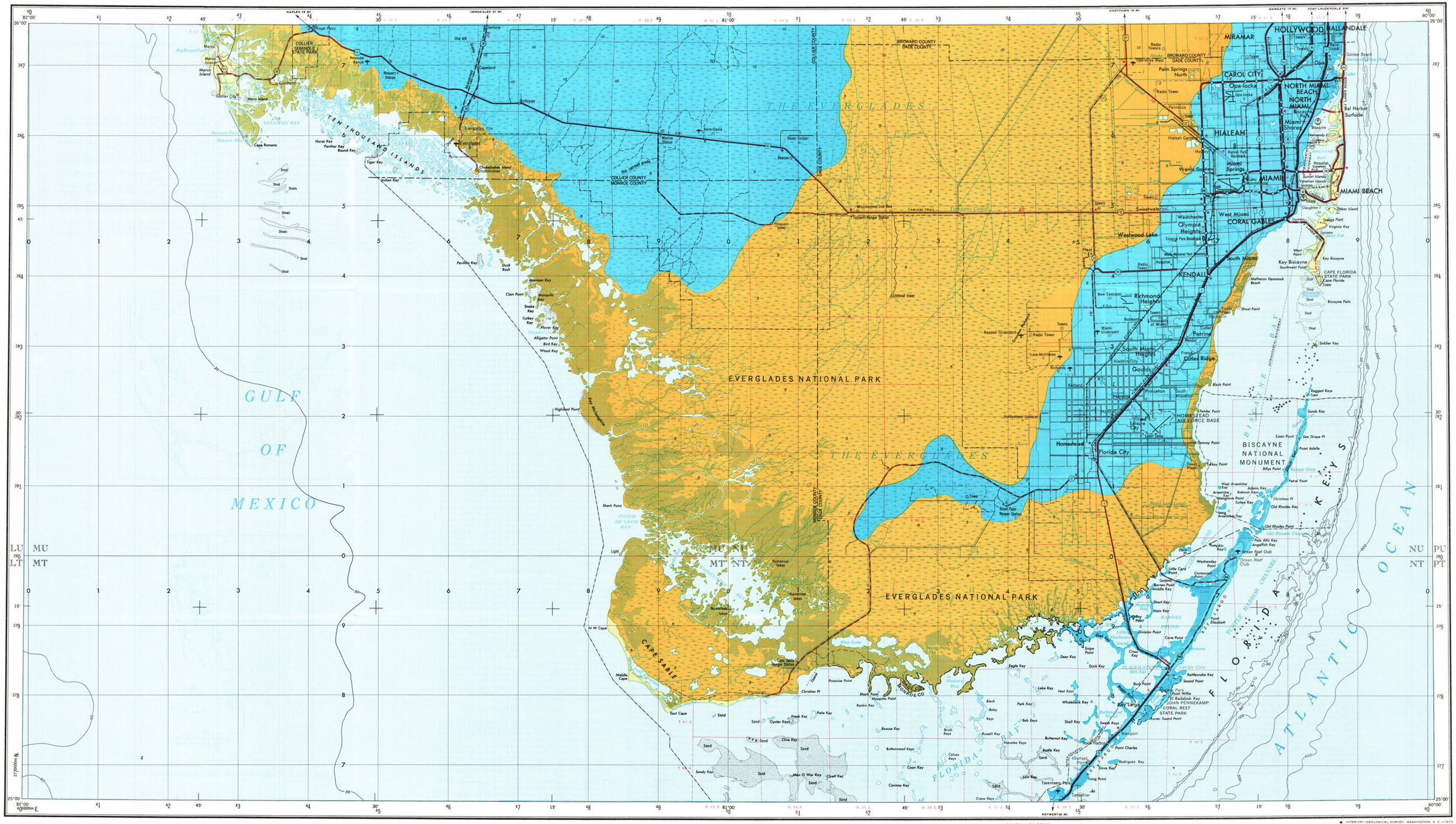
MIAMI

FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY



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

EXPLANATION

- Shelly Sand and Clay
- Limestone
- Peat

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

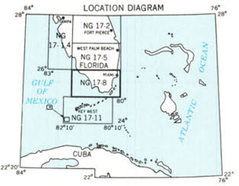
5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 15 Nautical Miles

MAXIMUM ELEVATION LESS THAN 50 FEET

ENVIRONMENTAL GEOLOGY SERIES
MIAMI 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: 17R
100,000 M. SQUARE IDENTIFICATION

LU MU NU PU
LT MT NT PT

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: 2770000

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

SAMPLE POINT: LOOKOUT TOWER

1. Read letters identifying 100,000 meter square in which the point lies: NU
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: 2
   Estimate tenths from grid line to point:
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: 3
   Estimate tenths from grid line to point: 7

SAMPLE REFERENCE: NU2337
If reporting beyond 18° in any direction, prefix Grid Zone Designation, as: 17RNU2337

MIAMI, FLORIDA
1956
REVISED 1971

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1973

FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

ENVIRONMENTAL GEOLOGY SERIES

MIAMI SHEET

By

Ed Lane

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

Tallahassee

1981

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 intended that this map will not only serve these purposes, but that it 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.

POPULATION

(All population data are from the 1970 census.)

The population is concentrated along the eastern seaboard of Dade County in the megapolitan strip associated with Miami. This urban complex has enabled Dade County to rank as the most populous county of the State for more than 30 years. From 1960 to 1970 its population increased 35%, from over 935,000 to more than 1,268,000. By contrast, the west coast area is almost devoid of people. Everglades City, in Collier County, had a population of less than 500 in 1970. Construction is underway on a major resort and residential complex at Marco Island in Collier County; this will be a large population center on the southwest coast when it is completed. Limited population data indicate that there are about 5,000 residents on the upper Keys shown on this map. About one-half of the mainland area is within the Everglades National Park, which will preclude development and urbanization.

CLIMATE

Situated at the extreme southern tip of the Florida peninsula, the area's climate is sub-tropical. Temperatures range from an average low of 68 degrees F (20 degrees C) in January to an average high of 83 degrees F (28 degrees C) in August, with a year-round average of 76 degrees F (24 degrees C). Rainfall distribution is uneven, both geographically across the peninsula and seasonally. Rainfall is lowest on the west coast, slightly higher on the east coast, with maximum rainfall occurring over the Everglades region. Summer rainfall, from May to October, considerably exceeds winter rainfall across the peninsula. Average summer rainfall on the west coast, the east coast, and the Everglades is, respectively, 36 inches (91 cm), 40 inches (101 cm) and 44 inches (112 cm). Winter precipitation varies more gradually across the peninsula without any distinct maximum over the Everglades, and ranges from 14 inches (35 cm) on the west coast to 16 inches (40 cm) on the east coast.

TRANSPORTATION

U.S. 41 (Tamiami Trail) is the main east-west road across the Everglades. U.S. 27 provides access from the center of the peninsula. The major north-south highways are U.S. 1, I-95 and Florida routes A1A, 441 and the Sunshine State Parkway. U.S. 1 is the only highway that extends the entire length of the Keys. Miami International Airport is one of the major airports of the eastern U.S. and is the busiest in the State. It provides airline service to many parts of the world. Miami is an important seaport and its location makes it a natural gateway for trade with Latin America. For smaller boats the Intracoastal Waterway provides sheltered passageway north from Miami. Two railroads serve the east coast as far south as Homestead, the Florida East Coast and the Seaboard Coast Line.

INDUSTRY

Tourism and retirement living, as industries, are personified in this part of Florida. The title "Gold Coast" that is attached to the Miami area and the eastern coast attests to the proportion of money contributed by tourism and retirement living to this area's economy. Many of the other leading industries or activities are closely tied to tourism and retirement living and include: construction, real estate, housing, recreation, the service trades, sports events, limestone mining and cement production, transportation, and manufacturing. Commercial and sport fishing are large contributors to the economy. Agriculture, which includes such major cash crops as citrus, vegetables, cattle, and special tropical fruits, is important to the area's economy. Miami is one of Florida's principal deep-water ports and its trade activities provide much money to the economy.

GEOLOGY

The Florida peninsula is the emergent portion of a larger extension of the North American continent that is known as the Floridan Plateau. Ancient, deep-lying igneous and metamorphic rocks form the basement upon which the Florida peninsula has been built. The deepest well drilled in south Florida penetrated over 18,600 feet (5,670 m) of sedimentary rocks before contacting basement (unpublished data). This was an oil-test well approximately three miles southeast of Royal Palm, in the northwest corner of the map. The Florida peninsula is composed of sedimentary rocks that have accumulated on top of the basement rocks. In this part of the peninsula, the upper few thousand feet of these sedimentary rocks are mainly carbonates, such as limestone, dolomites, marls, and shell beds.

Sediments exposed at the surface range from Miocene to Recent in age. The present geologic and physiographic features of south Florida are primarily the result of climatic fluctuations during the Pleistocene Epoch, which spanned from approximately 2,000,000 to 10,000 years before present. These Pleistocene climatic changes caused worldwide sea level changes, which created much of south Florida's physiography.

The Tamiami Formation, of Upper Miocene age through Lower Pliocene, underlies all of this part of south Florida. From the east coast to the western boundary of the Everglades, the younger Pleistocene and Recent formations cover the Tamiami Formation. The Tamiami Formation is composed of interbedded limestones and marls, which are usually gray to tan, sandy, and very fossiliferous. West of the Everglades throughout Collier County and part of northwestern Monroe County, the Tamiami Formation occurs near the surface. In many places, the limestone is veneered with a few feet of Pleistocene sand or Recent peat deposits.

Rocks of Pleistocene age are associated with the Fort Thompson, Key Largo Limestone, Miami Oolite and Anastasia formations and the Pamlico sands. Several factors make it difficult to precisely delineate the boundaries among these formations. Because of the flatness of the south Florida peninsula, small fluctuations of Pleistocene sea levels caused gradual changes of depositional environments across large areas, and various combinations of lithologies were being deposited contemporaneously across the peninsula. In some areas their contacts are gradational; in other areas they interfinger or are interbedded. Because of the above factors, the order in which they are described below does not assign them a definite geologic age. Their relative ages can only be determined by their stratigraphic relationships at a particular location. For example, along the east coast near Miami, lower units of the Miami Oolite interfinger with upper units of the Key Largo Limestone, which means that in places these two formations are the same age.

The Fort Thompson Formation contains alternating units of freshwater and marine origin. These units are composed of sands, marls, shell hash, and sandy fossiliferous limestones. It occurs from eastern Collier County to the eastern edge of the Everglades. It pinches out to the west in eastern Collier County, where it is less than 10 feet thick (3 m) at the county line. It thickens to the east and attains thicknesses up to 70 feet (21 m) beneath the eastern Everglades. In eastern Collier County and beneath the Everglades it overlies the Tamiami Formation. In turn, it is overlain by the younger Miami Oolite in extreme southeastern Collier County, and beneath the Everglades. In the rest of eastern Collier County where the Fort Thompson occurs, it is overlain by the younger sands of Pamlico age.

The Key Largo Limestone is an ancient coral reef. It is composed primarily of coral heads, surrounded by other cemented debris from the reef's environment, which makes it very porous. It is a component of the Biscayne Aquifer along the coast of Dade County. All of the Florida Keys on this map are the emergent remnants of the Key Largo Limestone reef. It lies near the surface under thin Miami Oolite and the dredged deposits on Key Biscayne, Virginia Key, and Miami Beach. Besides forming the emergent Keys, the Key Largo Limestone extends in a band up to 13 miles wide (21 km) along the coast. It extends under Biscayne Bay, where it interfingers with the Miami Oolite of the Atlantic Coastal Ridge, and seaward for several miles under the present coral reef tract. Thickness under the Keys varies from 75 to over 180 feet (23 to 55 m).

The Anastasia Formation is composed of marine units of shelly sands, and sandy and sometimes coquinoid limestones. It underlies the Miami Oolite of the Atlantic Coastal Ridge at least as far south as Homestead, where it interfingers with the Key Largo Limestone. It probably is contemporaneous with some of the marine units of the Fort Thompson Formation and merges with them west of the ridge, under the Everglades. In places it may be 70 feet (21 m) thick and very permeable due to solution cavities. As such, it constitutes an important part of the Biscayne Aquifer of Dade County. On the west coast mainland, north of Marco Island, the Anastasia may occur as a thin, very hard limestone near the surface. Where it occurs on the west coast, it overlies the Tamiami Formation and it is overlain by sands.

The Miami Oolite underlies most of this part of peninsular Florida, as shown on Figure 1. The Miami Oolite is a soft, white to yellow, cross-bedded, marine limestone that varies from a sandy limestone to relatively pure calcium carbonate. In the eastern and southeastern half of the Everglades it is primarily an oolitic limestone, whose major constituents are ooids (tiny spherical grains of calcium carbonate), with some shelly units. In the western and southwestern parts of the Everglades it is composed primarily of massive clusters of bryozoan colonies (Hoffmeister, et al., 1967). It forms a veneer on the islands offshore from Miami: Miami Beach, Virginia Key, and Key Biscayne. The Miami Oolite forms the floor of shallow Florida Bay, where it is covered by thin deposits of limey silt and ooze that are now accumulating. The Miami Oolite underlies Whitewater Bay, and the thin mangrove and marsh deposits on Cape Sable. The Miami Oolite pinches out to the west and is less than 10 feet (3 m) thick in eastern Collier County. It attains thicknesses of 10 to 15 feet (3 to 4.5 m) in parts of the Everglades. The Miami Oolite gradually thickens to the east and attains its greatest thickness of about 40 feet (12 m), where it forms the Atlantic Coastal Ridge. In eastern Dade County it is an important hydrologic unit of the Biscayne Aquifer.

Deposits of quartz sand of late Pleistocene age form terrace deposits of marine origin (Parker and Cooke, 1944). These sands are unconsolidated, white to gray, with occasional shells or organic materials. With the exception of the wind-heaped dunes on Marco Island, these Pleistocene sands lie below 25 feet (8 m) elevation. They are usually thin; however, where they fill solution cavities, old channels, or depressions, they may be several feet thick. Thin deposits occur on the Atlantic Coastal Ridge south of Miami. On the west coast, they occur as a thin mantle over much of southern Collier County and as dunes on Marco Island and some of the Ten Thousand Islands. Minor amounts extend into the fringes of the Everglades and are mixed with the peat. Because of their thin nature, these veneers of sand are not shown on the map.

The most conspicuous lithologic unit is the Everglades peat. This enormous expanse of peat is indirectly the result of Pleistocene conditions, although the peat has only been forming since the end of the last Pleistocene glacial period, from about 10,000 years ago to the present (Davis 1946). The shallow trough, whose floor was formed by Miami Oolite and other Pleistocene formations, in combination with milder post-Pleistocene climate created ideal conditions for peat to form and accumulate. Thickness of peat in some of the deeper parts of the Everglades trough may have been as much as 10 feet (3 m). Over the past century man's activities of draining and cultivating large areas have altered the natural environment of the Everglades to such an extent that huge volumes of peat have been lost through fires, oxidation, dessication and compaction. Present thickness of peat over much of this area of the Everglades probably ranges between one to five feet (0.3 to 1.5 m).

PHYSIOGRAPHY

This map includes the extreme southern tip of the Florida peninsula and several of the upper Florida Keys, all of which are on the Floridan Plateau. The Floridan Plateau is a wide, relatively flat platform that forms a boundary between the Gulf of Mexico and the Atlantic Ocean. The Plateau's boundaries are arbitrarily placed where the water depths equal 300 feet (91 m). The edge of the Plateau lies less than 5 miles (8 km) offshore from Miami Beach, in contrast to the Gulf side of the peninsula, where it lies more than 100 miles (160 km) offshore to the west of Marco Island. The Florida peninsula is that part of the Floridan Plateau which is above present sea level.

This map includes parts of the following physiographic provinces, as proposed by Puri and Vernon (1964). From east to west are the Atlantic Coastal Ridge, the Upper Keys, Florida Bay Mangrove Islands, the Everglades, the Southwestern Slope, Big Cypress Spur, the Reticulate Coastal Swamps, and the Ten Thousand Islands. With the exception of the Atlantic Coastal Ridge this entire part of the Florida peninsula can be described as a flat, very gently sloping plain.

The Atlantic Coastal Ridge (also locally known as the Miami Ridge) is a narrow, gently rolling limestone ridge that runs from Hollywood to Homestead, where it loses stature and becomes indistinct. It borders the coast south to the vicinity of Perrine, where it bends to the southwest away from the coast. U.S. 1 approximates the crest of the Ridge from South Miami to Homestead. The highest elevations are between 20 to 24 feet (6 to 7 m) in the Coconut Grove area of South Miami; usual crest elevations are from 10 to 15 feet (3 to 4.5 m), becoming lower to the southwest until the Ridge merges into the Everglades' topography southwest of Homestead.

The ridge is composed of the Miami Oolite of Pleistocene age. This oolite (a limestone made primarily of small, calcareous, spherical grains) was formed as a shoal under shallow water conditions during the Pleistocene Epoch (Hoffmeister, et al., 1967; Halley, et al., 1977), and subsequently became cemented when sea level fell. As far south as Miami, it is veneered in places by quartz sand. Because of its thin and sporadic nature, the sand associated with the Ridge is not shown on the map; only the limestone bedrock is shown.

The Atlantic Coastal Ridge is the most prominent physiographic feature in south Florida, and, as such, it has exerted major influence over both natural and man-made developments. Several important characteristics of the Atlantic Coastal Ridge are illustrated by the elevation contours on Figure 1, which shows the top of the Miami Oolite. This ridge forms the foundation upon which has been built almost all of the metropolitan Gold Coast. Its prominence above sea level and above the Everglades has, in fact, enabled the Gold Coast development to take place. Highest elevations are along the eastern side with a very gradual slope to the west into the Everglades' trough. The Silver Bluff scarp forms part of the steeper eastern side. Elevations gradually decrease away from Miami to the southwest and to the north. The higher elevations of the ridge can be seen to form a rock-rim to the east and southeast of the Everglades. This rock-rim has controlled the flow of water from the Everglades by deflecting it to the southwest, where its greatest discharge is into the Gulf from Cape Sable to First Bay, on the north. Figure 1 shows the general configuration of the shallow, rock-floored trough of the Everglades, in which the peat deposits have accumulated.

Narrow channels, called transverse glades, cut through the ridge perpendicular to its southwesterly trend. These channels are important components of the region's hydrologic system. The rock-floors of these channels lie about 5 feet (1.5 m) lower than the elevation of the adjacent ridge, and are filled with organic soils, sand, and marl. They originated as tidal channels in the ancient oolite shoal that formed the present ridge (Hoffmeister, et al., 1967). In the past, these channels conveyed some of the overflow from the Everglades to the Atlantic. Now, the valleys have canals dug along them which serve for flood control and as sources of fresh water recharge for the upper Biscayne Aquifer.

In Miami, evidence of an ancient shoreline exists as the Silver Bluff Scarp, which is cut into the Miami Oolite. South of the Miami River it runs along the eastern side of the Atlantic Coastal Ridge, closely parallel to the western shore of Biscayne Bay. In places along South Bay Shore Drive the face of the wavecut cliff reaches heights of 15 feet (4.5 m). Elevations of the toe of the scarp, and of the relatively flat terrace east of the scarp, varies between 5 and 10 feet (1.5 to 3 m) above present sea level. These variations of elevation may indicate that various parts of the scarp were carved at different times by the changing levels of Pleistocene seas. White (1970) thought that present-day hurricanes are capable of attacking and cutting back the Scarp, and that they probably have done so in recent time. As with the Atlantic Coastal Ridge, the Silver Bluff Scarp gradually loses stature to the south. In the vicinity of Perrine, along Old Cutler Road, it is no longer a scarp, but only an indistinct slope.

Offshore from Miami, the large islands of Miami Beach, Virginia Key, and Key Biscayne are topped by recent deposits, most of which have been dredged from Biscayne Bay. Beneath these deposits is a thin section of Miami Oolite which overlies relatively thick Key Largo Limestone.

The Florida Keys on this map, from Soldier Key south to Key Largo, are the remains of ancient coral reefs, and are composed of the Key Largo Limestone. Originating under water during one of the higher stands of a Pleistocene sea, they now stand partially emergent. Highest elevations are on Key Largo, and range from 10 to 14 feet (3 to 4 m). Modern reef counterparts are now growing in the shallow water seaward of the Keys. The Florida Keys have the only living coral reefs in continental North America, and John Pennekamp Coral Reef State Park on Key Largo was created to protect part of this unique national heritage.

Florida Bay, between the Keys and the mainland, is very shallow. Depths vary from one to six feet (0.3 to 2 m), with some tidal channels up to nine-feet deep (3 m). Tidal range is from one-half foot to three feet (0.2 to 1 m) generally decreasing from west to east across the Bay. The bottom is loose lime mud. Mangroves and sea grasses have trapped the sediment to form countless shoals and islands. Most of the mangrove islands are less than three feet (1 m) above mean sea level. Because of its shallowness, storms can stir up the loose lime mud, causing turbidity which may remain in suspension for days.

Most of peninsular Monroe and western Dade counties are within the Everglades, which corresponds to the peat lithologic unit. Topographically, the vast expanse of the Everglades is one of the flattest, most featureless areas on Earth. Elevations range from about 10 feet (3 m) at the top of the map to sea level along the Gulf and Florida Bay. During wet seasons when the water table rises above land surface, usually from May to October, much of the Everglades is covered by water. At these times surface water flows to the south, gradually becoming southwesterly flow south of the Tamiami Canal. The gradient of the water surface in the Everglades may only be two inches per mile (1.2 cm per km), which is so flat that rain storms can reverse the slope of the local water surface. The Everglades region is covered by thick peat and organic-rich soils. These organic deposits have accumulated on Miami Oolite that forms the floor of a broad, shallow trough. The bedrock floor rises to the east and west where it lies at, or very near, the surface. The Atlantic Coastal Ridge lies to the east and the Southwestern Slope lies to the west. The exact demarcation of the Everglades boundaries, however, is tenuous in most areas. One criterion for the east and west boundaries is where the true grasses and cypress trees give way to the saw grass, or sedges, of the Everglades. These floral differences are usually gradational through transition zones that may be many miles wide. Also, elevations are generally higher to the east and west. However, changes in elevation are usually so imperceptible over long distances that they provide an imprecise criterion. In addition, man's activities of ditching, diking, draining and diverting water have considerably altered the historical and natural boundaries of the Everglades.

The western Everglades merges into the Southwestern Slope physiographic province. The part of the Southwestern Slope that is shown on this map is also known as Big Cypress Swamp. It is an area of swamps, cypress hammocks, and ground that is generally higher than the Everglades. Where the land is sufficiently high and drained, it also supports palmettos, pines, and grass. Most of the surface and near-surface lithologies are limestone, calcareous sandstone, and marls associated with the Tamiami Formation. On its southwest side it merges with the Reticulate Coastal Swamp physiographic province. This boundary is also gradational, though the Southwestern Slope usually has elevations higher than five feet (1.5 m).

As their name implies, the Reticulate Coastal Swamps consist of very low, intricately channeled coastal marshes and mangrove swamps that border all the Gulf Coast on this map south to Shark Point on Florida Bay. Less than five feet (1.5 m) in elevation, they are subject to tidal action. Their thin organic and marly soils cover limestones and calcareous sandstones associated with the Tamiami Formation.

Ten Thousand Islands is an aptly descriptive name for the unique group of islands that stretch from Cape Romano to Pavilion Key, along the Gulf of Mexico. According to Shier (1969), these islands have been built over the past 3,000 to 5,000 years as the result of vermetid reefs colonizing the area. Vermetids are marine gastropods having a tube-like shell. The species of vermetid that form these islands have tubular shells that are typically about one-eighth inch (4 mm) in diameter and may be more than one foot (30 cm) long. Their large colonial reefs form the cores of the outer, Gulf-ward islands, which trap sand, silt, and other sediments. The inner islands in Chokoloskee Bay are long, narrow, twisting oyster bars, which also trap sediments. Both types of island are predominantly covered by mangroves, and many have exposed ledges of reef or oyster rock. The bedrock under the islands, upon which the reefs have grown, is the limestone of the Tamiami Formation. Its surface lies about eight feet (2.5m) below sea level on the landward side of the islands and about 20 feet (6 m) below sea level on the Gulf side. Elevations of most islands are less than 5 feet (1.5 m). Several larger, higher islands lie west and southwest of Everglades City and attain elevations of 10 feet (3 m).

On the Gulf Coast there are two prominent capes, Cape Romano on the north and Cape Sable on the southern tip of the peninsula. Marco Island is separated from north Cape Romano by a narrow channel, but both are part of the same complex of barrier beaches, dunes and islands. An area of shallow sand shoals extends south of Cape Romano for about 10 miles (16 km).

A spectacular dune system is found on Marco Island. The dune system is roughly elliptical, and the dunes form the shoreline of shallow Barfield Bay, just north of Horrs Island. Barfield Bay is two miles long and one mile wide (3.2 by 1.6 km), and the dunes have a total length of about eight miles (13 km). Most of the dunes are more than 25 feet high (8 m). A dune on the southwest side of the Bay, near Collier City, is 52 feet high (16 m), which is the highest elevation on this map. Marco Island, Cape Romano and its associated shoals, and the sandy beaches of some of the Ten Thousand Islands are considered to be the southernmost extent of significant deposits of quartz sand on the peninsula's west coast. The transport of quartz sand south of this point has been negligible.

On Cape Sable, from Northwest Cape to Flamingo, are narrow beaches of calcareous marls and shells. Behind these beaches are narrow, shelly, calcareous sand dunes, usually less than 5 feet high (1.5 m). The highest of these dunes is at Northwest Cape, and is about one-half mile (0.8 km) long, with an elevation of 10 feet (3 m). The remainder of Cape Sable is covered with mangroves, marshes, marls and peat. The bedrock that underlies all of Cape Sable is Miami Oolite.

WATER RESOURCES

Surface water is abundant in south Florida. Ninety per cent of the map is covered by the "swamp/marsh" symbol, which indicates areas that are either perennial marshes or that are periodically flooded. Unfortunately, most of the surface water is unfit for human consumption. Its contact with the swamps and organic matter usually taints it with disagreeable odor, taste, color, or bacteria.

Most of the Everglades on this map that lie north of the Tamiami Trail are designated water conservation areas. Extensive systems of dikes and canals allow water to be impounded or released, depending on demand. These water conservation areas function as supply reservoirs during periods of low rainfall and as holding reservoirs if floods threaten. They also serve to maintain prescribed flows to the southern Everglades, most of which lies within the Everglades National Park.

Important components of the surface water resources are the complex networks of canals and drainage ditches. Their primary functions are to drain unwanted surface water, and to lower the usually high water tables. Besides these functions, however, in many areas they also act as sources of recharge for the ground-water aquifers. These recharge functions are particularly important for the urbanized southeastern coast, whose main source of potable water is the water-table Biscayne Aquifer. Most of these canals are required to have water-level control structures near their outlets, thereby maintaining ground-water heads to prevent salt-water intrusion.

Ground water occurs in shallow water table aquifers and in the deeper artesian Floridan Aquifer. A water table aquifer contains water which is unconfined, and whose surface fluctuates up and down in response to recharge, which is usually rainfall, or withdrawals by evapotranspiration, springs, streams, or pumping from wells. A water table's surface tends to be a subdued replica of local ground surface. Water table aquifers in this area occur in geologic units ranging in age from Miocene to Recent. These units are the surficial sands and the underlying shell beds, silts, clays, and limestones. Most of the potable water throughout south Florida is obtained from the shallow water table aquifers. Water from the Floridan Aquifer is too highly mineralized for most uses.

Artesian ground water occurs when water is confined under or between relatively impermeable strata, which imposes a hydraulic pressure, or head, on the water. In an artesian aquifer, water will rise above the top of the aquifer in a well that penetrates through the confining strata into the aquifer. Water may flow above land surface if the hydraulic head is great enough, but this does not always happen. The artesian Floridan Aquifer underlies all of south Florida. In this area, the top of the Floridan Aquifer is from 500 to 1,000 feet (150 to 300 m) below land surface and confined beneath a 400 to 800-foot section (120 to 240 m) of rocks of low permeability. Although presently unsuited for most purposes, some of the aquifer's less mineralized water may be useful in the future for desalination. Also, it may be possible to inject fresh water into the aquifer, store it, and recover it as needed.

The populous southeast coast of Florida on this map depends entirely on the water-table Biscayne Aquifer for potable water. While a few private locations on the Keys have desalination facilities, practically all water supplies come to the Keys via pipeline from a well field on the mainland at Homestead. The areal extent of the Biscayne Aquifer coincides with the occurrence of the Miami Oolite, as shown on Figure 1. However, the Biscayne Aquifer is not restricted to any one geologic formation; rather, it crosses stratigraphic boundaries and includes units ranging in age from upper Miocene through Pleistocene. Recent deposits, such as the peat of the Everglades and coastal marls, are not included in the Biscayne Aquifer. The base of the aquifer is formed by the thick, impermeable clayey marls of the Tamiami Formation, of Miocene age. These impermeable units also form the upper confining beds of the Floridan artesian aquifer. In the coastal areas of southeastern Broward and northeastern Dade counties, the oldest and lowest units of the Biscayne Aquifer are shelly calcareous sandstones in the upper part of the Tamiami Formation. Elsewhere throughout this area, the basal units of the aquifer are in the Pleistocene Fort Thompson, Miami Oolite, Anastasia, and Key Largo Limestone formations.

A common characteristic of all of the geologic units that form the Biscayne Aquifer is the pervasive solution activity that has taken place to create a very porous and permeable aquifer. Vertical and horizontal solution cavities, some up to several feet wide in the limestones, form a honeycombed reservoir that is one of the most productive aquifers ever tested by the U.S. Geological Survey (Schroeder, Klein, and Hoy, 1958). Figure 2 is an isopachous map showing the approximate thickness of all units comprising the Biscayne Aquifer in the Miami-Homestead area. It should be noted that this map does not show the saturated thickness of the aquifer, which will vary seasonally by several feet from the values shown, and also in response to rainfall, withdrawals from well fields, and releases from the water conservation areas. The aquifer is thickest along the coast near Miami. It extends eastward under Biscayne Bay, where it contains saline water. Large withdrawals from well fields for Miami has induced the saline water in the aquifer beneath the bay to move inland, posing a constant threat to the city's water supply. Regulated pumping and continual monitoring are necessary to control the salt-water intrusion. The general trend is for the aquifer's thickness to decrease to the west, beneath the Everglades, and pinching out along the western limit of the Miami Oolite. Another thicker section is located in the vicinity of Homestead, where the well field is located that supplies the Keys.

On the west coast the population centers also derive their water supplies from shallow aquifers; here, too, the Floridan Aquifer is highly mineralized. Along the western coast of Collier County these aquifers occur within the upper 100 feet (30 m) of the surface. Geologic formations associated with the shallow aquifer system are, from older to younger; Tamiami, Miami Oolite, and thin surficial sands. According to McCoy (1962) the most important component of the shallow aquifer in Collier County is the limestone of the Tamiami Formation, which occurs throughout most of the county, and which is usually permeable due to extensive solution activity. It is exposed at the surface or is covered by thin younger materials over most of southern Collier County. The Miami Oolite is a minor part of the shallow aquifer where it occurs in the extreme southeast corner of Collier County. A veneer of sand or peaty-sand covers most of Collier County. It is thin but varies in thickness due to the uneven eroded surface of the underlying formations. Locally, it may constitute a shallow water table aquifer for domestic supplies. The town of Everglades, however, obtains water from the upper part of the Floridan Aquifer that is not too mineralized for public use. Limited data indicate that this is an exceptional situation for this part of south Florida.

ECONOMIC GEOLOGY

Mineral commodities that are available for production in this area are sand, limestone, and oil. Sand and limestone are used in the construction trades for fill, landscaping, cement manufacture, and for road construction. Over most of the area, limestone occurs at the surface or at relatively shallow depths, beneath thin sand or peat deposits. Sand prospects are best in western Collier County and along the Atlantic Coastal Ridge.

Oil has been produced in the past, but at present there are no producing oil wells in this area. In 1954, two wells discovered oil in Dade County near Forty Mile Bend, about five miles east of the Collier County line on the Tamiami Trail. Historically, these were the second wells to discover oil in Florida; the first having been the Sunniland well in 1943 in Collier County. Total production for both wells was small, only 33,000 barrels, and the wells were shut down in 1956. They did prove the area has potential for oil production, and prospecting continues.

Peat is an important non-mineral commodity. These vast deposits of organic soils make possible the extensive agricultural industry of south Florida. Also, they may be considered as potential commodities, in the event that market conditions and technology can create a large enough demand for them as soil conditioners, low-grade fuels, or related uses. At present, small quantities of peat are used by nurseries.

OUTCROPS OF INTEREST

1. Collier County, T52S, R26E. State Road 92 from U.S. 41 at Collier-Seminole State Park to Marco Island. Barfield Bay is rimmed by a spectacular dune system which has the highest elevations in this part of south Florida. Paved streets follow the crests of the dunes.
2. U.S. 41 (Tamiami Trail) parallels the Tamiami Canal across the peninsula. From west to east, the Tamiami Formation is exposed along the road and canal to approximately the edge of the Everglades, near the Dade County line. In Dade County the Miami Oolite underlies the Everglades peat until near Miami, where it is exposed at the surface and forms the Atlantic Coastal Ridge.
3. The Silver Bluff Scarp and shoreline, cut into the Miami Oolite, occurs in many places along South Bay Shore Drive in Miami.
4. The Key Largo Limestone is exposed everywhere on the large keys, from Soldier Key south through Key Largo.

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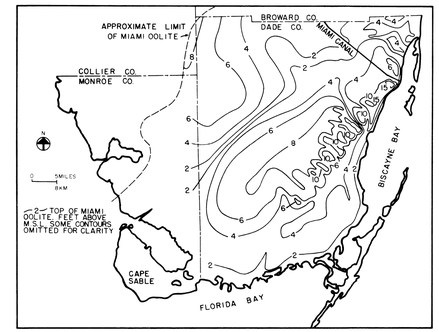

Figure 1. Elevation of the top of the Miami Oolite. (Modified from Parker, et al., 1955.)

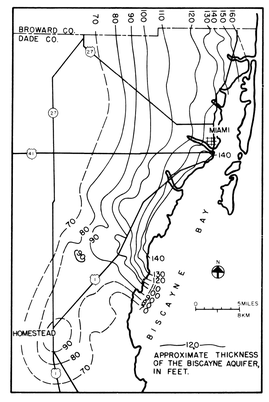

Figure 2. Map of the Biscayne Aquifer in Dade County showing approximate thickness.

DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

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