Geomorphologic 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

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!

Chloride (mg/L) May 11, 2016

Shallow Wells (<7.6 m)
Coring, well installation, monitoring & water sampling
Geophysics – GPR & Resistivity
Eastern core elevation: 14 to 26 ft

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

From Brian Meyer
Core data - surficial sand thickness: East > 10.7 m
West < 4.9 m
LiDAR-Based Aspect Map
1753 journal of Jonathan Bryan on SCI:

“...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
Central Depression vibracores

Organic sediment with fresh water palynoflora

Ghost shrimp burrows
Coastal Plain joint trends after Bartholomew et al., 2007

N24°E trend (M1) is same as interpreted Brunswick fault trend of Maslia and Prowell (1988)

Yellow Banks Joint Trend

Joint trends, faults and sag structures.
Sag Structures on 100 MHz GPR Profiles

5 m ~ 2 m ~ 2 m

5 m

Location Map: Y-Y

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
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

Possible faults

Aquifers

Aquitard
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
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)
• 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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