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OPEN-FILE MAP SERIES 112, Plate 3
GEOMORPHOLOGY OF THE USGS VERO BEACH
30 X 60 MINUTE QUADRANGLE, CENTRAL FLORIDA

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BY
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Barrier Island Sequence District

The Barrier Island Sequence District, the only geomorphic district in the mapped area, occurs along the Atlantic Coast. It extends from Georgia (Clark and Zisa, 1976) into Florida, and south to the vicinity of Lake Okeechobee (Figure 3). Elevations of the district within Florida range from sea level to just over 300 feet (91.4 meters) above mean sea level (MSL). Elevations within the Vero Beach quadrangle portion of the district range from sea level at the Atlantic Coast in the Atlantic Coastal Complex Province, to just over 90 feet (27.4 meters) above MSL in the Ocala Plain Province (Figure 2). The eastern boundary of the Barrier Island Sequence District is along the Atlantic Coast. In Florida, it is bounded to the south by the Everglades District and to the west by the Lakes District and the Okefenokee Basin District (Figure 3). The Barrier Island Sequence District is subdivided within the mapped area into three provinces: the Ocala Plain, the Upper St. Johns River Valley, and the Atlantic Coastal Complex (Figure 4). Pleistocene-Pleistocene and Holocene coastal processes formed extensive barrier islands, beaches, lagoons, embayments, and shallow-water marine terraces in the district. While modern coastal processes are dominantly erosional along the Atlantic coast, with net longshore transport from north to south, there are many older depositional features in the mapped area. Strand plains and shore-parallel dunes represent the preserved depositional features of former shorelines created by beach accretion and/or declining relative sea-levels. The swales between beach ridges are often swampy and contain lakes, wetlands, linear swales, and tributary streams. The swales control the development of lakes on portions of the Ocala Plain Province and the extensive linear wetlands of the Atlantic Coastal Complex Province. The modern estuarine coastline in the study area are dominated by mangrove swamps. Strand plains are common in the Barrier Island Sequence District. Outstanding examples of strand plains can be seen north of the study area on Merritt Island and Cape Canaveral in the Atlantic Coastal Complex Province and the eastern third of the Ocala Plain Province within the study area. Wetlands are commonly coast-parallel and found in the swales between the ridges of the strand plains and tidal marshes or mangrove swamps landward of the barrier islands. Inland, the broad, relatively flat Ocala Plain Province includes a marine escarpment and strand plain. The southern part of the Barrier Island Sequence District includes several important coastal drainage systems. The St. Sebastian River is the only significant overland stream flowing toward the Atlantic Coast within the study area, but the North and South forks of the St. Lucie River (south of the mapped area) are also important regionally. The Indian River is an estuarine lagoon that receives water from St. Sebastian River, St. Lucie River, and numerous small streams that drain east toward the Atlantic Ocean. The St. Johns River and its tributaries, Fort Drum and Blue Cypress creeks, are the other major streams of the Barrier Island Sequence District in the study area. The St. Johns River valley largely follows low areas in paleo-lagoons and ancient embayments, where the drainage patterns are consistent with the presence of coastal depositional landforms. In the study area, the St. Johns River is mostly within the marshes of the Upper St. Johns River Valley Province. Discrete flow in a distinct river channel is only apparent in the northwestern part of the mapped area. These marshes form the headwaters of the St. Johns River. In the district, much of the river and stream drainage is controlled by the relief ridges forming distinct, swale-induced, drainage patterns. Undifferentiated Tertiary/Quaternary shelly sediments underlie the Barrier Island Sequence District within the study area. The Pleistocene Anastasia Formation, Quaternary beach ridge and dune deposits, undifferentiated Quaternary sediments, and Holocene sediments overlie the Tertiary/Quaternary shelly sediments. The Anastasia Formation occurs at and near the coast and is sporadically exposed along the barrier island coastlines within the mapped area. Holocene sediments exist in river and stream valleys and along the Atlantic Coast (Plate 1). Karst features in the Barrier Island Sequence District are mostly related to dissolution of shell and carbonate beds within the undifferentiated Tertiary/Quaternary shelly sediments and the Anastasia Formation. Undifferentiated Tertiary/Quaternary shelly sediments occur near the land surface in the Upper St. Johns River Valley and Atlantic Coastal Complex provinces within the mapped area. Coquina limestone of the Anastasia Formation is at or near the land surface in coastal parts of the Atlantic Coastal Complex Province (Plates 1 and 2). Shallow karst depressions, including cover-subsidence sinkholes and solution pits, were formed by dissolution of shell and coquina (Schmidt and Scott, 1984). Cover-subsidence sinkholes often form wetlands. In areas where the Anastasia Formation crops out along the Atlantic Coast, microkarst surfaces have developed (Upchurch et al., 2018).

Ocala Plain

The Ocala Plain Province extends from Seminole County in the north to Martin County in the south (Figure 4). It is a subtle, but complex, geomorphic area that includes most of the Kissimmee River valley in the western two thirds of the province and a strand plain in the eastern third (Green et al., 2019a; Figure 4). This strand plain is well developed from southeastern Seminole and eastern Orange counties into eastern Ocala County. The strand plain ends in westernmost Indian River County and northeastern Okeechobee County (Figure 4). The Ocala Plain Province has the low and flat topography of a marine terrace (White, 1970). The eastern third of the province includes a strand plain that White (1970) associated with the linear sets of lakes, streams, and beach ridges observed in the Geneva Hill Province and the Deland Ridge and Crescent City Ridge of the Lakes District (see Green et al., 2018a; Green et al., 2018b). In the western Ocala Plain Province, the land surface is relatively flat with an undulating surface. This area appears to have been a shallow marine platform. There are significant accumulations of dune and beach sand on the western boundary of the province, continuing onto the eastern flank of the Lake Wales Ridge Complex Province of the Lakes District (Figure 4). Some of the dune fields are well developed and have significant relief. Elevations of the Ocala Plain Province in the study area range from approximately 20 feet (6.1 meters) above MSL, along the ancient marine escarpment at the boundary with the Upper St. Johns River Valley Province (Figure 1), to over 90 feet (27.4 meters) above MSL along the western edge of the mapped area. Drainage in the province includes swale-controlled streams and wetlands associated with the Econlockhatchee River and the many streams that parallel the Atlantic Coast. Several creeks cut across the ridges and flow toward the St. Johns River. The Kissimmee River once meandered through a shallow, wetland valley south to Lake Okeechobee (Figure 4). In the 1960s, the Kissimmee River was channelized for flood control, and the landscape was significantly altered. In the late 1990s, efforts began to restore the natural flow of the river system, including meanders and other fluvial landforms. The headwaters of the Kissimmee River originate in a series of lakes at or near the base of the Lake Wales Ridge Complex Province in the northwestern part of the Ocala Plain Province. The surficial geologic units exposed on the Ocala Plain include undifferentiated Tertiary/Quaternary shelly sediments, undifferentiated Quaternary sediments, and Quaternary beach ridge and dune sediments (Figure 1). Undifferentiated Tertiary/Quaternary shelly sediments underlie the surficial sands in the province throughout the mapped area (Plate 2). Large karst landforms are not common in the Ocala Plain Province. The shallow depressions, sand ponds, and cover-subsidence sinkholes which are present are most likely due to dissolution of shell material in the shallow subsurface within the Tertiary/Quaternary shelly sediments which underlie the majority of the Ocala Plain Province.

Upper St. Johns River Valley

The Upper St. Johns River Valley Province follows a low-elevation drainage system that was an ancient embayment or lagoon between the Atlantic Coastal Complex Province to the east and the strand plain of the eastern Ocala Plain Province to the west (Figure 4). The main leg of the northward-flowing drainage system, the Upper St. Johns River, meanders through the province. The southern part of the province includes the headwaters of the St. Johns River in extensive wetlands and lakes, whereas the northern part of the province includes a distinct channel and several large lakes. The Upper St. Johns River Valley Province includes the fluvial/paludal valley from the headwaters of the St. Johns River, near the St. Lucie-Martin County boundary, northward to the outfall of Lake Monroe between Seminole and Volusia counties. Most of the Upper St. Johns River Valley Province is very flat with riverine floodplains, wetlands, and lakes. The southern part of the province is slightly higher in elevation and lacks the distinct river channel and fluvial landforms that are present in the northern part of the province. Lakes are present along the course of the river in the northern part of the province. There are many distributaries and oxbows, as is typical of a sediment-choked, low gradient stream system. Sediment transport in the system is negligible, but wetland development and the lacustrine/paludal sediments influence the presence of distributaries, lakes, and other landforms. Elevations in the Upper St. Johns River Valley Province in the mapped area range from five feet (1.5 meters) above MSL to about 60 feet (18.3 meters) above MSL. However, elevations above 35 feet (10.7 meters) MSL are generally restricted to the border regions with the Atlantic Coastal Complex Province and the Ocala Plain Province. The eastern boundary with the Atlantic Coastal Complex Province follows the change from coastal ridges to the east, and the wetland and river complex to the west. The boundary of the Upper St. Johns River Valley Province with the Ocala Plain Province is placed at the toe of a marine escarpment where elevations increase on to the Ocala Plain Province to the west. The concept that the province was once an embayment or lagoon is supported by the presence of coastal landforms on the margins of the Atlantic Coastal Ridge Complex Province to the east and the Ocala Plain Province to the west. The Upper St. Johns River Valley Province is a broad area where undifferentiated Tertiary/Quaternary shelly sediments and undifferentiated Quaternary sediments occur at or near the land surface. Holocene sediments overlie these deposits in many of the low, riverine, floodplains, wetlands, and lakes. Anthropogenic alteration of the southern portion of the Upper St. Johns River Valley Province is extensive. Regions that are relatively unaffected by ditching and drainage systems have common, but not abundant, shallow depressions that are cover-subsidence sinkholes. These formed as a result of dissolution of shell material in the underlying Tertiary/Quaternary shelly sediments.

Atlantic Coastal Complex

The Atlantic Coastal Complex Province consists of Quaternary barrier islands and related features on, and inland from, the Atlantic Coast. Water bodies and wetlands landward of the barrier islands include lagoons and small embayments. Within the study area, tidal ridges of the lagoons are dominated by mangrove swamps. The Atlantic Coastal Complex Province extends from the St. Johns River in Duval County to central Palm Beach County. Most of the Atlantic Coastal Complex Province is a Pleistocene strand plain. Many of the beach ridges and dunes in the Atlantic Coastal Complex Province are coast-parallel, although complex beach ridge patterns occur on Cape Canaveral and Merritt Island just north of the study area (Figure 4). In the study area, Holocene sediments of the tidal estuarine coastlines were deposited mostly within mangrove swamps. The ridge and dune topography of the Atlantic Coastal Complex Province gives way to slightly lower elevation and flatter topography along most of its western boundary with the Upper St. Johns River Valley Province within the mapped area. Elevations in the Atlantic Coastal Complex Province for the study area range from sea level along the Atlantic Coast to about 55 feet (16.8 meters) above MSL along the western boundary of the province. Sporadic exposures of the Anastasia Formation from St. Johns County to Palm Beach County create a series of rocky coastlines. Open lagoons and small embayments, located landward of the barrier islands, are locally termed "rivers" because of their historic uses for navigation. Drainage patterns in the Atlantic Coastal Complex Province are swale-dominated and coast-parallel in nature, with streams and wetlands occupying the swales between ridges. Some streams flow toward the Atlantic Ocean through breaks in the beach ridges, such as the St. Sebastian River and the north and south branches of the St. Lucie River, the latter to the south of the study area. Other streams flow toward the St. Johns River, including Fort Drum and Blue Cypress creeks. The surficial stratigraphic units that affect the landforms in the Atlantic Coastal Complex Province include undifferentiated Tertiary/Quaternary shelly sediments, the Pleistocene Anastasia Formation, undifferentiated Quaternary sediments, and Quaternary beach ridge and dune sediments (Scott et al., 2001). Undifferentiated Holocene sediments occur on many of the barrier islands and in the tidal mangrove estuaries. Cover-subsidence sinkholes and sand ponds occur in the Atlantic Coastal Complex Province where the undifferentiated Tertiary/Quaternary shelly sediments and the Pleistocene Anastasia Formation are at or near the land surface. Dissolution features can be seen where the Anastasia Formation is exposed along the modern coast and in the undifferentiated Tertiary/Quaternary shelly sediments exposed in mines and borrow pits.

*Note: See Open-File Report 109 for references

Disclaimer

This map was created using Florida Department of Environmental Protection (DEP) databases and data obtained from the Florida Geological Survey (FGS). It was completed March 31, 2021, by the DEP/FGS Geological Investigations Section. This document was prepared for the presentation of the geologic information shown and is not intended to replace site-specific or use-specific investigations. The FGS does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for inappropriate change of scale, interpretations, or decisions based thereon. Cooperatively funded by the DEP/FGS and the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program under USGS assistance award number G19AC00313. The views and conclusions in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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

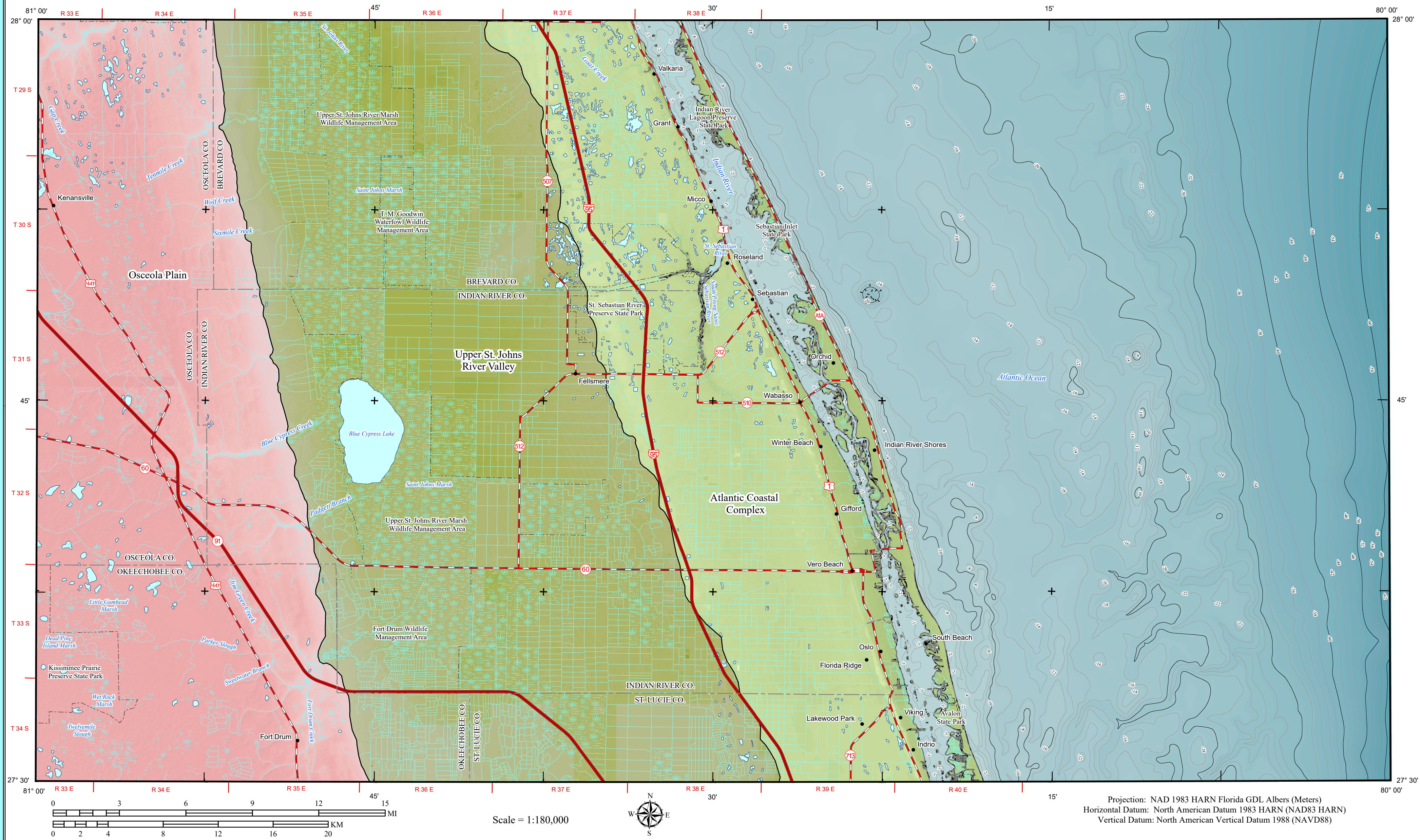


Figure 2. LiDAR and digital elevation model (DEM) mosaic.

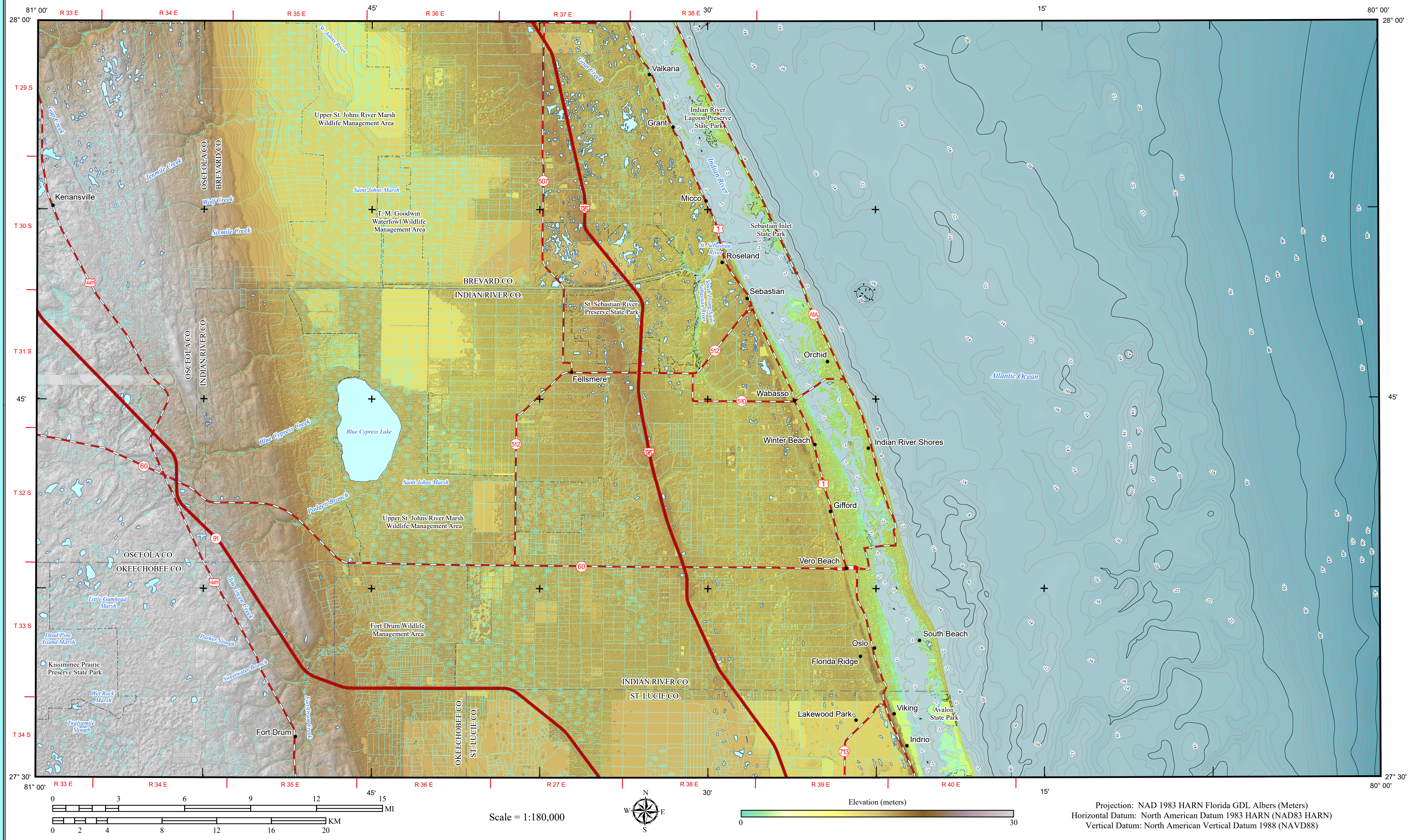


Figure 3. Geomorphic districts (modified from Williams et al., in preparation).

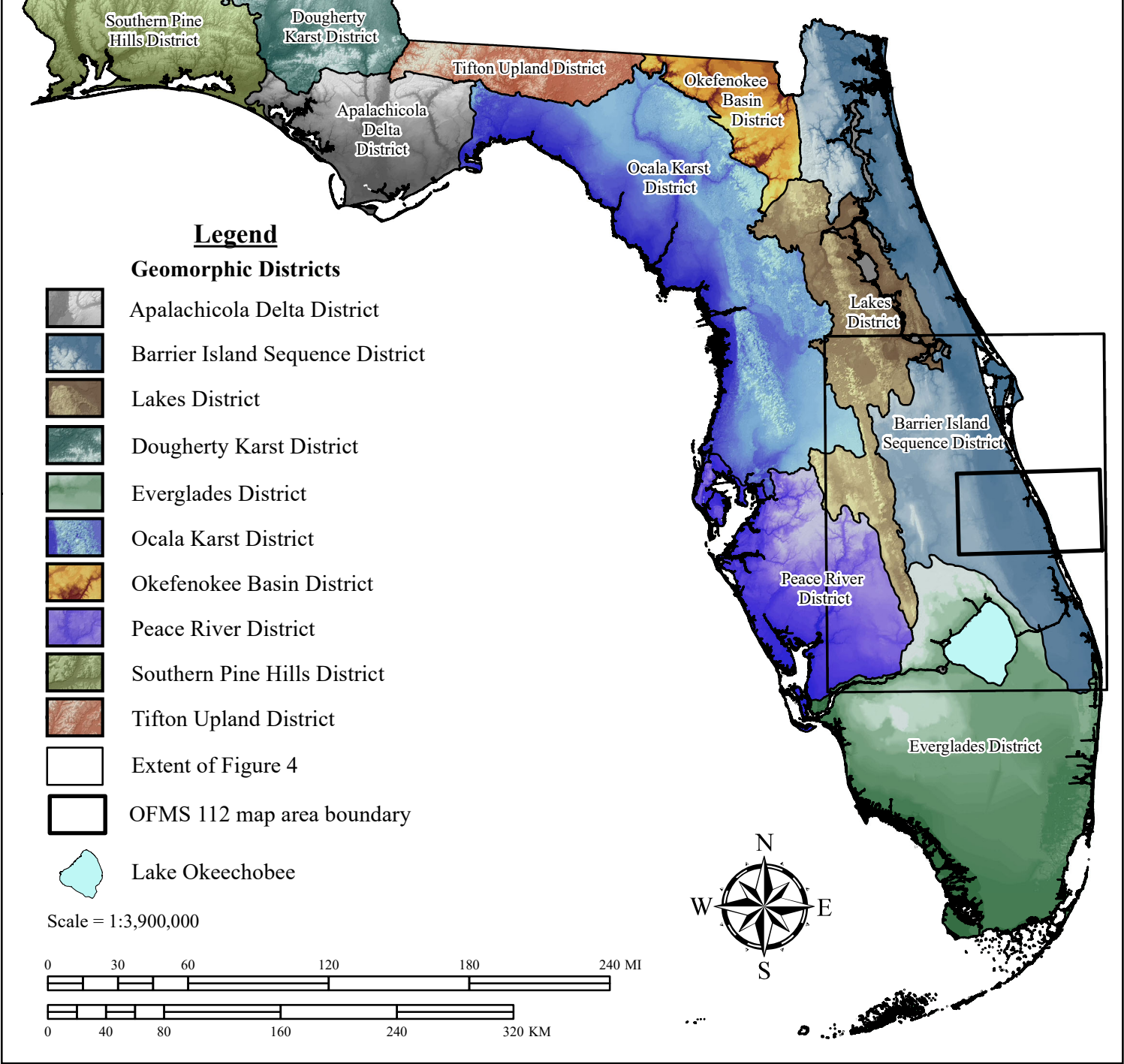


Figure 4. Geomorphic provinces (modified from Williams et al., in preparation).

