Investigation of the Shallow Hydrogeologic System on St. Catherines Island Georgia

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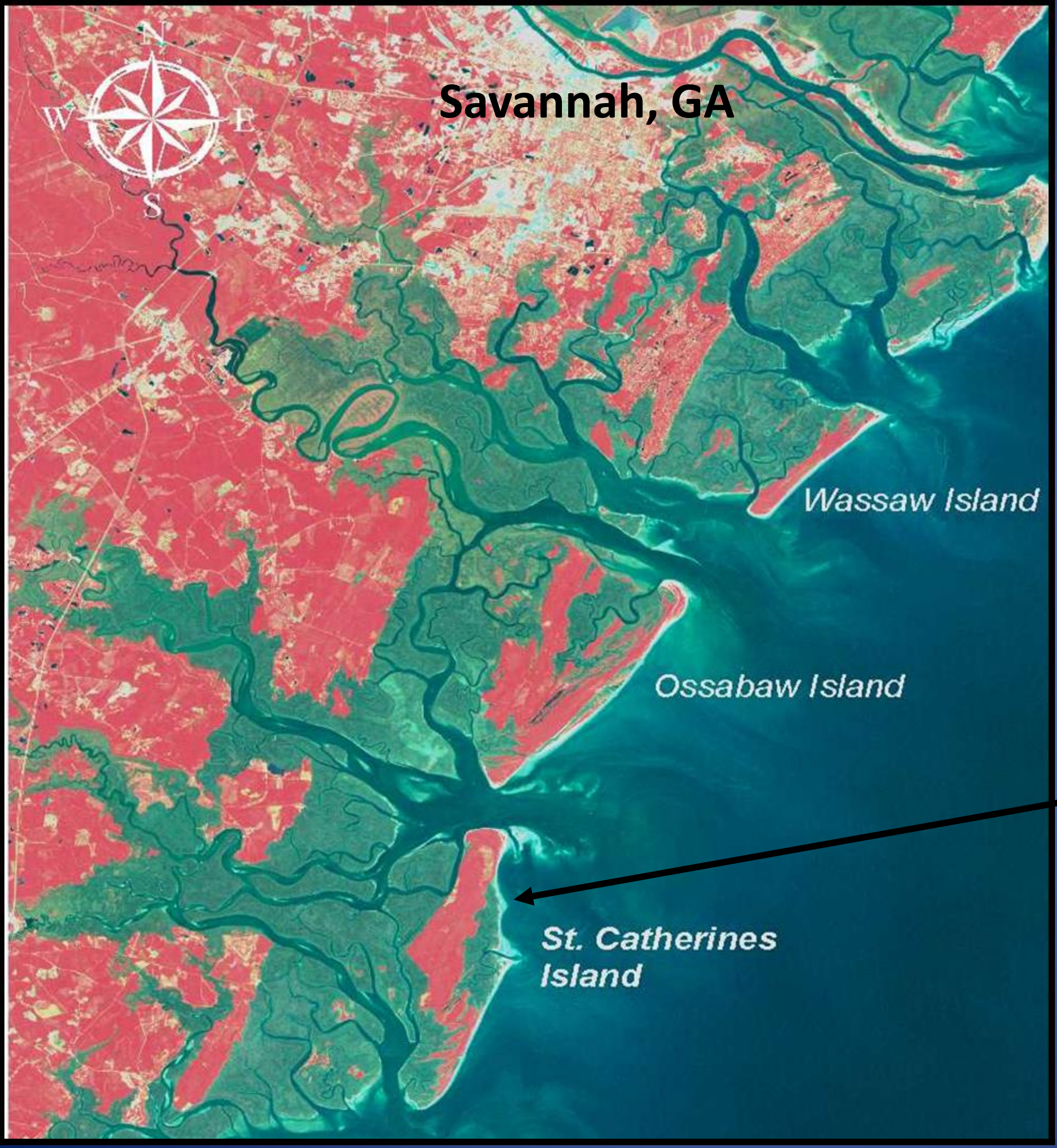
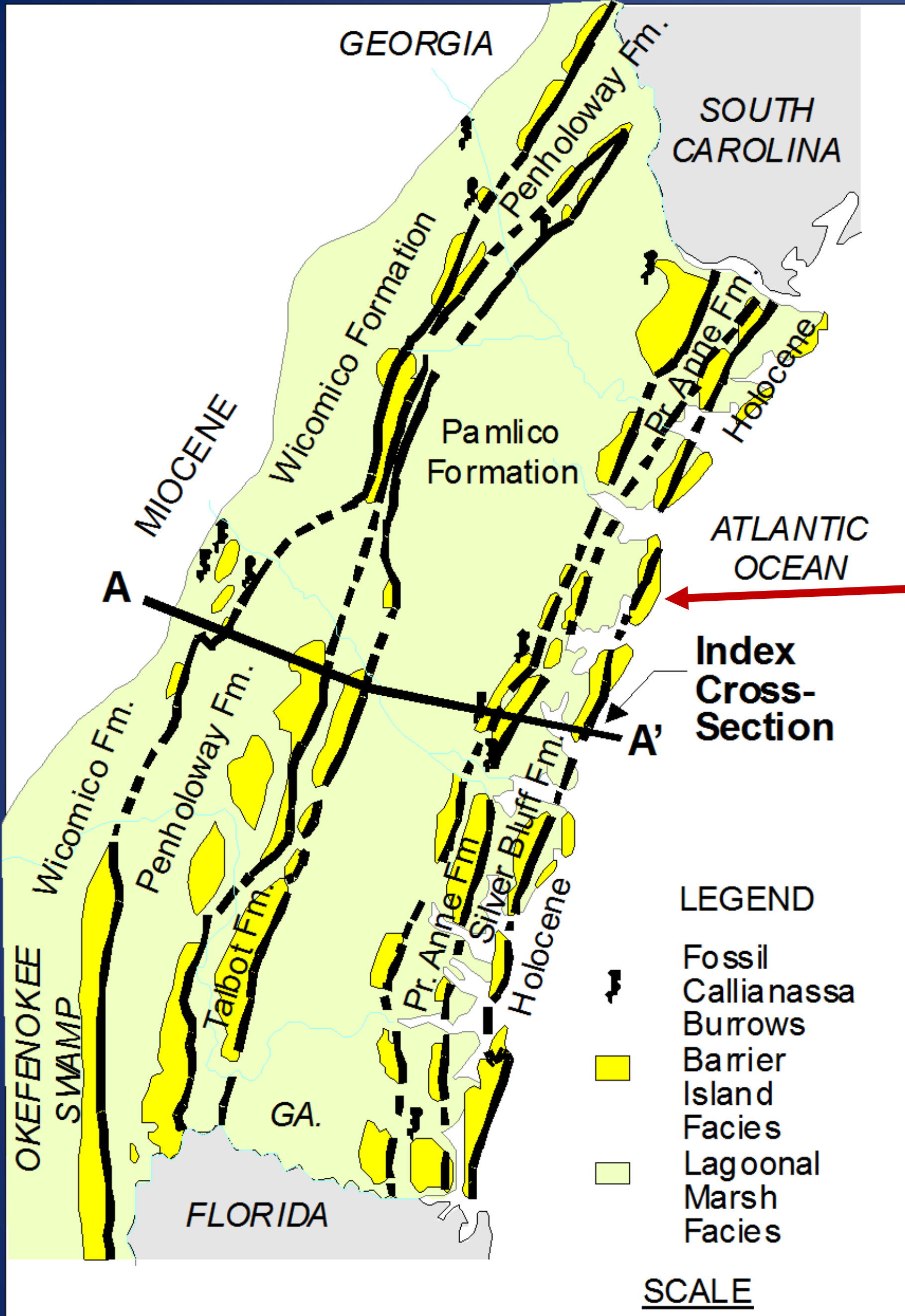
GA Coastal Plain and Barrier Islands



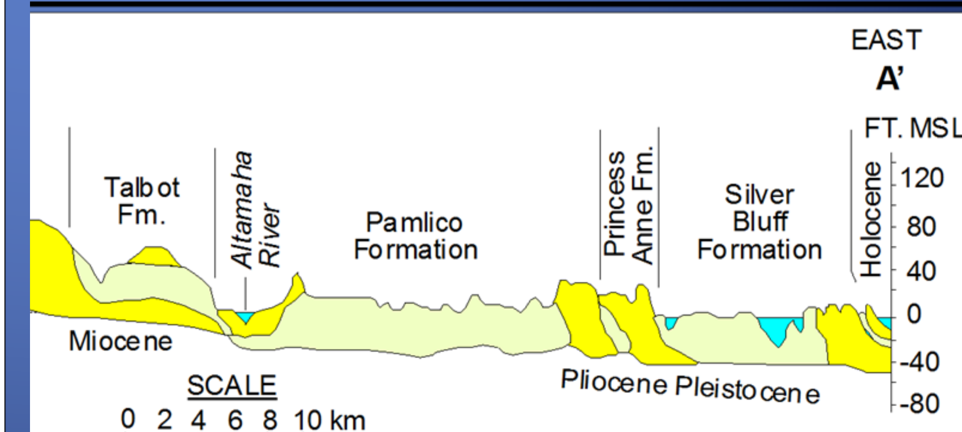
St. Catherines Island

Geological Setting (shoreline systems)



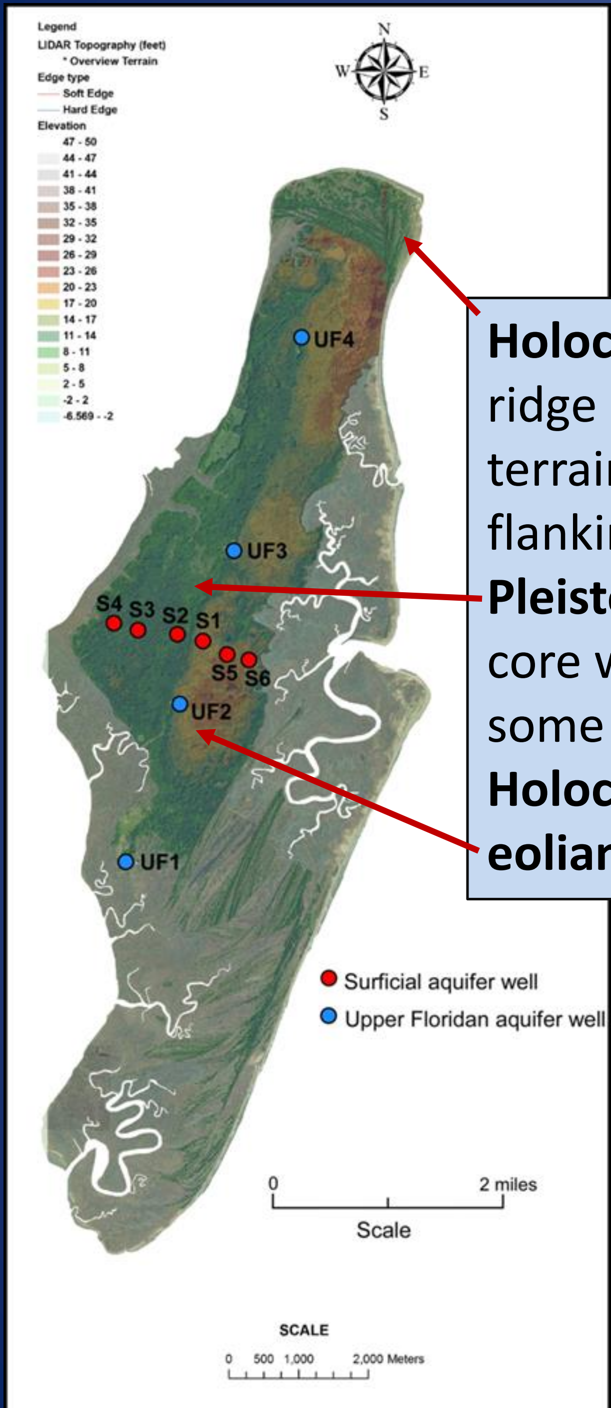
(After Hoyt & Hails, 1968)

St. Catherines Island



(After Hoyt & Hails, 1968)

St. Catherines Island geology and previous research

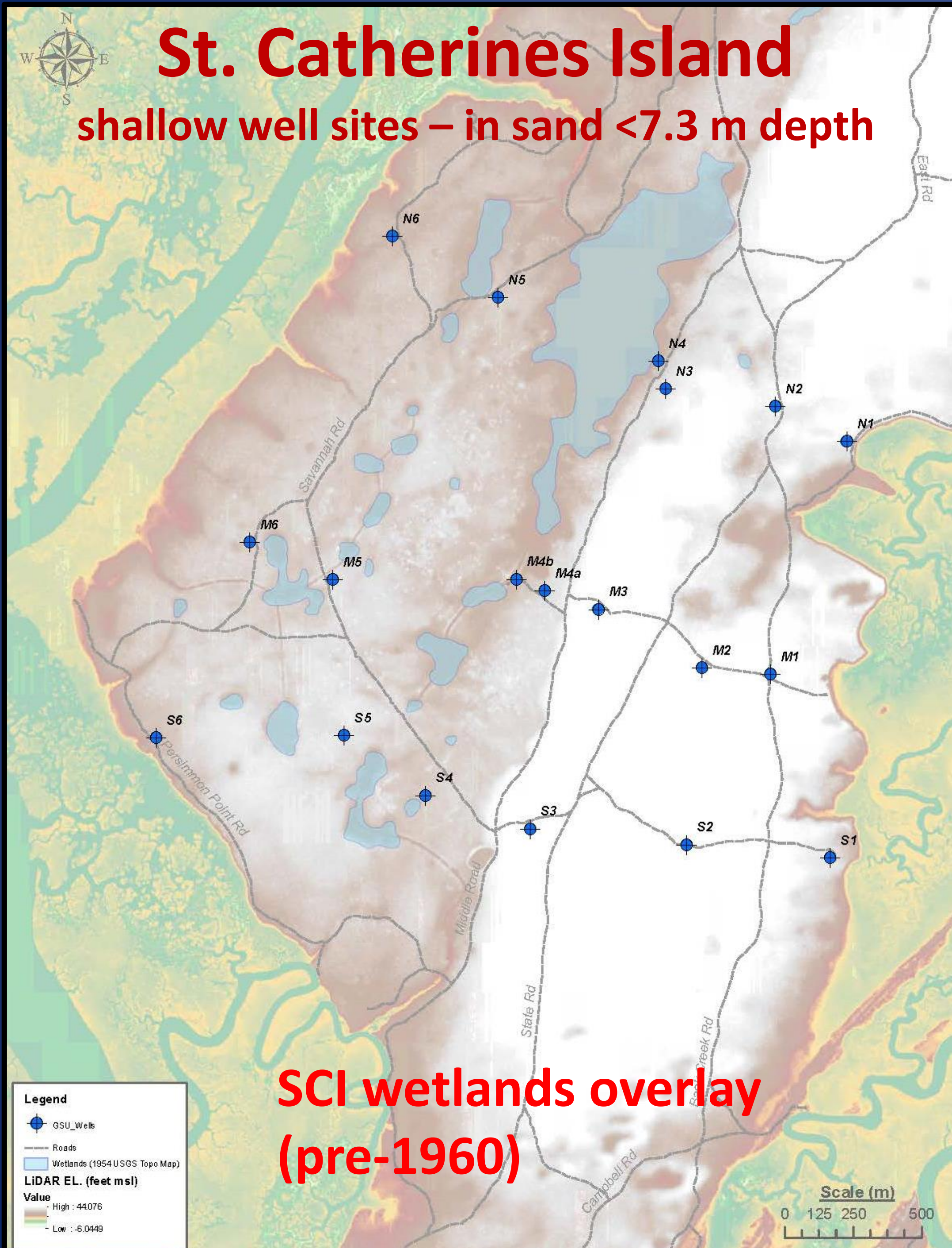


Holocene ridge & swale terrain flanking **Pleistocene** core with some **Holocene eolian** cover.

Sampling and analyses of wells in Upper Floridan indicate saline water contamination from below (Reichard et al., 2014).

Salt water intrusion by upconing and the past occurrence of Artesian springs <u>requires structural access </u>through confining layers.

Chloride spikes (salt water intrusion) detected in the surficial aquifer.



Current Research:

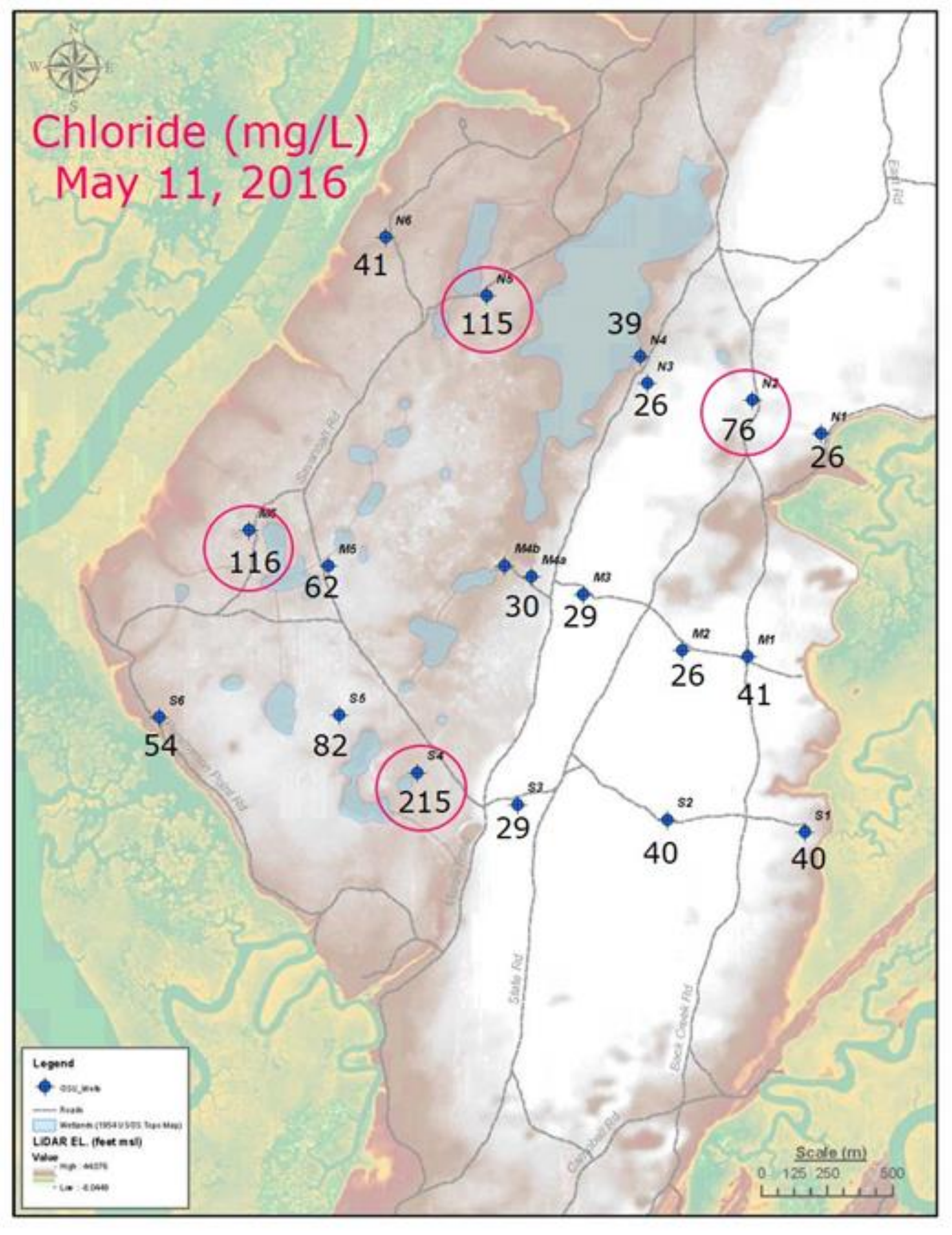
*__Determine__ salt water intrusion pathways into surficial aquifer.

*__Evaluate__ potential for communication with the Upper Floridan aquifer.

Methods:

- Monitoring head and water chemistry
- resistivity & GPR surveys
- coring as needed.

Shallow well data



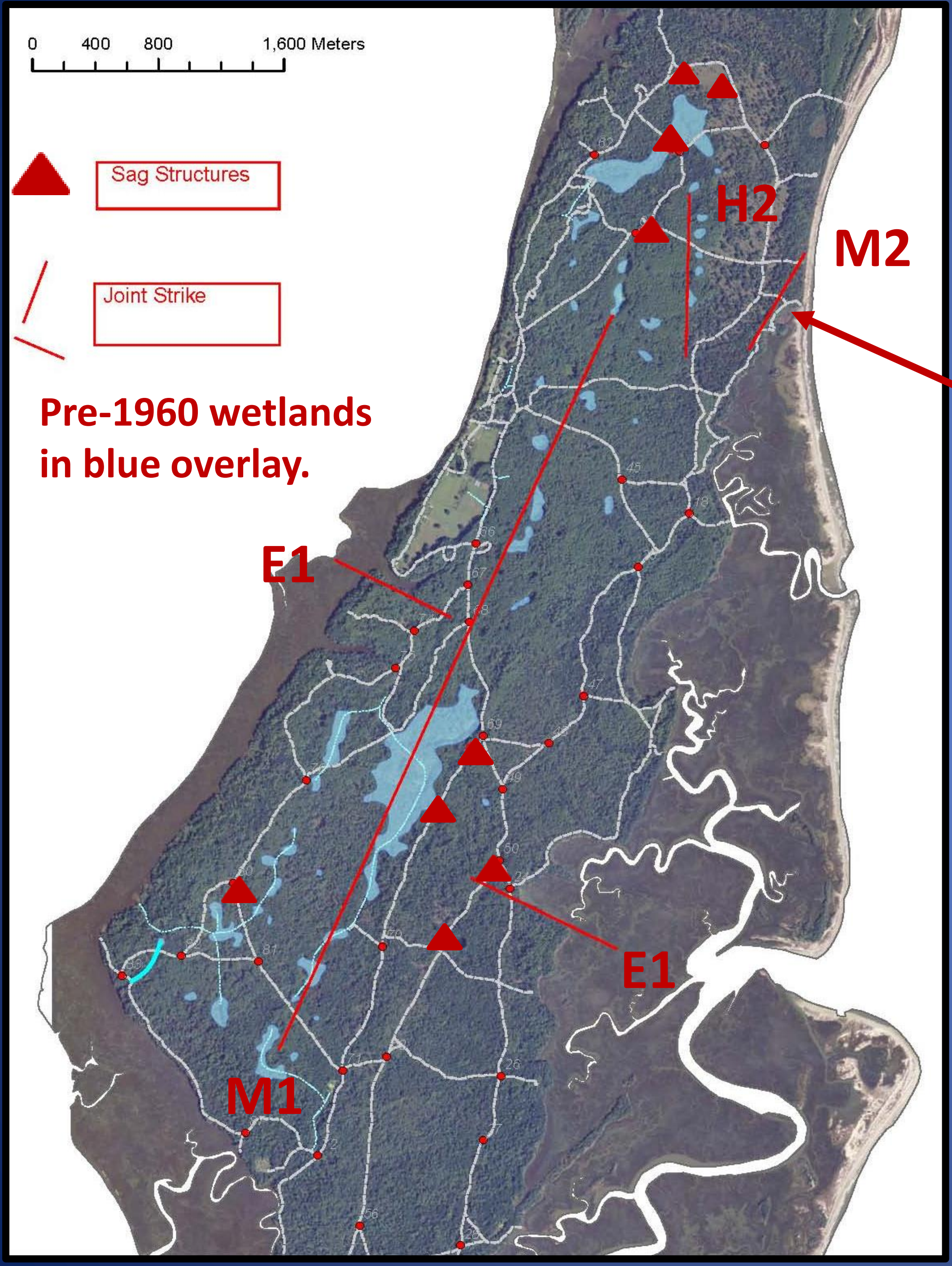
"Snapshot" of chloride concentration in the surficial aquifer on St. Catherines. Circled wells have concentrations that change rapidly in response to peak tides.

How do you explain the irregular occurrence of chloride spikes with respect to well proximity to shorelines?

Potential salt water intrusion pathways:

- Flooding and vertical infiltration
- Lateral intrusion via tabular sand aquifers or buried channel sands
- Lateral intrusion through structural pathways (joints, faults)
- Vertical intrusion through structural pathways (joints, faults, sag structures)

Structural Components of St. Catherines Island

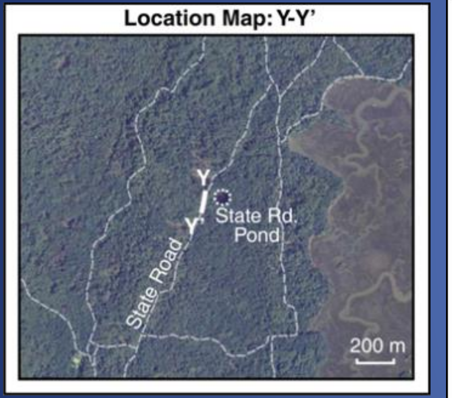


Yellow Banks Joint Trend

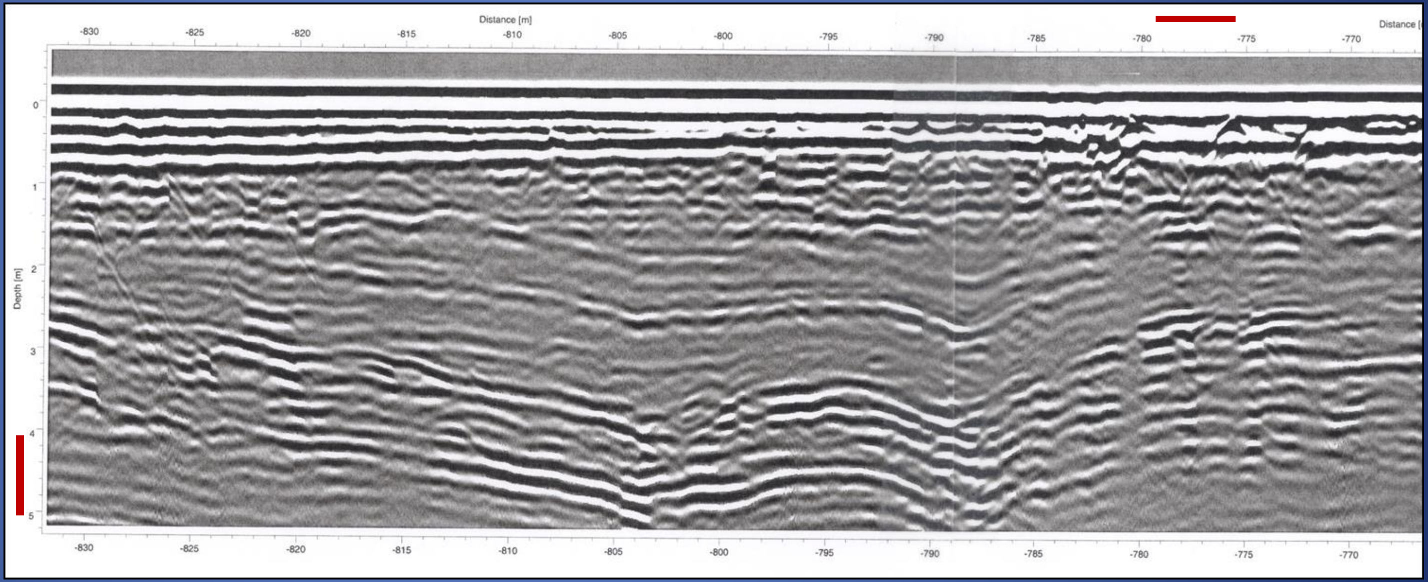
Coastal Plain joint trends after Bartholomew et al., 2007

N24ºE trend (M1) is same as interpreted Brunswick fault trend of Maslia and Prowell (1988) and Atlantic Coast Fault System

Faults and joints focused dissolution in Upper Floridan carbonates. Collapse of deep caverns produced sag structures and basins in surficial sediments.



5 meters



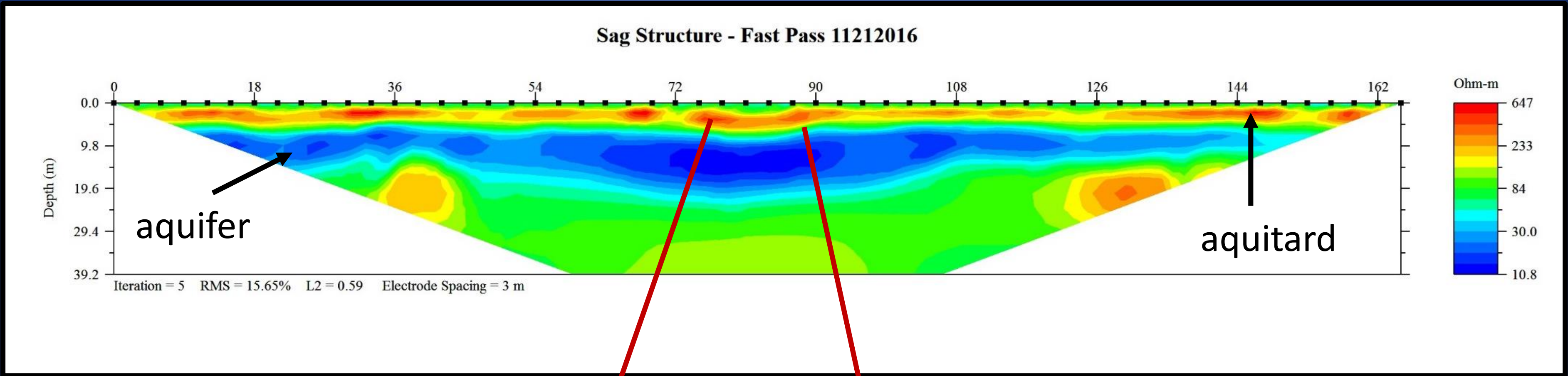
1 meter

100 MHz GPR profile

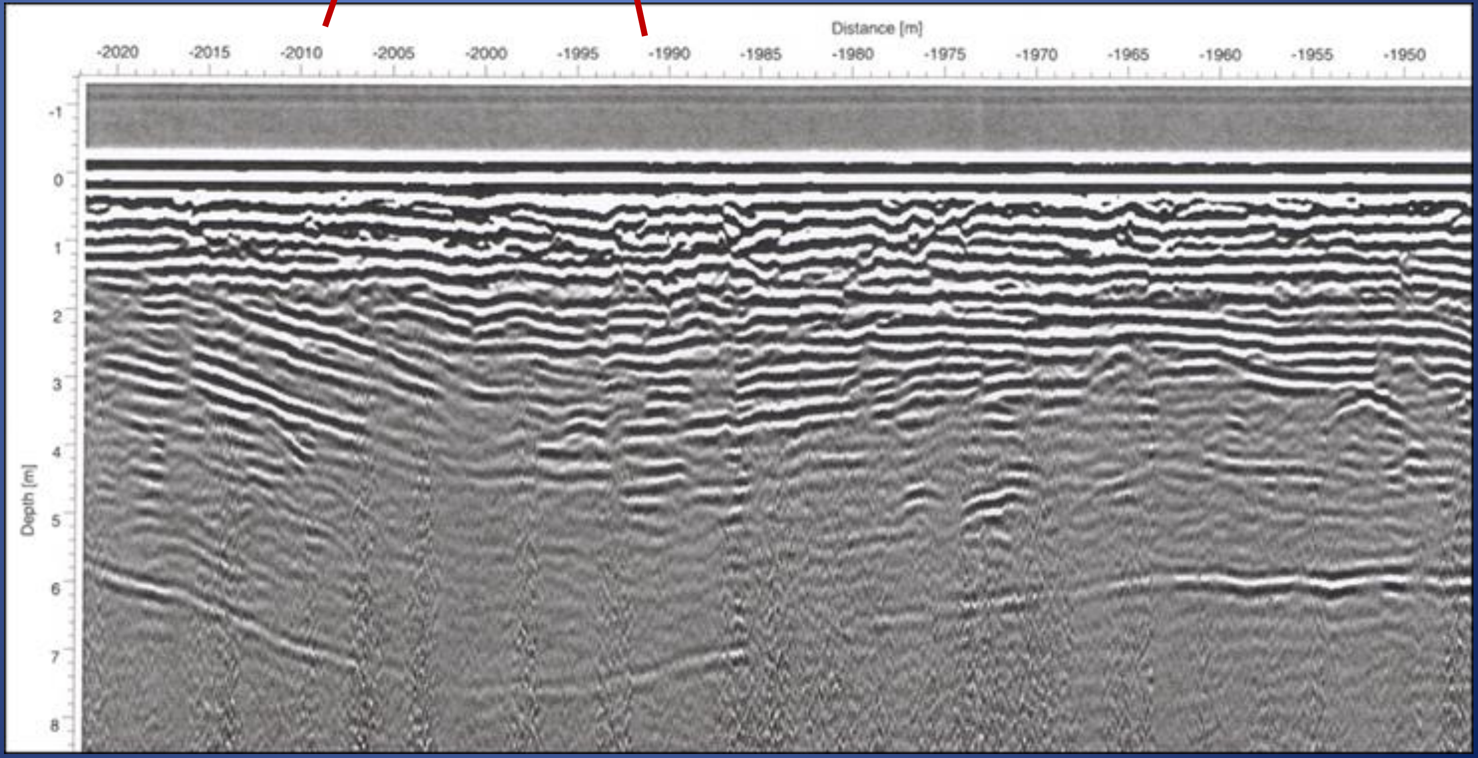
Sinkhole near Middleground Community, Bulloch County

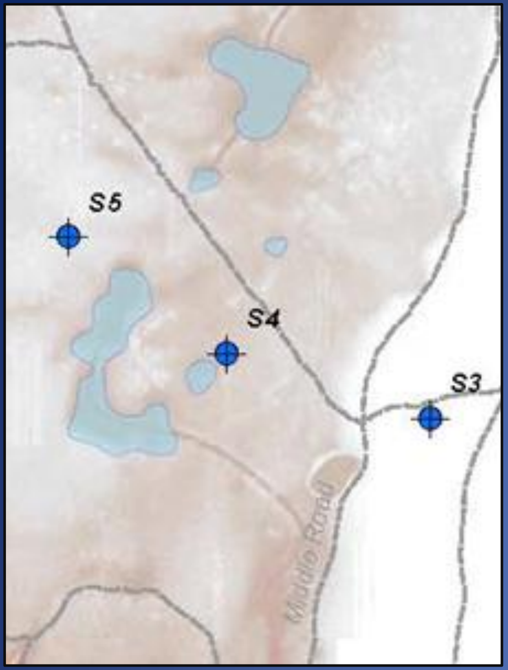
Diameter ~ 26 meters, Depth to Upper Floridan carbonates > 300 ft

Exploring Links Between Structure and Hydrology



Resistivity profile (above) and 100 MHz GPR profile (right).

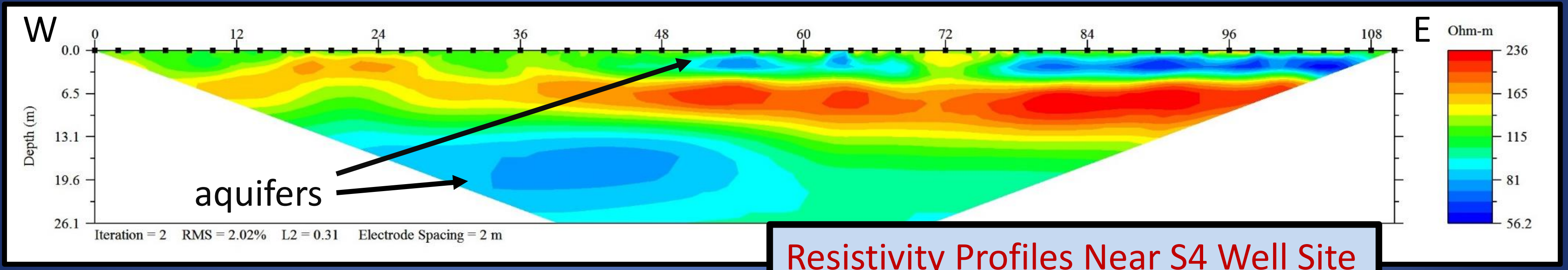




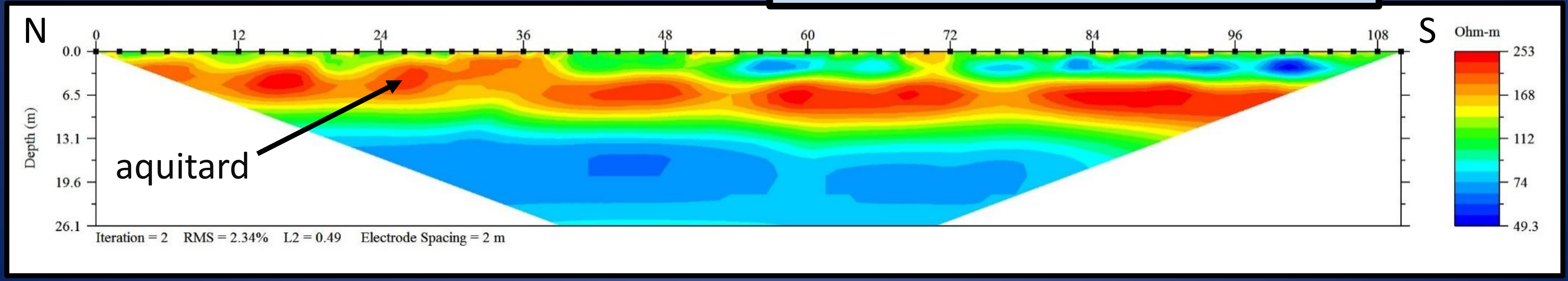
Core data at well site S4:

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

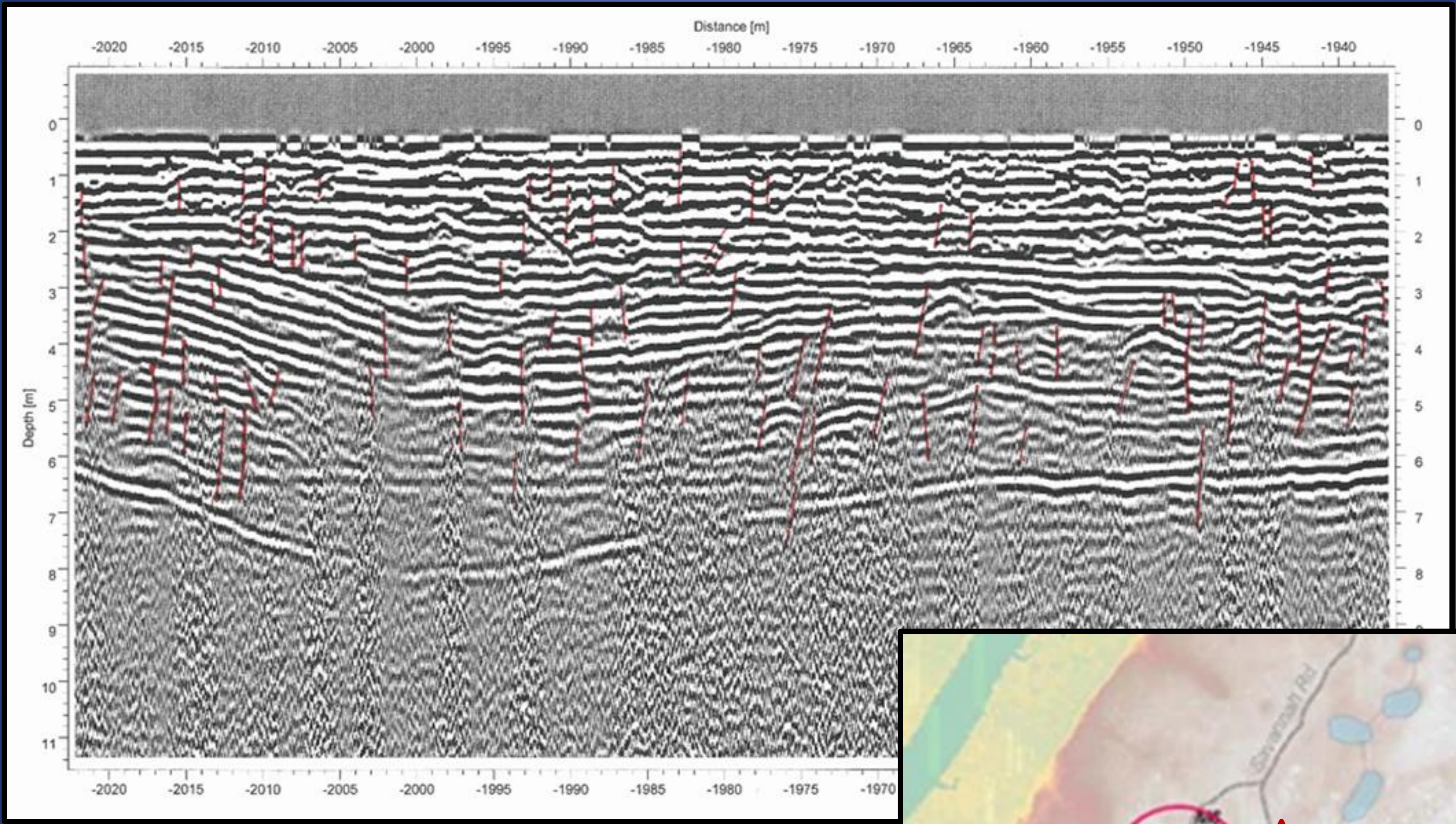
- Shallow wells < 7.3 meter depth
- Sharp density increase at ~ 5 m depth (2% compaction)
- SCI clays are kaolinite dominant



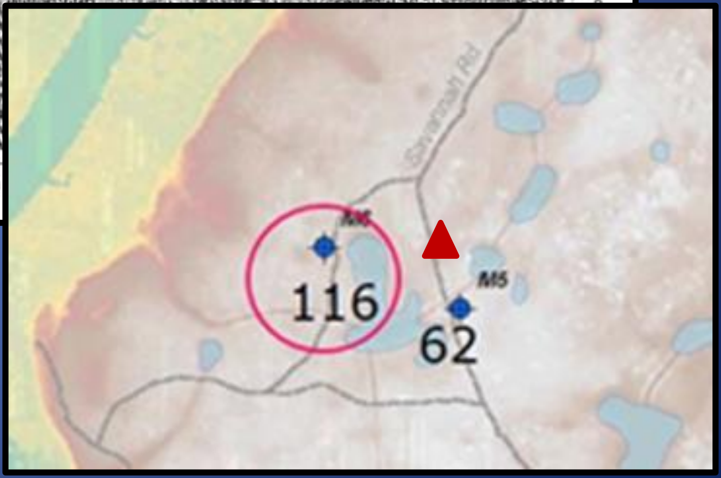
Resistivity Profiles Near S4 Well Site

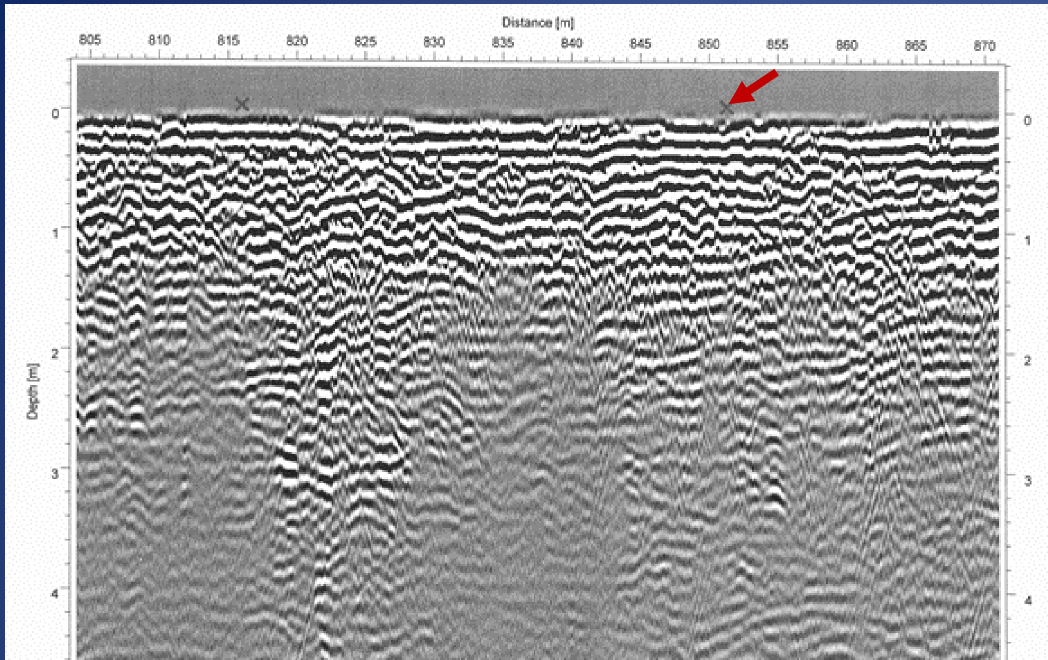


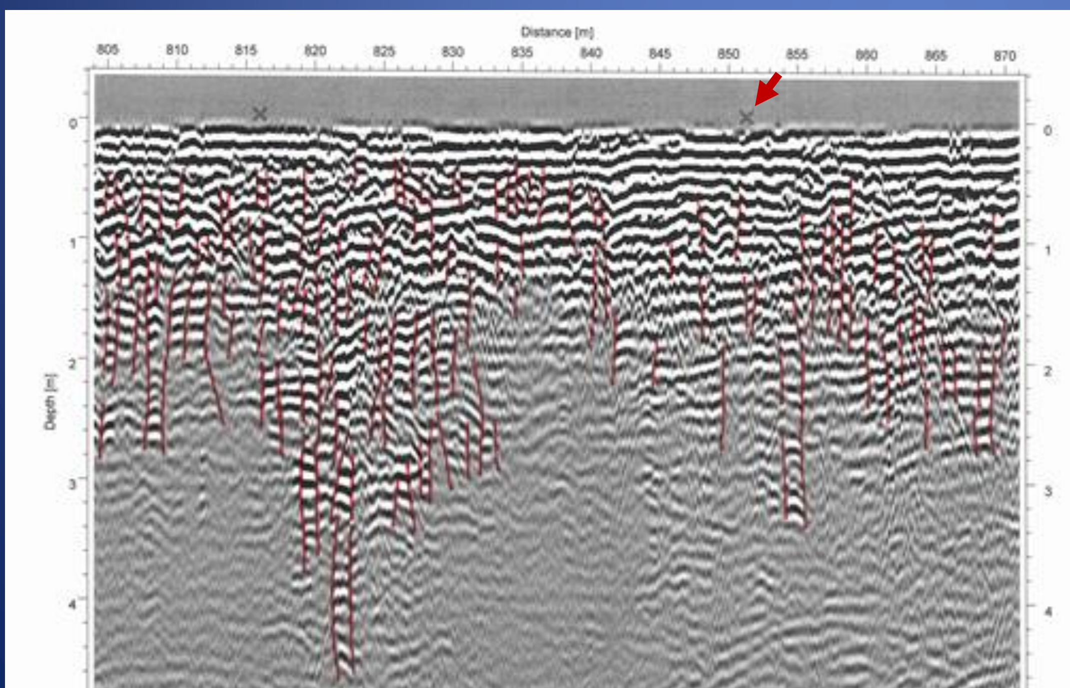
Radar element offsets suggest minor faults and fractures (sag structure with offsets highlighted)



100 MHz GPR profile





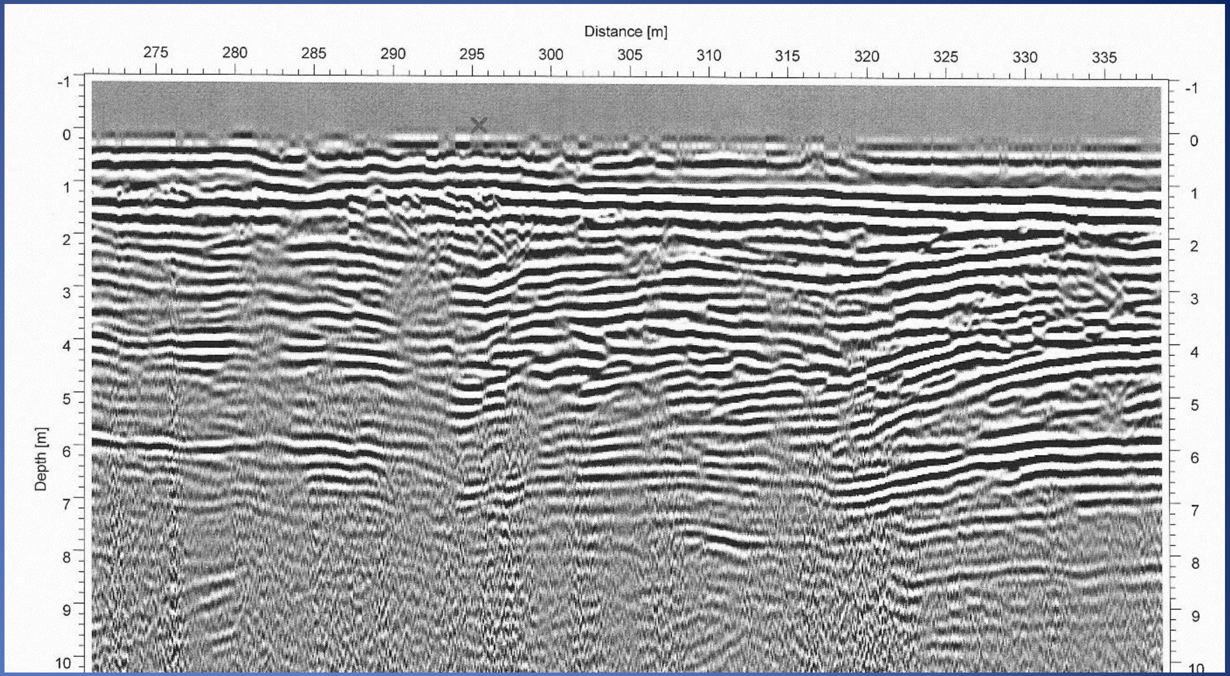


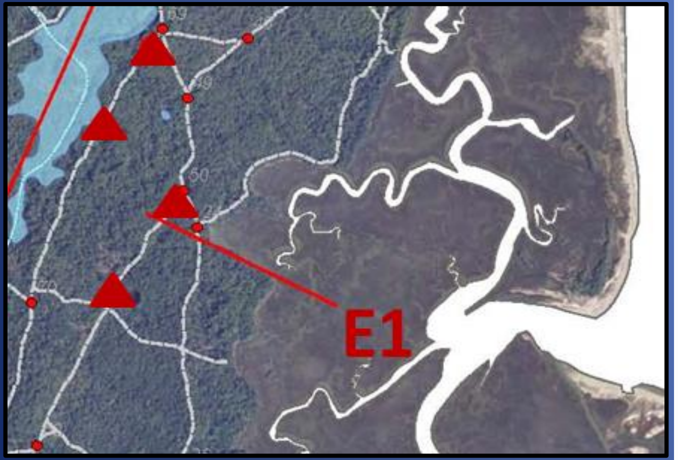
Fault influence at well site M6↙?

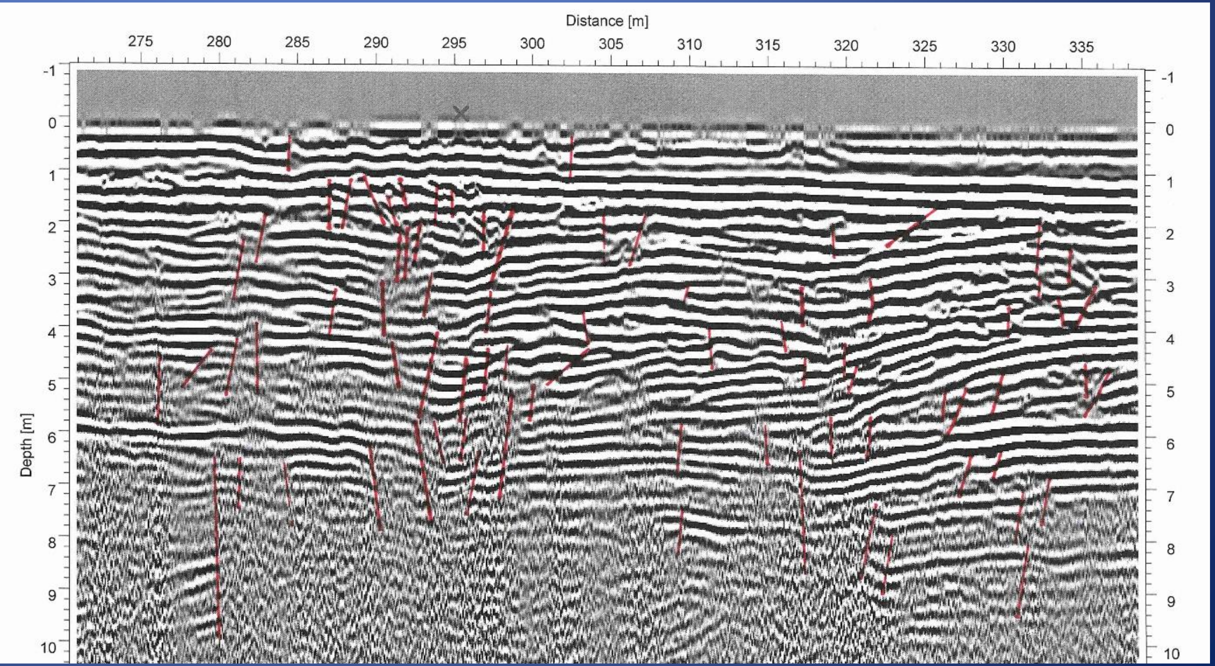
250 MHz GPR profile with highlighted offsets in radar elements

A Test: Are offsets true subsurface displacements or artifacts from surface irregularities? They appear in same location for parallel profiles run from opposite directions.

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

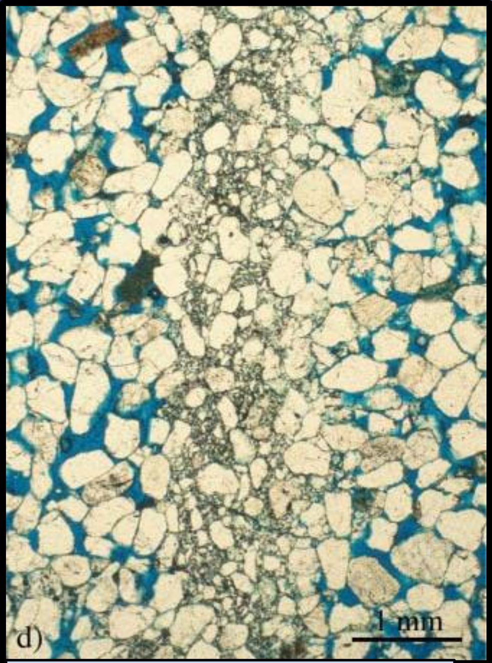






Notes on faulting in soft sediments:

- 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

- Faults and joints and associated sag structures permitted former Artesian springs and now allow salt water intrusion via upconing.
- The surficial aquifer is also experiencing local salt water intrusion linked to peak tides.
- Structural features (faults and sags) are probably responsible for irregular nature of salt water intrusion in shallow wells.
- Buried channels may be another potential salt water intrusion source.

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