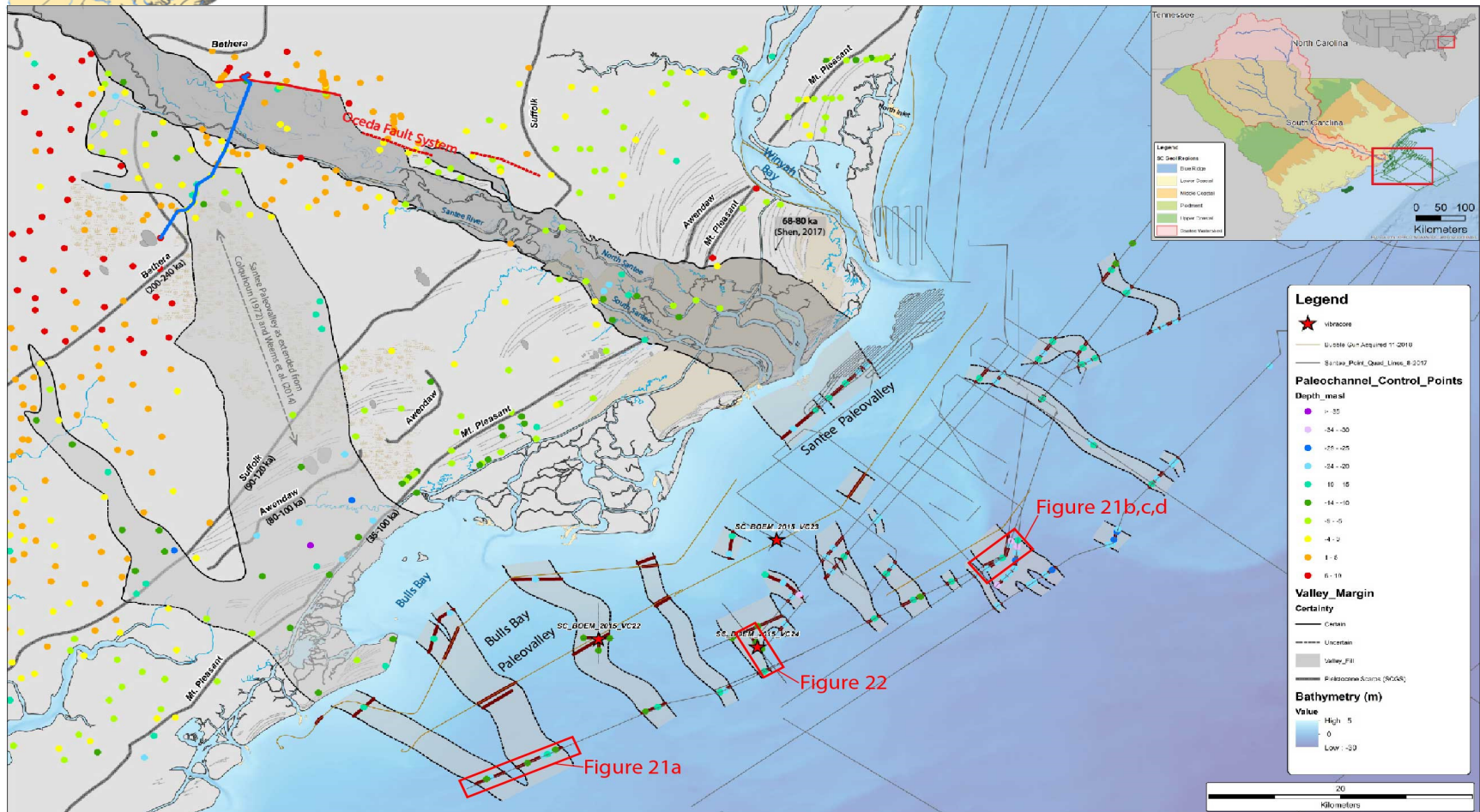
## Paleo-channel records – offshore:

- Very heterogeneous sedimentary facies.
- Fully marine, coastal, terrestrial environments.
- Long hiatuses.





# Continental Shelf Paleo-Geomorphology





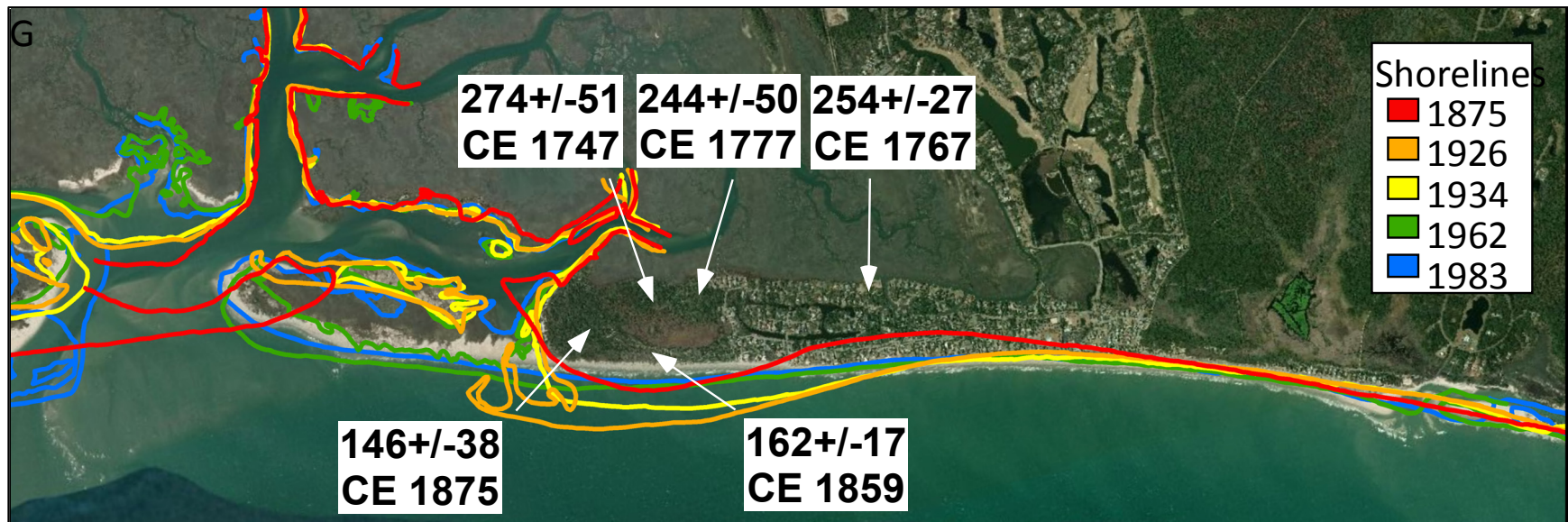
## Coastal Dynamics





### Reconstructing shoreline change:

- Comparing historic maps; dating barrier islands.
- Tidal inlets are the most dynamic coastal element.



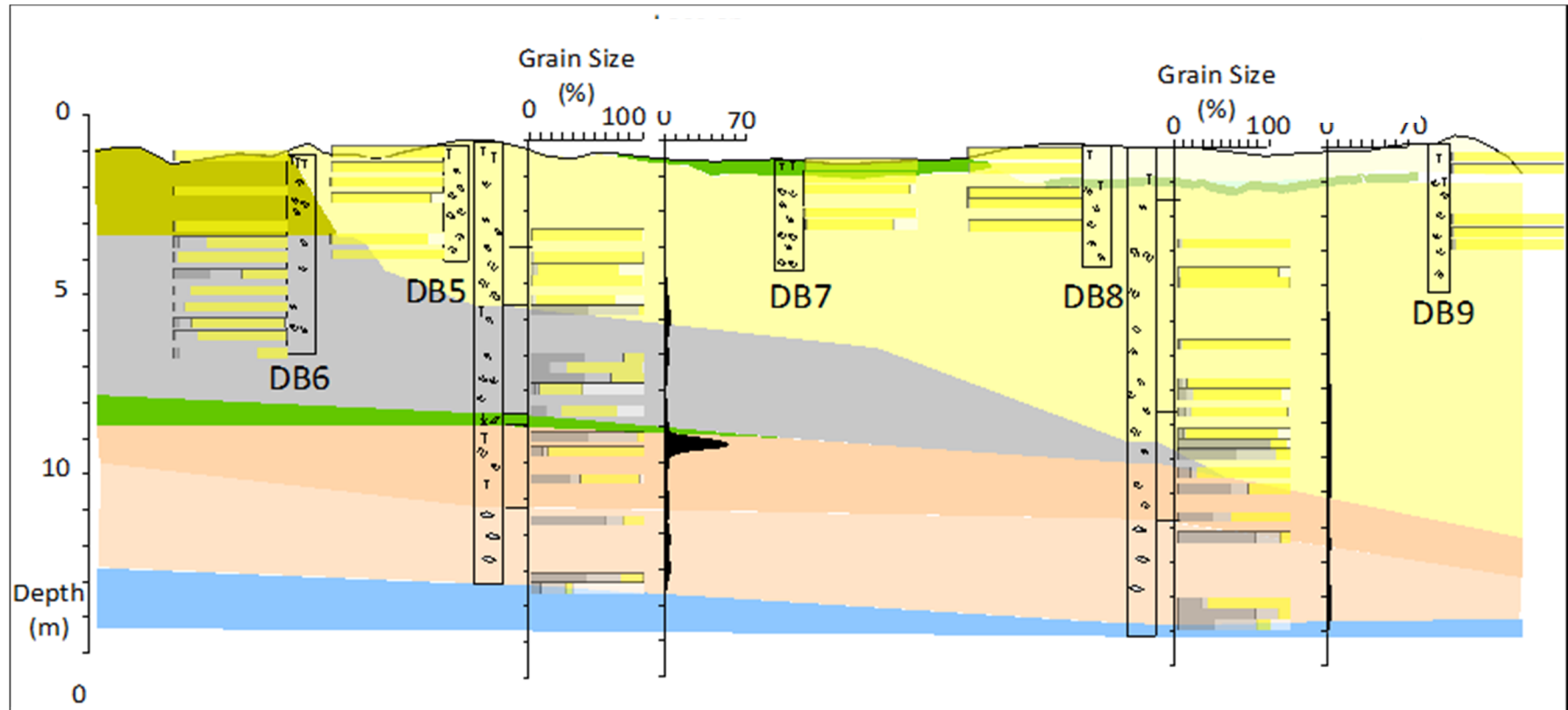


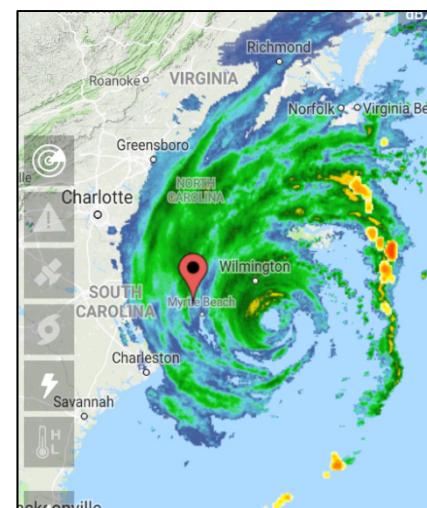
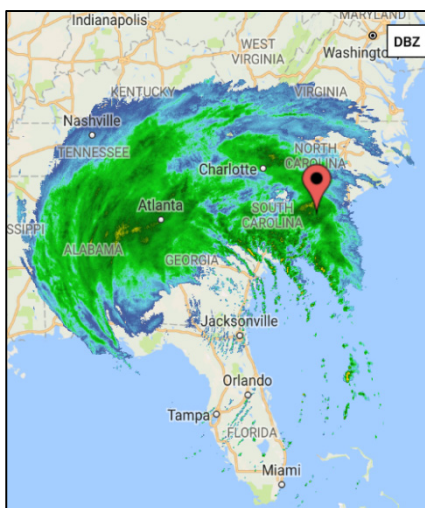
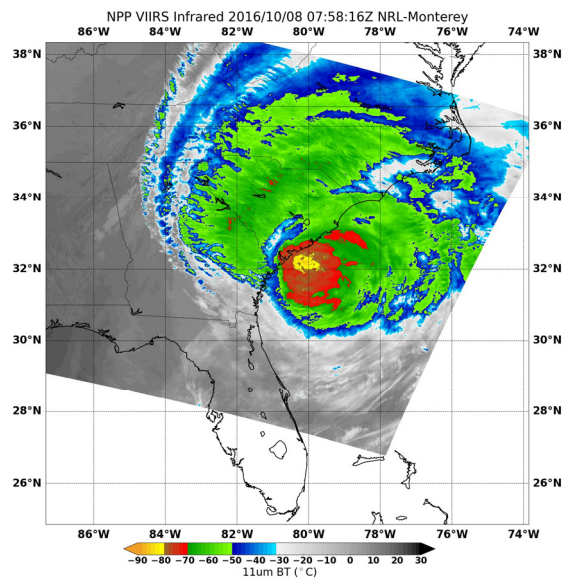


## Quaternary Coastal Architecture

|        |                             |
|--------|-----------------------------|
| Yellow | Beach deposits              |
| Gray   | Estuarine deposits          |
| Green  | Freshwater wetland deposits |
| Orange | Pre-Holocene soils          |
| Blue   | Basal fossil-rich limestone |

## Debordeau Island Sediment Core Profile







# Coastal Dynamics



## Erosion



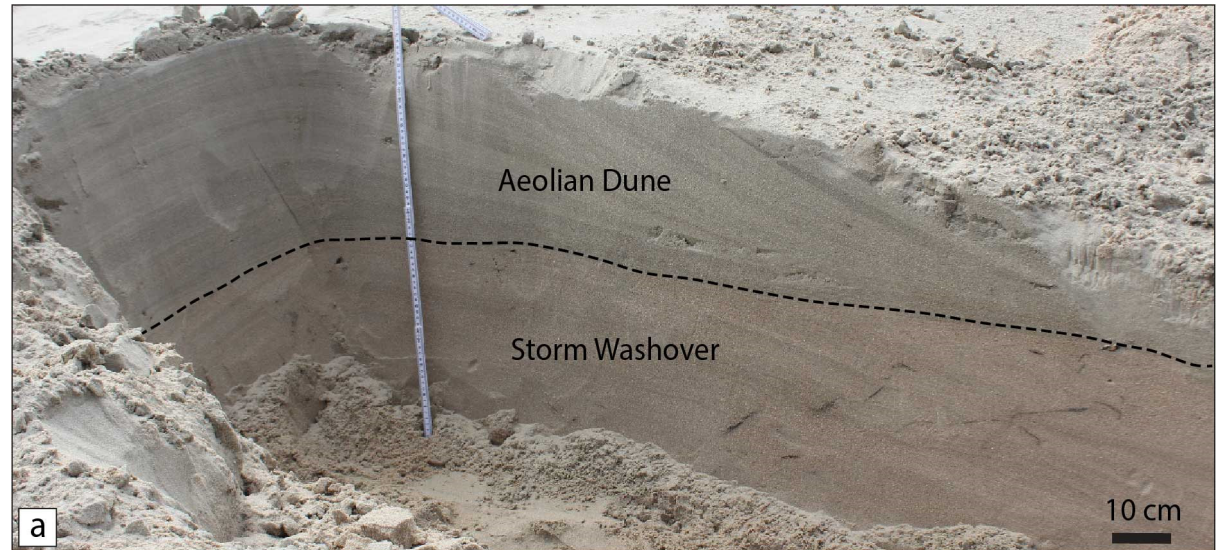
## Dune breaching and overwash



Hurricane  
Isaias  
June 2020







## Overwash deposits:

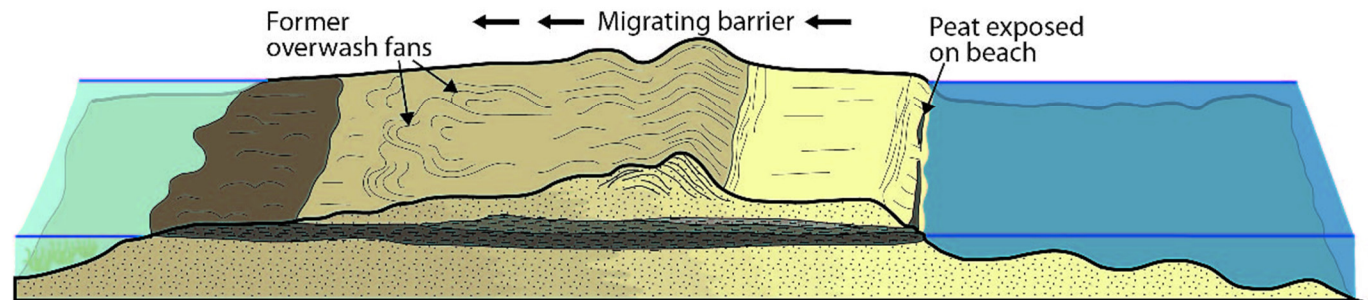
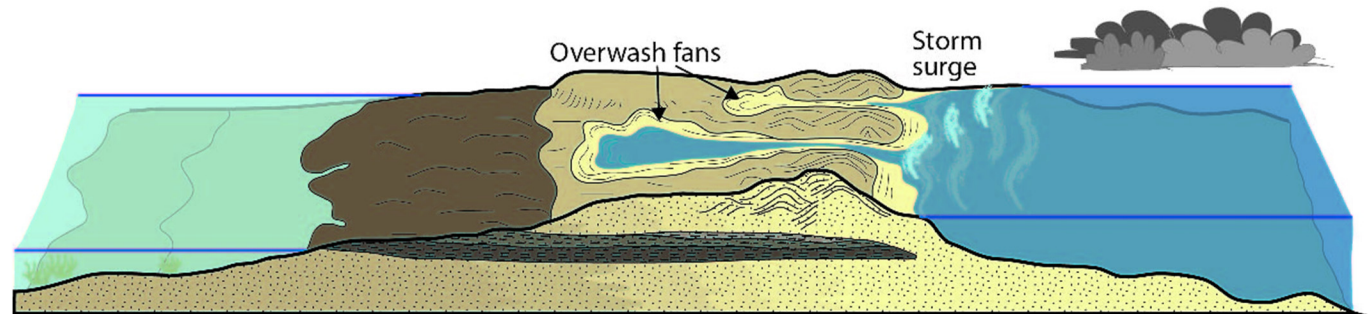
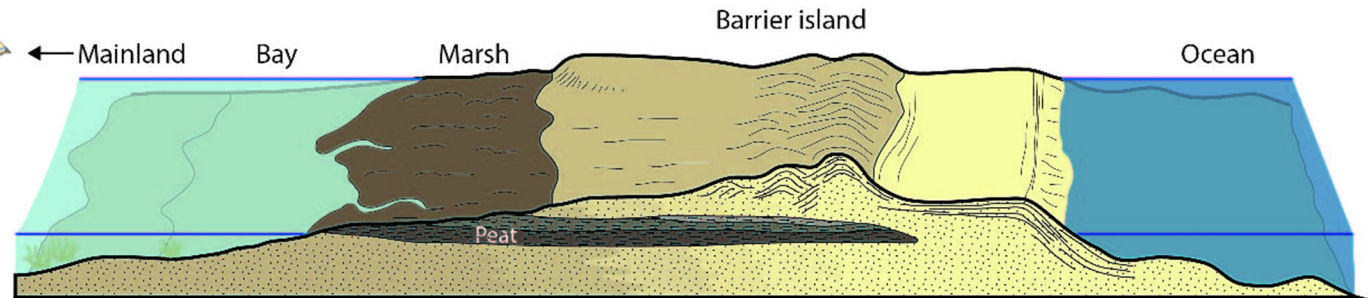
- Transport of beach and dune material in landward direction.







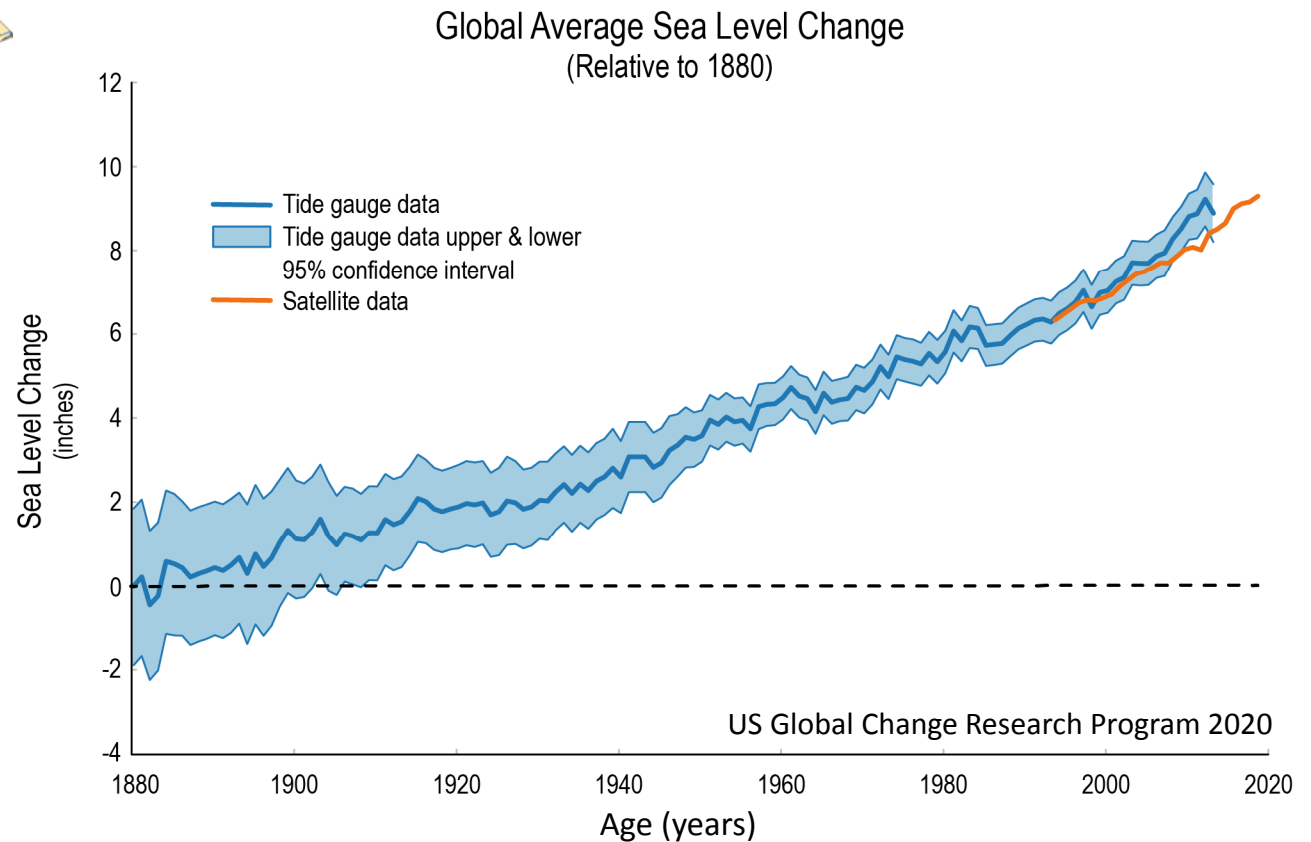
## Coastal Dynamics



### Overwash deposits:

- Essential process to keep barrier island systems alive.
- Mechanism to adjust to a changing sea level.

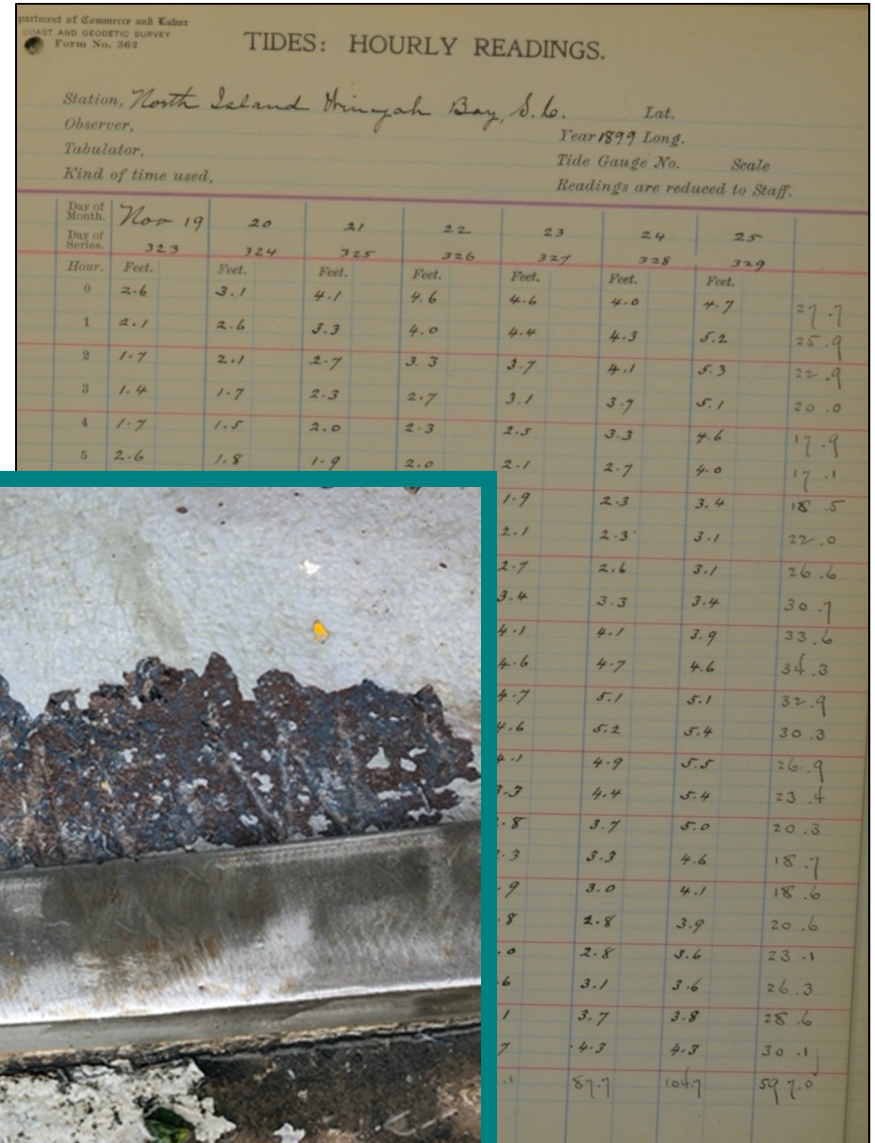
## A Changing World – Pressure on the Coastlines



### ***A rising sea level – What is required for an intact coastline?***

- Space to retreat.
- Sufficient sediment available.
- A natural rather than hardened coastline allowing for dynamic response.





## A Changing World – Pressure on the Coastlines

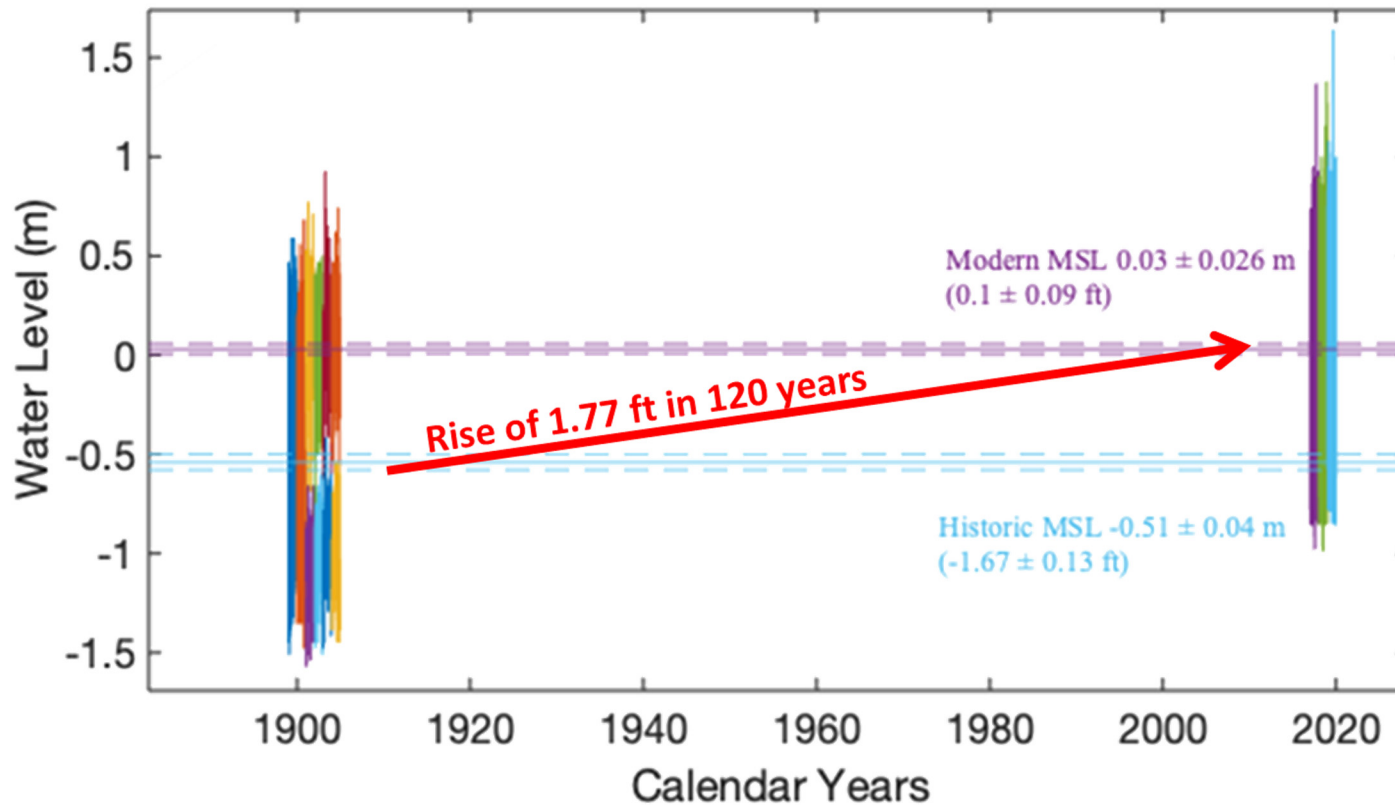


### Sea level rise since 1898:

**Georgetown:** 21.6 inches

**Charleston:** 15.3 inches

**Global average:** ca. 9 inches

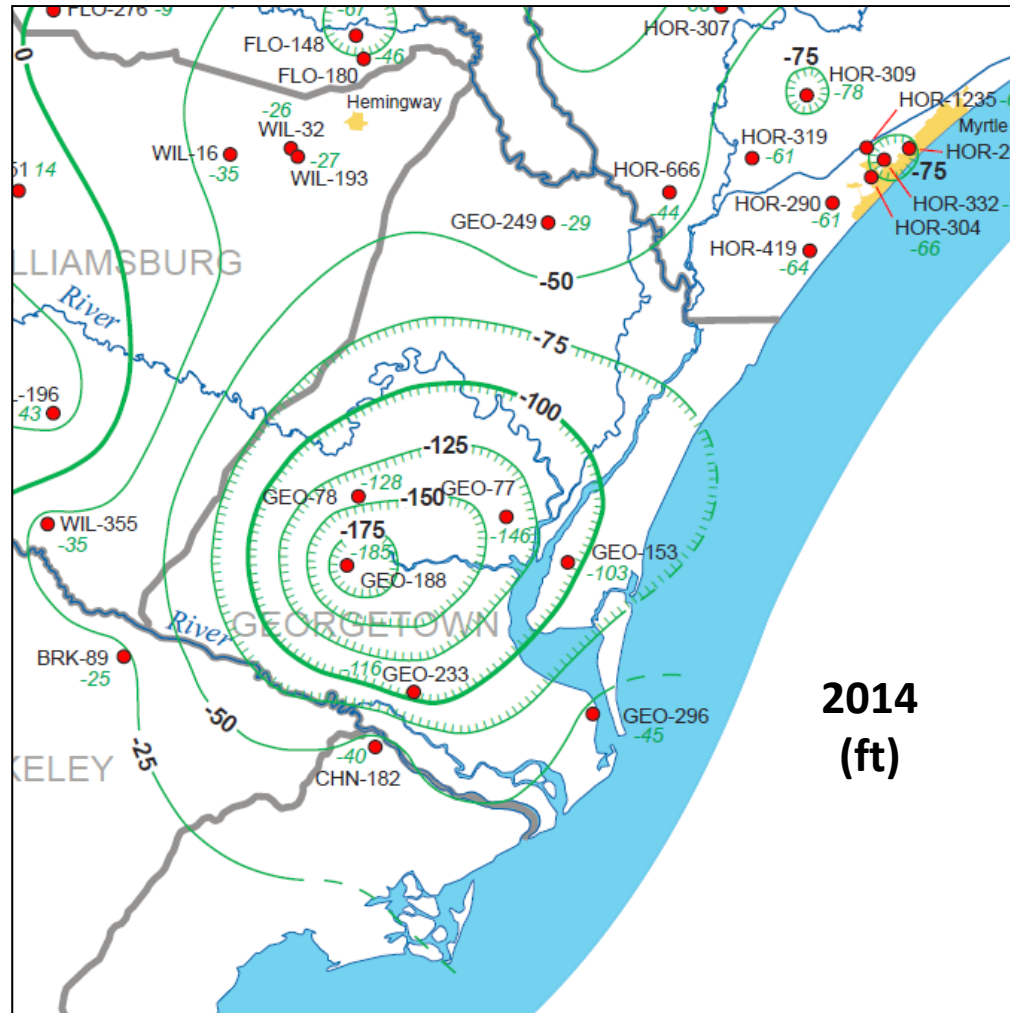




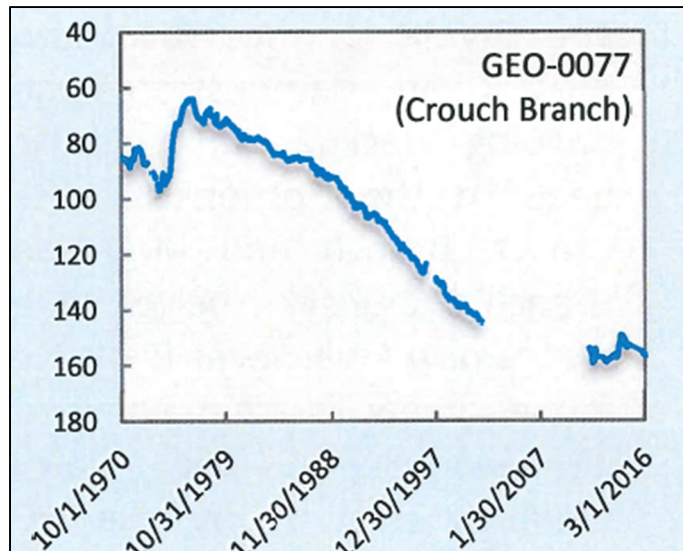
## A Changing World – Pressure on the Coastlines



### Groundwater table Black Creek Formation/Aquifer



### Sinking groundwater tables due to groundwater extraction



## A Changing World – Pressure on the Coastlines



Hurricane Matthew 2016



Hurricane Florence 2018



### **A rising sea level – *What is required for an intact coastline?***

- Space to retreat.
- **Sufficient sediment available.**
- A natural rather than hardened coastline allowing for dynamic response.

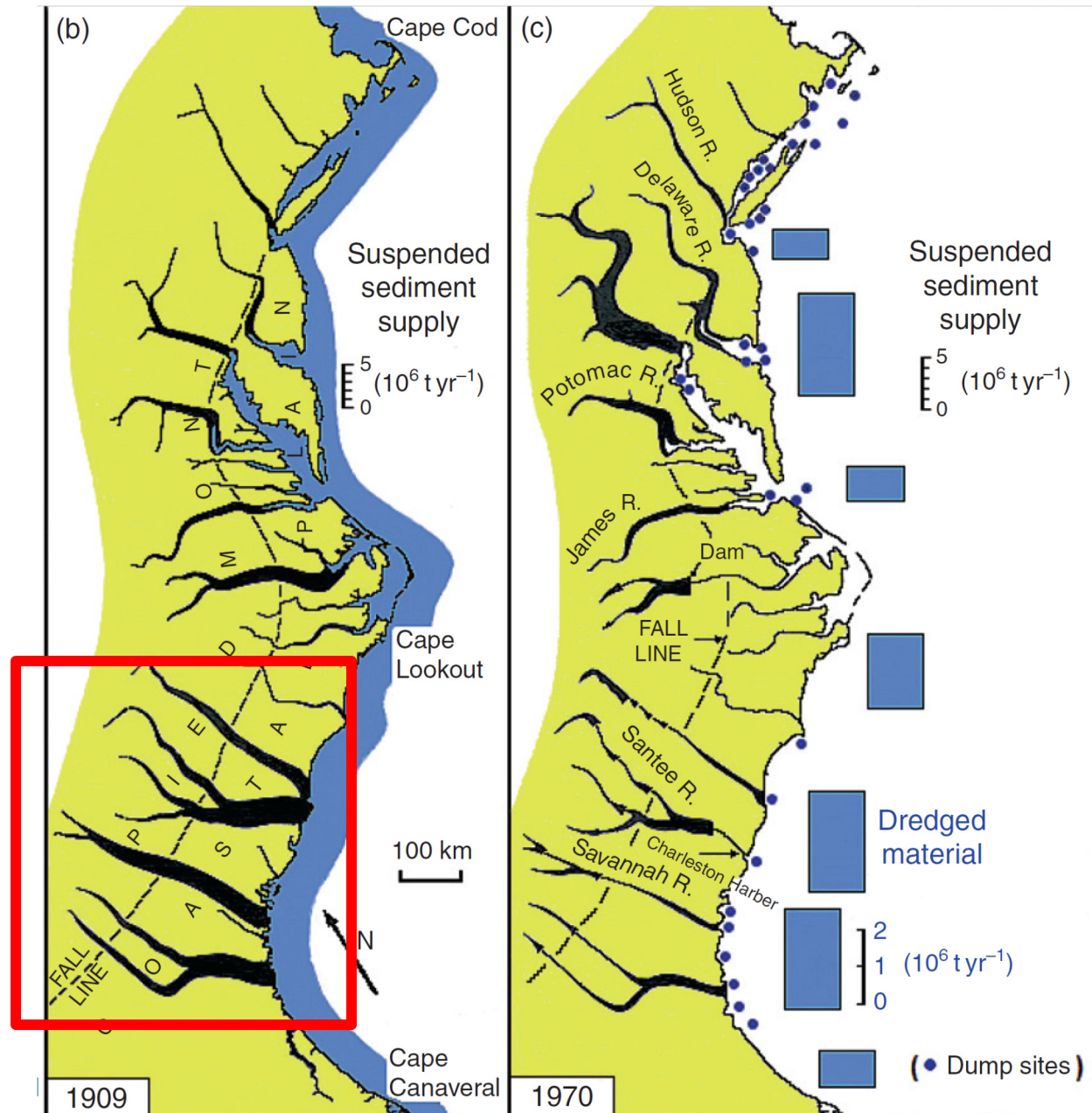


# A Changing World – Pressure on the Coastlines



## River damming:

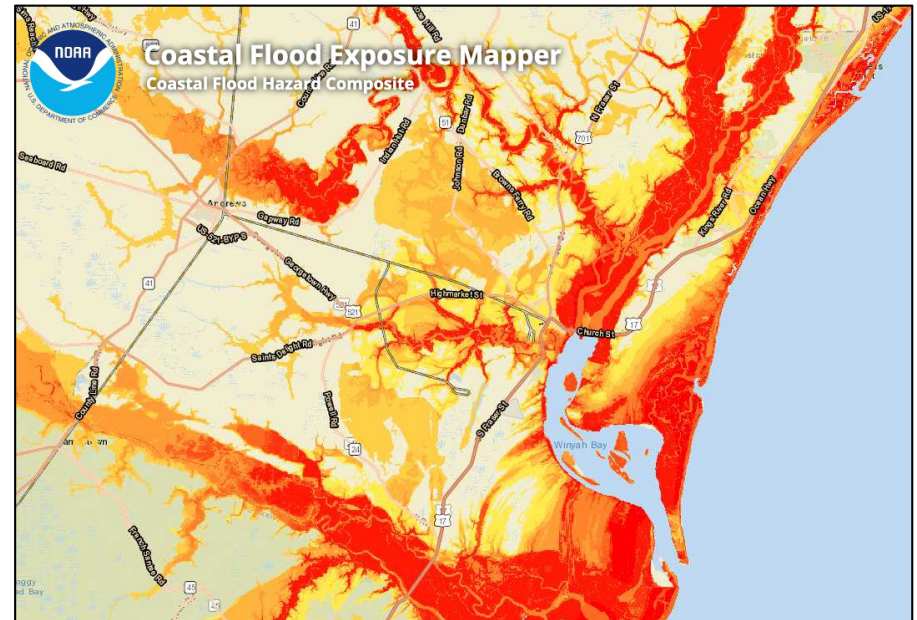
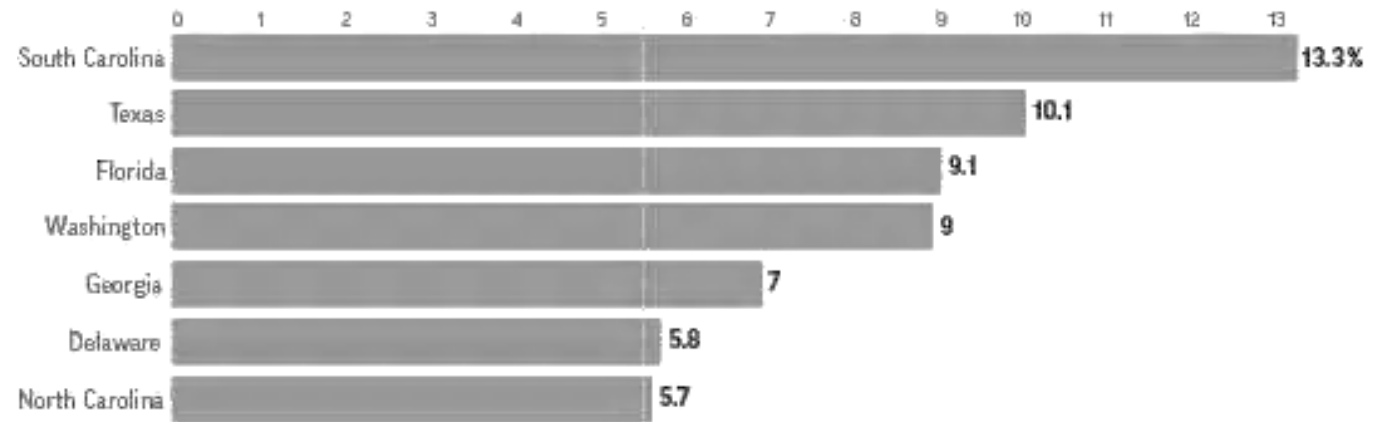
- Up to 90% of natural sediment supply to the ocean interrupted.



## A Changing World – Pressure on the Coastlines



### Coastal Counties Change in Population 2010-2016 (%)





## A Changing World – Pressure on the Coastlines

### Coastal Development, Garden City

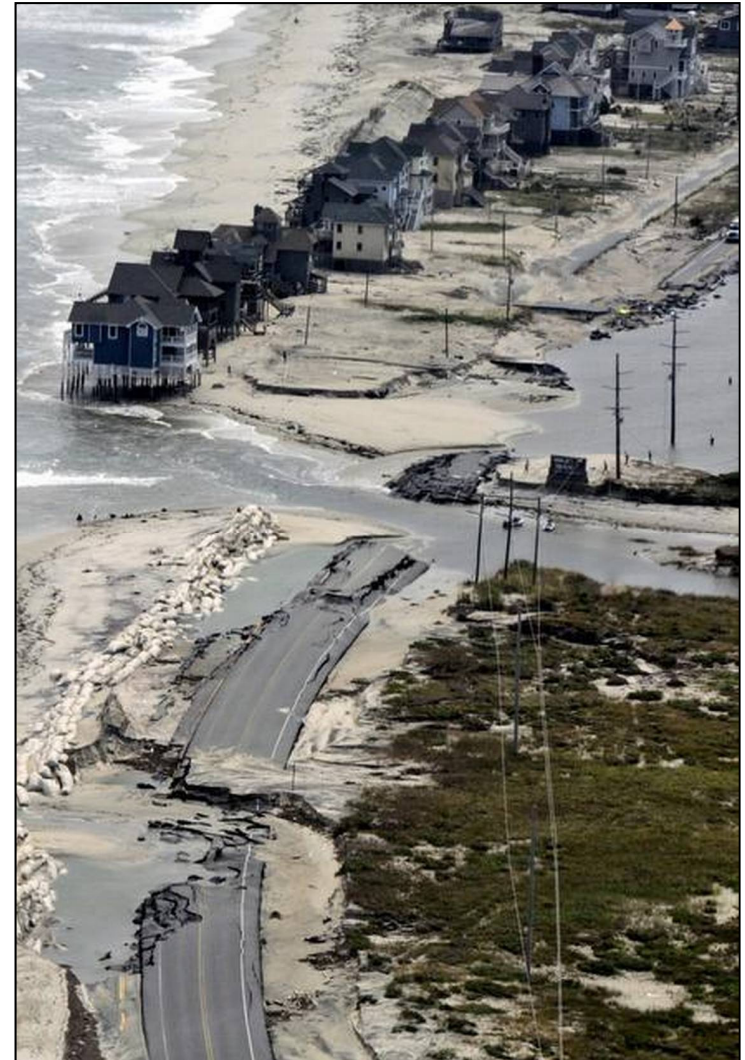




## A Changing World – Pressure on the Coastlines



Cape Hatteras, 2018, 2019





## A Changing World – Pressure on the Coastlines

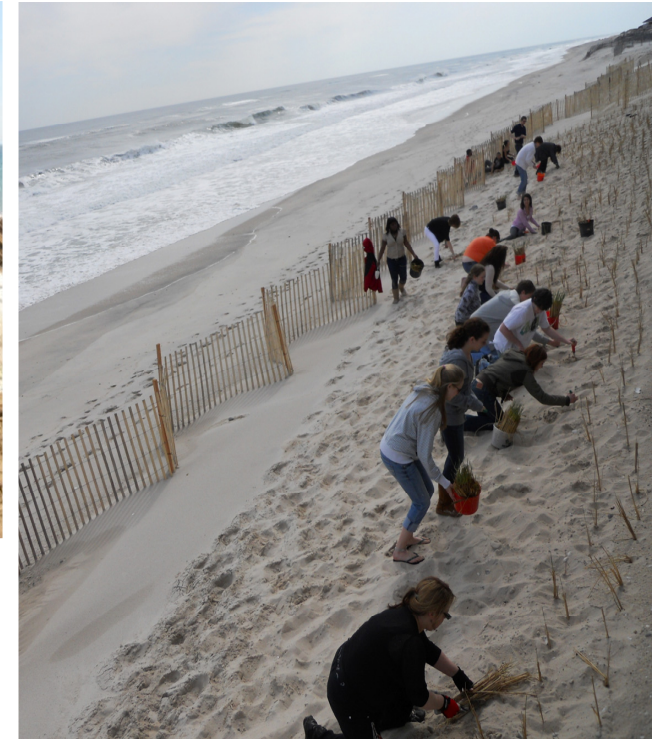


Myrtle Beach



Pawleys Island





What are our choices?

