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The Geology of Collier County, Florida

by

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SUMMARY OF THE GEOLOGY OF COLLIER COUNTY, FLORIDA

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GEOMORPHOLOGY

Although several authors have discussed the geomorphology of the Florida peninsula, White's (1970) classification will be utilized in this report. Collier County lies within the Southern or Distal Physiographic Zone. The dominant geomorphic features within the county include the Immokalee Rise, the Big Cypress Spur, and the Southwestern Slope (White, 1970) (Figure 1). The remainder of the county falls within the Gulf Coastal Barrier Chain and Lagoons, Reticulated Coastal Swamps and the Ten Thousand Islands.

The Immokalee Rise is located primarily in Hendry County but extends into eastern Lee County and northeastern Collier County. The Immokalee Rise is bounded on the north by the Caloosahatchee Valley, on the east by the Everglades, on the south-southeast by the Big Cypress Spur and on the southwest by the Southwestern Slope (White, 1970). The boundaries between these features are poorly defined. The Immokalee Rise is described by White (1970) as a "southerly extention of Pamlico (?) marine sand invading the Distal Zone from the sand dominated Central Zone to the north." White (1970) further states that the rise appears to have formed

as a submarine shoal which extended southward from a mainland cape during the Late Pleistocene. Relict shoreline features are only weakly developed, apparently due to low energy conditions as the shoal emerged from the receeding sea (White, 1970). The Immokalee Rise lies at elevations which range from 25 to 42 feet above mean sea level (MSL) (Lane, 1980) and dips very gently to the southwest. Numerous small karst lakes are located along the margin of the rise (White, 1970).

The Big Cypress Spur is transitional between the Immokalee Rise, the Everglades Trough and the Southwestern Slope. Elevations on the spur are only slightly higher than those of the Everglades and the Southwestern Slope. Drainage is from the north, off the Immokalee Rise then to the Everglades and the Southwestern Slope. The Big Cypress Spur is characterized by large areas of limestone or marl exposed at the surface as well as areas of sandy or peaty soils (Lane, 1980; Drew and Schomer, 1984).

The Southwestern Slope lies at elevations below approximately 25 feet above MSL (Lane, 1980), between the Gulf of Mexico and the western edges of the Immokalee Rise and the Big Cypress Spur. Drainage is to the southwest. The majority of this area is thinly mantled with sand (generally thickening to the north) overlying an eroded Tamiami Formation limestone surface (Drew and Schomer, 1984).

Cape Romano forms the southern end of the quartz sand dominated Gulf Barrier Island Chain. The majority of the quartz sand transported past Cape Romano is deposited in a large shoal

complex south of the cape. North of Cape Romano, the Collier County coastline consists of barrier islands and lagoons.

The Ten Thousand Islands are located to the south of Cape Romano and are transitional between the quartz sand dominated barrier island coastline to the north and the carbonate dominated, quartz deficient shoreline to the south. Sufficient quartz sand is present to form beaches on the gulf side of the outermost islands, but not enough to allow the beaches to coalesce (White, 1970). The outer islands are often built on a core composed of vermetid (gastropod) reef rock (Shier, 1969). The inner islands are generally composed of oyster reefs. Both types of islands are generally topped by mangrove swamps (White, 1970).

The Reticulated Coastal Swamps border the Gulf Coast in the southern portion of Collier County. These swamps are tidally influenced (elevations less than five feet above MSL), complexly channeled mangrove swamps and coastal marshes. Thin organic and marl deposits overlie limestone and calcareous sandstone of the Tamiami Formation (Lane, 1980).

LITHOSTRATIGRAPHY

To date no wells in Collier County have penetrated Paleozoic rocks. In the general region of Collier County, basement rocks consist of predominantly mafic volcanic rocks (Winston, 1971; Barnett, 1975). These rocks are Late Triassic - Early Jurassic in age. Well cuttings from W-15095 (Exxon, P1042) in Collier County "reveal felsic igneous rock directly below the top of the

basement surface at a depth of approximately 17,000 feet" (Arthur, 1988).

Mesozoic rocks consist of several thousand feet of limestone, dolomite and evaporites. The Sunniland Formation (Lower Cretaceous) is the source of oil and gas production in Collier County. The top of the Sunniland Formation is encountered at approximately 11,500 feet below MSL in Collier County (Applegate and Lloyd, 1985).

Cenozoic rocks in Collier County consist of over 5,000 feet of carbonates. Significant quantities of siliciclastic material are present only in the Miocene and younger sediments (Figures 2-5).

The Paleocene Cedar Keys Formation is the basal unit of the Cenozoic section in Collier County. It consists primarily of nonfossiliferous dolomite along with gypsum or anhydrite. Anhydrite is often interbedded with the dolomite while gypsum commonly fills pore spaces (Chen, 1965). The percentage of evaporites generally decreases toward the top of the formation. The top of the Cedar Keys Formation is found at approximately 3,400 feet below MSL in Collier County and has a thickness of more than 2,000 feet (Chen, 1965). Braunstein et al. (1988) show the age of the Cedar Keys Formation to range from the Late Paleocene to the Early Eocene.

Unconformably overlying the Cedar Keys Formation is the Oldsmar Limestone. The Oldsmar Limestone is presently considered to be Early to Middle Eocene in age (Braunstein et al., 1988).

The Oldsmar consists of dolomite and limestone with gypsum, anhydrite, and chert as minor components (Chen, 1965). In Collier County, the Oldsmar Limestone ranges from about 800 to 1,200 feet thick and thins to the south (Chen, 1965).

The Middle Eocene Avon Park Formation consists of fossiliferous limestone and dolomite with carbonaceous material as thin seams, flecks and blebs along with minor quantities of gypsum (Chen, 1965). Miller (1986) combined the Avon Park and Lake City Limestones of previous usage into the Avon Park Formation in order to more accurately reflect the absence of lithologic characteristics on which to differentiate the two units and to reflect the presence of considerable quantities of dolomite. Miller's (1986) usage of the Avon Park Formation has been adopted by the Florida Geological Survey. The thickness of the Avon Park Formation in Collier County ranges from about 800 to 1,700 feet (Chen, 1965). The top of the Avon Park has been encountered at depths of approximately 1,200 feet below MSL in the northern part of the county and at depths of at least 1,700 feet below MSL in the west-central portion of the county (C. S. Chen, 1963, unpublished lithologic logs W-5, W-1885, W-2420).

The Late Eocene Ocala Group consists of three formations. In ascending order these are the Inglis, Williston and Crystal River Formations (Puri, 1957). For the purposes of this report, the formations of the Ocala Group will not be differentiated. In Collier County, the Ocala Group consists of highly fossiliferous limestone with only minor quantities of dolomite. The top of the Ocala Group is at depths of 1,000 to 1,350 feet below MSL

(Peacock, 1983), and varies in thickness from about 300 to more than 400 feet (Chen, 1965).

The Oligocene-age Suwannee Limestone consists of white or beige recrystallized limestone (calcarenite and calcilutite) containing abundant microfossils, quartz sand and trace amounts of phosphate. The upper portion of the Suwannee contains up to 12 percent quartz sand while the lower portion generally contains less than 3 percent sand (Peacock, 1983). Peacock (1983) shows the top of the Suwannee Limestone at approximately 750 feet below MSL in the north half of coastal Collier County, dipping to depths of more than 900 feet below MSL in the northeastern portion of the county. Peacock (1983) reports that the thickness of the Suwannee Limestone ranges from approximately 100 feet in the northeastern portion of the county to over 600 feet in the coastal areas south of Cape Romano.

The Miocene-age Hawthorn Group unconformably overlies the Suwannee Limestone. Scott (1986, 1988) raised the Hawthorn Formation to Group status and erected new formations within the Group statewide. The Hawthorn Group in Collier County consists of two formations: the Arcadia Formation (Hawthorn carbonate unit and Tampa Limestone of previous usage) and the Peace River Formation (Hawthorn clastic unit of previous usage).

The Arcadia Formation consists primarily of dolomite, dolomitic limestone and limestone that is variably recrystallized, and contains variable amounts of phosphate and quartz sand, and clay (Scott, 1988). Peacock (1983) reports that

the phosphate and quartz sand content ranges from 3 to 25 percent. The base of the Arcadia is a hard dolomite with well developed secondary porosity (Peacock, 1983).

The top of the Arcadia Formation is found at approximately 200 feet below MSL at the extreme northwestern coastal corner of Collier County (Knapp et al., 1986, Scott, 1988). The formation top dips to approximately 450 feet below MSL in the central and southern portions of the county and between 350 and 380 feet below MSL along the eastern edge of the county (Peacock, 1983) (Figures 2-5).

The Peace River Formation of the Hawthorn Group is a predominantly siliciclastic unit which ranges in age from Early Middle Miocene to possibly Early Pliocene (Scott, 1988). The basal portion of the Peace River Formation in Collier County is a green to grey, unconsolidated, phosphatic, quartz and dolomite silt with scattered, very thin limestone beds (Peacock, 1983). The middle portion of the Peace River consists of fine grained, well sorted, slightly phosphatic sand with thin limestone beds and in part a calcilutite matrix (Peacock, 1983). The upper portion consists of poorly sorted, shelly sand and gravel along with occasional thin beds of limestone and dolomitic silt (Peacock, 1983).

The top of the Peace River Formation ranges from near MSL in the north-central portion of the county (Knapp et al., 1986) to over 150 feet below MSL in the vicinity of Cape Romano (Knapp et al.; 1986, Scott, 1988). Through the majority of the central portion of Collier County, the top of the Peace River is between

50 and 100 feet below MSL. The thickness of the Peace River ranges from approximately 125 feet in the northwestern portion of the county and thickens in a southeasterly direction to over 300 feet (Scott, 1988).

The Pliocene-age Tamiami Formation overlies the Hawthorn Group in Collier County. It consists primarily of moldic limestone, sandy limestone and occasionally calcareous sandstone containing small amounts of phosphate sand (Peacock, 1983). Matrix material in the Tamiami is often calcilutite, or where recrystallized, calcite, and induration is variable (Peacock, 1983; Knapp et al., 1986).

The top of the Tamiami Formation is encountered from 0 to 10 feet above MSL throughout Collier County (Knapp et al., 1986) with the exception of the coastal margin of the county where the top of the Tamiami may be as much as 20 feet below MSL (Shier, 1969). The thickness of the Tamiami ranges from zero in the vicinity of Lake Trafford in the northern portion of the county to over 150 feet. Within a north-south band through the center of Collier County, the Tamiami is less than 100 feet thick (Peacock, 1983; Knapp et al., 1986).

Pleistocene and Holocene-age sediments in Collier County consist primarily of quartz sand with minor quantities of clay and shell (Lane, 1981). The Pleistocene and Holocene sands form only a thin veneer where the Tamiami is at or near the ground surface. In the vicinity of Immokalee in the northern portion of the county, the surficial sands are 20 to 40 feet thick (Knapp et

al., 1986). Along the Gulf Coastal Barrier Chain and in the Ten Thousand Islands this unit may exceed 20 feet in thickness.

HYDROLOGY

Two regional aquifer systems are important in Collier County: the surficial aquifer system and the intermediate aquifer system (Southeastern Geological Society, 1986). The Floridan aquifer system, important in much of peninsular Florida, contains nonpotable water (chloride and/or sulfate concentrations above 250 mg/L) in the Collier County region (Knapp et al., 1986) and thus will not be discussed in this report.

Surficial aquifer system

The surficial aquifer system is the most important in Collier County from the viewpoint of public water supply (Knapp et al., 1986). Knapp et al. (1986) subdivided the surficial aquifer system into two units, the "water table" and "lower Tamiami" aquifers, which are separated by a leaky confining unit. The "water table aquifer" is present throughout Collier County and extends from near the land surface to depths of as much as 50 feet (Knapp et al., 1986). The aquifer is composed of sediments assigned to either undifferentiated surficial sands or the Tamiami Formation. Impermeable beds in the Tamiami Formation form the base of the "water table aquifer." The "lower Tamiami aquifer" occupies limestones of the Tamiami as well as coarse siliciclastic materials in the upper portion of the Peace River

Formation. The upper portion of the "lower Tamiami aquifer" (limestones) is generally more permeable than the lower portion (siliciclastics of the Peace River Formation) due to poor sorting of the sands and the presence of calcilutite and silty matrix (Knapp et al., 1986). The top of the "lower Tamiami aquifer" is encountered between MSL and 100 feet below MSL and ranges from 75 to approximately 200 feet thick (Knapp et al., 1986).

Water quality within the surficial aquifer system is generally within potable standards (Knapp et al., 1986). Characteristically it is low in dissolved minerals and low to moderate in hardness. Chlorides reported by Knapp et al. (1986) range from 5-215 mg/L for the "water table aquifer" and 100-500 mg/L for the "lower Tamiami aquifer". Iron content in the "water table aquifer" generally exceeds potable water standards (.3 mg/L) however it is generally lower in the "lower Tamiami aquifer" (Knapp et al., 1986).

Intermediate aquifer system

The intermediate aquifer system is composed of dolosilt, clay and limestone of the Peace River Formation. Knapp et al. (1986) identified two aquifers in the intermediate aquifer system. The "sandstone aquifer" is relatively thin and discontinuous while the "mid-Hawthorn aquifer" underlies all of Collier County (Knapp et al., 1986). The top of the "sandstone aquifer" is encountered between 100 and 250 feet below MSL in Collier County, and is missing from the southern half of the county (Knapp et al., 1986). The "mid-Hawthorn aquifer" is encountered at about 200 feet below MSL in the extreme

northwestern corner of the county and dips to the east and southeast to over 400 feet below MSL. Average thickness is about 100 feet (Knapp et al., 1986).

Water quality within the intermediate aquifer system is variable. Within the "sandstone aquifer" sulfate and hardness are about the same as for the surficial aquifer system, while iron concentrations are lower. Chlorides generally increase to the south and west (Knapp et al., 1986). Water quality within the "mid-Hawthorn aquifer" is generally poor, with high concentrations of sulfate and hardness and moderate to high chloride levels (Knapp et al., 1986).

MINERAL RESOURCES

Crushed stone, oil and gas are the primary mineral resources in Collier County. Quartz sand and peat are also found, but at the present time are not being mined.

Crushed stone is mined from the Pliocene age Tamiami Formation primarily in western Collier County (Knapp et al., 1986). All limestone mining within the county is by the open pit method. Prior to mining, overburden (generally less than 5 feet) is cleared away by bulldozers. The limestone is then fractured either by heavy equipment or blasting. The fractured rock is then extracted by dragline or front-end loader and transported to crushers for processing (Campbell, 1986; Yon et al., 1988). Primary processing and beneficiation operations include crushing and screening to produce the desired size material as well as washing to remove fines and impurities.

The primary uses of the Tamiami Formation limestone in Collier County are road base rock, aggregate for concrete and asphalt, riprap and drain field material. Fines are utilized as filler material in bituminous road surface mixes (Campbell, 1986; Yon et al., 1988).

Oil and gas are produced from eight fields located either entirely or partially within the county. Production is from the Cretaceous-age Sunniland Formation at depths in excess of 11,500 feet below MSL (Applegate and Lloyd, 1985). Cumulative oil and gas production through the end of 1987 for the fields located entirely in Collier County was 31,867,000 barrels of oil and 2,959 million cubic feet of gas (unpublished data, C. Tootle, Florida Geological Survey, 1988). These figures amount to approximately 6 percent of the state wide total production of oil and less than 1 percent of the gas production (unpublished data, C. Tootle, Florida Geological Survey, 1988).

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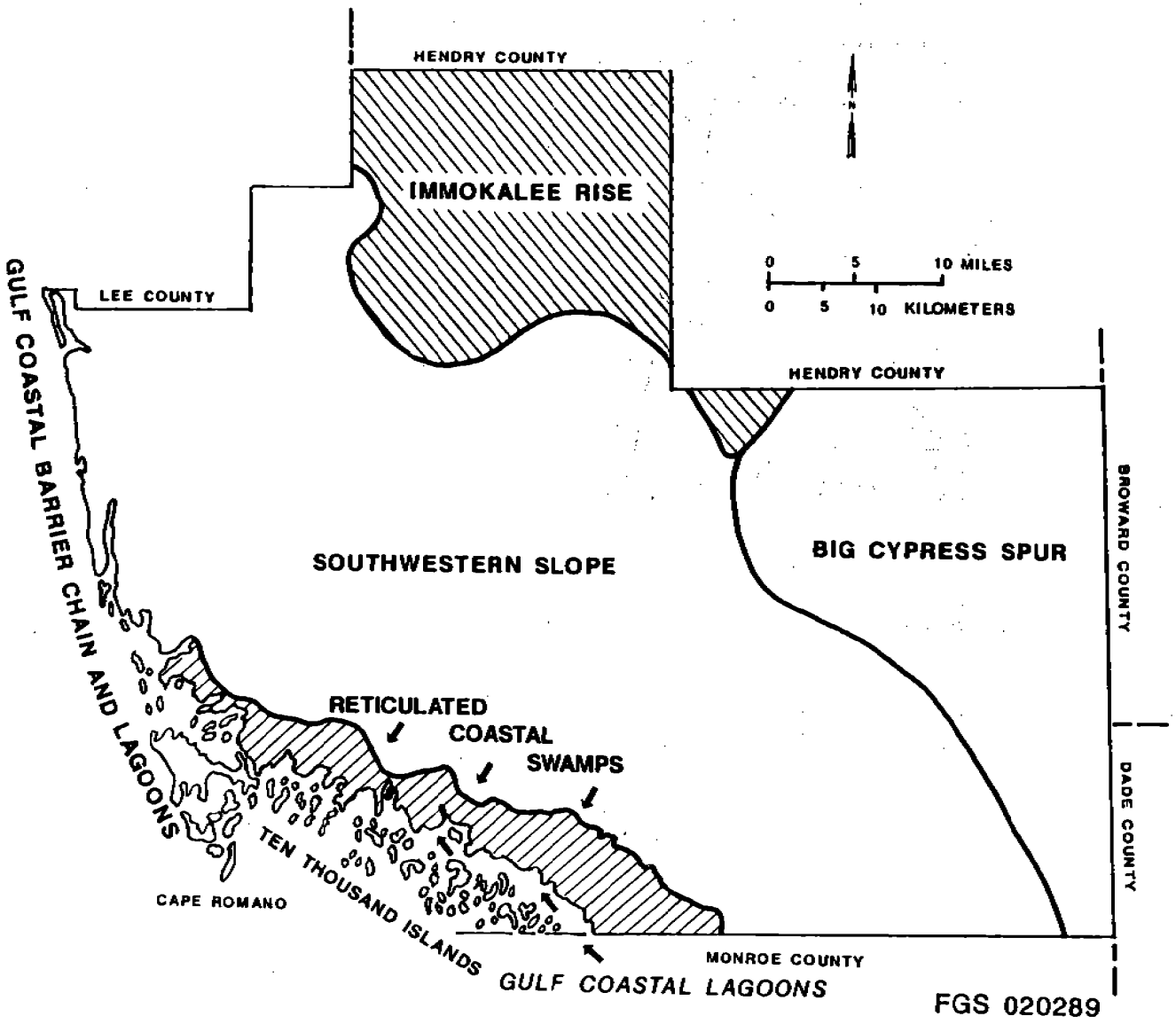
HENDRY COUNTY
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LEE COUNTY
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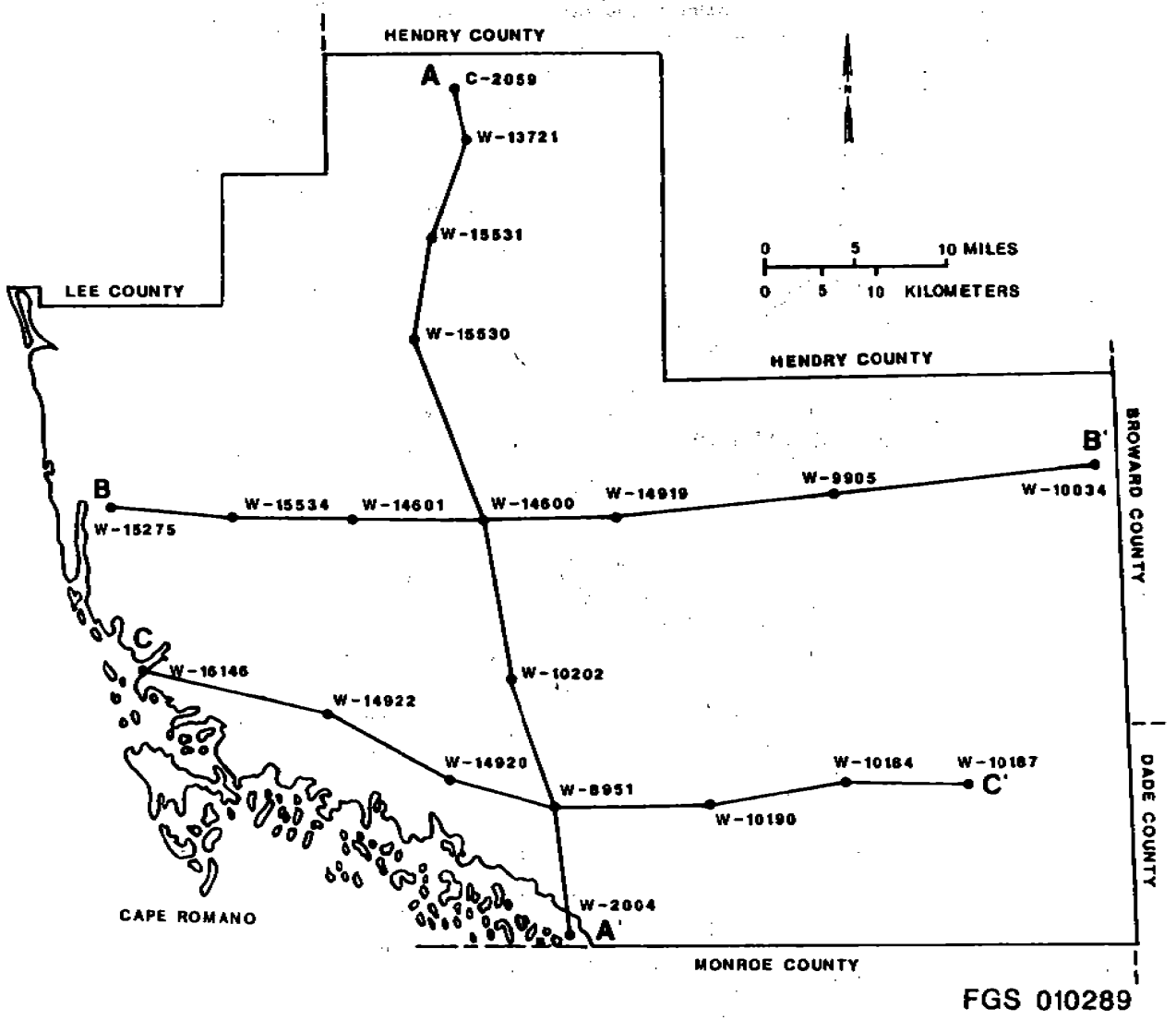
HENDRY COUNTY
BROWARD COUNTY
DADE COUNTY
GULF COASTAL BARRIER CHAIN AND LAGOONS
SOUTHWESTERN SLOPE
BIG CYPRESS SPUR
RETICULATED
COASTAL
SWAMPS
TEN THOUSAND ISLANDS
CAPE ROMANO
MONROE COUNTY
GULF COASTAL LAGOONS
FGS 020289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W-14919
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W-15275
C
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W-14922
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CAPE ROMANO
DADE COUNTY
MONROE COUNTY

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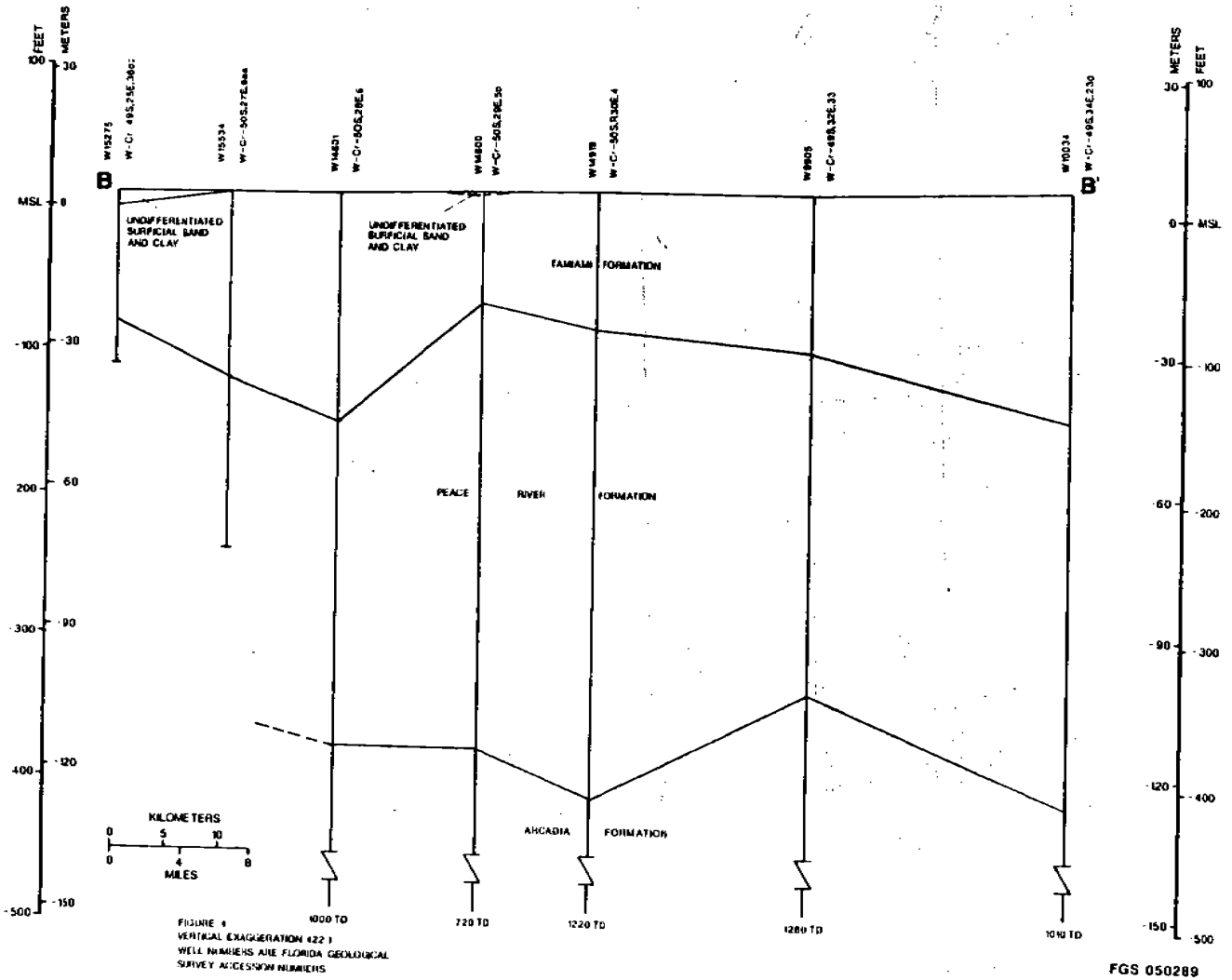

FIGURE 4
VERTICAL EXAGGERATION 42 X
WELL NUMBERS ARE FLORIDA GEOLOGICAL SURVEY ACCESSION NUMBERS

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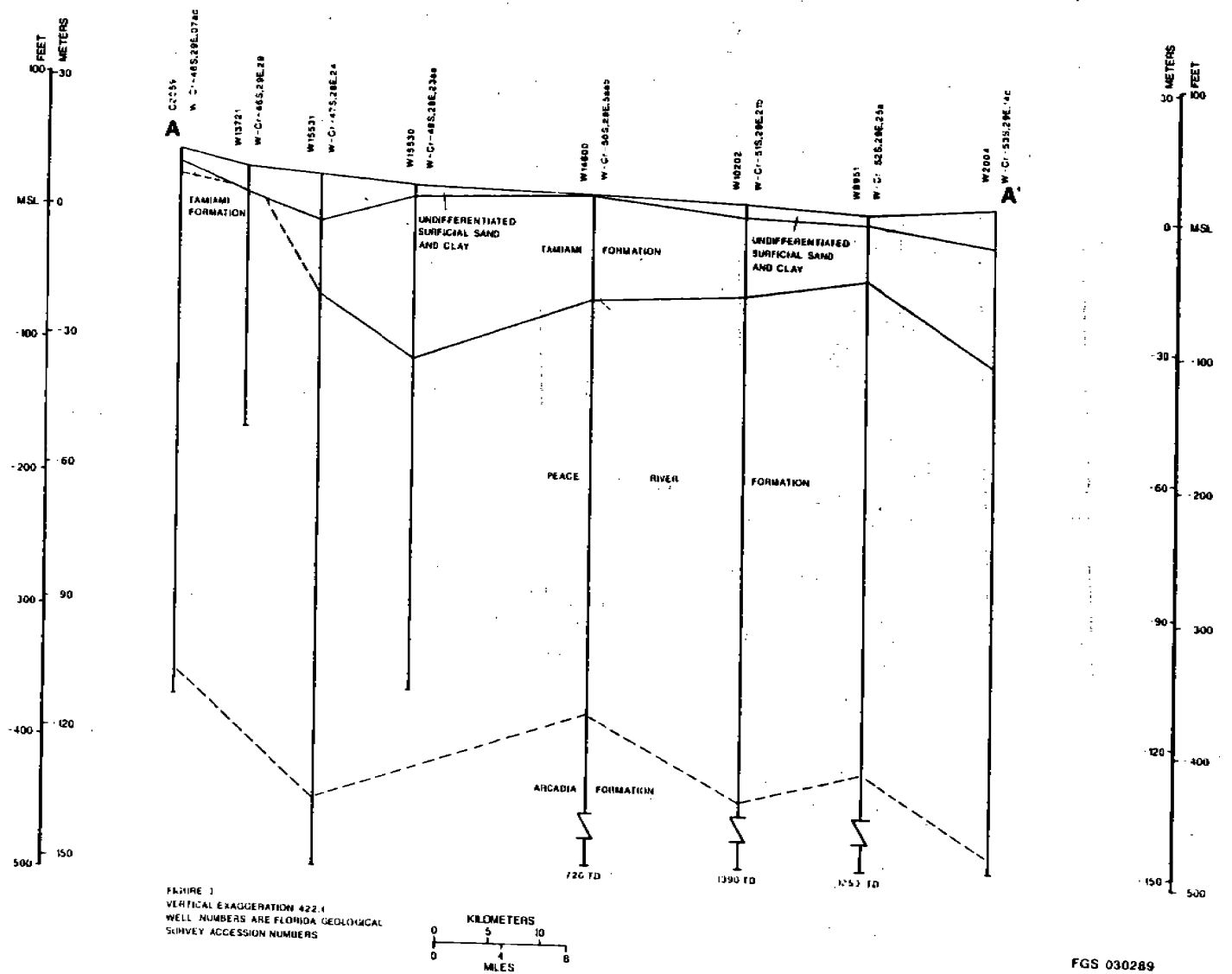

FIGURE 3
VERTICAL EXAGGERATION 422:1
WELL NUMBERS ARE FLORIDA GEOLOGICAL SURVEY ACCESSION NUMBERS

FGS 030289

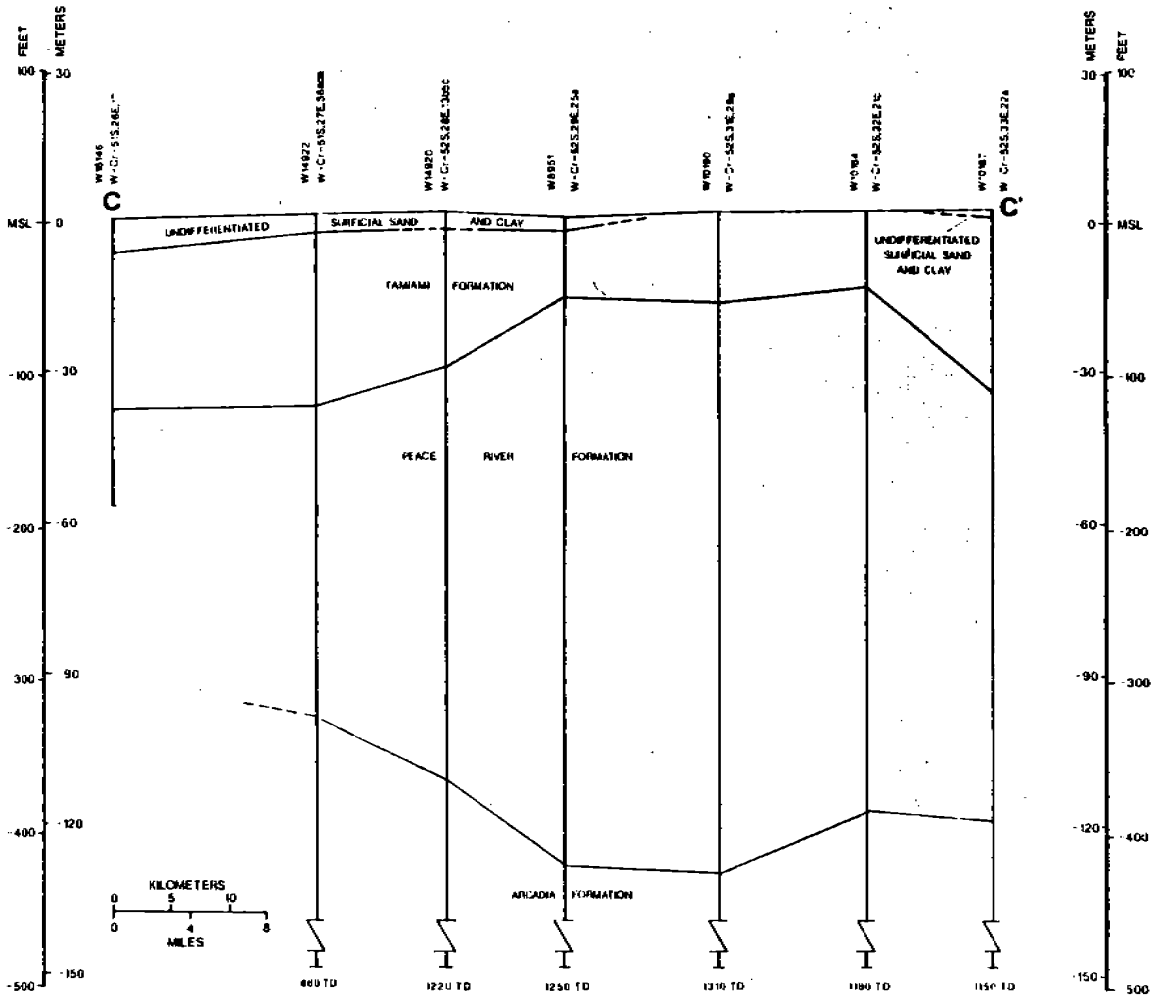

FIGURE 5
VERTICAL EXAGGERATION 42:1
WELL NUMBERS ARE FLORIDA GEOLOGICAL SURVEY ACCESSION NUMBERS

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