U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

85°00'00" 84°00'00" 83°00'00" 82°00'00" 81°00'00" 80°00'00" 79°00'00"

31°00'00" 30°00'00" 29°00'00" 28°00'00" 27°00'00" 26°00'00" 25°00'00" 24°00'00"

APALACHICOLA EMBAYMENT

SOUTHEAST GEORGIA EMBAYMENT

TAMPA BASIN

SOUTH FLORIDA BASIN

APALACHICOLA NF
ST MARKS NWR
OSCEOLA NF
TIMUCUAN ECOLOGICAL AND HISTORICAL PRESERVE
LOWER SUWANEE NWR
OCALA NF
LAKE WOODRUFF NWR
CANAVERAL NS
MERRITT ISLAND NWR
CHASSAHOWITZKA NWR
AVON PARK AF RANGE
BRIGHTON IR
ARTHUR R MARSHALL-LOXAHATCHEE NWR
FLORIDA PANTHER NWR
BIG CYPRESS NATIONAL PRESERVE
EVERGLADES NP
BISCAYNE NP

APALACHICOLA
LIBERTY
GADSEN
LEON
JEFFERSON
WAKULLA
TAYLOR
FRANKLIN
MADISON
LAFAYETTE
DIXIE
GILCHRIST
LEVY
CITRUS
HERNANDO
SUMTER
PASCO
HILLSBOROUGH
PINELLAS
MANATEE
SARASOTA
CHARLOTTE
LEE-COLLIER SWELL
COLLIER
HAMILTON
SUWANNEE
COLUMBIA
BAKER
NASSAU
DUVAL
UNION
BRADFORD
CLAY
ST JOHNS
ALACHUA
PUTNAM
FLAGLER
VOLUSIA
SEMINOLE
ORANGE
LAKE
POLK
OSCEOLA
BREVARD
INDIAN RIVER
ST LUCIE
OKEECHOBEE
HARDEE
HIGHLANDS
DE SOTO
GLADES
MARTIN
PALM BEACH
HENDRY
BROWARD
DADE
MONROE

MIDDLE GROUND ARCH
PENINSULAR ARCH
TAMPA-SARASOTA ARCH
FLORIDA ESCARPMENT
PINE KEY ARCH
LARGO HIGH
CHARLOTTE HIGH
40 MILE BEND
40 MILE BEND HIGH
RACCOON POINT
BAXTER ISLAND
PEPPER HAMMOCK
SUNNILAND
BEAR ISLAND
LAKE TRAFFORD
CORKSCREW
WEST FELDA
MID FELDA
SUNOCO FELDA
LEHIGH PARK
TOWNSEND CANAL

5001
5005

GULF OF MEXICO
Florida Bay
Dry Tortugas
Marquesas Keys

APALACHICOLA RIVER
LOWER CRETACEOUS SHELF EDGE

Lambert Conformal Conical Projection
Units: Meters, Standard Parallels: 33 00 00, 45 00 00
Meridian: -94 00 00, Latitude of Origin: 29 00 00
False Easting: 0, False Northing: 0
Original data accurate at scale of 1:500,000.
Digital base from U.S. Geological Survey.

Manuscript approved for publication July 7, 1995

Map A. Upper Sunniland Tidal Shoal Oil Play (5001) and Extended Upper Sunniland Tidal Shoal Oil Play (5005)

EXPLANATION

- Area of similar hydrocarbon accumulation
- Explored, oil production
- Explored, no production
- Field outline for a reservoir
- Structural uplift
- Shoreline
- County boundary
- Federal lands
- Province boundary

INDEX MAP SHOWING THE FOUR USGS PETROLEUM PROVINCES OF THE GULF COAST, USGS REGION 6

Florida Peninsula Province (50) Province boundaries

SCALE 1: 1 000 000

25 0 25 50 MILES

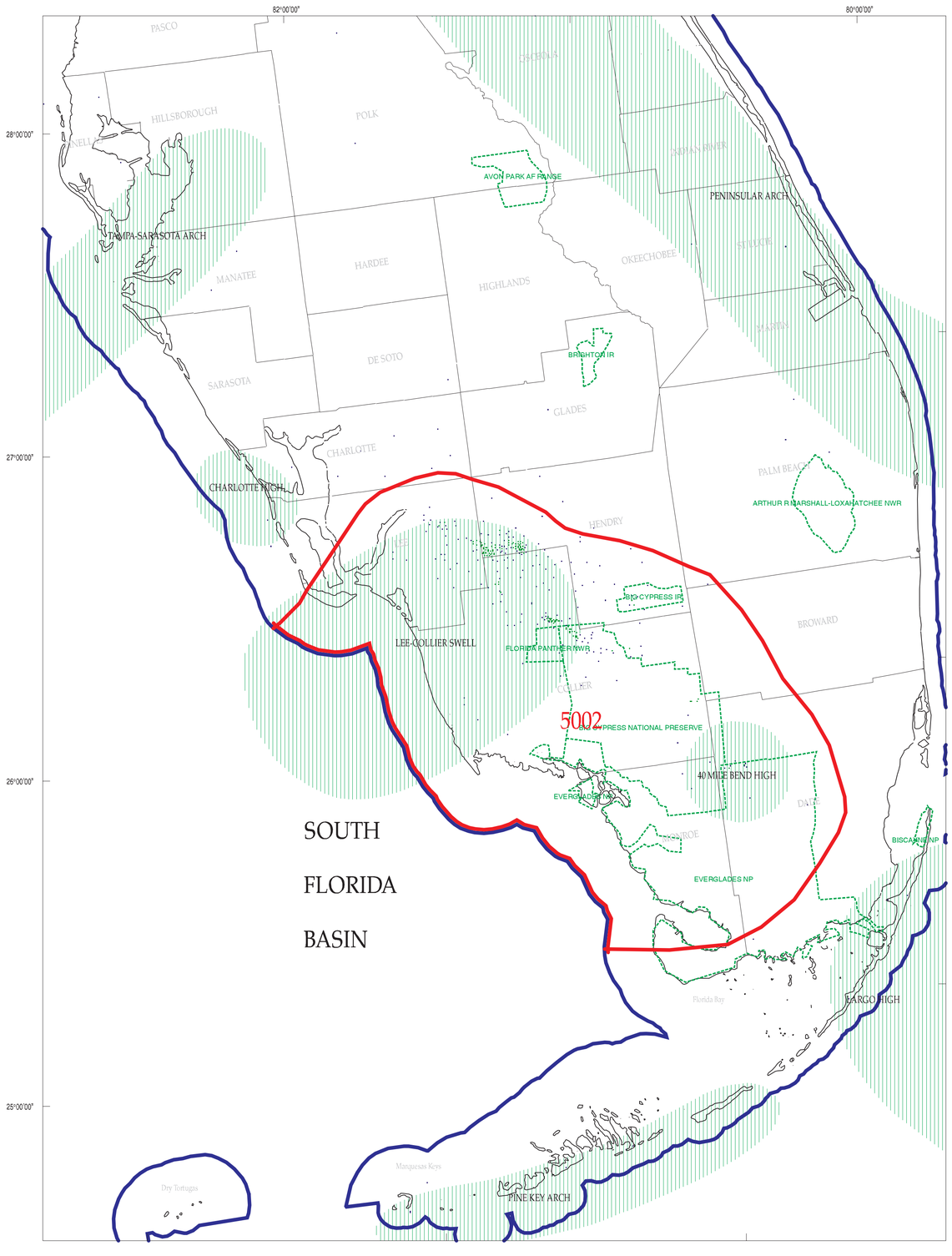
25 0 25 50 KILOMETERS

MAPS SHOWING HYDROCARBON PLAYS OF THE FLORIDA PENINSULA, USGS PETROLEUM PROVINCE 50

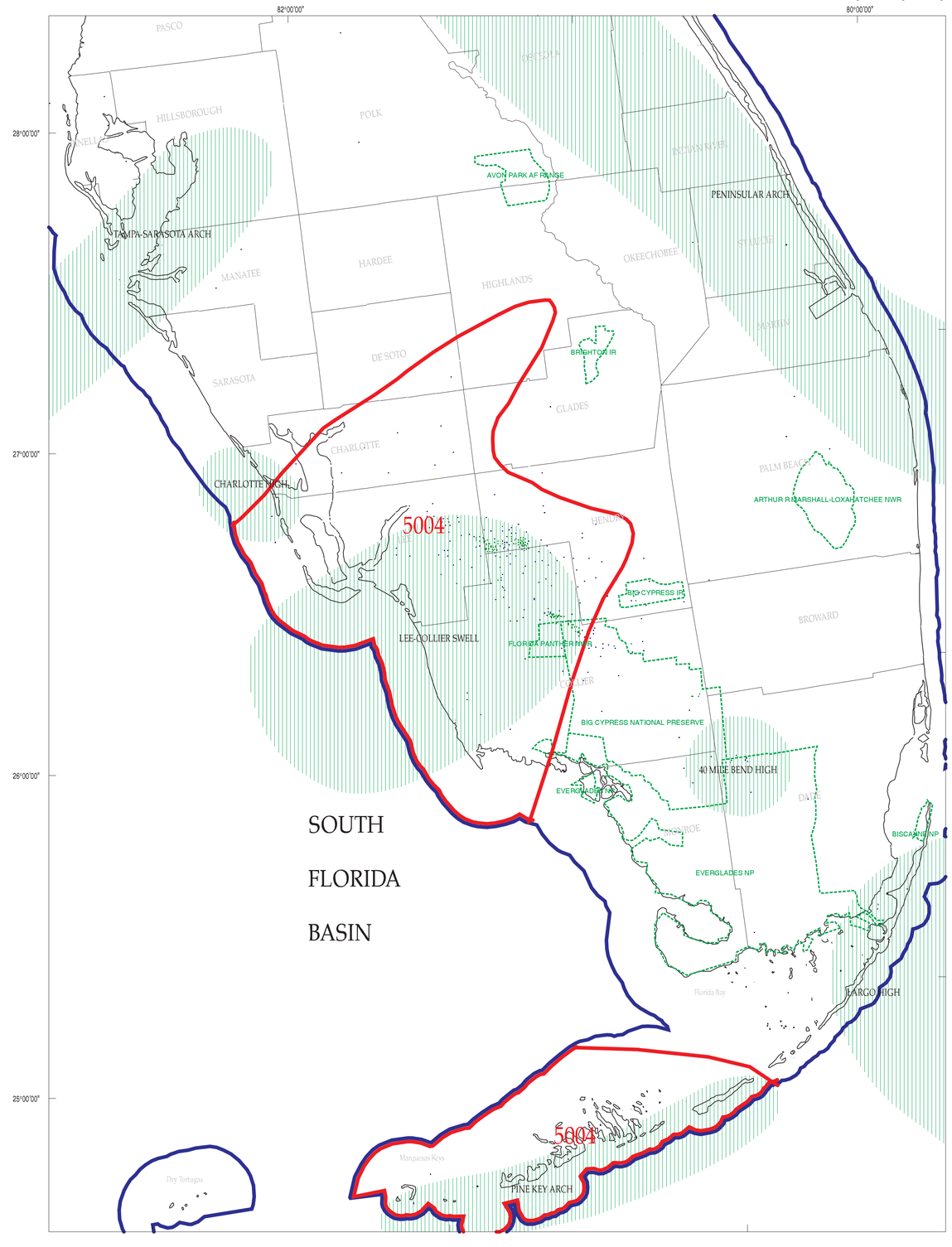
By

Richard M. Pollastro and Roland J. Viger

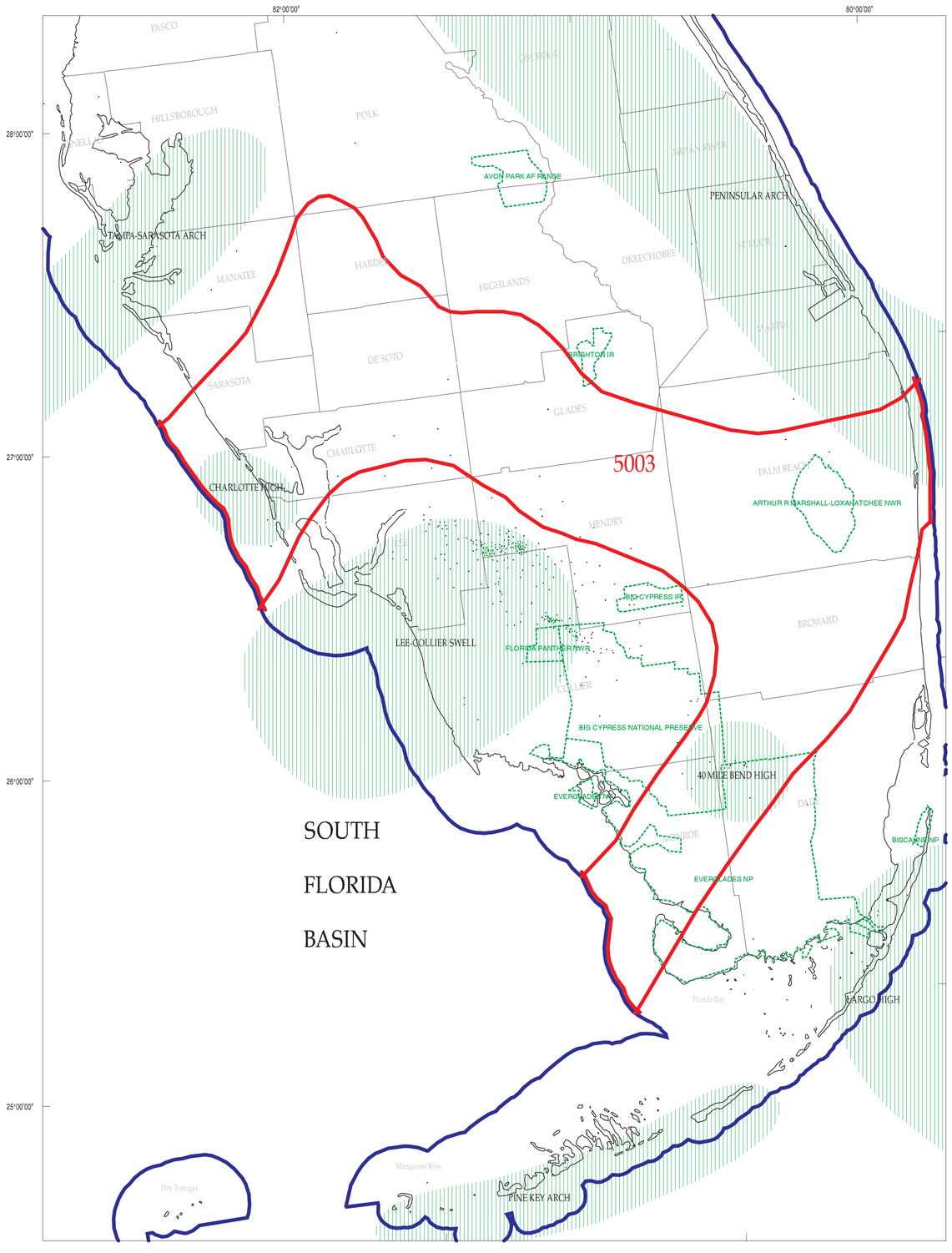
1998



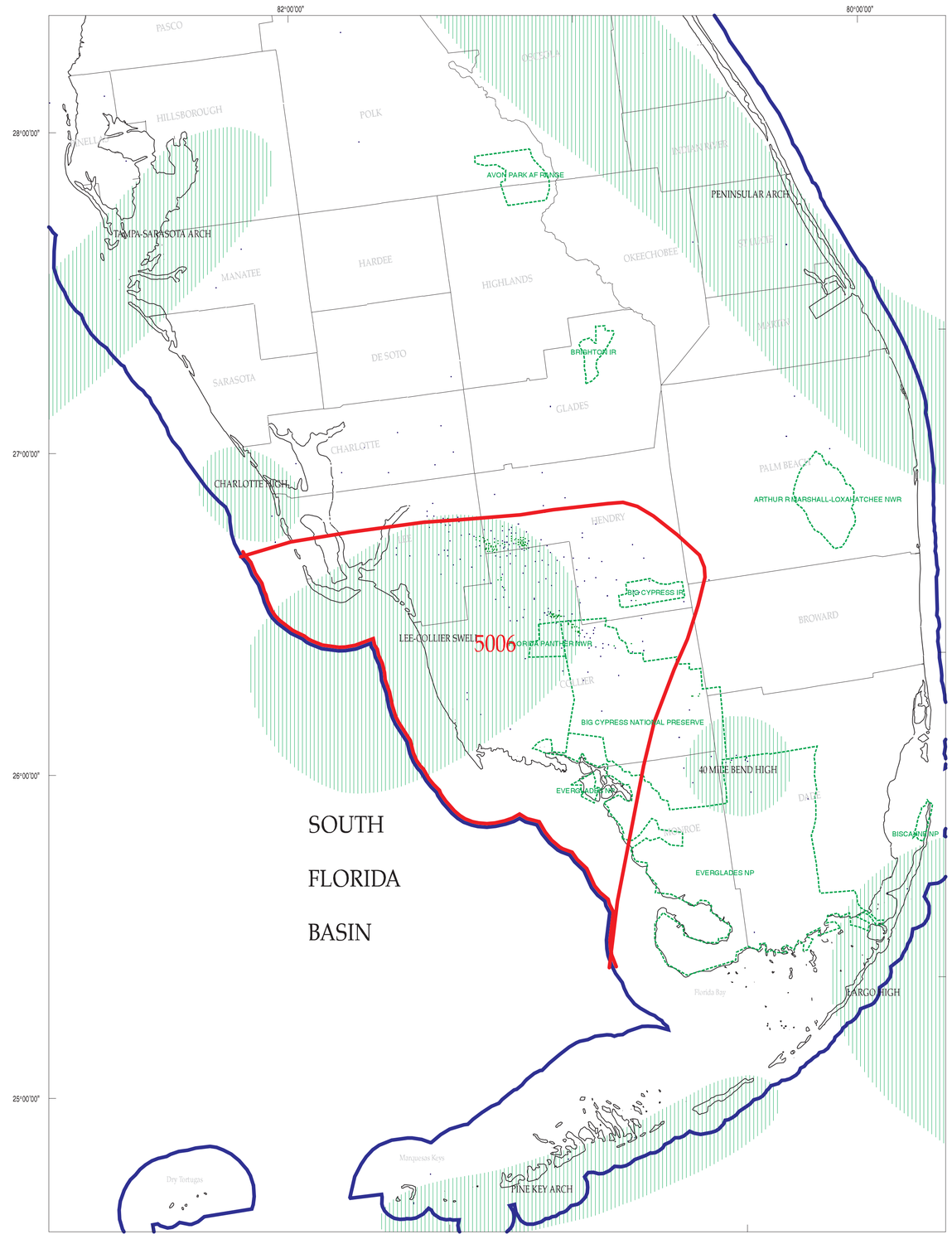
Map B. Lower Sunniland Fractured Dark Carbonate Oil Play (5002)



Map D. Lower Cretaceous Carbonate Composite Oil Play (5004)



Map C. Dollar Bay Shoal-Reef Dolomite Oil Play (5003)



Map E. Wood River Dolomite Deep Gas Play (5006)

Digital data prepared with ARC/INFO 7.0.2 running under DGIUX 5.4R3.10 on a Unix workstation

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OIL AND GAS INVESTIGATIONS
MAP OM–226
PAMPHLET

MAPS SHOWING HYDROCARBON PLAYS OF THE FLORIDA PENINSULA, USGS PETROLEUM PROVINCE 50

By
Richard M. Pollastro and Roland J. Viger

1998

PROVINCE INTRODUCTION AND GEOLOGIC SUMMARY

The Florida Peninsula, USGS petroleum Province 50 as defined by the 1995 USGS National Oil and Gas Assessment (Gautier and others, 1995), includes all of the State of Florida east of the Apalachicola River, and the adjoining State waters; the part of the Florida Panhandle west of the Apalachicola River is part of USGS petroleum Province 49 (Mississippi-Louisiana Salt Basin). The Apalachicola River generally trends north-south, separating Gadsden, Liberty, and Franklin Counties on the east from Jackson, Calhoun, and Gulf Counties on the west. USGS petroleum Province 50 (hereafter referred to as Province 50), inclusive of State waters, is approximately 150 mi wide and about 400 mi long, totaling about 70,000 mi^2. It is bounded to the north by the State boundary with Georgia and to the east, south, and southwest by the boundaries of the Florida State waters. The State water boundaries extend to 3 leagues (10.36 statute miles) on the Gulf of Mexico side of Florida and to 3 mi on the Atlantic Ocean side (the Gulf-Atlantic boundary line runs westward from the Marquesas Keys along latitude 24°35' N. and then turns southward, just west of the Dry Tortugas, along longitude 83° W.).

The most prominent positive structural element within the province is the Peninsular arch, which is a crystalline basement high plunging south-southeast along the axis of the Florida Peninsula (map A). Other smaller positive structural elements generally define the boundaries of the associated South Florida basin, the Apalachicola embayment, and the Southeast Georgia embayment (map A). The South Florida basin is the most prominent of these features and has the greatest petroleum potential.

The South Florida basin is a structurally simple basin containing 25,000 ft or more of sediment in the apparent depocenter that lies northwest of the Florida Keys under present-day Florida Bay. Sedimentation in the South Florida basin kept pace with subsidence, producing nearly continuous carbonate-evaporite deposition from the Jurassic(?) to the present (fig. 1). The South Florida basin covers some 50,000 mi^2 and incorporates the southernmost one-third or more of the peninsula of Florida including the Florida Keys and the easternmost Gulf of Mexico. Onshore, the basin exhibits only subtle structures with no major faults or vertical fractures. However, more complex structural elements are believed to exist in the offshore part of the basin, which, if present, may provide excellent potential for hydrocarbon accumulations. The basin has a generally low (~1.0°F/100 ft) geothermal gradient; however, the gradient of some onshore oil fields may reach 1.5°F/100 ft.

The Southeast Georgia embayment in the northeastern part of the province contains as much as 6,000 ft of sedimentary rock. Because this area contains only shallow, thermally immature sequences and lacks potential petroleum source rocks, its potential for undiscovered petroleum resources is estimated as slight. The Apalachicola embayment in the northwestern part of the province, however, has petroleum potential in the Jurassic Smackover Formation, which produces in the Florida Panhandle in Province 49.

Six conventional hydrocarbon plays are defined for Province 50. These plays were developed for the 1995 USGS National Oil and Gas Assessment (Gautier and others, 1995). Two plays are confirmed: Upper Sunniland Tidal Shoal Oil play (5001) and Lower Sunniland Fractured Dark Carbonate Oil play (5002). The other four are hypothetical: Dollar Bay Shoal-Reef Dolomite Oil play (5003), Lower Cretaceous Carbonate Composite Oil play (5004), Extended Upper Sunniland Tidal Shoal Oil play (5005), and Wood River Dolomite Deep Gas play (5006). The easternmost part of the Smackover Alabama/Florida Updip Oil play (4911) also extends into Province 50 but has been assigned to Province 49; therefore, this play is not shown or defined here.

EXPLORATION CELLS AND FIELD OUTLINES

Each cell on the maps represents 0.25 mi^2 in which exploration has taken place. Cell data from this map were summarized from the December 1993 version of the Well History Control System of Petroleum Information, Inc. of Houston, Texas. Solid green squares indicate explored cells with oil production; solid blue squares indicate explored cells, but no hydrocarbon production. Field outlines were established from a variety of sources including: (1) the exploration cells and (2) well data, structure contour maps, and oil/water contact maps published by the Florida Geological Survey (Lloyd, 1991).

PLAY DESCRIPTIONS

MAP A. UPPER SUNNILAND TIDAL SHOAL OIL PLAY (5001)

Known only in the subsurface, the Lower Cretaceous Sunniland Formation is the basal unit of the Ocean Reef Group (fig. 1). Onshore, the formation is relatively uniform in thickness and consists of limestone, dolomite, and anhydrite. The upper part of the Sunniland Formation produces heavy, marginally-mature crude oils onshore from porous bioclastic debris mounds, banks, and pods on the eastern margin of the South Florida basin. The region of productive reservoir facies of the upper Sunniland Formation is defined in part by eight fields that have produced more than one million barrels of oil (MMBO) and five smaller fields; most of the smaller fields are abandoned or shut in. Combined, these fields form an arcuate northwest-southeast trend, the "Sunniland trend," which is about 20 mi wide and 150 mi long. Generally, the updip limit of the Sunniland varies from about 50 to 60 mi northeast of the producing trend. The first upper Sunniland oil field discovery was the Sunniland field in 1943; the largest is the West Felda field, discovered in 1966, with total production through July 1993 of over 44 MMBO. Cumulative production for all upper Sunniland Formation reservoirs through July 1993 was about 100 MMBO.

The northern and updip play boundary for the Upper Sunniland Tidal Shoal Oil play (5001) is defined here by an area in which the upper Sunniland consists of only micritic limestone and contains no reservoir mounds within its intertidal, lagoonal-mudflat facies. Moreover, the lower part of the Sunniland dark carbonate source rocks is also absent. The downdip southern boundary of the play is limited by an area where wells identify an anhydrite-cemented, nonporous, sabkha-like facies.

The existing reservoir facies in the upper Sunniland Formation consist mostly of isolated fossil-shell hash (skeletal grainstones). These bioclastic buildups represent probable storm deposition as shoals in a regionally restricted, back-reef lagoonal area in the warm, shallow marine shelf setting of the eastern South Florida basin during the late Early Cretaceous (Mitchell-Tapping, 1984, 1987). These tidal shoals were deposited on subtle bathymetric highs probably related to underlying basement structure. Later, the upper parts of these porous shoal mounds were subaerially exposed, leached, and dolomitized during a low sea-level stand, further enhancing the reservoir quality of the upper porous zones. Individual debris mounds vary in thickness between about 40 and 100 ft (Means, 1977; Montgomery, 1987). Depth to the upper Sunniland tidal shoal reservoirs in the producing trend is from about 11,200 to 11,600 ft. Most mounds are sealed by overlying impermeable lagoonal mudstones and wackestones, some of which have been dolomitized. Porosities of primary (interparticle) and secondary (dissolution and dolomitization) origin range from 10 to 25 percent and average 15–18 percent (Mitchell-Tapping, 1984, 1987). Impermeable micritic carbonate and nodular anhydrite beds within the upper Sunniland enclose and seal many of the individual porous reservoir mounds. Moreover, the entire Sunniland Formation is sealed above and below by thick anhydrite units (fig. 1). Most hydrocarbon traps are stratigraphic; however, some mixed stratigraphic/structural traps have been recognized.

Oils produced from the upper Sunniland grainstones are immature, having API gravities that range from about 21° to 28° and average 25°–26°; on average, the gas-to-oil ratio (GOR) is about 85 (Palacas, 1984; Palacas and others, 1984; Tootle, 1991). The source rocks are a dark, micritic carbonate unit (informally referred to as the dark carbonate interval) in the lower part of the Sunniland Formation. These micritic carbonates are commonly algal laminated and have total organic carbon (TOC) ranging from <0.4 to 3.0 weight percent. Potential source rocks (as identified by >0.4 weight percent TOC) average 1.8 weight percent TOC. Greater than 80 percent of the organic matter within these source rocks is composed of algal-amorphous (oil-prone) kerogen (Palacas and others, 1984). The hydrocarbon-generating potential of the lower Sunniland dark carbonate facies ranges from poor in wells updip from the producing trend to good just downdip to excellent near the depocenter of

the basin (Applegate and Pontigo, 1984). Onshore, the dark carbonate facies varies in thickness from zero at the updip limit of the Sunniland to >150 ft in the producing trend. Oil produced from reservoirs in the Sunniland trend was probably generated downdip where the organic matter in the dark carbonate facies is richer and more mature. The petroleum then migrated updip and accumulated in the porous grainstone facies of the upper Sunniland (Palacas and others, 1984).

Exploration and development of the upper Sunniland Formation has been minimal based on the drilling history and well distribution within the play area, which is shown by the limited number of explored cells on the maps. The eight upper Sunniland fields containing >1 MMBO are Bear Island, Corkscrew, West Felda, Lehigh Park, Mid-Felda, Raccoon Point, Sunniland, and Sunoco-Felda (see map A for outlines and locations). At least three of these eight fields are located in the Big Cypress Swamp drainage and (or) National Reserve, an area of critical environmental concern (Lloyd, 1991). Factors such as environmental and political concerns and the present oil prices probably have discouraged full resource development. Minimal exploration and development of petroleum resources because of these factors, coupled with the success of wells drilled in the past few decades, indicate that the Upper Sunniland Tidal Shoal Oil play has good potential for undiscovered oil accumulations of moderate size.

MAP A. EXTENDED UPPER SUNNILAND TIDAL SHOAL OIL PLAY (5005)

This hypothetical play is an extension to the east and south of the productive Sunniland trend in the Upper Sunniland Tidal Shoal Oil play (5001). Thus, reservoirs and source rocks are the same as those for play 5001. Shown on map A, this play forms a southwest-to-northeast arcuate trend approximately 20 mi wide and 250 mi long from the State waters of the Dry Tortugas northeast through the Florida Keys and along the southeastern Atlantic Coast of the Florida Peninsula to Broward County. Bioclastic mounds of smaller size than those in currently productive units from the upper part of the Sunniland Formation accumulated on subtle structural highs in this updip, less thermally mature area of the basin to the east and far south. Prominent positive structural elements include the Pine Key arch and the Largo high. Some heavy oil shows having low API gravity (10°–14°) have been reported in wells in the northern part of the play area; however, 22° API gravity oil was reported in shows from wells near the Marquesas Keys in the west and southernmost part of the play area (Faulkner and Applegate, 1986; Lloyd, 1991).

The Extended Upper Sunniland Tidal Shoal Oil play (5005) is delineated by an area of suspected porous tidal-shoal facies forming on topographic/bathymetric highs. The dark carbonate source unit in the lower part of the Sunniland Formation thins toward the east and south margins of the basin south of the play area, making it less favorable than the proven Upper Sunniland Tidal Shoal Oil play (5001). The Sunniland in this area is also less thermally mature than in play 5001. The eastern and southern Atlantic coastal boundaries of the play are determined by the 3-mi line, and the northern, Gulf of Mexico boundary by the 3-league (10.36 mi) Florida State waters boundary.

MAP B. LOWER SUNNILAND FRACTURED DARK CARBONATE OIL PLAY (5002)

The Lower Sunniland Fractured Dark Carbonate Oil play is based solely on the discovery of the Lake Trafford field in Collier County. The Lake Trafford field (shown on map A) is represented on maps A–E by one productive cell. The dark carbonate unit of the lower part of the Sunniland Formation is believed to contain the primary source beds for oils produced in the tidal shoal grainstones of the upper part of the Sunniland Formation (plays 5001 and 5005). Although no oil accumulations are proven of minimum (>1 MMBO) size, the one discovery well (Mobil Oil Corporation) defining the Lake Trafford field has produced commercial quantities of oil since its discovery in March 1969, from fractured limestone at a depth of about 11,800 ft. The producing zone is commonly referred to as the rubble zone of the dark carbonate unit in the lower Sunniland Formation (Means, 1977). The matrix porosity of the producing zone, as measured by well logs, is about 9 volume percent, and the pore space is oil saturated. Core of the rubble zone from the discovery well has been described as burrowed, fractured, and stylolitized (Lloyd, 1991); these characteristics are thought to be responsible for enhancing the porosity and permeability for commercial production. In March 1988, the discovery well was shut in after oil production totaled about 278,000 barrels. Two offset vertical wells, located to the northwest and south of the producing well, and a recent horizontal test well were dry holes. Based on the production history of the one vertical well, horizontal wells penetrating the rubble zone of the dark carbonate unit could potentially produce a few hundred barrels of oil per day (BOPD). Owner/operator

Brian Richter (oral commun., 1994) reports that the horizontal test missed the targeted pay zone.

The play boundary is defined by thickness (>60 ft) of the dark carbonate unit, as partly determined from cross sections and isopachs (Applegate and Pontigo, 1984), and from offshore well summaries of Lloyd (1991). In addition to thickness, the area defined for the Lower Sunniland Fractured Dark Carbonate Oil play was further delineated from reference wells having a combination of good source-rock qualities and evidence of either the rubble zone or some fracturing present (Montgomery, 1987). This play is assigned fair potential for undiscovered oil resources. The most favorable part of the play is in an area northwest of the Lake Trafford field. Expected depths of production within the play area are estimated between 10,000 and 13,000 ft, with a median depth of about 11,800 ft. Potentially productive fractured reservoirs are within the lower dark carbonate zone of the lower Sunniland and are enclosed by impermeable, micritic, tidal flat, lime mudstones. The unit is sealed below by the Punta Gorda Anhydrite.

Indigenous hydrocarbons are produced from brown and medium-dark-gray micritic and argillaceous limestones with total carbonate content averaging 76 weight percent, and ranging from 50 to 98 weight percent. These micritic carbonates are commonly algal laminated and have TOC ranging from <0.4 to 3.0 weight percent. Potential source beds (>0.4 weight percent TOC) within the unit average about 1.8 weight percent TOC. Oil produced from the one well at the Lake Trafford field has an API gravity of about 26°, similar to the oil in the upper Sunniland producers (API gravities ranging from 21° to 28°). Inasmuch as oils in the upper Sunniland are derived from sources in the lower dark carbonate, the similarity in API gravities is expected. Similarly, lower Sunniland oils are expected to have a GOR range of that of upper Sunniland oils from about 80 to 100.

MAP C. DOLLAR BAY SHOAL-REEF DOLOMITE OIL PLAY (5003)

The hypothetical Dollar Bay Shoal-Reef Dolomite Oil play is based on (1) interpretations of well-log data from a series of onshore wells reporting numerous shows (Winston, 1971) and (2) the paleoenvironmental reconstructions of Winston (1971) and Mitchell-Tapping (1990) of the reservoir tidal shoal and patch reef facies; the data of Faulkner and Applegate (1986) were also used in the definition of this play.

The youngest formation in the onshore portion of the South Florida basin that shows characteristics favorable for petroleum generation and accumulation is the Lower Cretaceous Dollar Bay Formation, the uppermost unit of the Big Cypress Group (fig. 1). The unit lies about 1,500 ft or more above the Sunniland Formation and is as much as 620 ft thick in some parts of the basin. Onshore, the unit ranges in thickness from about 475 to 550 ft. Many wells penetrating the Dollar Bay Formation in south Florida have reported low-gravity (~17° API) oil shows or tarry residues in both limestone biohermal deposits and an upper dolomite section; however, no commercial production has occurred from this play. Like the Sunniland Formation, the Dollar Bay commonly consists of evaporite-carbonate cycles of anhydrites, dolomites, and limestones. These evaporite-carbonate beds formed during a transgressive-regressive cycle; some thin beds of calcareous shale, salt, and lignite are also present (Applin and Applin, 1965; Mitchell-Tapping, 1990). In certain areas of the basin, however, limestone is the predominant lithology of the formation. Speculative production in the Dollar Bay Formation will be from leached limestones in the middle part of the formation, or from a dolomite section in the upper part.

Reservoirs are believed by Mitchell-Tapping (1990) to exist in tidal shoal deposits and patch reefs in a tidal flat, lagoonal, restricted-marine setting, and in a subtidal platform, open-marine setting. Potential reservoirs include (1) porous, leached, and dolomitized grainstones in the upper parts of isolated debris mounds, (2) isolated patch reefs in the middle part of the Dollar Bay Formation, and (3) a porous dolomite in the upper part (Mitchell-Tapping, 1990). These potential reservoirs have measured porosities ranging from about 10 to 30 percent and permeabilities on the order of 5–60 millidarcies (mD). Traps are created because these reservoirs are draped with impermeable, micritic, tidal flat deposits, and in some cases argillaceous lime mudstones and anhydrite. The formation is underlain by thick, dense, nodular and nodular-mosaic anhydrites of the Gordon Pass Formation.

Oil and tarry residues recorded in Dollar Bay wells are believed to originate within the formation (Palacas, 1978a, b; Winston, 1971). The organic-matter content of the Dollar Bay Formation ranges from very lean to fairly rich, with some beds containing more than 3 weight percent TOC; the average TOC of the Dollar Bay is about 0.6 weight percent (Palacas, 1978a, b). Most petroleum explorationists infer that the Dollar Bay Formation located updip and to the northeast of the Sunniland trend is thermally immature and has probably not generated hydrocarbons of commercial quality and quantity (Montgomery,

1987). Others strongly disagree, however, and predict that the Dollar Bay Formation has been overlooked and should be a considered a primary oil target with good potential (Winston, 1971; Palacas, 1978a, b; Mitchell-Tapping, 1990).

Offshore, in the more central part of the basin where the Dollar Bay lies at depths >10,000 ft, the formation should be more thermally mature. Based on one major show, which consisted of 15 ft of free oil, API gravity measured 17° at a depth of about 10,000 ft . Thus, API gravities of oil from this play are expected to be low, probably ranging from 15° to 20° (Mitchell-Tapping, 1990). Sulfur contents are similar to those of Sunniland-type oils (2–4 percent). Moreover, the inferred presence of patch reefs and more complex structures in the Federal offshore, and increased thermal maturity for the Dollar Bay in the offshore part of the basin, enhances the potential for new field discoveries and commercial oil production.

MAP D. LOWER CRETACEOUS CARBONATE COMPOSITE OIL PLAY (5004)

The hypothetical Lower Cretaceous Carbonate Composite Oil play comprises two units in the South Florida basin: the brown dolomite zone of the Twelve Mile Member of the Lehigh Acres Formation, and a potentially porous dolomite unit within the underlying Pumpkin Bay Formation (fig. 1). Both units in this play are believed to contain oil derived mainly from organic-rich beds in the upper part of the Pumpkin Bay Formation.

The extent of the play is delineated by two separate areas: one centered in Lee County and intersecting the Sunniland trend, and the other centered near the Marquesas Keys. The northern area (Lee County and vicinity) includes the area outlined by Applegate (1987) of the porous brown dolomite and the area within the Pumpkin Bay Formation shown to contain live oil in porous dolomite (6–16 percent porosity). The section is the thickest (as much as 1,200 ft thick) in these areas, as measured from reference wells in State waters near Charlotte Harbor and onshore in Collier and Hendry Counties, and has good to excellent source-rock potential from geochemical and thermal maturity measurements (Means, 1977; Applegate and others, 1981; Palacas and others, 1981; Attilio and Blake, 1983; Faulkner and Applegate, 1986; Applegate, 1987; Montgomery, 1987). The northern segment also corresponds to an area of brown dolomite where high porosity is caused by epigenic dolomitization from an active geothermal lineament system (Saul, 1987). Several oil shows are reported in thick, porous dolomite sections in the southern segment of the play area (Faulkner and Applegate, 1986; Lloyd, 1991).

The informally named brown dolomite zone refers to a dolomite unit commonly found within the Twelve Mile Member of the Lower Cretaceous Lehigh Acres Formation (Aptian). The brown dolomite lies about 300 ft below the base of the Punta Gorda Anhydrite and about 1,000 ft below the Sunniland Formation (fig. 1). The unit is best developed where thickest (~100 ft) and most porous (10–22 percent) onshore in Charlotte County and surrounding counties at a depth of about 12,000 ft . Good oil shows are reported, and because it is about 1,000 ft lower in the stratigraphic section than the Sunniland Formation, oils from the brown dolomite are predicted to have higher API gravity (20°–50°?) and thermal maturity than Sunniland oils.

Reservoir rocks consist of sucrosic dolomite and exhibit pinpoint to vuggy porosity in beds found at least 50 ft below the top of the Twelve Mile Member of the Lehigh Acres Formation. As much as 50 ft of porous dolomite has been found onshore where the brown dolomite zone reaches a maximum thickness of about 100 ft. An area having highest potential onshore is defined mostly by the porous zones shown by Applegate (1987) in Charlotte, Lee, Hendry, Collier, Highlands, and Glades Counties and adjacent State waters. Good oil shows were observed in the Bass Collier 12-2 well in Collier County in dolomite having sonic well-log porosities ranging from 10 to 22 percent and core porosities as high as 18 volume percent. Good potential is also predicted offshore in both State and Federal waters. In particular, oil stains were noted in wells where about 350 ft of mostly porous dolomite has been penetrated near the Marquesas Keys (Faulkner and Applegate, 1986; Lloyd, 1991).

The thickest and deepest interval in the South Florida basin with significant reservoir potential is the Lower Cretaceous Pumpkin Bay Formation. The formation is mostly limestone except at its northern limit, where it has been found to be mostly dolomite. Within Province 50, the Pumpkin Bay is as thick as 1,200 ft in offshore Florida State waters of Charlotte Harbor; the formation is projected to thicken westward in the Federal offshore and into the basin depocenter (Faulkner and Applegate, 1986). Onshore, the Pumpkin Bay Formation is found at depths from about 12,500 to 14,000 ft. Core porosities for the Pumpkin Bay are as high as about 20 percent, and its sonic well-log porosities measure slightly higher. Porosities are generally lower in the Pumpkin Bay Formation than in potential reservoirs found in younger units. Generally, the best potential for the Pumpkin Bay Formation is

predicted in the Pulley Ridge area of Federal offshore waters in the Gulf of Mexico (Faulkner and Applegate, 1986). Projections suggest that the formation is as much as 1,500 ft thick in this area and that good reservoirs exist within a thick porous dolomite zone (300–350 ft thick; pinpoint to vuggy porosity as great as 25 percent) in the middle to upper part of the formation, at depths from about 12,500 to >15,000 ft.

Source-rock studies by Palacas and others (1981) suggest that organic rich beds in the upper Pumpkin Bay Formation are likely source rocks for oils that could be reservoired both within the middle and upper part of the Pumpkin Bay and in the porous brown dolomite zone. Palacas and others (1981) identified organic-rich, argillaceous carbonate beds with high (0.43–3.2 weight percent) TOC in the upper Pumpkin Bay and concluded that these beds had the greatest petroleum-generating potential of all rocks older than the Punta Gorda Anhydrite.

The TOC contents of these rocks, however, varies within the basin. Most rocks within the Twelve Mile Member of the Lehigh Acres Formation contain insufficient organic matter (average ~0.3 percent TOC) to have generated commercial amounts of petroleum. Some richer source beds occur within this unit, however, having marginal (~0.5 percent TOC) to good source potential. Particularly, greater than 2.0 percent TOC is contained in a relatively thin (~1 ft thick) limestone bed in the West Felda field.

The thermal maturation level for oil generation is greater in this play than that for the upper and lower Sunniland plays (5001 and 5002). Thus, oils of this play are expected to be marginally to moderately mature and to have higher API gravities (25°–50°) and higher GOR than Sunniland oils.

MAP E. WOOD RIVER DOLOMITE DEEP GAS PLAY (5006)

In the hypothetical Wood River Dolomite Deep Gas play, the Upper Jurassic(?) and Lower Cretaceous Wood River Formation averages about 1,700 ft thick and is the lowest sedimentary unit in the South Florida basin (fig. 1). The few wells that have penetrated this formation show that a 100- to 150-ft-thick clastic unit forms the basal part of the Wood River Formation and consists of dark-red shale and fine- to coarse-grained arkosic sandstone and calcareous sandstone (Applegate and others, 1981). These basal clastics possibly represent fan, fan-delta, and fluvial-lacustrine or marine deposits. Below the basal clastic sequence in Collier County is a rhyolite porphyry with an age of 189 Ma. Overlying these clastic rocks is a thick sequence of anhydrite, dolomite, and limestone with occasional interbedded salt stringers, indicating marine transgression (Applegate and others, 1981).

One well, the Mobil-Phillips Seminole C in Hendry County, produced measurable gas and water flows at depths of about 15,700 ft from perforations in a dolomite zone averaging about 8 percent porosity. Moreover, logs from the well indicated higher porosities and increased resistivities just above the perforated section, possibly indicating the presence of gas (Applegate and others, 1981; Palacas and others, 1981). Although formation damage occurred in the well bore, this well had potential for commercial gas production (J.G. Palacas, oral commun., 1994) and the occurrence of a potentially commercial well indicates a possible source of deep gas. Marine beds, generally regarded as potential petroleum sources, are predominant, and the depositional environment, especially in the southern areas, probably favored reef growth; thus a source, a seal, and a reservoir should be present.

Organic geochemistry studies of well samples from the Wood River Formation indicate that the hydrocarbon-generating potential of the unit ranges from poor to excellent (Palacas and others, 1981; Faulkner and Applegate, 1986). The scarcity of wells penetrating the Wood River Formation, however, makes any evaluation inconclusive. Potential reservoirs in the Wood River are porous (8 percent or greater) dolomites enclosed by anhydrite, salt stringers, and (or) micritic limestone at depths from about 15,000 to 19,000 ft onshore and in State waters. The play area includes areas of the southern part of the basin where reef growth is favored. It is possible that gas in the Wood River in the area of the Sunniland trend may have originated in deeper parts of the basin and migrated updip, perhaps as a single, large accumulation.

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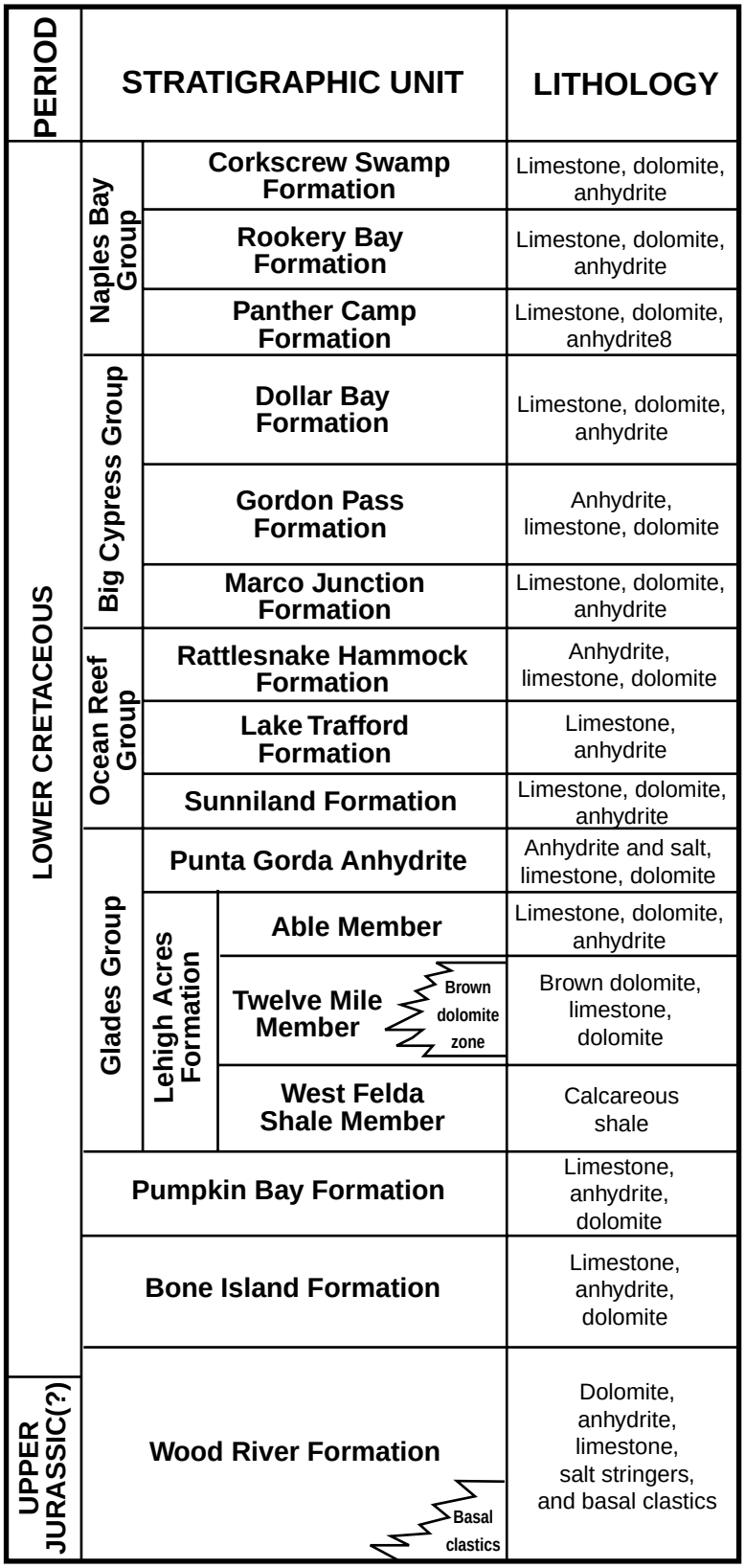

Figure 1. General stratigraphic section for the South Florida Basin [modified from Faulkner and Applegate (1986) and Lloyd (1991)].