Thermal Infrared Mapping of Coastal-Aquifer Seeps and Associations Between Seeps and Coastal Habitats

By E. A. Raabe[1] and E. Bialkowska-Jelinska[2]
[1]U.S. Geological Survey, 600 Fourth Street South, St. Petersburg, FL 33701
[2]Jacobs Technology, Inc., contractor for USGS, 600 Fourth Street South, St. Petersburg, FL 33701

Abstract

Aquifer seeps along Florida's Gulf Coast were detected as temperature anomalies in airborne thermal infrared imagery. The coastal lowland is characterized by relatively flat terrain, near-surface and water-bearing limestone, sinkholes, and other surficial karst features (Crane, 1986; Rupert, 1988; Rupert, 1991). Several 1st and 2nd order springs are documented in the region (Suwannee River Water Management District, 2007). Anecdotes about aquifer seeps along the coast are common, but confirmation of their location and distribution has been lacking. This oral presentation describes the results of an analysis of temperature anomalies in the lower Suwannee River and nearby tidal creeks as derived from thermal infrared imagery acquired in late winter 2005 (VeriMap, 2005). Field reconnaissance and comparisons to other data sources confirmed the distribution of numerous seeps along the coast near Cedar Key, Florida (Fig. 1).

A key component to the analysis is the consistent temperature of the Floridan aquifer at approximately 22o Celsius year-round (Suwannee River Water Management District, 2007). During extended cold-winter or hot-summer weather, water temperature from the aquifer can contrast sharply with that of surrounding surface waters (Siegel et al., 1996; Spechler, 1996). Airborne acquisition of thermal imagery during a winter-cold spell made it possible to generate maps of multiple aquifer-discharge locations and their associated thermal plumes. Nighttime thermal infrared-image acquisition eliminated the possibility of false positives such as solar-heated sand. Water features exceeding ambient temperatures by 4o Celsius or more were mapped as "hot spots." Thermal plumes from these features were mapped when they exceeded ambient water temperature by 1o Celsius or more. Field reconnaissance confirmed temperature anomalies, small boils, and a variety of discharge-location characteristics. Full methodology and results were published by Raabe and Bialkowska-Jelinska (2007).

Identified "hot spots" included linear sections of tidal creeks, "tadpole-shaped" features leading into tidal creeks, sinkholes within the coastal forest, and thermal plumes associated with temperature anomalies (Fig. 1). Mobile species, such as manatee and sturgeon, use seep locations as thermal refugia during cold winter weather (Carr et al., 1996; Packard and Wetterquist, 1986). Local plant communities can indicate distinct water quality and discharge characteristics. Additionally, the discharge associated with these submarine features can play an important role in estuarine water quality (Katz et al., 1999; Katz and Raabe, 2005). Comparison of these features with existing data sources such as habitat maps, historic change analysis, satellite thermal imagery, and biomass fluctuation reveal unique habitat characteristics at coastal-aquifer exit points in the coastal ecosystem. The application of thermal infrared imagery in mapping the distribution of coastal-aquifer seeps shows promise in visualizing underlying karst, fracture zones, and underground conduits.

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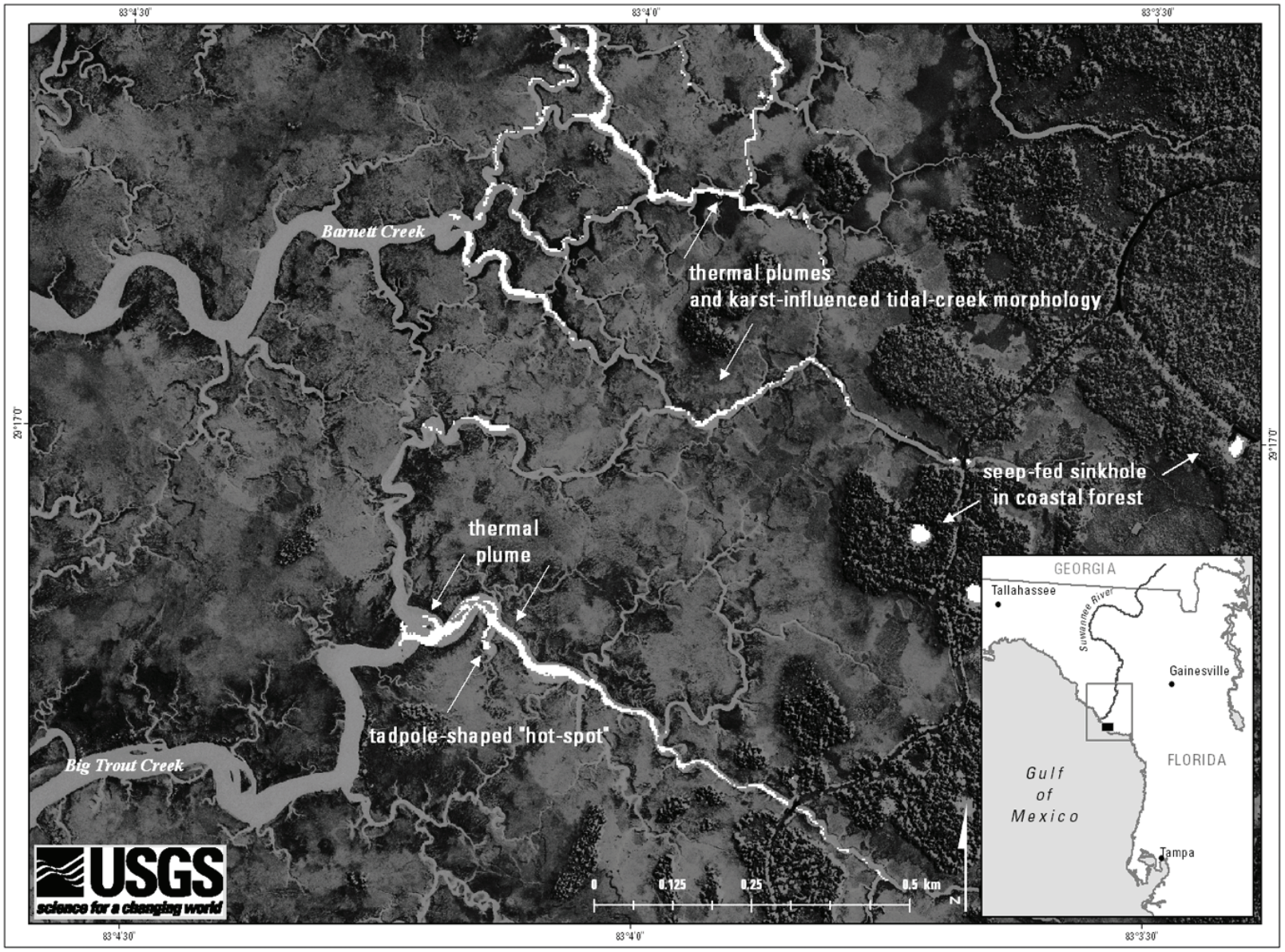

Figure 1. Tidal-creek temperature anomalies in nighttime thermal infrared imagery near Cedar Key, FL. Thermal plume direction reflects an incoming tide.