MAP SERIES NO. 80

FORT PIERCE

FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976

Each area outlined on this map may consist of more than one kind of sub-surface sediment. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

This public document was promulgated at a total cost of $2,093.00 or a per copy cost of $1.67 for the purpose of disseminating geologic data.

EXPLANATION

- Med. Fine Sand and Silt
- Clayey Sand
- Shelly Sand and Clay
- Peat

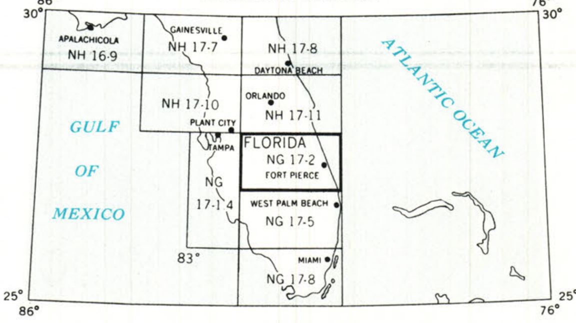
Scale 1:250,000

5 0 5 10 15 20 Statute Miles
5 0 5 10 15 20 25 30 Kilometres
5 0 5 10 15 Nautical Miles

CONTOUR INTERVAL 50 FEET
WITH SUPPLEMENTARY CONTOURS AT 25 FOOT INTERVALS

ENVIRONMENTAL GEOLOGY SERIES
FORT PIERCE SHEET

LOCATION DIAGRAM



SECTIONIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

TOWNSHIP OR RANGE LINE
LAND GRANT BOUNDARY

GRID ZONE DESIGNATION:
17 R
100,000 M. SQUARE IDENTIFICATION

MA	NA
MV	NV

IGNORE the SMALLER figures of any grid number; these are for finding the full coordinates. Use ONLY the LARGER figure of the grid number; example: 2990000

TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 1000 METRES

SAMPLE POINT: BRIGHTON

1. Read letters identifying 100,000 metre square in which the point lies: MA
2. Locate first VERTICAL grid line to LEFT of point and read LARGE figure labeling the line either in the top or bottom margin, or on the line itself: 9
   Estimate tenths from grid line to point: 1
3. Locate first HORIZONTAL grid line BELOW point and read LARGE figure labeling the line either in the left or right margin, or on the line itself: 1
   Estimate tenths from grid line to point: 1

SAMPLE REFERENCE: MA9111

If reporting beyond 18° in any direction, prefix Grid Zone Designation, as: 17RMA9111

FORT PIERCE, FLORIDA
1956
REVISED 1972

ENVIRONMENTAL GEOLOGY SERIES

FORT PIERCE SHEET

by
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FLORIDA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF RESOURCE MANAGEMENT
BUREAU OF GEOLOGY

Tallahassee
1980

INTRODUCTION

Development of guidelines for wise management of Florida's natural resources depends upon a good working knowledge of the State's geology as it relates to man's environmental problems. Management decisions must be based upon adequate geologic data for such fields as waste disposal, water resources management, land management, highway construction, geologic hazards, soils mapping, mining and reclamation. Environmental geologic maps provide the basic data needed for the creation and execution of sound programs in the above-mentioned fields. It is hoped that this map will not only serve the purpose for which it is intended but will also serve as a base map for future presentation of geologically related data of a more specialized or local nature. The ultimate purpose of the State's environmental geology mapping program is to insure development of Florida's natural resources with the least possible environmental damage.

This map presents geologic data in such a way that it can be understood by persons not specially trained in the science of geology. Common rock types are shown as they occur from just below the soil zone to depths of expected use for most purposes. Mapping involved aerial photographic and topographic interpretation and field work (visiting quarries, borrow pits, canals, road cuts, and other rock exposures) to provide the necessary data points. Use was also made of all published and unpublished data in the files of the Florida Bureau of Geology plus published reports of the U.S. Geological Survey and the U.S. Soil Conservation Service.

REGIONAL SETTING

The study area is located in east central peninsular Florida and includes Highlands, Indian River, Okeechobee, and St. Lucie counties; the northern parts of Charlotte, Glades, and Martin counties; the eastern parts of De Soto, and Hardee counties; and the southern parts of Brevard, Osceola, and Polk counties.

POPULATION AND DEVELOPMENT

The 1970 census showed that several cities in this area had populations over 10,000; these were: Bartow - 12,891, Ft. Pierce - 29,721, Lake Wales - 23,714, and Vero Beach - 11,908. The portion of Glades and Charlotte counties shown on the map do not contain any urban areas; it has a rural population density of less than four people per square mile. According to the 1970 census population by county was: Brevard - 230,006, 70% urban; De Soto - 13,060, 43% urban; Hardee - 14,889, 20% urban; Highlands - 29,507, 48% urban; Indian River - 35,992, 70% urban; Martin - 28,035, 18% urban; Okeechobee - 11,233, 33% urban; Osceola - 25,267, 48% urban; Polk - 227,222, 61% urban; and St. Lucie - 50,836, 66% urban.

INDUSTRY AND TRANSPORTATION

The area's economy is based primarily on agriculture, with citrus growing, cattle raising and truck-farming predominant. Tourism contributes a minor part to the economy and is important mainly along the Atlantic coast. However, past trends indicate that tourism will probably grow rapidly in the future and will contribute more to the economy.

Many small, shallow, open-pit mines are scattered through the area which extract sand, limestone, coquina, shells, and clayey sands. These commodities are primarily for localized consumption in construction and for roads. Part of the Central Florida phosphate district is located in the eastern part of Polk County that is shown on the map.

Several major roads cross the area. U.S. 1 parallels the Atlantic Ocean on the east coast and serves as the main route for tourism to South Florida. Interstate 95 (Florida's Turnpike) runs from the approximate north-center of the area to the southeast corner. U.S. 27 runs down the center of the Lake Wales Ridge and provides access for the citrus industry that is concentrated there. U.S. 441 is a main north-south route that provides access to the Lake Okeechobee area. On the western side of the map, State Route 17 closely follows the trend of the Peace River and provides access to the phosphate producing areas. Many other secondary, east-west roads interconnect among these major highways. Innumerable dirt roads and trails criss-cross the swampy hammocks, plains and prairies that make up much of the area. Many railroad branches are concentrated in the northwest area of the map to serve the needs of the phosphate industry. Other rail lines run down the Atlantic coast and the Lake Wales Ridge to serve the population centers and their industries. Almost every population center has a local airport and private landing strips are common. The St. Lucie Canal is the eastern half of a barge-canal system that crosses the entire peninsula from the city of Stuart on the Atlantic Ocean, across Lake Okeechobee, thence southwestward via the Caloosahatchie River/Canal (not shown on this map) to Fort Myers on the Gulf. The Kissimmee River has been extensively dredged and now provides a navigable waterway between Lake Kissimmee on the north and Lake Okeechobee on the south. The Intracoastal Waterway between the mainland coastline and the outer barrier islands provides sheltered passage for boat traffic along the Atlantic coast.

CLIMATE

Situated in central peninsular Florida, the area's climate is mild subtropical. Temperatures range from an average low of 63 degrees F (17 degrees C) in January to an average high of 81 degrees F (27 degrees C) in August, with a year-round average of 73 degrees F (22 degrees C). Average annual rainfall is 50-55 inches (127-139 cm) with the heaviest rainfall in June, July, August, September and October.

GEOLOGIC DISCUSSION

Thick sequences of sedimentary rocks overlie the crystalline basement rocks in this part of the central peninsula. The sediments range from over 6,000 feet thick (1,830 m) in northwestern Polk County to over 12,000 feet thick (3,660 m) in eastern St. Lucie and southern Highlands counties. Sediments within a few hundred feet of the surface generally consist of clastics, such as sands, silts and clays; and carbonates, such as limestones, dolomites or shell beds. In many cases these lithologic units are interbedded or interfingered and are gradational from one to another.

Sediments exposed at the surface range from Miocene age (26 to 12 million years old) through Pleistocene age (3 to 2 million years old) to recent age. Miocene sediments are those associated with the Hawthorn Formation and consist of sands and clayey sands exposed in some borrow pits on the Lake Wales Ridge. Pleistocene sediments are those associated with the Caloosahatchee, Fort Thompson and Anastasia Formations, which consist mainly of shell beds (colloquially called marls), clays and clayey sands that crop out in the shallow ditches and streams, around Lake Okeechobee, and along the Atlantic coast. Also, Pleistocene sediments are the fine-to-medium size sands and silts that comprise the upper sections of the coast-parallet ridges. the Atlantic Coastal Lowlands, the Osceola, Okeechobee and De Soto Plains, and Bombing Range and Lake Wales Ridges. Recent sediments are the deposits of peat, lake deposits, dune sands and alluvial deposits of streams.

Almost all of St. Lucie, Martin, Okeechobee, Highlands, Brevard, Osceola, and Indian River counties are covered by a veneer of Pleistocene sand. On the map some areas of these counties have had their sand-cover deleted to reveal the underlying lithologic units; these stripped-off areas are where the sand is less than 10 feet (3 m) thick; exceptions are the areas of peat, which are surface deposits. Shell beds, clays and clayey sands underlie the surficial sands and the peat, as shown on the cross sections.

The shell beds, clays, sands, and limestones were laid down by marine processes. During the last two million years of Pleistocene time sea level rose more than 100 feet (30 m) above present sea level and fell more than 200 feet (60 m) below present sea level. These sea level fluctuations occurred several times, alternately covering and exposing parts of the Floridan Plateau. Each significant change in sea level created a different environment of deposition for any given location across the relatively flat Plateau. The result of these sea level changes is a very complex interbedding and interfingering of heterogeneous lithologies in the subsurface stratigraphy. The present coastal beaches, offshore barrier islands, and back-bay deposits have been designated as shell lithology because of their shell, silt, and clay content. Quite often these shell beds have been changed to a coquina, which is a limestone composed of shells, corals, organic debris, sand or other minerals that have been cemented together. Fragments of these coquina units are commonly found in spoil piles along the many canals. Exposed sections in canals and borrow pits show evidence that these shell beds originally were thicker. Through geologic time, however, their calcareous shells and debris have been leached away leaving their included quartz sand and other insoluble minerals as residuum. Interfingered and interbedded among the various shell, clay and sand units are thin, discontinuous lenses and stringers of sandy, phosphatic limestones and dolomites. Most of these are too thin to be shown on the scale of the cross section.

The peat deposits are accumulations of partly decomposed plant materials. These peats are recent, having formed within the past 5,000 to 10,000 years. The peat south of Lake Istokpoga formed in a swampy, marshy environment similar to the Everglades; a much larger lake formerly covered the areas where the peat is now exposed. Depending on location, the peaty deposits may be 20 feet (6 m) thick in places, but an average would be from 3 to 6 feet (1-2 m). They are generally underlain by clayey sands and shell beds. Drainage ditches and canals have lowered the water table to allow cultivation and truck farming operations. A large area of peat is located in Brevard and Indian River counties in the St. Johns River swamp. Many small deposits of peat can be found associated with the countless lakes, stream channels, and the perennially flooded or poorly drained swampy areas. These deposits are usually thin or discontinuous, and are of little potential value for farming or mining.

PHYSIOGRAPHY

The geologic history of peninsular Florida is reflected in its physiographic landforms. Peninsular Florida is the part of the Floridan Plateau which is presently above sea level. On the eastern side of the map area the edge of the Floridan Plateau lies from 10 to 20 miles (16 to 32 km) offshore of St. Lucie, Brevard, Indian River, and Martin counties. On the Gulf side of the peninsula the edge of the Floridan Plateau lies as much as 100 miles (160 km) offshore.

During the past two million years sea level has fluctuated several times above and below its present level, alternately covering and uncovering parts of the Floridan Plateau. As sea level changed, the advancing and retreating shorelines modified the surface of the Plateau and the peninsula to produce its present physiography. The locations of many of these ancient shorelines and marine features can still be traced by the presence of terraces, sand ridges and dunes.

Physiographic provinces for the State of Florida have been proposed by Puri and Vernon (1964). This map includes parts of the following physiographic provinces, from east to west: Atlantic Coastal Lowlands (includes the Atlantic Coastal Ridge, Ten-Mile Ridge and Green Ridge), Osceola Plain (includes Bombing Range Ridge), the Okeechobee Plain; Central Highlands (includes Lake Wales Ridge and the Intra-Ridge Valley), and the De Soto Plain. The geographic boundaries of these physiographic provinces, or landforms, are based on their differences in elevation.

Practically all of Brevard, Indian River, St. Lucie and Martin counties lie within the Atlantic Coastal Lowlands physiographic province. The Atlantic Coastal Lowlands extend inland from the coast for approximately 20 miles (32 km). These Lowlands are characterized by monotonously flat, low elevations (less than 25 feet (7.5 m) above sea level) that are swampy and poorly drained. These lowlands (or flatlands, as they are also called) represent the shallow, flat bottoms of ancient seas. Superimposed upon these low flatlands are several sand ridges which are distinguished by their significantly higher elevations, their linearity and their coast-parallel orientation, all of which reflect their geologic origins as ancient shorelines, dunes, or offshore bars. On the map and cross-sections these ridges lie above 25 feet elevation (7.5 m). Going from the coast to the west, they are: Atlantic Coastal Ridge, Ten-Mile Ridge and Green Ridge.

The Atlantic Coastal Ridge closely parallels the entire coastline of Brevard, Indian River, St. Lucie and Martin counties and is about one or two miles (1.6 to 3.2 km) wide. The general elevations along the Ridge are from 30 to 60 feet (9 to 18 m), with some local hills near Jensen Beach and in Jonathan Dickinson State Park rising to over 80 feet (24.5 m). These sand hills are ancient coastal sand dunes which are now relatively stable and sparsely vegetated. Ten-Mile Ridge and Green Ridge are indistinct features that are difficult to distinguish from the ground, but which can generally be delineated on topographic maps by their slightly higher elevations above the Atlantic Coastal Lowlands. They range in elevation from 25 to 35 feet (7.6 to 10.5m). They are probably relict beach ridges or offshore bars. Examples of modern-day counterparts of these features may be found along the Atlantic Coast in the form of Prang, Hutchinson and Jupiter Islands, and the offshore shoals and bars.

The western edge of the Atlantic Coastal Lowlands terminates along a prominent scarp that rises relatively steeply above the 30 feet (9 m) elevation contour line. This scarp marks the boundary of the Osceola Plain. On the map the Osceola Plain encompasses all of Osceola County, approximately the eastern third of Polk County, the northern and eastern parts of Okeechobee County, and small parts of western Brevard, Indian River, St. Lucie and Martin counties. Elevations range from about 80 feet (24.4 m) across its broad, northern part and gradually sloping down to about 50 feet (15 m) at its southern edge to the north of Lake Okeechobee; with a narrower extension that slopes down to about 40 feet (12 m) at Indian Town in Martin County. Above the scarp this plain is essentially flat and, except for its very gradual downward slope from north to south, local relief seldom exceeds 5 feet (1.5 m). The main body of this plain is composed of sand and probably represents an ancient line of barrier beaches, which formed when sea level stood 40 feet (12 m) or more above present level. A finger-like extension of this plain points to the southeast through western St. Lucie and Martin counties, and closely parallels the eastern shore of Lake Okeechobee. This may have been a sand-spit, or cape, which terminated the chain of barrier beaches.

Superimposed on the Osceola Plain is a very prominent linear sand ridge, called Bombing Range Ridge, that is located between Lake Kissimmee and Lake Istokpoga (on the map it is situated between the legend "Avon Park Air Force Range"). It trends north-south for 22 miles (35 km) and is from 1 to 4 miles wide (1.6 to 6.4 km). Rising above the 75 feet (23 m) contour line, its top slopes downward from north to south, similar to the Osceola Plain. Peak elevations range from 146 feet (44.5 m) at its north end to 97 feet (30 m) at its south end. This sand body may have been a large offshore sand bar that was associated with, and created contemporaneously with, the Lake Wales Ridge.

The Okeechobee Plain is an extremely flat, featureless area that slopes very gradually downward to the south from the toe of the Osceola Plain. It is a triangular-shaped area whose apex is at the northwestern shore of Lake Istokpoga. One side of the triangle runs north-south from the apex to the bottom border of the map and is approximated by the 50-foot (15 m) contour line that extends from Lake Istokpoga east-southeast and south to the point of intersection of the Okeechobee County line with the shoreline of Lake Okeechobee, at elevation 15 feet (4.6 m). It is poorly drained, although in recent years large tracts have had their water tables lowered through extensive drainage ditches. The area to the south of Lake Istokpoga that is shown as "peat" lithology is underlain by relatively thick deposits of peat (commonly called muck) and organic-rich sands, depending on location. The peaty deposits may be 20 feet (6 m) thick in places, but an average would be from 3-6 feet (1-2 m). They are generally underlain by clayey sands and shell beds. Experience with these types of peaty soils in the Everglades has shown that rapid oxidation, even spontaneous combustion, takes place after lowering their water table; consequences of these effects have been the compaction of the peat and the significant lowering of the surface over vast areas. A similar fate can be foreseen for this peat prairie if it is developed and utilized as the Everglades have been.

The western edges of both the Osceola and Okeechobee Plains terminate at an abrupt scarp that is the eastern side of the Lake Wales Ridge. The Lake Wales Ridge is one of the most prominent topographic features on the Florida peninsula, both in elevation and areal extent; it is distinctive enough to be recognizable from orbiting spacecraft and on space photography. Route 27 closely approximates the axis of the Ridge. The southern tip is outlined by the 75-foot (23 m) contour line where it touches the Glades-Highlands County line about 3 miles (5 km) south of the town of Venus. The Ridge consists of rolling sandy hills with many large lakes. The lakes tend to cluster along the central axis of the Ridge; they have steep sides; and they are roughly circular or combinations of coalescing circles. These characteristics point to their origins from solutioning of deeper-lying limestones and subsequent collapse of the overlying sandy sediments. The highest elevation on the Ridge in this area is 293 feet (89 m) on a hill just east of Crooked Lake in T 31 S, R 28 E.

The southwestern corner of the map is the flat, featureless De Soto Plain. It is very sparsely populated and is mainly devoted to cattle raising. Although two large streams run across it, the Peace River and Fisheating Creek, it is poorly drained with countless boggy areas during the wet season. Its eastern boundary is the west margin of the Lake Wales Ridge. It begins at the point where Polk, Hardee and Highlands counties' boundaries meet (T 33 S, R 27 E) and trends to the southeast along the 100 foot (30 m) contour line to the Glades County line at the southern tip of the Lake Wales Ridge. Its northern boundary is approximated by the 100 foot (30 m) contour line from the common boundary point of the three counties southwestward to Zolfo Springs and thence west to the border of the map; State Route 64 follows this line closely. North of this line is another region of high, rolling sandy hills, the Polk Upland.

Lake Okeechobee, with the exception of the Great Lakes, has the distinction of being the largest fresh-water body in the 48 contiguous states of the U.S.; its surface area is approximately 700 square miles (1,813 sq. km). It is very shallow and most of it is less than 10 feet (3 m) deep.

WATER RESOURCES

Water resources of the region consist of surface and ground water, both of which contribute significantly to the economic and environmental health of the area. Surface waters are those occurring on the surface, such as in lakes, streams, canals and marshes. If it were not for the ready accessibility of large quantities of surface water for irrigation, possibly much of the area's citrus cultivation would be prohibitively expensive.

Ground water occurs in this region in artesian aquifers and nonartesian aquifers. Water lying unconfined under the surface is said to occur under non-artesian, or water table conditions. In contrast, ground water that is confined and under pressure between relatively impermeable rock units, is said to occur under artesian conditions. Water table conditions exist throughout the map area. Over most of the flat, low-lying areas the top of the water table varies seasonally from ground surface to about 20 feet deep. Exceptions to these conditions occur in the areas of high dunes of the Atlantic Coastal Ridge and along the Lake Wales Ridge and other ridges. In these areas the top of the water table is deeper, generally, and more variable in configuration.

The geologic units that comprise the water-table aquifer systems are approximately 150 to 200 feet thick in this region. Water quality is usually better in these shallow water-table aquifers than it is in the deeper artesian aquifers. Quality varies, with some locales having problems of high iron content, hardness, sulfur taste or color, depending on the local geology. Still, throughout the region, most of the domestic or small-demand water supplies are obtained from the water-table aquifers. Also, in Brevard, Indian River, Martin, and St. Lucie counties many large-demand supplies for municipal, irrigation and cattle are obtained from the shallow water table, since the artesian Floridan aquifer water is too highly mineralized in their area.

The artesian Floridan aquifer underlies the entire region. It is separated from the shallower water-table aquifers by sections of relatively impermeable clays and marls, which may be up to 500 feet thick in the southern areas of the map. The trend of the top of the Floridan aquifer is from a high in the northwest corner of the map to the southeast. This trend reflects the general regional attitude of the top of the limestones that comprise the upper part of the Floridan aquifer. In the northwest corner of the map in Polk County the top of the aquifer lies near land surface; from there it dips to the southeast, where it reaches 800 feet deep in Martin County. The Lake Wales Ridge in Polk County serves as the major recharge area for the aquifer, because it transmits surface and water-table waters to the Floridan through innumerable sinkholes, permeable sandy units and semi-permeable clayey units. In general, water quality in the Floridan decreases with both depth and down the regional dip to the south and southeast. Water quality is usually good from the upper parts of the Floridan aquifer in Polk, Hardee, Highlands, Osceola, Glades and Okeechobee counties, but, in each case, becomes poorer with depth. Water quality deteriorates along the Atlantic coast in Brevard, Indian River, St. Lucie, and Martin counties, and water from the upper part of the Floridan may be unusable, depending on requirements.

ECONOMIC GEOLOGY

Mineral commodities in this region consist of: clayey sands, marls (shell beds), limestone and phosphate. With the exception of phosphate, most of the other commodities are utilized in the construction industry, or related. Countless marl pits exist throughout the area which supply large quantities of fill material for road-base and construction sites. Some limestone is mined in the vicinity of the town of Okeechobee, which is used in asphalt and concrete manufacturing. Sand is mined at several places along the Lake Wales Ridge in Polk, Highlands and Glades counties and also at several places on the large dunes along the Atlantic coast. Several of the pits along the Lake Wales Ridge also extract clayey sands, mostly for fill material.

The part of the Central Florida phosphate district that is located in the eastern part of Polk County constitutes a major, multi-million dollar per year industry for the area. Also, several phosphate-producing companies have recently begun to extract uranium oxide as a marketable by-product of processing phosphate. The predicted recovery capabilities may amount to 15 per cent of the United States' domestic requirements (Sweeney and Windham, 1979).

OUTCROPS OF INTEREST

1. Highlands County, Township 33 S, Range 28 E, Section 4, northwest quarter. Abandoned sand pit showing Pleistocene sands lying on the uneven top of clayey sands of the Miocene Hawthorn Formation.
2. Highlands County, Township 36 S, Range 30 E, Section 34, along Route 621 on south shore of Lake Istokpoga. Ditches in fields near the ridge show several feet of peat; farther east shell beds are exposed
3. Okeechobee County, Township 35 S, Range 36 E, Section 12, northeast quarter, just west of county line on Route 68. Marl pit used by road department. Has thin sand veneer underlain by bedded shell units showing undulatory contacts.

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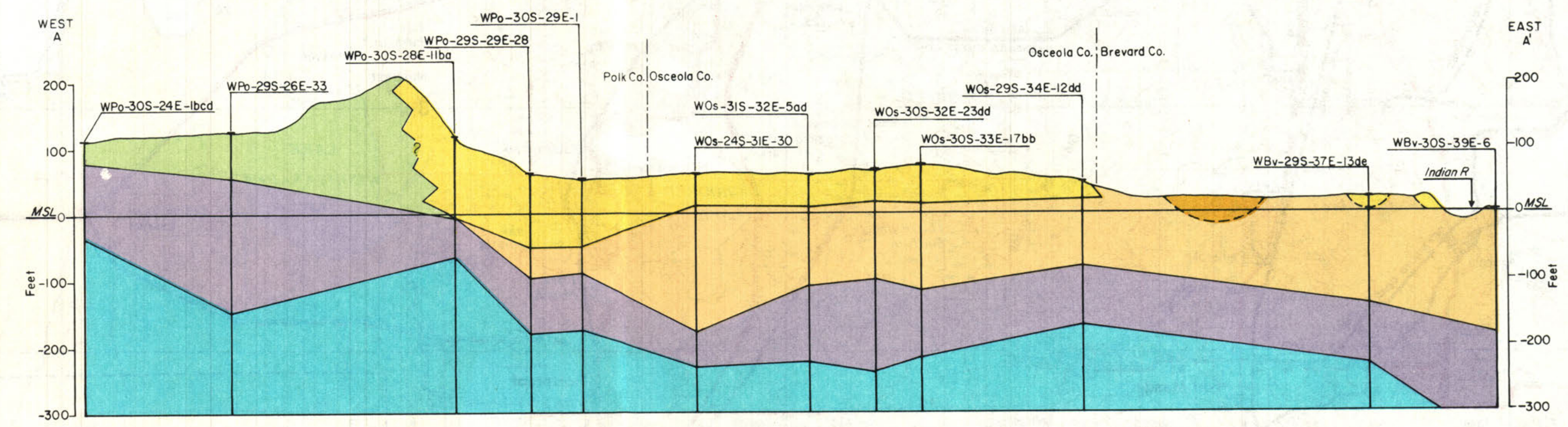

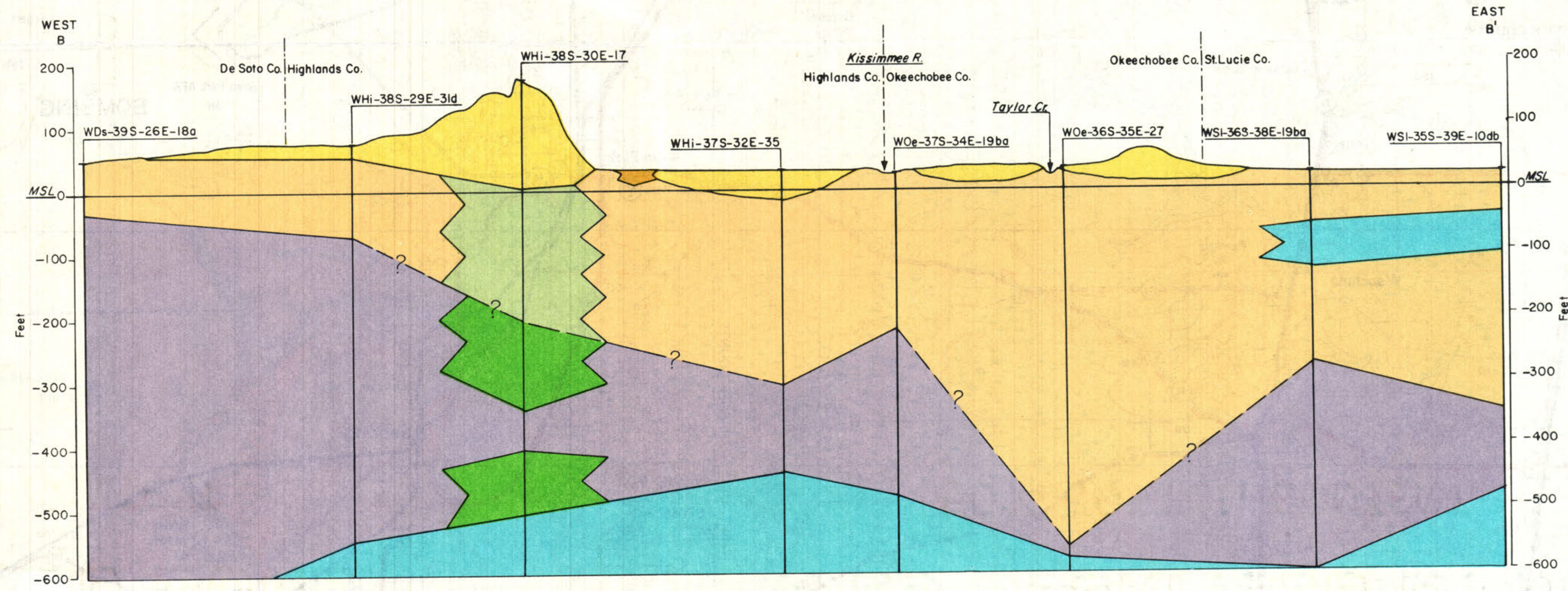

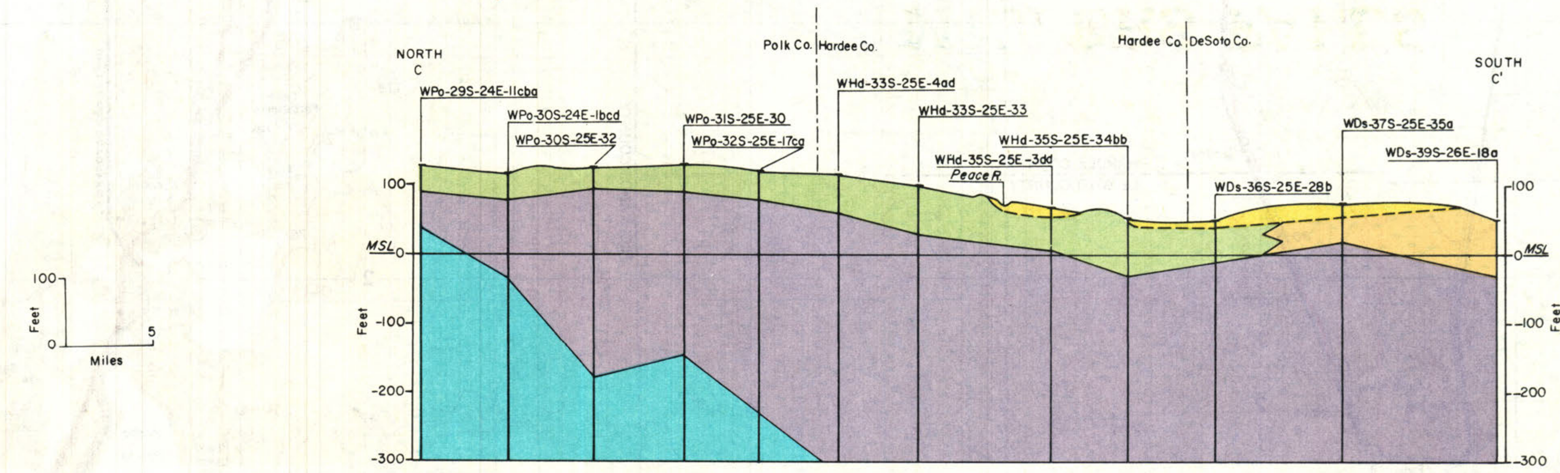

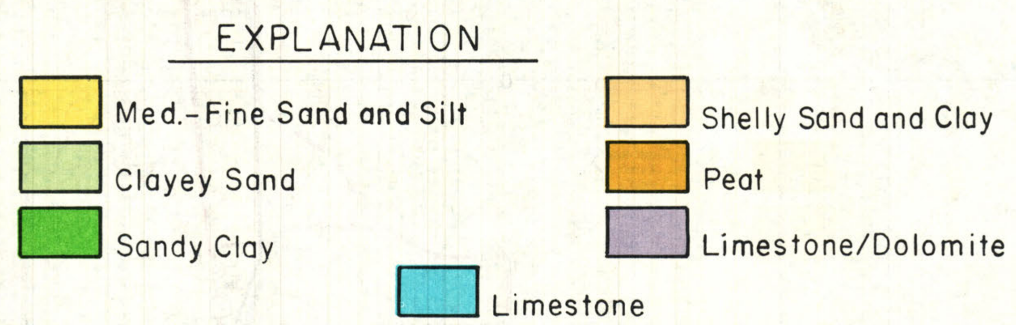

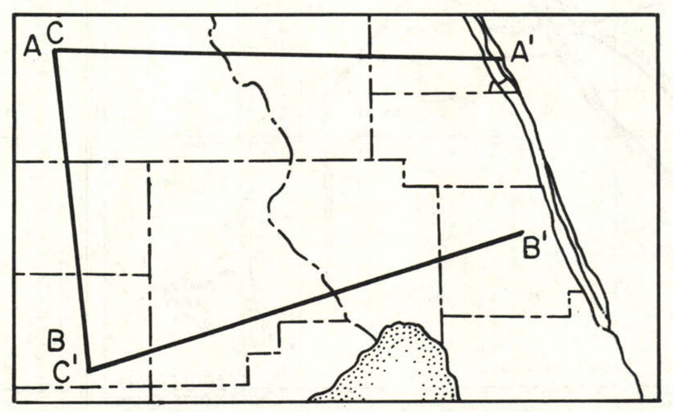

LOCATION of CROSS SECTIONS