Characterizing the Surficial Aquifer Across the Pleistocene Core of St. Catherines Island, Georgia

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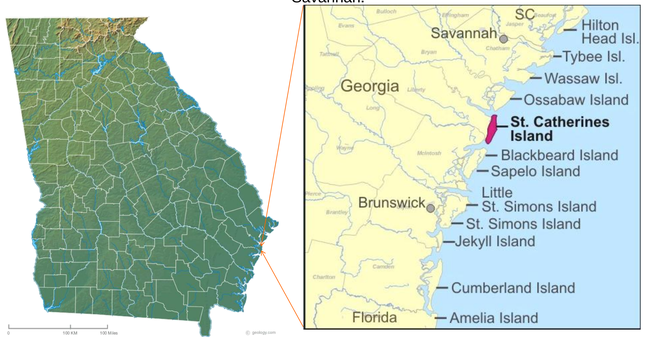
Abstract

St. Catherine's Island is a 20 km by 2 to 4 km barrier island located between the Savannah and Altamaha Rivers on the Georgia coast. The Pleistocene core of the island is flanked by Holocene ridge and swale terrain on the north, northeast, and southeast. LIDAR topographic models of the core show a higher (4.3 – 7.9 meters elevation) eastern portion and lower (2.4- 5.0 meters elevation) western portion. The models also reveal former ponds, marshes and drainage patterns along topographic lows that trend parallel to the long axis of the core. It is believed that artesian springs fed the fresh water ponds and marshes that have since given way to ephemeral wetlands due to post-industrialization loss of artesian pressure. Ground-penetrating radar profiling has identified sag structures in the Pleistocene core that are compatible with 2 to 5 meter subsidence of sandy surficial strata concomitant with filling of the sag basins. These sag structures are tentatively interpreted as the uppermost manifestation of solution collapse features that may originate at depth in the Floridan Aquifer, the principal artesian aquifer for the region.

Recent work has involved installing an east-west transect of four, 4.5 to 7.5 meter deep monitoring wells across the Pleistocene core. Head data indicate that shallow groundwater moves uniformly away from the topographic high and towards the adjoining salt marshes during wet periods. As the water table lowers during dry periods, a small groundwater divide develops, creating a reversal in groundwater flow within the topographic low adjacent to the core. Water chemistry data show that within the topographic low, the surficial aquifer contains Na-Cl type waters that are acidic (pH 4.5 to 5.0) and under reducing conditions. On the topographic high portion of the core, the shallow aquifer contains Na-Cl-SO4 type water that is less acidic (pH 5.5) and under oxidizing conditions. From these data it is hypothesized that any chemical signature from the previous discharge of alkaline, Ca-HCO3 type water associated with the springs and sag structures has been erased by the loss of positive artesian pressure within the Floridan Aquifer over the past 40 years.

Research Site

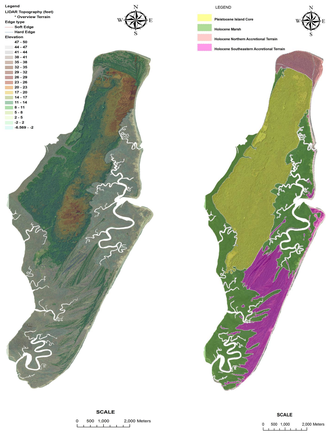
The study area is located on the Georgia coastline approximately ~60 kilometers south of Savannah.



Meyer et. al. 2009

Geology of St. Catherine's Island

St. Catherine's Island is composed of a Pleistocene core with Holocene accretionary beach dune-ridge and swale systems. The core also has topographic low stands that trend along the long axis of the island which is referred to as the Central Depression.



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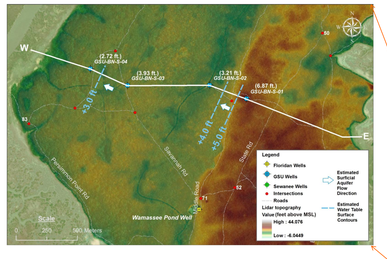
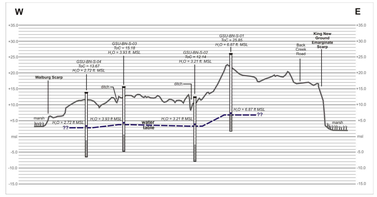
Well Installation

Wells were installed using a vibra-core system combined with water-jetting to drive a 4-inch aluminum pipe into the ground. Water-jetting removed sediment and allowed the pipe to be driven to the desired depth. A permanent 3-inch PVC casing and 5-foot screen were installed before removing the aluminum pipe.

GSU Well Transect





The east-west transect was strategically placed to determine the surface hydrology across the Pleistocene core of the island, and to see if the Central Depression influences the shallow groundwater system.

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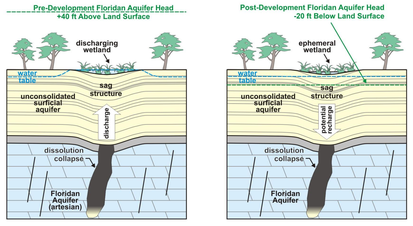
SCALE
0 500 1,000 2,000 Meters

Possible Geologic Controls on the Surface Hydrology

Ground Penetrating Radar (GPR) profiles across the Central Depression show extensive sag structures within the shallow subsurface (Vance et. al. 2011) . These features are interpreted as surface manifestations of solution collapse within the Upper Floridan aquifer, creating fractures and vertical groundwater pathways between the surficial and artesian systems. Under pre-development conditions, artesian springs could have been present, but today, vertical gradients are downwards, allowing surficial groundwater to migrate into the Upper Floridan.



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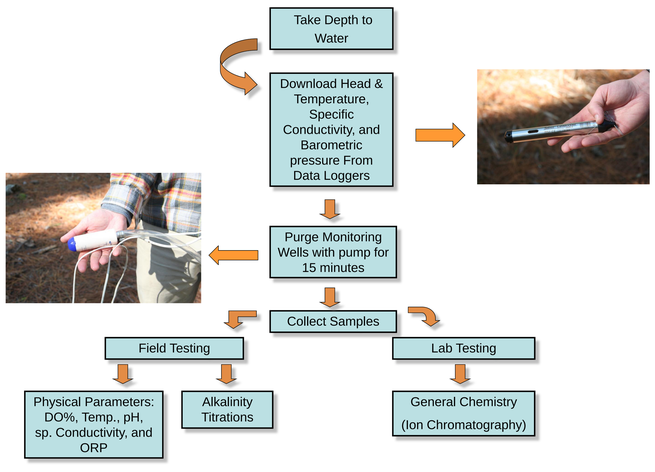
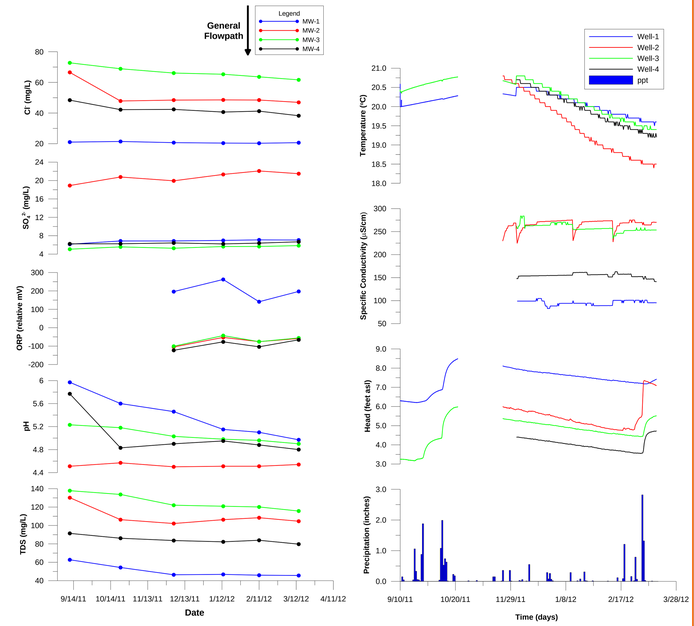
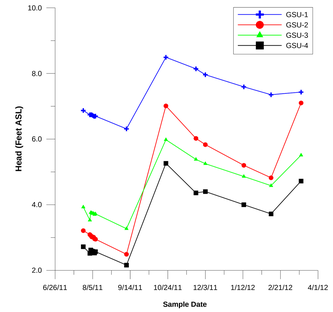
Methodology for Monthly Sampling

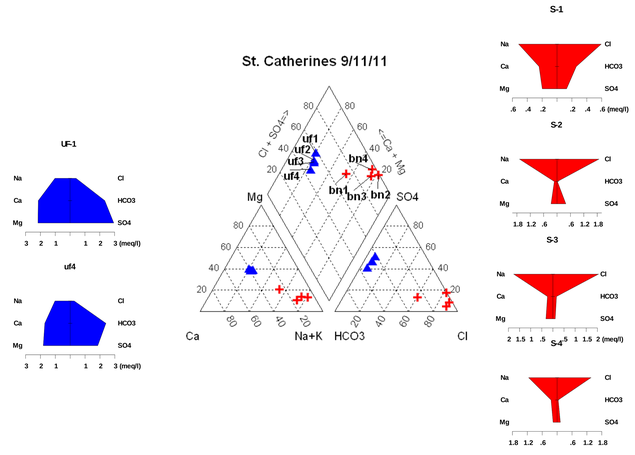


Preliminary Results



- Continuous data loggers and in-situ field measurements, have revealed physical and chemical differences along the transect.
- Head measurements have shown a variation in seasonal flow paths.
- Well 1 is the only well undergoing oxidation; the other 3 wells have reducing conditions.
- Well 2 is the most responsive to precipitation events.
- Wells 2-4 interpreted to be screened in marine deposits
- Upper Floridan does not appear to be influenced by Na-Cl type waters from the surficial aquifer





Acknowledgements

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