Structural Controls on Saltwater Intrusion in the Surficial Aquifer on St. Catherines Island, Georgia
James S. Reichard¹, R. Kelly Vance¹, Jacque L. Kelly¹, and Brian K. Meyer²

Abstract
St. Catherines Island is a composite barrier island located along the Georgia coast, consisting of a Pleistocene core surrounded by Holocene rocks, and by quarterly data from this study indicates that large tidal events periodically cause saline water to move laterally, and perhaps vertically, into the surficial aquifer along faults and solution collapse features at wells S4 and M6. This study concludes that the primary mechanism of saltwater intrusion is not necessarily by diffuse lateral flow of modern seawater, but rather by the flow of more saline water along structural pathways.

Research Site and Hydrogeologic Setting

LIDAR map (left) of St. Catherines shows the Pleistocene core outlined in black along with two well transects; an E-W transect of 6 wells installed in the surficial aquifer and an existing N-S transect of 4 production wells in the Upper Floridan aquifer. Surficial wells 1-4 (right) were installed in 2011 and wells 5 and 6 were added in 2013 – wells range in depth from 15 to 22 ft. Data loggers (head, temp, conductivity) were placed in wells 1-4 and set to record every 12 hrs. Water samples were collected on a monthly basis for the first year, followed by quarterly sampling over the past five years. Water chemistry data (right) show that wells 2-4 in the topographic low part of the island have a strong Na-C1 type water with ion proportions similar to that of seawater. In contrast, wells 1 and 5 on the topographic high have lower proportions of Na-C1 and contain fewer total dissolved solids.

Initial Hydrogeologic Study on St. Catherines

There's substantial evidence that some of these buried basement faults (left) have been re-activated at various times in the geologic past and have propagated upwards, creating permeable pathways for the vertical movement of groundwater within the coastal plain. A good example is beneath the city of Brunswick, Georgia (right), where a fault and/or solution conduit, at least 2,000 ft in length, has allowed hypersaline water to move up from depth, causing vertical saltwater intrusion in the Upper Floridan aquifer, which is part of major carbonate system that serves as the principle water supply for the region.

The overall hydrogeologic setting at St. Catherines is that of a surficial aquifer on a barrier island, which consists of unconsolidated Pleistocene and Holocene sediments that overlay a regional artesian system composed of Eocene to Cretaceous carbonate units. Historically, the vertical hydraulic gradient has been upwards (blue arrow), but due to modern pumping withdrawals, the gradient is now downwards (red arrow) within the study area.