Open-File Map Series 110, Plate 3
*See Open-File Report 107 for accompanying text

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Florida Department of Environmental Protection
Florida Geological Survey

OPEN-FILE MAP SERIES 110, Plate 3

GEOMORPHOLOGY, SPRINGS, AND KARST FEATURES OF THE USGS KISSIMMEE 30 X 60 MINUTE QUADRANGLE, CENTRAL FLORIDA

2018

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Barrier Island District

The Barrier Island District, characterized by beach ridges, dunes, and relict lagoons, extends into Florida from Georgia southward to the vicinity of Lake Okeechobee (Figure 3). Beach ridge plains occur in several of the provinces in the district. Of the eight provinces in the district, only the Osceola Plain is present in this study area. Elevations of these beach ridge plains range from sea level in the Atlantic Coastal Complex to about 135 feet (41.1 meters) above mean sea-level (MSL). Drainage in the district is strongly controlled by the relict beach ridges forming distinct trellis drainage. Modern coastal processes are dominantly erosional with net littoral and longshore transport from north to south, but there are many depositional coastal features from Pliocene to Recent age in the mapped area. Beach ridge plains represent the preserved depositional features of former shorelines, particularly the shore-parallel dunes. The swales between beach ridges are swampy and contain many lakes, extensive linear swamps and wetlands, and are a nexus for tributary stream development. Relict lagoons are dissected by two major rivers in the Barrier Island District, the St. Johns River and the Kissimmee River. A relict lagoon in the Upper St. Johns River Valley extends uninterrupted from the southern end of the district to southern Volusia County (see Figure 4). White (1970) recognized a relict lagoon on the western Osceola Plain, now occupied by the Kissimmee River. The entire province is underlain by undifferentiated Tertiary/Quaternary shelly sediments, which supports the lagoon or estuary hypothesis. These rivers also largely follow trellis drainage patterns consistent with coastal depositional landforms. Cypresshead Formation, undifferentiated Quaternary sediment, or regions geomorphically interpreted as Quaternary beach ridge and dune, dominate the surficial geology over much of the Barrier Island District (see OFMS 110, Plate 1). These lie unconformably on units ranging from the Avon Park Formation to the Hawthorn Group (Scott et al., 2001). The two other most extensive surficial geologic units include undifferentiated Tertiary/Quaternary shelly sediments and the Anastasia Formation (east and northeast of the mapped area). Sinkhole activity is rare in the district. Where observed, it is typically related to dissolution of shell concentrations, particularly mollusks, near the land surface (Upchurch et al., 2015). These are usually expressed as shallow (a few feet, about one meter) cover-settlement features which may form where the undifferentiated Tertiary/Quaternary shelly sediments or Anastasia Formation are present.

Osceola Plain

The surficial geologic units exposed on the Osceola Plain are undifferentiated Quaternary and Quaternary beach ridge and dune sediments, the latter covering approximately the eastern quarter of the province. Although the Cypresshead Formation occasionally occurs in the subsurface along the western edge of the province, undifferentiated Tertiary/Quaternary shelly sediments are most common beneath the surficial quartz sands. These overlie relatively thin undifferentiated Hawthorn Group sediments to the north and the Peace River and Arcadia formations (Hawthorn Group) as the unit thickens to the south. The Ocala Limestone and Hawthorn Group are missing under part of the northwestern Osceola Plain. Both the Ocala Limestone and Avon Park Formation become more deeply buried from north to south in the province (see OFMS 110, Plate 2). These formations appear to have the most impact on karst landforms in the north near many of the largest lakes in the province. The province has the topographic form of a terrace, but it is unlikely related to one single stand of sea level (White, 1970). Most of the terrain is relatively flat, with about 80% of elevations falling between 50 and 75 feet (15.2 and 22.9 meters) above MSL. Elevation and local relief increase to the north where the Econlockhatchee River and other tributaries of the St. Johns River are more developed and incised than other drainages in the province. Elevations range from five feet (1.5 meters) to 120 feet (36.6 meters) above MSL. Highest elevations are rarely above 100 feet (30.5 meters) and occur in the northwest. Elevations of the province within the mapped area range from 30 feet (9.1 meters) to 120 feet (36.6 meters) above MSL. The Kissimmee River drains much of the western portion of the Osceola Plain southward to Lake Okeechobee and the Everglades. The eastern portion is a beach ridge plain with subtle ridges and swampy swales with trellis drainage, particularly in the Econlockhatchee River basin. Many of the streams flowing east to the St. Johns River run perpendicular to the ridges, but some segments and tributaries show trellis drainage. Karst features are not common. Shallow sag ponds occur. They are cover-settlement features and likely exist due to dissolution of shallowly buried concentrations of shell material, primarily mollusks, within the Tertiary/Quaternary shelly unit which underlies the majority of the Osceola Plain. In the eastern part of the province, many of these features become elongated parallel to the beach ridge strand plain deposition. Their genesis may be related to the origin of wetlands and swamps in swales, in addition to the dissolution of shell material of the undifferentiated Tertiary/Quaternary shelly sediments.

Lakes District

The Lakes District occupies most of the Central Highlands of Cooke (1939) in peninsular Florida. The district lies east of the Ocala Karst and Peace River districts, west of the Barrier Island District, and south of the Okefenokee Basin District (OFMS 110, Plate 3, Figure 3). A thick sequence of up to 200 feet (61 meters) of siliciclastic and carbonate sediments of the Hawthorn Group, siliciclastic sediments of the Cypresshead Formation and undifferentiated Tertiary/Quaternary sediments overlie the Ocala Limestone in the Lakes District, except from central Polk County and southward, where Suwannee Limestone is present, and where the Ocala Limestone and the Hawthorn Group are locally absent (Arthur et al., 2008). Dissolution of carbonates and subsequent subsidence or collapse has created the characteristic rolling hills, sinkhole lakes, and dry sinks that dominate the landscape. Portions of the district are internally drained due to the presence of karst features and permeable sand cover. Elevations in the Lakes District vary from less than five feet (1.5 meters) above MSL to nearly 315 feet (96 meters) above MSL. In the study area, the Lakes District includes the Lake Wales Ridge Complex, the Mt. Dora Ridge, and the Orlando Ridge (OFMS 110, Plate 3, Figure 4). The higher elevation regions were once part of an extensive Cypresshead Formation upland that subsequently eroded, leaving remnant highs. The boundaries of the district generally follow the outcrop belt of the Cypresshead Formation in Florida. Topographic relief between the sandy ridges and the karst lakes and depressions can be over 100 feet (30.5 meters) in the hillier regions. Sea-level fluctuations have influenced landform development of the Lakes District, evident by its coast parallel orientation, and many of its provinces are relict beach ridges associated with deposition of the Cypresshead Formation. In some areas, the distribution of karst lakes is controlled by the beach ridges, with many of the lakes in the ancient swales or on the flanks or toe of the ridges. Drainage is mostly interior with few surface streams other than those draining to the local karst lakes, or occasionally connecting a chain of lakes. Significant exceptions are the Ocklawaha River and major tributary, the Palatlakaha River) and the St. Johns River, two of the state's larger rivers. These flow through the district, the Ocklawaha having its headwaters and entire valley within the district. The headwaters of the Peace River are also within the Lakes District. Distinctive circular to sub-circular lakes are visible in aerial photographs, LiDAR, maps, and satellite imagery, revealing the individual sinkholes and coalescing sinkholes which give the Lakes District its name. Dissolution of the limestone and subsequent subsidence or collapse of the overlying siliciclastic sediments has formed karst lakes of varying size and depth, and some exist as wetlands or dry depressions. Swallets are present in the district, but most are small, and few are documented. Springs are also common in the Lakes District, but they are much more abundant in the northern portion.

Lake Wales Ridge Complex

The Lake Wales Ridge Complex is a remnant of broader uplands, underlain by the Cypresshead Formation, which have a coastal depositional history with numerous ridges. This province has been eroded and lowered by sea-level fluctuations, fluvial erosion, aeolian redistribution of sediments, and karst processes. Elevations range from 50 feet (15.2 meters) to more than 310 feet (94.5 meters) above MSL. Elevations above 180 feet (54.9 meters) MSL are all within the Lake Wales Ridge, Lakeland Ridge, and Lake Henry Ridge. Within the mapped area, elevations range from 60 feet (18.3 meters) to 250 feet (76.2 meters) above MSL. The area is well drained via the numerous karst features present. The noted exceptions are the Palatlakaha River and the headwaters of the Peace River. Aeolian dune fields are present in many regions. Sediment in these areas often lacks some of the clay that may be present where the Cypresshead Formation is at or near the surface, and water rapidly infiltrates the ground. The most common features of the Lake Wales Ridge Complex are numerous karst lakes. The location of the lakes in the province appear to be strongly related to swale locations. Concentrated linearly, largely following the north-northwest to south-southeast trend of the beach ridges, these swales create a trellis drainage pattern of streams and wetlands. Springs are not common except in the northern part of the province. The upper Peace River valley contains several swallets, some in-channel, and others only capturing water during high flow conditions. Mapped and documented swallet features are not common in the remainder of the Lake Wales Ridge Complex.

Mt. Dora Ridge

The Cypresshead Formation dominates the surficial geology on the Mt. Dora Ridge. The northern part of the province includes several aeolian dune fields manifesting the Cypresshead Formation, which is underlain by carbonates of the Hawthorn Group and Ocala Limestone (Scott et al., 2001). Mt. Dora Ridge is a rolling karstic landscape with numerous lakes, more distinct in the south. Elevations within the province range from five feet (1.5 meters) above MSL adjacent to the Lake Plain and the St. Johns River Offset (OFMS 110, Plate 3, Figure 4) to over 190 feet (57.9 meters) above MSL. Relief often exceeds 100 feet (30.5 meters). Elevations within the mapped area range from 90 feet (27.4 meters) to 175 feet (53.3 meters) above MSL. The sediments of the Cypresshead Formation that form the Mt. Dora Ridge were deposited in a nearshore marine environment. The strong linear component to the karst lakes of the western lobe and southern region display the coastal ridges common to the province. The predominantly interior drainage, and later reworking of surficial sediments in the aeolian dunes of northern Mt. Dora Ridge, has precluded development of trellis drainage. Interior drainage is to the numerous karst lakes, but localized surface flow exists, typically via springs and spring runs, many of which drain east to the St. Johns River. Karst processes acting through a thick sequence of siliciclastic sediments formed the landscape of karst lakes that are most evident in southern and western Mt. Dora Ridge where there are fewer aeolian dune fields. Several karst lowlands are adjacent to springs on the border and a few in the interior of the province. These lowlands appear to be valleys formed in part by karst processes, having forms more like coalescing sinkholes than fluvially incised valleys.

Orlando Ridge

The Orlando Ridge is surficially comprised of undifferentiated Quaternary sediments, underlain by the Cypresshead Formation in the northern part of the province. Carbonates in the undifferentiated Tertiary/Quaternary shelly sediments, Hawthorn Groups, and Ocala Limestone influence karst landform development via limestone and shell dissolution. Most of the province has ridge-and-swale topography, but this diminishes toward the southwest. The strong northwest to southeast trend of the ridges and swales run subparallel to the modern Atlantic Ocean coastline, revealing that deposition of this landscape was by longshore and littoral processes. Elevations within the province vary from 20 feet (6.1 meters) to 125 feet (38.1 meters) above MSL in the province and from 80 feet (24.4 meters) to 115 feet (35.1 meters) above MSL within the mapped area. Some internal drainage exists on the Orlando Ridge, mostly via overland drainages that have developed in swales and incipient valleys of karst origin, sometimes both conditions operating together. The karst and swales together are most evident in the northern part of the province. Some of the overland drainage includes chains of lakes, but many have been connected by anthropogenic activity in the 20th century. Karst lakes are prominent on the Orlando Ridge. The northern lakes are distinctly aligned with the regional subparallel ridge and swale topography, but karst lakes are common throughout the province. Springs are uncommon, but exist at the northwestern edge of the province.

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. The district lies east of the Apalachicola Delta District, south of the Tifton Upland and Okefenokee Basin districts, west of the Lakes District and north of the Peace River District (OFMS 110, Plate 3, Figure 3). The district, which developed in part on the crest of the Ocala Platform, is underlain by carbonates ranging in age from the middle Eocene Avon Park Formation to the Oligocene/Miocene Tampa Member of the Arcadia Formation and the Miocene St. Marks Formation. In the study area, the district is primarily underlain by the upper Eocene Ocala Limestone. Elevations within the district range from sea level along the Gulf of Mexico to over 300 feet (91.4 meters) above mean sea level (MSL) on the Brooksville Ridge. Green Swamp is the only Ocala Karst District province within the mapped area (OFMS 110, Plate 3, Figure 4). Provinces are delineated based upon several factors including elevation, abundance, type of karst features, drainage, geology, and topographic relief. The topography over much of the district is gently rolling with only minor relief. However, the relief may exceed 200 feet (61 meters) on the Brooksville Ridge. Dissolution of carbonates has created distinct landforms that characterize the Ocala Karst District, including caves, caverns, springs, sinkholes, siphons, swallets, and resurgences. The southern terminus of the district occurs where siliciclastic sediments of the Hawthorn Group impede the development of karst features and streams and rivers become more common. The entire district has siliciclastic cover of varying thickness ranging from a few feet (1 meter), to as much as 200 feet (61 meters) overlying carbonate rocks. Dissolution of carbonate sediments forms voids into which the overlying sediments settle, ravel, or collapse. The Ocala Karst District is dominated by solution sinkholes, and shallow, broad, bowl-shaped depressions. These occur in areas where there is a thin, permeable, siliciclastic cover allowing groundwater to slowly dissolve the limestone surface. Areas of the Ocala Karst District with a thicker cover of permeable siliciclastic sediments are characterized by cover-subsidence sinks. These areas have few shallow sinks formed by the downward movement of the siliciclastic cover to fill voids created by the dissolution of carbonate sediments. Cover-subsidence sinkholes develop slowly in response to the dissolution. Cover-collapse sinkholes, which form abruptly, occur in areas where the siliciclastic sediments overlying the limestone are thicker and more cohesive and collapse into voids formed in the carbonate sediments. As siliciclastic sediment thickness increases to the north, south, and east in the district, the type of sinkholes and their abundance changes, grading from solution sinks to cover-collapse sinks. The maturity of the karst varies across the district. In general, the karst is more mature and has less relief due to more extensive carbonate dissolution and erosion of the overlying siliciclastics toward the Gulf coast. Planation by transgressing seas also influenced the geomorphology near the Gulf Coast.

Green Swamp

The Green Swamp province is underlain primarily by the upper Eocene Ocala Limestone, which crops out in the Withlacoochee River valley along the western edge of the map area (OFMS 110, Plate 1). The lower Oligocene Suwannee Limestone is present in the southwestern corner of the province. Oligocene/Miocene Hawthorn Group sediments are scattered throughout the province overlying these carbonates. Tertiary/Quaternary Cypresshead Formation and reworked Cypresshead sediments overlie the Hawthorn Group in much of the Green Swamp in the mapped area. Remnant linear ridges of reworked Cypresshead Formation in the eastern part of the province were once part of the Lake Wales Ridge Complex, but are now reduced in elevation through karstification of underlying limestones. Elevations in the province generally increase from west to east and southeast and range from 40 feet (12.2 meters) above MSL to more than 180 feet (54.9 meters) above MSL. Within the mapped area, elevations in the province range from 90 feet (27.4 meters) to more than 180 feet (54.9 meters) above MSL. The Green Swamp is very poorly drained, and swampy conditions prevail due to the high potentiometric surface of the Floridan aquifer system. Swancar and Hutchinson (1995) suggest that this is largely a result of rejected recharge due to the underlying Ocala Limestone in the province having reduced hydraulic conductivity relative to adjacent regions and compared to the Suwannee Limestone. Headwaters for both the Withlacoochee and Hillsborough rivers are in Green Swamp. Headwaters of the Ocklawaha and Peace rivers occur near the northeastern and southern boundary of Green Swamp, respectively. Karst features are limited due to low hydraulic conductivity and subsurface flow through the underlying limestones. The province contains many shallow, closed topographic depressions formed by solution sinkholes and depositional processes in the thin cover of undifferentiated sediments.

Peace River District

The Peace River District covers much of west-central peninsular Florida, extending from Hillsborough and Pinellas counties, southward to the Caloosahatchee Valley in Lee and Glades counties. The district lies south of the Ocala Karst District, west of the Lakes District, and northwest of the Everglades District (OFMS 110, Plate 3, Figure 3). Only the Hardee Upland province of the Peace River District is within the mapped area. Elevations in the district range from sea level to more than 190 feet (57.9 meters) above MSL in the hills among the headwaters of the Alafia River. Within the mapped area, elevations range from 120 feet (36.6 meters) to 155 feet (47.2 meters) above MSL. Low permeability siliciclastic sediments of the Hawthorn Group underlie the Peace River District allowing the development of numerous rivers and streams, including the Alafia, Little Manatee, Manatee, Myakka, Peace, and their tributaries (Scott et al., 2001). Drainage in the district is predominantly dendritic. The Peace River District has limited karst development due to the thick cover of Hawthorn Group sediments over most of the region. Karst is limited to sag ponds and swampy areas that develop above shell beds, typically within the undifferentiated Tertiary/Quaternary shelly sediments. Springs occur, but almost all are located near the coastline. Karst features become more common in the north where the Tampa Member of the Arcadia Formation and the Suwannee Limestone approach land surface as the Hawthorn Group clayey sediments thin. Cover-collapse sinkholes occur in the northern part of the district. The Ocala Karst District merges with the Peace River District where the Hawthorn Group sediments impede the development of karst features. The transition from the Peace River District to the Lakes District occurs where the low permeability sediments of the Hawthorn Group either become more permeable due to facies changes, or where Hawthorn Group sediments are eroded and no longer retard the development of karst features. The separation of the Peace River District from the Everglades District is defined where the surface-water flow pattern becomes westerly in the Caloosahatchee Valley. The landscape of the Peace River District is relatively flat, with limited relief outside of areas incised by local rivers and hills in the eastern part of the district in the Hardee Upland.

Hardee Upland

Sand and clayey sand of weathered Hawthorn Group and undifferentiated Quaternary siliciclastic sediments overlie the Hawthorn Group throughout the Hardee Upland (Scott et al., 2001). Hawthorn Group sediments, usually the Peace River Formation, consisting of phosphatic sand, clay, and carbonate, overlie the Suwannee Limestone (Arthur et al., 2008). Carbonates of the Tampa Member of the Arcadia Formation and Suwannee Limestone come near the surface, and karst becomes prevalent in the northern part of the province. Much of the northern Hardee Upland has been terraformed due to phosphate mining throughout the 20th and into the 21st century. The Hardee Upland is a broad, south-southeasterly sloped plain. Elevations vary from about 10 feet (3 meters) in the incised river valleys, toward the Gulf of Mexico and Tampa Bay, to over 190 feet (57.9 meters) above MSL. Only a small portion of the province is present in the extreme southwest corner of the mapped area (OFMS 110, Plate 3, Figure 1) where elevations range from 120 feet (36.6 meters) to 155 feet (47.2 meters) above MSL. The Hardee Upland includes the headwaters and most of the tributaries of the Alafia, Little Manatee, Manatee, and Myakka rivers. Although there are isolated wetland features, most of the region is drained by overland flow, though river corridors can be swampy. Most of the drainage is dendritic, primarily developed on the siliciclastic sediments of the Peace River Formation. The remnant trellis drainage in the upper Peace River may have been inherited from the ridges and swales of the western Lake Wales Ridge Complex to the north, but the ridges and swales are no longer evident in the northeastern Hardee Upland. Due to the thick cover of Hawthorn Group sediments over much of the province, very few karst features are present on the Hardee Upland. Springs are present mostly in the northwestern province in the Alafia River valley and near the coastline. In the north, the overlying clayey sediments of the Hawthorn Group thin, and limestones of the Tampa Member of the Arcadia Formation and the Suwannee Limestone are near the surface. Cover collapse sinkholes occur in this portion of the Hardee Upland.

*Note: See Open-File Report 107 for references

Figure 1. Geomorphic provinces (modified from Williams et al., in preparation) with LiDAR and digital elevation model (DEM) mosaic.

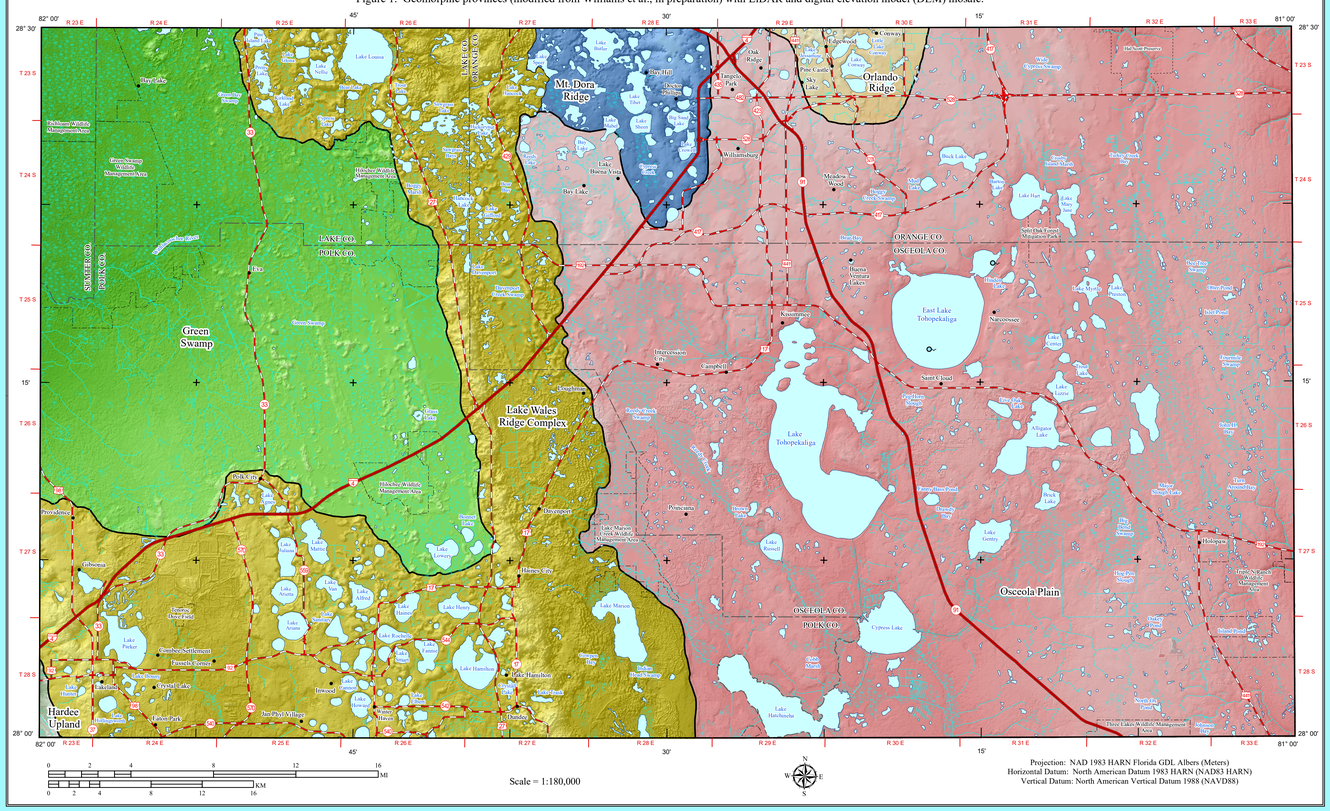


Figure 2. Springs and subsidence incident reports (SIRs) shown with LiDAR and digital elevation model (DEM) mosaic.

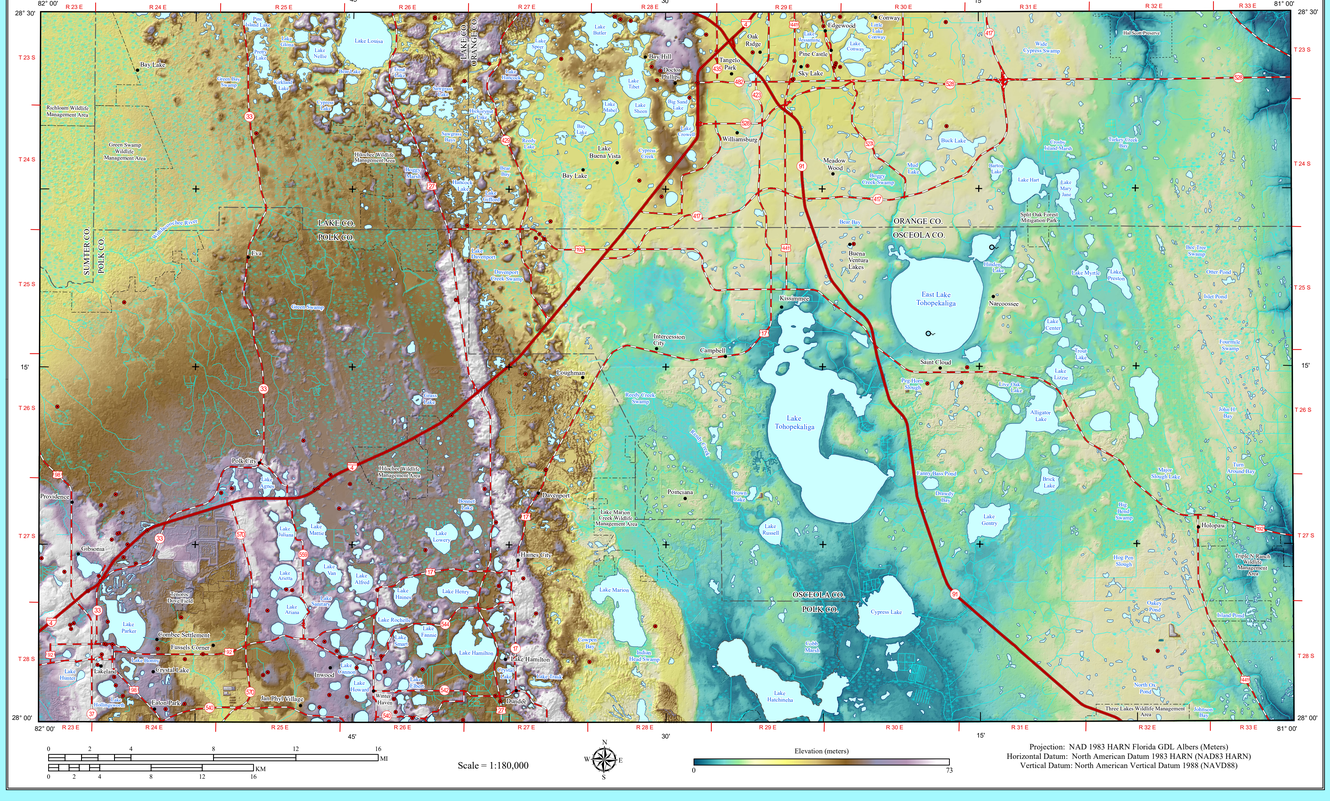


Figure 3. Geomorphic districts (modified from Williams et al., in preparation)

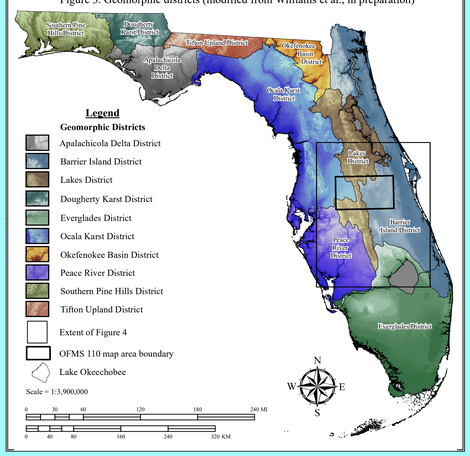
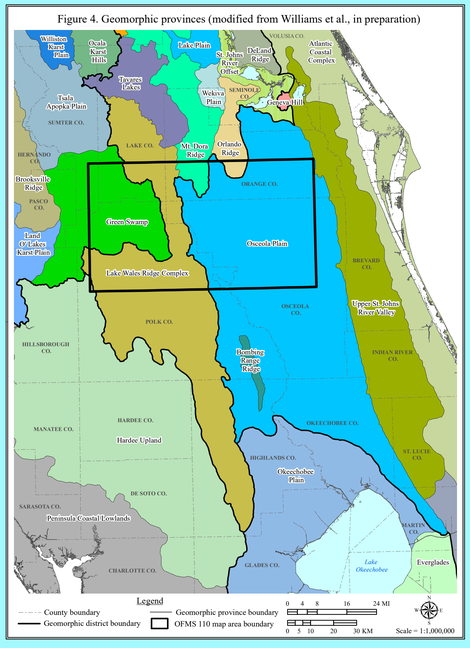


Figure 4. Geomorphic provinces (modified from Williams et al., in preparation)



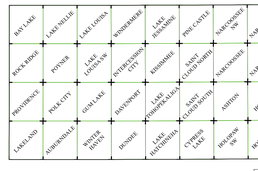
Legend for Figures 1 & 2

City/town
County boundary
Primary highway
Secondary highway
USGS 1:24,000 Quadrangle tick mark
Geomorphic province boundary
Geomorphic district boundary
State lands and parks
River or stream
Waterbody
Wetland
Spring
Subsidence incident report (SIR)

Karst Features

NOTE: Information regarding subsidence incident reports collected by the FGS can be found at: https://floridadep.gov/fgs/sinkholes/content/subsidence-incident-reports

1:24,000 Quadrangle Grid



ADJOINING MAPS

1	2	3
4		5
6	7	8

1 Inverness (OFMS 102/103)
2 Orlando (OFMS 107)
3 Titusville
4 Tarpon Springs (OFMS 104)
5 Cape Canaveral
6 Saint Petersburg (OFMS 109)
7 Bartow (to be mapped 2019)
8 Vero Beach

For more information or to order maps contact:
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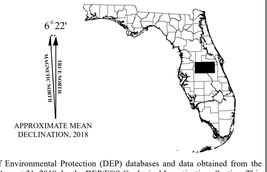
APPROXIMATE MEAN DECLINATION, 2018



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