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OPEN-FILE REPORT 97

Text to accompany geologic map of the western portion of the USGS Inverness 30 x 60 minute quadrangle, central Florida

By

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Text to accompany geologic map of the western portion of the USGS Inverness 30 x 60 minute quadrangle, central Florida

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ABSTRACT

The accompanying 1:100,000 scale geologic map (Open-File Map Series 103, Plate 1) depicts the areal distribution of bedrock and surficial geologic units for the western portion of the United States Geological Survey (USGS) Inverness 30 x 60 minute quadrangle. The map was constructed using a combination of field mapping (at 1:24,000 scale), compilation of data from existing maps (various scales), core and cuttings analyses and descriptions, and analyses of various Geographic Information System (GIS) data sources. The resulting data were compiled in Environmental Systems Research Institute (ESRI®) ArcGIS® ArcMap™ 10 software for publication as part of the Florida Geological Survey Open-File Map Series. Mapped units range from Middle Eocene to Quaternary. Important resources in the mapped area include potable groundwater, springs, sand, clay and limestone. Numerous springs, swallets (sinking streams), and other karst features are present in the study area. Understanding of geologic units, karst, springs and their interactions within the area aids urban and land planners, environmental professionals, and citizens in making land-use decisions. Examples include designing new construction projects, siting new water supply wells and energy production facilities, siting waste management and storage facilities, locating sources of mineable resources for aggregate supply, and protection of springs, surface and groundwater quality.

Keywords: Florida, geologic map, Ocala Limestone, Suwannee Limestone, Avon Park Formation, Hawthorn Group, geomorphology, hydrogeology, springs, swallets, sinkholes, Floridan aquifer system, Citrus County, Hernando County, Levy County, Brooksville Ridge, Crystal River, Weeki Wachee Spring, Chassahowitzka, Homosassa, Homosassa Springs.

INTRODUCTION

The Florida Geological Survey (FGS) Open-File Report (OFR) 97 accompanies Open-File Map Series (OFMS) 103, which is comprised of three plates. Plate 1 depicts the near-surface geology of the eastern half of the USGS Inverness 30 x 60 minute quadrangle (U.S. Geological Survey, 1978) on a light detection and ranging (LiDAR) digital elevation model (DEM). Plate 2 depicts eight geologic cross-sections, a stratigraphic correlation chart, and representative photos for several of the lithostratigraphic units in the study area. Plate 3 is a geomorphology map on a LiDAR DEM, showing locations of known springs, sinkholes and swallets, along with photographs of selected exposures within the study area.

The study area lies southwest of Ocala and north-northwest of Tampa. It includes the communities of Crystal River, Homosassa, Homosassa Springs, Ozello, Weeki Wachee and northernmost Spring Hill. It includes portions of Citrus, Hernando and Levy Counties (Figure 1). It is surrounded by the USGS Ocala 30 x 60 minute, eastern Inverness 30 x 60 minute and Tarpon Springs 30 x 60 minute quadrangles mapped and being mapped under the STATEMAP program (Green et al., 2009a; 2009b; 2010; 2011; 2012a; 2012b; Williams et al., 2010; 2011).

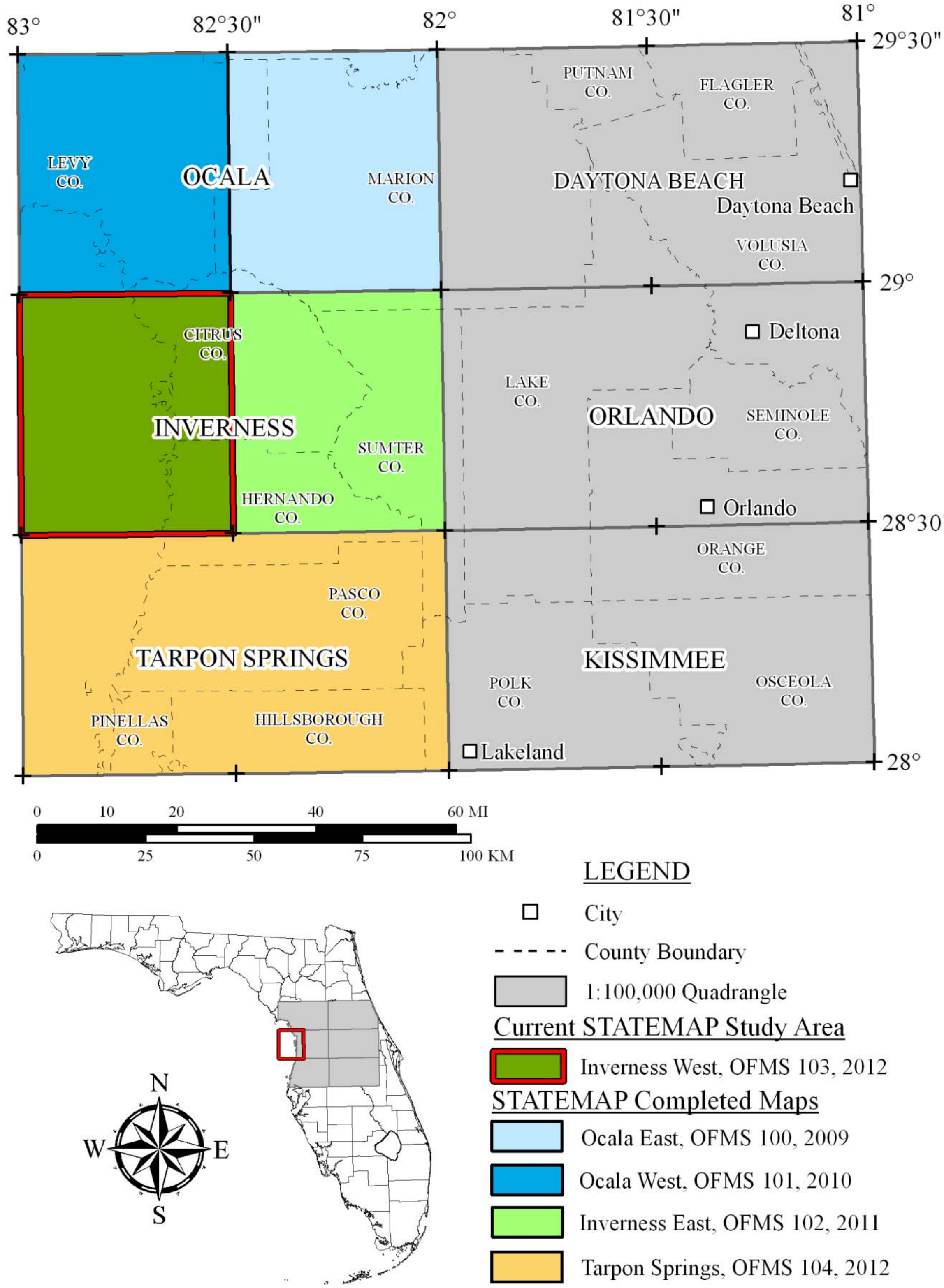

Figure 1. Nearby areas mapped under the FGS STATEMAP Program.

The mouth of the Withlacoochee River and numerous spring-fed rivers and creeks occur in the map area. Recharge to and discharge from the Floridan aquifer system (FAS) occurs throughout the study area. The FAS is the primary source of water for springs and drinking water in the region.

One objective for this report is to provide basic geologic information for the accompanying OFMS 103. Information provided by this report and the plates in OFMS 103 reaches a diverse audience comprising professionals in geology, hydrology, engineering, environmental and urban planning, and laypersons, all of whom have varying levels of geologic knowledge. The maps can help users identify and interpret geologic features which impact activities related to groundwater quality and quantity, as well as aid in locating mineral resources, land-use planning and construction project design. Applied uses of the maps and data in this report include: 1) identifying potential new mineral resources, 2) characterizing zones of potential aquifer recharge and confinement, 3) aiding water-management decisions on groundwater flow and usage, 4) providing information on aquifer vulnerability to potential pollution, 5) ecosystem, wetlands and environmental characterization and 6) recreational uses.

Methods

Mapping efforts consisted of 1) reviewing and compiling existing geologic literature and data, 2) mapping geologic units in the field at 1:24,000 scale using standard techniques, 3) analyses of existing core and cuttings samples from the FGS sample repository, 4) new core drilling, 5) collecting and describing outcrop samples and 6) preparing a geologic map, cross-sections and geomorphic map of the area. Field work, performed during the fall of 2011 through the spring of 2012, consisted of sampling and describing numerous outcrops, river and quarry exposures.

In the fall of 2010, the FGS's STATEMAP program undertook upgrading its collection methods for *in situ* data collection. The mobile GIS package that emerged to meet these requirements is an innovative GIS solution that is easy to use, reliable, low-cost, and highly customizable to the STATEMAP program's needs. A laptop computer with Microsoft® Windows XP operating system, flat-panel monitor, and Garmin® GPS unit form the core of the vehicle-based system. Data collection is handled in ESRI®'s ArcPad®, which runs a customized collection of tools that bypass time consuming digital forms and automatically attribute the relevant fields when a new point is added to the map: latitude and longitude; date and time; the type and geologic classification of observation; and the geologist recording the observation. The ease of use of these custom tools is further supplemented by a Logitech® G13, 25-button keypad. This piece of hardware allows the geologists and field personnel to perform a variety of operations: toggle layers on and off, perform basic operations such as pan, zoom and switching the current ArcPad tool in use by pressing a single key, rather than navigating multiple on-screen menus and forms, and record a variety of point, line and polygon features of a specific type or class. This ArcPad system allows rapid recording of digital location of float, non-outcrop displaced fragments of rock, and outcrop as well as other features that aid geologic mapping.

Thirty-four new samples of geologic material were added to the FGS surface-sample archives (M-Series) and two cores (490.5 feet or 149.5 meters total) were drilled. Approximately 100 outcrops and exposures were also examined during this project. All data, including about 310 wells from the study area and bordering 7.5 minute quadrangles, were compiled and analyzed by the authors. Figure 2 shows the locations of FGS cores and cuttings, field data

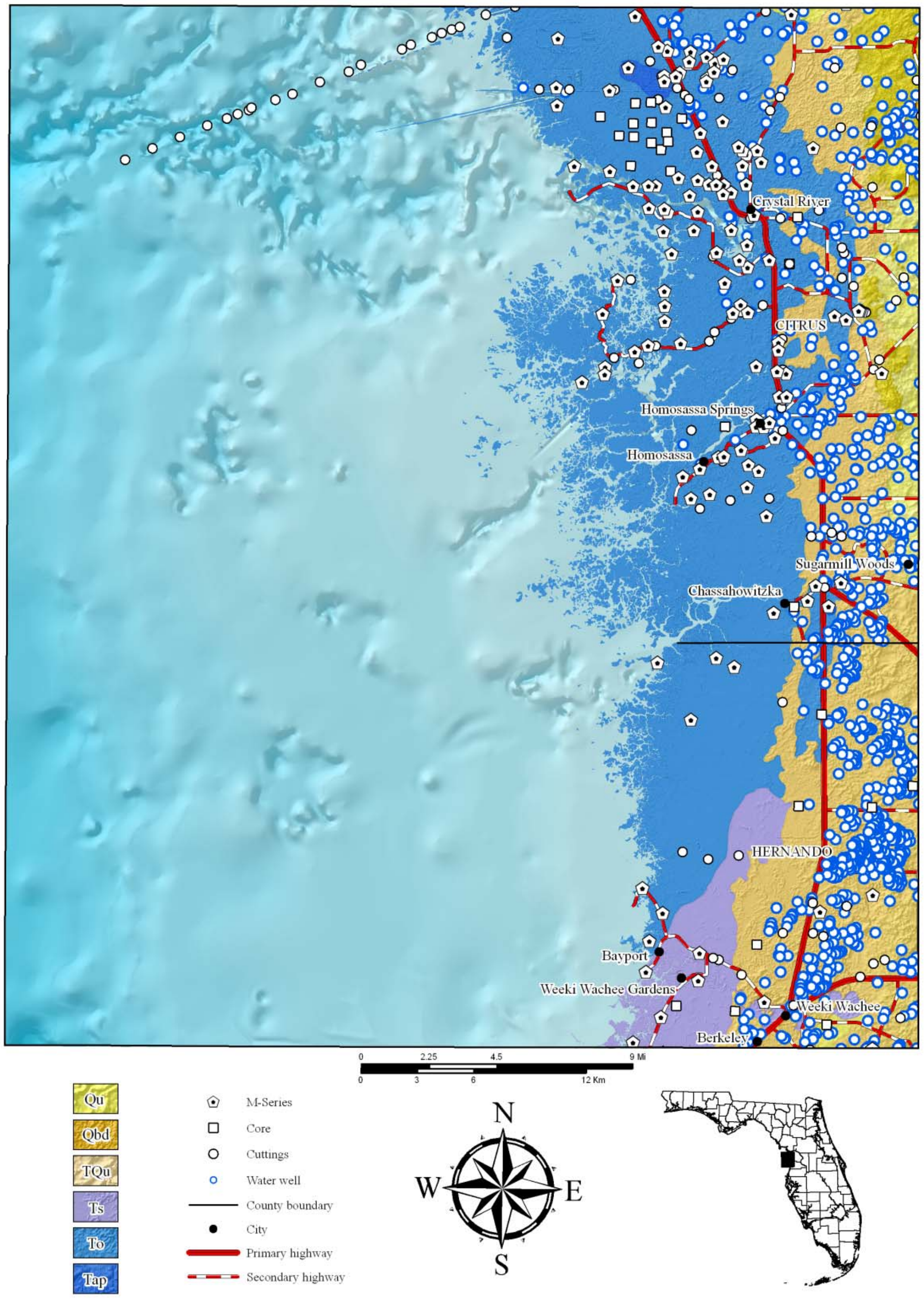

Figure 2. FGS cores and cuttings, field data points and M-series samples and Southwest Florida Water Management District (SWFWMD) water well data implemented for top of rock model. SWFWMD well elevations were acquired from an FGS-generated DEM. See discussion starting on page 14 for lithostratigraphic unit abbreviations and descriptions.

points, M-series outcrop samples, and Southwest Florida Water Management District (SWFWMD) water well data points within the study area with top of limestone/dolostone rock information. An interpolated top of rock surface was developed using kriging along with a LiDAR derived DEM to generate an overburden thickness model. The map and accompanying plates were developed in ESRI® ArcGIS® ArcMap™ 10 software for publication as part of the FGS OFMS. Appendix A includes only FGS wells with core and/or cuttings samples within the actual study area.

Much of the study area is blanketed by a veneer of undifferentiated Tertiary and Quaternary sediments and soils. For this reason, and in keeping with geologic mapping practices developed by Scott et al. (2001), the authors have adopted the policy of mapping the first named geologic unit within 20 feet (6.1 meters) of the surface. If undifferentiated Tertiary/Quaternary (TQu) or undifferentiated Quaternary (Qu) sediments attain a thickness greater than 20 feet (6.1 meters), then they appear as the mapped unit. If these undifferentiated sediments are less than 20 feet (6.1 meters) thick, then the underlying lithostratigraphic unit appears on the map.

The region is generally vegetated, and public access in parts of the mapped area is hindered by the presence of numerous wetlands, farms, ranches and privately owned land. The authors had to rely on existing well cuttings and core data in these areas. Fieldwork access was typically limited to public roads, State-owned lands, County-owned lands, and SWFWMD-owned lands.

Previous Work

The current study builds on previous geologic investigations in and around the present map area. A regional study of the geology of Citrus and Levy Counties, conducted by Vernon (1951), is the baseline study for the current study area. Preliminary county geologic maps for Citrus (Campbell and Scott, 1992), Hernando (Campbell, 1993) and Levy (Campbell, 1992) Counties at 1:126,720 scale were previously published by the FGS. However, each of these in the series of statewide OFMS county geologic maps were constructed in an average of 2-4 weeks utilizing selected in-house geologic data, with no new core drilling and not more than one week of field work. A statewide geologic map (Scott et al., 2001) was published by the FGS in digital format from these OFMS county maps. These maps provided a framework for the current mapping which offers significant refinement of prior geologic maps due to more extensive reconnaissance and more robust three dimensional geologic data. A structure-contour map of the top of the Floridan aquifer system (Allison et al., 1995; Arthur et al., 2008), and an isopach map of the Hawthorn Group in the region (Groszos and Rupert, 1992) also proved useful.

This study benefited greatly from previous STATEMAP work performed during geologic mapping of the USGS Ocala 30 x 60 minute quadrangle (Green et al., 2009a; Green et al., 2009b; Green et al., 2010; Williams et al., 2010) and the eastern portion of the USGS Inverness 30 x 60 minute quadrangle (Green et al., 2011; Williams et al., 2011). Some of the field relationships and stratigraphic problems were worked out during those projects and data gathered during those projects proved invaluable to the completion of this project.

GEOLOGIC SUMMARY

The near surface geology of the western portion of the USGS 30 x 60 minute Inverness quadrangle is composed of a complex mixture of Middle Eocene to Quaternary carbonate and siliciclastic sediments. A combination of factors, including fluvio-deltaic deposition and erosion, marine deposition, dissolution of underlying carbonates, erosion of sediments as a result of eustatic sea level changes and structural features have influenced the geology of the study area.

Distinction between the Middle Eocene Avon Park Formation and the unconformably overlying unit, the Upper Eocene Ocala Limestone, is at times difficult in the study area. Dolomitization of the Avon Park Formation and common recrystallization of the lowermost Ocala Limestone, particularly in the northern portion of the study area where both of these formations crop out at the surface, has significantly altered the original rock lithology and fabric. Fossil indicators are only somewhat helpful because the latest deposits of the Avon Park Formation and the earliest deposits of the Ocala Limestone are both bank assemblages, consistent with deposition in a shallow-water limestone bank or plateau, not unlike the present day Bahama Bank (Bryan, 2004). Karst development on the surface of the Avon Park Formation and later the Ocala Limestone, in addition to regional erosion over the Ocala Platform, has left an undulatory contact that does not allow clear definition of regional outcrops based upon elevation. A modern analog is evident along the Waccasassa Bay and Withlacoochee Bay shorelines where islands of Ocala Limestone with elevations rarely more than 5 feet (1.5 meters) above MSL exist in shallow flats where water depths are typically less than 3 feet (0.9 meters) (Green et al., 2010; Plate 3, Photos 1 and 3).

In the southern portion of the study area, both the Lower Oligocene Suwannee Limestone and the Upper Eocene Ocala Limestone crop out at the surface. Suwannee Limestone outcrops are most common in the coastal plain near the Gulf of Mexico and just to the east of the study area in the Brooksville Ridge. Many of the cuttings and cores between the Brooksville Ridge and coastal plain Suwannee Limestone outcrops exhibit signs of karstification. Commonly, the first recognizable limestone present is the Ocala Limestone. The top of the limestone surface is highly variable in this region. Where the Suwannee Limestone is present, it is underlain by the Ocala Limestone. These two formations can both vary from wackestone to grainstone. Current authors and others (Brewster-Wingard et al., 1997) have noted that, lithologically, the contact between the Suwannee Limestone and the Ocala Limestone can be difficult to differentiate in cores and cuttings. At times, such as seen in Photo 1, Plate 3, Green et al. (2011), there is a distinct contact between the two formations; however, this is not always (or even usually) present. More detailed lithology of all units found in the study area start on page 14 of this publication. Along with lithologic description, several diagnostic foraminifera and echinoids aid distinction of Suwannee Limestone from Ocala Limestone. Furthermore, there are some microfossil assemblage similarities between the Suwannee Limestone and the Avon Park Formation that are not similar to the Ocala Limestone. Both of the former contain *Fallotella* spp. which is only found infrequently at the base of the Ocala Limestone (personal communication, Jonathan Bryan). These units contain *Discorinopsis gunteri* which is not found in the Ocala Limestone. The abundant occurrence of *Nummulites* spp. and *Lepidocyclina* spp. in the Ocala Limestone distinguish it from the Suwannee Limestone and the Avon Park Formation.

The Hawthorn Group occurs infrequently in the subsurface toward the eastern boundary of the study area as weathered sandy clays and clayey sands lacking phosphate. The presence of these siliciclastics is hypothesized by the authors to have effectively capped and hindered dissolution of the underlying limestones. Where the Miocene undifferentiated Hawthorn Group sediments are present, the Lower Oligocene Suwannee Limestone and/or Upper Eocene Ocala Limestone resides at a higher elevation relative to surrounding areas without Hawthorn Group sediments.

Figure 3 reveals that much of the western portion of the Inverness quadrangle is located within the Crystal River to St. Petersburg basin and some of the northeastern part of the study area is in the South Withlacoochee River basin (Hydrologic Unit Codes Basins, 1993). Within the study area, there are numerous springs and spring-fed rivers within the Crystal River to St. Petersburg basin. There are at least 32 springs and springs groups in the Citrus County portion of the study area and six in the Hernando County portion. These include five first magnitude springs and springs groups, Hunter Spring and Tarpon Hole Spring of the Kings Bay Springs Group, Homosassa Springs Group, Chassahowitzka Springs Group and Weeki Wachee Spring (Scott et al., 2004). As of 2011, only the Chassahowitzka Springs Group and Weeki Wachee Spring are still classified as first magnitude springs due to a trend of decreasing springs flow rates (Springs 2011). A first magnitude spring is defined as having a minimum average flow of 100 cubic feet per second, or 64.6 million gallons per day (Copeland, 2003). These feed several of the more dominant rivers in the area, Crystal River, Homosassa River, Halls River, Chassahowitzka River, Salt River and Weeki Wachee River. Portions of the recharge areas for many of the mentioned first magnitude springs and the numerous smaller springs in Citrus and Hernando Counties are located within the study area. Many of these springs have shown significant increases in pollutants in the last few decades, particularly nitrate (Phelps, 1994; Phelps, 2004; Jones et al., 1996; Scott et al., 2002; Upchurch et al., 2004; Copeland et al., 2009). Detailed geologic mapping of lithostratigraphic units in this area provides critical data needed for future assessments of the vulnerability of the aquifer systems and springs to contamination. Understanding the surficial geology of the map area is a key factor in developing management and protection plans, not only for the springs, but for the unconfined portions of the Floridan aquifer system.

Structure

Several structural variables have affected the geology of the region (Figure 4). The Peninsular Arch, a structurally high area which affected deposition from the Cretaceous to the early Cenozoic, is the dominant subsurface feature of the Florida peninsula (Applin and Applin, 1944; Applin, 1951; Puri and Vernon, 1964; Williams et al., 1977; Schmidt, 1984; Miller, 1986; Scott, 1997). The axis of the Peninsular Arch, which lies to the east of the study area, extends from southeastern Georgia to the vicinity of Lake Okeechobee in southern Florida in a general northwest to southeast trend. The crest of the arch passes beneath Alachua County and is highest in Union and Baker Counties north of the study area. The arch was a topographic high during most of the Cretaceous Period and had Upper Cretaceous sediments deposited upon it (Applin, 1951). It formed a relatively stable base for Eocene carbonate deposition (Williams et al., 1977). The arch did not affect mid-Tertiary to Holocene sediment deposition (Williams et al., 1977; Scott, 1997).

The Ocala Platform is the most prominent structure affecting the near surface depositional and post-depositional environments within the map area. Hopkins (1920) originally named this feature the Ocala Uplift. Vernon (1951) described the Ocala Uplift as a gentle flexure developed in Tertiary sediments with a northwest-southeast trending crest. Because there is continuing uncertainty about the origin of this feature, Scott (1988) used the term Ocala Platform, rather than Ocala Uplift or Ocala Arch, since it does not have a structural connotation.

The Ocala Platform, which underlies the current study area, influenced late Tertiary sediment deposition. Miocene sediments of the Hawthorn Group are thought to have been

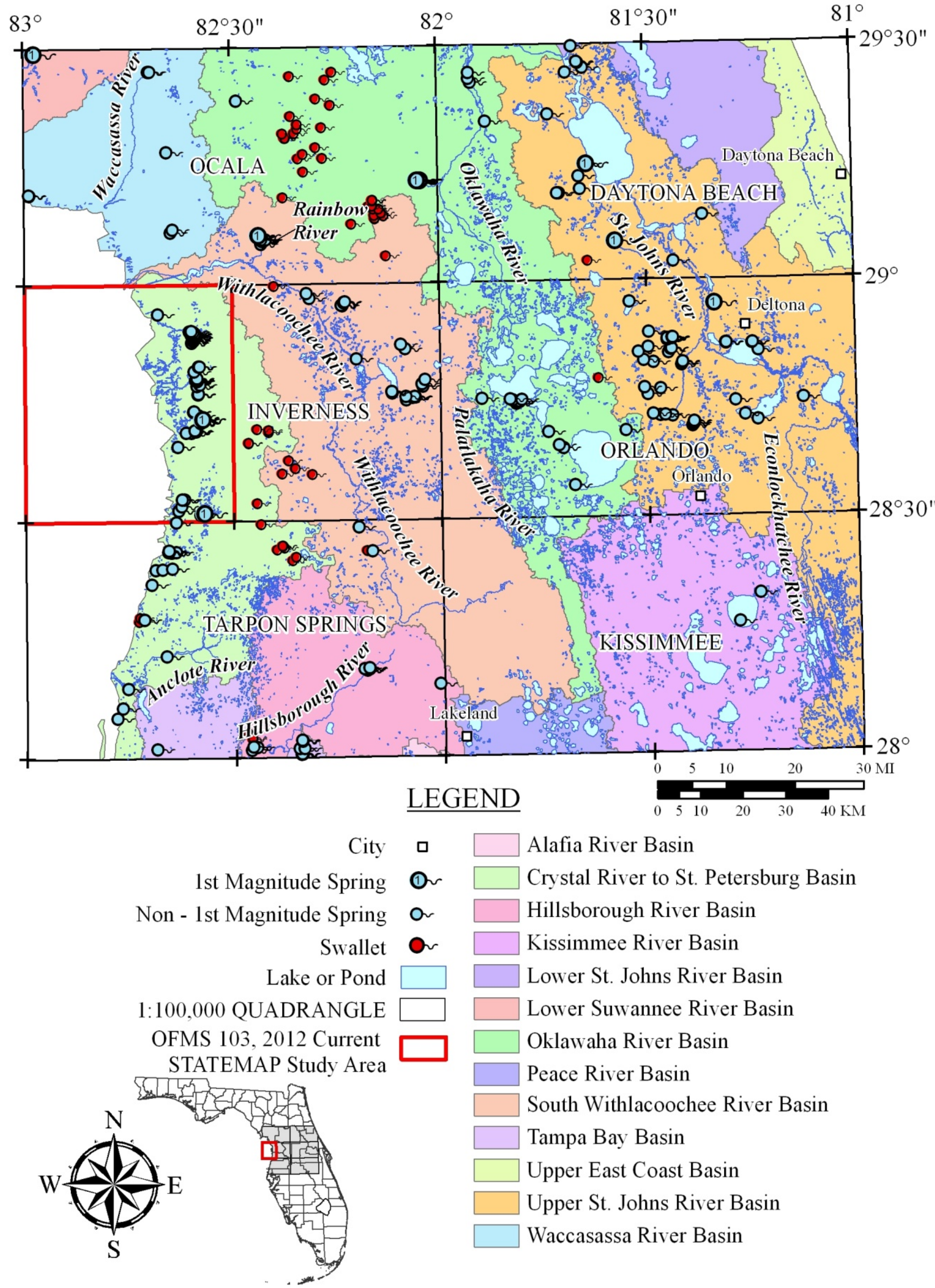

Figure 3. Location of selected river basins, springs, swallets and other water bodies.

deposited across the platform (Scott, 1981a; Scott, 1988; Scott, 1991a). Post-Miocene erosion has removed sediments of the Hawthorn Group from much of the crest of the Ocala Platform, exposing Eocene and Oligocene carbonates (Cooke, 1945; Espenshade and Spencer, 1963; Scott, 1981b). This is evident throughout the northern portion of the map area (OFMS 103; Plate 1). Undifferentiated sediments, thickest over the eastern portion of the study area on the western

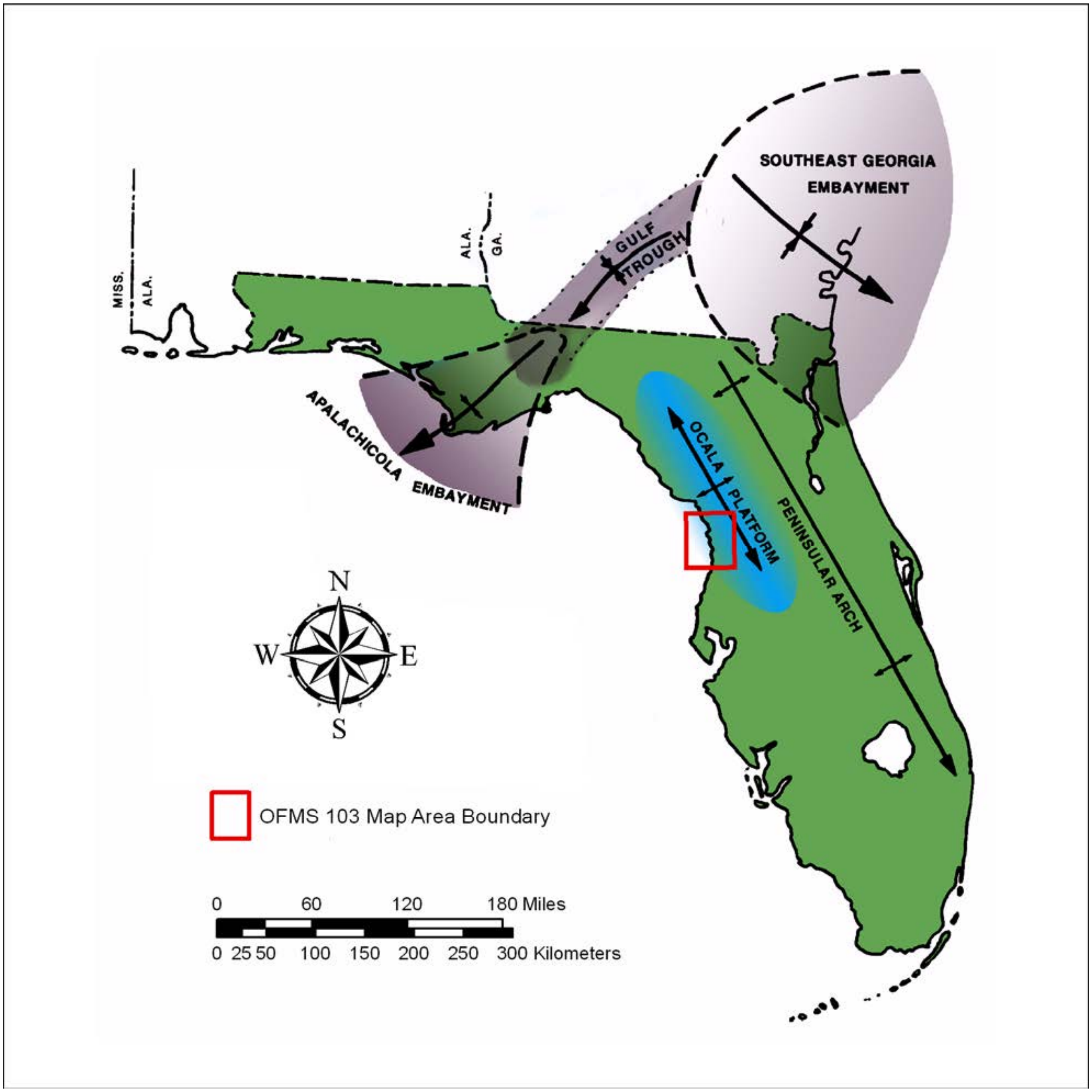

Figure 4. Principal subsurface structures of North Florida (modified from Puri and Vernon, 1964 and Schmidt, 1984).

flank of the Brooksville Ridge, have subsequently been deposited on the exposed Oligocene and Eocene carbonates. These consist of residual clays, marine sands, and aeolian sands deposited during the Miocene to Holocene (Scott, 1997).

Vernon (1951), utilizing aerial photographs, mapped fracture patterns throughout northern peninsular Florida. Regionally, these fractures generally trend parallel to the axis of the Ocala Platform in a northwest-southeast orientation. A secondary system of fractures intersects these primary fractures at high angles in a northeast-southwest trend (Vernon, 1951; see p. 47-52 for discussion of fractures). Orientation of stream meanders along portions of the Withlacoochee River suggests that these fracture patterns may be a controlling factor in stream location.

Vernon (1951) also discussed the occurrence of faults in part of the Florida peninsula. He attributed the origin of the faults to his postulated uplift of the Ocala Platform (his Ocala Uplift). Although he described the occurrence and surface-strike orientation of the faults, there was no discussion of the dip of the faults. Vernon did mention that his postulated faults were very steeply inclined. Vernon (1951) also mentioned seeing slickensides and grabens in quarries in the study area. Similar features have been observed by the authors while conducting fieldwork in the region, including karst and karst breccia encountered when coring W-19291 (Williams et al., 2011). It is believed that these are related to karst collapse and localized block movement within karst features, not to faulting as Vernon (1951) suggested. When a cover collapse sinkhole forms, large blocks may move downward along fractures created by the collapse and create localized slickensides which are not related to tectonic structural faulting. Additionally, numerous wells that Vernon (1951) used for cross-sections, which depicted faults in his report, were investigated by Green et al. (2009b) and several wells were deemed to be karst features. For example, W-1198 (see Vernon, 1951; Figure 14), appears to be karst infill. Karst features in the study area are very common.

A secondary critique of the faulting described by Vernon (1951) is the fact that many of the purported faults are actually offsets between biozonations within a formation, such as the Avon Park Formation, or between members of what Vernon (1951) called the Moodys Branch Formation (now Ocala Limestone; Puri, [1957], Scott, [1991b]). Through analyses and interpretation of hundreds of wells in the USGS Ocala and Inverness 30 x 60 minute quadrangles, the present authors recognize that there is great variability in the Suwannee Limestone, Ocala Limestone and the Avon Park Formation that is in large part related to original environments of deposition. Therefore, any faulting inferred based upon lithologic differences within the Avon Park Formation, Ocala Limestone and Suwannee Limestone are more likely variations due to environmental facies, not that these formations have distinct, continuous horizontal beds that are contiguous throughout the entire formation. As has already been discussed, the unconformable contact of the Avon Park Formation and the Ocala Limestone is not a planar surface, but formed on a topographically variable surface. Thus, adjacent localities where Ocala Limestone and Avon Park Formation are at the same elevation do not require a structural solution.

Geomorphology

Healy (1975) recognized six possible marine terraces within the study area (Figure 5) based upon elevation. However, it must be noted that most of what are labeled terraces are more correctly elevation zones that may or may not have specific associated terrace deposits of the ages noted in the scientific literature. The elevations for possible marine terrace deposits are the

Silver Bluff terrace at elevations between 1 and 10 feet (0.3 and 3 meters), the Pamlico terrace at elevations between 10 and 25 feet (3 and 7.6 meters), the Talbot terrace at elevations between 25 and 42 feet (7.6 and 12.8 meters) above mean sea level (MSL), the Penholoway terrace at elevations between 42 and 70 feet (12.8 and 21.3 meters) above MSL, the Wicomico terrace at elevations between 70 to 100 feet (21.3 to 30.5 meters) above MSL, and the

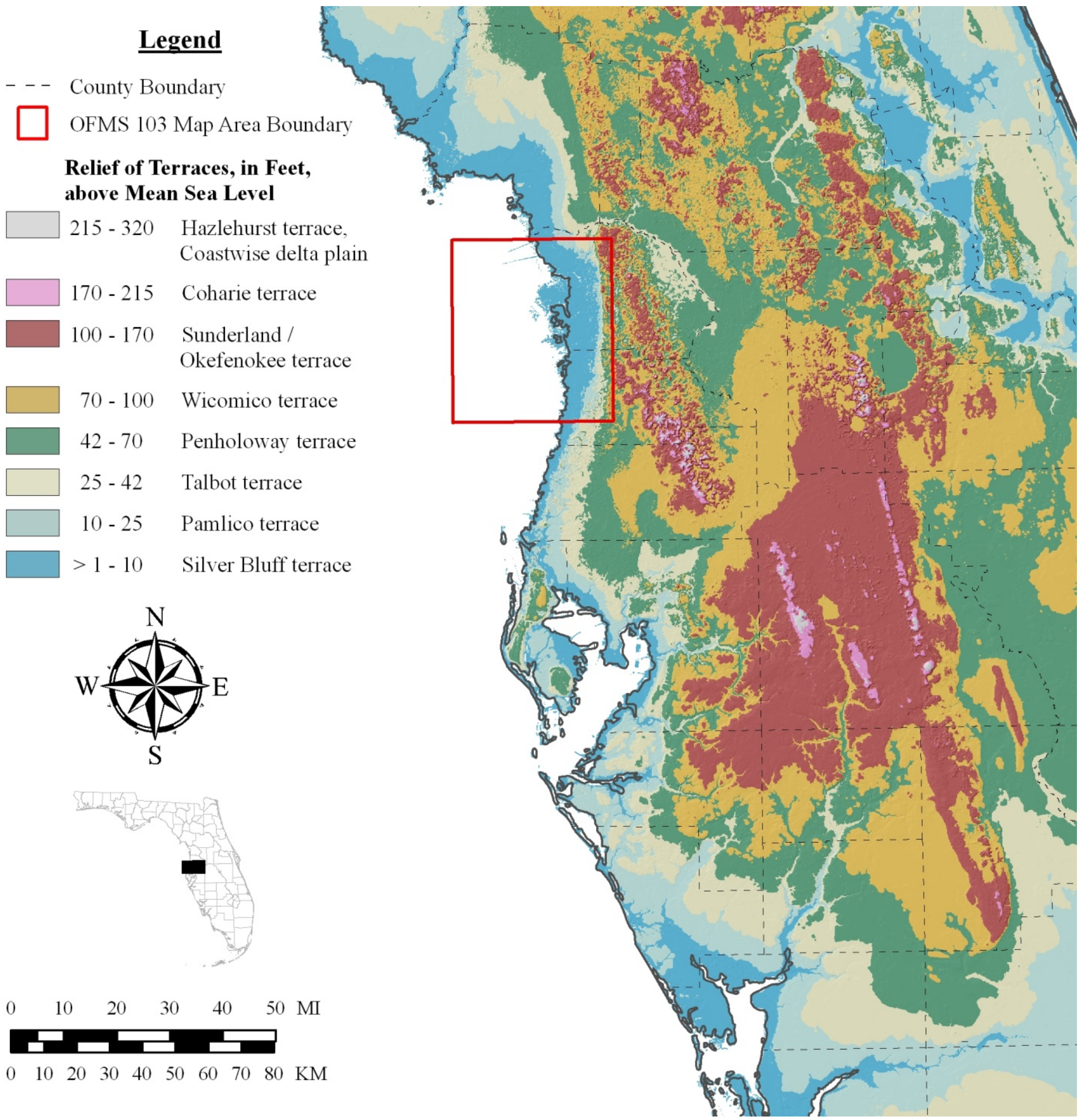

Figure 5. Terraces in Florida (after Healy, 1975).

Sunderland/Okefenokee terrace at elevations between 100 and 170 feet (30.5 and 51.8 meters) above MSL. Detailed discussions and correlations of these marine terraces and relict shorelines have been attempted by many authors, including Matson and Sanford (1913), Cooke (1931, 1939), Flint (1940, 1971), MacNeil (1950), Alt and Brooks (1965), Pirkle et al. (1970), Healy (1975), and Colquhoun et al. (1991).

The terrace best associated with the western Brooksville Ridge is the Penholoway which represents a later geomorphic event that modified the western flank of the ridge. The elevations of the Brooksville Ridge overall suggest that it may have formed at some earlier, higher sea level. White (1970) inferred by its elevation that the Brooksville Ridge must be related to the Wicomico with sea level over 100 feet (30.5 meters) above MSL. However, White (1970) also noted that the Brooksville Ridge has "suffered so much differential subsidence from solution of underlying limestone that it is difficult to correlate." Isostatic rebound initiated by carbonate dissolution further complicates tracing elevation delineated features in Florida (Opdyke et al., 1984; Adams et al., 2010).

According to Scott et al. (in preparation), the study area is entirely within the Ocala Karst District (OFMS 103; Plate 3, Figure 2). Within the map area, the Ocala Karst District has been further subdivided topographically into three regional geomorphic terranes: Brooksville Ridge, Crystal River Karst Plain and Land O' Lakes Karst Plain.

Ocala Karst District

The Ocala Karst District encompasses a broad area from central Wakulla County in the panhandle of Florida, south to Hillsborough and Pinellas Counties in the west-central peninsula and inland to nearly the center of the peninsula (OFMS 103; Plate 3, Figures 2 and 3). Elevations within the district range from sea level along the Gulf of Mexico coast to a maximum of 300 feet (91.4 meters) above MSL on the Brooksville Ridge. Within the study area, elevations range from sea level to 183 feet (55.8 meters) above MSL in the western flank of the Brooksville Ridge.

Carbonate sediments of the Middle Eocene Avon Park Formation, the Upper Eocene Ocala Limestone and Lower Oligocene Suwannee Limestone lie at or near the land surface in this district within the study area. There also exist Miocene undifferentiated Hawthorn Group, undifferentiated Tertiary/Quaternary sediments, and Quaternary Beach Ridge and Dune, particularly associated with or along the western flank of the Brooksville Ridge.

The Ocala Karst District is dominated by sinkholes and shallow bowl-shaped depressions, producing a rolling topography. Generally, a variably permeable siliciclastic cover allows downward migration of groundwater to slowly dissolve the underlying limestone, leading to cover-collapse sinkholes and cover-subsidence features (Sinclair and Stewart, 1985). Cover-collapse sinkholes form rather abruptly from the structural failure of an underlying cavern roof. An excellent example of this is at Devil's Millhopper Geological State Park, located in Alachua County north of the present study area (Evans et al., 2004). Cover-subsidence features generally occur in areas where sediments sag as carbonates dissolve underneath. Typically, areas such as these have shallow sinks formed by the downward raveling of the siliciclastic overburden filling voids created by dissolution of underlying carbonates or by dissolution of the carbonate surface. Springs, sinks, sinking (swallets) and resurgent streams, and caverns commonly occur within the Ocala Karst District.

Brooksville Ridge

The Brooksville Ridge, described by White (1970) as "the most massive of the ridges which rise above the general level of the Central Upland", stands out in stark contrast to the surrounding karst plains. The Brooksville Ridge province encompasses the eastern edge of the study area (OFMS 103; Plate 3, Figures 1 and 3). It is separated into two sections (northern and southern) by the Withlacoochee River. The northern portion of the Brooksville Ridge begins in Gilchrist and Alachua Counties and terminates in Levy and Marion Counties. The southern portion extends from Citrus County southward into Pasco County.

The two sections of the ridge differ in elevation, length-to-width ratio and underlying geology. Elevations in the northern, narrower portion of the Brooksville Ridge range from approximately 50 feet (15.2 meters) to greater than 150 feet (45.7 meters) above MSL. Elevations in some sinkholes are less than 50 feet (15.2 meters) above MSL. The southern, broader part of the ridge ranges in elevation from approximately 50 feet (15.2 meters) to more than 300 feet (91 meters) above MSL. In a few sinkholes, elevations of approximately 5 feet (1.5 meters) above MSL occur. Within the study area, elevations in this province range from 20 feet (6.1 meters) to 183 feet (55.8 meters).

The topography of the Brooksville Ridge displays significant variability. The northern section has low, rolling karst hills interspersed with moderately shallow sinkholes. The southern portion of the ridge becomes progressively hillier and terrain relief increases from north to south. White (1970) describes the southern ridge area as having "the most irregular surface to be found in any area of comparable size in peninsular Florida." From the vicinity of Brooksville southward, the hills are higher and more closely spaced. North of Brooksville, the hills are more widely spaced and generally have lower elevations, an indication of more mature karst. The Brooksville Ridge is well drained with wet conditions existing only in the low lying karst features. There are no springs found on the ridge, but many swallets occur within the southern Brooksville Ridge.

The Upper Eocene Ocala Limestone underlies the northern portion of the Brooksville Ridge. Weathered Miocene undifferentiated Hawthorn Group sediments lie unconformably on the Ocala Limestone with undifferentiated Quaternary and/or Tertiary/Quaternary siliciclastics mantling the ridge. The southern portion of the Brooksville Ridge is more complex geologically than the northern section. The southern section of the Brooksville Ridge is present on the eastern edge of the mapped area (OFMS 103; Plate 3, Figures 1 and 3). The province is underlain by carbonates of the Middle Eocene Avon Park Formation, the Upper Eocene Ocala Limestone and the Lower Oligocene Suwannee Limestone. These carbonates are overlain by variable thicknesses of weathered Miocene undifferentiated Hawthorn Group sediments and undifferentiated Tertiary-Quaternary siliciclastics, Quaternary siliciclastics or relict dunes of the Quaternary Beach Ridge and Dune map unit (also see Green et al., 2009a; 2009b; 2010; 2011; Williams et al., 2010; 2011).

Crystal River Karst Plain

The Crystal River Karst Plain occurs between the Gulf of Mexico coastline and the southern Brooksville Ridge in Citrus and Hernando Counties, south of the Withlacoochee River (OFMS 103; Plate 3, Figures 1 and 3). It is an area of low relief with mature karst features and most elevations ranging from sea level to 90 ft (27.4 m) above MSL. Within the mapped area, elevations range from sea level to 84 ft (25.6 m) above MSL. Karst features are usually shallow depressions. Springs are very common near the coast, as previously discussed. The area is often well drained, becoming more poorly drained toward the coast. Sand dunes are common along the boundary with the Brooksville Ridge (OFMS 103; Plate 1).

The Upper Eocene Ocala Limestone and Middle Eocene Avon Park Formation underlie most of the karst plain with some Lower Oligocene Suwannee Limestone at the southern end of the terrane. There is a thin, discontinuous layer of undifferentiated Hawthorn Group sediments on top of the Ocala Limestone toward the eastern part of the map area on the western flank of the Brooksville Ridge. Undifferentiated Tertiary and Quaternary siliciclastic sediments cover this karst plain in varying thicknesses.

Land O' Lakes Karst Plain

The Land O' Lakes Karst Plain province occurs from southwestern Hernando County southward to Pinellas and Hillsborough Counties. It lies west of the southern end of the Brooksville Ridge, west of the Green Swamp and north of the Pinellas Ridge, Coastal Lowlands and Polk-DeSoto Plain (OFMS 103; Plate 3, Figure 3). The occurrence of karst features varies from abundant and closely spaced to scattered. Sand dunes are present in several areas of the karst plain. This area varies from poorly drained to well-drained and there are many springs. The northern half of the Land O' Lakes Karst Plain, including the present study area, is underlain by the Lower Oligocene Suwannee Limestone or by the Upper Eocene Ocala Limestone, where the Suwannee Limestone is missing through marine and karst erosion off the western flank of the Brooksville Ridge. The Upper Oligocene to Lower Miocene Tampa Member of the Arcadia Formation, Hawthorn Group, underlies the southern portion of the karst plain. Clays and sands of Miocene undifferentiated Hawthorn Group overlie the carbonate sediments over much of the area. Quaternary siliciclastic sediments cover much of the karst plain. Elevations in the Land O' Lakes Karst Plain range from sea level to 142 feet (43.3 meters) above MSL. Elevations in the Land O' Lakes Karst Plain over the study area range from sea level to 133 feet (40.5 meters).

LITHOSTRATIGRAPHIC UNITS

Tertiary System

Eocene Series

Avon Park Formation

The Middle Eocene Avon Park Formation (Tap), first described by Applin and Applin (1944), is the oldest unit investigated in the study area. The unit consists of cream to light brown to tan, poorly to well-indurated, variably fossiliferous limestone (grainstone to wackestone, with rare mudstone). The limestones are interbedded with tan to brown, very poorly to well-indurated, very fine to medium crystalline, fossiliferous (molds and casts), vuggy dolostones. Organics are often present. Fossils present in the unit include mollusks, foraminifera (*Spirolina coryensis*, *Lituonella floridana*, *Bolivina* spp., and *Cushmania* [*Dictyoconus*] *americana*), echinoids, algae and both marine and terrestrial carbonized plant remains.

The Avon Park Formation underlies the mapped area and crops out in the northern part of the study area where the Upper Eocene Ocala Limestone is absent. Outcrop of the Avon Park Formation is likely more irregular than mapped as scattered thin remnants of Ocala Limestone are not uncommon in the area. The top of the Avon Park ranges from 3 feet (0.9 meters) above

MSL in W-17109 (OFMS 103; Plate 2, cross-section F-F') to 231 feet (70.4 meters) below MSL in W-18153 (OFMS 103; Plate 2, cross-sections E-E' and F-F'). No wells utilized for cross-sections penetrated the entire thickness of the Avon Park Formation. The Avon Park Formation forms part of the Floridan aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Ocala Limestone

The Upper Eocene Ocala Limestone (To), first described by Dall and Harris (1892), is a biogenic marine limestone comprised largely of foraminifera, mollusks, echinoids and bryozoans. Where present, the Ocala Limestone sits unconformably on the Avon Park Formation. When the Ocala Limestone is absent, such as in isolated locations near the Withlacoochee River, the Avon Park Formation may be in direct, unconformable contact with the overlying undifferentiated Quaternary sediments. The Ocala Limestone is recrystallized to varying degrees, particularly within the northern part of the study area, making the contact between the two units difficult to discern. Based on lithologic differences, the Ocala Limestone can be informally subdivided into an upper and lower unit (Scott, 1991b). This subdivision, while often apparent in cores and quarries, is not readily apparent in cuttings. As a consequence of this, the geologic cross-sections do not break out the upper and lower Ocala Limestone.

The upper unit is typically a white to cream, fine- to coarse-grained, poorly to well-indurated, moderately to well-sorted, very fossiliferous limestone (wackestone, packstone, and grainstone). Fossils commonly include foraminifera (*Lepidocyclina ocalana*), bryozoans, mollusks, and a rich diversity of echinoids. The lower unit is typically a white to cream, fine- to medium-grained, poorly to moderately-indurated, moderately to well-sorted limestone (grainstone to packstone). Fossils include foraminifera (*Amphistegina pinarensis*, *Nummulites* [*Camerina*] *vanderstoki*, *Nummulites* [*Operculinoides*] *ocalana*), bryozoans, algae, mollusks, echinoids, and crustaceans.

The top of the Ocala Limestone ranges from 130 feet (39.6 meters) above MSL in the Old Crystal River Rock Quarry site C-64 (OFMS 103; Plate 2, cross-section H-H') to 69 feet (21.0 meters) below MSL in W-18153 (OFMS 103; Plate 2, cross-sections E-E' and F-F'). Approximately 80 percent of the wells utilized for geologic cross-sections penetrate the entire thickness of the Ocala Limestone. In these wells, the thickness of the Ocala Limestone ranges from being absent in W-17109 on cross-section F-F' (OFMS 103; Plate 2) to 162 feet (49.4 meters) in W-18153 (OFMS 103; Plate 2, cross-sections E-E' and F-F'). The Ocala Limestone thins toward the north and northeast part of the study area approaching the central portion of the Ocala Platform. The Ocala Limestone is generally thickest in the southern portion of the study area off the nose of the Ocala Platform. The Ocala Limestone forms part of the Floridan aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Oligocene Series

Suwannee Limestone

The Lower Oligocene Suwannee Limestone (Ts), named by Cooke and Mansfield (1936), consists of dolomitized grainstone and packstone in the study area. The unit is typically gray, tan, light brown to moderate brown, moderately to very well-indurated, finely to coarsely crystalline, with limited occurrences of fossiliferous beds. Fossils present in the unit include mollusks, foraminifera (*Fallotella* spp.), corals and echinoids (*Rhyncholampas gouldii*). In the field area the Suwannee Limestone is often highly karstified. The Suwannee Limestone and Ocala Limestone can be exceedingly difficult to distinguish in the study area because both units may be dominated by packstones and often contain no diagnostic fossils. Brewster-Wingard et al., 1997 in their study further south in the Florida peninsula state, "…the delineation of the formational boundary [between the Ocala Limestone and the Suwannee Limestone] is often difficult, and foraminifera frequently provide the most reliable means for identifying the units." The present authors agree with this opinion for the present study area.

The Suwannee Limestone lies unconformably on the Ocala Limestone and is unconformably overlain by the undifferentiated Hawthorn Group, undifferentiated Quaternary sediments or Quaternary Beach Ridge and Dune sediments. Outcrops of Suwannee Limestone are concentrated in the southern portion of the study area near the Gulf of Mexico. Approaching the western flank of the Brooksville Ridge, the Suwannee Limestone may be absent in this heavily karstified region and the Ocala Limestone can be the first limestone encountered beneath the overlying Quaternary and Tertiary sediments and units. The Suwannee Limestone again crops out in the Brooksville Ridge just east of the study area and is mapped and discussed more fully in Green et al., 2011 and Williams et al., 2011. The top of the Suwannee Limestone ranges from 160 feet (48.8 meters) above MSL in the former Crystal River Rock Company quarry site C-64 (OFMS 103; Plate 2, cross-section H-H') to 18 feet (14.3 meters) below MSL in W-18153 (OFMS 103; Plate 2, cross-sections E-E' and F-F'). Thicknesses encountered range from 80 feet (24.4 meters) in W-14628 (OFMS 103; Plate 2, cross-sections E-E' and H-H') to 10 feet (3.0 meters) in W-7438 (OFMS 103; Plate 2, cross-section F-F'). The Suwannee Limestone forms part of the Floridan aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Miocene Series

Hawthorn Group

Sediments of the Upper Oligocene to Miocene Hawthorn Group are thought to have been deposited over the Ocala Platform throughout the area, but post-Miocene erosion and karstification have removed sediments from the crest of the Ocala Platform, exposing the Eocene carbonates in the central portion of the map area (Cooke, 1945; Espenshade and Spencer, 1963; Scott, 1981b). Fossils in the Hawthorn Group are sparse but may include vertebrate remains, corals, and mollusks. Williams et al. (1977) report that the most commonly found fossils are oysters and coral heads. Within the mapped area, the Hawthorn Group is composed of Miocene undifferentiated Hawthorn Group (Th) sediments, and was observed to be variably-weathered in cores and cuttings.

Undifferentiated Hawthorn Group

The Miocene undifferentiated Hawthorn Group (Th) sediments are light olive gray and blue gray in unweathered sections and reddish brown to reddish gray in weathered sections. They consist of poorly to moderately consolidated, clayey sands to silty clays and relatively pure clays with little to no phosphate due to leaching and transport (Scott, 2001). They are typically deeply weathered. In the southern Brooksville Ridge, undifferentiated Hawthorn Group sediments are often overlain by more than 20 feet (6.1 meters) of undifferentiated Tertiary/Quaternary sediments and/or Quaternary sediments. Hard rock phosphate deposits are associated with the undifferentiated Hawthorn Group sediments in several places along the eastern flank of the Brooksville Ridge (Green et al., 2011; Williams et al., 2011). These hard rock phosphate deposits were formed by dissolution of phosphate from the Hawthorn Group and subsequent precipitation in karst features within the Ocala Limestone (Scott, 2001).

Where present, undifferentiated Hawthorn Group sediments unconformably overlie the Ocala Limestone or the Suwannee Limestone (Scott, 1988). They may be unconformably overlain by undifferentiated Quaternary sediments or undifferentiated Tertiary/Quaternary sediments. Thin beds of the undifferentiated Hawthorn Group were penetrated in a few wells in the eastern portion of the map area. In these, the top of the Hawthorn Group ranges from 55 feet (16.8 meters) above MSL in W-19331 (OFMS 103; Plate 2, cross-section D-D') to 18 feet (5.5 meters) below MSL in W-19238 (OFMS 103; Plate 2, cross-sections D-D' and H-H'). The undifferentiated Hawthorn Group ranges from 10-70 feet (3.1-21.3 meters) thick in wells in the study area some thickness of which includes deeply weathered sections. Undifferentiated Hawthorn Group sediments are often clayey sands with some permeability, and only rarely consist of relatively pure clays. The undifferentiated Hawthorn Group sediments generally have low permeability and form part of the intermediate aquifer system/intermediate confining unit (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Tertiary/Quaternary Systems

Pliocene/Pleistocene Series

Undifferentiated Tertiary/Quaternary Sediments

Undifferentiated Tertiary/Quaternary sediments (TQu) are siliciclastics that are separated from the lithologically similar undifferentiated Quaternary sediments solely on the basis of elevation (Scott et al., 2001). Pleistocene sea levels reached a maximum of approximately 100 feet (30.5 meters) above MSL (Colquhoun, 1969; Colquhoun et al., 1991). The sediments which occur above 100 feet (30.5 meters) MSL are predominately older than Pleistocene but may have been reworked during the Pleistocene. They are present in the northwestern portion of the map area (OFMS 102; Plate 1) in areas where elevations exceed 100 feet (30.5 meters). Some areas below 100 feet (30.5 meters) may be included in the undifferentiated Tertiary/Quaternary sediments where not including them would have created very complex map polygons. These poorly-consolidated to unconsolidated siliciclastics are white to gray to orange to blue-green, fine- to coarse-grained, clean to clayey unfossiliferous sands, sandy clays and clays with variable admixtures of clay and organics. Permeable sediments of the undifferentiated Tertiary/Quaternary sediments form part of the surficial aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

Pleistocene to Holocene Series

Undifferentiated Quaternary Sediments

Undifferentiated Quaternary sediments (Qu) in the study area lie unconformably on the Avon Park Formation or the Ocala Limestone. The Avon Park Formation and the undifferentiated Quaternary sediments are only in direct contact where the Ocala Limestone, the Suwannee Limestone and the Hawthorn Group are absent from the section. The undifferentiated Quaternary sediments present in the eastern portion of the mapped area are highly variable in thickness.

Generally, these undifferentiated Quaternary sediments consist of white to gray to orange to blue-green, fine- to coarse-grained, clean to clayey unfossiliferous sands, sandy clays and clays with variable admixtures of organics. They are only separated from the undifferentiated Tertiary/Quaternary sediments due to current elevations below 100 feet (30.5 meters). The undifferentiated Quaternary sediments form part of the surficial aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). Where these sediments lack clays and overlie the Eocene or Oligocene limestones, they are hydraulically connected to the Floridan aquifer system.

Quaternary Beach Ridge and Dune

The sediments of the beach ridge and dune (Qbd) are a subdivision of the undifferentiated Quaternary sediments that are noted on the basis of surficial expression of beach ridges and dunes. These sediments typically unconformably overlie the Ocala Limestone, the Suwannee Limestone or the undifferentiated Hawthorn Group. Beach ridge and dune sediments occur in the eastern part of the study area along the western flank of the southern Brooksville Ridge (OFMS 103; Plate 1). Subdivisions of the undifferentiated Quaternary sediments are not formally recognized lithostratigraphic units, but are noted to facilitate a better understanding of Florida's Quaternary geology (Scott, 2001).

Beach ridge and dune sediments are dominantly siliciclastic sands and are unconsolidated to poorly consolidated. Organics typically occur as disseminated organic matrix, roots and plant debris, carbonized remains or charcoal. These sediments are considered part of the surficial aquifer system (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986).

HYDROGEOLOGY

Hydrostratigraphic units within the map area, in ascending order, consist of the Floridan aquifer system (FAS), the intermediate aquifer system/intermediate confining unit (IAS/ICU), and the surficial aquifer system (SAS) (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). The FAS, the primary source for springs and drinking water in the region, is comprised of carbonate units of the Avon Park Formation, the Ocala Limestone, and the Suwannee Limestone. The sands, silts, clays and carbonates of the Hawthorn Group comprise the IAS/ICU. The IAS/ICU is highly localized and laterally discontinuous in the study area. The SAS is comprised of the undifferentiated

Tertiary/Quaternary sediments (TQu), the undifferentiated Quaternary sediments (Qu) and the Beach Ridge and Dune sediments (Qbd).

Where clayey siliciclastic sediments of the Hawthorn Group and younger units are thick and continuous, they provide confinement for the FAS, but where the clayey siliciclastic sediments of the Hawthorn Group and younger units are thin, missing or lack significant clay component, karst features often occur. Swallets (stream-to-sink features) are of particular interest to geoscientists. Several of these are found in the southern Brookville Ridge, particularly where areas of undifferentiated Hawthorn Group sediments thinly cover the Suwannee Limestone.

DERIVATIVE PRODUCTS

Several derivative products will come from this project. During the mapping project, data from 312 wells with samples were analyzed, and data for over 900 wells total were used (Appendix A includes only FGS wells within the study area boundary and Figure 2 includes water management district wells with top of limestone rock information). Formation picks, made on all available wells with cores and cuttings samples, allow creation of a structure contour map of the top of the Floridan aquifer system. Some additional descriptive and interpretive work could allow construction of structure contour and isopach maps of the IAS/ICU in the area. Additional derivative data anticipated to come from this mapping effort include aquifer vulnerability assessment maps. Data derived from prior STATEMAP products have often been used to augment other Florida Geological Survey and Florida Aquifer Vulnerability Assessment (FAVA) projects in the state (Arthur et al., 2007; Baker et al., 2007).

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APPENDIX A: FGS WELLS AND LOCALITY UTILIZED FOR STUDY

Map ID	Well Label	Data Source	Sample Type	Longitude	Latitude	24K Quad	Elevation (ft)	Total Depth (ft)
1	W-1221	FGS	Cuttings	-82.738385	28.995650	RED LEVEL	1	42
2	W-1763	FGS	Cuttings	-82.575737	28.807348	HOMOSASSA	4	55
3	W-1767	FGS	Cuttings	-82.499561	28.947406	HOLDER	113	233
4	W-2827	FGS	Cuttings	-82.653917	28.828666	OZELLO	3	68
5	W-6313	FGS	Cuttings	-82.586006	28.856583	HOMOSASSA	12	100
6	W-7438	FGS	Cuttings	-82.612503	28.543271	WEEKI WACHEE SPRING	7	160
7	W-7761	FGS	Cuttings	-82.582231	28.950049	CRYSTAL RIVER	20	34
8	W-7764	FGS	Cuttings	-82.629332	28.594136	BAYPORT	8	97
9	W-7765	FGS	Cuttings	-82.615309	28.590637	WEEKI WACHEE SPRING	8	125
10	W-7766	FGS	Cuttings	-82.598646	28.592507	WEEKI WACHEE SPRING	8	140
11	W-7767	FGS	Cuttings	-82.568542	28.520619	WEEKI WACHEE SPRING	22	94
12	W-7768	FGS	Cuttings	-82.532032	28.534354	WEEKI WACHEE SPRING	35	260
13	W-7769	FGS	Cuttings	-82.551897	28.721131	CHASSAHOWITZKA	13	245
14	W-7775	FGS	Cuttings	-82.620283	28.758873	HOMOSASSA	3	45
15	W-7776	FGS	Cuttings	-82.603641	28.762886	HOMOSASSA	4	50
16	W-7777	FGS	Cuttings	-82.582319	28.763871	HOMOSASSA	5	95
17	W-7778	FGS	Cuttings	-82.708951	28.959887	RED LEVEL	2	70
18	W-7838	FGS	Cuttings	-82.542667	28.869680	HOMOSASSA	15	55
19	W-8374	FGS	Cuttings	-82.611275	28.918867	CRYSTAL RIVER	5	50
20	W-10415	FGS	Cuttings	-82.555426	28.902183	CRYSTAL RIVER	10	75
21	W-11074	FGS	Cuttings	-82.525273	28.825873	HOMOSASSA	73	130
22	W-11121	FGS	Cuttings	-82.559437	28.499289	PORT RICHEY NE	35	418
23	W-11210	FGS	Cuttings	-82.558075	28.569799	WEEKI WACHEE SPRING	23	230
24	W-11259	FGS	Cuttings	-82.526642	28.942506	CRYSTAL RIVER	97	160
25	W-11553	FGS	Cuttings	-82.512936	28.858986	HOMOSASSA	50	105
26	W-11963	FGS	Cuttings	-82.536345	28.865774	HOMOSASSA	40	65
27	W-12357	FGS	Cuttings	-82.542687	28.745797	CHASSAHOWITZKA	18	80
28	W-12362	FGS	Cuttings	-82.625037	28.796498	OZELLO	3	449
29	W-14005	FGS	Cuttings	-82.610264	28.956006	CRYSTAL RIVER	10	488
30	W-14400	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
31	W-14628	FGS	Cuttings	-82.510052	28.514682	WEEKI WACHEE SPRING	111	400
32	W-14837	FGS	Cuttings	-82.592892	28.898141	CRYSTAL RIVER	4	470
33	W-15685	FGS	Core	-82.568628	28.711937	CHASSAHOWITZKA	9	284.5
34	W-17097	FGS	Core	-82.675379	28.946919	RED LEVEL	4	50
35	W-17099	FGS	Core	-82.656212	28.953308	RED LEVEL	5	50
36	W-17101	FGS	Core	-82.657045	28.937197	RED LEVEL	5	50
37	W-17102	FGS	Core	-82.647601	28.953864	RED LEVEL	7	47
38	W-17106	FGS	Core	-82.642045	28.931087	RED LEVEL	4	38
39	W-17109	FGS	Core	-82.660101	28.970252	RED LEVEL	7	50
40	W-17110	FGS	Core	-82.658712	28.923309	RED LEVEL	3	50
41	W-17692	FGS	Core	-82.553413	28.660241	CHASSAHOWITZKA	14	654
42	W-18057	FGS	Cuttings	-82.574818	28.666098	CHASSAHOWITZKA	23	450
43	W-18146	FGS	Core	-82.632598	28.520272	BAYPORT	7	168
44	W-18153	FGS	Core	-82.600375	28.517772	WEEKI WACHEE SPRING	17	308
45	W-18603	FGS	Cuttings	-82.571472	28.876472	CRYSTAL RIVER	6	24
46	W-19238	FGS	Core	-82.525778	28.615721	WEEKI WACHEE SPRING	40.83	90
47	W-19312	FGS	Core	-82.565888	28.616250	WEEKI WACHEE SPRING	12	230
48	W-19331	FGS	Core	-82.503333	28.625944	CHASSAHOWITZKA	87.62	260.5
49	C-64	FGS	Outcrop	-82.532123	28.854217	HOMOSASSA	160	131.95
50	W-720	FGS	Cuttings	-82.529562	28.853354	HOMOSASSA	170	300
51	W-1220	FGS	Cuttings	-82.722381	28.999596	RED LEVEL	4	43
52	W-1222	FGS	Cuttings	-82.752668	28.989748	WITHLACOOCHEE BAY OE S	-5	38
53	W-1223	FGS	Cuttings	-82.757094	28.988459	WITHLACOOCHEE BAY OE S	5	28
54	W-1225	FGS	Cuttings	-82.767948	28.984748	WITHLACOOCHEE BAY OE S	-3	38
55	W-1226	FGS	Cuttings	-82.779503	28.981117	WITHLACOOCHEE BAY OE S	-5	19
56	W-1227	FGS	Cuttings	-82.784338	28.978908	WITHLACOOCHEE BAY OE S	-11	31
57	W-1228	FGS	Cuttings	-82.806837	28.971408	WITHLACOOCHEE BAY OE S	-9	33
58	W-1229	FGS	Cuttings	-82.813497	28.968078	WITHLACOOCHEE BAY OE S	-14	33

Map ID	Well Label	Data Source	Sample Type	Longitude	Latitude	24K Quad	Elevation (ft)	Total Depth (ft)
59	W-1230	FGS	Cuttings	-82.829337	28.963078	WITHLACOOCHEE BAY OE S	-12	31
60	W-1231	FGS	Cuttings	-82.844327	28.957248	WITHLACOOCHEE BAY OE S	-15	27
61	W-1233	FGS	Cuttings	-82.868184	28.949411	WITHLACOOCHEE BAY OE S	-17	24
62	W-1234	FGS	Cuttings	-82.874327	28.947528	WITHLACOOCHEE BAY OE S	-17	24
63	W-1235	FGS	Cuttings	-82.880255	28.945387	N/A - GULF OF MEXICO	-13	28
64	W-1236	FGS	Cuttings	-82.890997	28.941968	N/A - GULF OF MEXICO	-16	41
65	W-1237	FGS	Cuttings	-82.905997	28.936408	N/A - GULF OF MEXICO	-20	43
66	W-1238	FGS	Cuttings	-82.920997	28.930858	N/A - GULF OF MEXICO	-18	41
67	W-1239	FGS	Cuttings	-82.935997	28.925298	N/A - GULF OF MEXICO	-32	42
68	W-1791	FGS	Cuttings	-82.501763	28.964698	CRYSTAL RIVER	107	250
69	W-3015	FGS	Cuttings	-82.574956	28.810965	HOMOSASSA	5	65
70	W-7422	FGS	Cuttings	-82.552236	28.553785	WEEKI WACHEE SPRING	35	51
71	W-7423	FGS	Cuttings	-82.609562	28.912512	CRYSTAL RIVER	5	60
72	W-7436	FGS	Cuttings	-82.612503	28.543271	WEEKI WACHEE SPRING	7	165
73	W-7437	FGS	Cuttings	-82.612503	28.543271	WEEKI WACHEE SPRING	7	155
74	W-7439	FGS	Cuttings	-82.612503	28.543271	WEEKI WACHEE SPRING	7	165
75	W-7543	FGS	Cuttings	-82.612445	28.843720	HOMOSASSA	4	5564
76	W-7758	FGS	Cuttings	-82.522170	28.830480	HOMOSASSA	93	46
77	W-7760	FGS	Cuttings	-82.541604	28.881732	HOMOSASSA	8	33
78	W-7770	FGS	Cuttings	-82.551897	28.721131	CHASSAHOWITZKA	11	50
79	W-7771	FGS	Cuttings	-82.667502	28.831196	OZELLO	2	45
80	W-7772	FGS	Cuttings	-82.644682	28.836946	OZELLO	8	55
81	W-7773	FGS	Cuttings	-82.615391	28.839207	HOMOSASSA	3	40
82	W-7774	FGS	Cuttings	-82.603321	28.850132	HOMOSASSA	5	75
83	W-7779	FGS	Cuttings	-82.692419	28.959886	RED LEVEL	4	50
84	W-7780	FGS	Cuttings	-82.667594	28.959836	RED LEVEL	6	85
85	W-8416	FGS	Cuttings	-82.584767	28.997524	CRYSTAL RIVER	27	62
86	W-8417	FGS	Cuttings	-82.602947	28.969468	CRYSTAL RIVER	22	64
87	W-8427	FGS	Cuttings	-82.596930	28.535245	WEEKI WACHEE SPRING	17	205
88	W-8699	FGS	Cuttings	-82.596930	28.535245	WEEKI WACHEE SPRING	17	260
89	W-10302	FGS	Cuttings	-82.524832	28.540736	WEEKI WACHEE SPRING	0	105
90	W-10319	FGS	Cuttings	-82.518701	28.542523	WEEKI WACHEE SPRING	87	240
91	W-10398	FGS	Cuttings	-82.508796	28.869969	HOMOSASSA	100	65
92	W-10453	FGS	Cuttings	-82.575292	28.840357	HOMOSASSA	10	85
93	W-10483	FGS	Cuttings	-82.613392	28.880023	CRYSTAL RIVER	5	200
94	W-10731	FGS	Cuttings	-82.542744	28.884233	CRYSTAL RIVER	12	47
95	W-11211	FGS	Cuttings	-82.558075	28.569799	WEEKI WACHEE SPRING	23	200
96	W-11219	FGS	Cuttings	-82.557919	28.555256	WEEKI WACHEE SPRING	22	200
97	W-11554	FGS	Cuttings	-82.512936	28.858986	HOMOSASSA	50	100
98	W-11922	FGS	Cuttings	-82.575109	28.825627	HOMOSASSA	3	58
99	W-11962	FGS	Cuttings	-82.576936	28.956504	CRYSTAL RIVER	10	110
100	W-11964	FGS	Cuttings	-82.576936	28.956504	CRYSTAL RIVER	10	110
101	W-12504	FGS	Cuttings	-82.559238	28.745693	CHASSAHOWITZKA	10	165
102	W-12743	FGS	Cuttings	-82.543497	28.941909	CRYSTAL RIVER	40	410
103	W-13015	FGS	Cuttings	-82.576477	28.898306	CRYSTAL RIVER	6	55
104	W-13457	FGS	Cuttings	-82.574961	28.796438	HOMOSASSA	8	196
105	W-13578	FGS	Cuttings	-82.574961	28.796438	HOMOSASSA	8	180
106	W-13863	FGS	Core	-82.567042	28.898866	CRYSTAL RIVER	8	399
107	W-14006	FGS	Cuttings	-82.610264	28.956006	CRYSTAL RIVER	10	245
108	W-14007	FGS	Cuttings	-82.610264	28.956006	CRYSTAL RIVER	10	250
109	W-14038	FGS	Cuttings	-82.643689	28.955231	RED LEVEL	8	125
110	W-14039	FGS	Cuttings	-82.633326	28.960758	RED LEVEL	11	90
111	W-14095	FGS	Cuttings	-82.548151	28.747483	CHASSAHOWITZKA	10	368
112	W-14395	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
113	W-14396	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
114	W-14397	FGS	Cuttings	-82.629023	28.957374	RED LEVEL	10	496
115	W-14398	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
116	W-14399	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
117	W-14401	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
118	W-14402	FGS	Cuttings	-82.626902	28.955543	RED LEVEL	10	200
119	W-14671	FGS	Core	-82.596770	28.853296	HOMOSASSA	5	200

Map ID	Well Label	Data Source	Sample Type	Longitude	Latitude	24K Quad	Elevation (ft)	Total Depth (ft)
120	W-14676	FGS	Cuttings	-82.571472	28.876472	HOMOSASSA	10	250
121	W-14873	FGS	Core	-82.588610	28.549720	WEEKI WACHEE SPRING	20	603.5
122	W-14885	FGS	Core	-82.571472	28.876472	CRYSTAL RIVER	10	370
123	W-16273	FGS	Core	-82.550373	28.511383	WEEKI WACHEE SPRING	30	36
124	W-17098	FGS	Core	-82.665101	28.937753	RED LEVEL	4	70
125	W-17100	FGS	Core	-82.657323	28.943586	RED LEVEL	6	50
126	W-17103	FGS	Core	-82.647323	28.944142	RED LEVEL	6	55
127	W-17104	FGS	Core	-82.647323	28.934420	RED LEVEL	4	70
128	W-17105	FGS	Core	-82.638989	28.939420	RED LEVEL	5	50
129	W-17107	FGS	Core	-82.638156	28.934976	RED LEVEL	5	50
130	W-17108	FGS	Core	-82.630656	28.946086	RED LEVEL	7	50
131	W-17111	FGS	Core	-82.636767	28.920809	RED LEVEL	3	50
132	W-17112	FGS	Cuttings	-82.726770	28.984695	RED LEVEL	1	50
133	W-18155	FGS	Core	-82.606585	28.798295	HOMOSASSA	3	18