Water Chemistry of the Upper Floridan Aquifer Along a Groundwater Flowpath on St. Catherines Island, Georgia

James S. Reichard1; Brock R. Nelson1; Brian K. Meyer2; R. Kelly Vance1; and Gale A. Bishop3

1 (1) Department of Geology and Geography, Georgia Southern University, Statesboro, GA 30460
2 (2) Department of Geosciences, Georgia State University, Atlanta, GA 30302
3 (3) St. Catherines Island Sea Turtle Program, Georgia Southern University, Statesboro, 30460

Abstract

St. Catherines Island is a 20 km by 3.6 km barrier island located on the Georgia coast between the Savannah and Altamaha Rivers. Hydraulic head and general water chemistry are being monitored on the island's Pleistocene core along a north-south transect of four wells completed in the upper Floridan Aquifer, the principal artesian aquifer for the region. Results from field observations and laboratory analysis of water samples collected along the 8 km long transect in this study show a south to north groundwater flow within the drawdown cone of the upper Floridan Aquifer. The hydraulic head averages 3.4 and 0.7 meters below sea level at the southern and northern ends of the transect, respectively. The groundwater is slightly alkaline (pH 7.6 to 7.9), has a low dissolved oxygen content (<2 mg/L), high concentrations of dissolved inorganic carbon (2.3 to 3.2 mg/L), and a decreasing chloride concentration along the flowpath (from 13.8 to 3.4 mg/L). Decreases in sulfate concentration along the flowpath are best explained by chemical reduction. The chloride decline can not be explained by evapotranspiration, with the chloride being located up-gradient (south) of the transect. Possible mechanisms include the downward movement of seawater through confining beds in the adjacent sound, and by the upwards flow of saline water from deep aquifers along vertical conduits. The groundwater is slightly alkaline (pH 7.6 to 7.9), has a low dissolved oxygen content (<2 mg/L), high concentrations of dissolved inorganic carbon (2.3 to 3.2 mg/L), and a decreasing chloride concentration along the flowpath (from 13.8 to 3.4 mg/L). Decreases in sulfate concentration along the flowpath are best explained by chemical reduction. The chloride decline can not be explained by evapotranspiration, with the chloride being located up-gradient (south) of the transect. Possible mechanisms include the downward movement of seawater through confining beds in the adjacent sound, and by the upwards flow of saline water from deep aquifers along vertical conduits. Additional sampling will be performed in an attempt to determine the source of the native water.

Study Area

Three main permeable zones (Fig. 2): Savannah drawdown cone is located 50 km to the north. Previous studies have documented both lateral and vertical solute intrusion in coastal Georgia due to the post-industrialization loss of artesian pressure within the upper Floridan Aquifer. The 6.5 km long transect in this study lies along a south to north groundwater flow within the drawdown cone of the upper Floridan Aquifer. The hydraulic head averages 3.4 and 0.7 meters below sea level at the southern and northern ends of the transect, respectively. The groundwater is slightly alkaline (pH 7.6 to 7.9), has a low dissolved oxygen content (<2 mg/L), high concentrations of dissolved inorganic carbon (2.3 to 3.2 mg/L), and a decreasing chloride concentration along the flowpath (from 13.8 to 3.4 mg/L). Decreases in sulfate concentration along the flowpath are best explained by chemical reduction. The chloride decline can not be explained by evapotranspiration, with the chloride being located up-gradient (south) of the transect. Possible mechanisms include the downward movement of seawater through confining beds in the adjacent sound, and by the upwards flow of saline water from deep aquifers along vertical conduits. Additional sampling will be performed in an attempt to determine the source of the native water.

Floridan Aquifer System

- Three main permeable zones (Fig. 2): Upper Floridan aquifer
- Lower Floridan aquifer
- Fernandina permeable zone
- Vertical conduit (red line) beneath Brunswick drawdown cone is allowing hypersaline water from the Fernandina to move into the Upper Floridan aquifer (Fig. 2).
- Savannah drawdown cone is causing saltwater from Port Royal to enter the Upper Floridan and flow laterally beneath Hilton Head Island (Fig. 3).
- Potential for lateral saltwater intrusion exists at numerous other locations, including St. Catherines Island – outlined in black (Fig. 3).

South-North Upper Floridan Transect

- Head data show that the transect lies completely within a major drawdown cone centered near Savannah, Georgia, created in 1979 due to withdrawal reductions by major industrial and municipal users in the Savannah area.
- The hydraulic head averages 3.4 and 0.7 meters below sea level at the southern and northern ends of the transect, respectively. The groundwater is slightly alkaline (pH 7.6 to 7.9), has a low dissolved oxygen content (<2 mg/L), high concentrations of dissolved inorganic carbon (2.3 to 3.2 mg/L), and a decreasing chloride concentration along the flowpath (from 13.8 to 3.4 mg/L). Decreases in sulfate concentration along the flowpath are best explained by chemical reduction. The chloride decline can not be explained by evapotranspiration, with the chloride being located up-gradient (south) of the transect. Possible mechanisms include the downward movement of seawater through confining beds in the adjacent sound, and by the upwards flow of saline water from deep aquifers along vertical conduits. Additional sampling will be performed in an attempt to determine the source of the native water.

Purpose and Objectives

The purpose of this study is to determine whether saltwater intrusion is occurring in the upper Floridan aquifer beneath St. Catherines Island. The objective is to use a south to north transect of four pumping wells to characterize the water chemistry along a groundwater flowpath within the aquifer.

Methodology

- Water chemistry of surficial (red) & Upper Floridan (blue) aquifers on St. Catherines along with Ogeechee River (black & tidal wetland (green) samples. Lower Floridan & new well data (magenta) from Falls et al. 2006.

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References