Geomorphic Expression of Subsurface Structure and Stratigraphy on St. Catherines Island, Georgia

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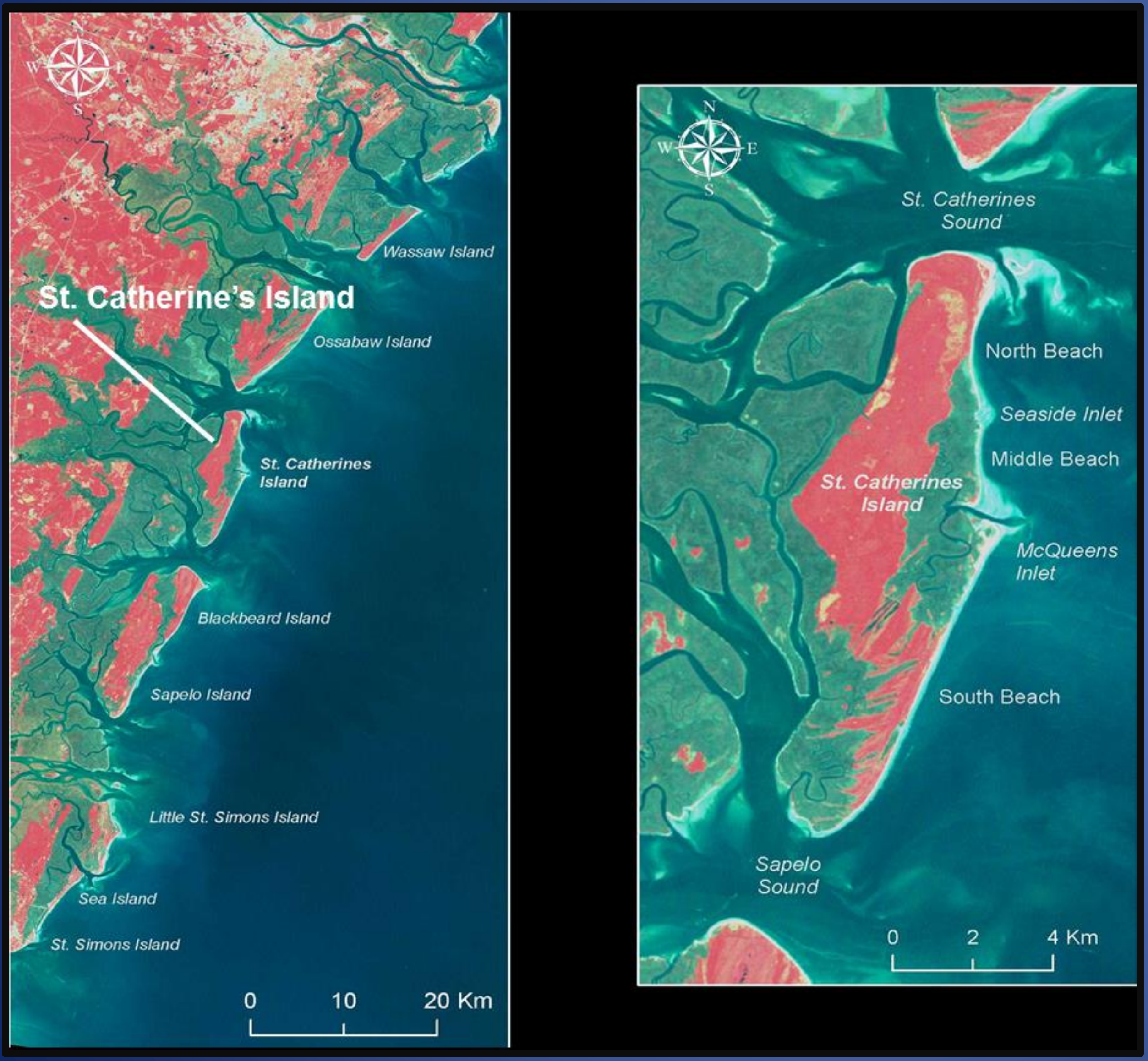
St. Catherines Island, Georgia

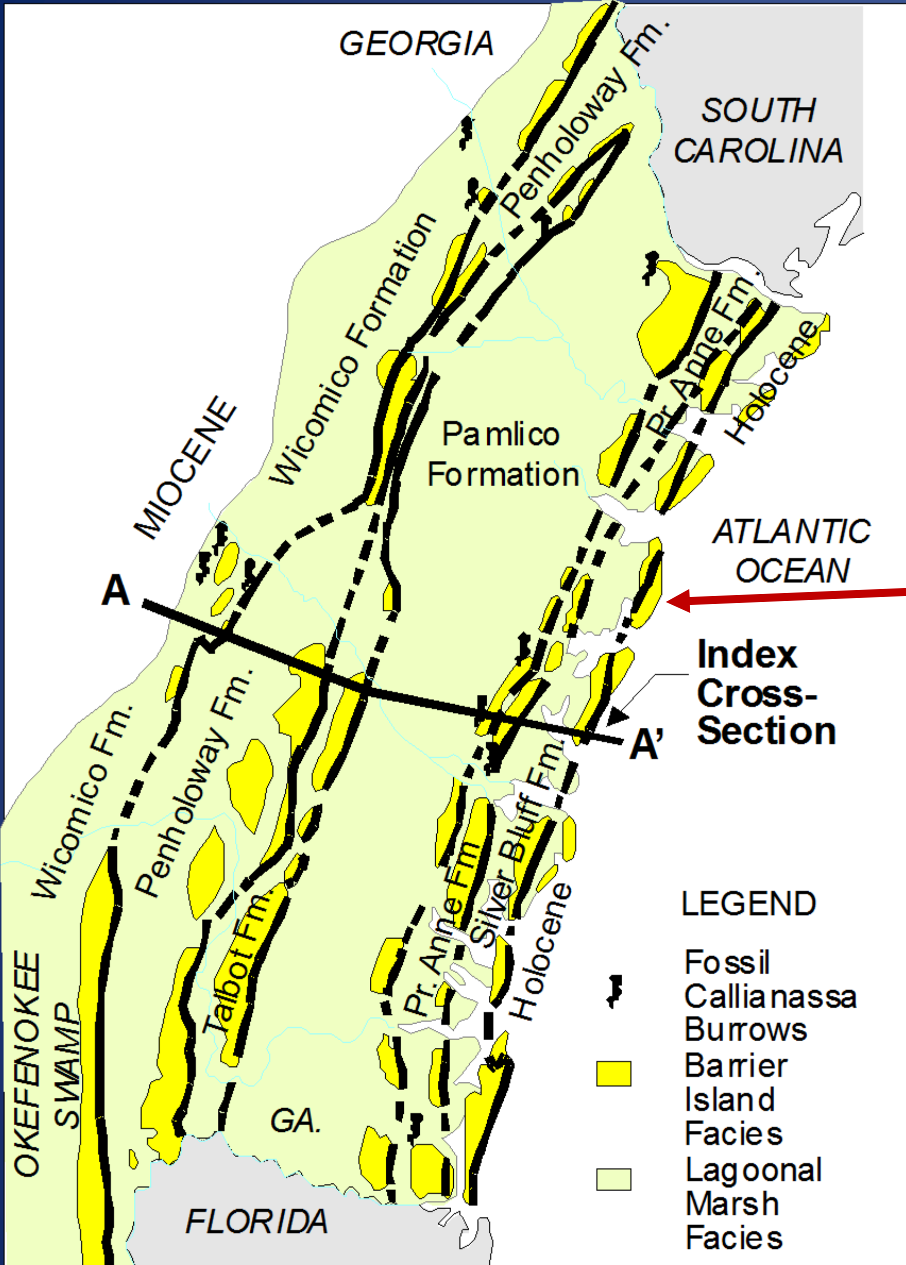


20 km long,
2 to 5 km wide

Pleistocene core with some Holocene cover and flanking Holocene ridge and swale terrain

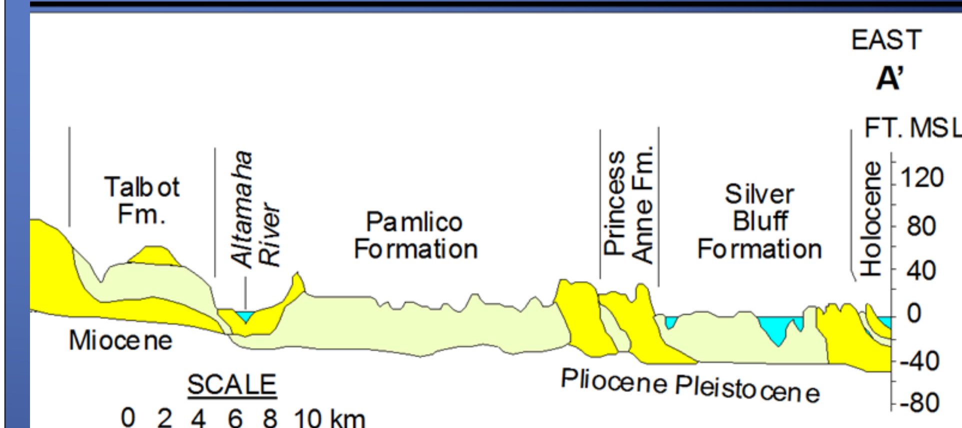
5,000 years of resource exploitation by humans !

Geological Setting



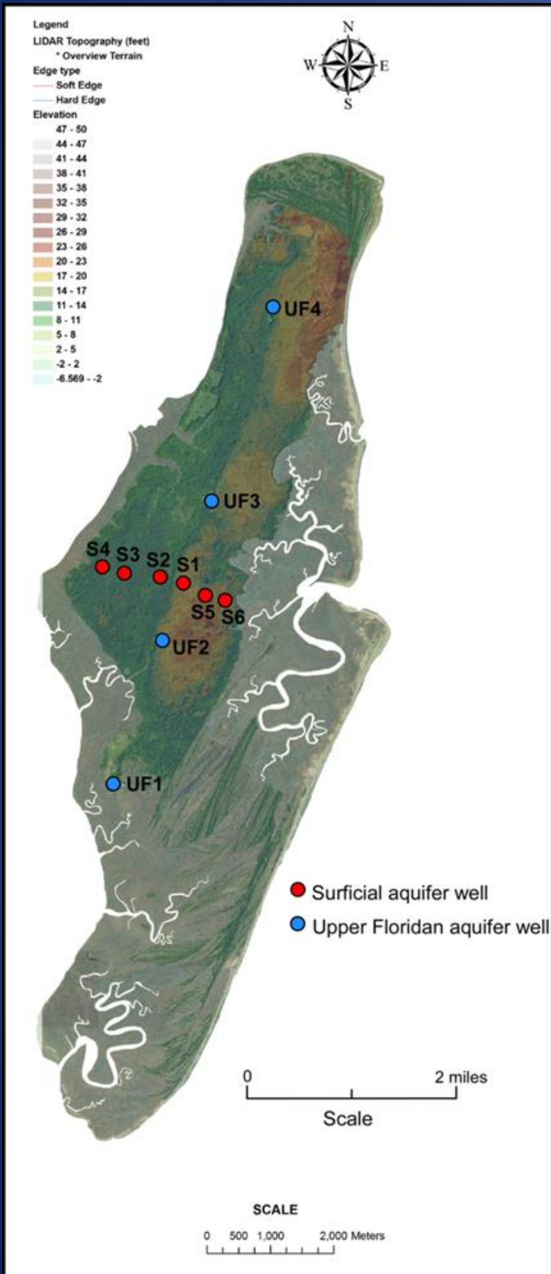
(After Hoyt & Hails, 1968)

St. Catherines Island



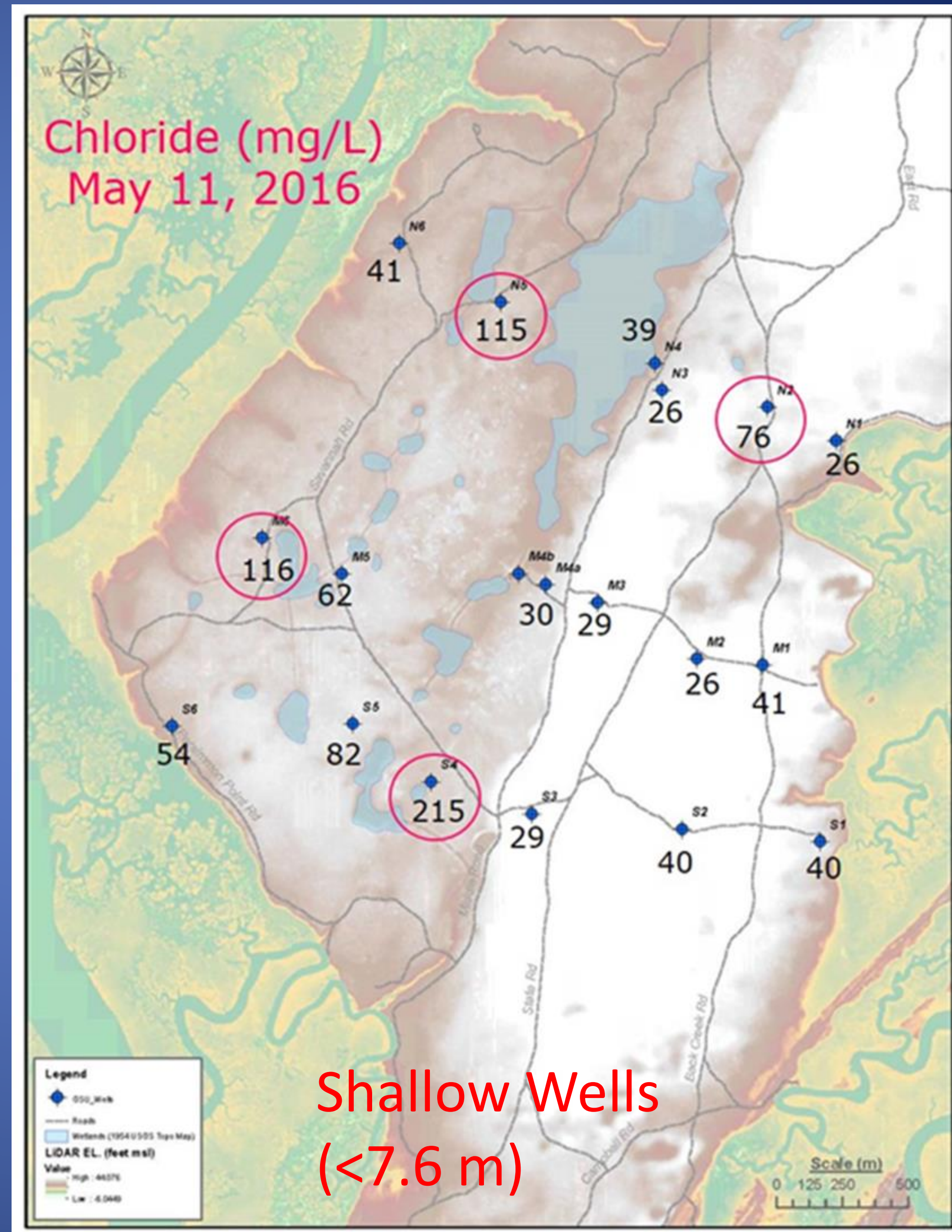
(After Hoyt & Hails, 1968)

Hydrogeology Research Focus - Saltwater Intrusion



Saltwater Intrusion in Upper Floridan and surficial aquifer !

3 m per year avg. shoreline retreat!

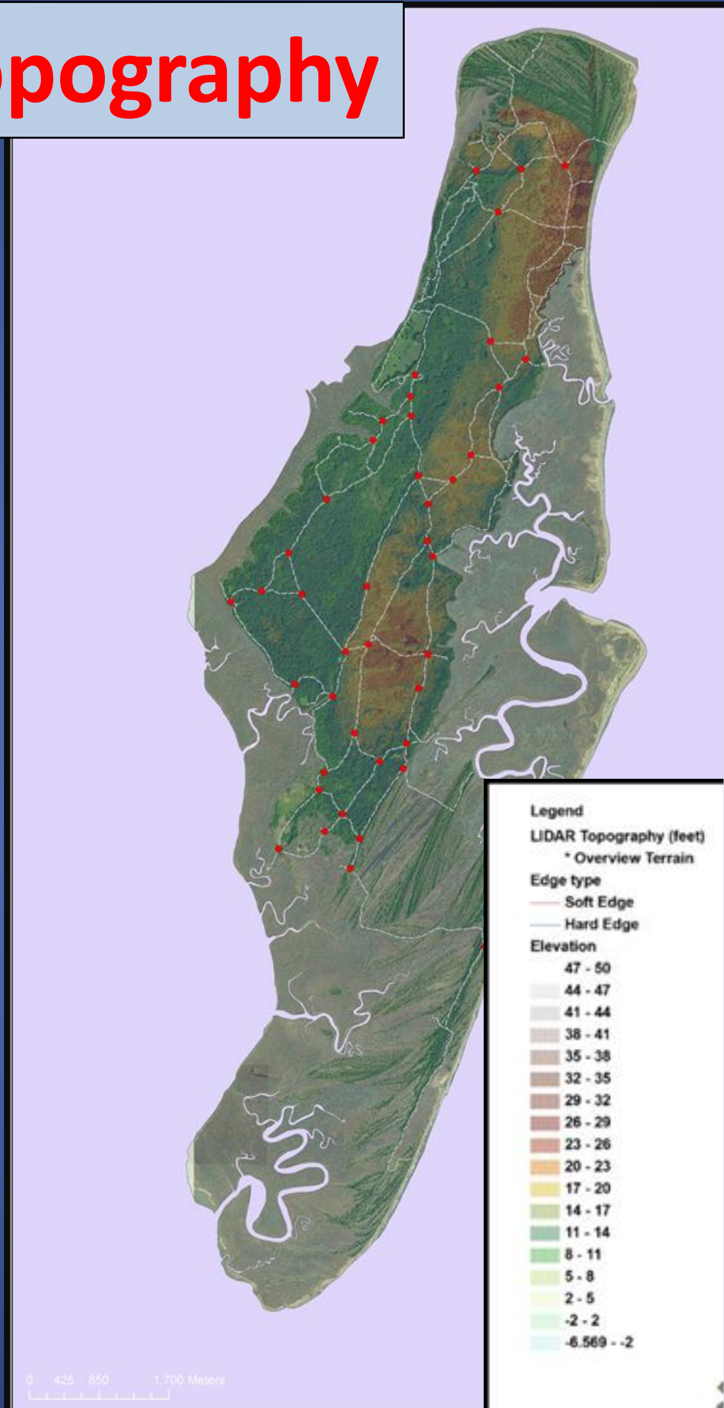


Coring, well installation, monitoring & water sampling

Geophysics – GPR & Resistivity

SCI Core Topography

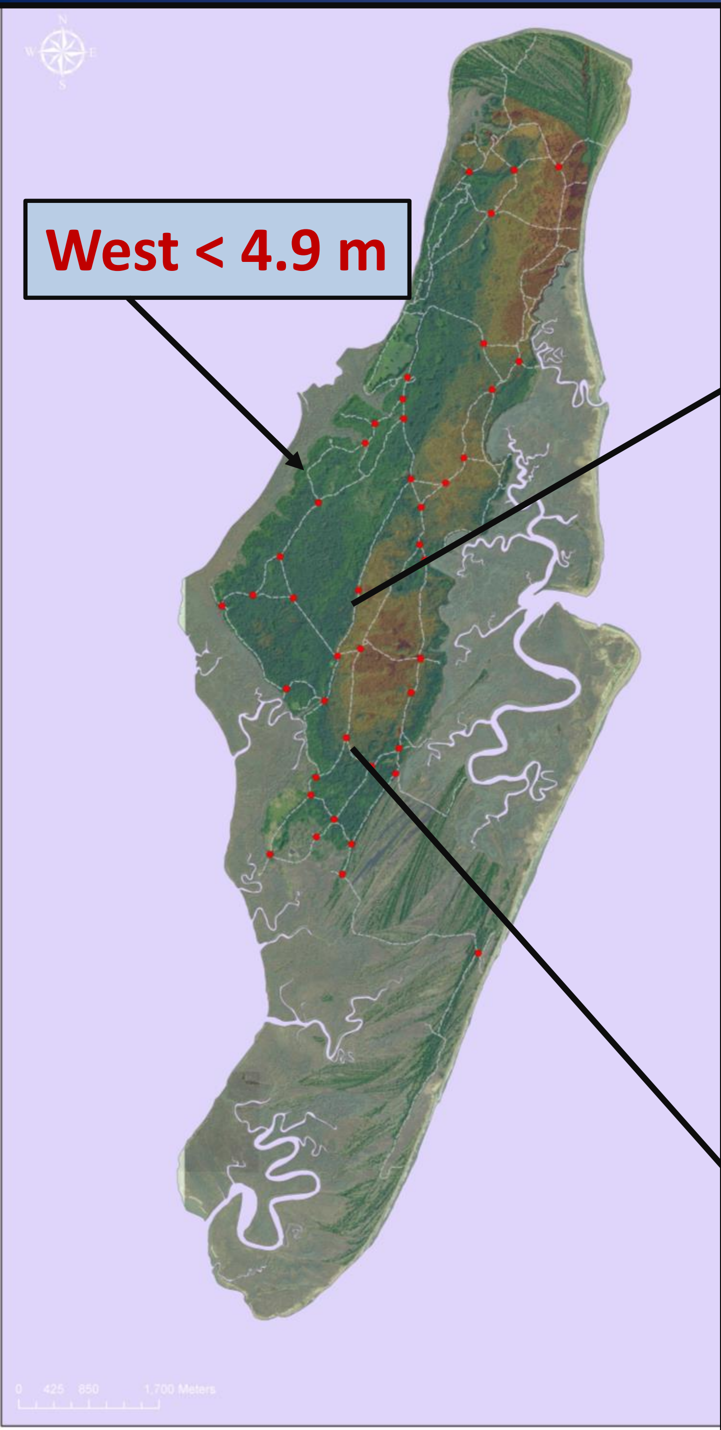
Western core lowlands and axial depression elevation:
 2 to 16 ft

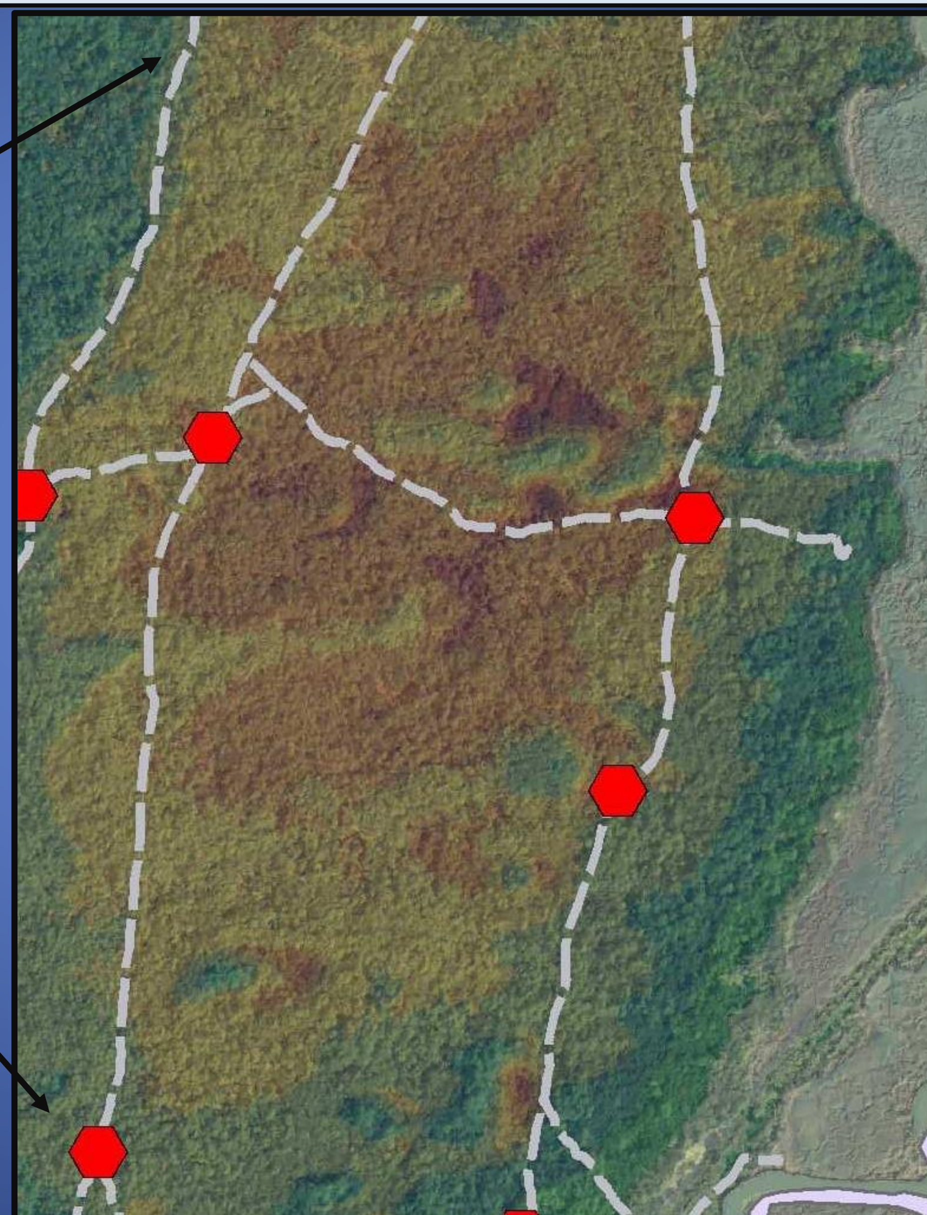


Eastern core elevation:
 14 to 26 ft

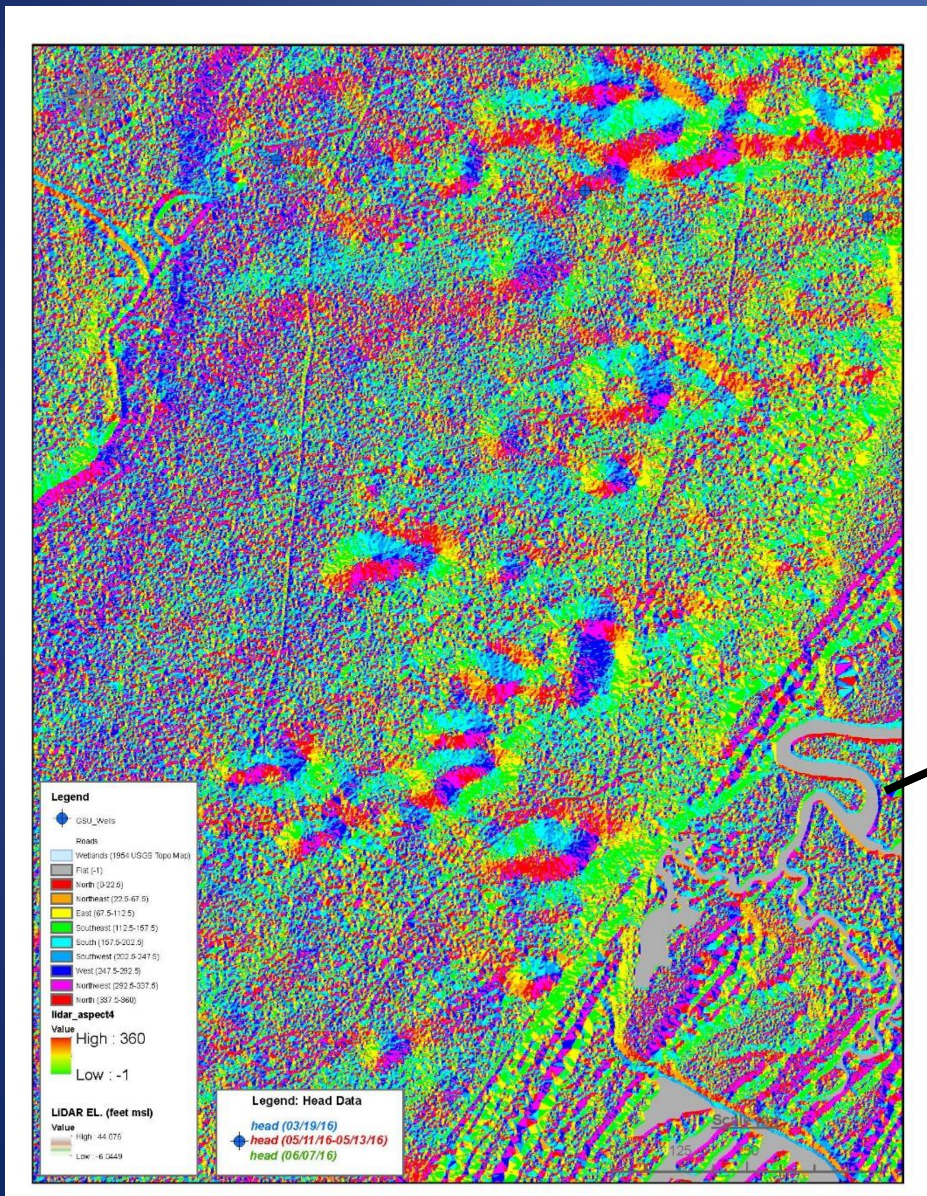
From Brian Meyer

Core data - surficial sand thickness: East > 10.7 m





LiDAR–Based Aspect Map

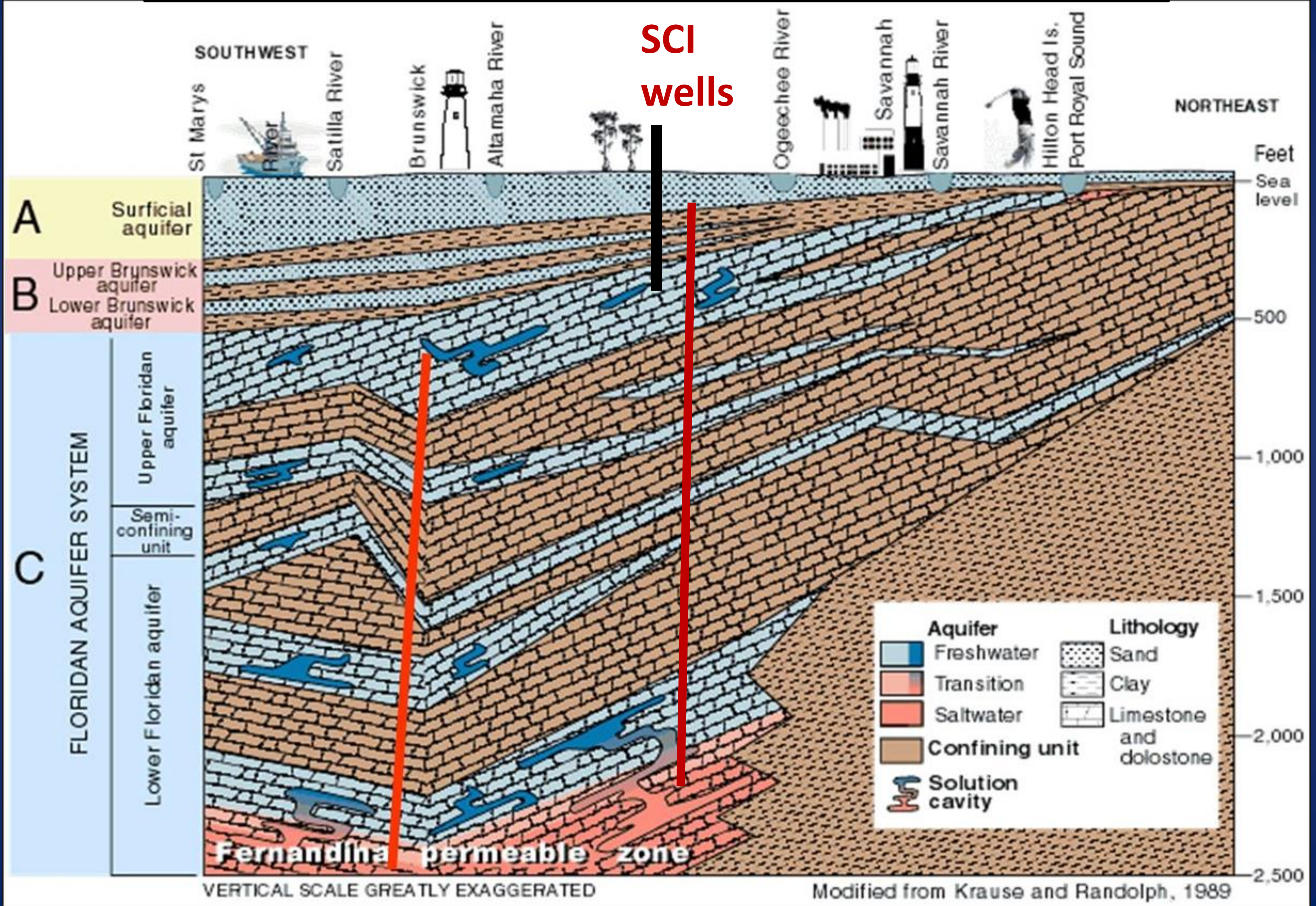


Hydrologic Evolution & Geomorphology

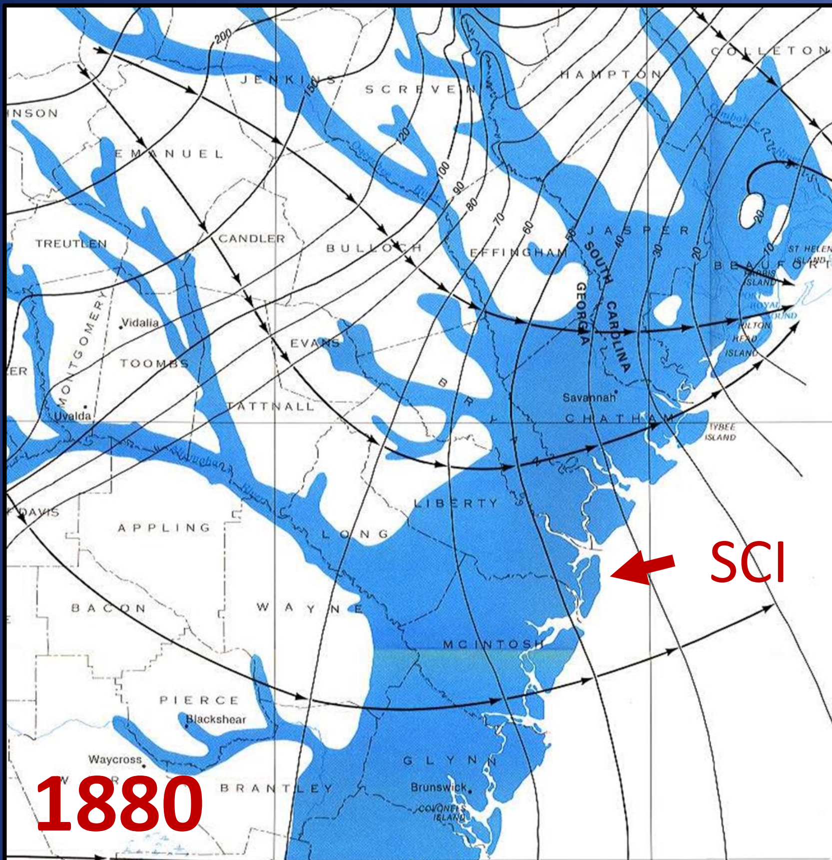
- **<u>1753 journal of Jonathan Bryan on SCI</u>**:
- "…the middle of the island appears a perfect Meadow being a large Savannah of about a Mile or Mile and half wide and four or five miles long, and finely water'd with Springs…"
- …"the cristial [crystal] Streams…"
- Palynoflora from cores verifies former wetlands.

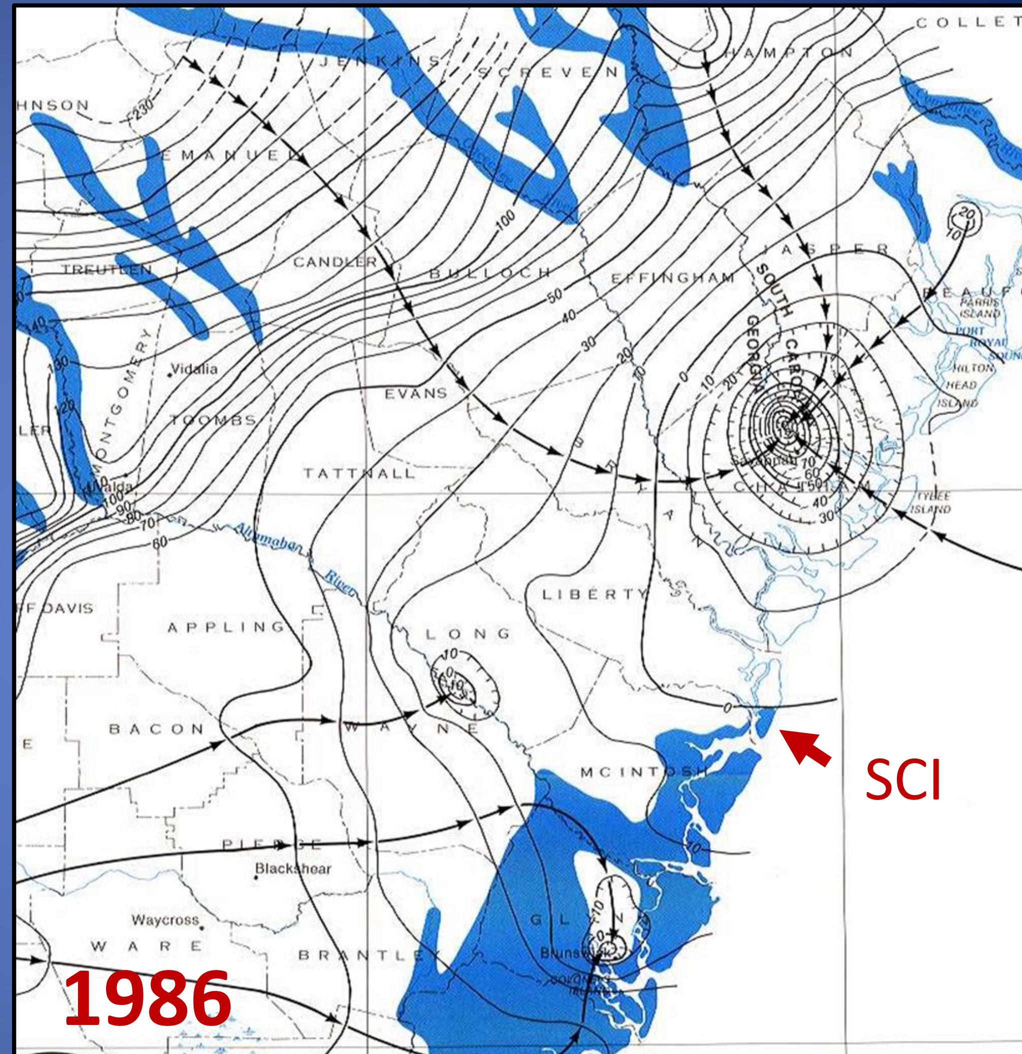
(Hayes & Thomas, 2008; Ferguson, Rich, Vance, 2010)

Salt water intrusion from below via fault system.



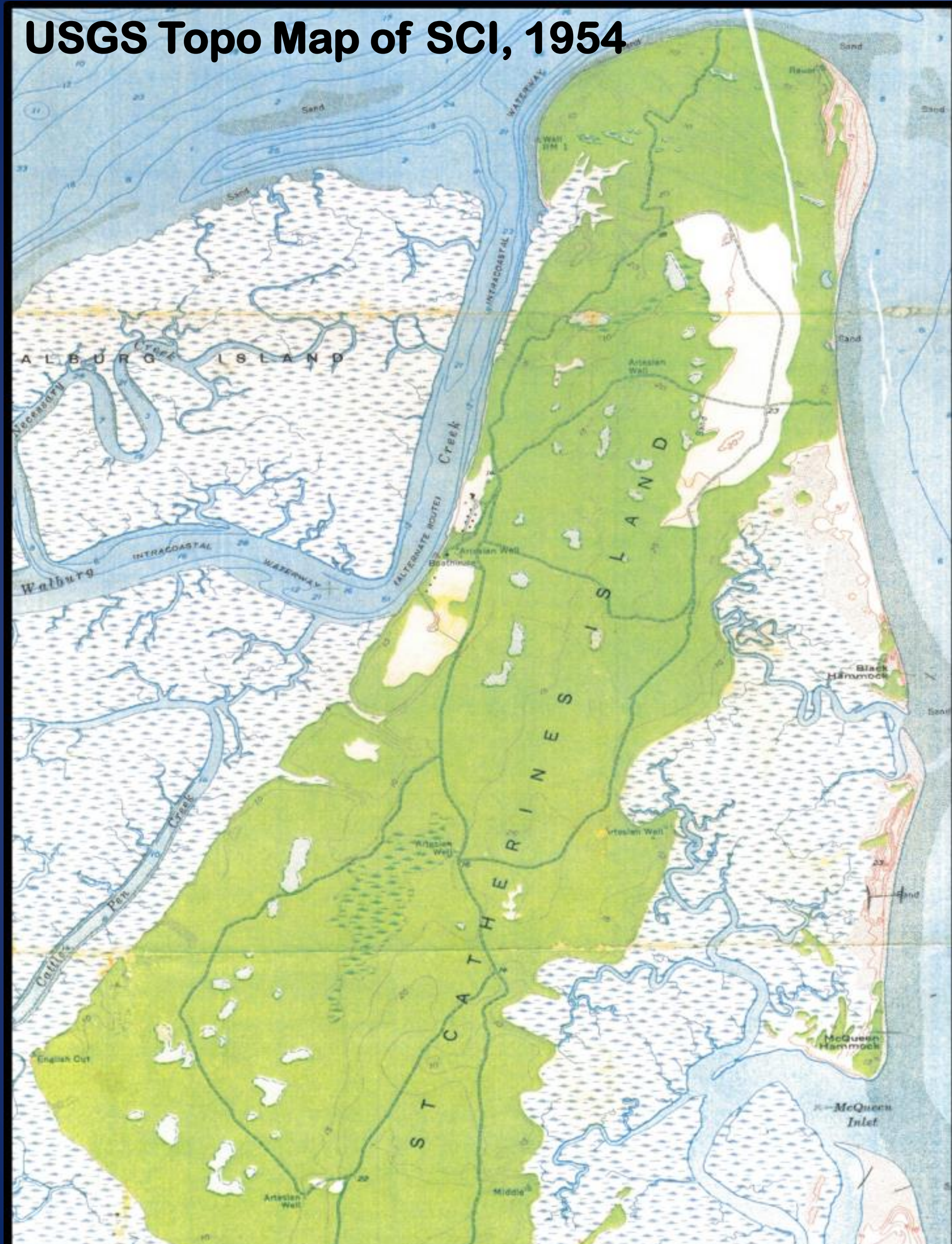
Upper Floridan aquifer - (Krause and Randolph, 1989)

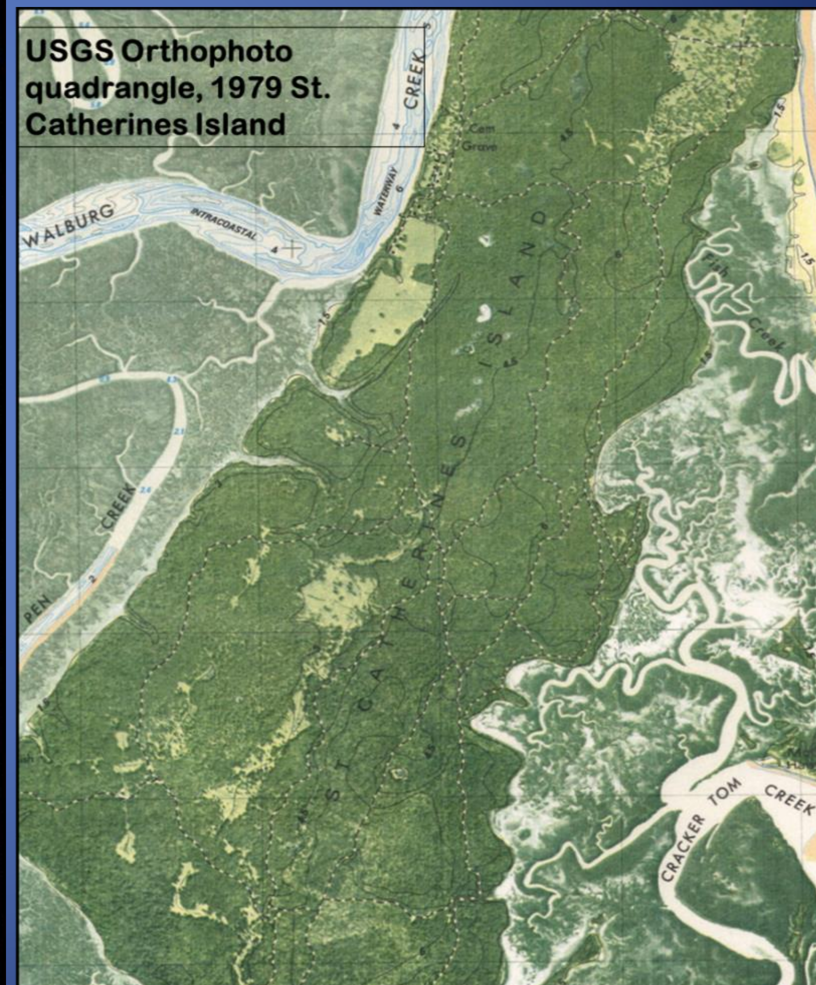




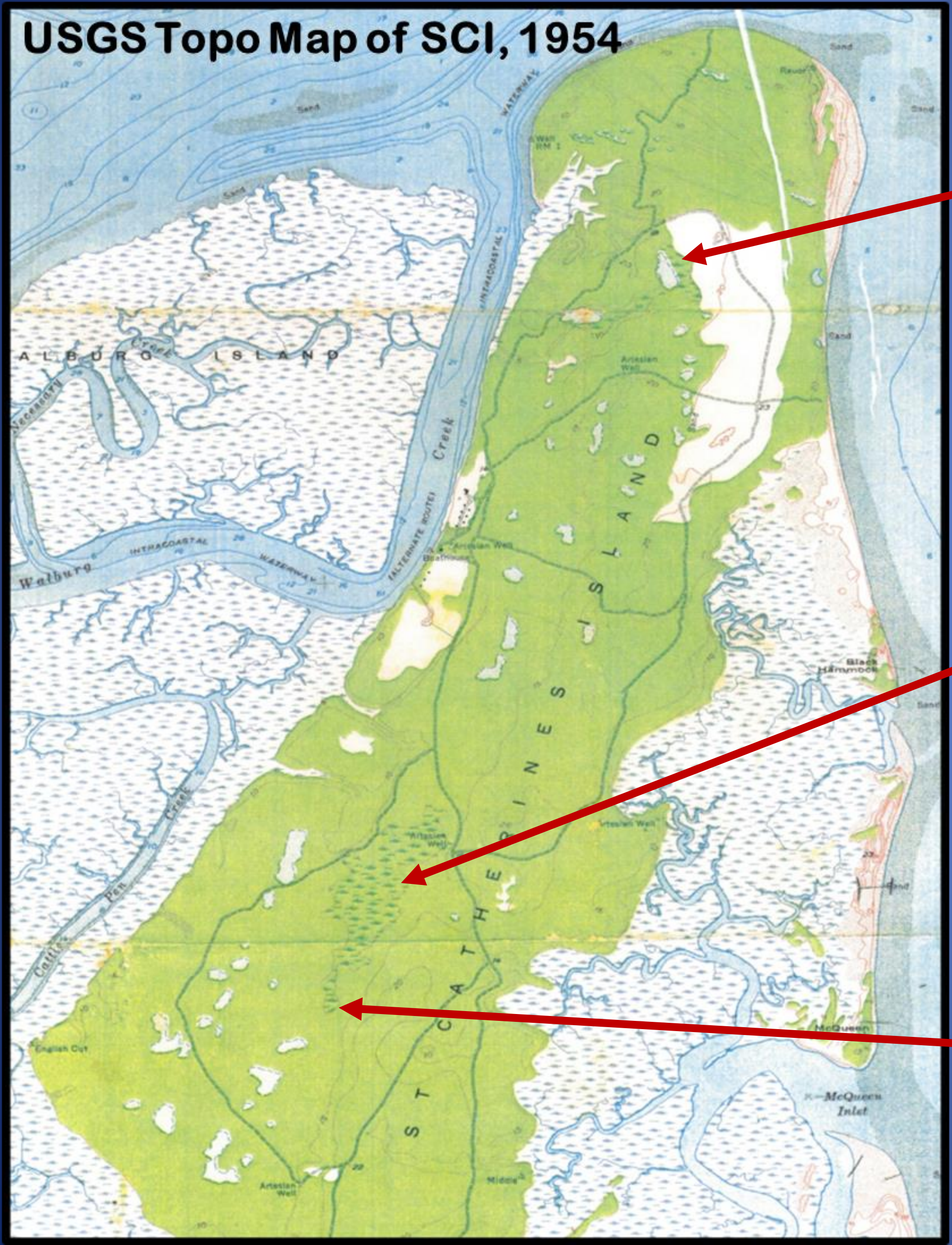
Artesian well on Sapelo Island between 1915 & 1934

SCI wetlands ditched and drained in late 1950’s



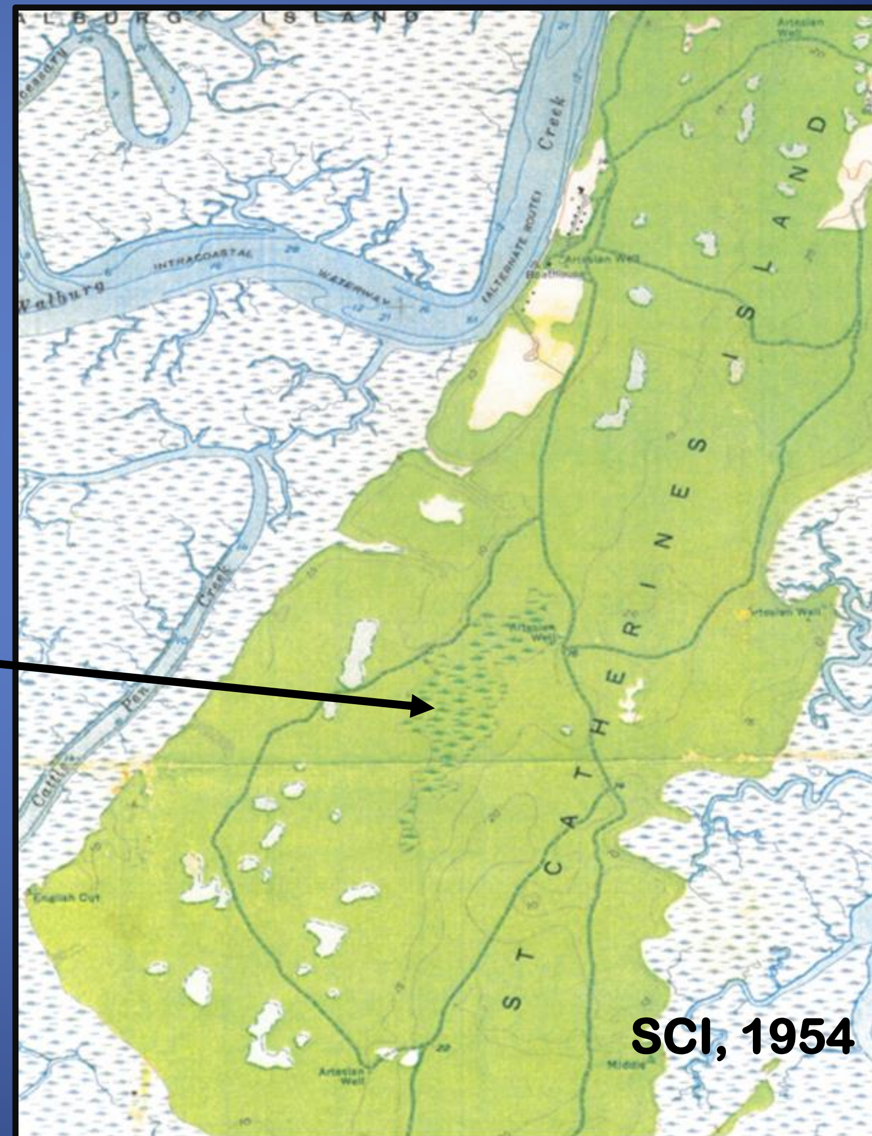


Only remnants of former perennial wetlands remain



Manadarin (Ma) & Rutledge (Ru) Soils mark former wetlands (Reitz et al., 2008) AMNH Anthr. Pap. No 88

USDA – NRCS
Liberty County
Soil Map



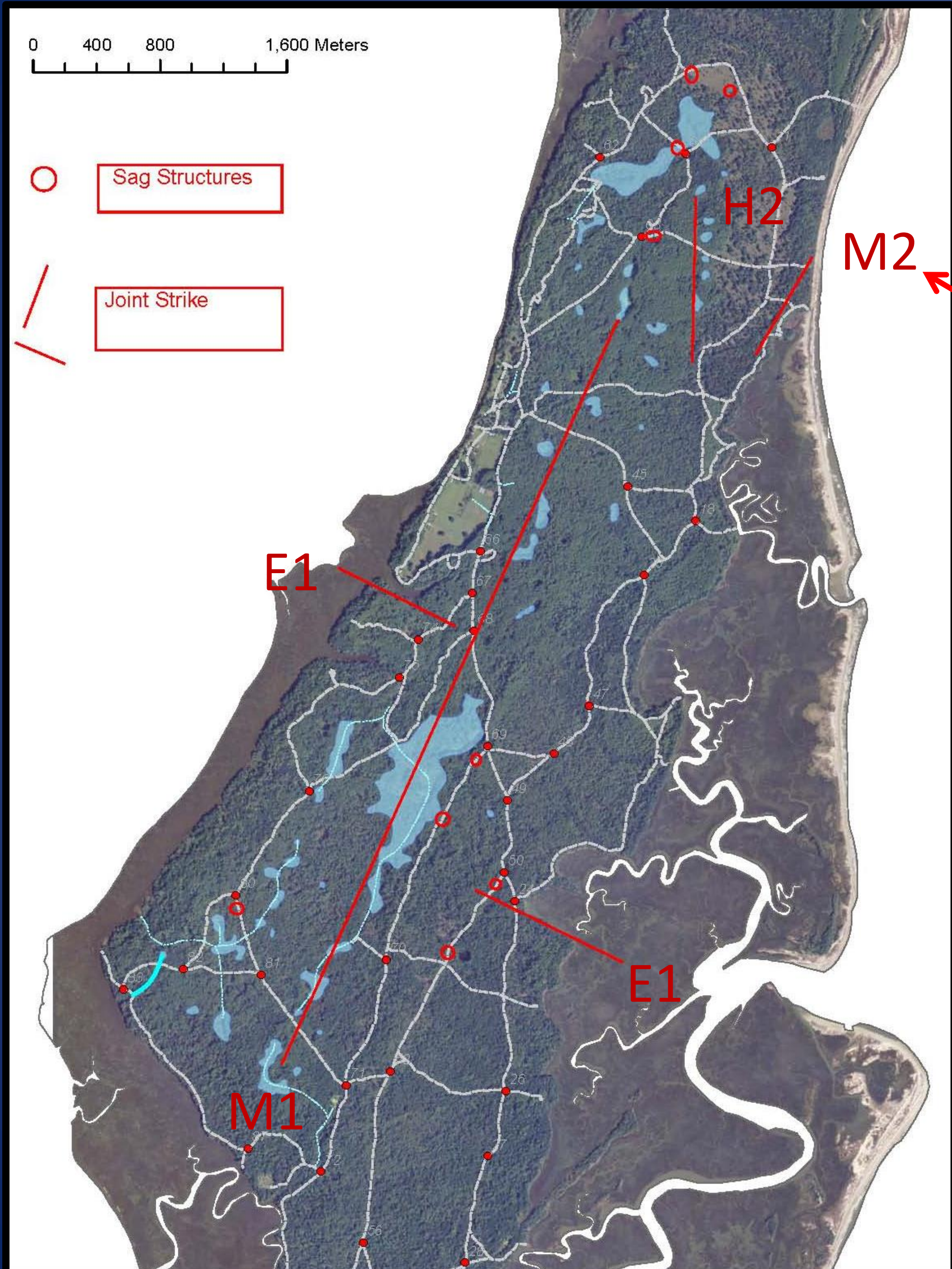
SCI, 1954

Central Depression vibracores

Organic sediment with fresh water palynoflora

Ghost shrimp burrows

Joint trends, faults and sag structures.

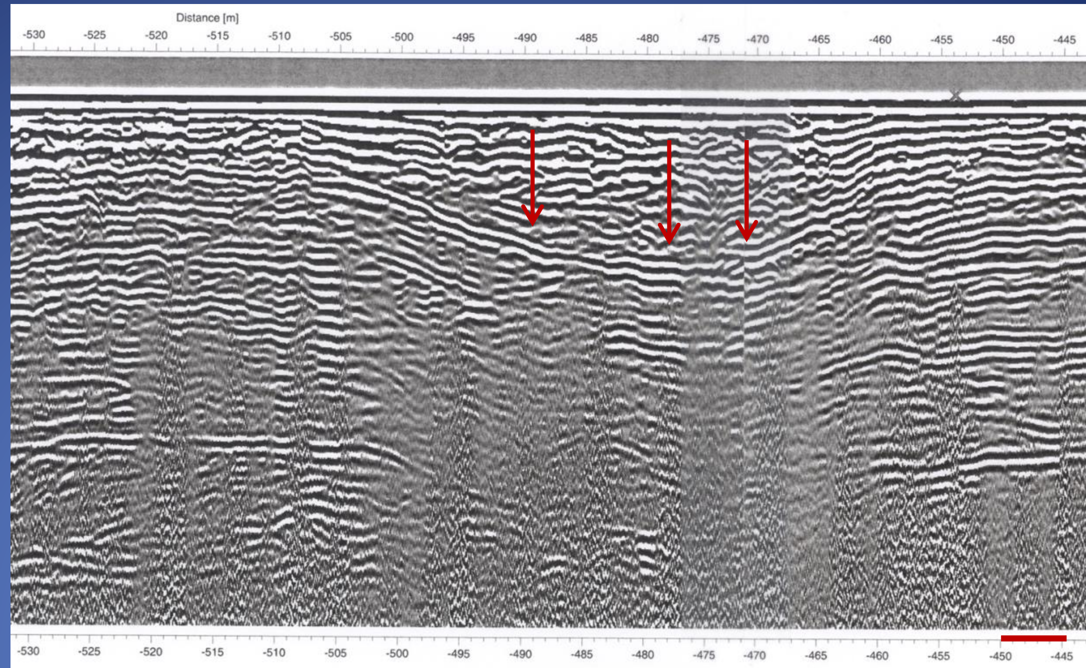


Yellow Banks Joint Trend

N24^{o}E trend (M1) is same as interpreted Brunswick fault trend of Maslia and Prowell (1988)

Coastal Plain joint trends after Bartholomew et al., 2007

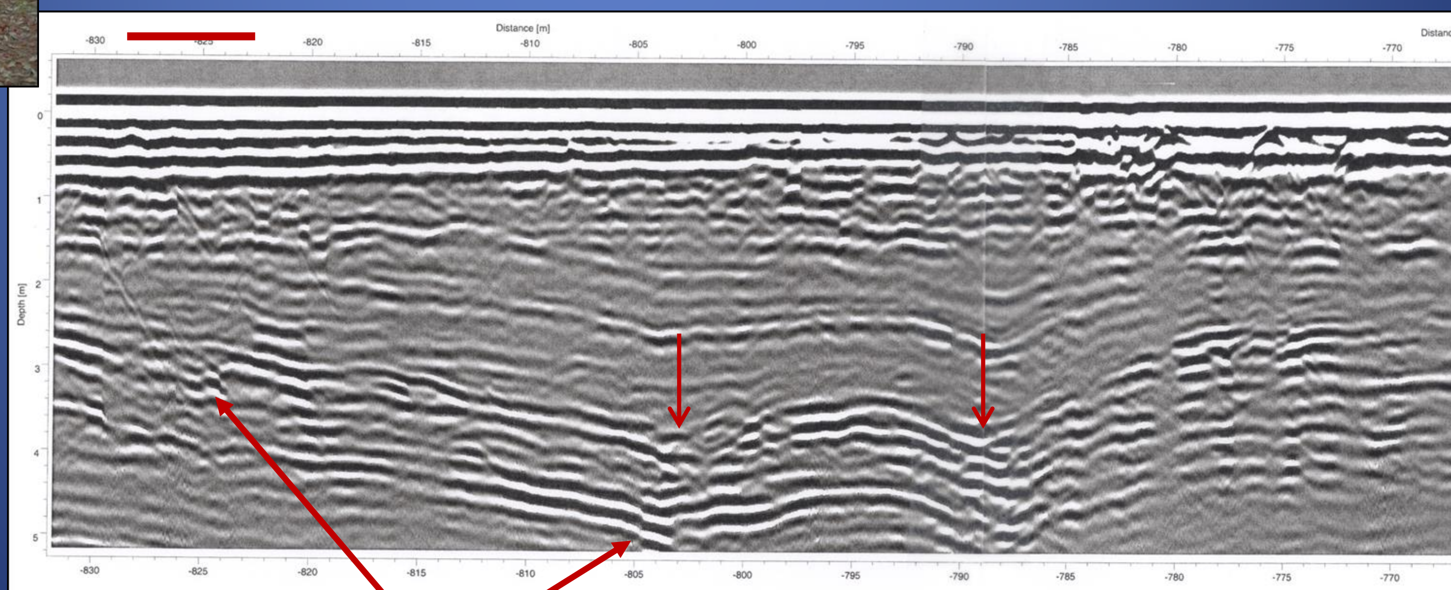
Sag Structures on 100 MHz GPR Profiles



~ 2 m

5 m

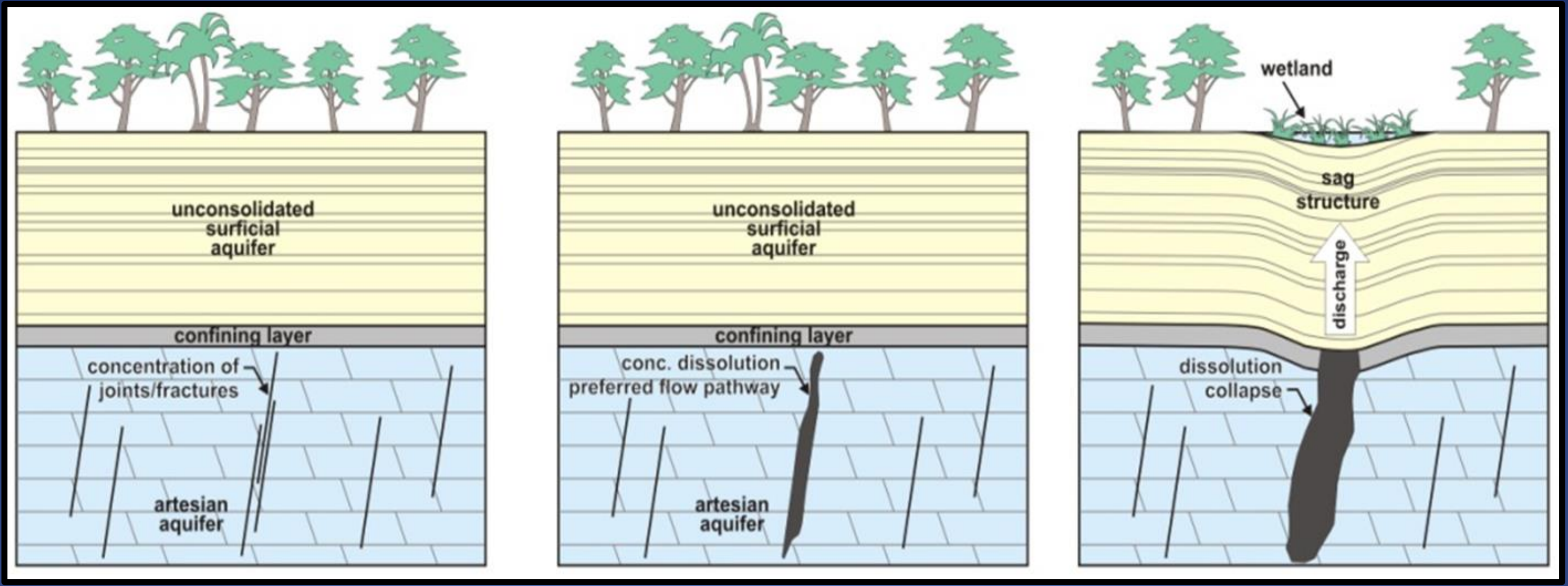
5 m

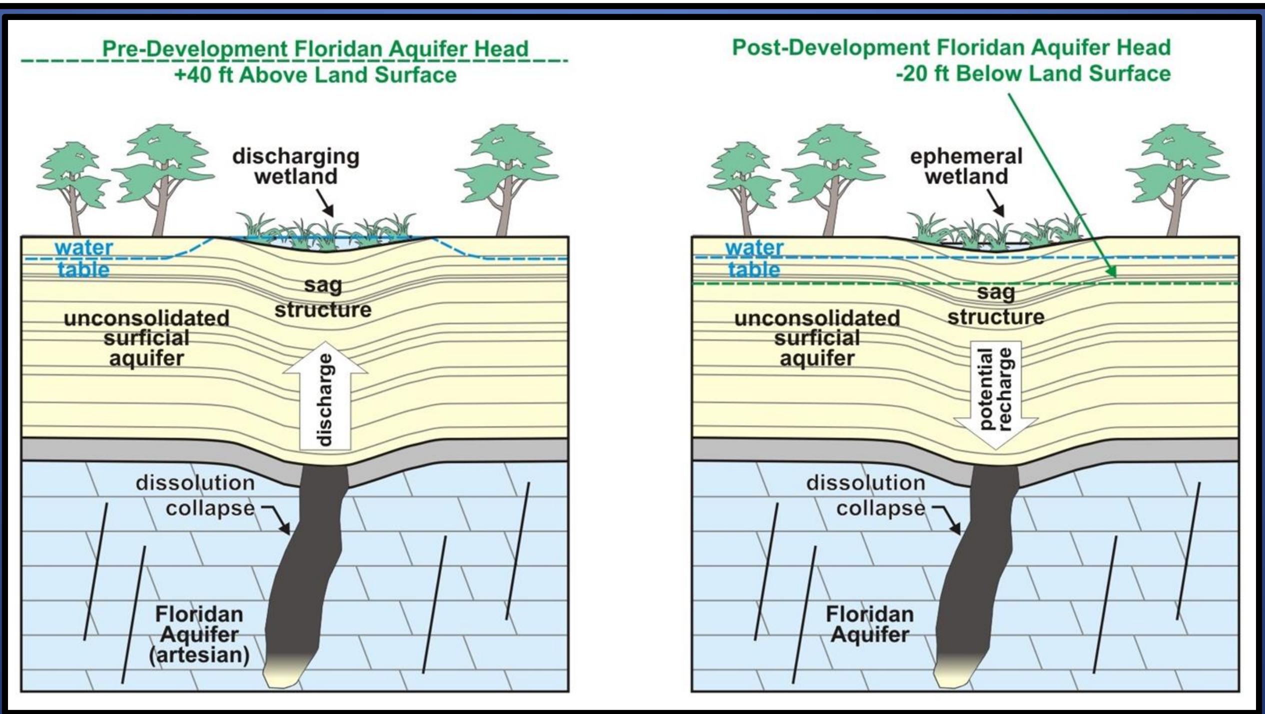


~2 m

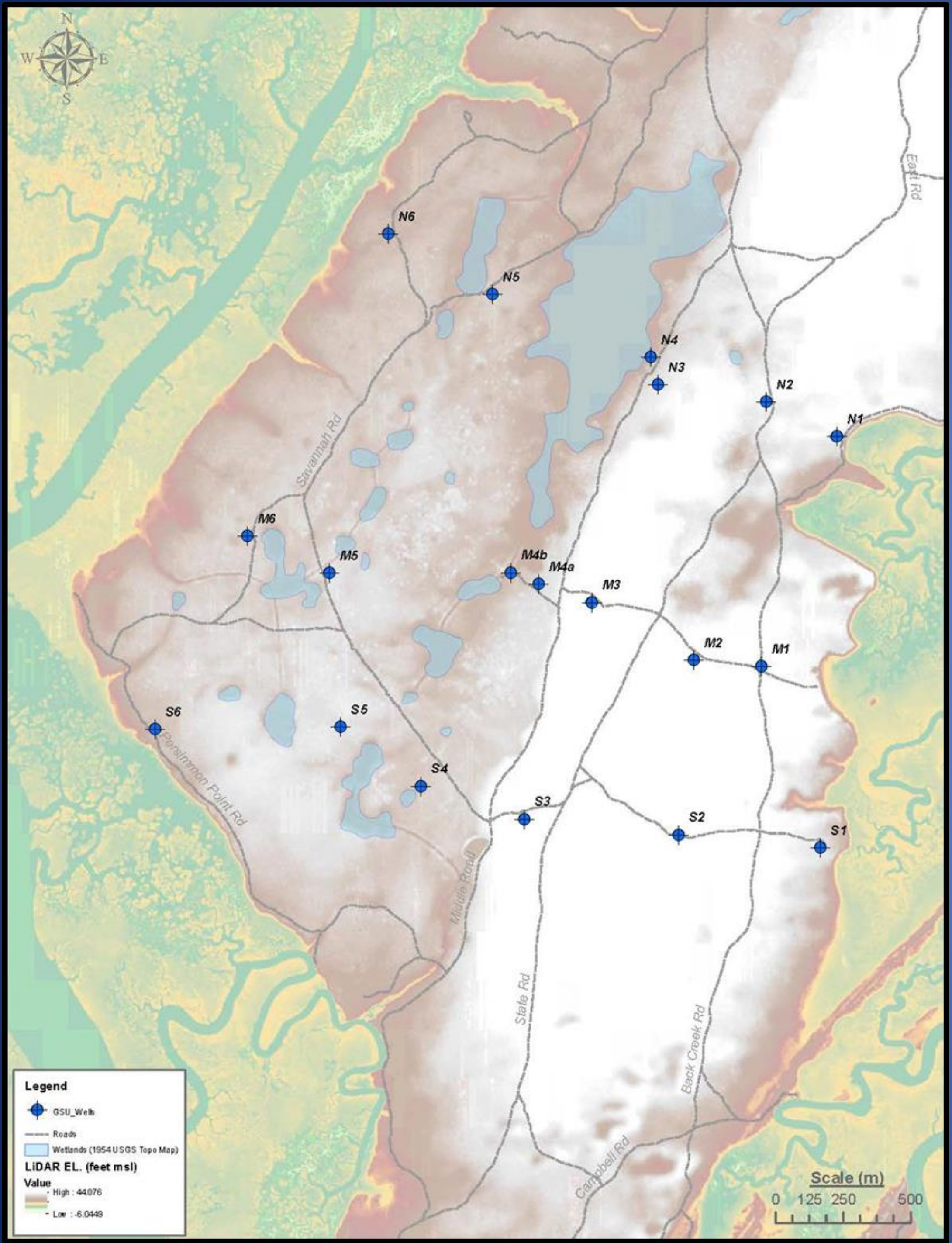
faults

Sag structure development and hydrogeology





From:
Brian
Meyer

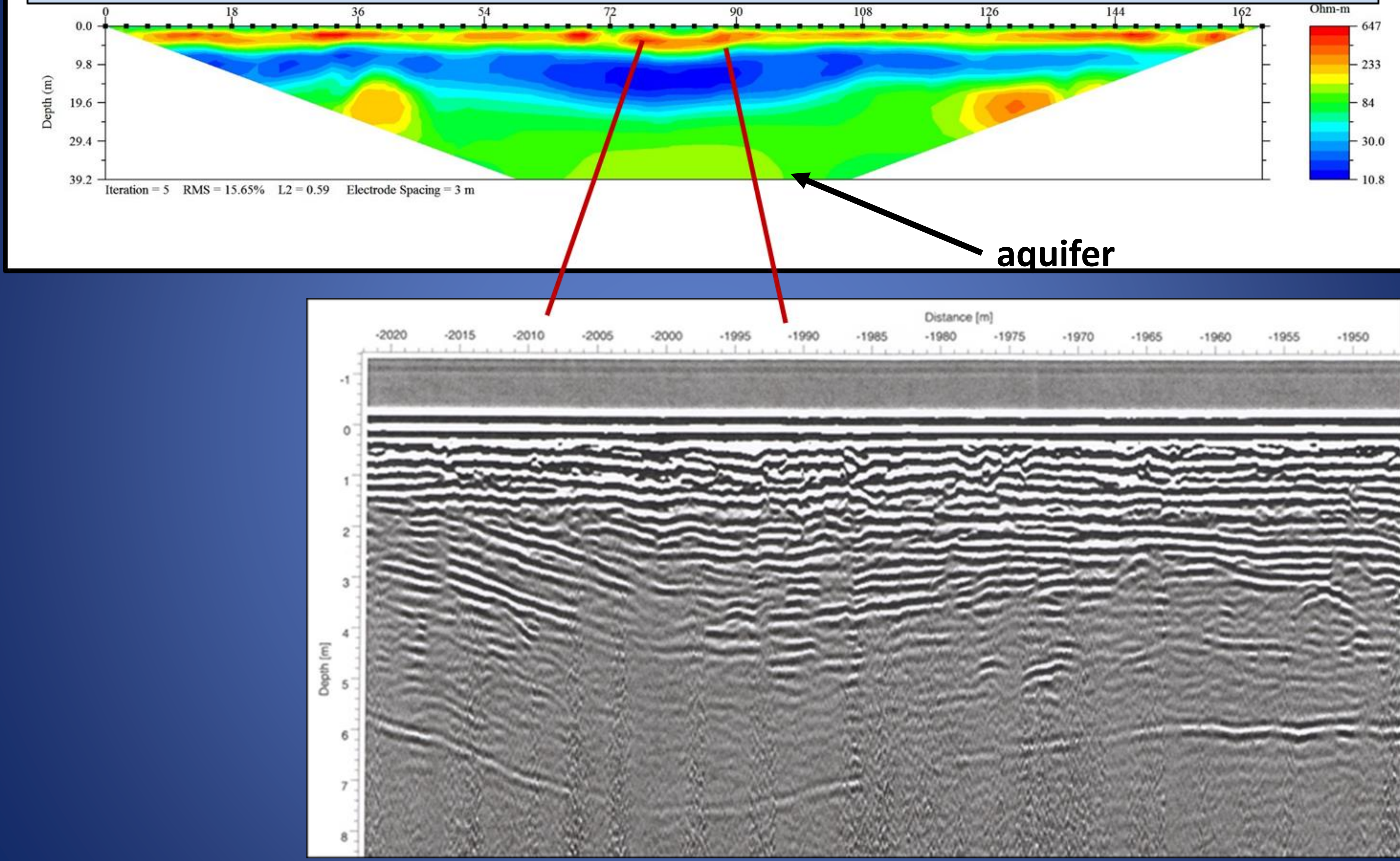


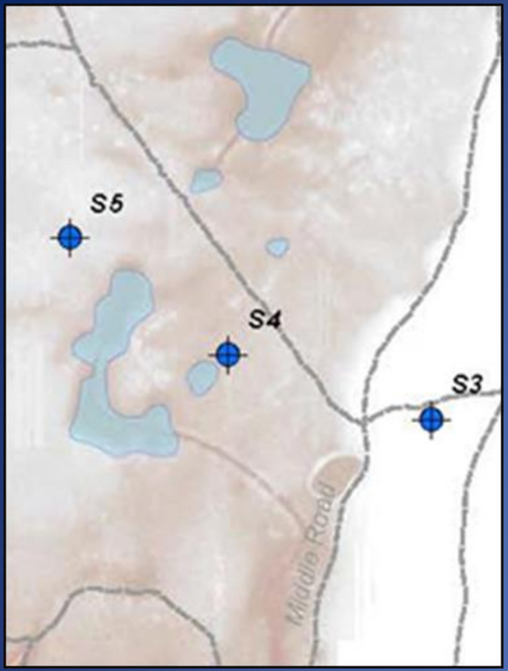
Abundance of former ponds suggests karst topography .

Sinkhole near Middleground Community, Bulloch County

Diameter ~ 26 meters, Depth to Upper Floridan carbonates > 300 ft

Exploring Links Between Structure and Hydrology

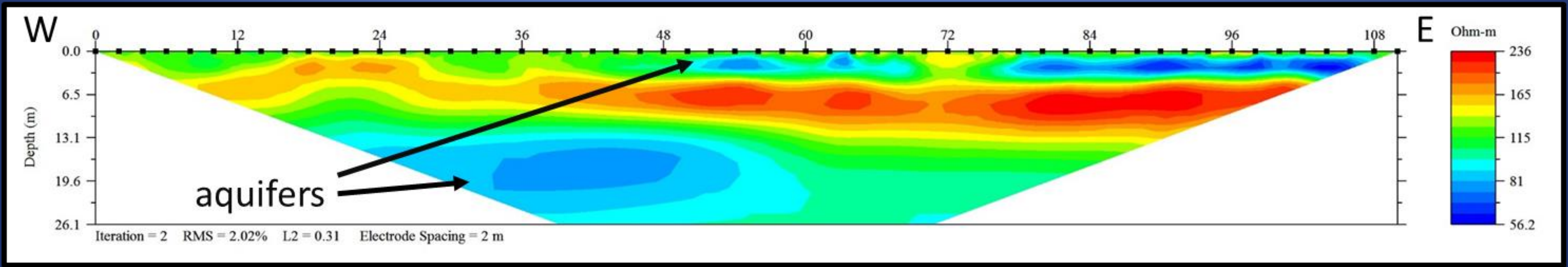


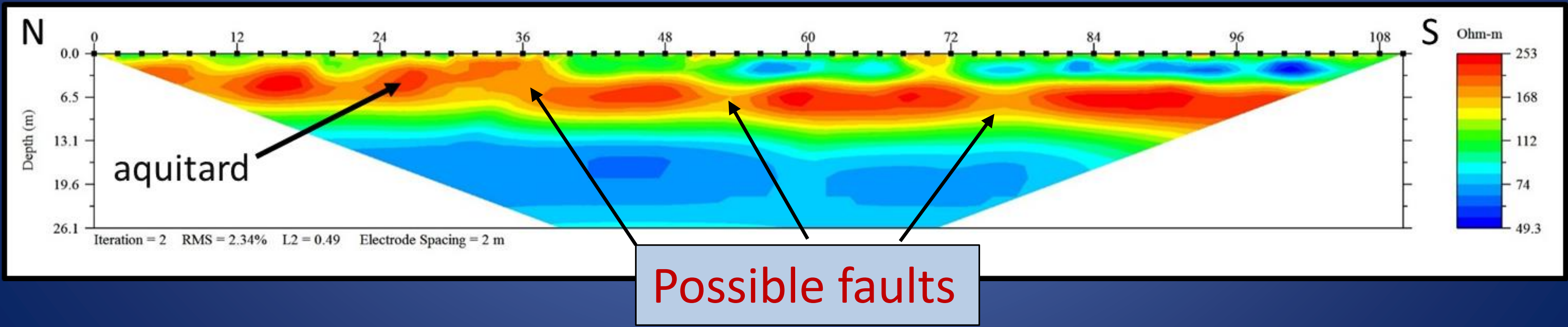


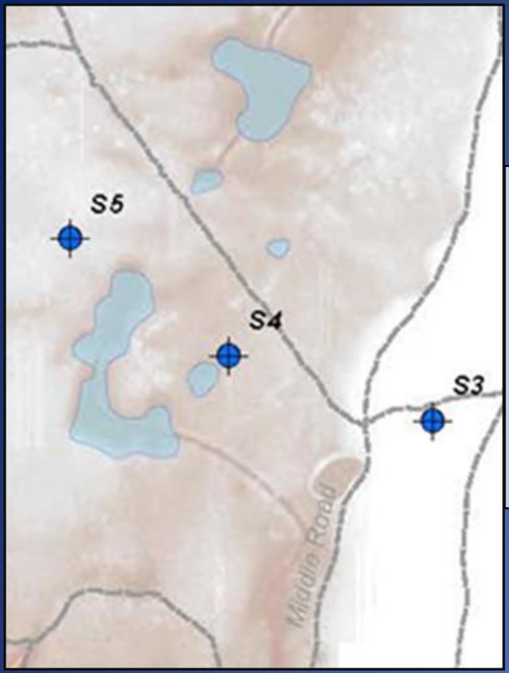
Core data at well site S4:

0 – 1.5 m: hydric black sandy top soil
1.5 m - 7.3 m: fine-very fine, subang., well sorted qtz sand
7.3 m - 11 m: muddy very fine qtz sand and mud
11m – 13.4 m: fine to very fine qtz sand

- Shallow wells < 7.3 meter depth
- Sharp density increase at ~ 5 m depth (2% compaction)
- SCI clays are kaolinite dominant







S3 site core data:

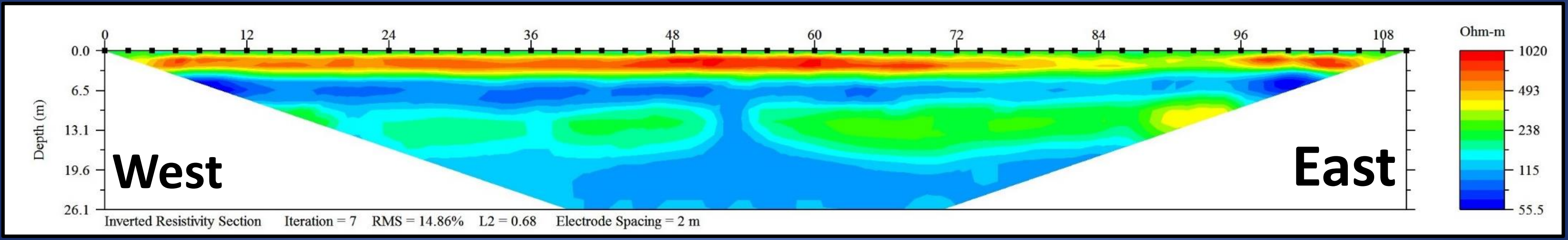
0- 9.1 m : f-vf, well sorted, subang. qtz sand

9.1 -11.0 m : f-vf qtz sand as above with trace clay

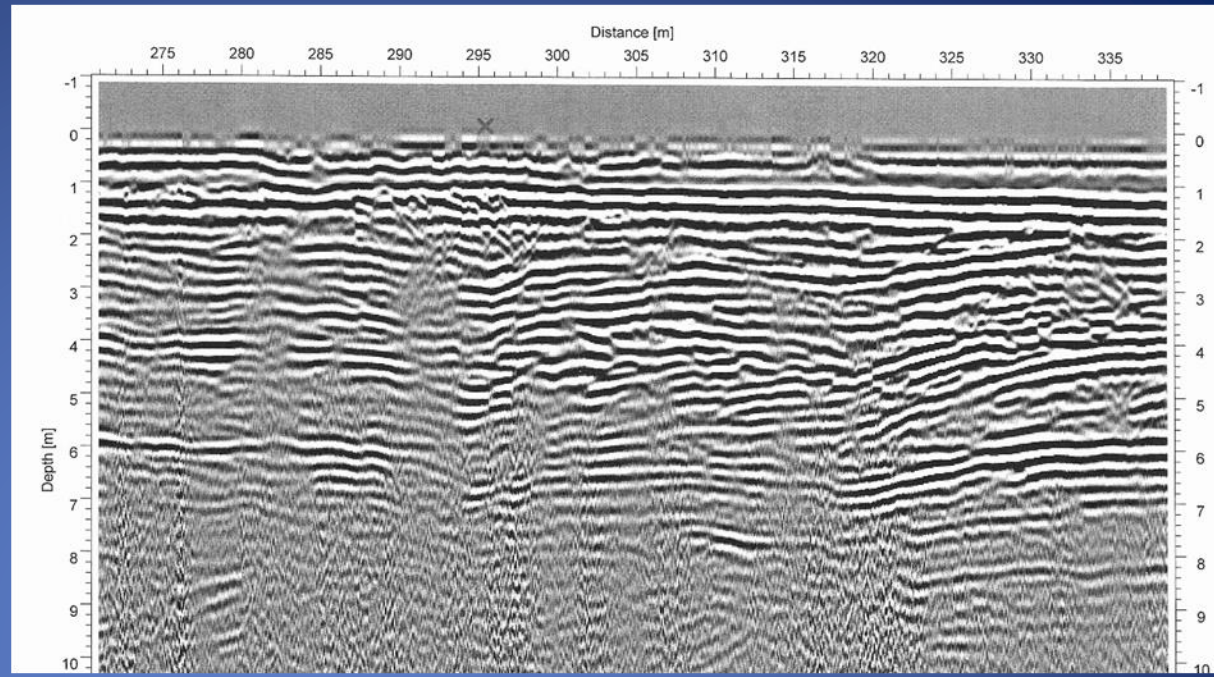
11.0 – 12.2 m : muddy sand and clay beds

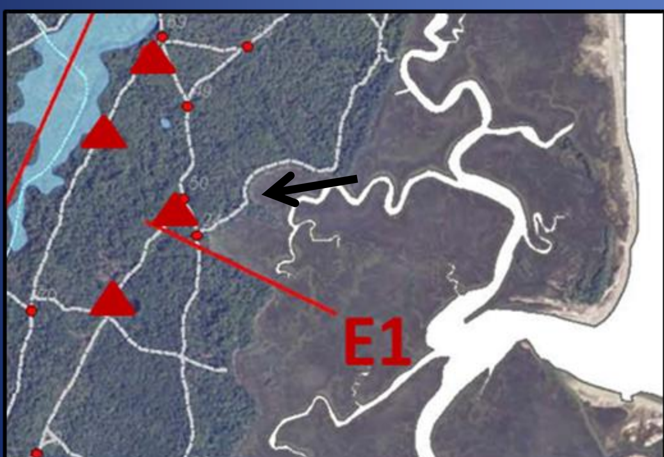
12.2 – 13.1 m: f–vf qtz sand with trace clay

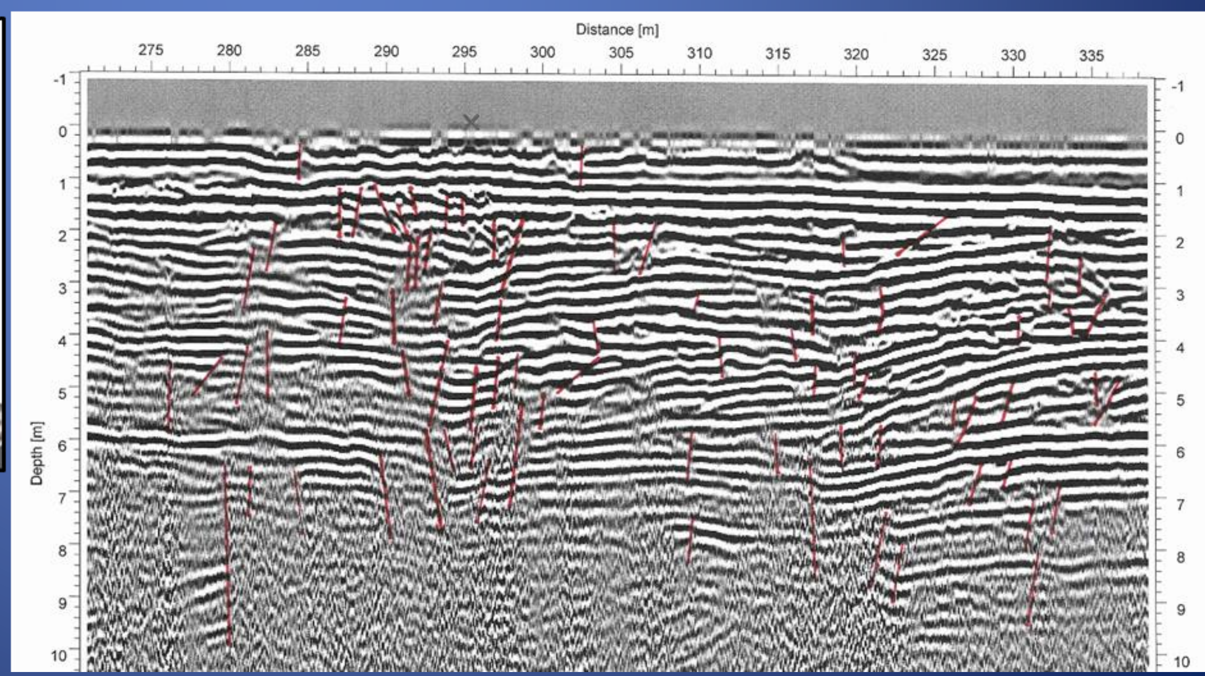
Resistivity Profile

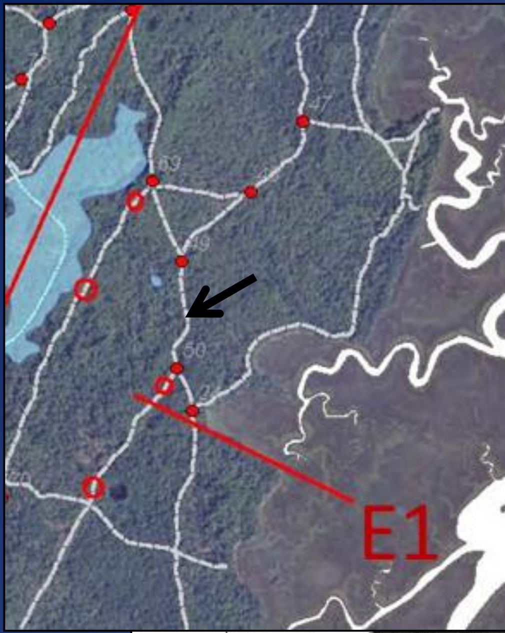


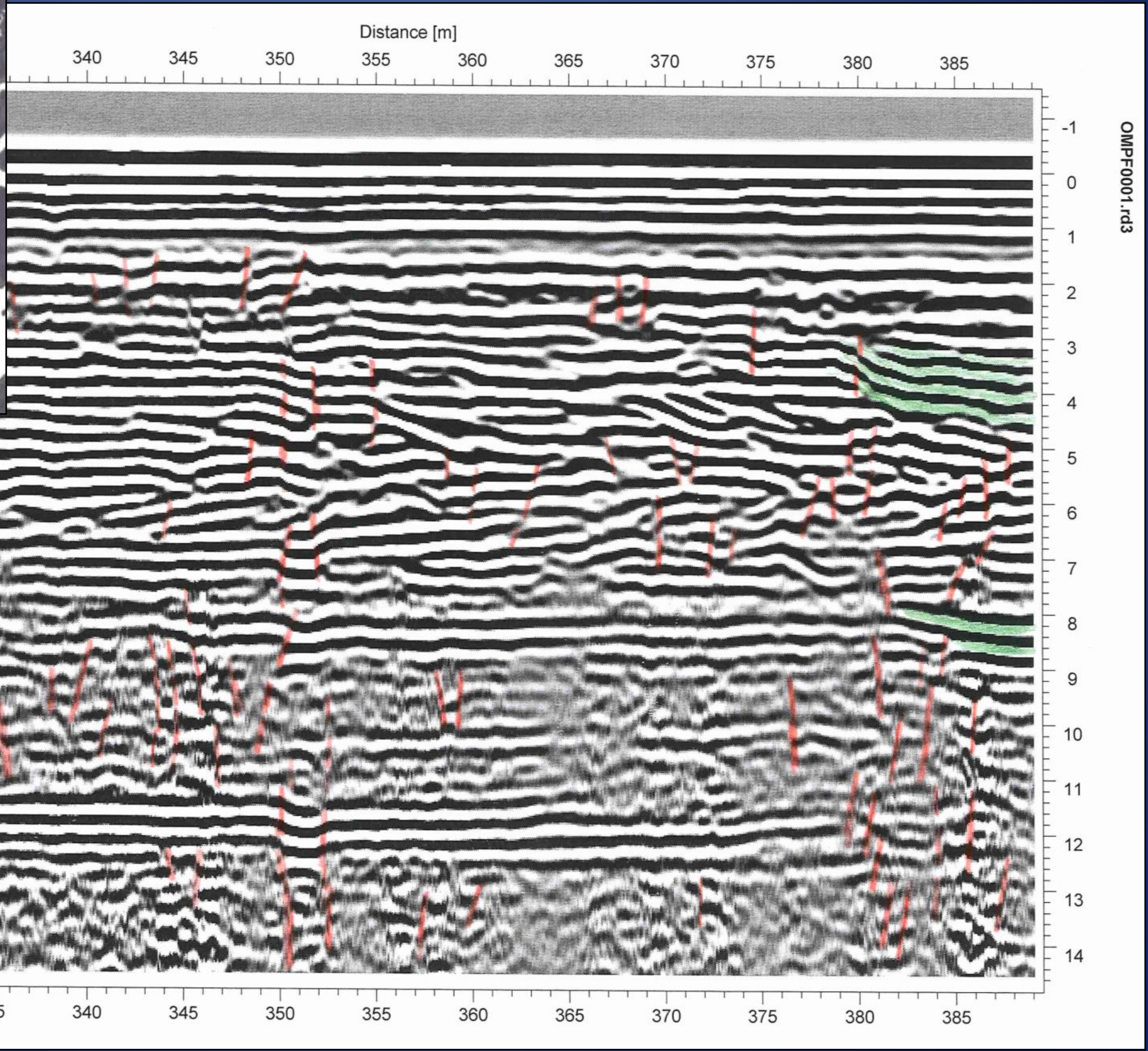
100 MHz GPR profile across NW-SE trending lineaments, offsets highlighted in lower figure





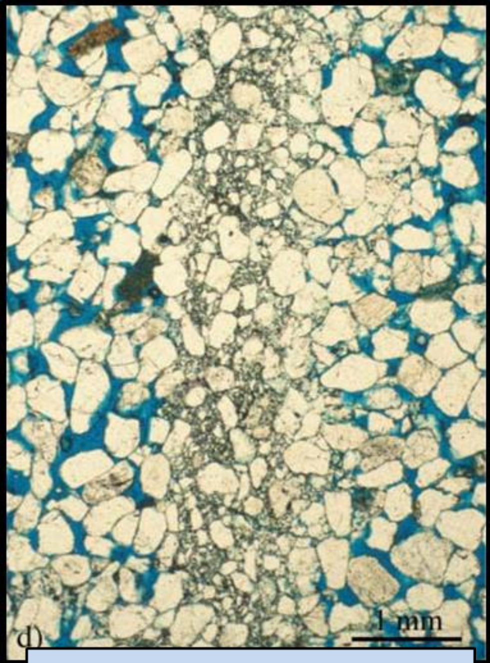



E1


Distance [m]
Depth [m]
OMPF0001.rd3
325
330
335
340
345
350
355
360
365
370
375
380
385
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Notes on faulting in soft sediments:

- Transition from single fault at depth to splays at ~ 35 to 20 m depth (see Basson et al., 2002 combined seismic & GPR study of Dead Sea Rift.
- Faults may produce deformation bands through combined effects of cataclasis and compaction (See Fossen et al., 2007; Cashman and Cashman, 2000)
- Deformation bands may result in increased density and reduced permeability in band (See Bense, 2004 – Roer Valley Rift study)



Fossen, et al., 2007

Hamilton, NZ: *Waikato Times,* L. Wilson, 2017

Summary

- Higher eastern side of SCI due in large part to greater thickness of eolian deposits.
- Faults and cavern collapse in Upper Floridan carbonates responsible for linear pond concentration, sag structures and former artesian springs and wetlands.
- Axial depression may be due in part to fault-related subsidence.
- Well data and geophysical profiles suggest faults and fault splays influence deep and shallow aquifer systems and focus salt water intrusion.

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Georgia Sea Grant – major research funding

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