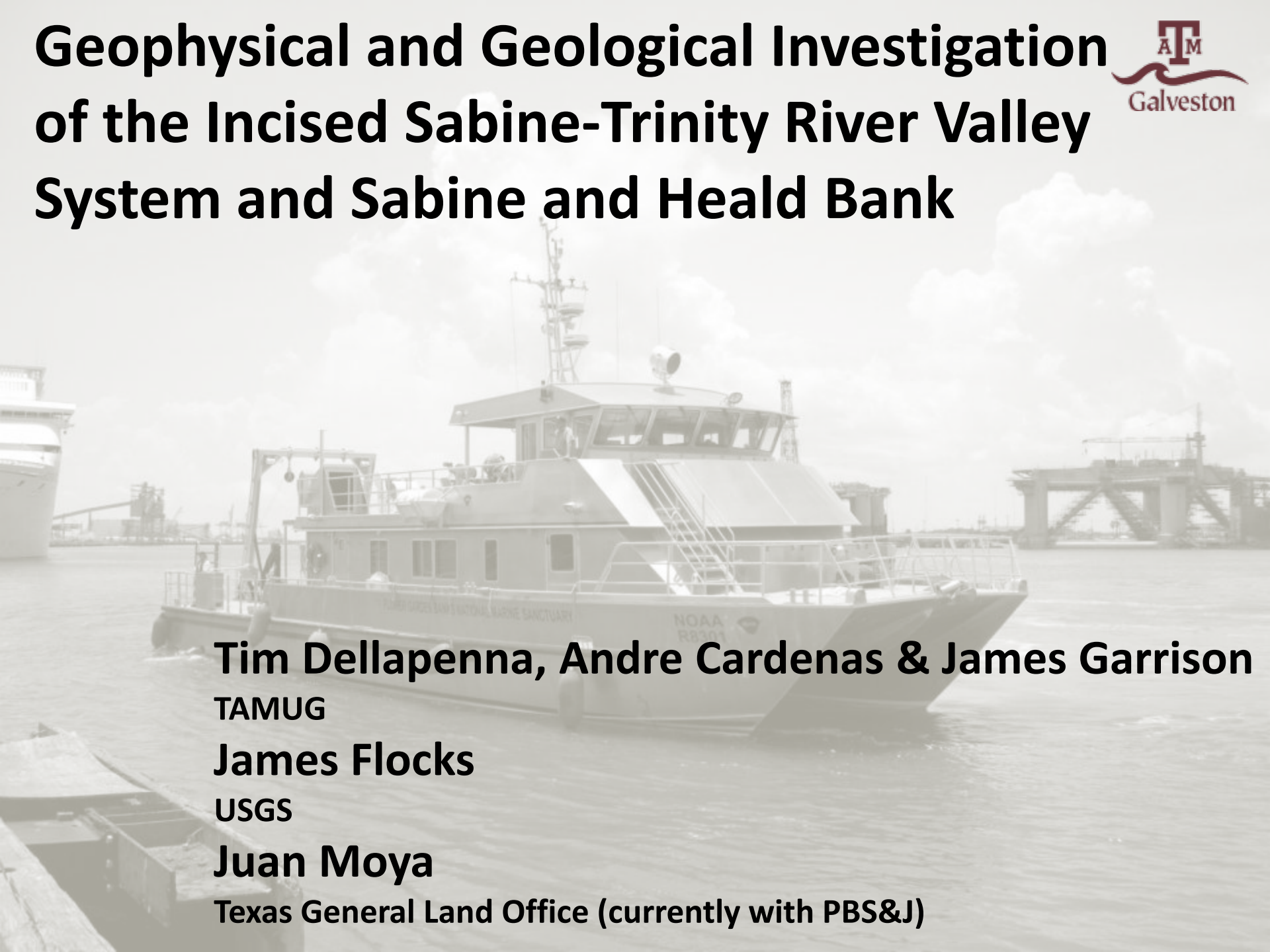
Geophysical and Geological Investigation of the Incised Sabine-Trinity River Valley System and Sabine and Heald Bank



Tim Dellapenna, Andre Cardenas & James Garrison

TAMUG

James Flocks

USGS

Juan Moya

Texas General Land Office (currently with PBS&J)

Bureau of Ocean Energy Management, Regulation and Enforcement

Flower Garden Banks National Marine Sanctuary

Texas General Land Office

U.S. Department of the Interior

Coastal Texas 2020

TAMU Galveston

utmb Health

USGS science for a changing world

Department of Oceanography
Texas A&M University
College of Geosciences

Louisiana Universities Marine Consortium

Texas A&M University at Galveston Coastal Geology Laboratory

NOAA Fisheries Service
National Oceanic and Atmospheric Administration

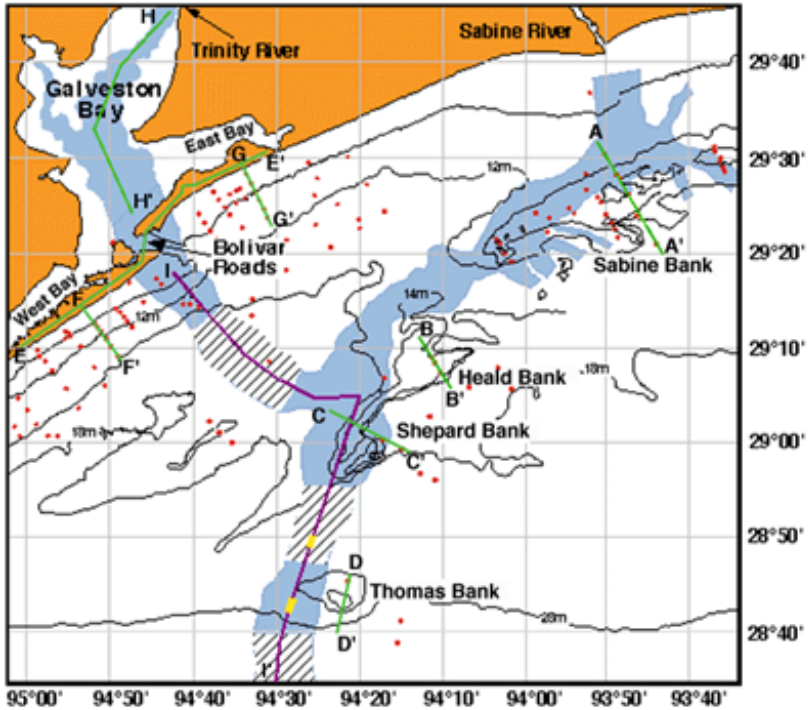
Talk Outline

1. Background on geology of Trinity-Sabine incised valley and formation of Sabine Bank

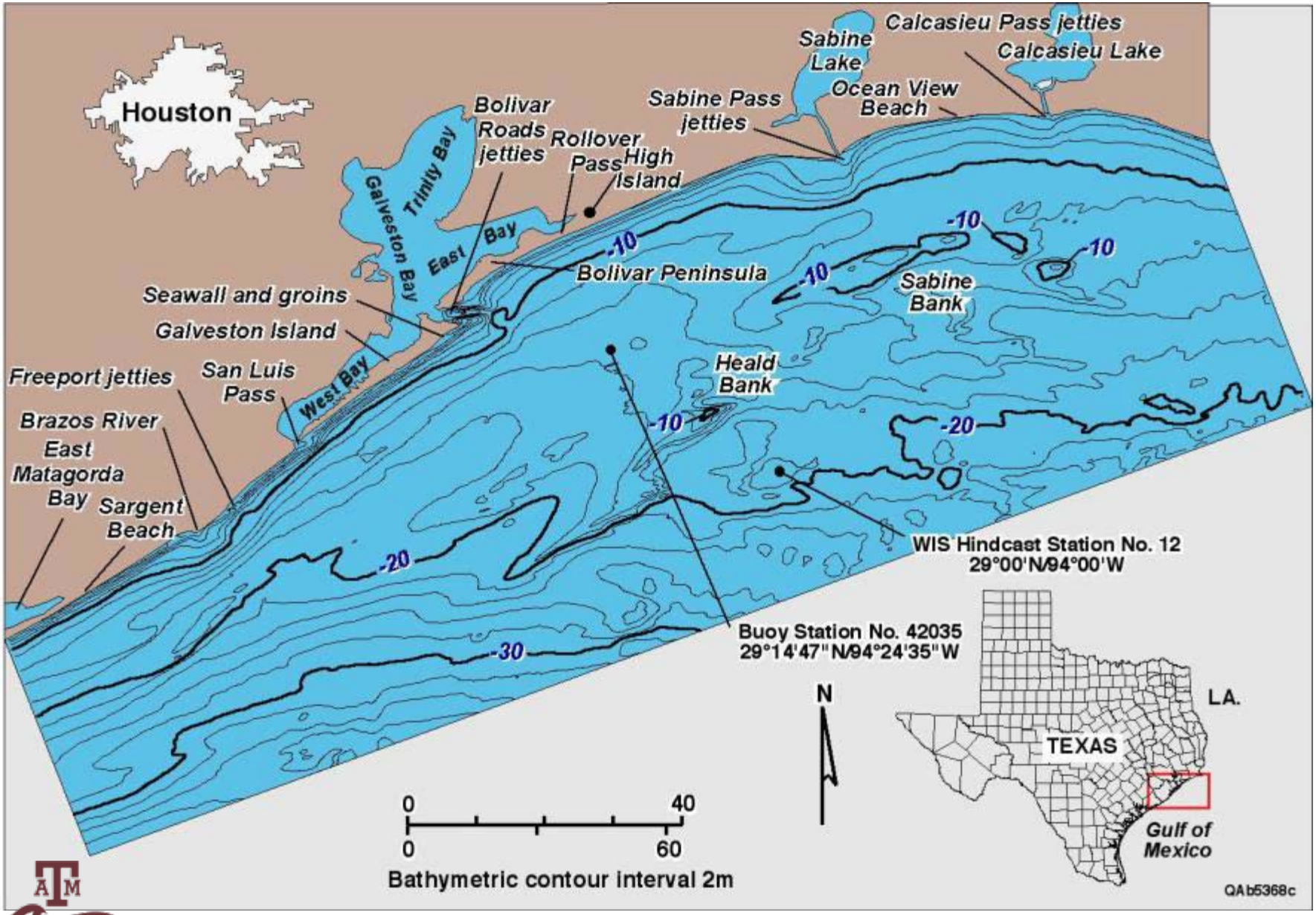
2. Summary of 2008 – 2010 field investigation of Trinity-Sabine Valley and banks

3. Revised estimates of sand volumes

4. Impact of Hurricane Rita on Sabine Bank

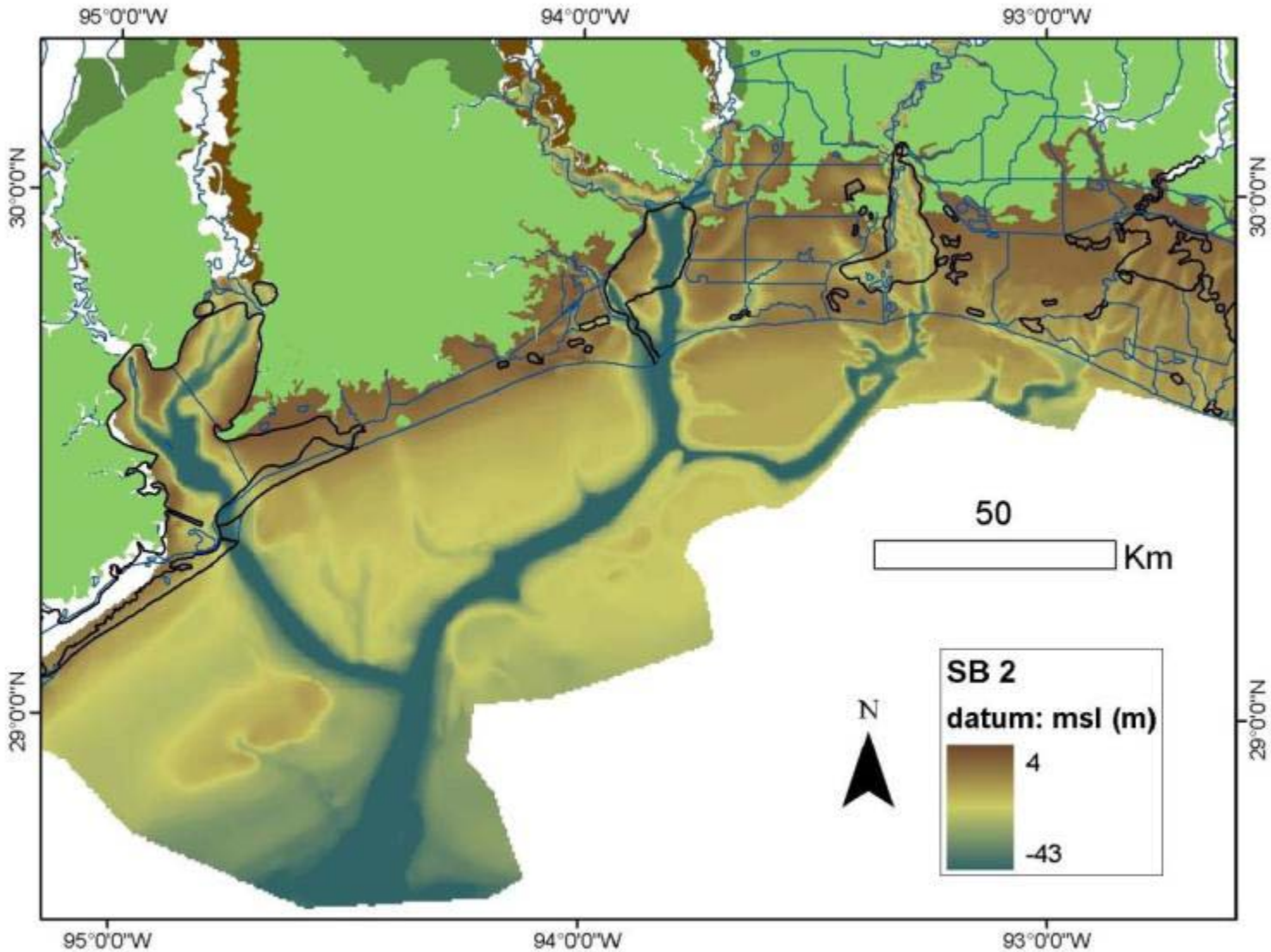


MAP AND BATHYMETRY OF THE SOUTHEAST TEXAS COAST

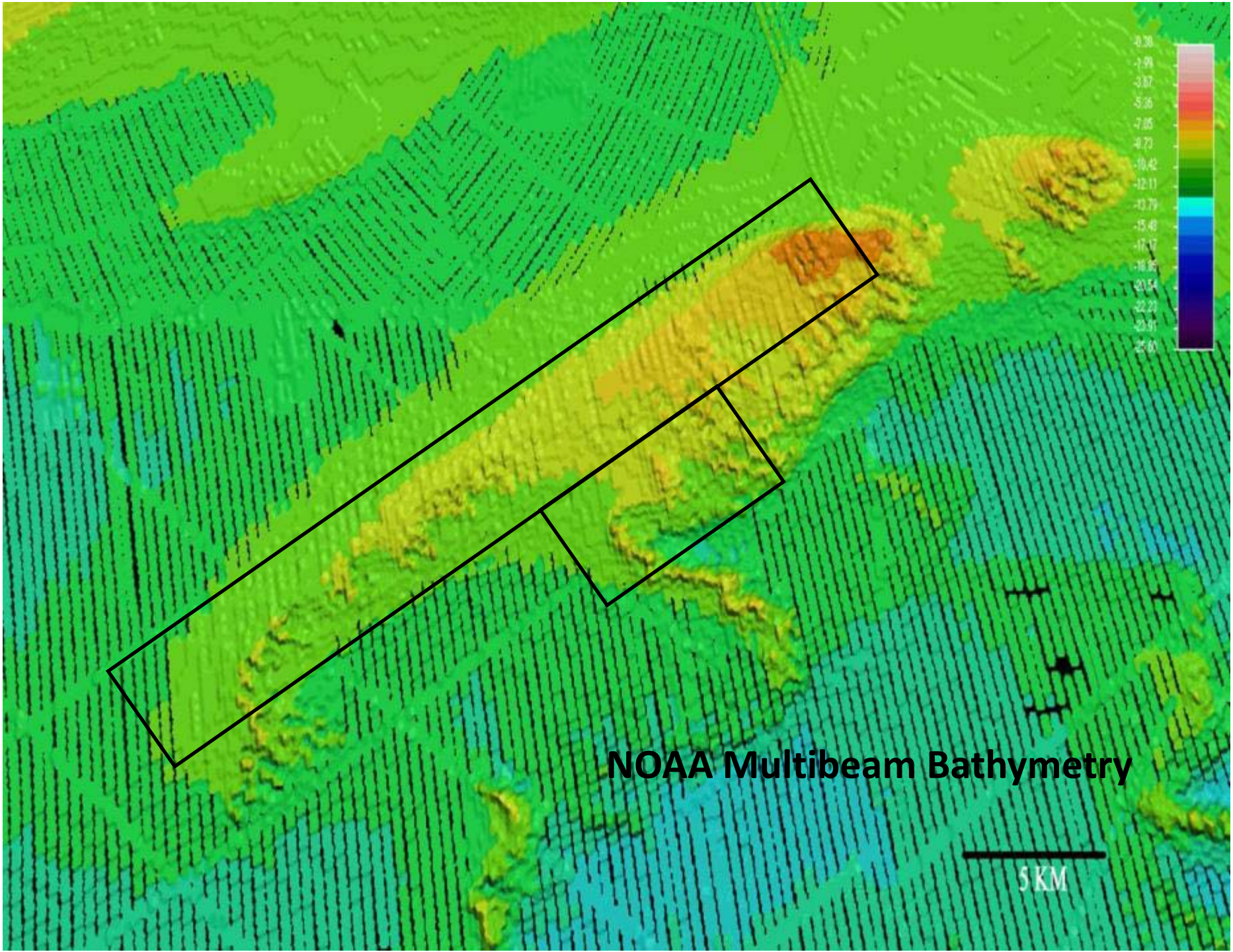


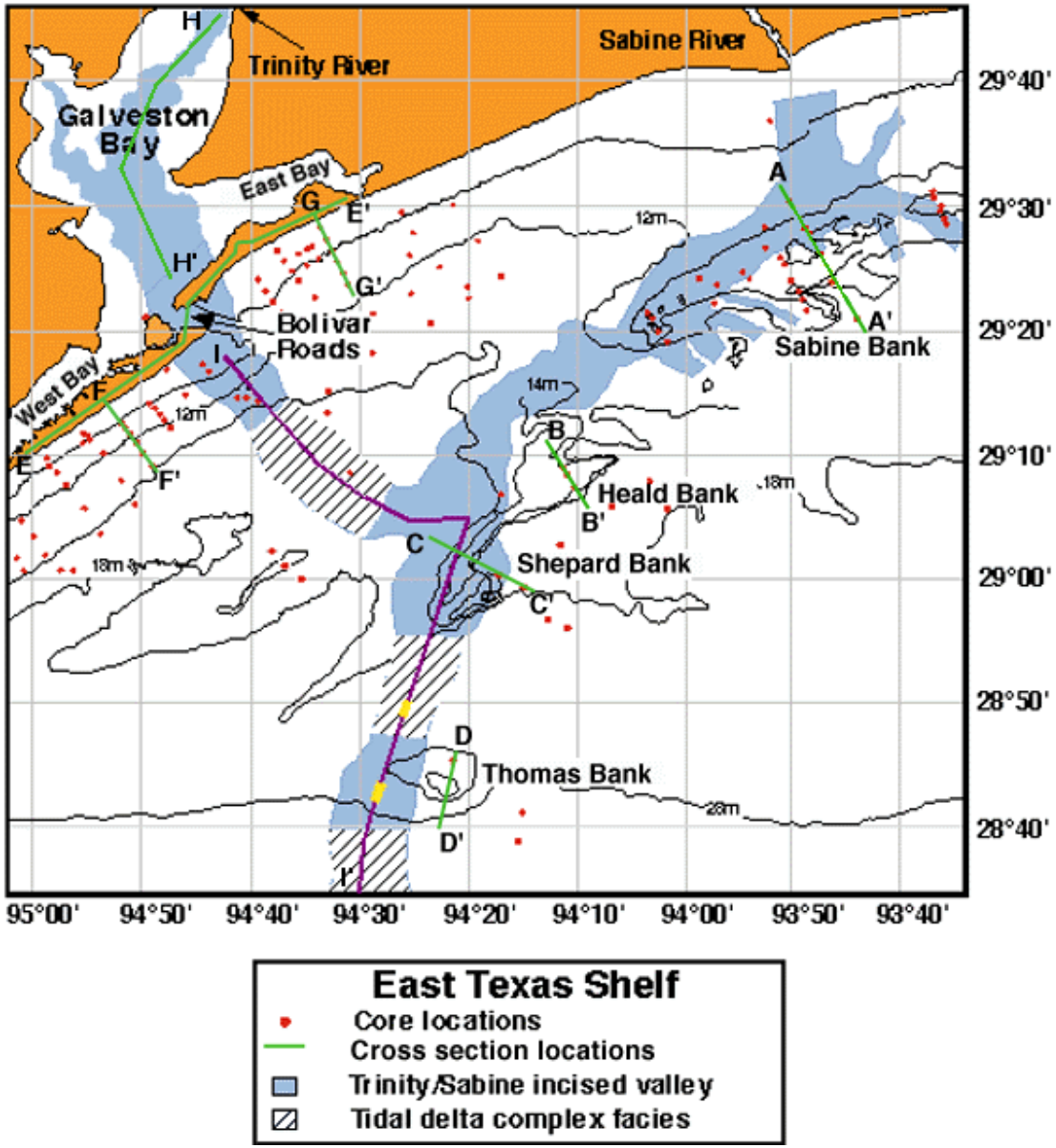
Galveston

Ancestral Calcasieu, Sabine and Trinity River Valleys



Anderson 2006 http://rice.gulf.edu


NOAA Multibeam Bathymetry
5 KM



Sabine/Trinity/San Jacinto-Pleistocene Drainage system

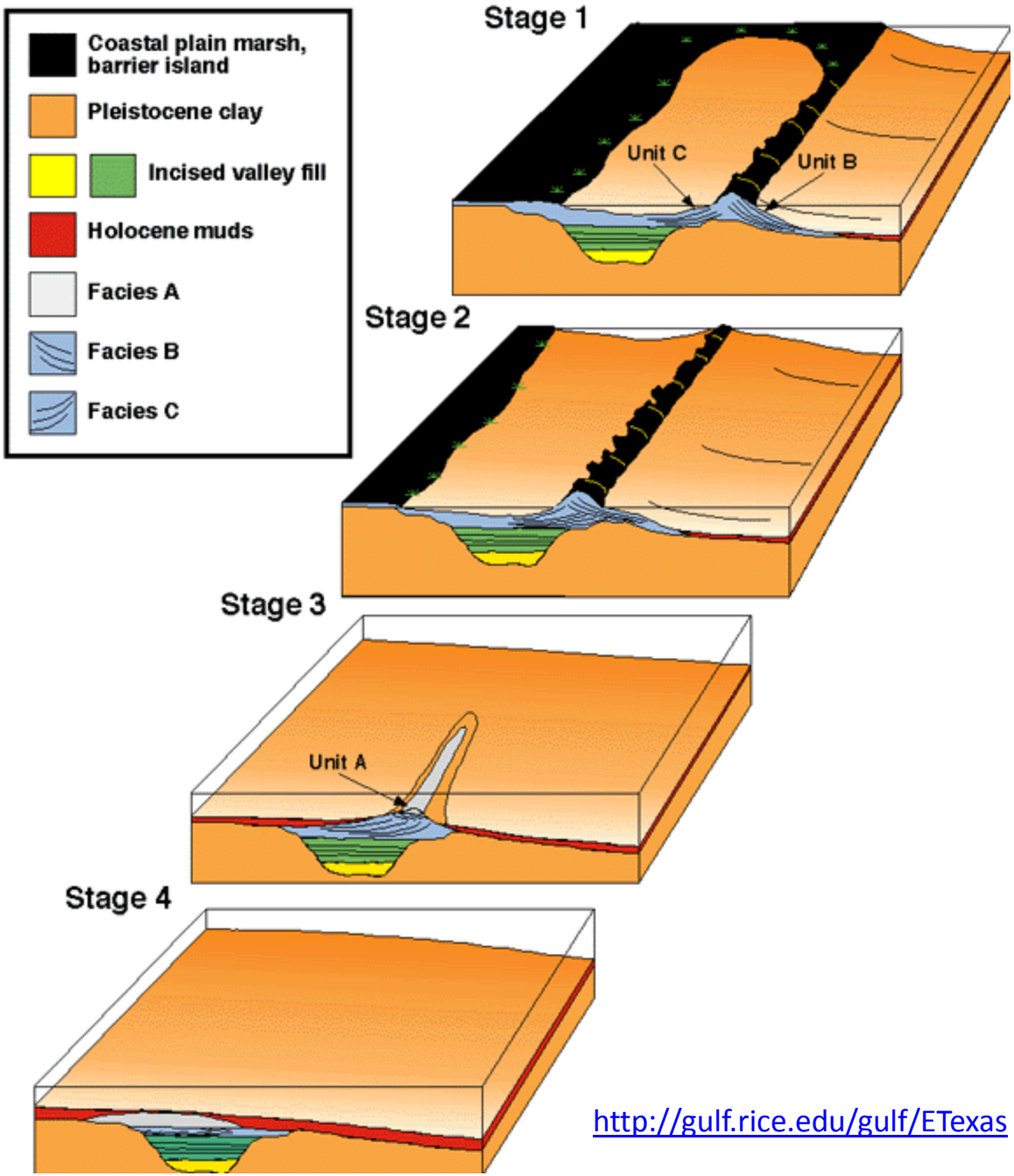
Sabine Bank was a barrier island formed on the levee of ancestral Sabine River 5,300 – 2,800 ybp

Sabine Bank forms a bathymetric high

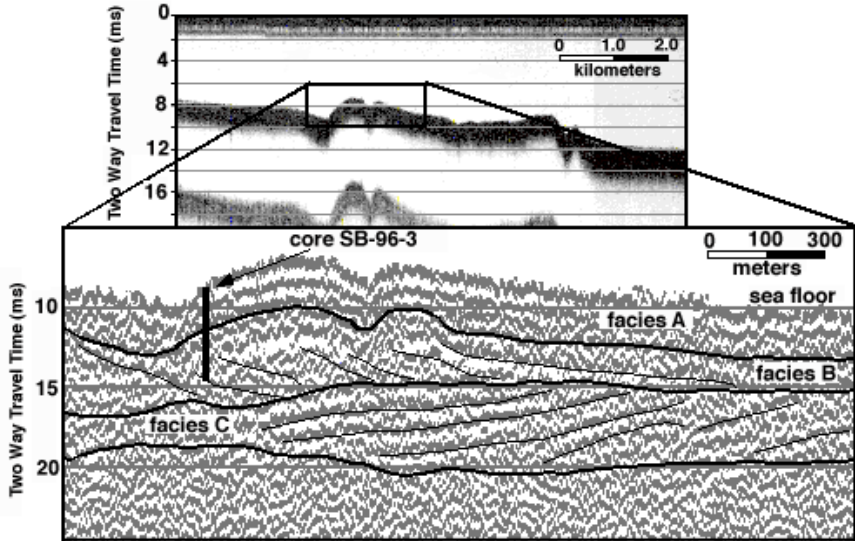
Considered:

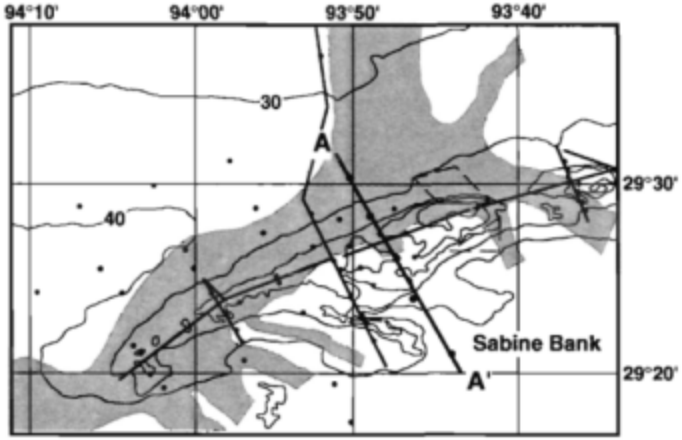
1) **Potential sand source**
2) **Essential red snapper habitat**

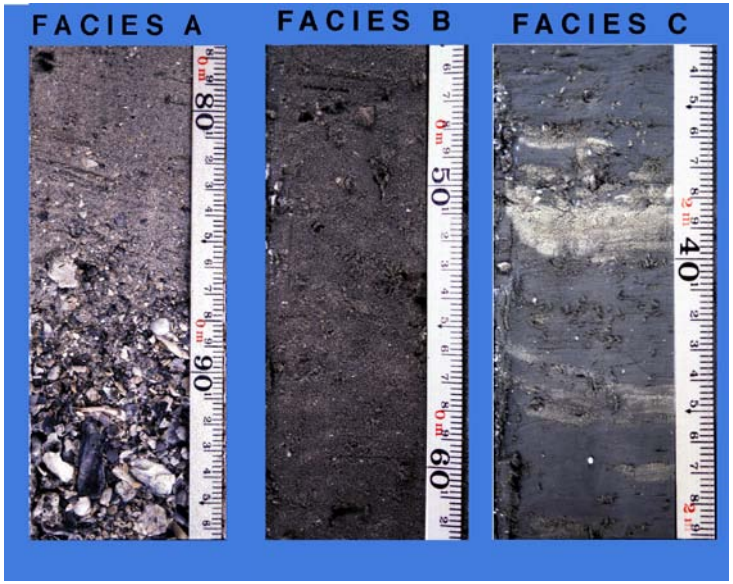
http://gulf.rice.edu/ETexas/gulfeTexasS_T_SJ_tst.html



http://gulf.rice.edu/gulf/ETexas







Typical Lithologic Facies

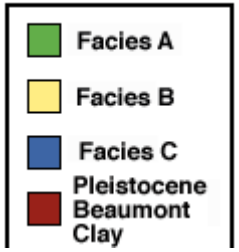
These representative core photographs characterize the sedimentary units that make up the banks.

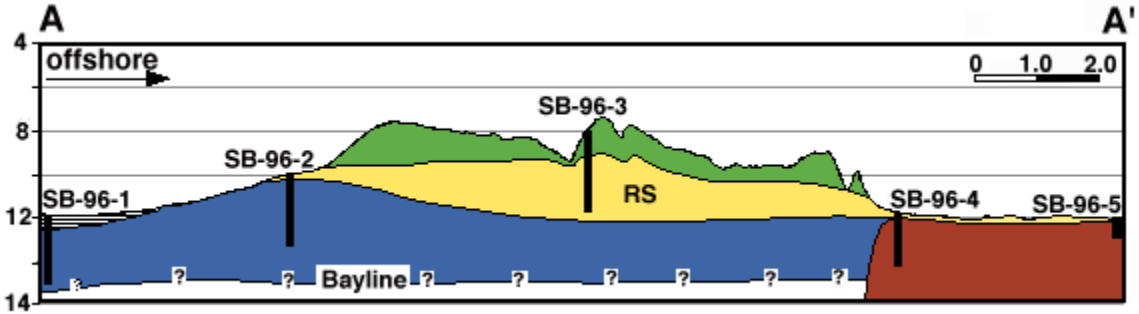
Facies A
an inter-bedded shell hash and sand unit

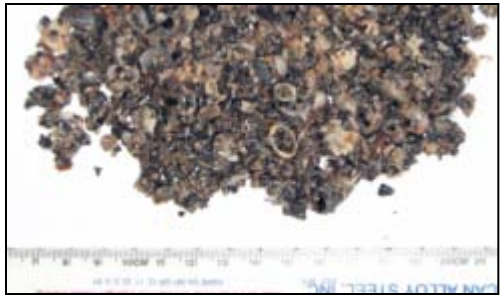
Facies B
a muddy-sand unit characterized by a seaward prograding and chaotic seismic facies

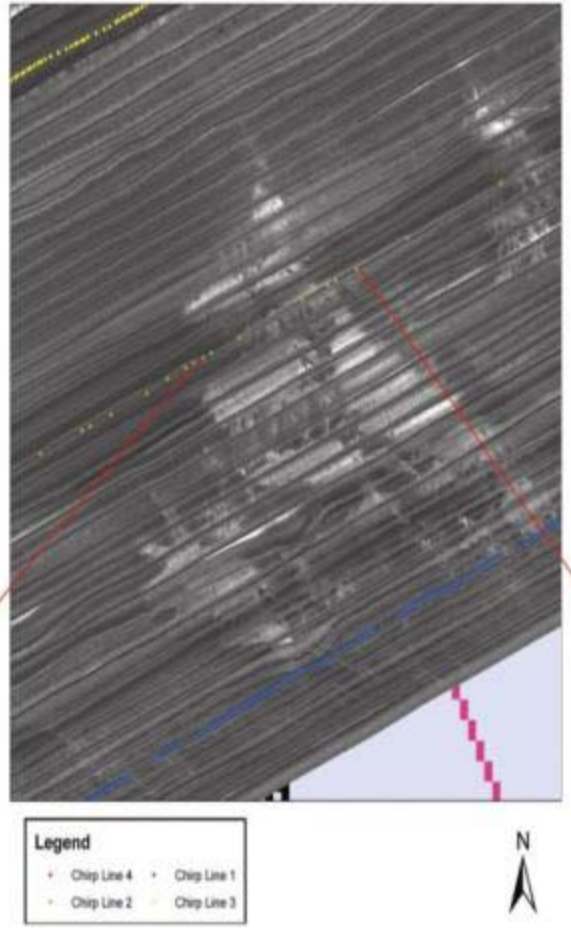
Facies C
an inter-bedded sand and mud unit characterized by landward dipping seismic reflectors

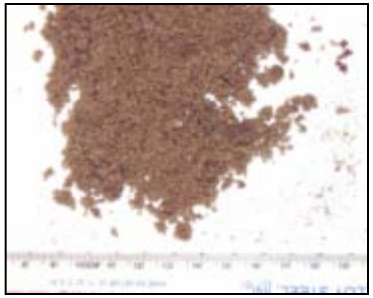
http://gulf.rice.edu/gulf/ETexas

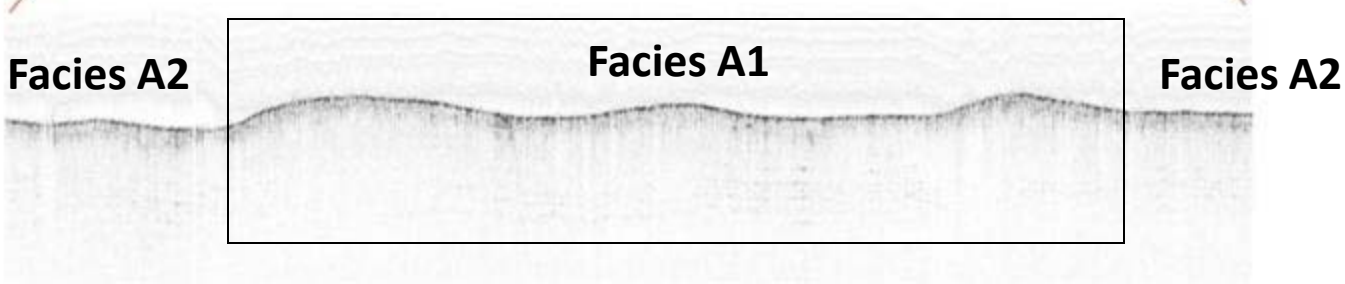




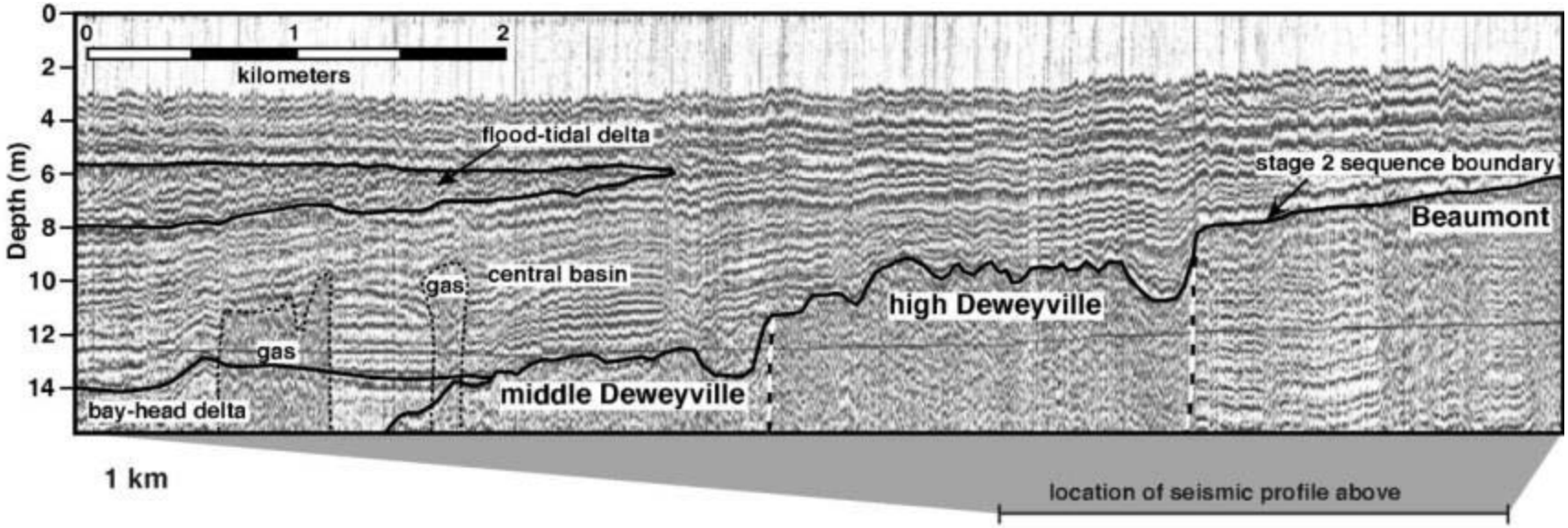


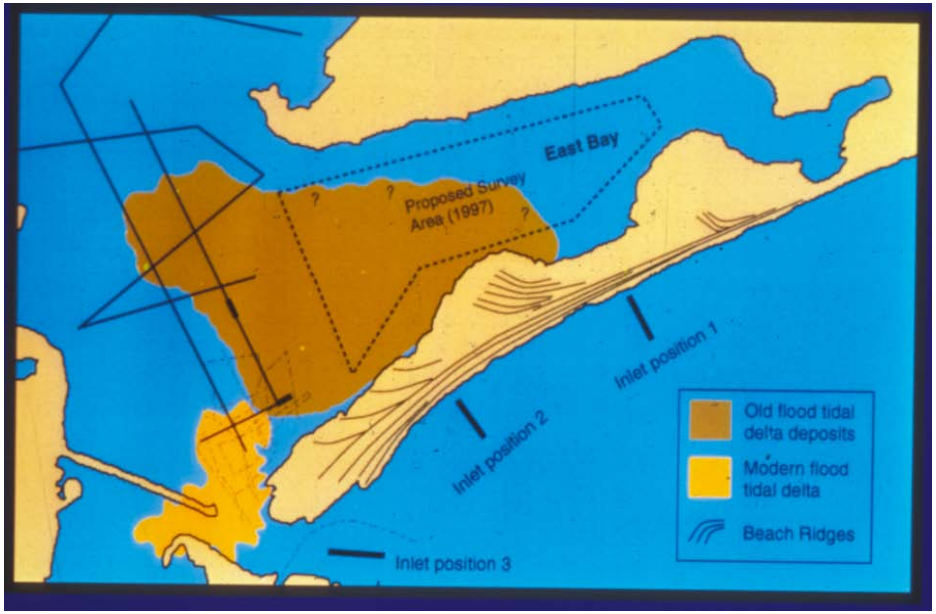

Legend
Chirp Line 4
Chirp Line 1
Chirp Line 2
Chirp Line 3
N




Facies A2
Facies A1
Facies A2

Subsurface Pleistocene Geology



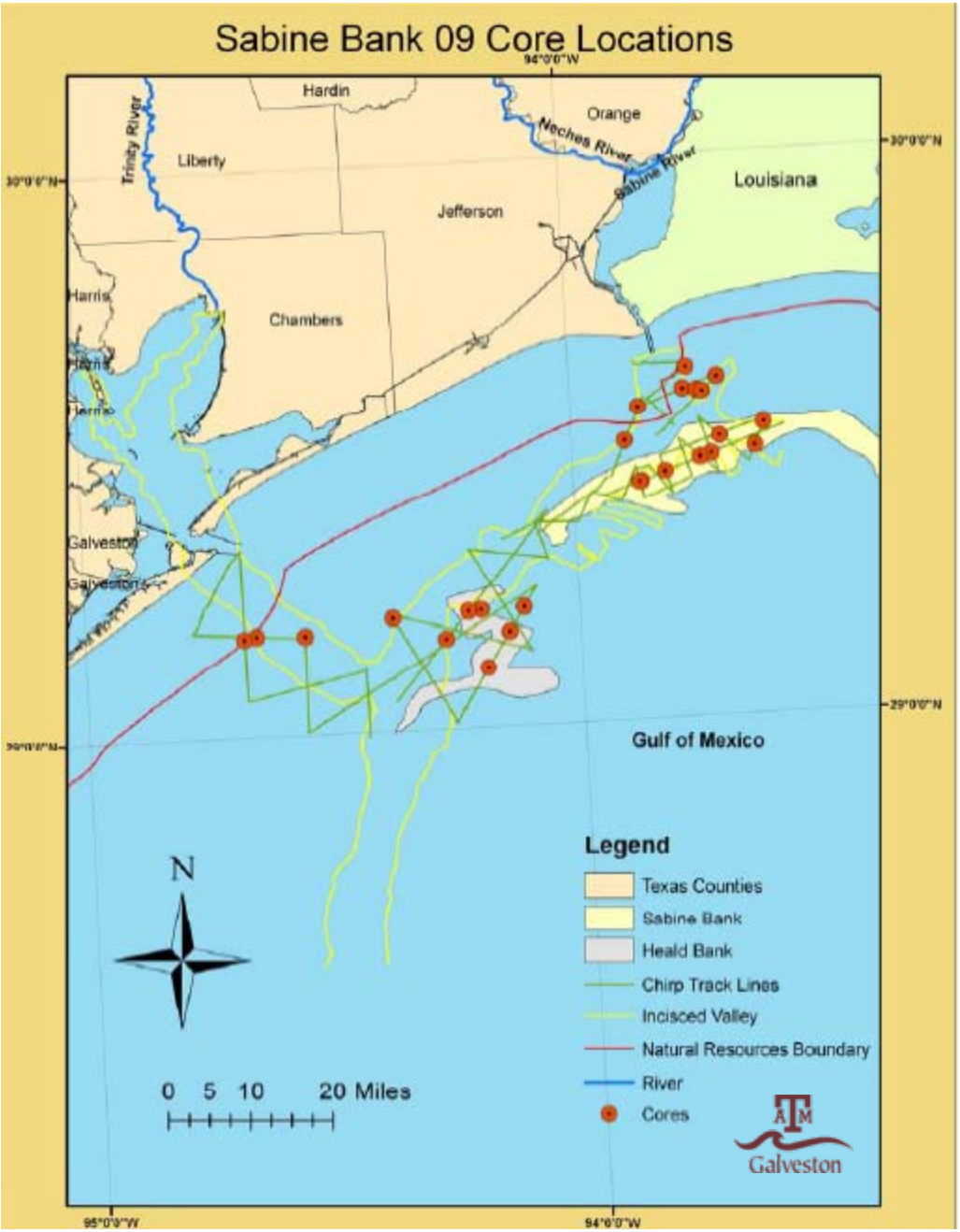


Anderson 2006
http://gulf.rice.edu

R/V *Manta*

Edgetech
512i Chirp
500 Hz- 12 kHz

R/V *Gilbert* USGSG with the submersible vibra corer

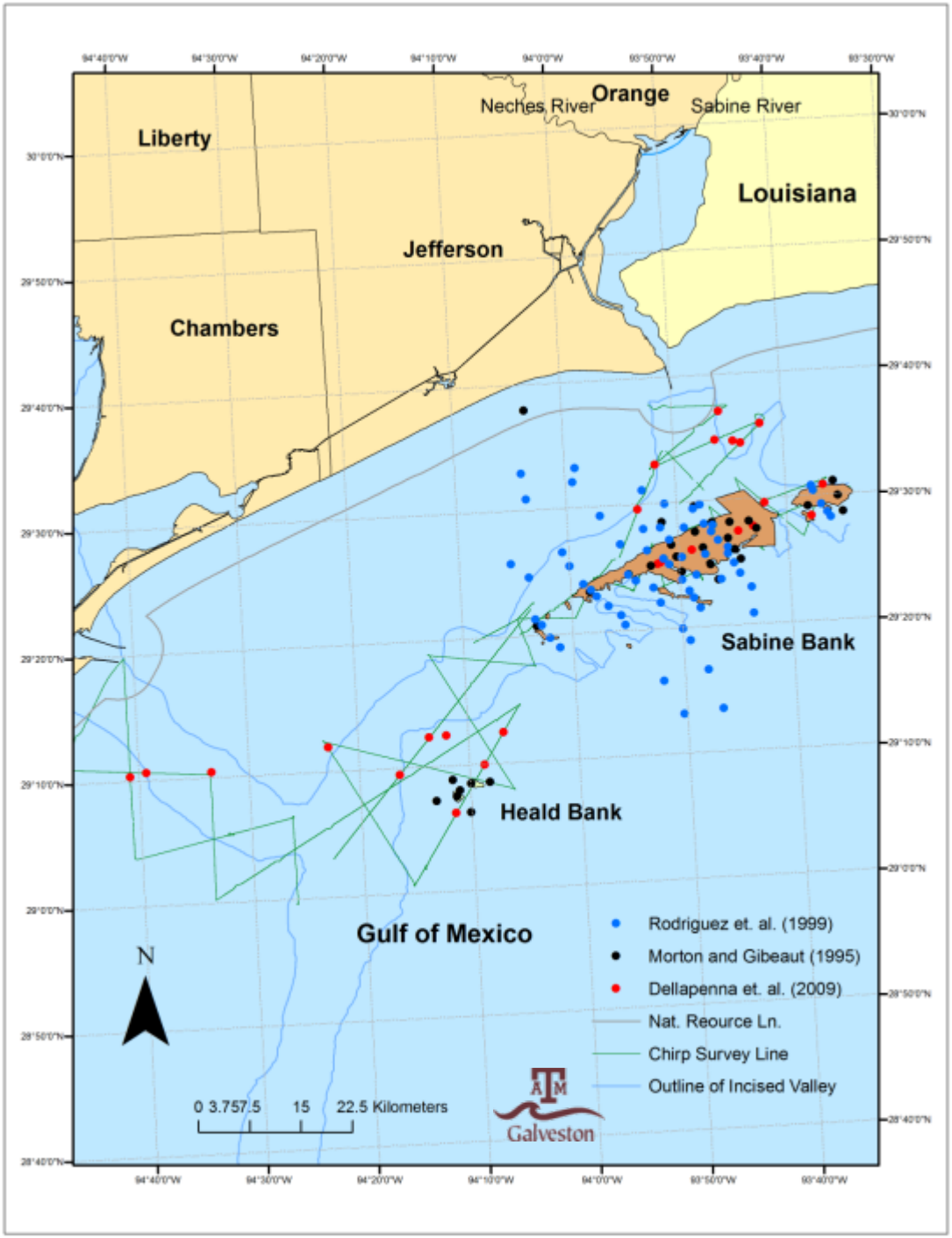


Study site area 1,400 km^2

500 km of Chirp Seismic Data

25 core sites sampled

Cores up to 5.6 m long


Liberty
Orange
Neches River
Sabine River
Louisiana
Jefferson
Chambers
Sabine Bank
Heald Bank
Gulf of Mexico
N
0 3.757.5 15 22.5 Kilometers
Rodriguez et. al. (1999)
Morton and Gibeaut (1995)
Dellapenna et. al. (2009)
Nat. Reource Ln.
Chirp Survey Line
Outline of Incised Valley
Galveston

Lab Methods

Each core was:

- **split**
- **digitally photographed**
- **described**
- **subsampled every 5 cm and at lithological transition**

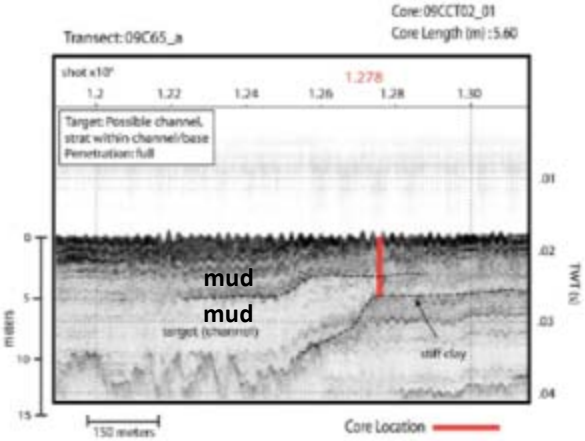
Samples were wet sieved:

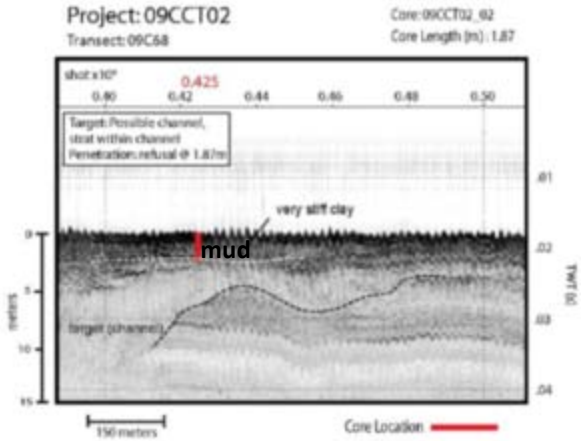
- **removed and weighed cores fraction**

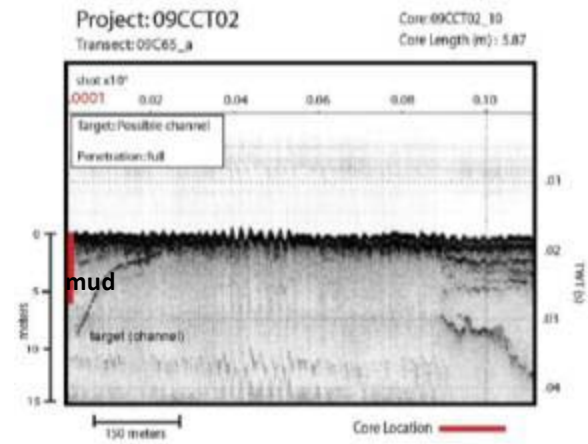
Grain size analysis for each sample was performed using a Malvern Mastersizer 2000, which uses laser diffraction to produce a grain size distribution ranging from .02 um to 200um

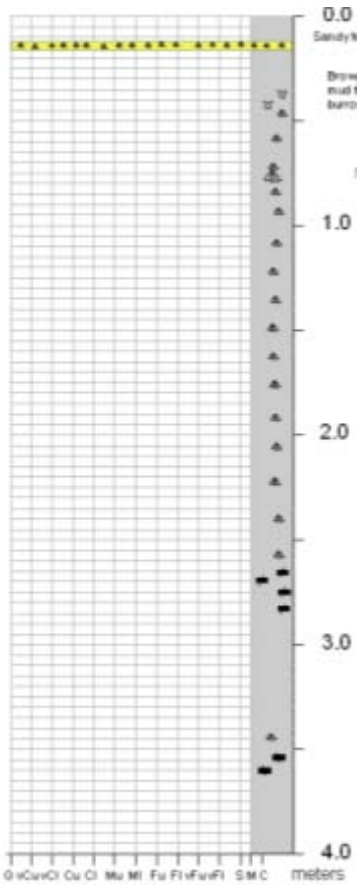
Data were assembled in Excel to acquire size distribution data and statistics

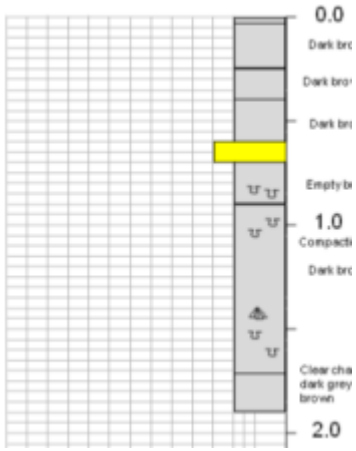
Galveston

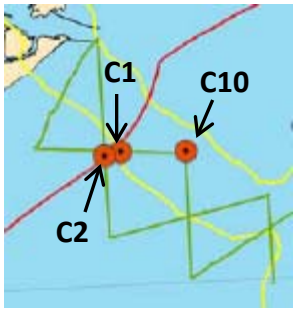




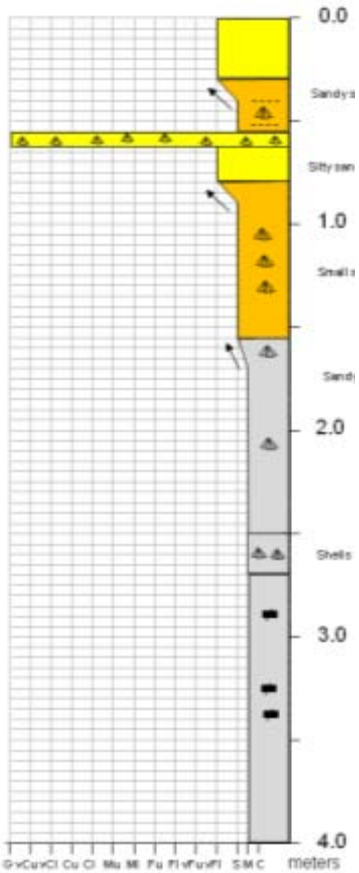


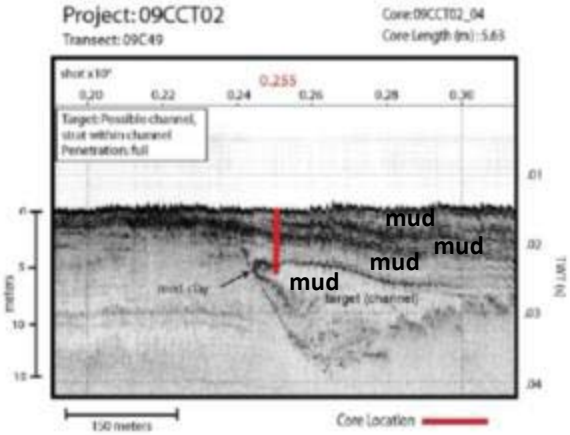


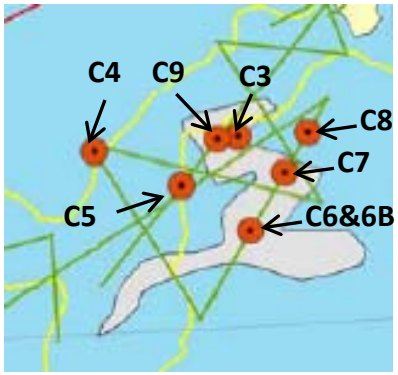


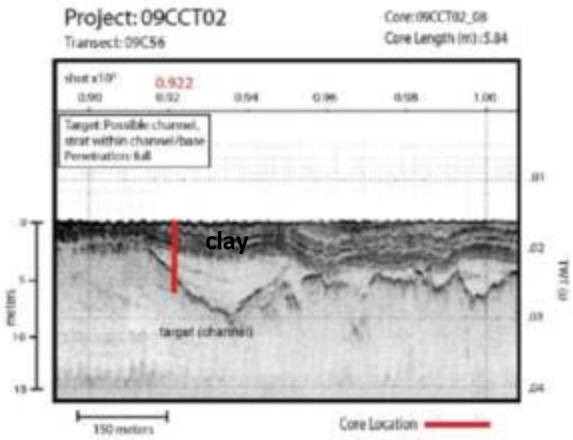


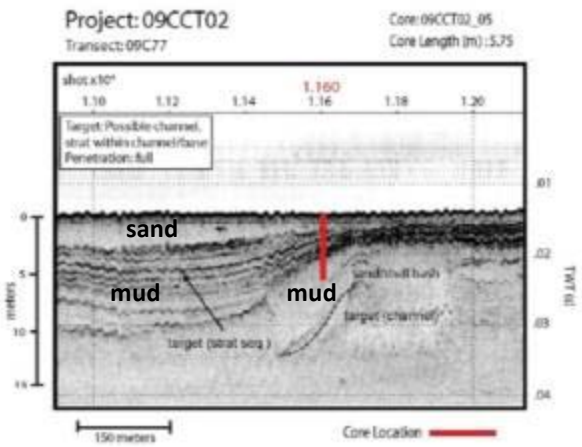
Trinity Channel

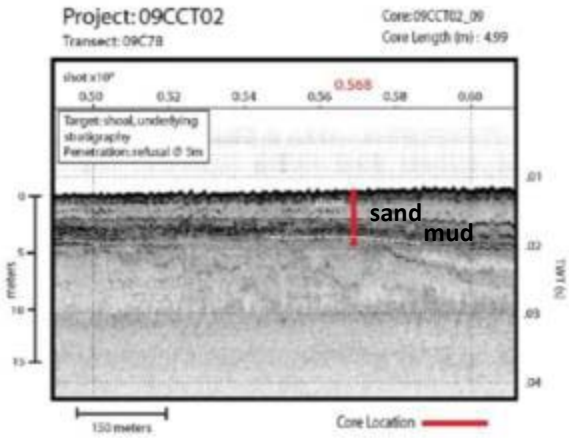



Project: 09CCT02
Transect: 09C49
Core: 09CCT02_04
Core Length (m): 5.63
0.255
Target: Possible channel, strat within channel
Penetration: full
mud
mud
mud
mud
target (channel)
150 meters
Core Location


C4
C9
C3
C8
C7
C5
C6&6B


Project: 09CCT02
Transect: 09C56
Core: 09CCT02_08
Core Length (m): 5.84
0.922
Target: Possible channel, strat within channel/base
Penetration: full
clay
target (channel)
150 meters
Core Location


Project: 09CCT02
Transect: 09C77
Core: 09CCT02_05
Core Length (m): 5.75
1.160
Target: Possible channel, strat within channel/base
Penetration: full
sand
mud
mud
target (channel)
target (strat seq.)
150 meters
Core Location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Core: 09CCT02_09
Core Length (m): 4.99
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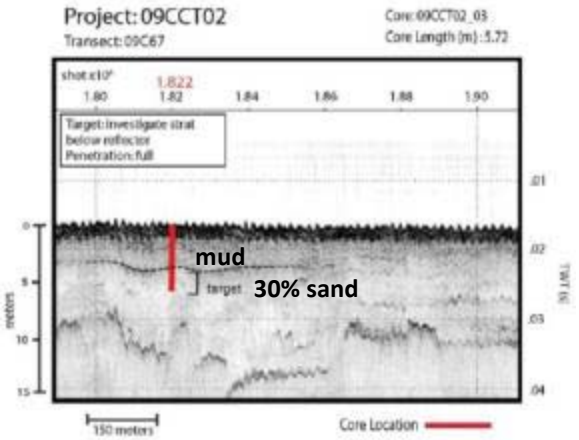
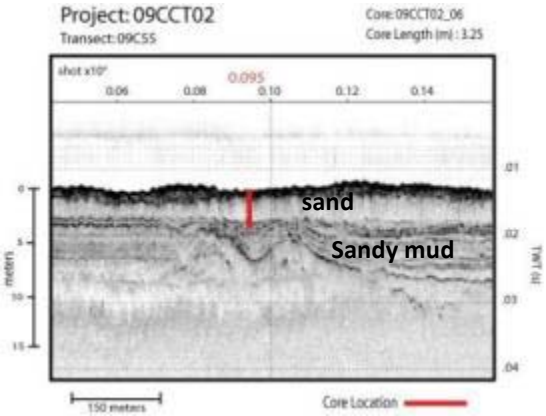
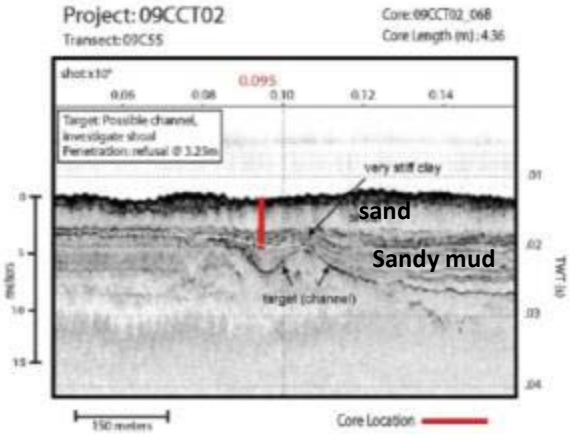
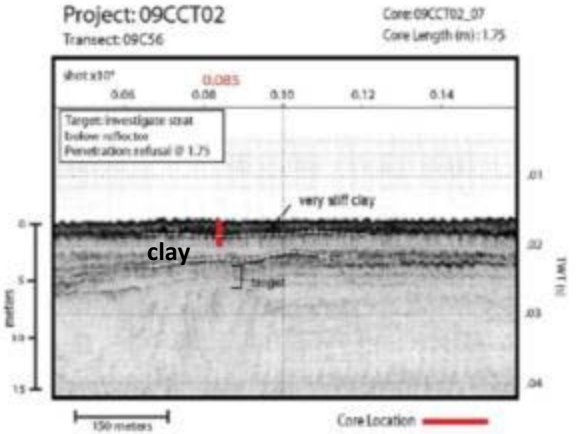
Target: shoal, underlying stratigraphy
Penetration: refusal @ 5m
sand
mud
150 meters
Core Location


Project: 09CCT02
Transect: 09C67
Core: 09CCT02_03
Core Length (m): 5.72
1.822
Target: Investigate strat below reflector
Penetration: full
mud
target
30% sand
150 meters
Core Location


Project: 09CCT02
Transect: 09C55
Core: 09CCT02_06
Core Length (m): 3.25
0.095
sand
Sandy mud
150 meters
Core Location


Project: 09CCT02
Transect: 09C55
Core: 09CCT02_06B
Core Length (m): 4.36
0.095
Target: Possible channel, investigate shoal
Penetration: refusal @ 3.25m
very stiff clay
sand
Sandy mud
target (channel)
150 meters
Core Location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Transect: 09C56
Core: 09CCT02_07
Core Length (m): 1.75
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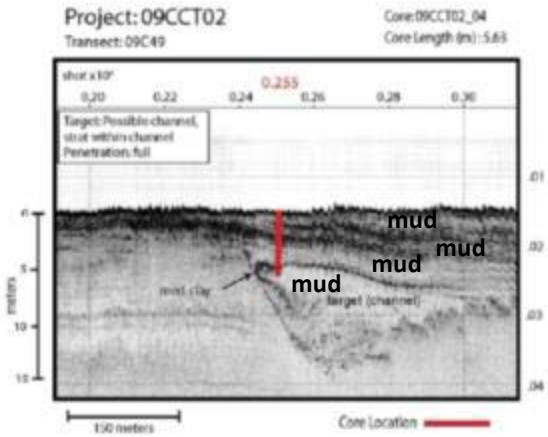
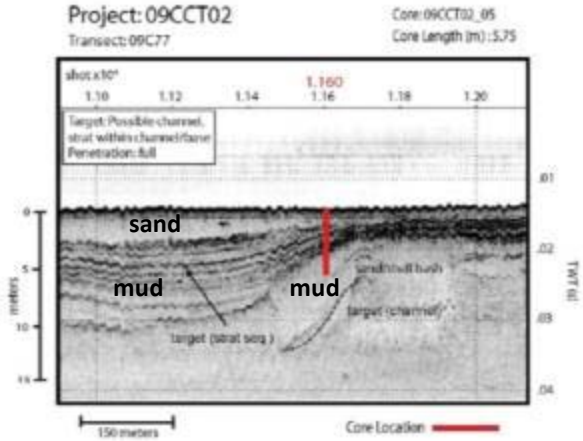
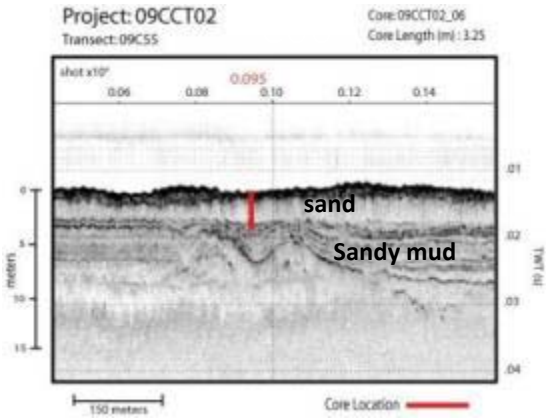
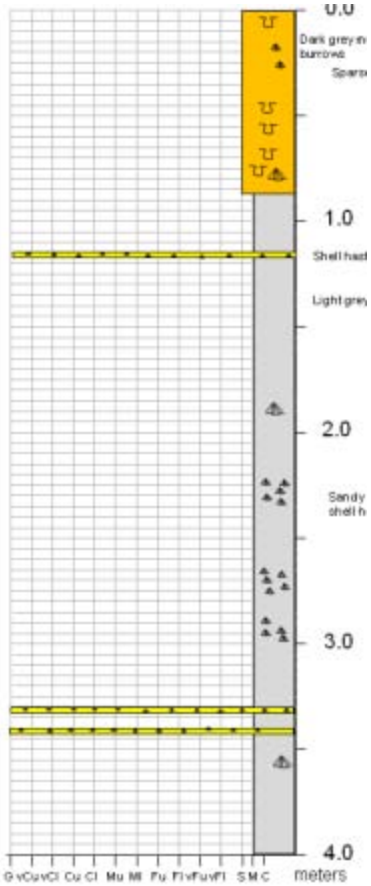
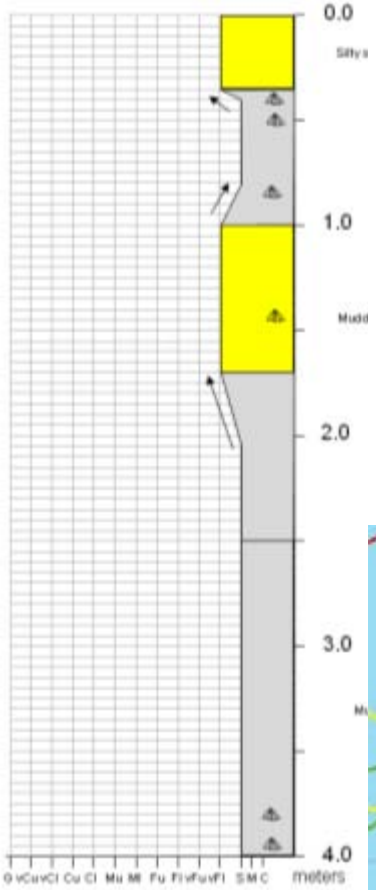
Target: Investigate strat below reflector
Penetration: refusal @ 1.75
very stiff clay
clay
target
150 meters
Core Location


Project: 09CCT02
Transect: 09C49
Core: 09CCT02_04
Core Length (m): 5.63
0.255
mud
mud
mud
mud
target (channel)
150 meters
Core Location

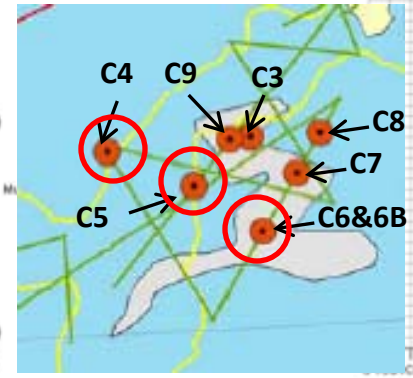

Project: 09CCT02
Transect: 09C77
Core: 09CCT02_05
Core Length (m): 5.75
1.160
sand
mud
mud
target (channel)
target (strat seq.)
150 meters
Core Location

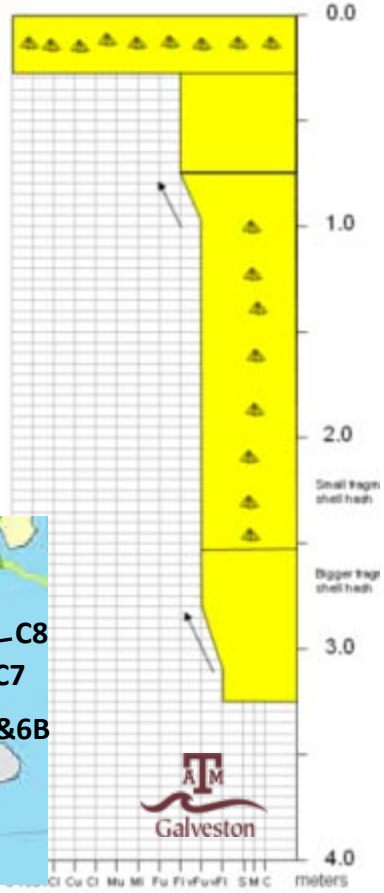

Project: 09CCT02
Transect: 09C55
Core: 09CCT02_06
Core Length (m): 3.25
0.095
sand
Sandy mud
150 meters
Core Location

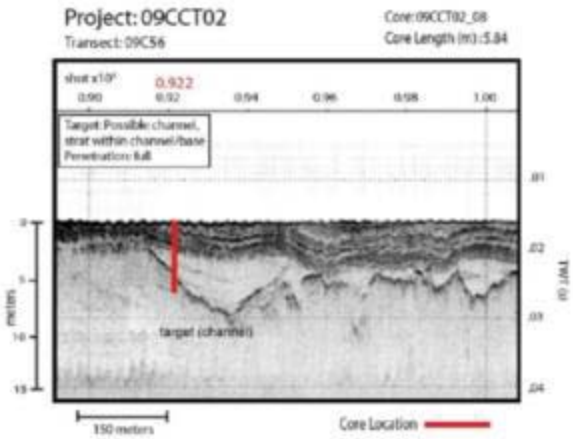

0.0
1.0
2.0
3.0
4.0
meters

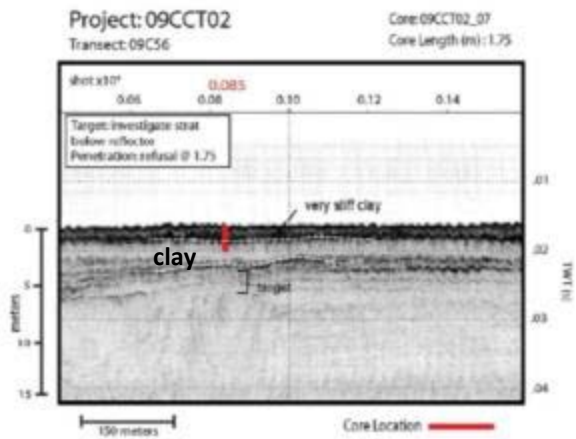

0.0
1.0
2.0
3.0
4.0
meters

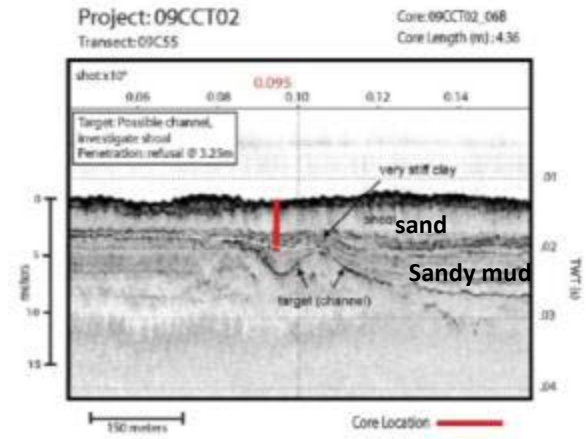
Heald Bank

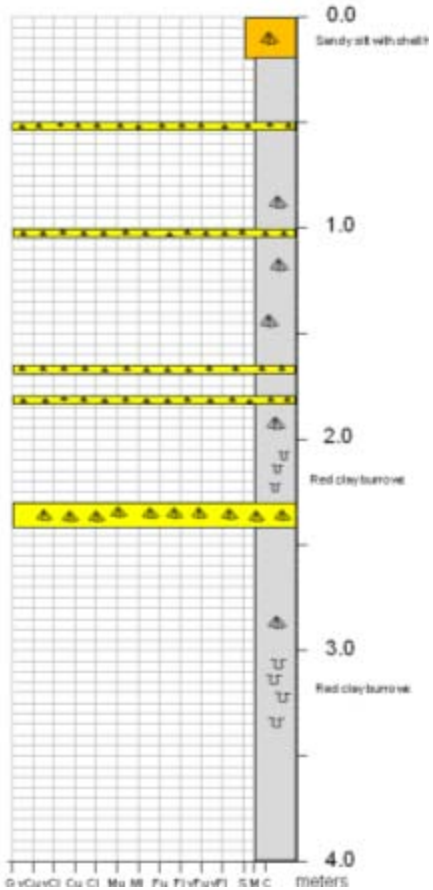

C4
C9
C3
C8
C7
C5
C6&6B

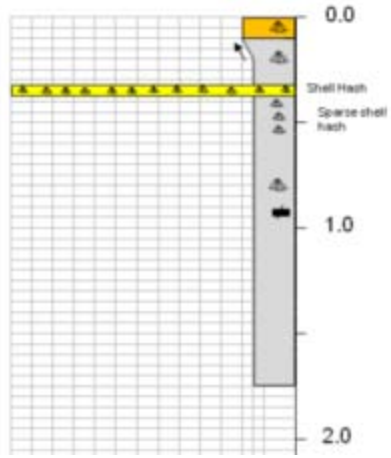

0.0
1.0
2.0
3.0
4.0
meters
Galveston

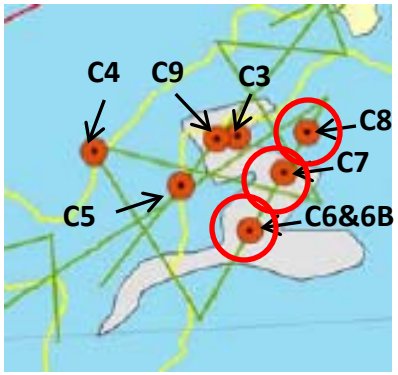

Project: 09CCT02
Transect: 09C56
Core: 09CCT02_08
Core Length (m): 5.84
0.922
Target: Possible channel, strat within channel/base
Penetration: full
target (channel)
150 meters
Core Location

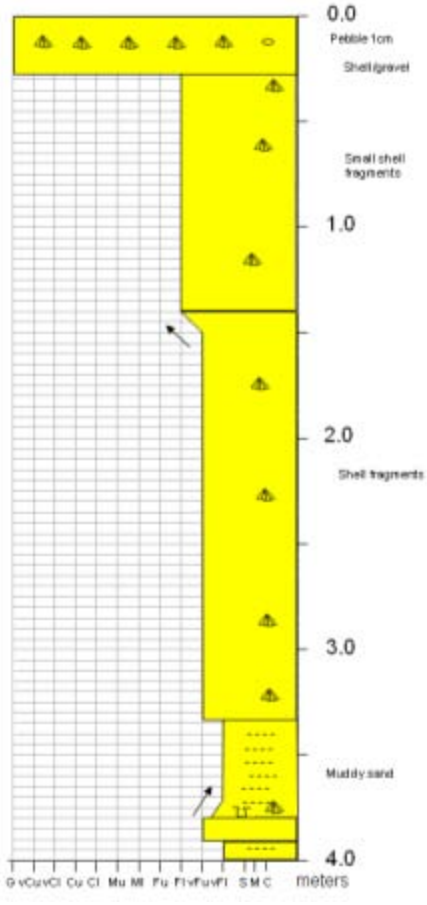

Project: 09CCT02
Transect: 09C56
Core: 09CCT02_07
Core Length (m): 1.75
0.085
Target: Investigate strat below reflector
Penetration: refusal @ 1.75
very stiff clay
clay
target
150 meters
Core Location


Project: 09CCT02
Transect: 09C55
Core: 09CCT02_06B
Core Length (m): 4.36
0.095
Target: Possible channel, investigate shoal
Penetration: refusal @ 3.25m
very stiff clay
sand
Sandy mud
target (channel)
150 meters
Core Location

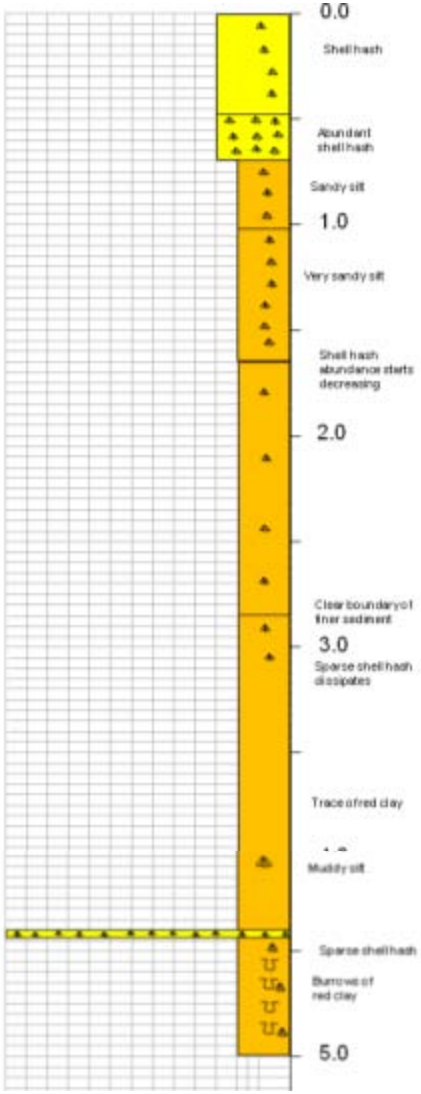

0.0
Sandy silt with shell?
1.0
2.0
Red clay burrow
3.0
Red clay burrow
4.0
meters

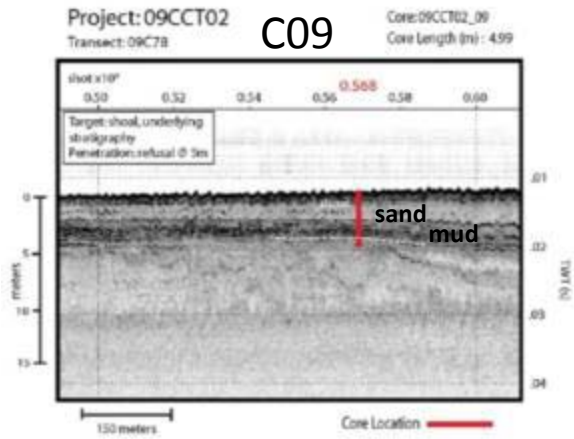

0.0
Shell Hash
Sparse shell hash
1.0
2.0

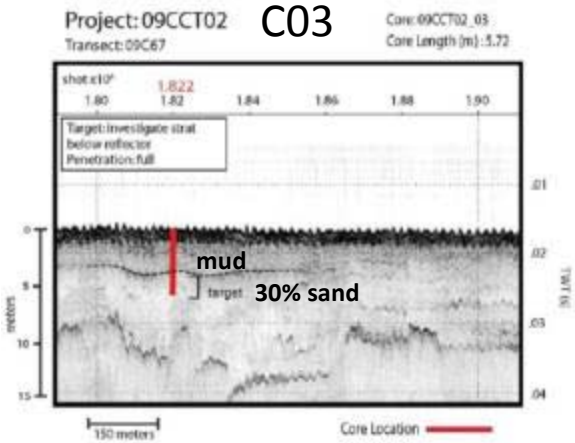

C4
C9
C3
C8
C7
C5
C6&6B

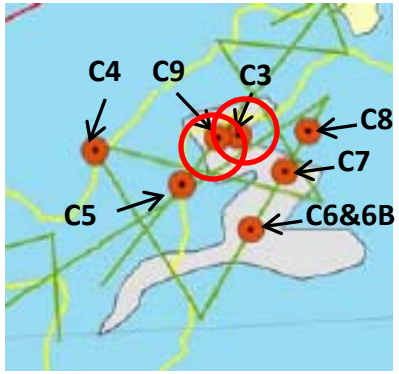

0.0
Pebble 1cm
Shell/gravel
Small shell fragments
1.0
2.0
Shell fragments
3.0
Muddy sand
4.0
meters

C09

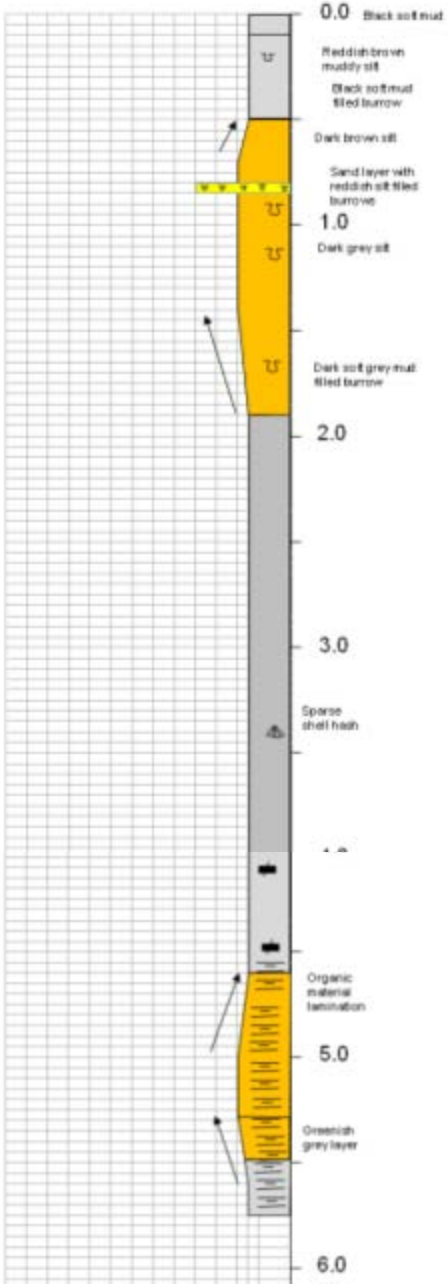

0.0
Shell hash
Abundant shell hash
Sandy silt
1.0
Very sandy silt
Shell hash abundance starts decreasing
2.0
Clear boundary of finer sediment
3.0
Sparse shell hash dissipates
Trace of red clay
Muddy silt
Sparse shell hash
Burrows of red clay
5.0

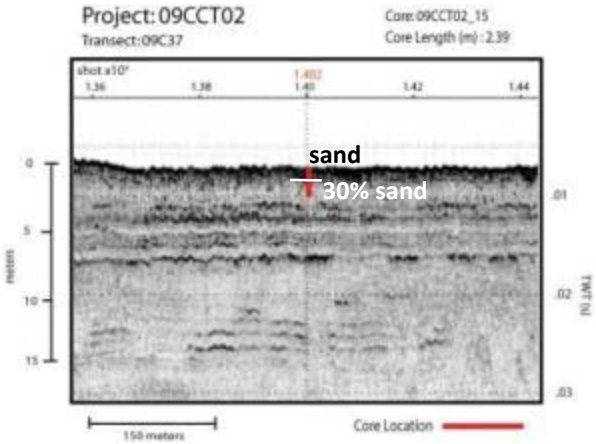

Project: 09CCT02
Transect: 09C78
C09
Core: 09CCT02_09
Core Length (m): 4.99
shot x10⁶
0.50
0.52
0.54
0.56
0.58
0.60
0.568
Target: shoal, underlying stratigraphy
Penetration: refusal @ 3m
sand
mud
meters
0
5
10
15
.01
.02
.03
.04
TWT (s)
150 meters
Core Location

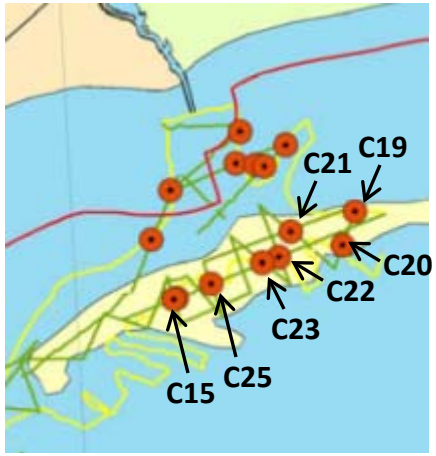

Project: 09CCT02
Transect: 09C67
C03
Core: 09CCT02_03
Core Length (m): 5.72
shot x10⁶
1.80
1.82
1.84
1.86
1.88
1.90
1.822
Target: investigate strat below reflector
Penetration: full
mud
target
30% sand
meters
0
5
10
15
.01
.02
.03
.04
TWT (s)
150 meters
Core Location

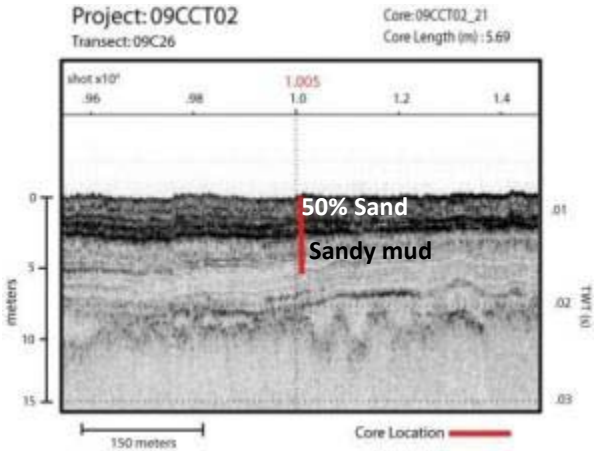

C4
C9
C3
C8
C7
C5
C6&6B

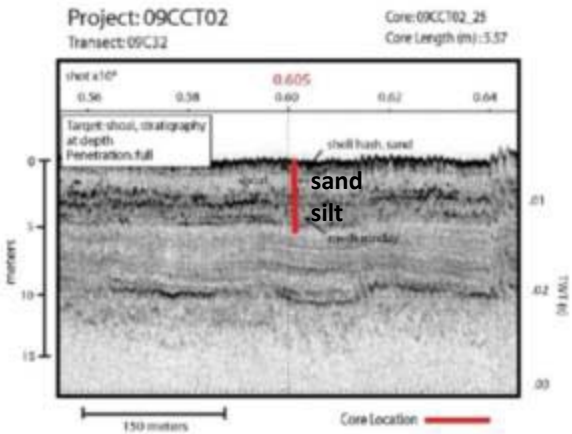
C03

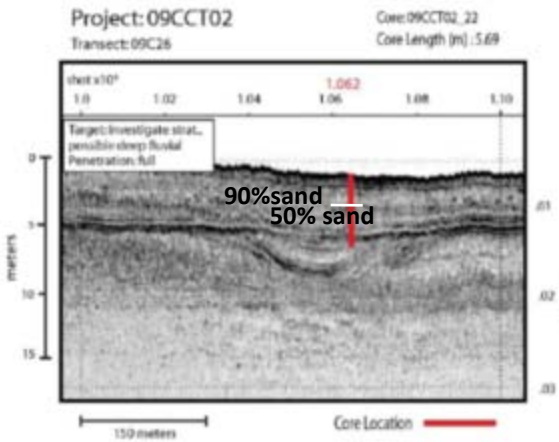

0.0
Black soft mud
Reddish brown muddy silt
Black soft mud filled burrow
Dark brown silt
Sand layer with reddish silt filled burrows
1.0
Dark grey silt
Dark soft grey mud filled burrow
2.0
3.0
Sparse shell hash
Organic material lamination
5.0
Greenish grey layer
6.0

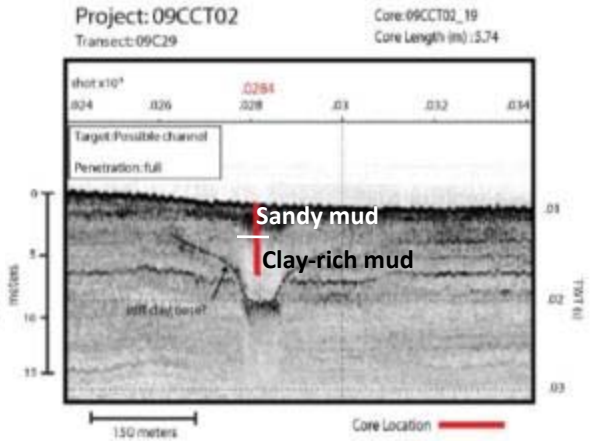

Project: 09CCT02
Transect: 09C37
Core: 09CCT02_15
Core Length (m) : 2.39
sand
30% sand
150 meters
Core Location

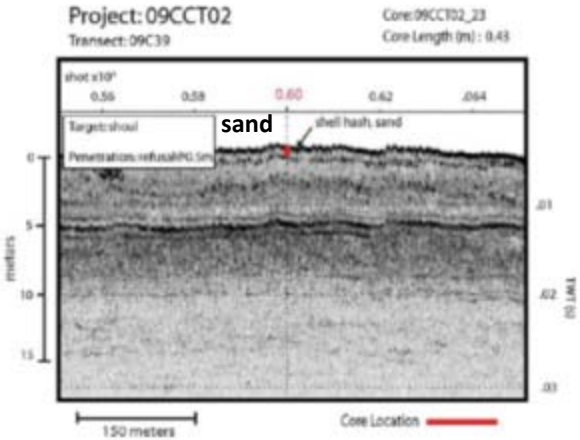

C19
C21
C20
C22
C23
C25
C15

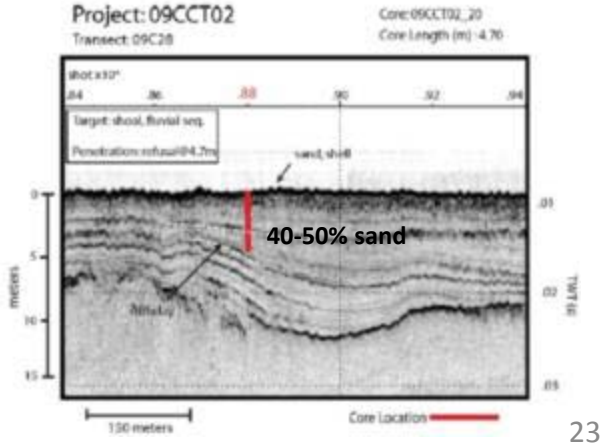

Project: 09CCT02
Transect: 09C26
Core: 09CCT02_21
Core Length (m) : 5.69
50% Sand
Sandy mud
150 meters
Core Location

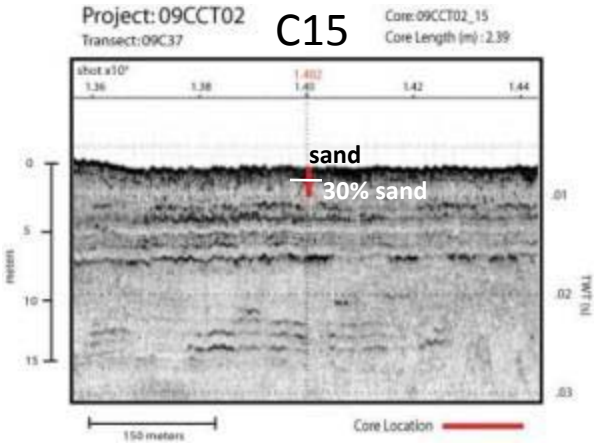

Project: 09CCT02
Transect: 09C32
Core: 09CCT02_25
Core Length (m) : 5.57
sand
silt
150 meters
Core Location

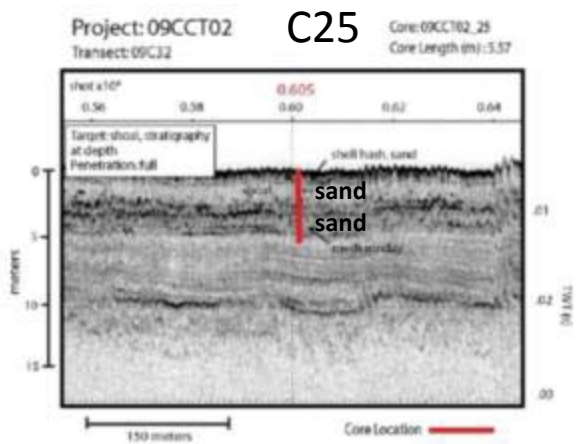

Project: 09CCT02
Transect: 09C26
Core: 09CCT02_22
Core Length (m) : 5.69
90%sand
50% sand
150 meters
Core Location

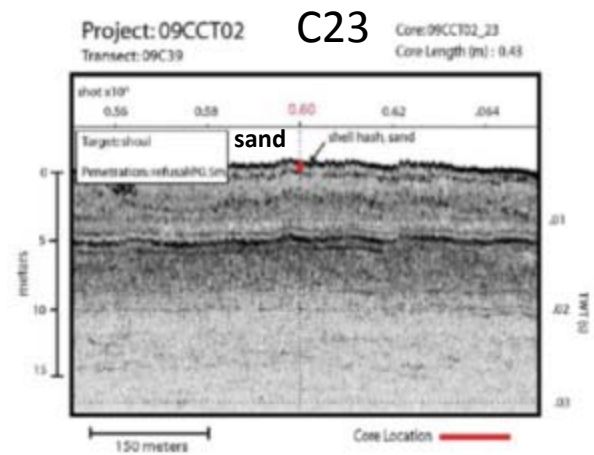

Project: 09CCT02
Transect: 09C29
Core: 09CCT02_19
Core Length (m) : 5.74
Sandy mud
Clay-rich mud
150 meters
Core Location

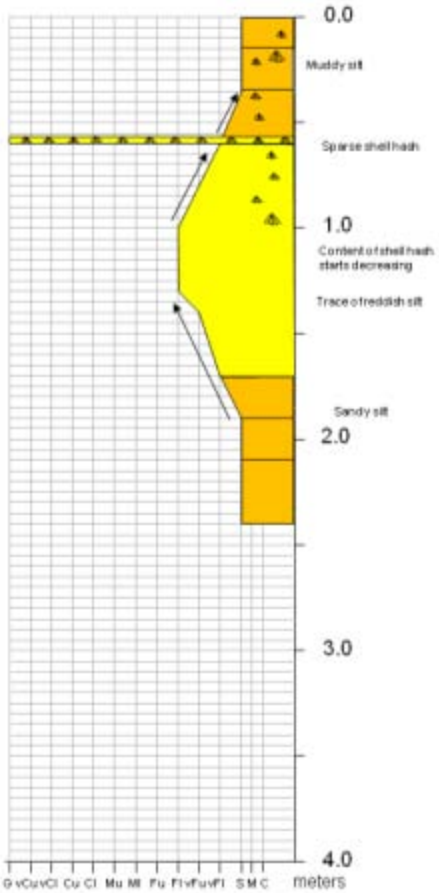

Project: 09CCT02
Transect: 09C39
Core: 09CCT02_23
Core Length (m) : 0.43
sand
150 meters
Core Location

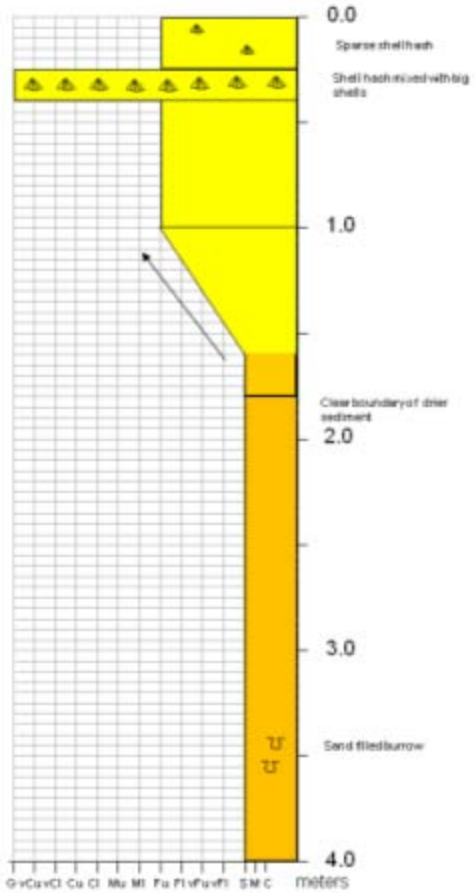

Project: 09CCT02
Transect: 09C28
Core: 09CCT02_20
Core Length (m) : 4.70
40-50% sand
150 meters
Core Location

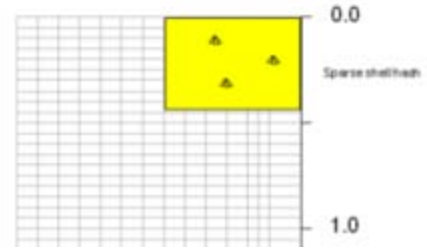

Project: 09CCT02
Transect: 09C37
C15
Core: 09CCT02_15
Core Length (m) : 2.39
sand
30% sand
150 meters
Core Location

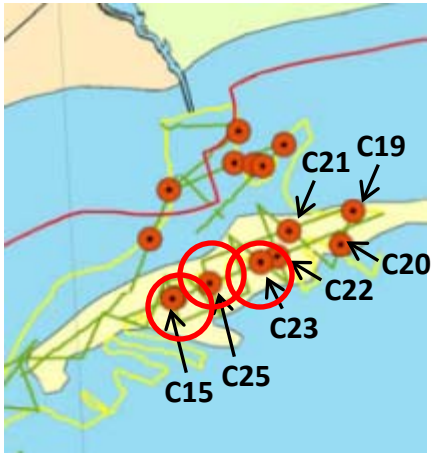

Project: 09CCT02
Transect: 09C32
C25
Core: 09CCT02_25
Core Length (m) : 5.57
sand
sand
150 meters
Core Location

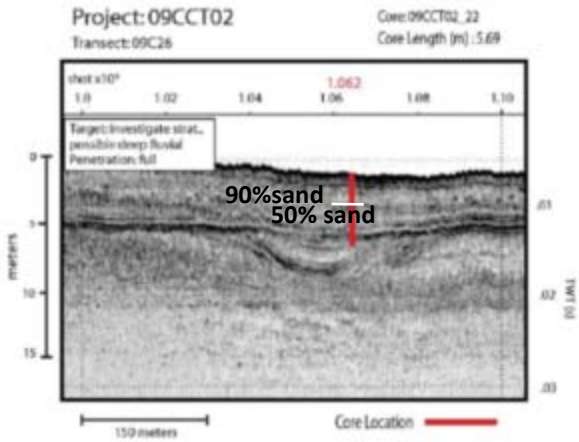

Project: 09CCT02
Transect: 09C39
C23
Core: 09CCT02_23
Core Length (m) : 0.43
sand
150 meters
Core Location

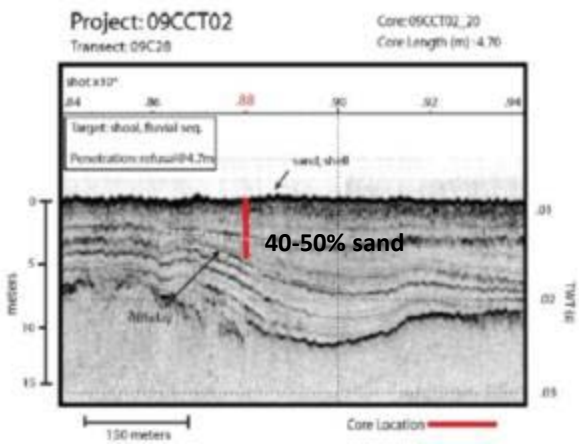

0.0
Muddy silt
Sparse shell hash
1.0
Content of shell hash starts decreasing
Trace of reddish silt
Sandy silt
2.0
3.0
4.0
meters

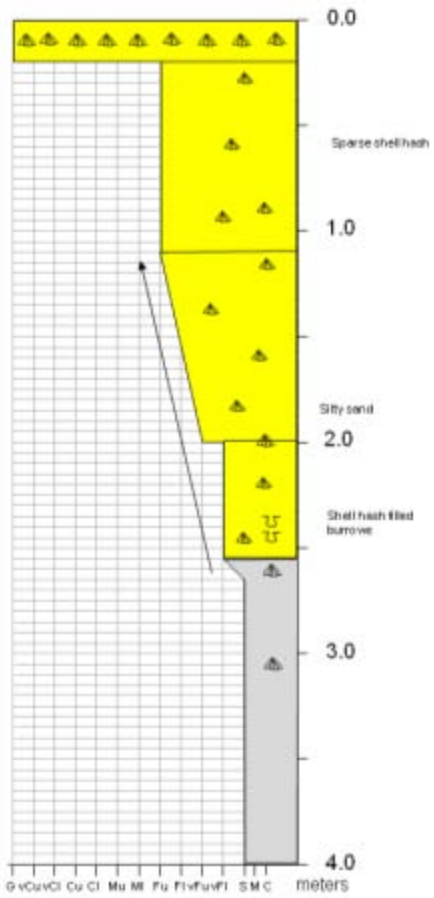

0.0
Sparse shell hash
Shell hash mixed with big shells
1.0
Clear boundary of drier sediment
2.0
3.0
Sand filled burrow
4.0
meters

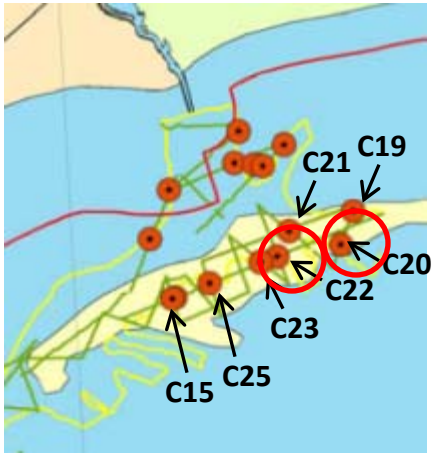

0.0
Sparse shell hash
1.0

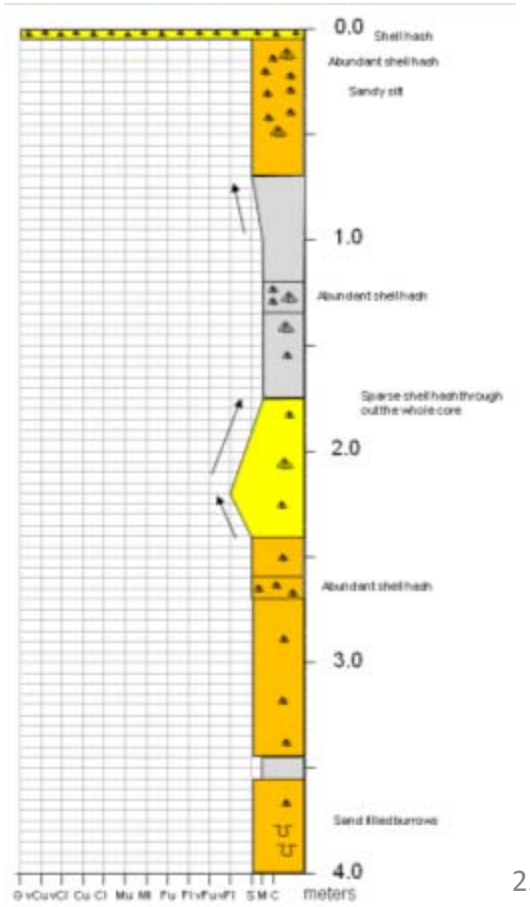

C21
C19
C20
C22
C23
C15
C25

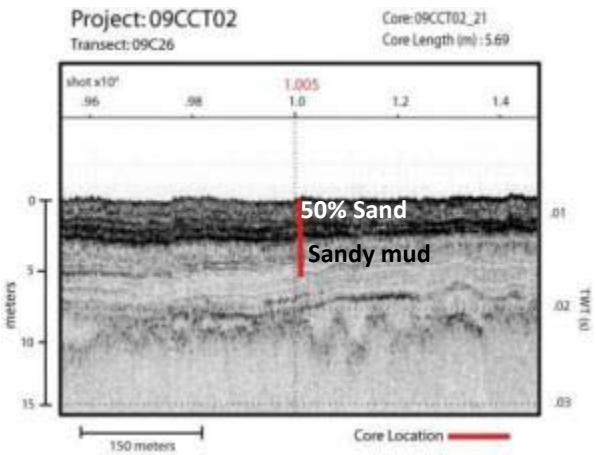

Project: 09CCT02
Transect: 09C26
Core: 09CCT02_22
Core Length (m) : 5.69
90%sand
50% sand
Core Location

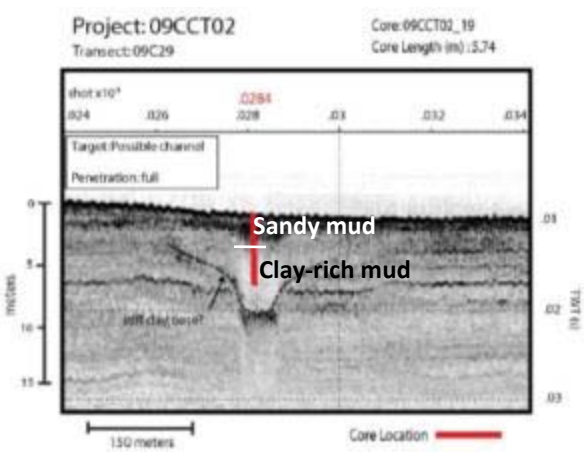

Project: 09CCT02
Transect: 09C28
Core: 09CCT02_20
Core Length (m) : 4.70
40-50% sand
Core Location

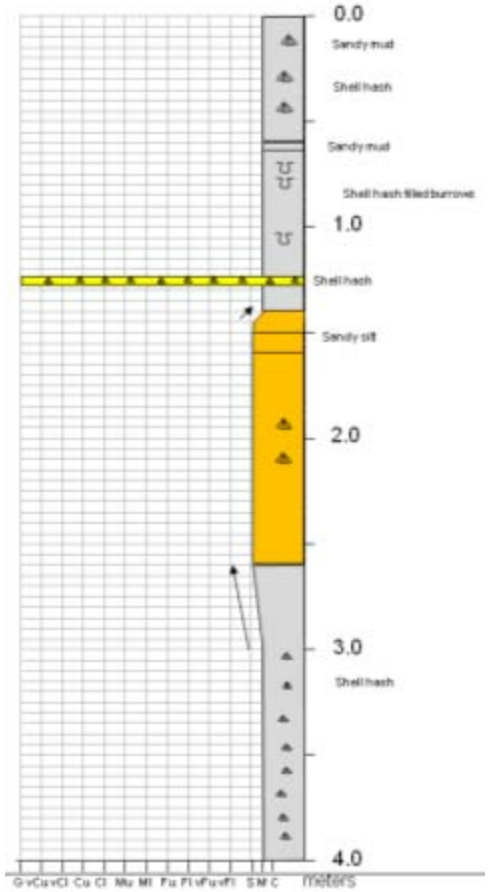

0.0
Sparse shell hash
1.0
Silty sand
2.0
Shell hash filled burrows
3.0
4.0
meters

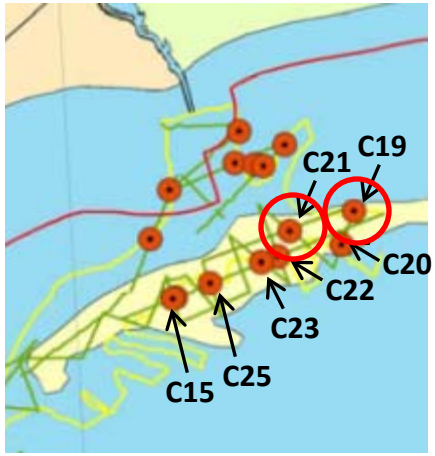

C21
C19
C20
C22
C23
C15
C25

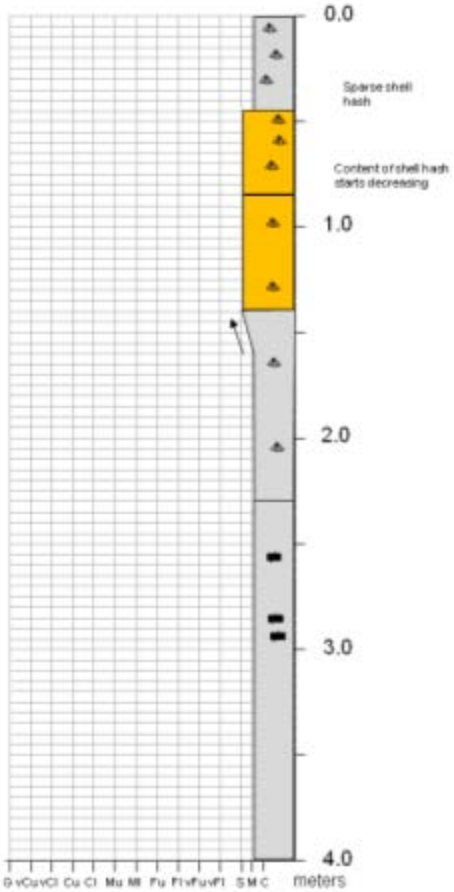

0.0
Shell hash
Abundant shell hash
Sandy silt
1.0
Abundant shell hash
Sparse shell hash through out the whole core
2.0
Abundant shell hash
3.0
Sand filled burrows
4.0
meters

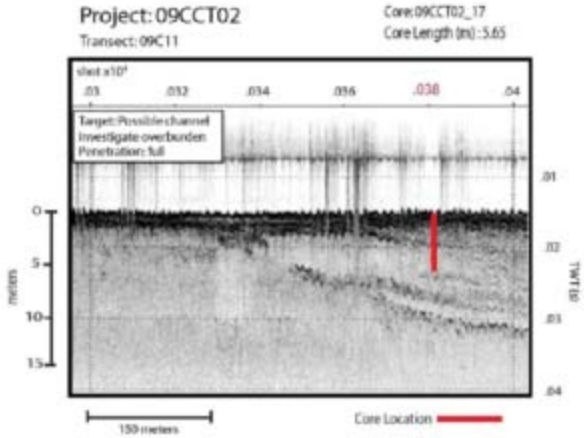

Project: 09CCT02
Transect: 09C26
Core: 09CCT02_21
Core Length (m) : 5.69
1.005
50% Sand
Sandy mud
meters
TWT (s)
150 meters
Core Location

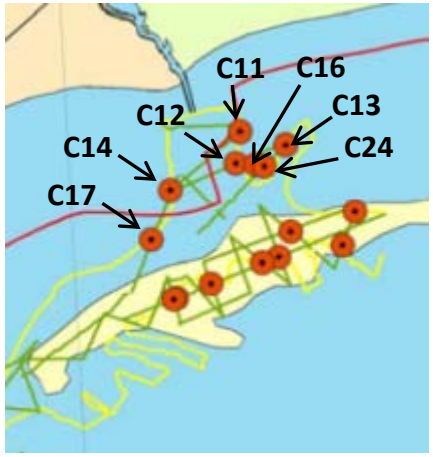

Project: 09CCT02
Transect: 09C29
Core: 09CCT02_19
Core Length (m) : 5.74
.0284
Target: Possible channel
Penetration: full
Sandy mud
Clay-rich mud
meters
TWT (s)
150 meters
Core Location

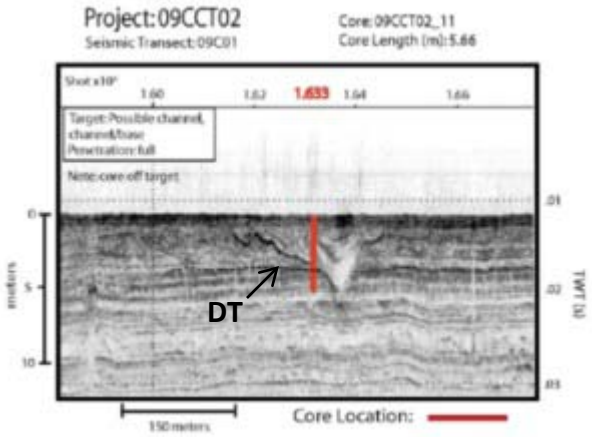

0.0
Sandy mud
Shell hash
Sandy mud
Shell hash filled burrows
1.0
Shell hash
Sandy silt
2.0
3.0
Shell hash
4.0
meters

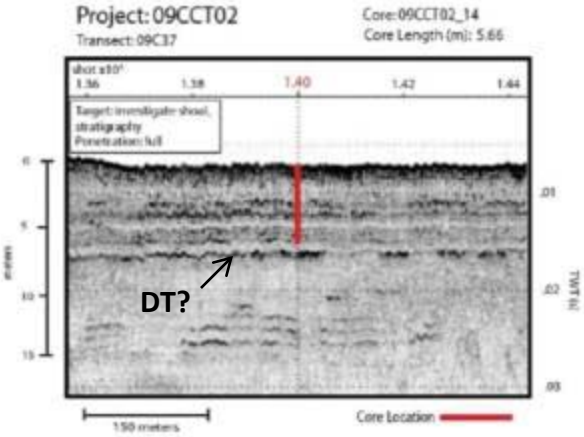

C21
C19
C20
C22
C23
C25
C15

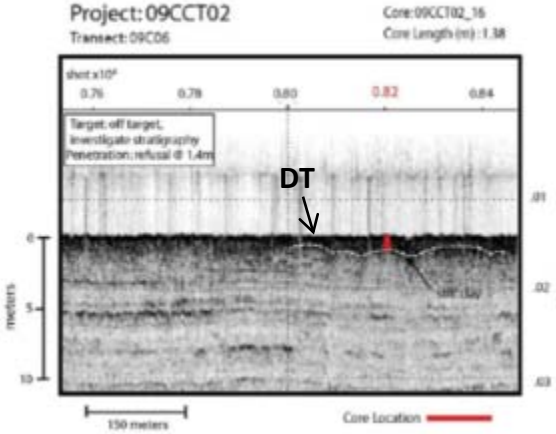

0.0
Sparse shell hash
Content of shell hash starts decreasing
1.0
2.0
3.0
4.0
meters

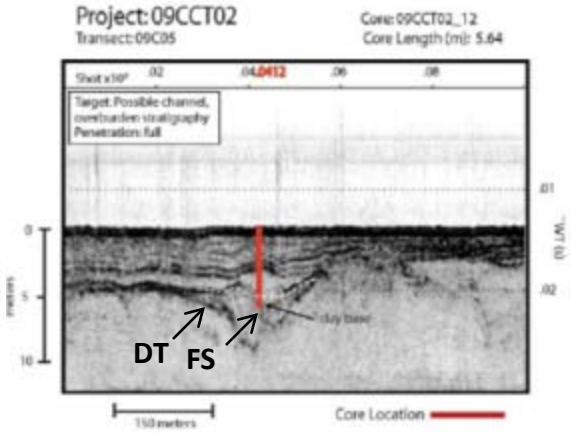


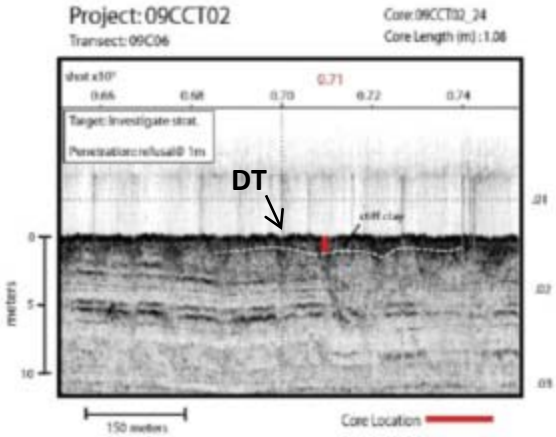


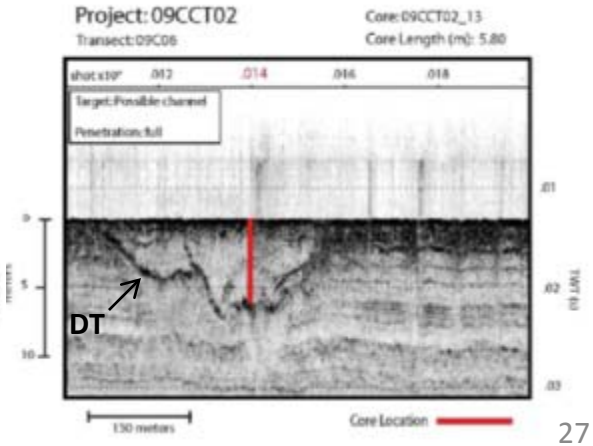






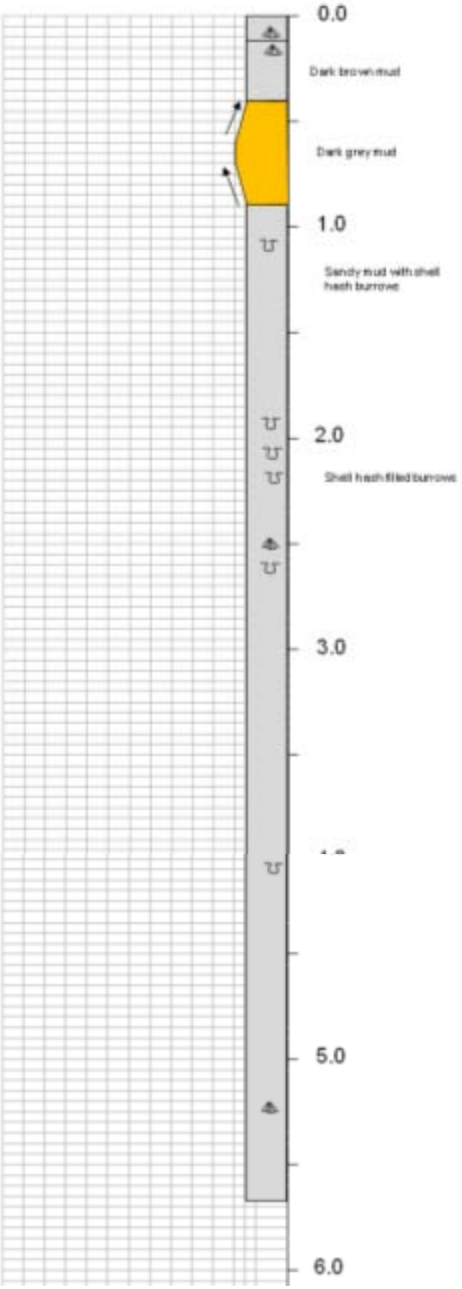


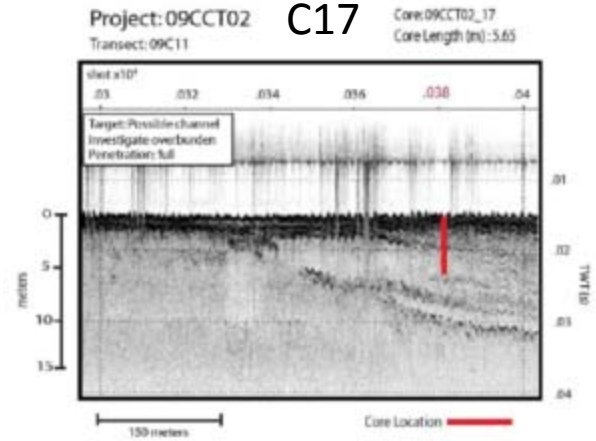


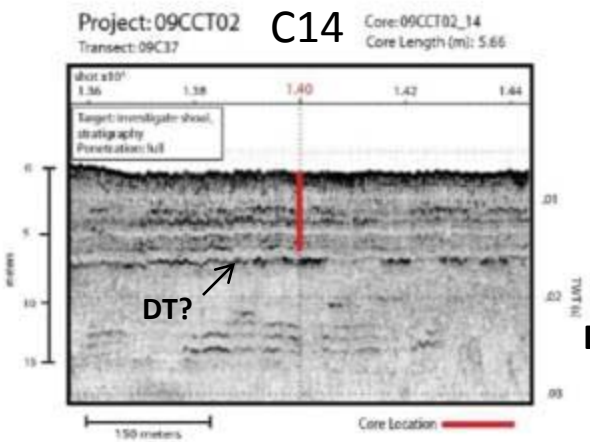


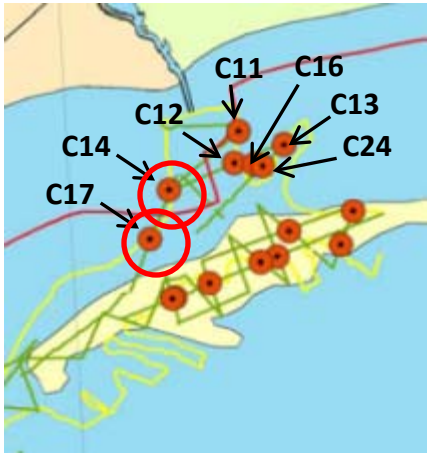
Deweyville Terrace = DT
Fluvial Sand = FS

C17



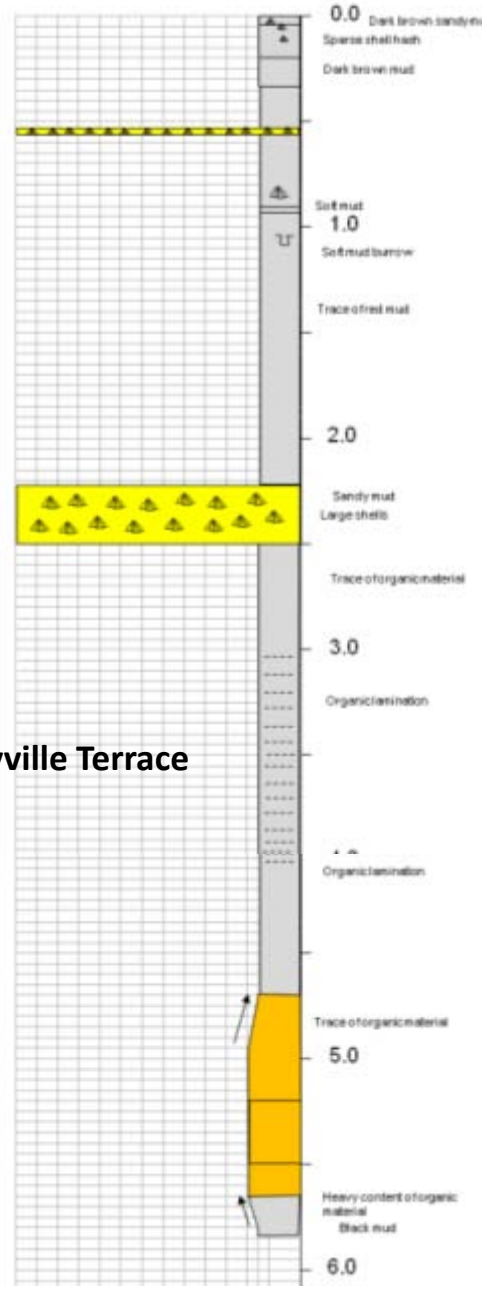


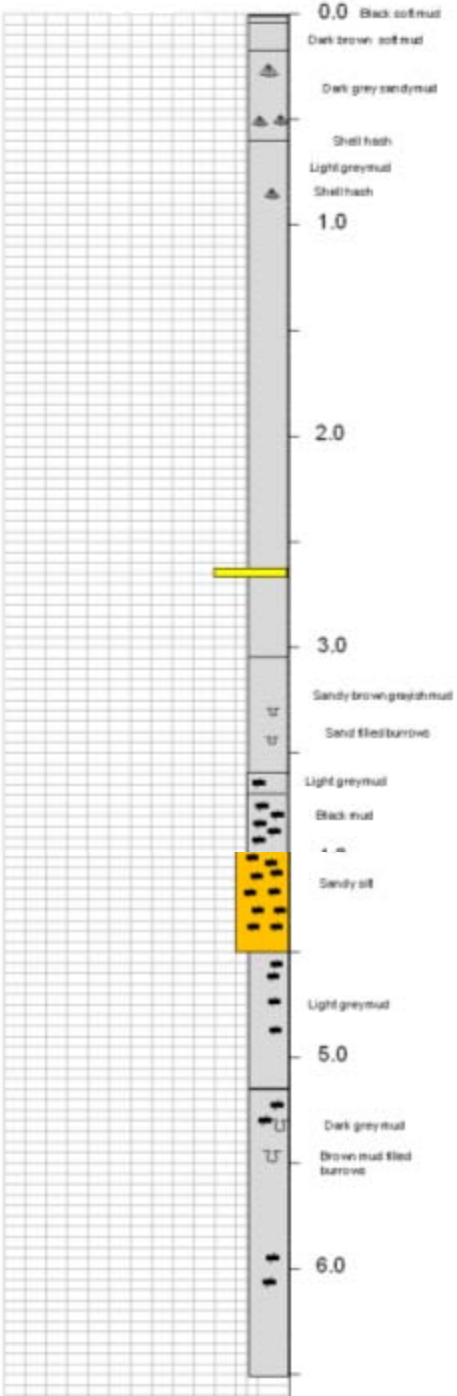


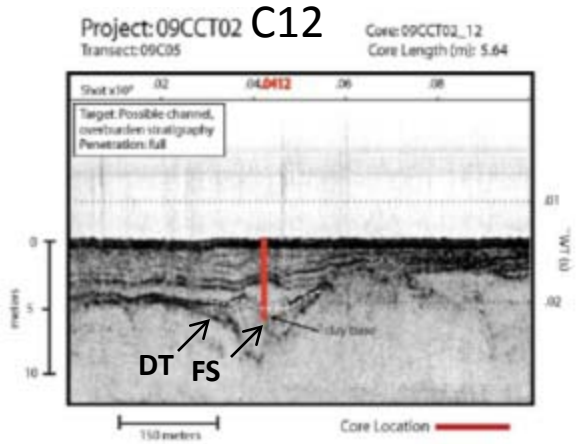


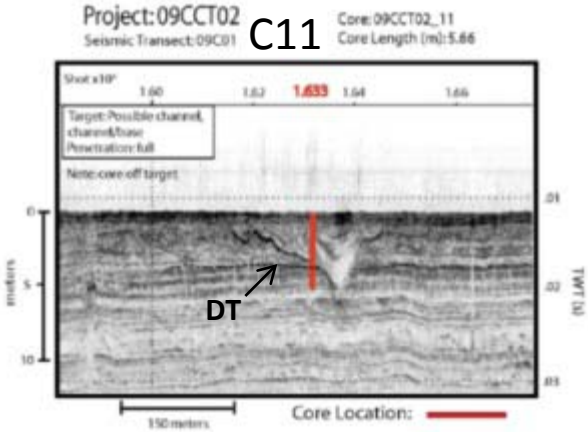
DT = Deweyville Terrace

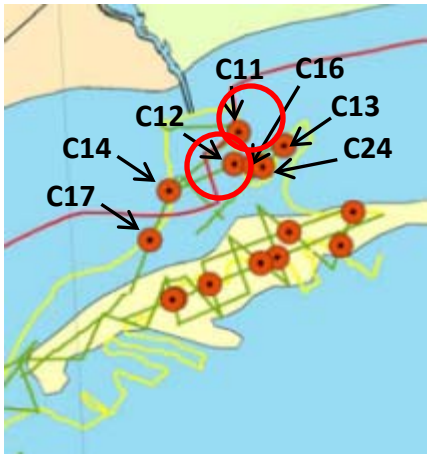
C14

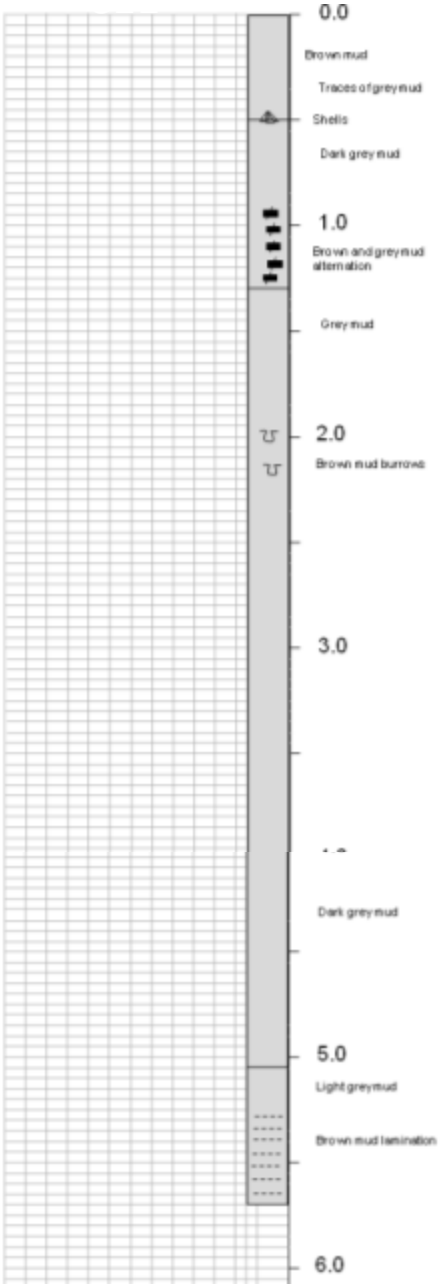


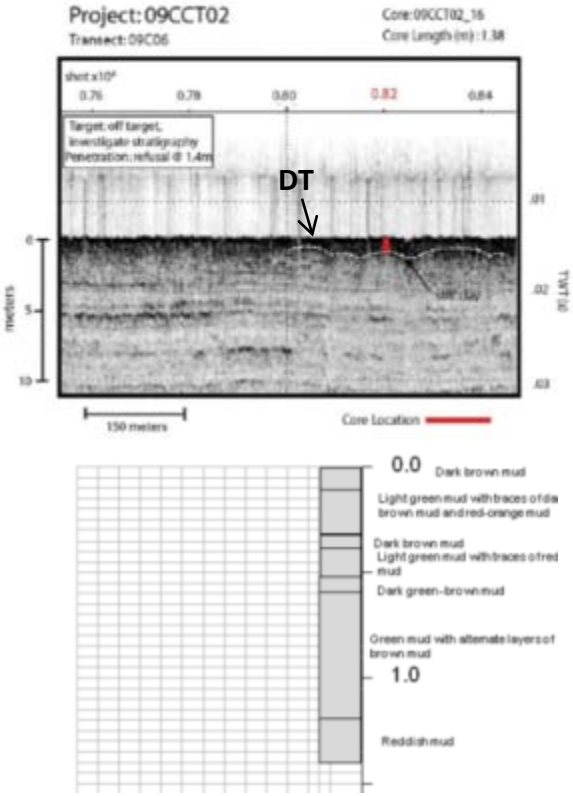

0.0
Black soft mud
Dark brown soft mud
Dark grey sandy mud
Shell hash
Light grey mud
Shell hash
1.0
2.0
3.0
Sandy brown greyish mud
Sand filled burrows
Light grey mud
Black mud
Sandy silt
Light grey mud
5.0
Dark grey mud
Brown mud filled burrows
6.0

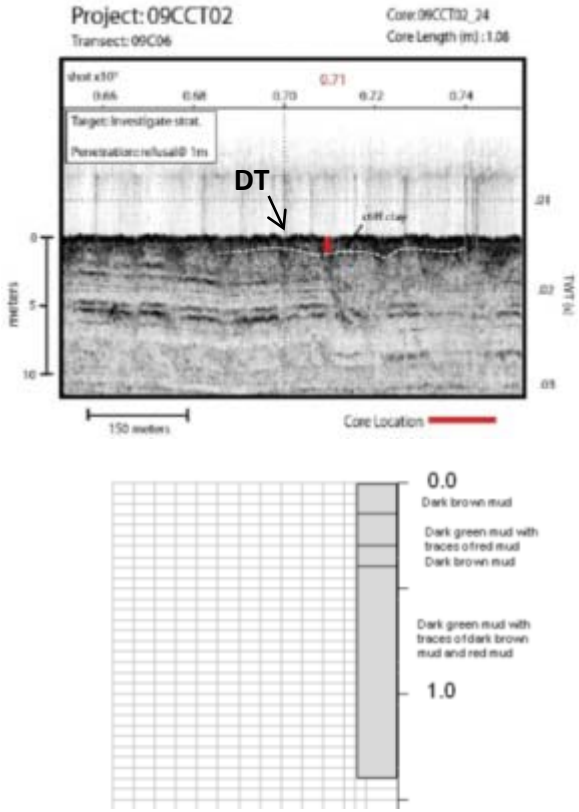

Project: 09CCT02 C12
Transect: 09C05
Core: 09CCT02_12
Core Length (m): 5.64
Target: Possible channel, overburden stratigraphy
Penetration: full
DT
FS
clay base
Core Location

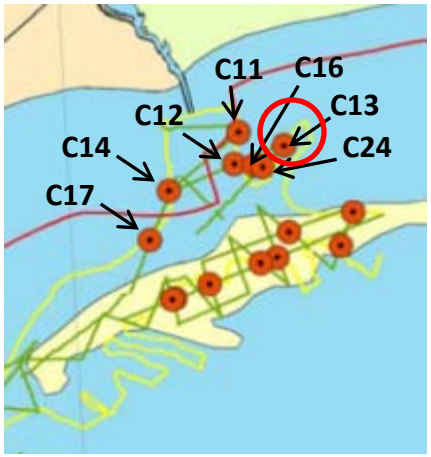

Project: 09CCT02 C11
Seismic Transect: 09C01
Core: 09CCT02_11
Core Length (m): 5.66
Target: Possible channel, channel/base
Penetration: full
Note: core off target
DT
Core Location:

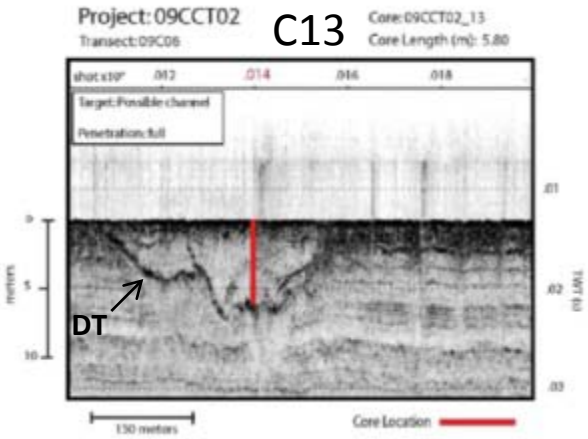

C11
C16
C12
C13
C14
C24
C17

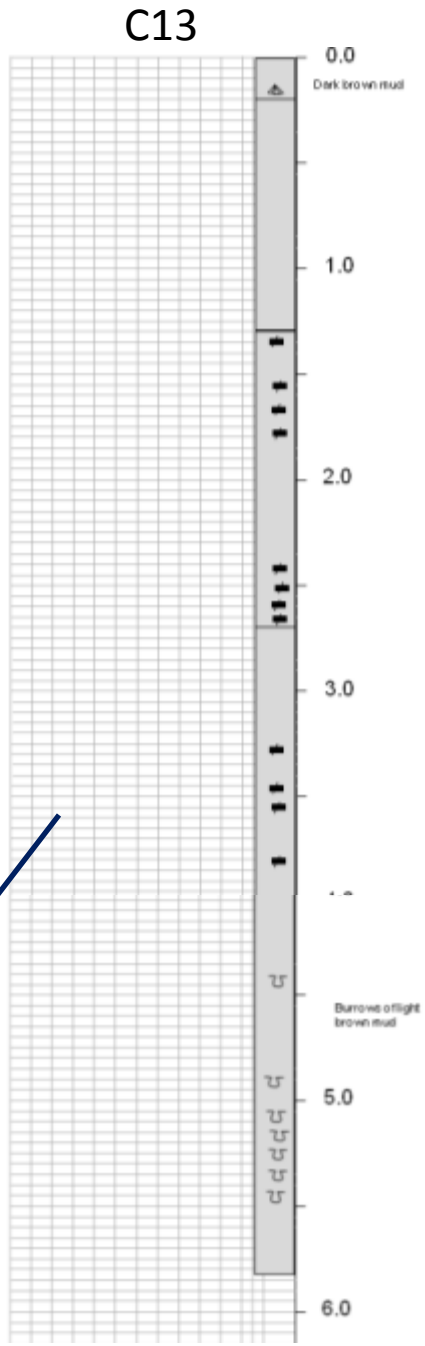

0.0
Brown mud
Traces of grey mud
Shells
Dark grey mud
1.0
Brown and grey mud alternation
Grey mud
2.0
Brown mud burrows
3.0
Dark grey mud
5.0
Light grey mud
Brown mud lamination
6.0

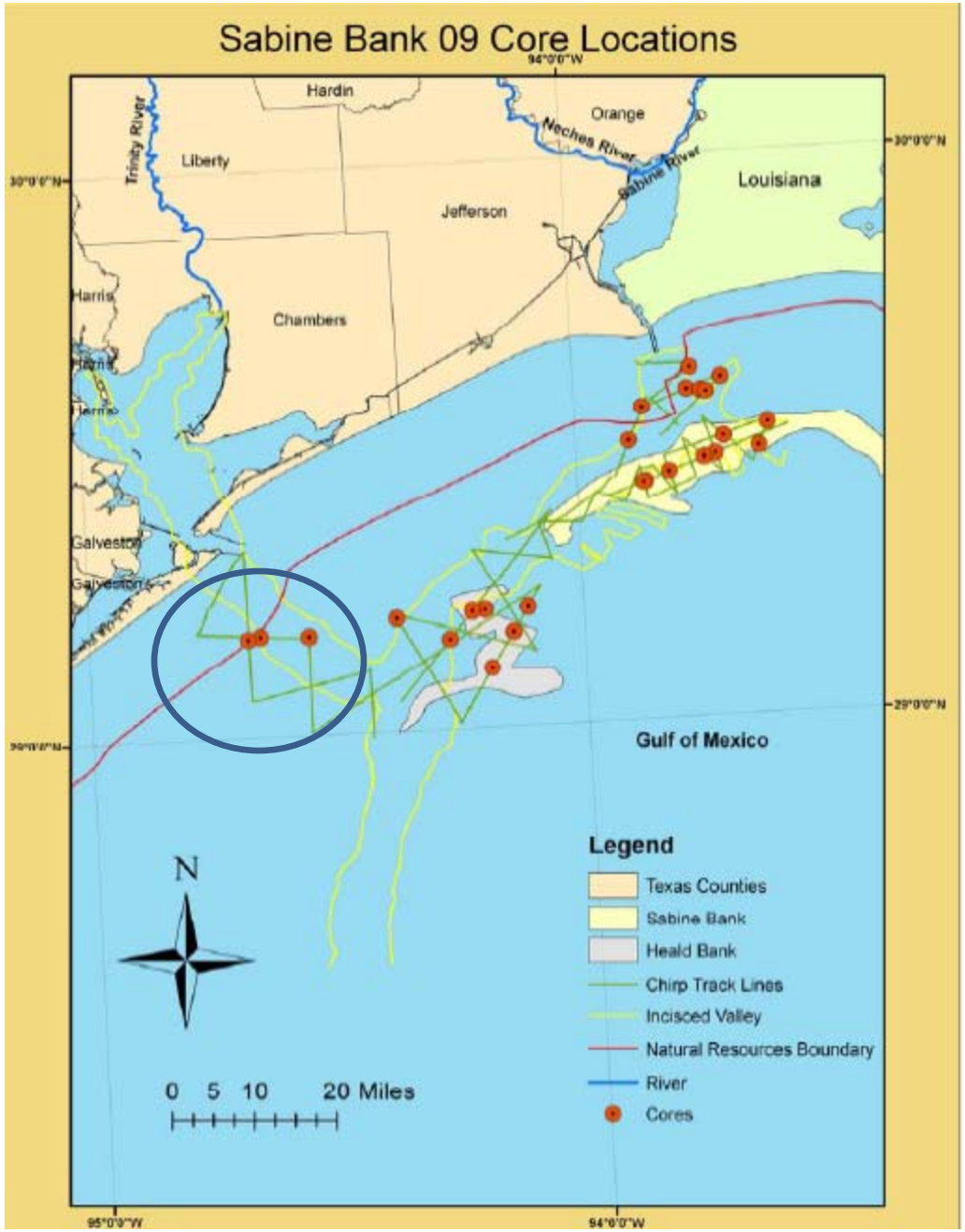

Project: 09CCT02
Transect: 09C06
Core: 09CCT02_16
Core Length (m): 1.38
DT
meters
TWT (s)
150 meters
Core Location
0.0
Dark brown mud
Light green mud with traces of dark brown mud and red-orange mud
Dark brown mud
Light green mud with traces of red mud
Dark green-brown mud
Green mud with alternate layers of brown mud
1.0
Reddish mud


Project: 09CCT02
Transect: 09C06
Core: 09CCT02_24
Core Length (m): 1.08
DT
meters
TWT (s)
150 meters
Core Location
0.0
Dark brown mud
Dark green mud with traces of red mud
Dark brown mud
Dark green mud with traces of dark brown mud and red mud
1.0


C11
C16
C12
C13
C14
C24
C17

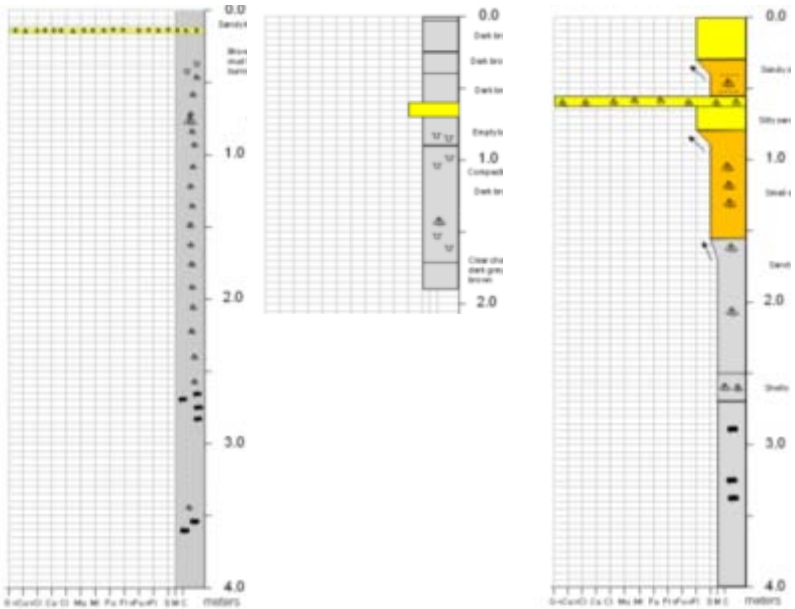

Project: 09CCT02
C13
Transect: 09C06
Core: 09CCT02_13
Core Length (m): 5.80
DT
meters
TWT (s)
150 meters
Core Location


C13
0.0
Dark brown mud
1.0
2.0
3.0
Burrows of light brown mud
5.0
6.0

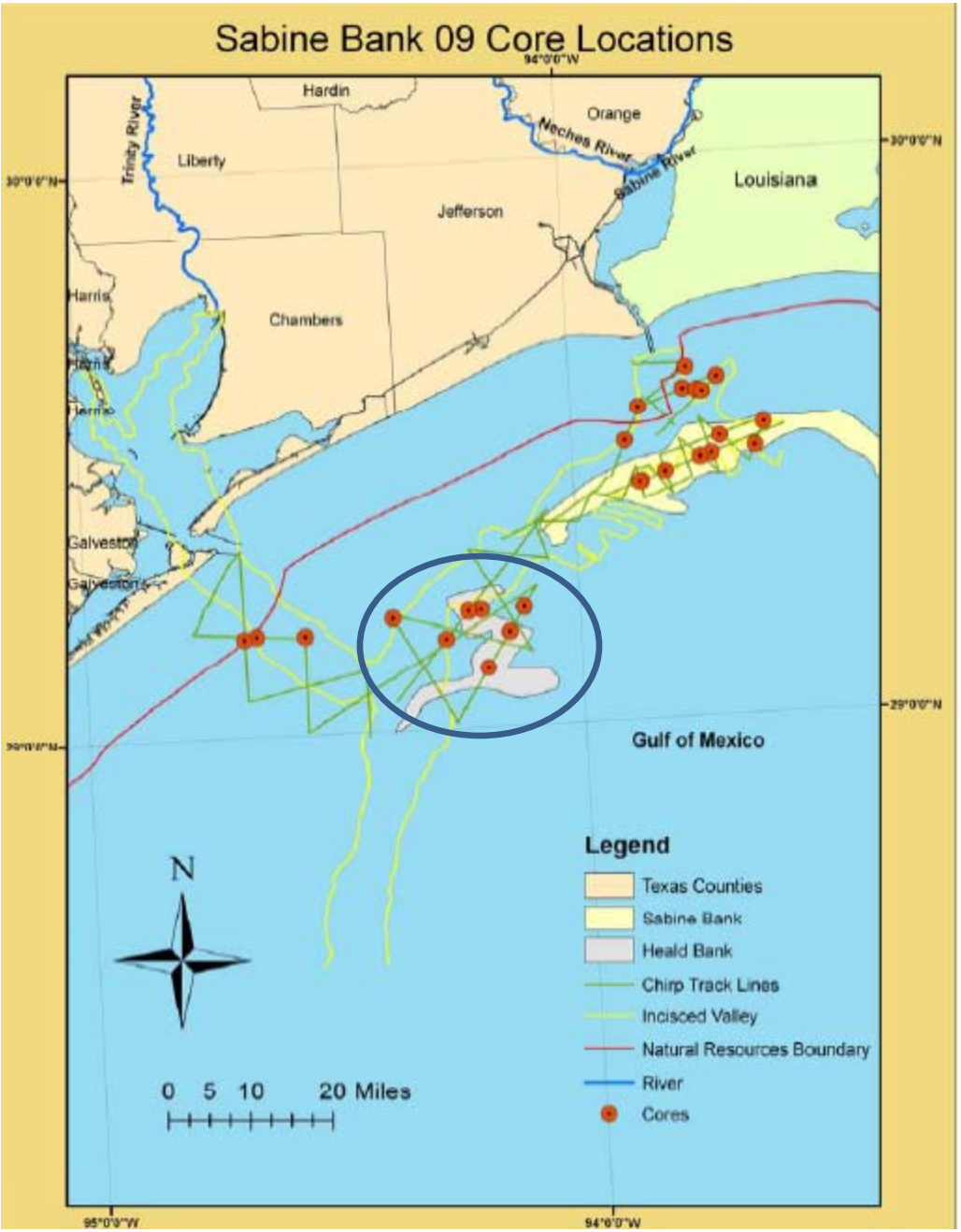


SUMMARY OF FINDINGS

Trinity Incised Valley

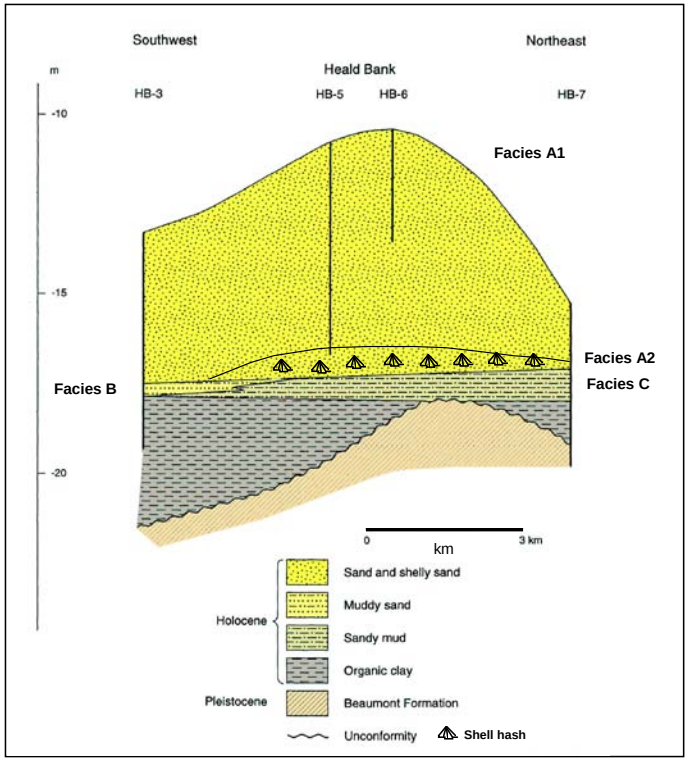


Mud-filled with no significant sand resources found

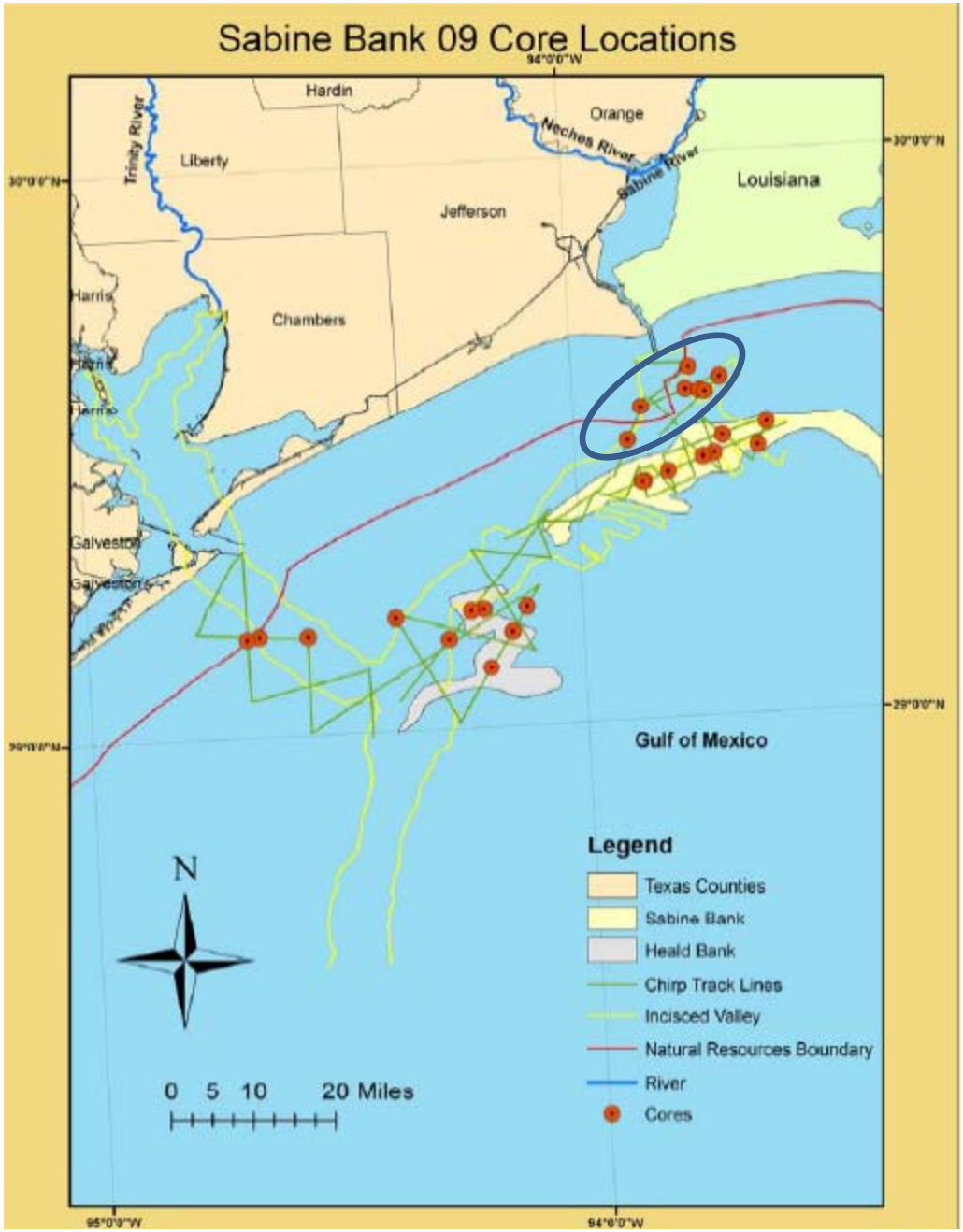


SUMMARY OF FINDINGS

Heald Bank

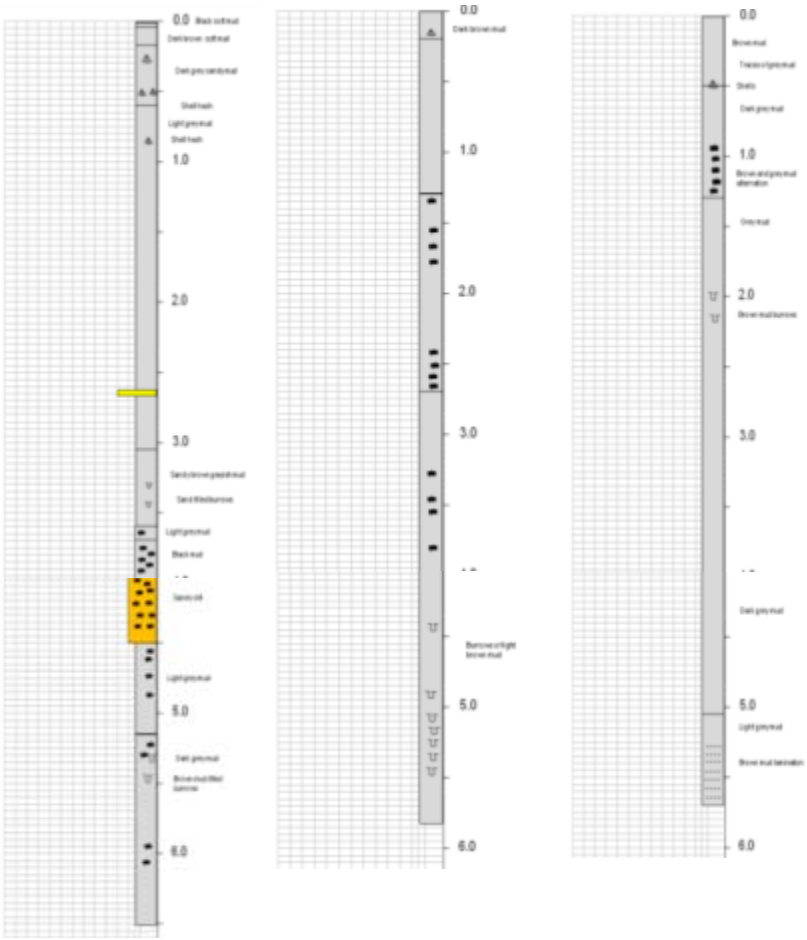


Significant sand resources

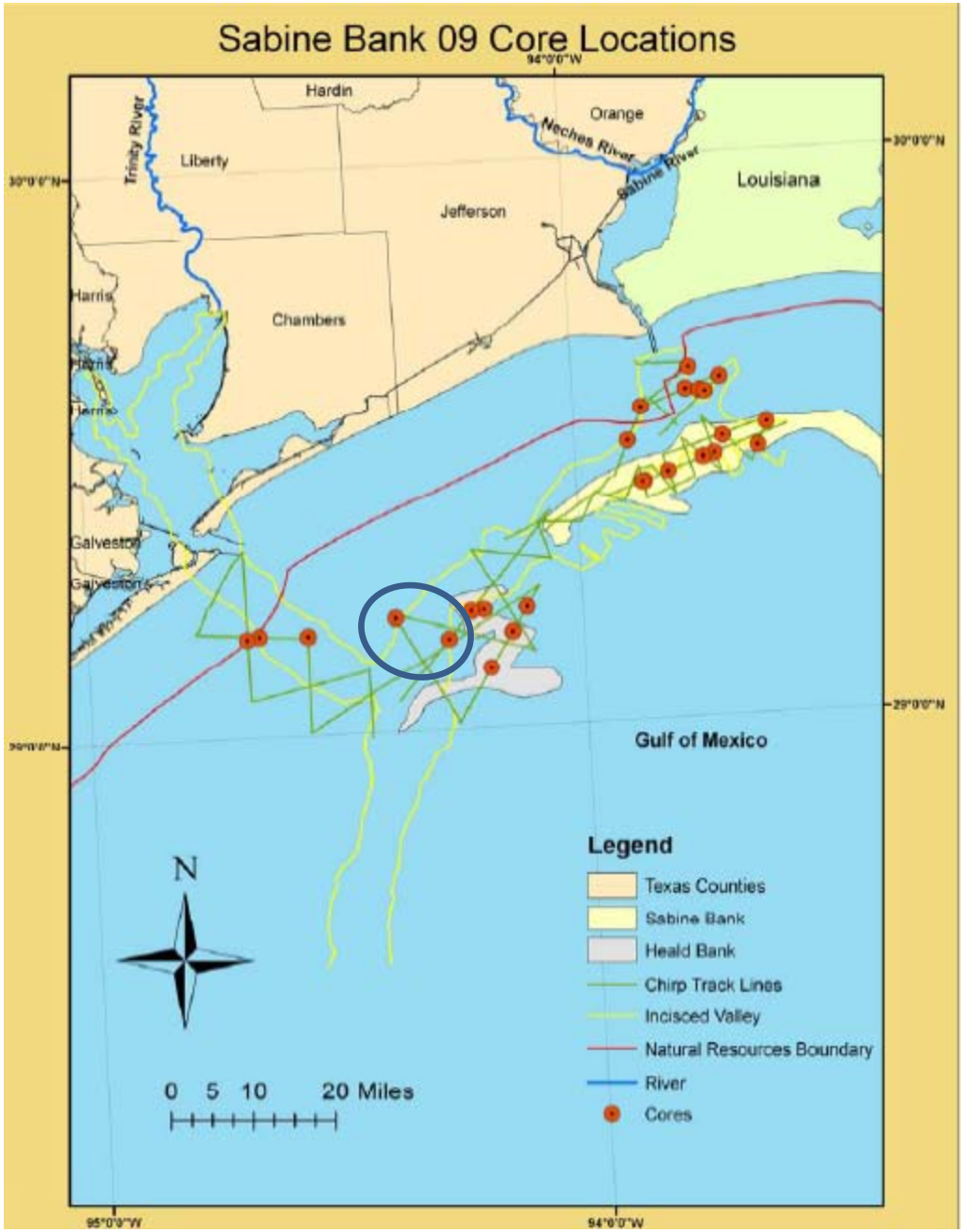


SUMMARY OF FINDINGS

Sabine Channel-north

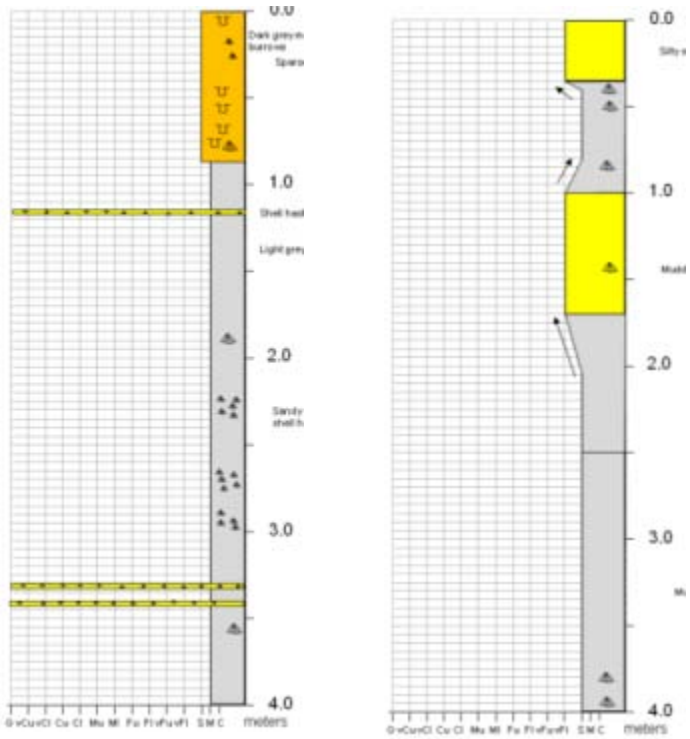


Mud-filled with no significant sand resources found

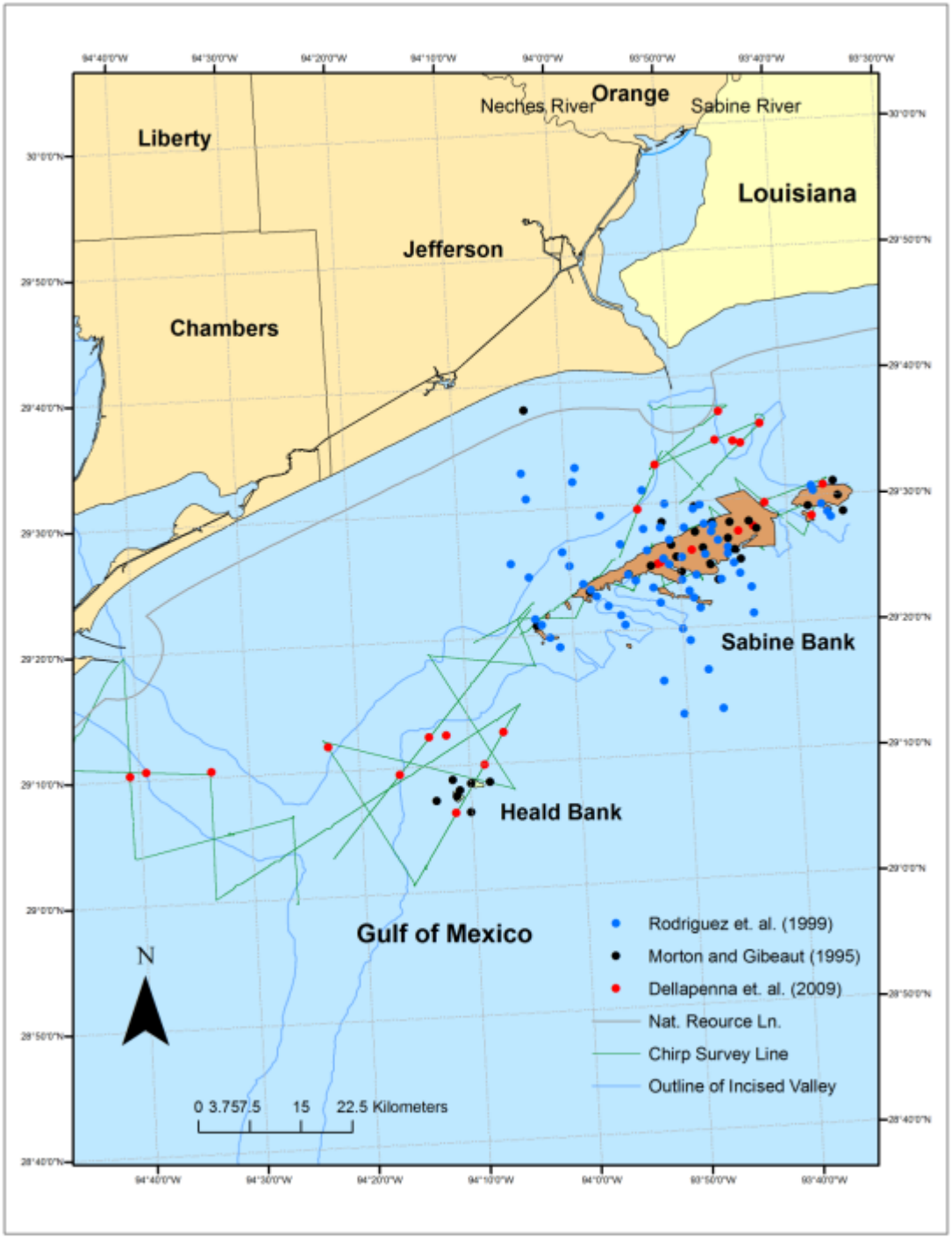


SUMMARY OF FINDINGS

Sabine Channel-south



Primarily mud-filled with no significant sand resources found


Liberty
Orange
Neches River
Sabine River
Louisiana
Jefferson
Chambers
Sabine Bank
Heald Bank
Gulf of Mexico
N
Rodriguez et. al. (1999)
Morton and Gibeaut (1995)
Dellapenna et. al. (2009)
Nat. Reource Ln.
Chirp Survey Line
Outline of Incised Valley
0 3.757.5 15 22.5 Kilometers

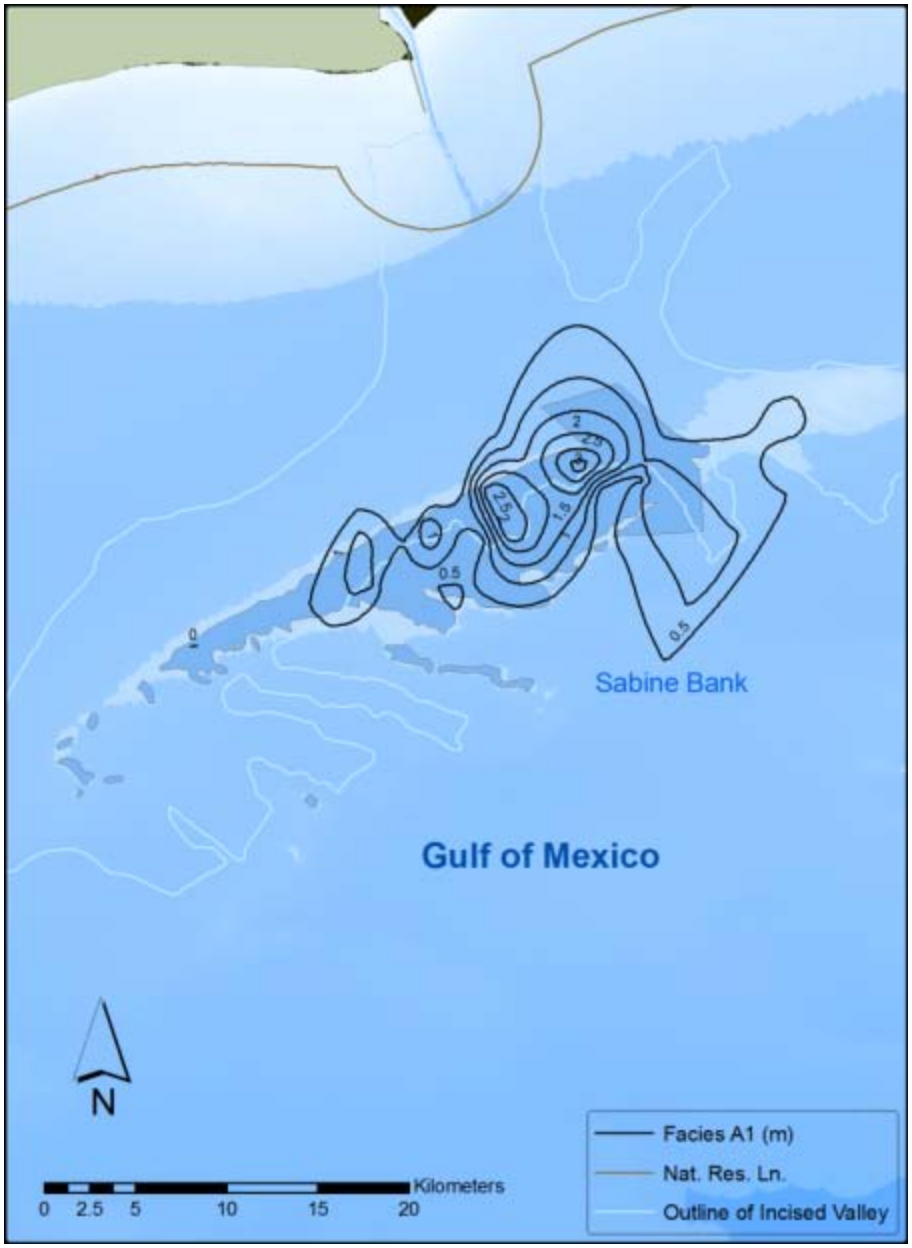


Figure 9. Net sand map of Sabine and Heald Banks sand facies A1.

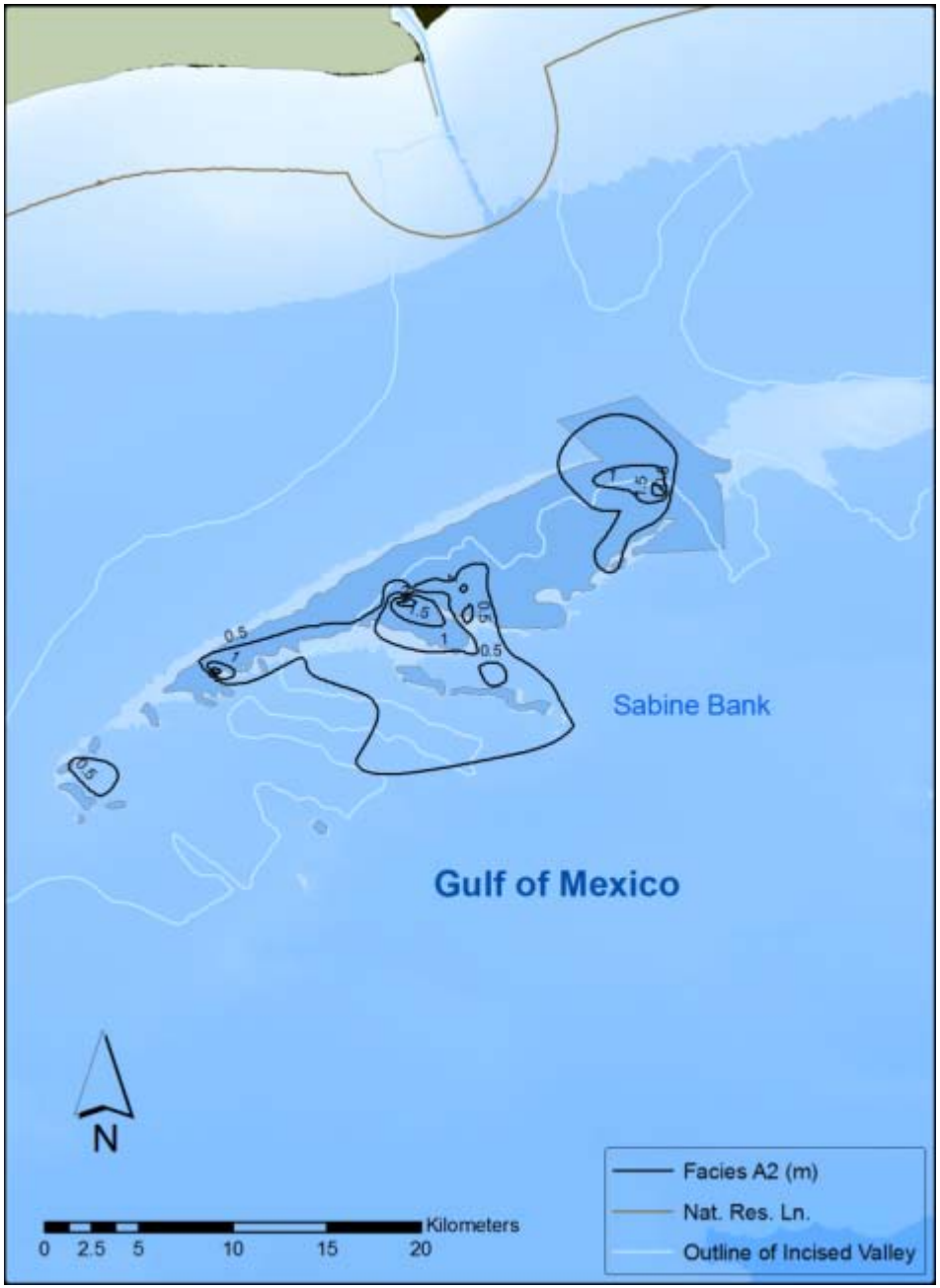


Figure 10. Net sand map of Sabine Bank shelly sand facies A2.

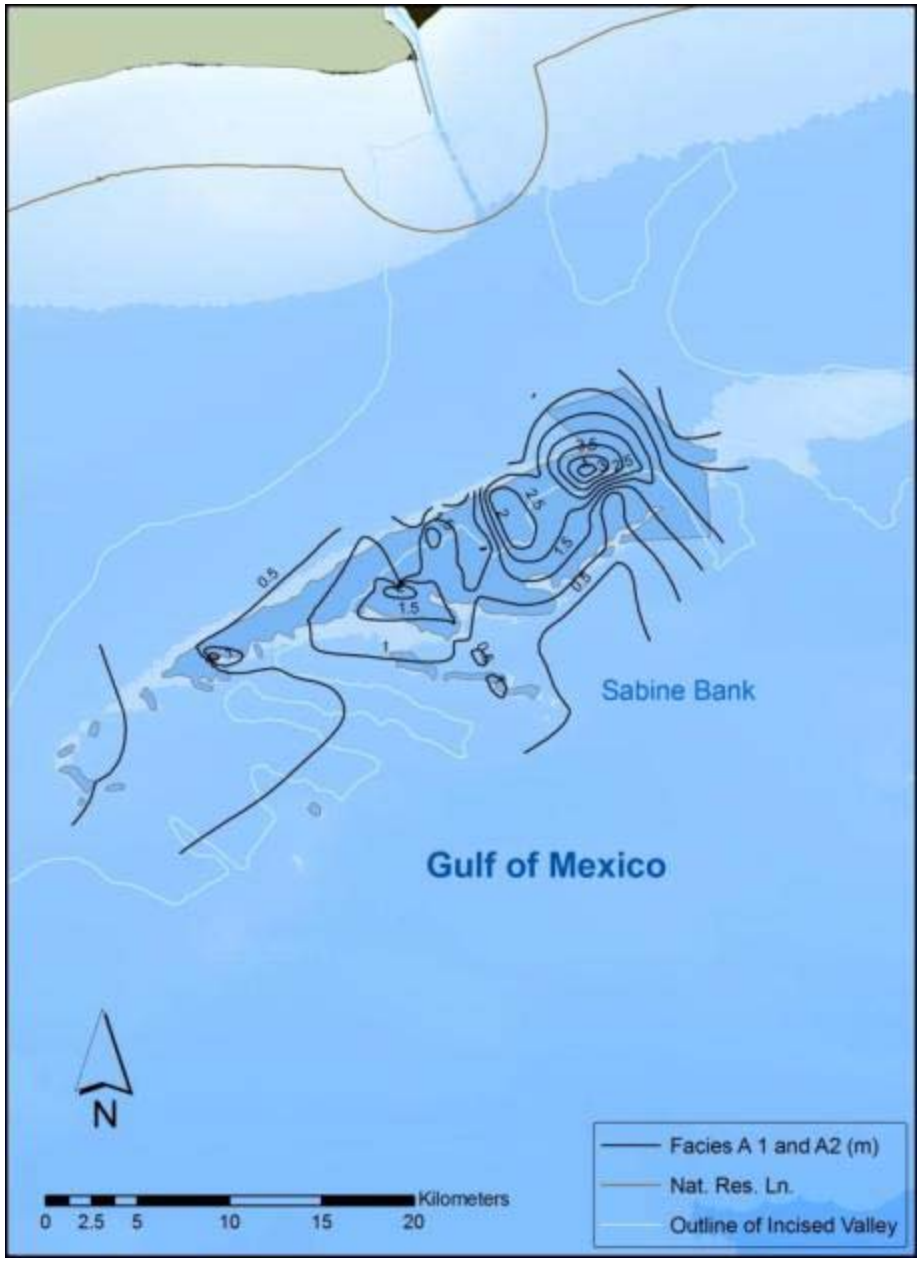


Figure 11. Net sand map of the total of Sabine Bank sandy facies A1 and A2.

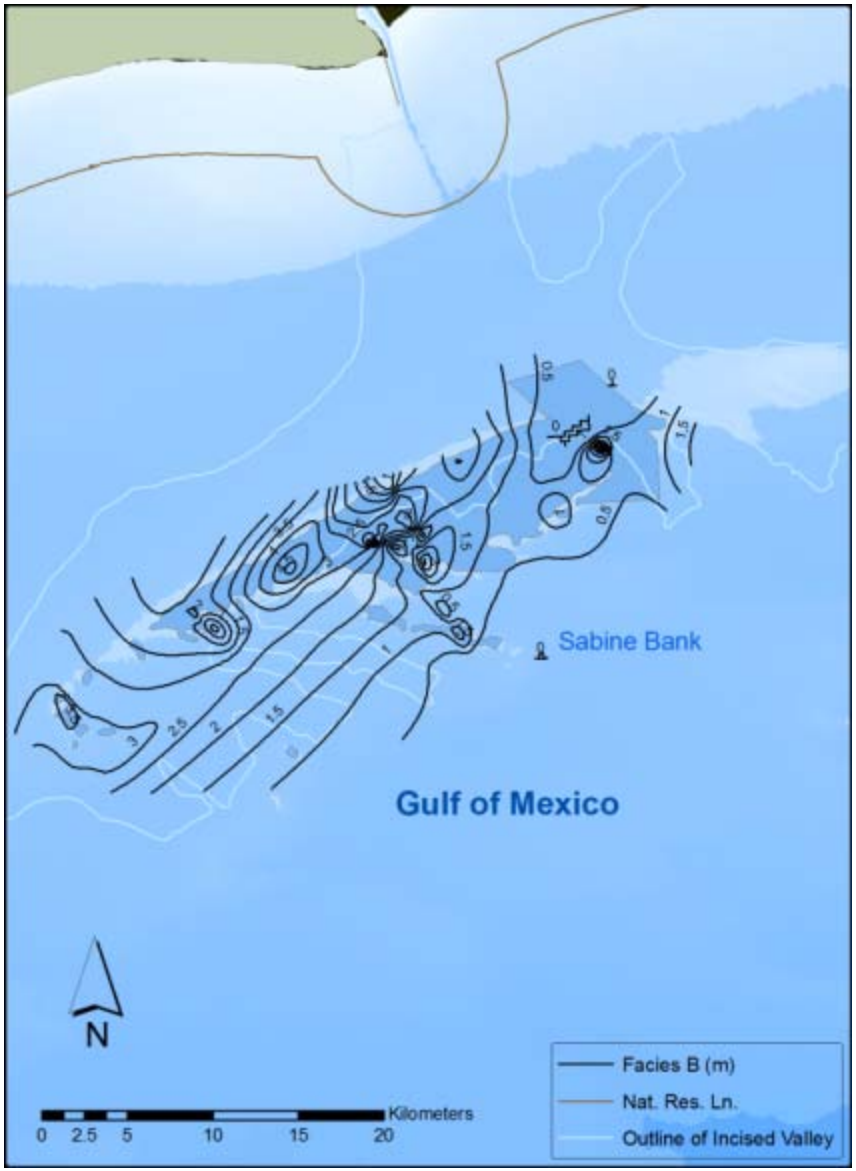
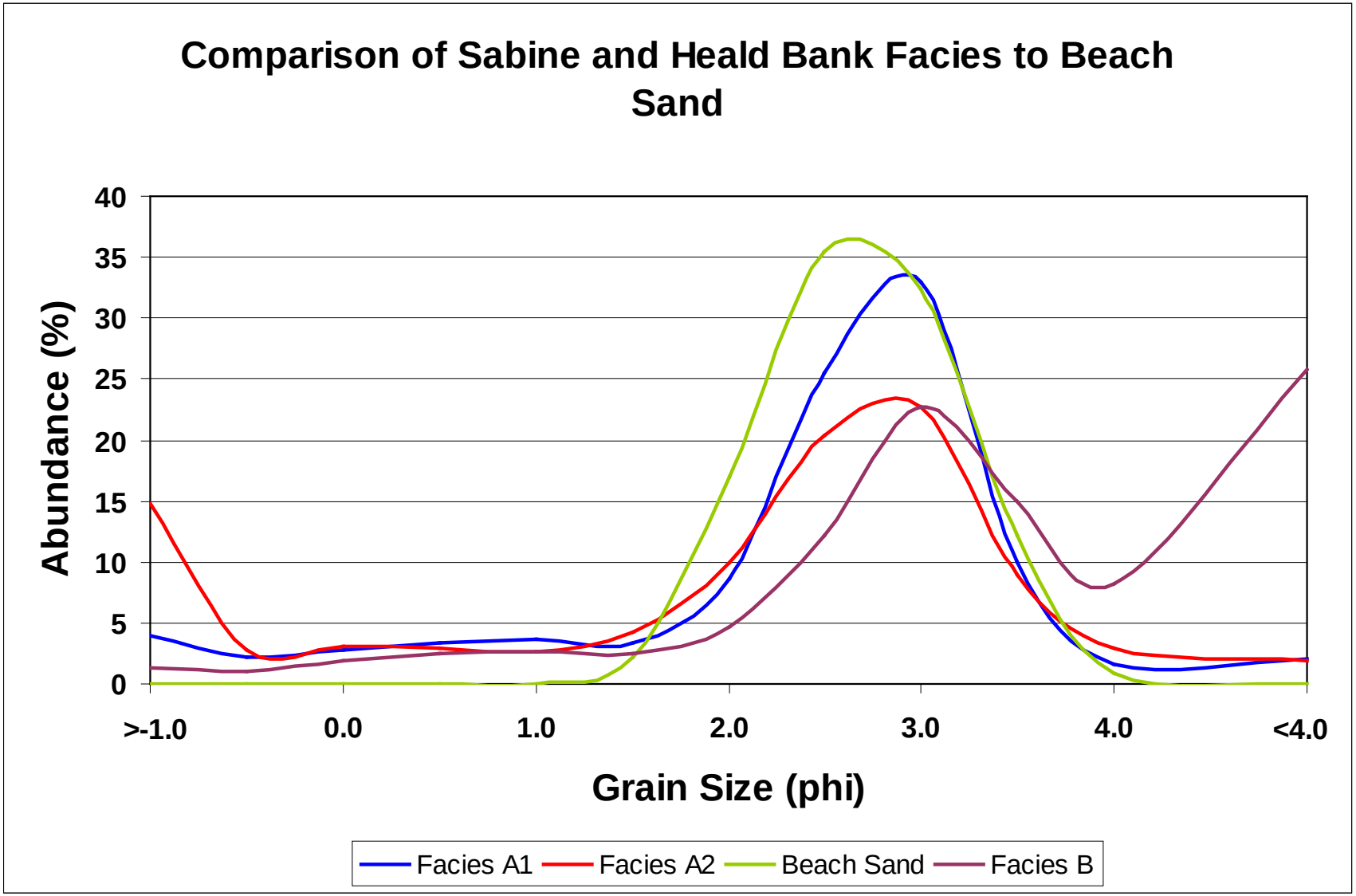


Figure 12. Net sand map of Sabine Bank muddy sand facies B.

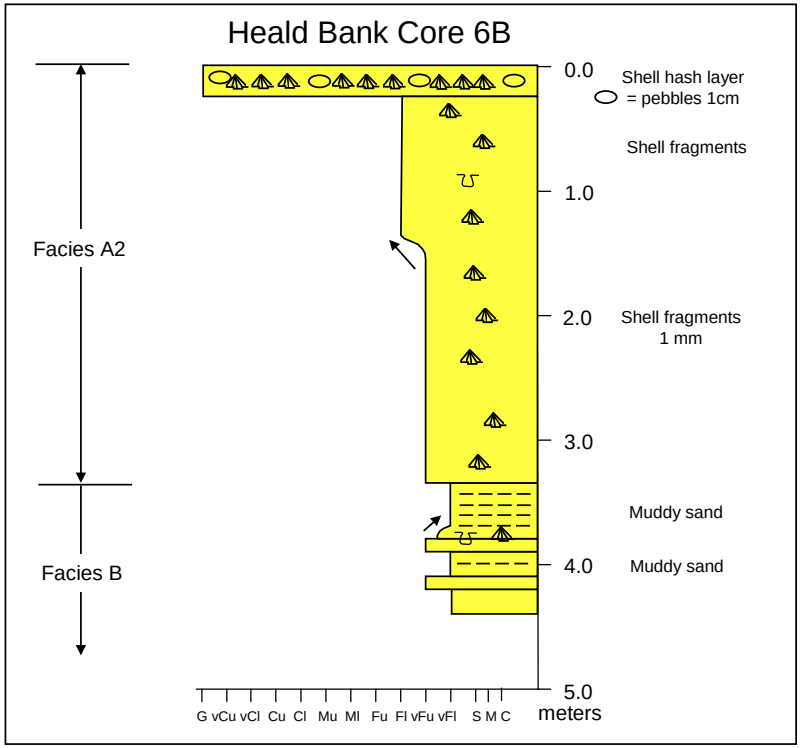


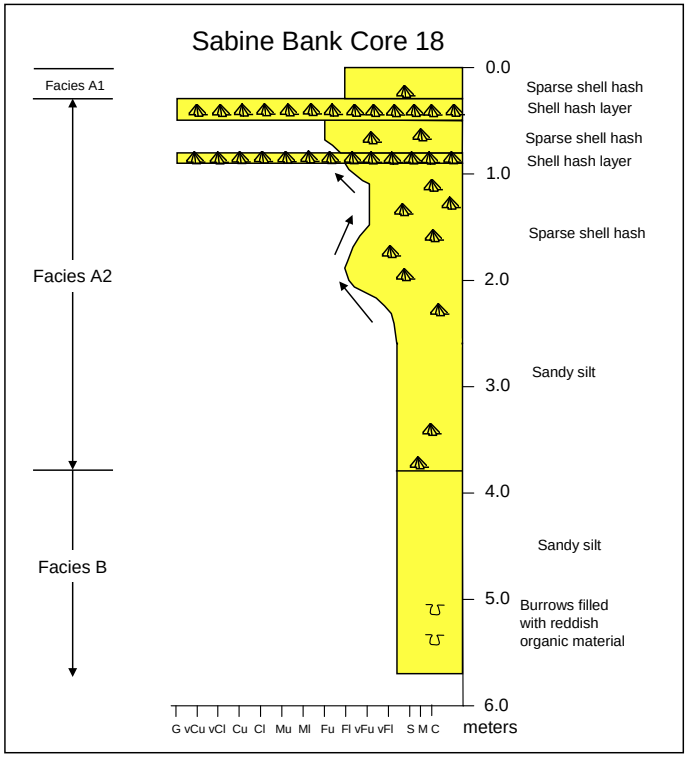
Grain size of Sabine Bank facies to Bolivar Peninsula beach sand.

Volume Estimates

	Facies A	Facies B	Facies C	Total
Sabine Bank	413 x 10^6 m^3	338 x 10^6 m^3	638 x 10^6 m^3	1389 x 10^6 m^3
Heald Bank	364 x 10^6 m^3	273 x 10^6 m^3	81 x 10^6 m^3	718 x 10^6 m^3
Total	**777 x 10^6 m^3**	661 x 10^6 m^3	719 x 10^6 m^3	2107 x 10^6 m^3

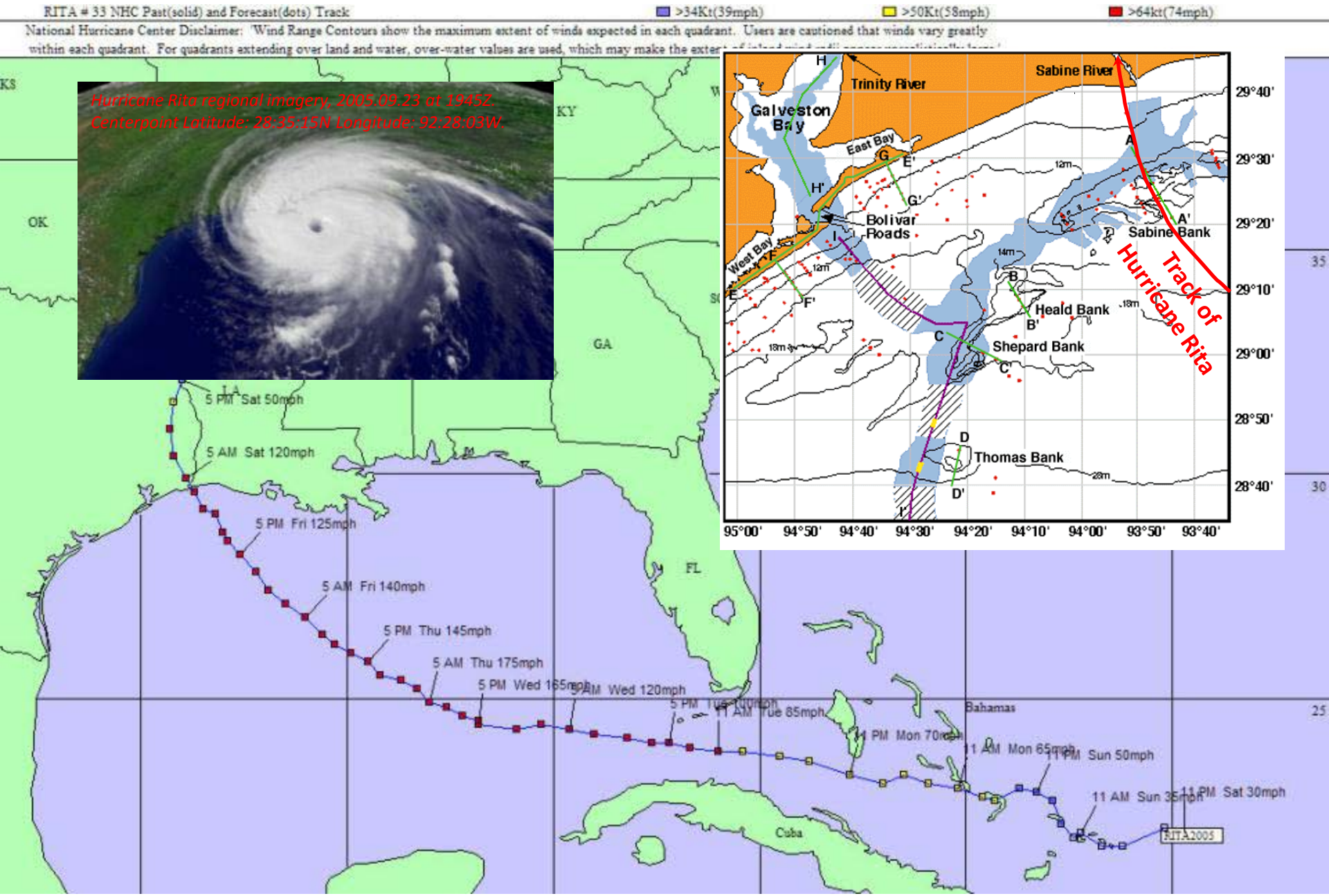
Morton and Gibeaut(1995) estimates: Sabine Bank 1200 x 10^6 m^3
Heald Bank 585 x 10^6 m^3

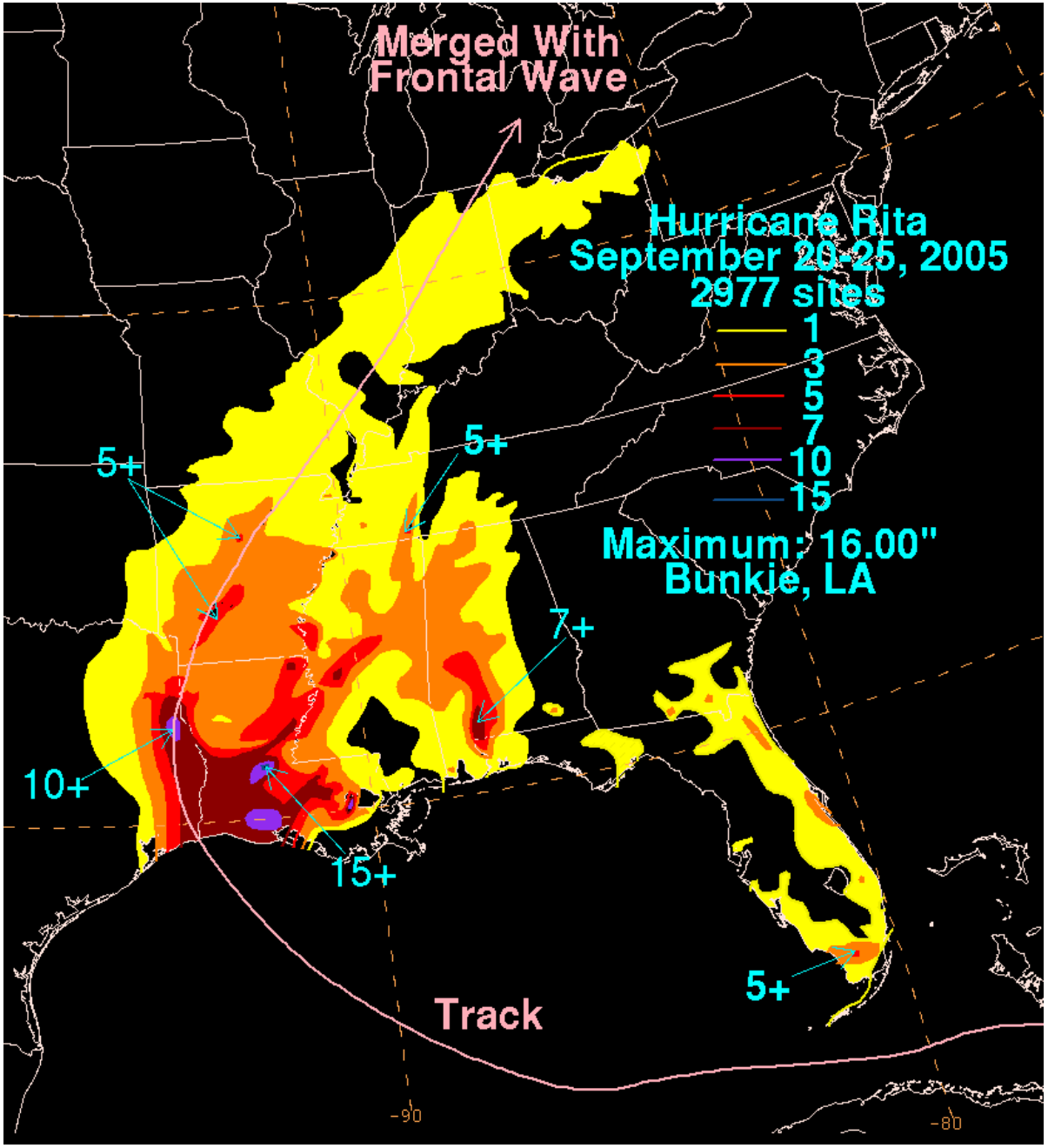




Hurricane Rita regional imagery, 2005.09.23 at 1945Z. Centerpoint Latitude: 28:35:15N Longitude: 92:28:03W.

http://www.nnvl.noaa.gov/cgi-bin/index.cgi?page=items&ser=109800


RITA # 33 NHC Past(solid) and Forecast(dots) Track
>34Kt(39mph)
>50Kt(58mph)
>64kt(74mph)
National Hurricane Center Disclaimer: Wind Range Contours show the maximum extent of winds expected in each quadrant. Users are cautioned that winds vary greatly within each quadrant. For quadrants extending over land and water, over-water values are used, which may make the extent
Hurricane Rita regional imagery, 2005.09.23 at 1945Z.
Centerpoint Latitude: 28:35:15N Longitude: 92:28:03W.
KS
OK
KY
GA
FL
Cuba
Bahamas
5 PM Sat 50mph
5 AM Sat 120mph
5 PM Fri 125mph
5 AM Fri 140mph
5 PM Thu 145mph
5 AM Thu 175mph
5 PM Wed 165mph
5 AM Wed 120mph
5 PM Tue 100mph
11 AM Tue 85mph
11 PM Mon 70mph
11 AM Mon 65mph
11 PM Sun 50mph
11 AM Sun 35mph
11 PM Sat 30mph
RITA2005
Trinity River
Sabine River
Galveston Bay
East Bay
West Bay
Bolivar Roads
Sabine Bank
Heald Bank
Shepard Bank
Thomas Bank
Track of Hurricane Rita
29°40'
29°30'
29°20'
29°10'
29°00'
28°50'
28°40'
95°00'
94°50'
94°40'
94°30'
94°20'
94°10'
94°00'
93°50'
93°40'



http://en.wikipedia.org/wiki/Image:Rita2005filledrainblk.GIF

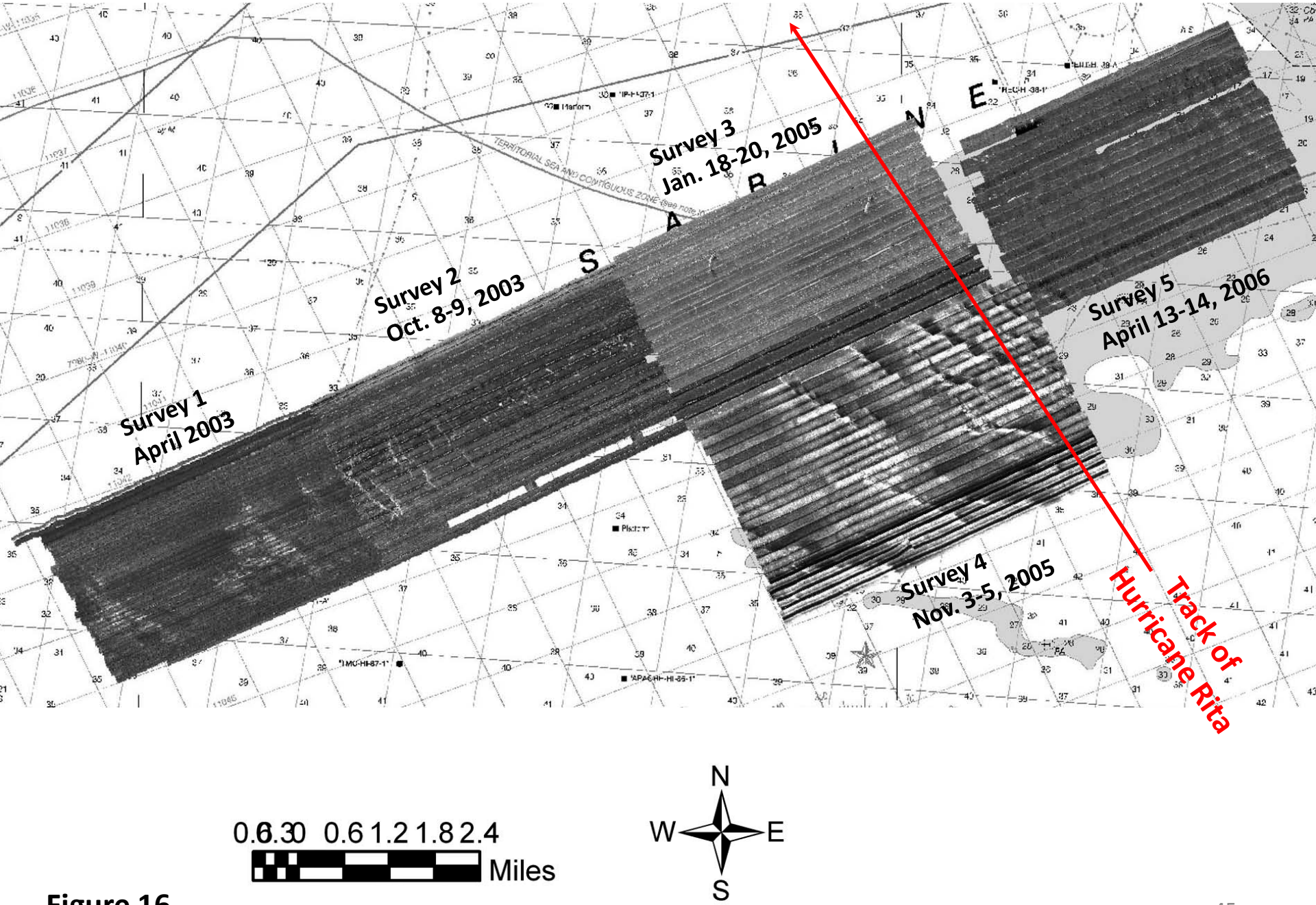
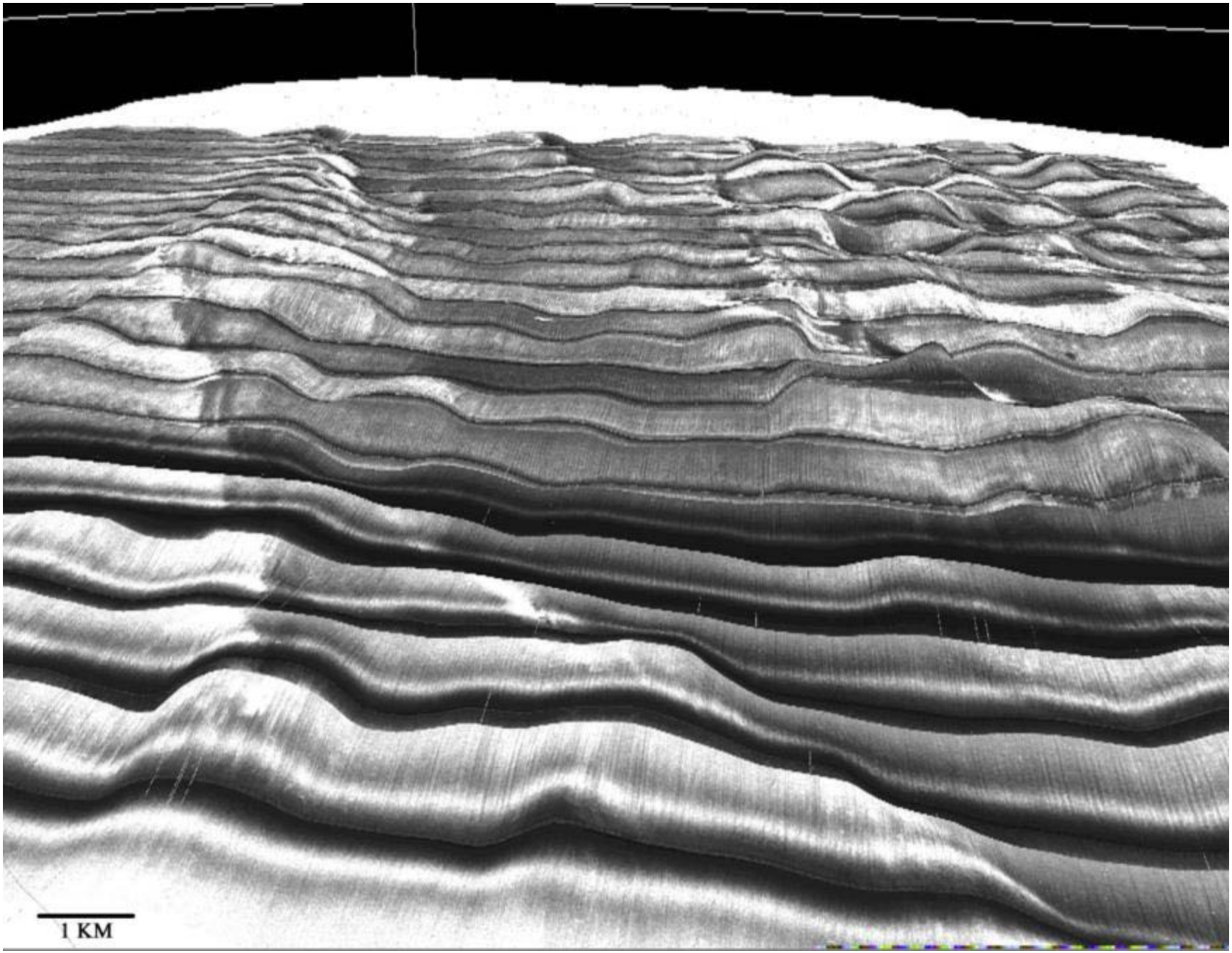

Survey 1
April 2003
Survey 2
Oct. 8-9, 2003
Survey 3
Jan. 18-20, 2005
Survey 4
Nov. 3-5, 2005
Survey 5
April 13-14, 2006
Track of
Hurricane Rita
0.6 0.3 0 0.6 1.2 1.8 2.4
Miles
N
W
E
S

Figure 16


1 KM

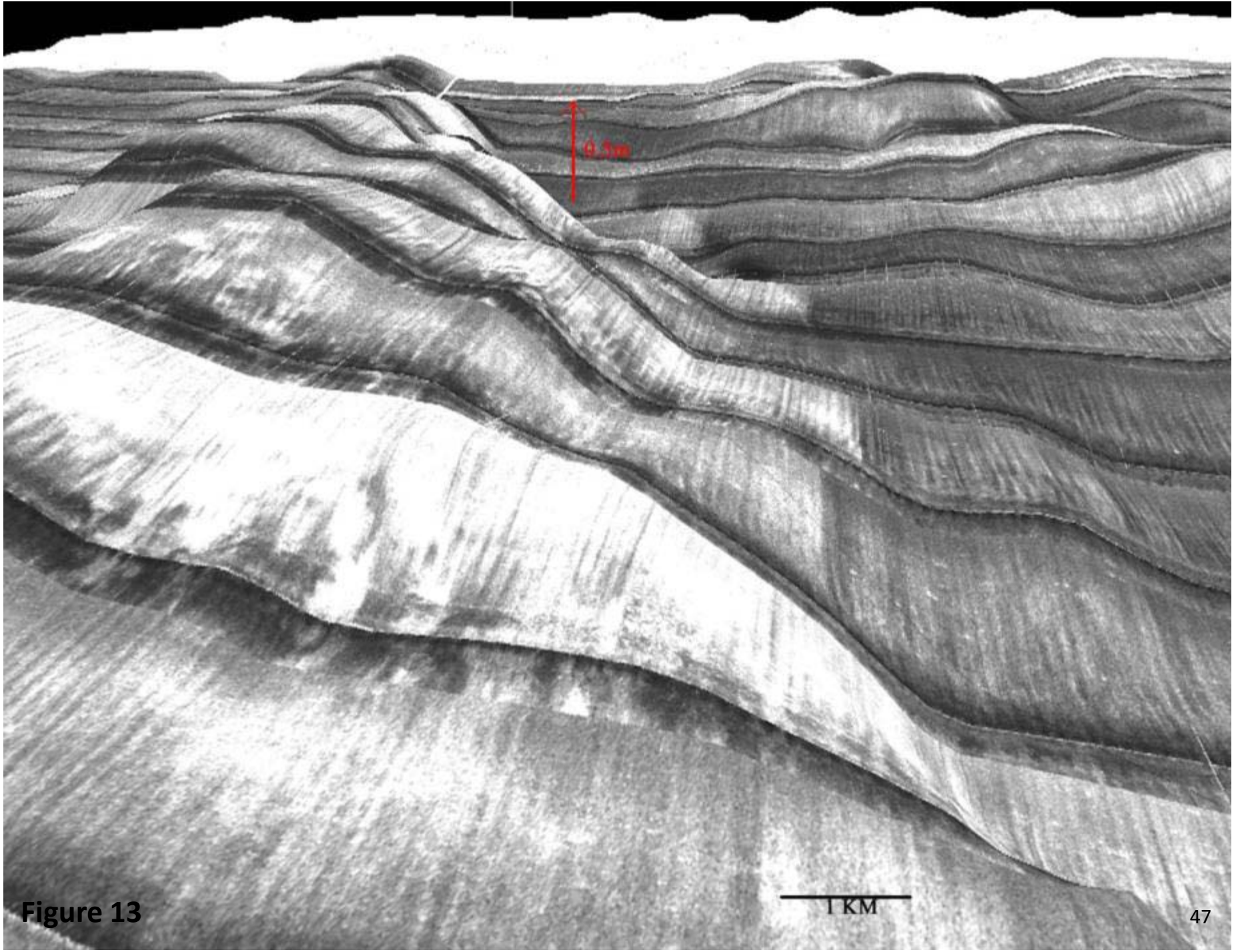


Figure 13

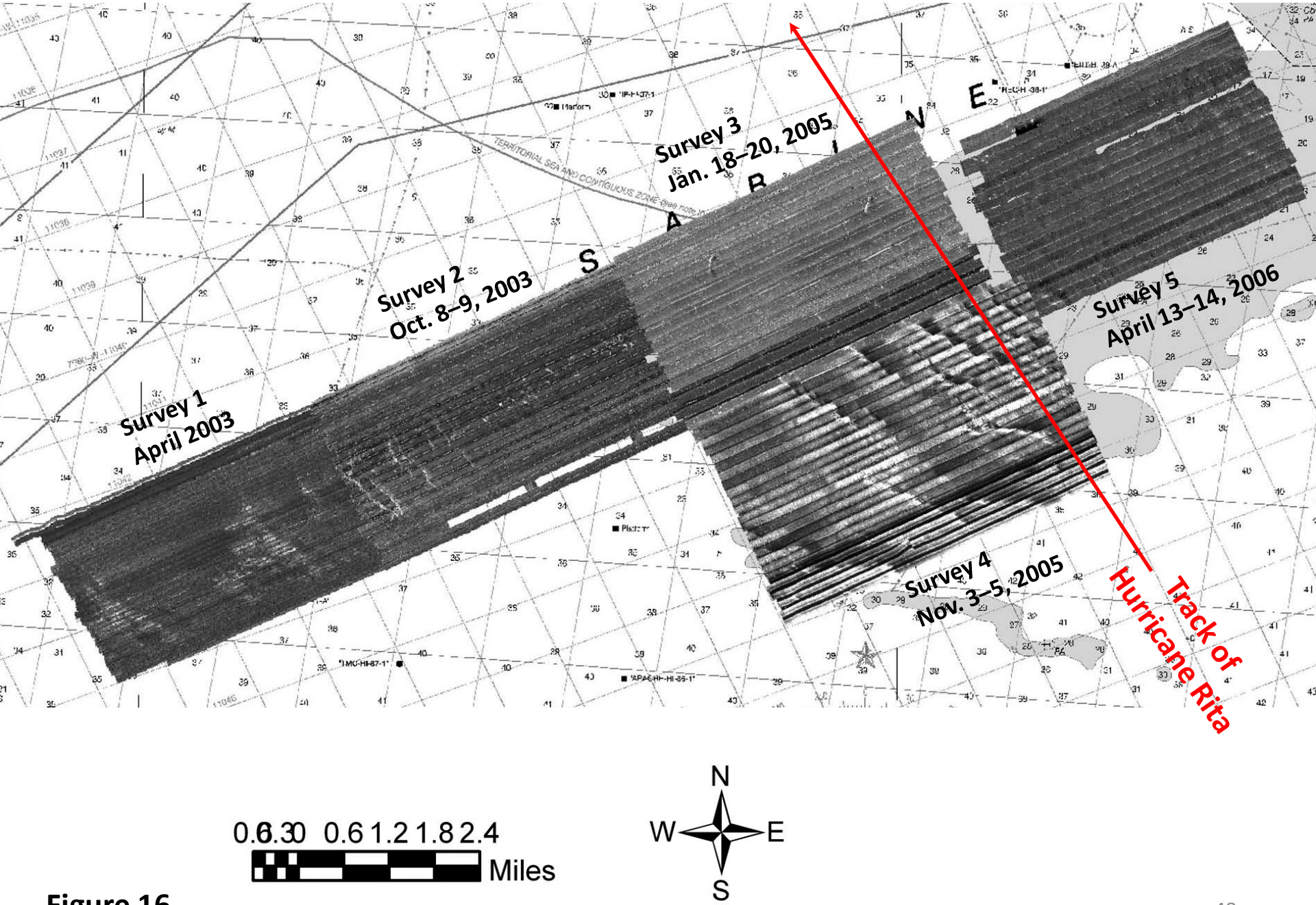
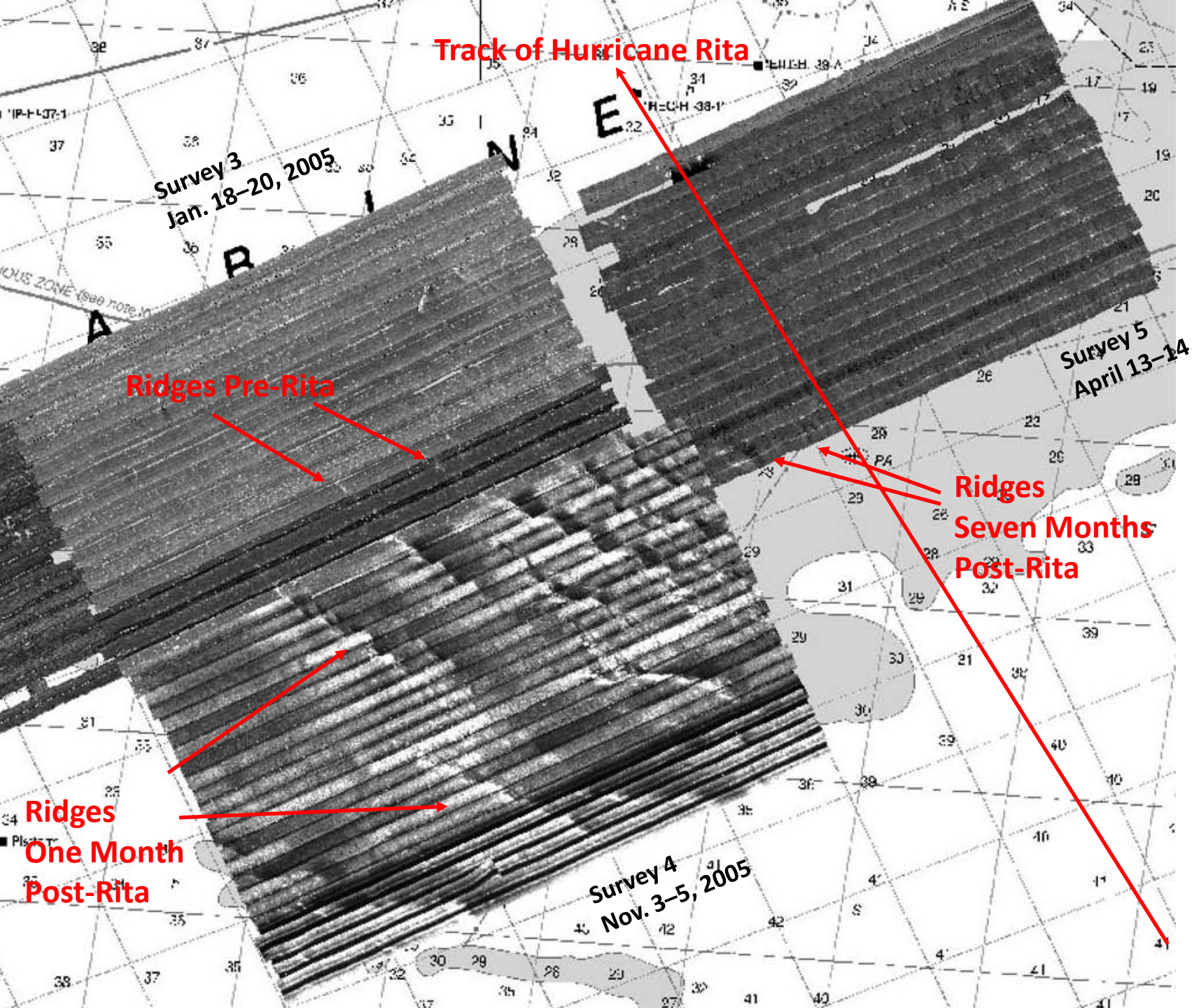
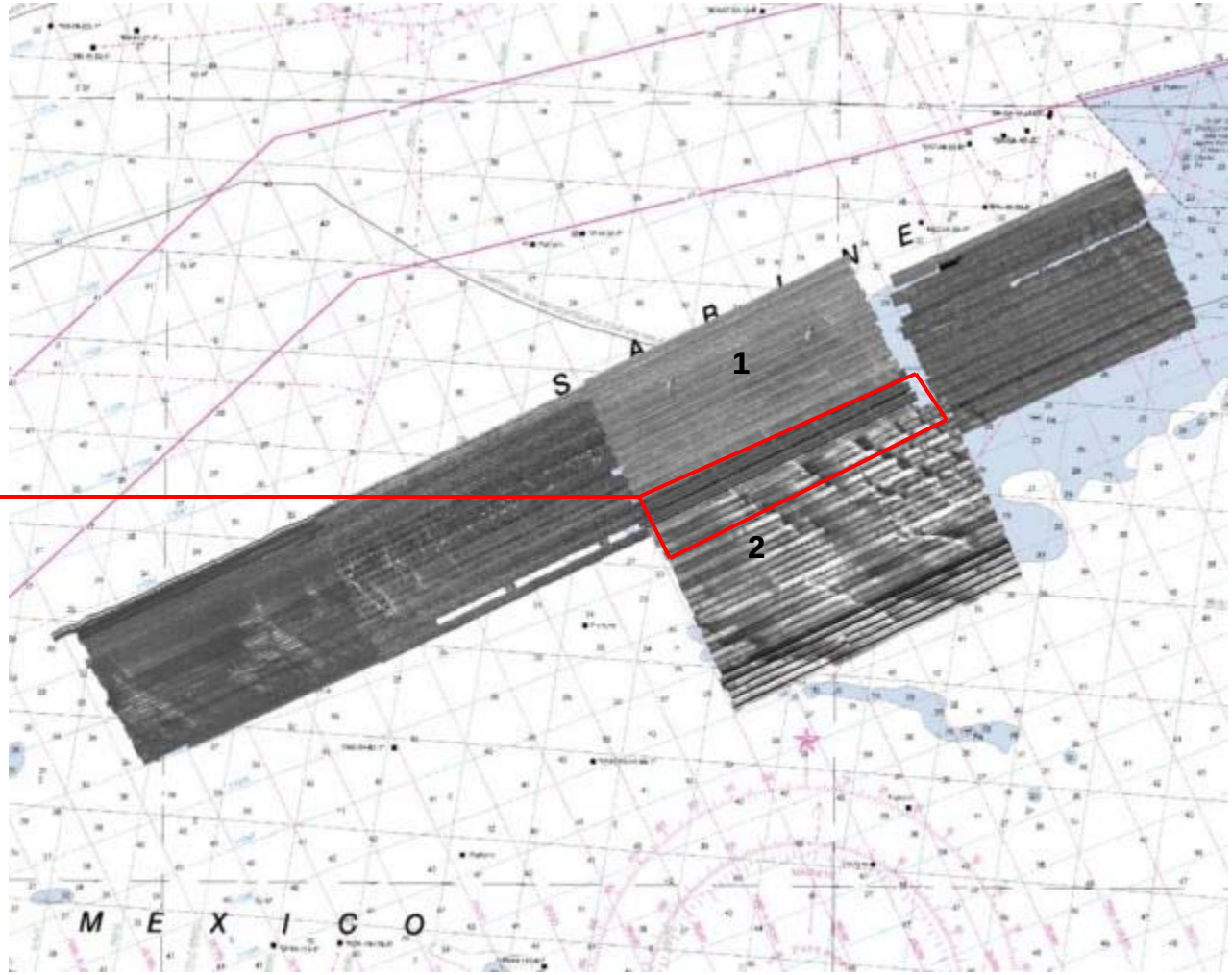

Survey 1
April 2003
Survey 2
Oct. 8–9, 2003
Survey 3
Jan. 18–20, 2005
Survey 4
Nov. 3–5, 2005
Survey 5
April 13–14, 2006
Track of
Hurricane Rita
0.6 0.3 0 0.6 1.2 1.8 2.4
Miles
N
W
E
S

Figure 16


Track of Hurricane Rita
Survey 3
Jan. 18–20, 2005
Ridges Pre-Rita
Survey 5
April 13–14, 2006
Ridges
Seven Months
Post-Rita
Ridges
One Month
Post-Rita
Survey 4
Nov. 3–5, 2005

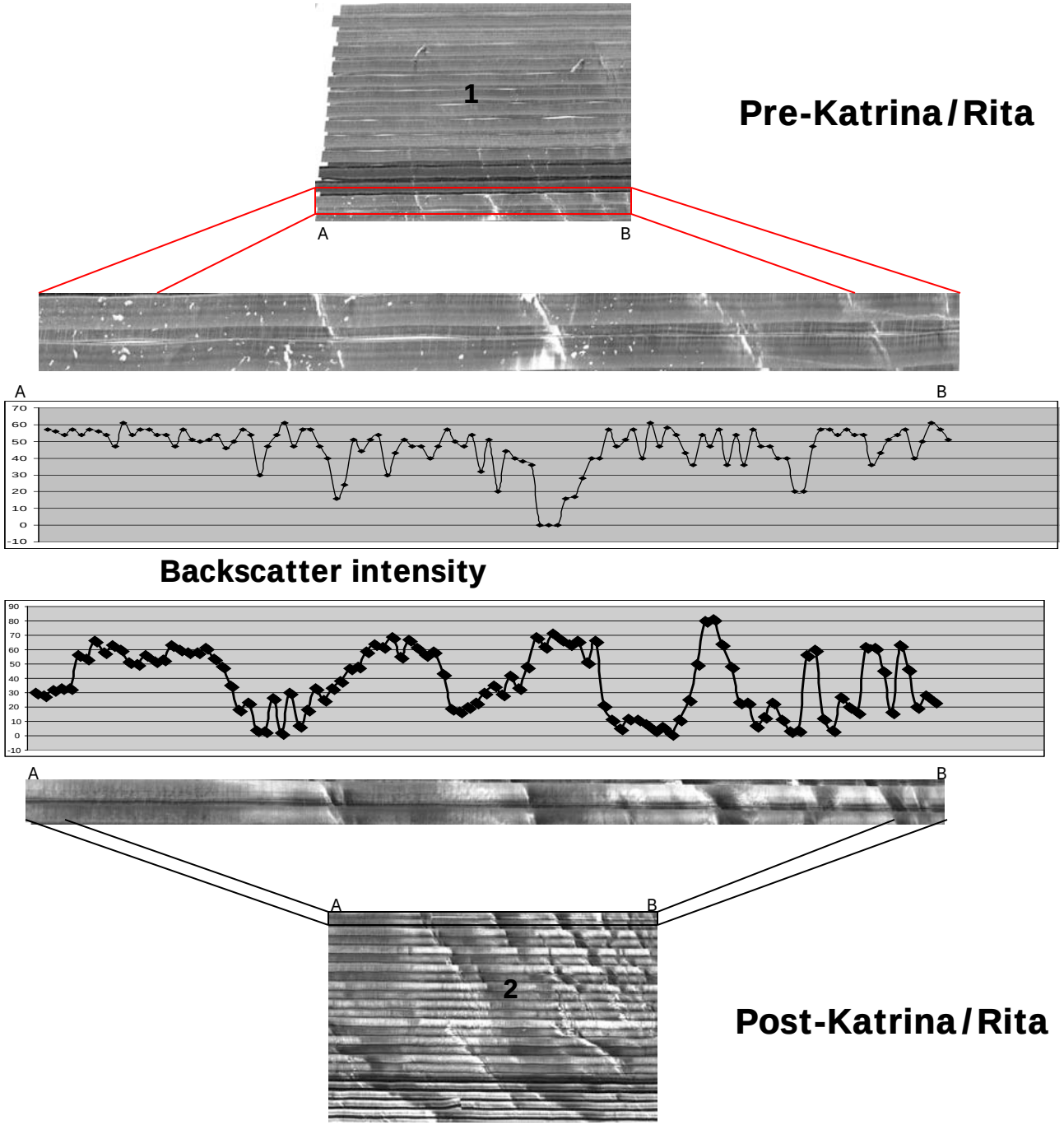
Sabine Bank Sorted Bedform Backscatter Time Series Analysis

Significant Overlap of Ridges



Survey 1 was collected before Hurricanes Katrina and Rita (Jan 2005).
Survey 2 was collected shortly after Hurricanes Katrina and Rita (Nov 2005).

Created by Scott Hiller


1
Pre-Katrina/Rita
A
B
A
B
70
60
50
40
30
20
10
0
-10
Backscatter intensity
90
80
70
60
50
40
30
20
10
0
-10
A
B
A
B
2
Post-Katrina/Rita

Summary

Crests of ridges appeared prior to Hurricane Rita

Entire ridge structure exposed 1 month after Rita

Ridges re-buried 7 months later

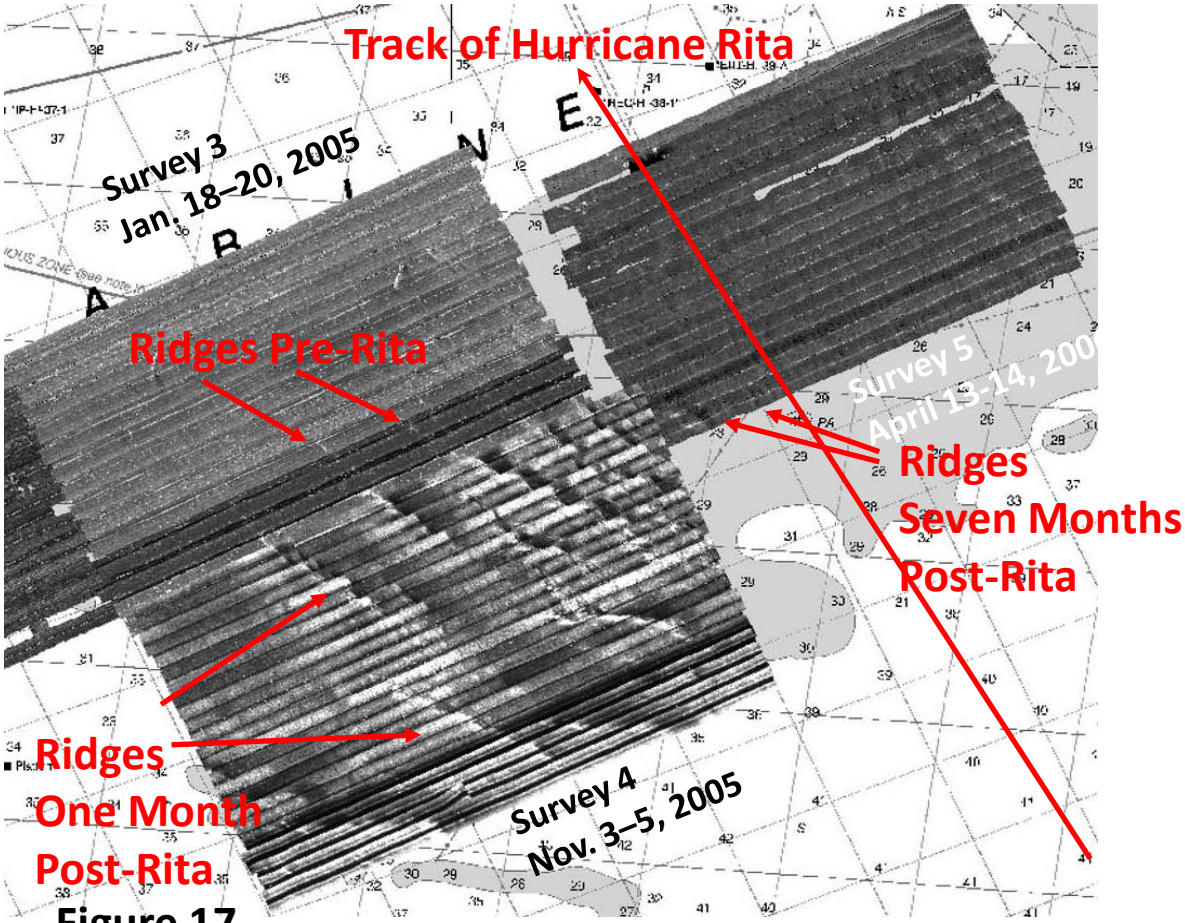


Figure 17

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