

Assessment of Undiscovered Oil and Gas Resources in the South Florida Basin, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean undiscovered, technically recoverable resources of 49 million barrels of oil and 18 billion cubic feet of gas in the onshore and State waters part of the South Florida basin.

Introduction

The U.S. Geological Survey (USGS) recently completed a geology-based assessment of technically recoverable continuous (unconventional) and conventional resources in the South Florida basin (fig. 1). The South Florida basin is located on the Florida platform, a carbonate platform that can be more than 350 miles wide (Hine and others, 2001; Scott, 2001). The basin has a maximum sediment thickness of 15,000–17,000 feet (ft) and a center that is located offshore, west of the southwest coast of the peninsula (Pressler, 1947; Halley, 1985). The onshore part of the South Florida basin, an emergent segment of the Florida platform, and the Florida State waters represent about half of the entire basin area (Applegate and Pontigo, 1984).

During the Middle Jurassic through to about the middle Oligocene, shallow-water marine deposition was dominant in the South Florida basin, and sequences of carbonate and evaporite rocks were deposited in water typically less than 300 ft deep (Halley, 1985; Scott, 2001). Organic-rich carbonate mud also accumulated during the intermittent occurrence of salinity-stratified interior lagoons (Halley, 1985).

At least two geochemically distinct composite total petroleum systems are recognized in the South Florida basin that are separated by the wedge-like, regionally persistent Punta Gorda Anhydrite of the Glades Group (fig. 2); this anhydrite unit varies in thickness from 200 to 2,100 ft (Applin and Applin, 1965). The rocks underlying the Punta Gorda Anhydrite are Upper Jurassic(?)–Lower Cretaceous and consist of the Wood River, Bone Island, and Pumpkin Bay Formations, as well as the Lehigh Acres Formation of the Glades Group (fig. 2). The Upper Jurassic(?) Wood River Formation consists of carbonate-rich deposits; however, the basal 100–150 ft of the formation contains approximately 100 ft of shale and arkosic sandstone (Braunstein and others, 1988; Pollastro and others, 2001). The overlying Lower Cretaceous Bone Island and Pumpkin Bay

Formations are carbonate and evaporite strata with variable porosity (Pollastro and others, 2001). The Lehigh Acres Formation overlies these formations and is divided from oldest to youngest into the West Felda Shale, Twelve Mile, and Able Members. The West Felda Shale Member is a

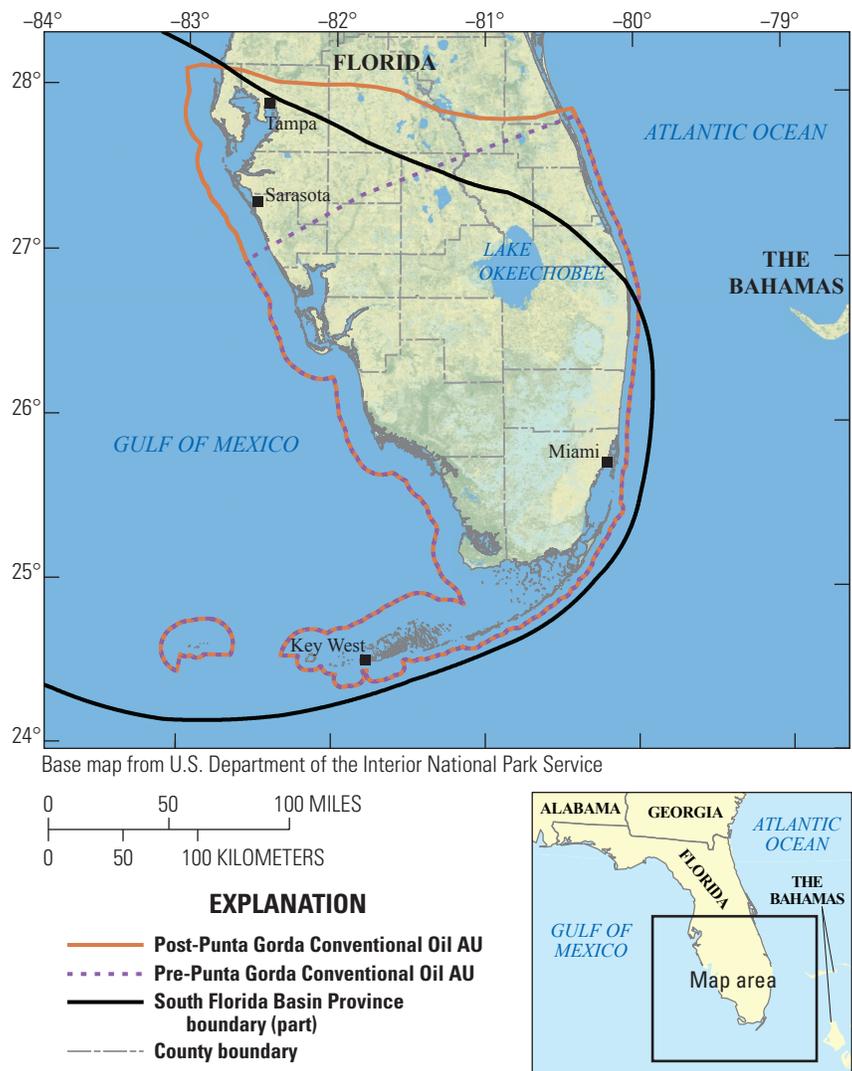


Figure 1. Map of the South Florida basin, showing the assessment unit (AU) boundaries for the conventional oil AUs.

regionally persistent calcareous shale that is typically less than 100 ft thick in the South Florida basin (Applegate and others, 1981). The Twelve Mile Member is a skeletal limestone (Winston, 1987) and contains the informal Brown Dolomite Zone (Applegate, 1987; Pollastro and others, 2001). The Able Member consists primarily of anhydritic and argillaceous limestone. Rocks overlying the Punta Gorda Anhydrite are Lower Cretaceous and consist of the Ocean Reef Group (Sunniland, Lake Trafford, and Rattlesnake Hammock Formations) and Big Cypress Group (Marco Junction, Gordon Pass, and Dollar Bay Formations) (fig. 2). This entire section of several thousand feet of rock consists of repetitive evaporite-carbonate cycles with anhydrite, limestone, and dolomite lithologies. The Sunniland Formation, consisting of a lower micritic dark carbonate zone source rock and an overlying porous grainstone, contains the only discovered commercial oil accumulations in south Florida with a total of 14 existing or depleted oil fields (Palacas, 1978; Palacas and others, 1981; Applegate and Pontigo, 1984; Applegate, 1987; Winston, 1987; Lloyd, 1997; Pollastro and others, 2001). The discovered oil accumulations are in isolated bioclastic-debris mounds and shoals from rudistid reefs. Low-gravity oil shows have been reported from the Dollar Bay Formation, but commercial production has not been established. Isolated oil shows have also been reported from the Lake Trafford Formation; however, similar to the Dollar Bay Formation, no commercial production has been established.

Isolith, isopach, and porosity maps were created and used in conjunction with production data to guide the geologic definition of the assessment units in this study. New information on source-rock characteristics for Upper Jurassic(?)–Lower Cretaceous formations underlying the Punta Gorda Anhydrite and the Lower Cretaceous Sunniland and Dollar Bay Formations were derived from programmed pyrolysis and other geochemical and petrographic approaches and were used to outline petroleum system properties.

Four assessment units (AU) were defined in the South Florida basin: two were quantitatively assessed, and two were not. Three of the AUs are contained within the Post-Punta Gorda Composite Total Petroleum System (TPS), and one AU is within the Pre-Punta Gorda Composite TPS. Input data for the two conventional oil AUs are summarized in table 1.

Most of the petroleum exploration and (or) production wells that are drilled and tested within the South Florida basin are located along a feature known as the Sunniland trend. The Sunniland trend is where the greatest thickness (up to 150 ft) of lower Sunniland source rock coincides with the location of overlying, highest porosity Sunniland grainstones (Applegate and Pontigo, 1984). Generation of low-maturity, high-sulfur, heavy oil is interpreted to have begun at approximately 40 mega-annum (Pollastro and others, 2001), followed by short-distance migration (hundreds of feet) along natural fractures to the overlying high-porosity grainstone shoal reservoirs. Trapping of oils on structural highs formed from rudistid debris occurs with updip permeability barriers against adjoining micrite and anhydrite layers.

Series	Provincial series/stage	Stratigraphic unit	
Lower Cretaceous	Washitan–Fredericksburgian	Naples Bay Group	Corkscrew Swamp Formation
			Rookery Bay Formation
			Panther Camp Formation
		Big Cypress Group	Dollar Bay Formation
			Gordon Pass Formation
			Marco Junction Formation
	Trinitian	Ocean Reef Group	Rattlesnake Hammock Formation
			Lake Trafford Formation
			Sunniland Formation
		Glades Group	Punta Gorda Anhydrite
Coahuillean	Nuevoleonian	Lehigh Acres Formation	Able Member
			Twelve Mile Member
	Durangoan	West Felda Shale Member	
Upper Jurassic	LaCastian	Pumpkin Bay Formation	
		Bone Island Formation	
	Zuloagan	Wood River Formation	

EXPLANATION

 Post-Punta Gorda Conventional Oil AU

 Pre-Punta Gorda Conventional Oil AU

Figure 2. Stratigraphic column for the South Florida basin, showing stratigraphic units included in conventional oil assessment units (AUs), from Roberts-Ashby and others (2015).

The boundaries for the Pre-Punta Gorda Conventional Oil AU are defined by the State water boundaries; the presence of porous reservoir rock of significant thickness within the formations underlying the Punta Gorda Anhydrite, as indicated by porosity maps created from geophysical well logs; and the Tampa-Sarasota Arch. Boundaries for the Post-Punta Gorda Conventional Oil AU are defined based on the documented presence of source rock in the lower Sunniland, dark-carbonate zone; overlying porous limestone reservoirs; locations of documented oil shows; and State water boundaries.

Boundaries for the Sunniland Unconventional Oil AU are defined based on the greater than 70-ft isopach thickness of dark carbonate (Applegate and Pontigo, 1984), whereas boundaries for the Dollar Bay Unconventional Oil AU used the 0–25 percent dark-carbonate facies boundary of Winston (1971). Additionally, both unconventional oil AUs were dependent upon State water boundaries. The unconventional oil AUs are defined but not assessed because of insufficient data and the absence of unconventional hydrocarbon production in south Florida at the time of this assessment.

Undiscovered Resources Summary

The USGS assessed technically recoverable, conventional resources for two AUs within the South Florida basin; two continuous AUs were not quantitatively assessed (table 2). For the conventional oil resources, estimated means totals are 49 million barrels of oil (MMBO) with an F95–F5 range from 0 to 147 MMBO; 18 billion cubic feet of gas (BCFG) with an F95–F5 range from 0 to 62 BCFG; and 1 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 0 to 2 MMBNGL. For the Pre-Punta Gorda Conventional Oil AU, the estimated mean resources are 34 MMBO with an F95–F5 range from 0 to 115 MMBO; 17 BCFG with an F95–F5 range from 0 to 59 BCFG; and 1 MMBNGL with an F95–F5 range from 0 to 2 MMBNGL. For the Post-Punta Gorda Conventional Oil AU, the estimated means are 15 MMBO with an F95–F5 range from 0 to 32 MMBO and 1 BCFG with an F95–F5 range from 0 to 3 BCFG. More than half (69 percent) of the total assessed mean oil resources and a majority of the total assessed gas (94 percent) and natural gas liquids (100 percent) are in the Pre-Punta Gorda Conventional Oil AU.

Table 1. Key input data for two conventional assessment units (AUs) in the South Florida basin.

[AU, assessment unit; MMBO, million barrels of oil. Shading indicates not applicable]

Assessment input data— Conventional AUs	Post-Punta Gorda Conventional Oil AU				Pre-Punta Gorda Conventional Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Number of oil fields	1	10	40	11.0	1	5	25	5.7
Size of oil fields (MMBO)	0.5	1	20	1.5	0.5	4	200	8.4
AU probability	0.9				0.7			

Table 2. Results for two conventional assessment units (AUs) in the South Florida basin.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids; AU, assessment unit. Results shown are fully risked estimates. For gas accumulations, all liquids are included in the NGL category. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

Total petroleum systems and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Post-Punta Gorda Composite Total Petroleum System														
Dollar Bay Unconventional Oil AU			Not quantitatively assessed											
Sunniland Unconventional Oil AU			Not quantitatively assessed											
Post-Punta Gorda Composite Total Petroleum System														
Post-Punta Gorda Conventional Oil AU	0.9	Oil	0	13	32	15	0	1	3	1	0	0	0	0
Pre-Punta Gorda Composite Total Petroleum System														
Pre-Punta Gorda Conventional Oil AU	0.7	Oil	0	22	115	34	0	11	59	17	0	0	2	1
Total undiscovered conventional resources			0	35	147	49	0	12	62	18	0	0	2	1

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For More Information

Assessment results are also available at the USGS Energy Resources Program website at <https://energy.usgs.gov>.