OIL RICH SUNNILAND FORMATION OF SOUTH FLORIDA

J. E. BANKS AND WENDELL L. ROBERTS

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ABSTRACT

Of the 56 exploratory wells in South Florida that penetrated the deeply buried Sunniland formation, 49 had oil or gas shows, 2 discovered oil fields, and 16 were producers that found approximately 20 million dollars worth of oil. The Sunniland formation contains all the essential factors for oil accumulation, such as source rocks, aquifer-reservoir rocks, and cap rocks. Because this formation is located on a broad shelf area, subjected only to gentle tilting and a minimum of local deformation, it is expected that most of the Sunniland oil will be found in stratigraphic and depositional type traps. The irregular surface between the reservoir rocks and the cap rocks of the Sunniland formation is known to have from 40 to 125 feet of local relief near present oil fields. Future drilling is expected to reveal other areas of local unconformity and to find facies controlled oil fields along with depositional anticlines containing oil.

1. Manuscript received.

2. The Catawba Corporation

3. Coastal Petroleum Company. Special thanks are due John D. Bates for helpful suggestions

INTRODUCTION

Historical Review

The Sunniland formation of South Florida is a sub-surface rock unit which has become important beacuse it contains commercial amounts of crude oil. The oil is a black, medium weight crude of from 10 to 28 degrees A. P. I. gravity with a small amount of gas. On fractional distillation one sample yielded 20 per cent gasoline, 35 per cent gas-oil, and 45 per cent residual oil, which is high in asphalt and contains a small amount of sulphur and salt.

The first deep oil test in South Florida, located in the northeast corner of Monroe County, was drilled under the supervision of the late Robert Barns Campbell, geologist and president of Peninsular Oil and Refining Company of Tampa. Mrs. Esther Applin was retained as a stratigraphic consultant. Although this well did not reach the Sunniland formation, it did penetrate 1838 feet of Lower Crotaceous rocks and proved the presence of a very large sedimentary basin of this age under South Florida. Campbell (1939a, p. 1714) made the following modest comment on his discovery.

"The occurrence of the Lower Cretaceous in the subsurface of Florida, though here published for the first time, was no surprise to the operators and Mrs. Applin had noted several years ago from another well in the state, and occurrence that could not be announced because of commercial commitments."

In 1944 Paul and Esther Applin reported on their discovery of Lower Crataceous limestone in Lake and Monroe counties, Florida (p. 1721).

"In the Arnold and Cory wells, the Lower Crataceous is mainly brown, porous limestone with streaks or lenses of gray and white, chalky, or nearly limestone and anhydrite. Underlying this section in the Arnold well, 60 feet of purple, red, and green clay, containing arkose and many small modular fragments of light greenish/gray limestone, was encountered above the granite reported at the bottom of the hole. The Limestone in the Arnold well is 648 feet thick, and in the Cory well 1838 feet was drilled, the well stopping in this unit.

The Lower Cretaceous limestone thus far seen in Florida is, on the whole, sparsely fossiliferous, but some highly fossiliferous lenses are present near the top of the unit in the wells mentioned. The upper part of the limestone in the Arnold well is hard, white or cream-colored, finely porous to dense millielid limestone similar to samples seem from the El Abra of Mexico (Conomanian and Albian)."

Some insight into the difficult nature of Florida stratigraphy can be gained by a comparison of an earlier report (Cushman, p. 97) of definite and widespread Lower Cretaceous in Florida at 115 to 1248 feet with the following current opinion (Mayne, 1955, p. 109) on the recurrence of certain Florida fossils.

"There are great similarities between the new Lower Cretaceous species of Florida and the known Escene forms of the same area, and it may be assumed that Coskinolina sunnilandensis, n, sp. is a direct forerunner of Coskinolina Floridana Cole. One can even say that the Lower Cretaceous species C. sunnilandensis hardly underwent any evolutionary differentiation, as Coskinolina Floridana from the Escene still shows the same interior features. This morphological stability is also evident in the Escene species Dictyncenus cookei (Noberg) which does not differ in its principal structure from the Lower Cretaceous Dictyoconus walnutensis (Carsev). The only differential criterian seems to be the fact that the Escene representatives of both genera are of larger size then their ancestral forms."

The second deep oil test in South Florida was drilled by Humble Oil and Refining Company in Collier County (Fig. 1) in 1943. It penetrated 1800 feet deeper into the Lower Cretaceous sedimentary basin and found commercial oil production in the Sunniland formation. The exploratory methods used were gravity meter, followed by core drilling (Hughes, 1944, p. 804). With completion of development wells it was found (Raasch, 1954, p. 1) that "the core test which were originally interpreted to show north dip proved to be located in a large solution cavity." In describing the near surface structure of Sunniland Oil Field, Raasch (1954, p. 26) notes the possible connection between sinkholes and structure.

"The structure map contoured on top of the Ocala limestone does not give a true picture of the Sunniland structure as reflected by deeper beds. It shows, instead, that there are at least three depressions or sinkholes, each with (Ocala) relief exceeding sixty-five feet. This distortion caused by the slumping of the sediment in the sinkholes, apparently obliterates any reflection of deep structures; however, the basic cause and location of the collapse may have been due to structure."

Thus, in the light of present and past reports, it may be said that Sunniland Oil Field is associated with a local gravity maximum and with sinkholes in the shallow Ocala limestone.

Including the discovery well as shown in Figure 1, 56 oil tests have been drilled into the Sunniland formation, resulting in 16 producers that found approximately 20 million dollars worth of oil.

Fig. 1,-- Map of South Florida showing location of Sunniland tests and shows.

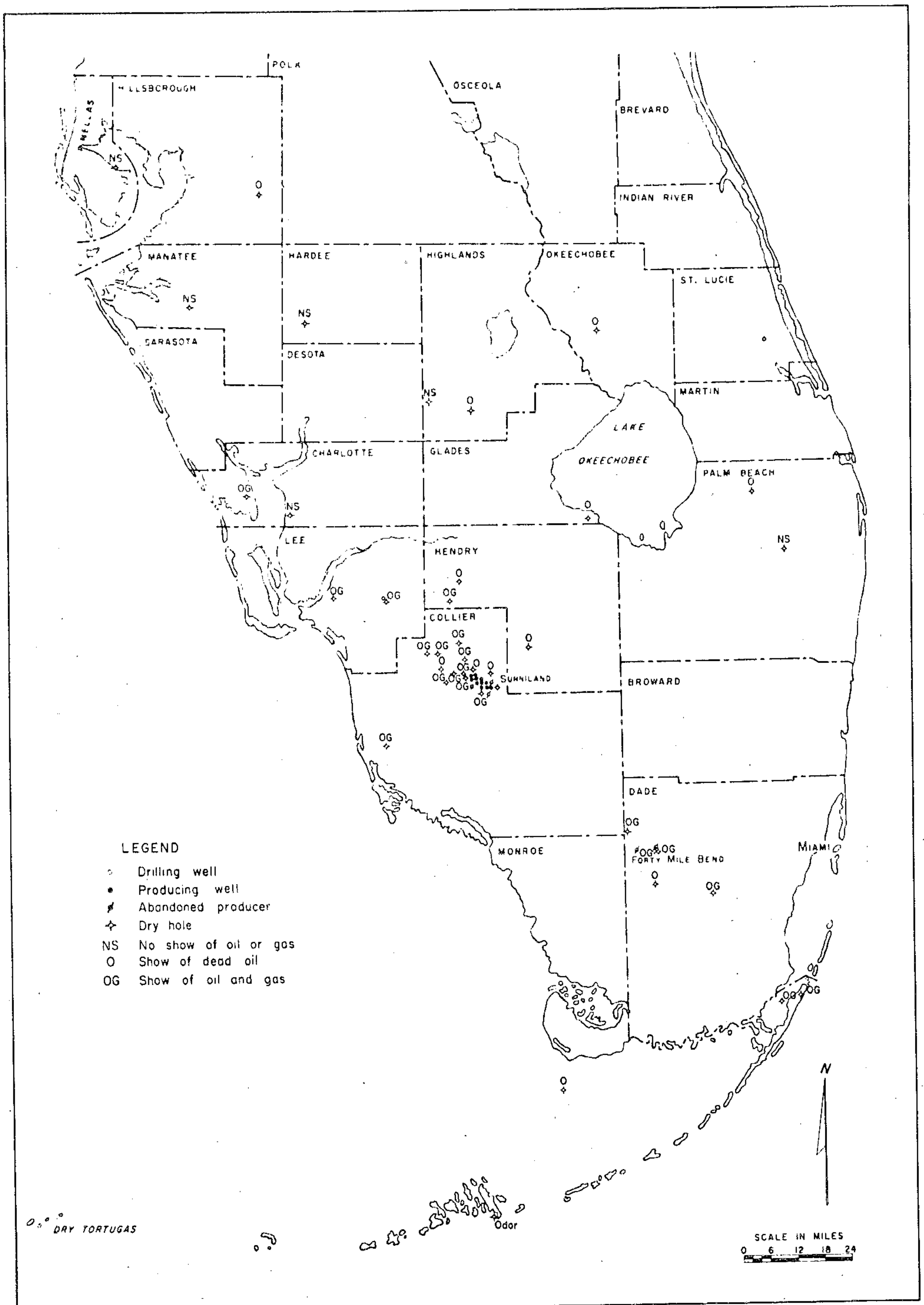


Fig. I.—Map of South Florida showing location of Sunniland tests and shows.

Previous Investigations

The Florida Geological Survey (Gunter, 1944, p. 162) announced the 1943 discovery of Florida's first oil field reporting the find to be in porous limestone at 11,613 feet in a Humble Oil and Refining Company well. Based on conversations with the Humble paleontologist, Dr. Gunter reported the oil productive limestone to be of Lower Cretaceous age and a possible Glen Rose equivalent.

This initial Florida and Sunniland formation discovery acquired its name from the nearby Sunniland Siding of the Atlantic Coast Line Railroad in Collier County. The rock unit from which oil is produced was briefly described by Edward D. Pressler in a 1947 report on oil in Florida. He noted that Florida oil was associated with roof type limestones and with unconformities.

"The limestones and dolomites of Upper, Middle, and Lower Cretaceous, sands of Lower Cretaceous, and beds of Jurassic age are considered the most important potential oil-producing formation of South Florida. Unconformities occur between these several formations, and there is evidence to indicate that sedimentation was interrupted during the deposition of some of the formation units. The porous dolomite and limestone cones are thought to be closely related to erosional surfaces as in the case of the formation at the top of the Lower Cretaceous and the Sunniland zone that occurs approximately 1,900 feet below the top of this formation. More sub-surface are needed for more definite conclusions. The term Middle Cretaceous is tentatively applied to the section of beds separated from the Upper and Lower Cretaceous on the basis of unconformities. This section occurs between the depths of 8,200 and 9.700 feet in the Humble Oil and Refining Company's Gulf Coast Roalties No. 2 at Sunniland." (1947, p. 1857)

"Well No. 2 and Well No. 7 encountered the Sunniland limestone at a sub-sea depth below the oil-water contact, but were drilled through the Sunniland limestone zone and proved the presence of 36-40 feet of very porous reef limestone in the formation." (1947, p. 1859)

The first published description of the Sunniland formation at its type locality can be obtained. From the upper structure map and lower cross-section of Pressler's Figure 3.

Pressler's Sunniland Limestone

Humble No. 2 Gulf Coast Realties Corporation
Sec. 30, T, 48S, R. 30E
Collier County, Florida

Depth	Thickness	Description
11,615 - 11,621	6 feet	Anhydrite
11,621 - 11,632	11 feet	Limestone and Dolomite
11,632 - 11,668	36 feet	Porous Limestone
11,668 - 11,872	204 feet	Limestone and Dolomite
	257 feet Total Thickness	

Another Humble Oil and Refining Company geologist, Albert C. Raasch, Jr., described the Sunniland formation in greater detail in a 1954 unpublished Masters Thesis at Florida State University in Tallahassee. He prepared several excellent maps showing the structure of Sunniland Field. He proposed expanding the Sunniland formation to include 1,300 feet of rocks.

Wolf Mayne (1955, p. 109) confirmed the position of the Sunniland formation in geologic terms.

"In Humble Oil and Refining Company's well No. 2, Gulf Coast Realties, Sec. 30, T.48S., R. 30E., Collier County, Florida, the biostratigraphic succession is as follows (Communication by Louise Jordan):

8401 feet	Top of Lower Cretaceous
9900 feet	Faunisone with *Coskinolinoides taxanus* Keijzer and *Lituola inflata* Lozo
11160 feet	Top occurrence of *Orbitolina taxana*

11619 feet   Top Sunniland producing horizon, with Orbizolime texana and Coskinolina sunnilandensis, b. sp. within 200 feet interval

In the sub-surface formations of Florida, Coskinolina sunnilandensis, therefore, characterizes the Sunniland limestone interval which attains a thickness of about 275 feet in the Sunniland Field. It occurs, in other words, above the horizon with Choffatalla decipiens and below the faunizone with Coskinolincides texuras and is of upper Trinity age (lower to basal middle Albian). Dictyoccnus walnotensis (Carney) is apparently not found in the lower Cretaceous sub-surface section of southern Florida but some specimens of Pseudocyalamnica hedbergi Mayne were observed in several of the prepared thin-sections.

In the lower 300 feet of the Glen Rose limestone of Canal County, Texas, Orbitolina texana (Roaner) occurs in association with an undescribed species of Coskinolina which is identical with the form of Coskinolina from the Sunniland Section, Southern Florida.

"in 1956 Wolf Mayne reports that "Coskinolina sunnilandensis Mayne,

a species recently described from the Lower-Middle Albian of Florida and Venezuela, was found in M. Alaman-1 (together with Dictyecenus walnutensis) and also in the well Jardin-35 (both drilled in the Middle Albian El Abra limestone of the Golden Lane Reef). Coskinolina sunnilandensis is, moreover, represented in some surface samples (Valle de Tonaltonge; sierra del Huese)."

Pressler's Sunniland formation (1947, Fig.3) extended from an unconformity several feet above the oil-productive coquina through 257 feet of limestone and shale, having scattered oil shows to the top of the "Massive Anhydrite" in Sunniland field wells of Collier County, Albert Raasch (1954, Fig. 3) calls this 257 feet plus 22 additional feet, Middle Sunniland. He also proposed a 400 feet Upper Sunniland unit composed of anhydrite and Orbitolina limestones and a 630 feet lower Sunniland unit composed of anhydrite, a this salt and thin Orbitolina limestone. The writers of this paper agree with Pressler that there is an uncomformity on top of the producing rocks in Sunniland Field but believe it is a facies unconformity and not a formation boundary. The writers agree with Raasch only to the extent of adding the overlying 178 feet of anhydrite and dense limestone beds to Pressler's type section of the Sunniland formation in the Humble Oil and Refining Company No. 2 Gulf Coast Realties of Collier County. In general, Raasch's Upper Sunniland unit plus still higher anhydrites and his Lower Sunniland unit plus still lower Orbitalina limestones need separate treatment as formations if their respective saline basins, porosity trends, and oil possibilities are to be discovered.

Oil-Show Record

To date, oil or gas has been found in the Sunniland formation at 49 widely scattered localities in South Florida, Of the 56 exploratory wells drilled into this formation, 2 discovered oil fields and all but 7 had oil or gas shows. Figure 1 shows the distribution of these wells. Table I presents a complete list and description of the Sunniland oil and gas shows.

Table I. Oil and Gas show Record of the Sunniland Formation of South Florida.

Oil in commercial quantities has been found in the Sunniland formation at two places. One field is at Sunniland siding, located 100 miles northwest of Miami, near the town of Immokalee

Table I. Uil and gas show record of the Sunniland formation of South Florida

County	Well Name & Number	Top	Thickness	Oil & Gas Shows Desciption
Charlotte	Gulf #1 Vanderbilt	11,240	2'	Limestone, oil stains in fractures
		11,242	5'	Dolomite, 75 gas unites and trace of oil.
		11,262	1'	Limestone, oil stains in fractures
Collier	Humble #1 Collier Corp.	12,231	1'	Limestone bleeding oil.
		12,399	15'	Caleareous shale with oil stains and odor.
		12,392	16'	Limestone, bleeding oil in spots.
	Humble #1 CCR Corp.*	11,468	6'	Dolomite, show oil and gas.
	(Discovery well)	11,547	1'	Dolomite, slight show of oil & gas
		11,613	13'	Coquina, saturated with oil.
		11,597	18'	16 hour DST recovered 450' oil and 10,750' of salt water.
		11,598	28'	Open hole, IP pumped 97 barrels of oil and 427 barrels of salt water in 24 hours. Total production 20,550 barrels of oil.
	Humble #2 CCR Corp.	11,623	16'	38 minute DST recovered 364' of oil cut mud and 182' of salt water.
		11,635	15'	Coquina, oil stained.
		11,623	16'	38 minute DST recovered 364' of oil
	Humble #4 CCR Corp.	11,559	31'	Dolomite with spotted oil stain.
		11,589	8'	Coquina with good oil show.
		11,549	48'	82 minute DST recovered 5990' of oil and 10' of salt water.
		11,569	28'	Open hole IP pumped 327 barrels of oil and 168 barrels of salt water per day. 25° API. OOR 100-1.
	Humble #5 CCR Corp.	11,560	20'	Open hole, IP flowed 518 BOPD.

*Gulf Coast Realties Corporation

TABLE 1 (Continued)

COUNTY	WELL Name and Number	Oil & Gas Shows Top	Thickness	Description
Collier (Continued)	Humble #6 GCR Corp.	11,556	22'	Open hole, IP Flowed 225 BOPD.
	Humble #7 GCR Corp.	11,708	17'	Dolomite with traces of oil stain.
		11,741	8'	Limestone with traces of oil.
		11,791	1'	Limestone with a light show dead oil.
	Humble #8 GCR Corp.	11,564	5'	Through perforations, IP Flowed 527 BOPD.
	Humble #9 GCR Corp.	11,566	4'	18 hour DST recovered 8900' of oil.
		11,566	4'	Tested 4 1/2 BOPD on pump.
		11,592	3'	24 hour DST recovered 1200' of oil and gas, cut mud, and 4050' of salt water.
	Humble #10 GCR Corp.	11,566	8'	Open hole, IP flowed after acid 175 BOPD.
	Humble #11 GCR Corp.	11,550	23'	Open hole, IP flowed after acid 125 BOPD.
	Humble #12 GCR Corp.	11,565	42'	12 hour DST recovered 15' of oil and 435' of salt water.
		11,619	10'	32 hour DST recovered 5' of oil and 6745' of salt water.
	Humble #13 GCR Corp.	11,538	24'	Open hole, Ip Flowed 319 BOPD.
	Humble #14 GCR Corp.	11,534	45'	Open hole, Ip flower 190 BOPD.
	Humble #15 GCR Corp.	11,660	6'	Limestone with slight oil show.
		11,681	1'	Limestone with slight oil show.
		11,686	5'	Limestone with slight oil show.
		11,707	9'	Limestone with slight oil show..
	Humble #16 GCR Corp.	11,560	15'	24 hour DST recovered 2430' of oil and 90' of salt water.

TABLE I-- (Continued)

County	Well Name & Number	Oil & Gas Shows: Top	Thickness	Description
Collier (Continued)	Humble #17 GCR Corp.	11,597	15'	21 hour DST recovered 660' of oil and 3750' of salt water.
		11,706	3'	Shale, fractured, bubbling gas
		11,825	9'	Limestone, spotted oil stains.
	Humble B-1 GCR Corp.	11,866	17'	Limestone, bleeding oil in spots.
		11,965	12'	Limestone, bleeding oil in spots.
	Humble C-1 GCR Corp.	11,918	20'	28 hour DST recovered 660' of oil and 150' of oil cut mud. Gas to surface is 24 hours.
		11,906	44'	36 hour DST recovered 2324' of oil and 528' of oil cut mud.
	Humble D-1 GCR Corp.	11,865	12'	Limestone, a light oil stain.
	Humble E-1 GCR Corp.	11,859	1'	Limestone, bleeding oil in spots
		11,905	8'	Limestone bleeding oil in spots
		11,935	12'	Limestone bleeding oil in spots
	Humble #1 J A Curry	11,636	5'	Dolomite, slight oil stain.
		11,665	11'	Coquina, Trace of oil.
		11,759	3'	Limestone with spotted oil stain.
		11,854	24'	Limestone bleeding oil in spots
		11,854	83'	24 hour DST recovered 135' of oil and 40' of oil cut mud.
	Humble #3 LT Cypress*	11,543	11'	Limestone bleeding oil in spots
		11,683	4'	Limestone spotted dead oil stai
		11,695	65'	Porous limestone with salt wtr.
		11,770	40'	Limestone with oil along fractures.

*Lee Tidewater Cypress Company

TABLE I-- (Continued)

County	Well Name & Number	Top	Thickness	Oil & Gas Shows Description
Collier (Continued)	Humble #3 LT Cypress (Continued)	11,804	21'	45 minute DST recovered 50' of oil and gas cut mud.
		11,818	7'	Limestone, with good show of oil.
		11,872	7'	Marl with spotted oil stain.
	Humble B-1 LT Cypress	11,550	8'	Open hole, IP flowed 136.5 BCPD.
	Humble C-1 LT Cypress	11,825	1'	Limestone bleeding oil.
		11,845	32'	Limestone and Dolomite with scattered oil shows.
	Humble B-2 LT Cypress	11,564	21'	open hole, IP flowed 519.3 BCPD.
	Humble B-3 LT cypress	11,555	24'	Open hole, IP flowed 447.24 BCPD.
	Humble B-4 LT Cypress	11,543	33'	Open hole, IP flowed 437 BCPD.
DADE	Coastal #1 State Lee 340	10,772	8'	Dolomite, part with oil stains & with 54 gas units.
		10,775	8'	24 hour DST recovered 20' of oil and gas cut mud and 2180' salt water.
		10,938	6'	Chalk with 43 to 90 gas units.
		10,965	12'	5 hour DST recovered 300' of slight oil and gas cut mud.
	Commonwealth #1 Wise hart (Discovery Well)	11,135	10'	Limestone with spotted oil stains.
		11,323	5'	Dolomite, saturated with oil.
		11,314	33'	12 hour DST recovered 2185' of oil and 270' of salt water.
		11,322	15'	Gas to surface in 6 3/4 hours through perforations. IP pumped 105 barrels of oil and 70 barrels of salt water after acid. Total production 14,866 barrels of oil.

TABLE 1 -- (Continued)

County	Well Name & Number	Oil and Gas shows: Top	Thickness	Description
Dade (Continued)	Commonwealth #1 Wisehart (Discovery Well) (Continued)	11,348	24'	Chalk bleeding oil in spots.
		11,346	33'	70 minute DST recovered 185' of salt water with a trace of oil.
		11,460	16'	Chalk, Bleeding oil.
		11,446	55'	5 1/2 hour DST recovered 25' of oil and 615' of salt water.
		11,514	10'	Limestone, bleeding oil in spots.
		11,503	48'	4 hour DST recovered 19' of oil and 251' of salt water.
	Gulf #1 State Lee 340	11,332	4'	Dolomite, Bleeding oil in spots.
		11,342	3'	Reeflike limestone, saturated with oil. (7' of core was not recovered).
		11,334	18'	8 hour DST recovered 9060' of oil and no free water. Gas to surface in 5 hours.
		11,342	10'	Open hole IP pumped 112 barrels of oil and 336 barrels of salt water per day. Total production 8380 barrels of oil.
	Gulf #2 State Lee 340	11,442	8'	Limestone, traces of oil.
		11,496	20'	Limestone, spotted oil stains gas odor.
		11,449	92'	6 1/2 hour DST recovered 30' of oil and 390' of salt water.
		11,554	20'	Limestone, oil stains in fractures and vugs.
		11,554	43'	3 1/2 hour DST recovered 3' of oil and 12' of salt water.
	Gulf #3 State Lee 340	11,342	10'	Limestone, bleeding oil in spots. Show of gas.
		11,341	5'	6 hour DST recovered 30' of oil and 2370' of salt water.
		11,442	1'	Limestone, oil stained.
		11,488	40'	Limestone, spotted oil stains.

TABLE I-- (Continued)

County	Well Name & Number	Top	Thickness	Description
				Oil and Gas Shows
Dade (Continued)	Humble #1 IIF State	11,420	10'	Chalk with oil show.
		11,414	12'	2 hour DST recovered 390' of mud with trace of oil.
		11,437	12'	Limestone, bleeding oil in spots.
		11,523	20'	Limestone, spotted oil stains.
		11,565	25'	Limestone, bleeding oil in spots.
	McCord #1 Damoco	11,440	12'	Limestone, odor of oil.
		11,470	20'	Chalk, bleeding oil in spots.
		11,550	30'	Limestone, strong oil odor and trace of oil in core barrel.
		11,625	11'	Limestone, saturated with oil and gas.
Glades	Coastal #1 Tiedtke	10,985	15'	Dolomite, saturated with dead oil.
Hendry	Commonwealth #3 Red Cattle Co.	11,444	22'	Dolomite, with spotted oil stains.
		11,435	57'	7 1/2 hour DST recovered 1090' of oil and 9410' of salt water. Gas to surface in 4 hours.
		11,480	10'	Limestone-coquina, oil saturated.
		11,505	8'	Dolomite, spotted oil stains.
		11,542	12'	Dolomite, spotted oil stains.
	Humble 1B Collier Corp.			
		11,504	5'	Limestone with slight oil shows.
		11,521	10'	Limestone with slight oil show.
		11,543	12'	Limestone with slight oil show.
		11,623	30'	Limestone, shaly, spotted oil stains.
	Humble #1 Cons. Nav. Stores			
		11,387	26'	Limestone with spotted oil stain.
		11,541	3'	Limestone with spotted oil stain.
Highlands	Humble #1 Carlton	10,340	10'	Dolomite with slight oil stain.

TABLE I -- (Continued)

County	Well Name & Number	Oil and Gas Shows		
		Top	Thickness	Description
Lee	Gulf #1 Cons. Nav. Stores			
		11,517	3'	Dolomite, bleeding oil.
		11,536	26'	Coquina, now show.
		11,562	2'	Limestone, oil in stylolites.
		11,596	10'	Limestone, oil in stylelites.
		11,617	45'	Limestone, oil in fractures and stylolites.
		11,745	25'	Limestone, fractures bleeding oil.
		11,771	3'	Limestone, oil saturated.
		11,748	51'	23 hour DST recovered 40' of oil and 145' of oil and gas cut mud.
	Humble #1 Kirchhoff	11,730	20'	Limestone with dead oil.
		11,821	17'	Limestone, bleeding oil.
		11,819	9'	21 hour DST recovered 75' of oil and 225' of oil cut mud.
		11,813	53'	Acidized and hydrafraced.
		11,772	114'	12 hour DST recovered 50' of oil and 4450' of salt water.
Monroe	Gulf #1 State Lee 373 (Big Pine Key)	12,620	50'	Shale, good odor of oil and gas.
	Gulf #1 State Lee 8260	11,856	2'	Coquina, with show of oil.
		11,881	20'	Limestone with oil in fractures.
		11,906	7'	Limestone with oil in fractures.
		12,005	8'	Limestone with oil in fractures.
		12,117	2'	Limestone with oil in fractures.
		12,147	19'	Salt.
		12,175	12'	Shale with gas bubbles (H_2S).
		12,187	24'	Limestone with oil along fractures.
		12,340	12'	Fossiliforous limestone with oil stains.
	Robinson #1 State	10,175	30'	Dolomite with spotted show of oil and gas.

TABLE I -- (Continued)

County	Well Name & Number	Oil and Gas Shows: Top	Thickness	Description
Monroe (Continued)	Robinson #1 State (Continued)	10,168	17'	2 hour DST, through perforations in 7" casing, recovered 13,301' of salt water and slight show of oil and gas.
		10,205	45'	Limestone, spotted oil stains.
		10,270	69'	Limestone, spots of oil along fractures.
		10,339	25'	Limestone, with spotted oil and gas shows.
		10,337	26'	75 minute DST, after acid, through perforations in 7" casing, recovered 200' of oil and 1600' of salt water.
	Sinclair #1 Williams			
		9,985	20'	Dolomite, bleeding oil in spots.
		9,976	22'	30 hour DST, after plug back, recovered 4368' of salt water with a trace of oil.
		10,010	20'	Limestone, spotted oil stains.
		10,022	23'	4 hour DST, after plug back, recovered 3450' of salt water and no show of oil or gas.
Okeechobee	Amerada #1 Swanson	9,168	2'	Dolomite, slight oil stain.
Palm Beach	Amerada #1 Sou. States			
		9,975	30'	Spotted dead oil stain.
		10,029	1'	Spotted dead oil stain.
		10,043	5'	Spotted dead oil stain.

in Collier County. Here cumulative production is over 4,500,000 barrels and current daily production form 11 wells is 1,200 barrels. The gentle decline curve and low pumping costs indicate profitable production for many years. Figure 2, showing the production record of Sunniland Field, was compiled by Dr. James L. Calver for a forthcoming state publication.

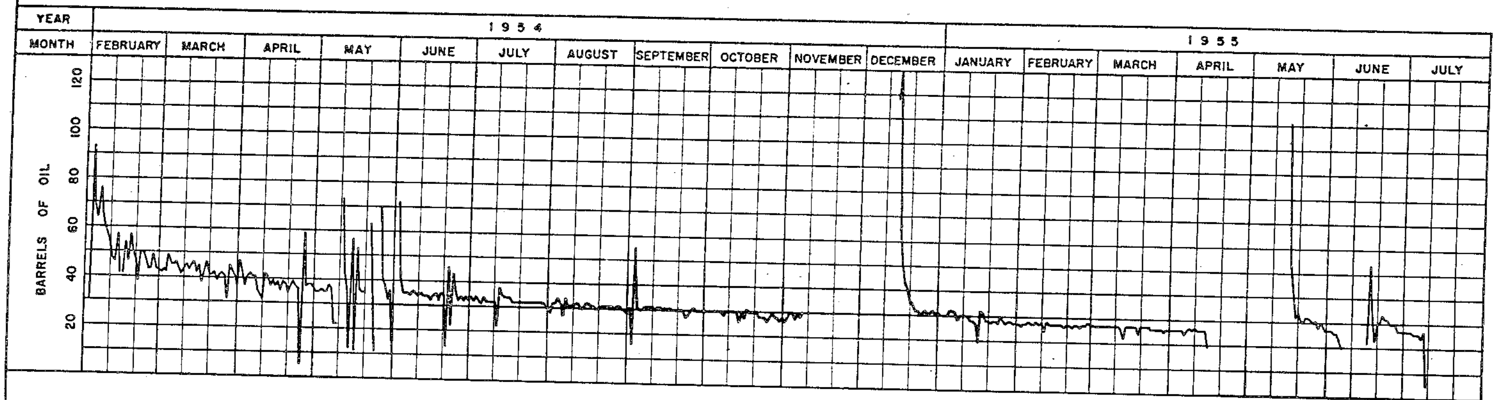
Fig. 2.- Sunniland Field Production Record (Courtesy of James L. Calver, Florida Geological Survey)

The second field is at Forty Mile Bend located 40 miles west of Miami in Dade County where total production is 33,000 barrels of oil. The two initial wells in this field were abandoned after salt water flooded out oil production. Their production histories are shown in Figure 3.

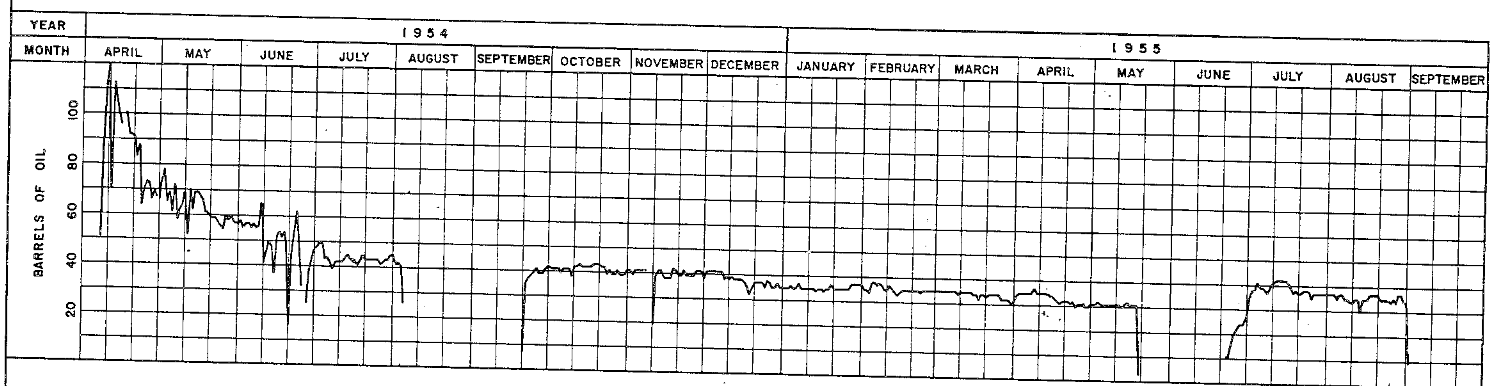
Fig. 3. - Daily Product records of the two initial wells in Forty Mile Bend Field.

Geographical Setting

The oil-rich Sunniland is completely buried below 9,000 to 13,000 feet of sediments. In hunting for Sunniland oil, workers have found that the structures involving oil production do not reach the surface. Neither does the oil naturally leak to the surface. In every direction from both oil fields, the surface is a bread, flat, coastal plain without tell-tale oil seeps. Yet, below



Commonwealth et al, No. 1 Wisehart-State



Gulf et al, No. 1 State Lease 340

AAPG Nov. ... Banks FIG. 5

this featureless surface lies an interesting oil producing trend.

The Sunniland formation is a part of the Floridan Plateau (Vaughn, 1910, p. 107) which joins North America with the Greater Antilles. Together with the Bahama plateau it separates the deep waters of the Atlantic Ocean. The Sunniland formation underlies the southeastern part of the Floridan Plateau and probably underlies part of the adjoining Bahama plateau. The southeastern part of the Floridan Plateau has a long depositional history an a near sea-level part of the continent dating back to Paleozoic time (Campbell, 1939b, p. 105). During Mesozoic and Cenozoic times, this part of the Floridan Plateau maintained its elevation; whereas, certain nearby areas sank 10,000 or more feet below sea level. The tremendous growth of plants and animals in the sunny, warm, shallow tidelands of South Florida is the prize factory causing the Floridan Plateau to maintain its position. actually, the oil pre-Mesozoic surface has sunk under South Florida and the Bahamas the same as under the Gulf of Mexico and parts of the Atlantic Ocean, but organic debris in the form of shells, marl, and thick chalk beds have kept Florida and the Bahamas at, or near, sea level. In a similar way, parts of Cuba have maintained a near sea-level position on the sinking shield of Sueaz, Schuchert and Eardley, due either to abundant organic debris or abundant volcanic debris. Also, in a similar way, a wide area along the north and west side of the Gulf of Mexico has maintained a near-level position because of the abundence of deltaic debris from major rivers. Thus the continental shelf area around the Gulf of Mexico represents the composite edge of abundant organic, volcanic, terrestial, and evaporite deposition occurring during all of Mesozoic and Cenozoic time, Copious deposition during two geologic eras has markedly decreased the apparent size of the sinking shield of Suess, Schuchert and Eardley and has separated it into a Gulf part and an Atlantic part.

It has been seriously suggested (Lynch, 1954, p. 73) that the steep side of the Gulf of Mexico at the edge of the Florida plateau is a fault scarp.

"There can be little doubt that the Florida Plateau has been faulted along its western edge, but the faulting is difficult to date. Schuchert believed this faulting was due to the inbreaking of the Gulf of Mexico "plate" an that it probably began in the Upper Cretaceous. However, Weaver (1950, p. 359) believed "that the Gulf of Mexico as a deep sea is young" and, therefore, the faulting must have occurred at a much more recent date."

However, it appears just an reasonable to attribute this steepness to the high initial angle of repost of carbonate sediments associated with reefing or to a composite channel face as proposed by Norman Newell (1955, p. 305) for the steep scarps on the east side of the plateau area.

"Leo (1951) has shown that gravity anonalies in the Bahamas follow topographic features, being least (30-60 Milligals) in the west, increasing progressively eastward to a maximum along the ocean margin (110-140 Milligals). Upon re-examination of the gravity problem, Worzel, Equing, and Drake (1953) concluded that the anomalies might equally well be explained by erosion without compensation, or alternately by upbuilding of platforms with compensation. In any case, the geophysical evidence seems to show that the rectilinear margins of the platform are not fault scarps."

The Floridan Plateau is only superficially separated from the Bahama plateau. The dividing strait is narrow and shallow. A similar shallow strait separates the Bahama plateau from Cuba. In the geologic past, straits of various dimensions have occupied other positions on the Floridan Plateau, giving rise to large islands and lakes. The low relief surface of the side Floridan Plateau also sets the stage for reefs, channels, deltas, estuaries, and dead seas.

The eastern half of the Floridan Plateau has a centrally located Miocene Delta (Bishop, 1955, p. 26). A large Miocene stream with head waters in the Appalachian Mountains brought quarts gravel onto the southeastern part of the Floridan Plateau (Vaughn, 1910, p. 129). The redistribution of this large mass of deltaic material has extended the Atlantic Quaternary terrace deposits on additional 300 miles into Southern Florida, and masked the typical karst topography of other emergent areas of the plateau. It is not unreasonable to suspect that the western part of the Lower Cretaceous Floridan Plateau may have had a centrally located major stream with a south growing delta which acted as a barrier as well as an intermittent source of water and sediment.

Geological Setting

Shallow water areas adjacent to the Gulf or the Atlantic are referred to as embayments. Old embayments over the Floridan Plateau can be recognized by the presence of sub-surface marine deposits. Water well and oil well records show that South Florida has repeatedly been flooded by shallow waters connected with the Gulf of Mexico and/or the Atlantic Ocean. Tideland sediments of the Gulf and of the Atlantic interfinger in the sub-surface of South Florida and both are inter-bedded with lacustrina sediments. Occasionally, within this layered setting, the soft parts of plants and animals became trapped and buried along with the hard parts to form oil and gas.

The following generalized description of the South Florida rock column is based, in large part, on a lithologic study of deep wells drilled in the Forty Mile Bend area of Dade County, Florida. As presently known, the rock column at Forty Mile Bend is 12,000 feet thick and is entirely sedimentary. It is expected that deeper drilling would extend this column to 30,000 feet without crossing a profound unconformity into a basement column. This estimate is not excessive as 45,000 feet of post-Paleozoic sediments are predicted by J. B. Carsey (1950, Fig. 2) for the Gulf coast area west of Florida and 93,000 feet of sediments are predicted by Worsel and Schurbert (1955, p. 99) in the vicinity of Andros Island east of South Florida. According to Campbell (1939b, Figs. 2, 4, 5, & 6) the additional sediments below the known column are expected to be of Ec-Cretaceous, Jurasaic, Triassic, and Paleozoic age.

For the sake of this discussion, the thin cover of Miocene to Recent sediments may be ignored and the sedimentary column divided into two thick rock groups. The upper group includes 7,500 feet of

rocks deposited in a sedimentary basin that covered all of Florida and extended into the Greater Antilles; whereas, the lower group included 4,500 feet of rocks deposited in a less wide-spread basin that did not cover North Florida. Both groups are composed dominately of limestone. Certain of the limestones of the upper group are cavernous, causing circulation problems in drilling and velocity problems in seismic prospecting. The limestone of the lower group are thin-bedded. These two groups of sediments are separated by a major regional unconformity along which part of the lower limestones have been weathered to green clay, and below which the lower limestones are discolored and mottled by irregular solution channels.
Both groups are so thick and so typical of shallow water deposition that their presence can only be attributed to a very long period of cominately organic and chemical desposition in an ever-expanding low relief shelf area, which gradually extended over the old hills of Appalachia in Southeastern United States and those of Antillia in Cuba with but one major break in Composition.

THE SUNNILAND FORMATION

Definition

The Sunniland Formation is a distinct part of the lower group of rocks in the Forty Mile Bend Column. It is a cycle of basin filling associated with subsidence of the wide Floridan Plateau. Within the Sunniland formation at Forty Mile Bend is the record of several despsitional environments including estuarine, neritic, litteral and lacustrine. In order to include all of one cycle of basin filling within one formation it is here proposed to expand Pressler's "Sunniland" to indlude the next above anhydrite beds which record the upper restricted water stage of a nearly full basin. As here expanded, the Sunniland formation has a typical thickness of 440 feet in the Forty Mile Bend area and at Sunniland Field. A central basin section, thickened by salt and anhydrite, is over 550 feet thick as shown by cross-sections (Fig. 4). Toward the north edge of the Sunniland deposition the formation thins dramatically and becomes difficult to follow due to the pinching out of characteristic facies.

Fig. 4 -- Corralation sections of the Sunniland Formation of South Florida

At Forty Mile Bend the Sunniland formation contains one obvious facies unconformity but the top and bottom surfaces appear conformable. Nevertheless, regionally, the lower part of the Sunniland formation loses section from the bottom. The upper part also shrinks toward the edge of the basin by loss of anhydrite beds. Problems in regional electric log correlation are caused by the unconformable bottom surface and by the abrupt loss or gain of anhydrite beds.

Facies

Within the Sunniland formation at the discovery well of Forty Mile Bend there are several facies. A distinct saline facies occurs

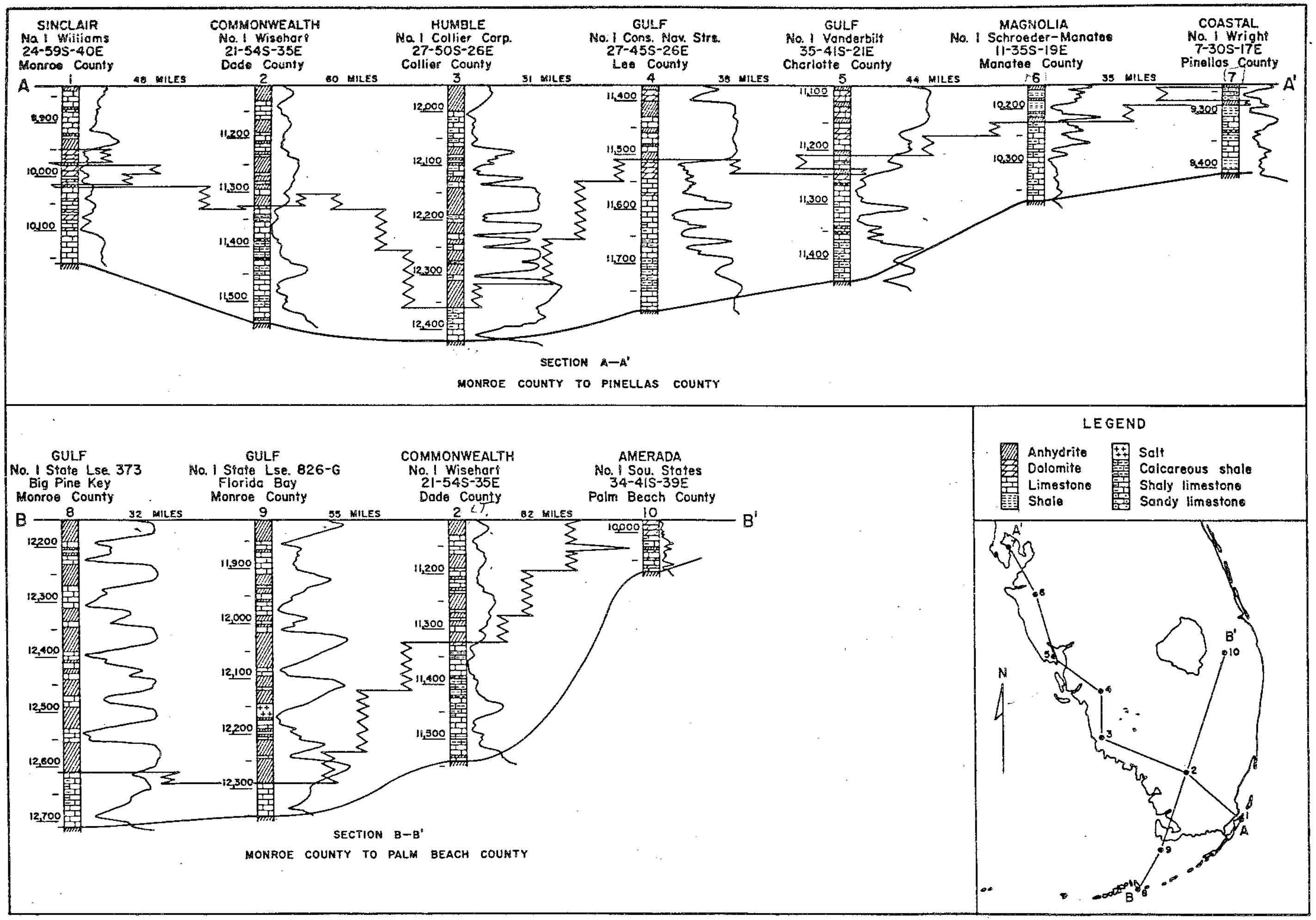


Fig. 4.—Correlation sections of the Sunniland formation of South Florida.

at the top (Fig. 7). The 225 feet of anhydrite with thin beds of dense argillaceous limestone and calcareous shale were deposited in a salt lake estuary during arid climatic conditions.

The upper facies is the apparent sealing agent for the oil at Forty Mile Bend Field. Below the upper saline facies there are other less distinct facies which, for the purpose of this report, are combined and called the lower facies. Admittedly this group= ing is necessitated by insufficient data and study.

In contrast with the sense upper facies the lower facies is in part porous and contains a limestone aquifer system. The 215 feet of the lower facies were deposited under humid to arid clim- atic conditions in a tidel embayment having a broad connection with the open ocean and an estuarine connection with rivers of the land. The organic shales and the organic limestone of the lower facies are the apparent source beds of the oil. The conquinac and dolomites of the lower facies are the aquifer and reservoir beds.

The surface between the upper and lower facies at Forty Mile Bend has 45 feet of local relief and greatly affects oil produc- tion. The uppermost reservoir beds of the lower facies are partly surrounded by the sense numbers of the saline facies. Future drilling in South Florida is expected to find other areas with great local relief on this facine unconformity and discover a trend of facies--controlled oil fields. Table II shows the variation in thickness of the upper and the lower facies in each South Florida well that drilled through these rock units. (Figs. 5 & 6)

Table II.-- Data on Sunniland tests in South Florida showing isopachous trends of both Sunniland facies.

The discordant surface between the upper and lower facies is called an unconformity beacuse, regionally, it effects one entire formation and is associated with a gap in the record. The anhydrite and shale members of the upper facies are only partial time and spatial equivalents to the chalk and shale members of the lower facies.

Fig. 5.-- Isopachous map of the upper Sunniland facies.

Fig. 6.-- Isopachous map of the lower Sunniland facies.

Members

The Sunniland formation has many distinct members. (Fig. 7) There is a basal log conglomerate of anhydrite or limestone pebbles locally present at the base.

Fig. 7.-- Generalized chart of the Sunniland formation in the Forty Mile Bend area.

Throughout the Sunniland formation there are dark gray to greenish gray members from less than an inch to thirty feet in thickness with are composed of varying amounts of clay to silt size argillaceous and calcareous particles. The argillaceous

ABL II. ata on Sunniland tests in South Florida showing inopachous trends of both Sunniland facies.

County	Well Name & Number	Location	Derrick Floor Elev.	Top (Subsea Depth)	Thickness Upper Facies	Thickness Lower Facies	Thickness Total	Lower Facies Porosity Count (feet)
Charlotte	Gulf #1 Vanderbilt	35-41S-21E	21	-11,059	130	230	360	25
	Humble #1A Loundez-Treadwell	17-42S-23E	20	-11,285	190	160	350	20
Collier	Humble #1 Collier	27-50S-26E	20	-11,930	410	60	470	10
	Humble #1 GCR Corp* (Discovery Well)	29-48S-30E	34	-11,406	165			
	Humble #2 GCR Corp.	30-48E-30E	34	-11,436	175	260	435	70
	Humble #4 GCR Corp.	20-48S-30E	34	-11,366	140			
	Humble #5 GCR Corp.	20-48S-30E	31	-11,374	140			
	Humble #6 GCR Corp.	19-48S-30E	32	-11,368	140			
	Humble #7 GCR Corp.	17-48S-30E	34	-11,586	155			
	Humble #8 GCR Corp.	19-48S-30E	29	-11,376	140			
	Humble #9 GCR Corp.	24-48S-29E	29	-11,386	145			
	Humble #10 GCR Corp.	20-48S-30E	30	-11,375	140			
	Humble #11 GCR Corp.	20-48S-30E	30	-11,350	140			

*Gulf Coast Realties Corporation.

TABLE II (Continued)

County	Well Name & Number	Location	Derrick Floor Elev.	Top (Subsea Depth)	Upper Facies	Lower Facies	Total	Lower Facies Porosity Count (In Feet)
Collier (Continued)	Humble #12 GCR Corp.	21-48S-30E	37	-11,393	165			
	Humble #13 GCR Corp.	19-48S-30E	39	-11,356	145			
	Humble #14 GCR Corp.	18-48S-30E	33	-11,362	140			
	Humble #15 GCR Corp.	12-48S-29E	35	-11,480	145			
	Humble #16 GCR Corp.	14-48S-29E	33	-11,392	145	270	415	85
	Humble #17 GCR Corp.	14-48S-29E	34	-11,406				
	Humble B-1 GCR Corp.	23-48S-28E	32	-11,518	265	170	435	5
	Humble C-1 GCR Corp.	21-47S-28E	37	-11,493	225	215	440	30
	Humble D-1 GCR Corp.	3-48S-28E	37	-11,583	230			
	Humble E-1 GCR Corp.	19-47S-28E	31	-11,509	240	200	440	50
	Humble #1 J A Curry	8-47S-29E	45	-11,430	145	285	430	95
	Humble #3 LT Cypress*	28-47S-29E	34	-11,476	145	290	435	85
	Humble B-1 LT Cypress	13-48S-29E	39	-11,371	140			
	Humble C-1 LT Cypress	7-48S-29E	32	-11,638	170			
	Humble B-2 LT Cypress	13-48S-29E	40	-11,375	140			

*Lee Tidewater Cypress Company

TABLE II (Continued)

County	Well Name & Number	Location	Derrick Floor Elev.	Top (Subsea Depth)	Upper Facies	Lower Facies	Total	Lower Facies Porosity Count (In Feet)
Collier (Continued)	Humble B-3 LT Cypress	13-48S-29E	34	-11,371	140			
	Humble B-4 LT Cypress	13-48S-29E	32	-11,373	140			
Dade	Coastal #1 State Lance 340	25-558-37E	25	-10,560	175	250	425	80
	Commonwealth #1 Wisehart (Discovery Well)	21-54S-35E	19	-11,081	225	440	50	
	Gulf #1 State Lee 340	18-54S-36E	18	-11,097	185			
	Gulf #2 State Lee 340	19-54S-36E	18	-11,122	205	240	445	50
	Gulf #3 State Lee 340	19-54S-36E	18	-11,132	180	260	440	70
	Humble #1 State	30-55S-36E	15	-11,145	175	285	460	40
	McCord #1 Damoco	31-53S-35E	17	-11,183	240	210	450	40
Glades	Coastal #1 Tiedtke	25-42S-33E	30	-10,860	0?	155??	155??	45
Hardee	Humble #1 Keene	23-35S-23E	83	- 9,867	70?	115?	185?	20
Hendry	Commonwealth #3 Red Cattle Company	25-45S-28E	50	-11,225	165	205	370	120
	Humble 1B Collier Corp.	14-47S-31E	40	-11,290	180	205	385	85
	Humble #1 Cons. Nav. Stores	5-45S--29E	40	-11,175	155	200	355	80

TABLE II -- (Continued)

County	Well Name & Number	Location	Derrick Floor Elev.	Top (Subsea Depth)	Upper Facies	Lower Facies	Total	Lower Facies Porosity Count (In feet)
Highlands	Continental #1 Carlton	20-38S-28E	88	-10,122	40?	130?	170?	40
	Humble #1 Carlton	34-38S-29E	114	-10,106	40?	120?	160?	30
Hillsborough	Humble #1 Jameson	7-318-22E	108	- 8,682	10?	50?	60?	0
Lee	Gulf #1 Cons. Nav. Stores	27-45S-26E	45	-11,325	140	275	415	40
	Humble #1 Kirchhoff	23-45S-24E	24	-11,406	260	170	430	20
Manatee	Magnolia #1 Schroader Manatee	11-358-19E	69	-10,081	65?	150?	215?	30
Monroe	Gulf #1 State Lee 373 (Big Pine Key)	2-678-29E	23	-12,127	460	100	560	0
	Gulf #1 State Lee 8260 Florida Bay	28-62S-32E	21	-11,789	480	60	540	4
	Robinson #1 State Lee 362	29-59S-40E	20	-10,025	130	235	365	40
Monroe	Sinclair #1 Williams	24-59S-40E	20	- 9,810	125	205	330	20
Okeechobee	Amerada #1 Swanson	5-36S-34E	54	- 9,096?	0?	35?	35?	5
Palm Beach	Amerada #1 Sou. States	34-41S-39E	36	-9,939?	0?	95?	95?	30
	Humble #1 Tuscon	35-43S-40E	34	-10,196	0?	125?	125?	20
Pinellas	Coastal #1 Wright	7-30S-17E	13	- 9,282	10?	160?	170?	5

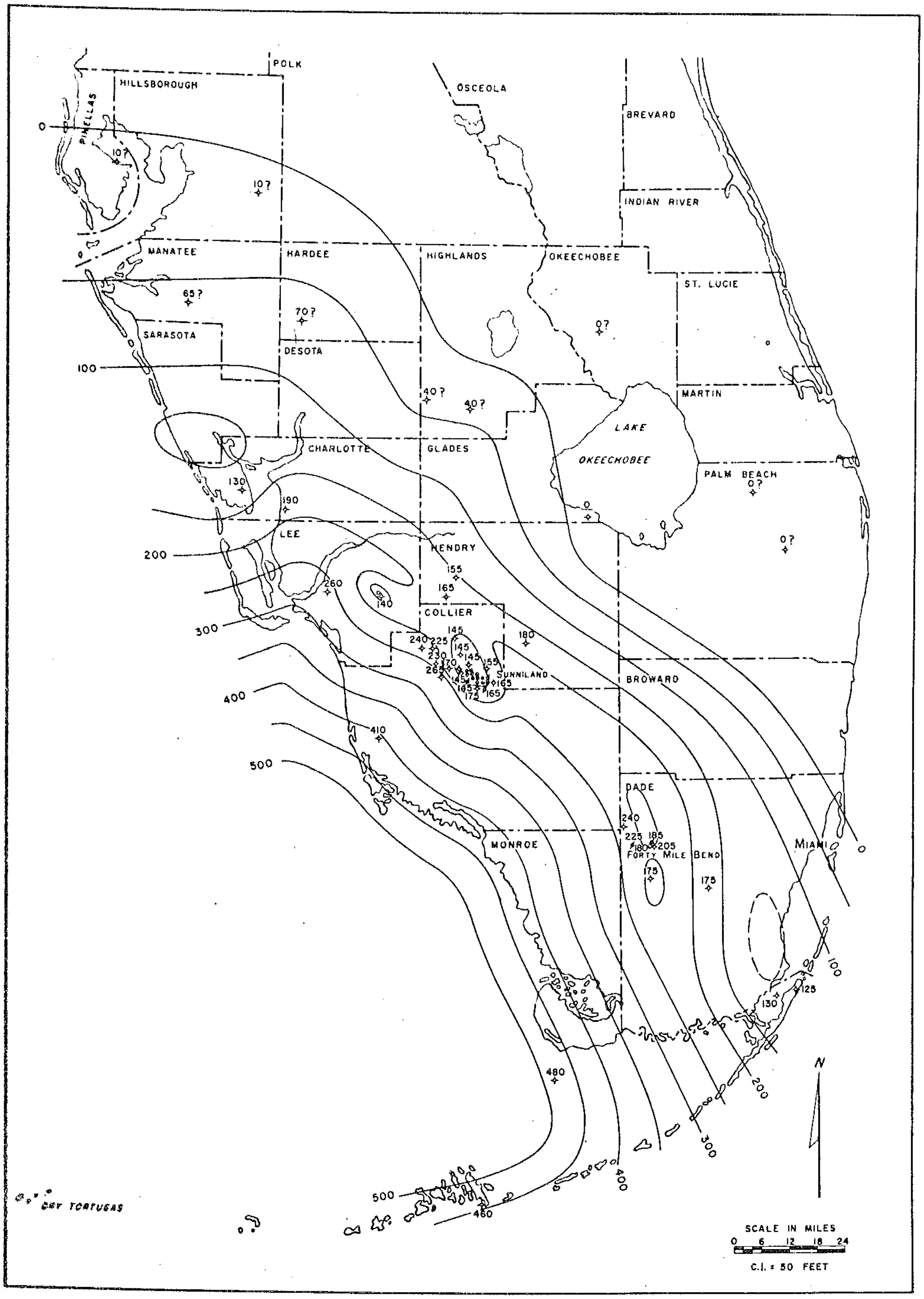


Fig. 5.—Isopachous map of the upper Sunniland facies.

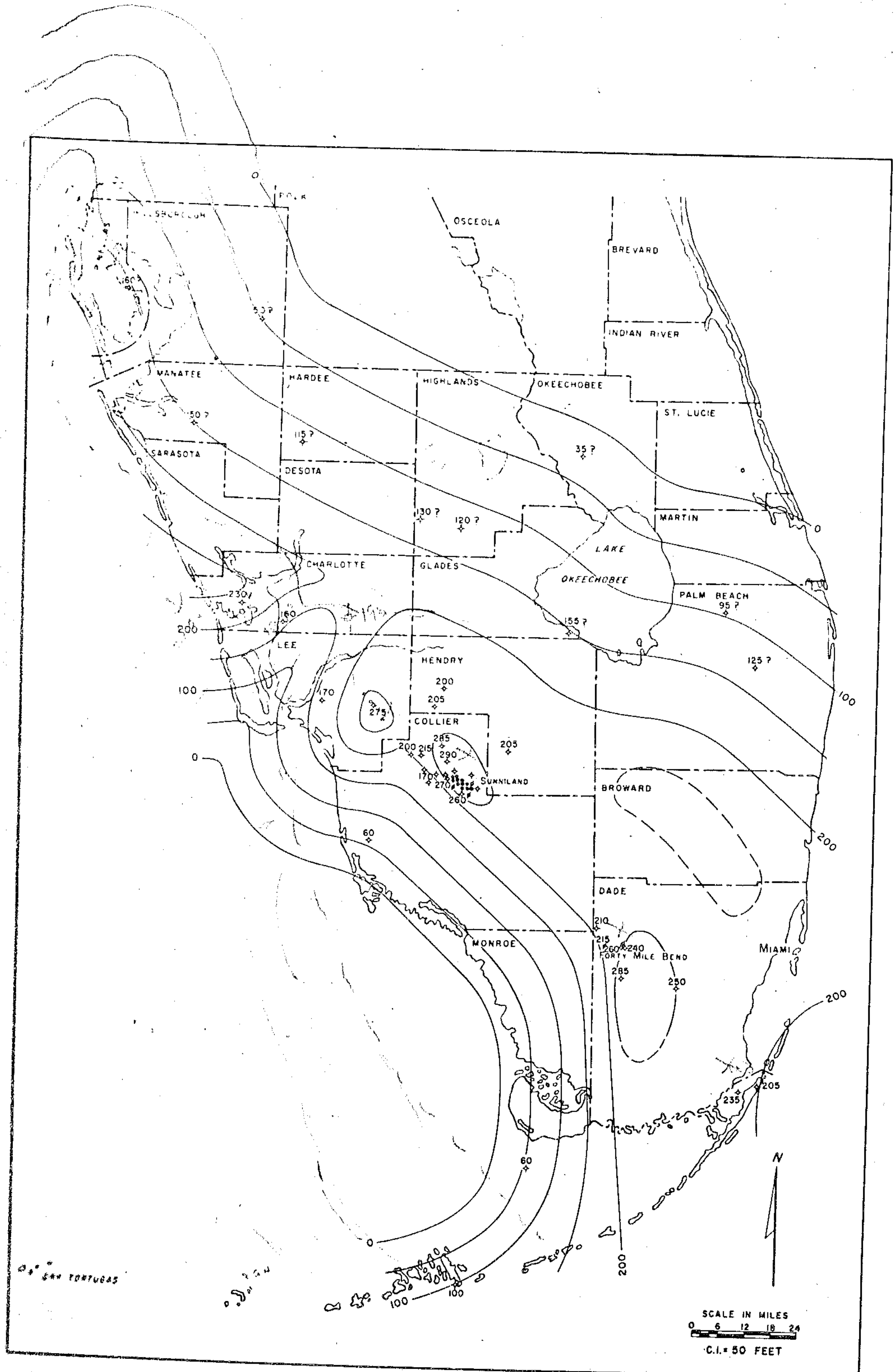


Fig. 6.--Isopachous map of the lower Sunniland facies.

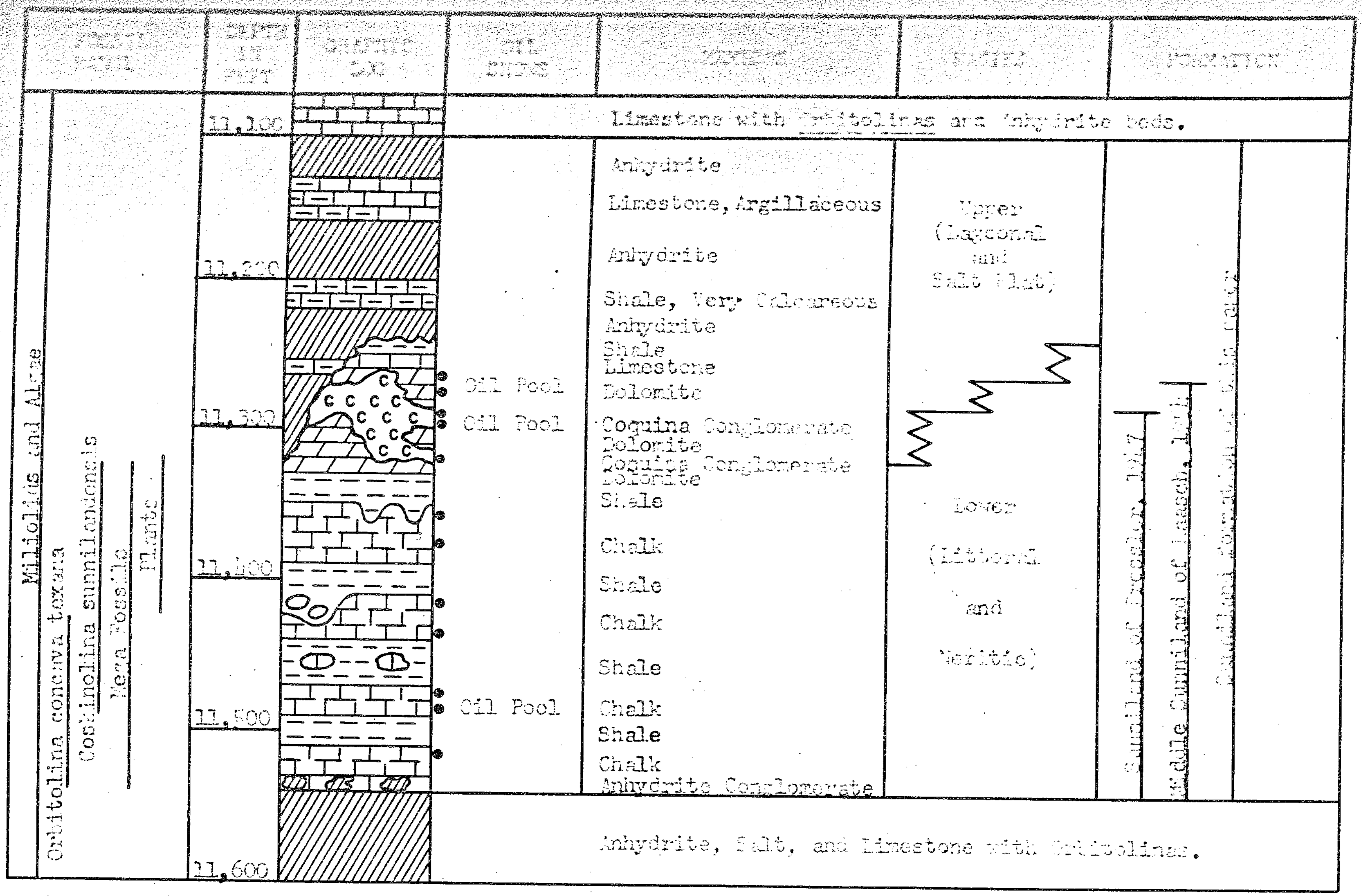


Fig 7. Generalized chart of the Sunniland formation in Bend Area.

fraction is a land derived sediment carried to the basin by rivers which flowed from depply weathered uplands located in North Florida. This clay may have been red before deposition in the toxic, hydrogen sulphide-rich low bottom. A certain amount of airborne volcanic ash from Cuba should be present but has not yet been recognized by the writers. The dark gray members are called shale by some and limestone by others. Within the upper facies the dark gray members are anhydritic and contain ailiolid tests and algal structures. Within the lower facies the dark gray members are typically thick, massive, pyritic and fossil poor with only a few large burrowing clams and snails. Certain thin dark gray members are gradational with chalk and have many fossils such as miliolids, swell high spired snails, Orbitolinas and plant remains. Certain of the dark gray members are inter-laminated with brown and black chale layers rich in organic matter. The dark gray members are the initial members of cyclic deposition within the Sunniland formation.

There are light gray chalk members from a few inches to thirty feet in thickness composed mostly of clay to sand size calcite particles. The Sunniland chalks are clastic marine depostis derived locally from the debris of plant and animal life which grew around oxygen-rich high bottoms. This debris became ground fine by wave motion and was deposited in marine bottoms without exposure to fresh water or air. Certain of the chalk members which are rich in organic matter are light brown or brown in color. Typical chalk fossils are the tents of the benthenic infauna Coskinolina sunnilandensis Mayac and Orbitolina concava-texana (Rosmer) together with miliolids, estracods, a few rudistid shells and a few plant remains. The chalk members are porous but poor aquifers. Much of their original oil is still trapped in and around the fossils. Secondary permability has developed along styolites, fractures and vugs which in part are now filled with anhydrite and oil. A chalk member of the lower facies at 11,462 to 11,486 feet in the discovery well of Forty Mile Bend Field was acid-fracked and appeared to be capable of producting 20 barrels of 23 degree A. P. I. gravity oil per day along with considerable salt water. After testing, it was plugged off and not produced.

In the upper part of the lower facies certain chalk beds are altered to dolomite. Initial deposition of fine organic debris in swamp areas or the flow of mineralized water through marine chalk beds has altered the original calcite and aragonite particles into dolomite crystals. Such dolomites are brown, finely to very finely crystalline, with fair inter-crystalline porosity but still with low permeability. In the alteration process the calcity fossils and perhaps the original oil was lost, but a desireable reservoir rock was gained. A few of the dolomites still contain abundent plant remains. The discovery well of Forty Mile Bend Field was completed in this type of reservoir. On drill-star-test a domomite from 11,323 to 11,326 feet having 14 millidarcy permeability and 19 per cent porosity showed gas to the surface in 6 3/4 hours and produced 32 barrels of 21 degree A. P. I. gravity oil and 5 barrels of salt water in 12 hours. After acidisation it was completed as a 175 barrel-per-day pumper producing 60 per cent oil and 40 per cent salt water with slow decline for a period of seventeen months when 100 per cent salt water broke in suddenly.

Coquina members are present in the upper part of the lower facies of the Sunniland formation. They might also be called shell conglomerates based on the particle size. These thin and thick beds of shells have been called "Rudisted Reefs" and "Chumid Zones". Along with the Chamacea remains there are miliolids, high spired gastropeds, a few Coakinolinas and other fossils which are being illustrated by Mrs. Esther Applin in a paper now in press. These coquina members are in part recrystallized, in part leached with holes up to three inches in size, and in part replaces with anhydrite, calcite, dolomite and oil. These coquina beds comprise an important part of the Sunniland aquifer and locally exhibit good permeability and porosity. They could easily contain and produce a prolific amount of oil. Pressler (1947, p. 1959) records the average permeability of four Sunniland wells completed in reef limestone as 312 millidarcys parallel with the bedding and 84 millidarcys perpendicular to the bedding. Rassch (1955, p. 30) gives the porosity range for the main pay at

Sunniland Field as 11 to 33 per cent with an average of 18 per cent. He describes the main pay as being in a limestone composed of fossil fragments (Caprinids) with chalky cement. In his opinion (1955, p. 29):

"Porosity and permeability are probably due to the recrystallization of either the chalky cement or the caprinid fragments or of both. When both the cement and the caprinids are recrystallized, the resulting inter-crystalline porosity is at its highest with little remaining of the original shell gragments except brown outlines from which minute calcity crystals project."

The second producer of Forty Mile Bend Field was completed in a coquinoid type of reservoir. On drill-stem-test eight feet of altered coquina from 11,344 to 11,352 yielded gas to the surface in 5 hours and produced 130 barrels of 20 degree gravity A. P. I. oil in 8 hours and no water. This well was completed natural as a 500 barrel per day pumper producing 20 per cent oil and 80 per cent salt water, with a rapid decline in a few months to less than 5 per cent oil. On abandonment a half-inch hole was found in the oil casing above the cement and below the pump seat. If only the three feet of oil-saturated coquina recovered in the incomplete bottom-hole core were productive, there could easily have been 250,000 barrels of oil in place under this 160 acre location.

The Sunniland formation has white anhydrite members which are mottled with irregular and intersecting seams of limestone, shale, and dolomite. The anhydrite members vary from a few inches to 65 feet in thickness. A few of the anhydrite members are lithographic in texture, colored dark gray, brown, or pink, depending on the type of disseminated impurities and are thin bedded to laminated. Typically, however, the anhydrite beds are fine to coarse crystalline, colored white, and the impurities are in irregular and intersecting seams or veins. This is a distinctive and hard to explain type of parting. Apparently, the original bedding has been destroyed over wide areas by some repeated physical rupture of the beds and by chemical unmixing of the anhydrite from original impurities during recrystallization.

In one part of the Sunniland basin, salt occurs in the thick anhydrite beds of the upper facies (Fig. 4). This is not surprising as the formation waters of the Sunniland formation are very salty being almost a saturated brine. However, it is surprising that so little salt is associated with the thick anhydrite beds. In the Florida Bay well there is 300 feet of anhydrite to 20 feet of salt, a ratio of 15 to 1. Even in the "massive anhydrite" zone below the Sunniland formation only two thin salt beds are presently known.

Many of the limestone and shale members of the Sunniland appear to be eroded. The beds of limestone and anhydrite pebbles in shale indicate reworking of certain members. The pits in the top of limestone members filled with shale indicate periods of solution. At Forty Mile Bend these inter-member diostems have local relief and cause the amount of closure on various horizons to differ by 10 feet more or less. In the nearly flat part of the Sunniland basin between Sunniland Field and Lake Okeechobee the pinch out of porous dolomite or coquina members could form commercial oil traps. Figure 8 shows a regional dip of only 10 to 20 feet per mile in part of the Sunniland trend.

Fig. 8.-- Structure map of the Sunniland formation.

From a grain size point of view, the shale-to-chalk-to-coquina cycle of sedimentation as found repeated in the Sunniland formation is the reverse of the usual conglomerate to sand to shale cycle of a marine transgression. Apparently this kind of grading is by an increase with time in the amount and size of source material (organic debris) resulting in the formation of summit conglomerates that locally fill the basin. Both basal and summit conglomerates are present in the lower facies of the Sunniland formation. It is economically important to note that the summit conglomerates of the Sunniland formation are much thicker that the basal conglomarates and much more porous and permeable. Another South Florida example of a summit conglomarate is the coquina at the top of the Upper Cretaceous. It is 500 to 600 feet thick, has oil shows, and is both porous and permeable, whereas, a basal Upper cretaceous conglomarate size-grade has yet to be found in South Florida. In this connection, and by way of comparision, the thick marine conglomarates described by Lewis and Straczek (1955, p. 262) in the San Louis

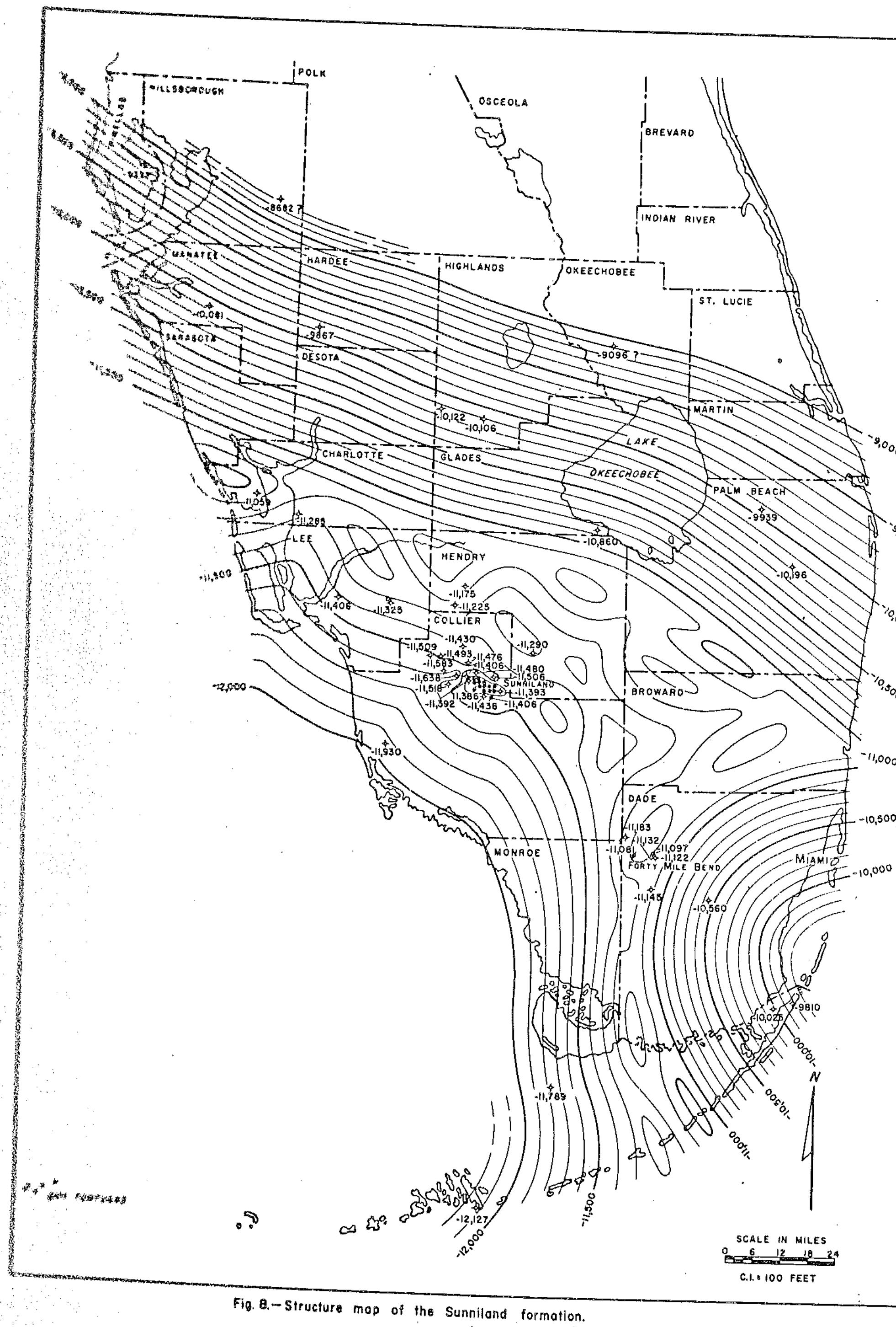


Fig. 8.—Structure map of the Sunniland formation.

formation of Cuba may be similar only related to and increases with time in the amount and size of volcanic debris within a shallow embayment that could become locally filled.

Bedding

Sunniland bedding is in part thin, in part laminated and in part missing. The Sunniland formation contains several thousand beds, each deposited during one storm, one flood, one dry speed, or one season. Repeated scour by surface waters plus corrosion and rupture by round waters have destroyed much of the original bedding. However, both the normal and the disordered bedding in the Sunniland formation records the multitude of Cretaceous events which were associated with the occurrence of oil in South Florida.

Oil Traps

The Sunniland formation contains many factors considered favorable for the accumulation of oil and gas. The organic shale and limestone members with their oil filled fossils and rank odor of hydrocarbons are source beds. These beds were given quick burial by flood type shale deposition. The chalk and coquina members have been altered into good reservoir beds. Over most of its extent the lower facies with source and reservoir beds is covered unconformably but quickly by contemporaneous anhydrite deposition. Hense, the stage is set for accumulation of oil and gas in stratigraphic and depositional traps.

Much of the Sunniland oil may have escaped because over a large part of the prospective area the inter-fingering of the capping upper facies is in a direction that permits the escape of oil and gas toward the edge of the basin. The dolomite saturated with dead oil found in the first well drilled into the Sunniland formation in Glades County (Coastal No. 1 Tiedtke) indicates an area of contemporaneous seepage. On the other hand, the member pinchouts within the lower facies appear to be in a direction that generally arrests the up-dip migration of oil. This accounts for certain wells having live shows of oil in the middle (Commonwealth No. 3 Red Cattle) and in the bottom (Robinson No. 1 State) of the formation.

In addition to stratigraphic type oil traps the Sunniland formation is known to be involved in gentle asymmetrical anticlines. The anticlinal structure at Sunniland Field is 5 miles long and

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Fig. 9.-- Structure map of Sunniland Field (courtesy of Humble Oil & Refining Company).

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3 miles wide and has 2,400 productive acres. As mapped by Raasch (Fig. 9), the fold is Asymmetrical. The northeast flank dips at the rate of 150 feet per mile, the southeast flank dips at 50 feet per mile. The crest at 8,500 feet is 2,500 feet southwest of the crest at 11,500 feet. (Raasch, 1955, Figs. 6 & 7) Because the crest-line plane dips toward the steep side of the anticline, it

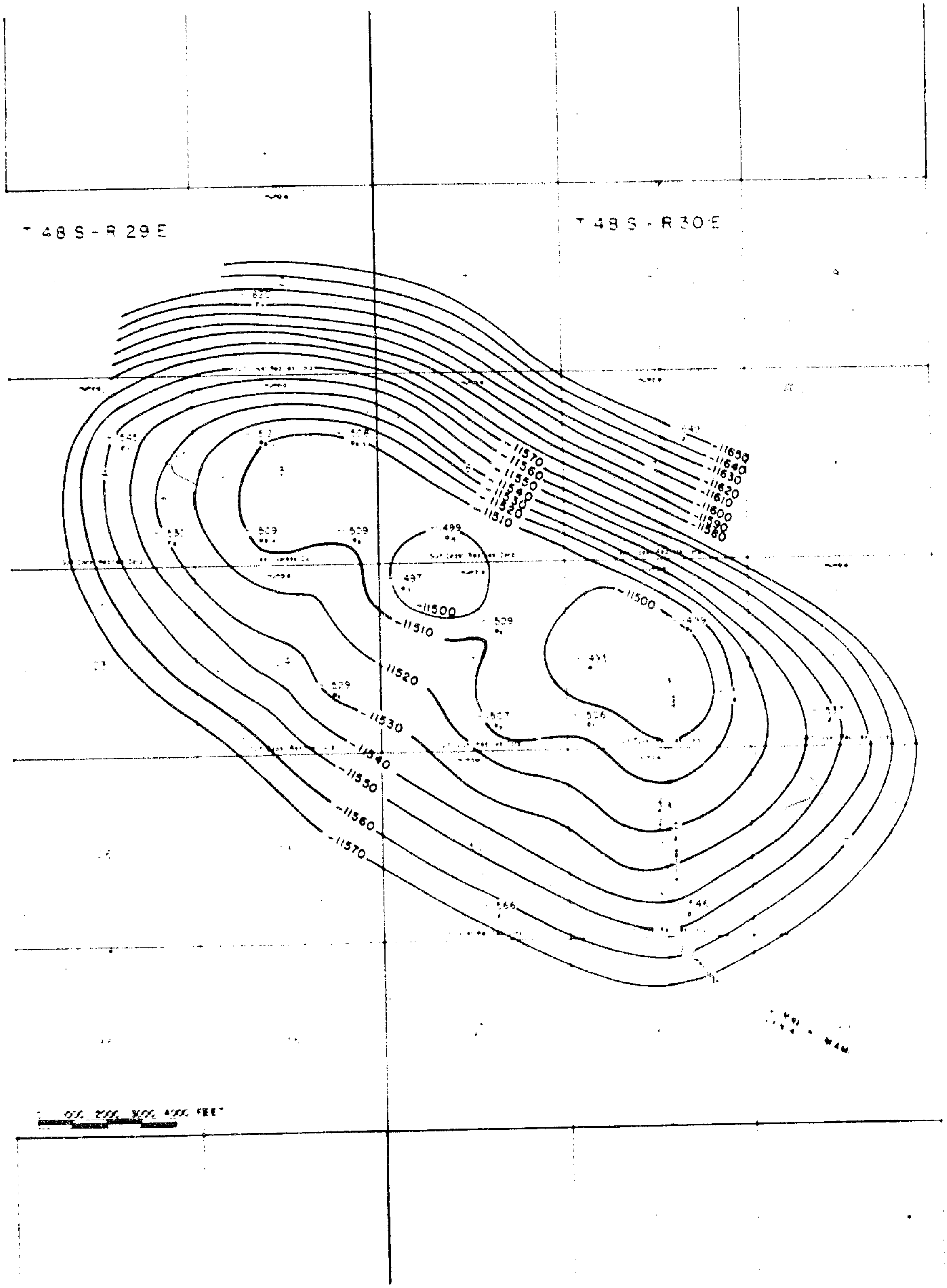

Fig. [illegible] - Structure map of the Sunniland field, contoured on top of the middle member of the Sunniland formation. Contour interval ten feet.

is a depositional structure (Condon, 1956) reflecting burried topography and not a tectonic fold.

Present sub-surface data show 50 feet of reversal on the Forty Mile Bend structure. The direction of crest line shift is not known, but such a shift could easily have caused the initial tests located on refraction seizmic anomalies at the 9,000 feet level to be edge wells.

Artesian Aquifer

Considering that the saline facies of the Sunniland has only a limited amount of sediment that might be classified as organic debris, and an equally small amount that might be of terrestial origin, there is a problem of source for this widespread deposit. Following the ideas presented by Scruton (1953, Fig. 4) the saline facies of the Sunniland could have been deposited in a large lagoon or estuary with minor fresh water inflow and major inflow from the open ocean. However, in order to explain the peculiar parting in the anhydrite beds, the partial dolomitization of the lower facies as well as the very low anhydrite to salt ratio, an inflowing marine surface current is not considered the major source of the saline facies. Rather, it is strongly suspected that a tremendous amount of ground water must have passed through the lower facies to supply the source for the bulk of the mineral matter of the saline facies. Since the Sunniland saline basin could have been below sea level, ground water may have flowed through the lower facies from the ocean. However, at any near sea-level position, ground water may have flowed from near by swamps or intake areas in the red, arbosic hills of North Florida which at that time extended near sea level to an elevation of about 3,000 feet. Such land derived ground water would be rich in calcium and magnesium and organic sulphur compounds. Whatever the source of the groundwater it appears reasonable to propose a well developed and efficient aquifer for the Sunniland formation.

An estimate of the thickness and distribution of porous limestone and dolomite within the lower facies of the Sunniland formation is shown in Figure 10.

Mineralized ground water flowing through the lower facies is the agent responsible for the converting of chalk and chalky coquina into dolomite and cavernous limestone. The flow of ground

Fig. 10.-- Porosity thickness map of the lower facies of the Sunniland formation.

water concentrated the Sunniland oil into the available reservoirs. Ground water under pressure is the agent that destroyed the bedding of most of the anhydrite members and gave to them the intersecting mud-filled partings and their ruptured and pebbly appearance. Thus it is probable that the rocks of the upper facies of the Sunniland formation were deposited in a broad, arid estuary that had many oil, gas, and salt water soaps feed by a low pressure artesian aquifer.

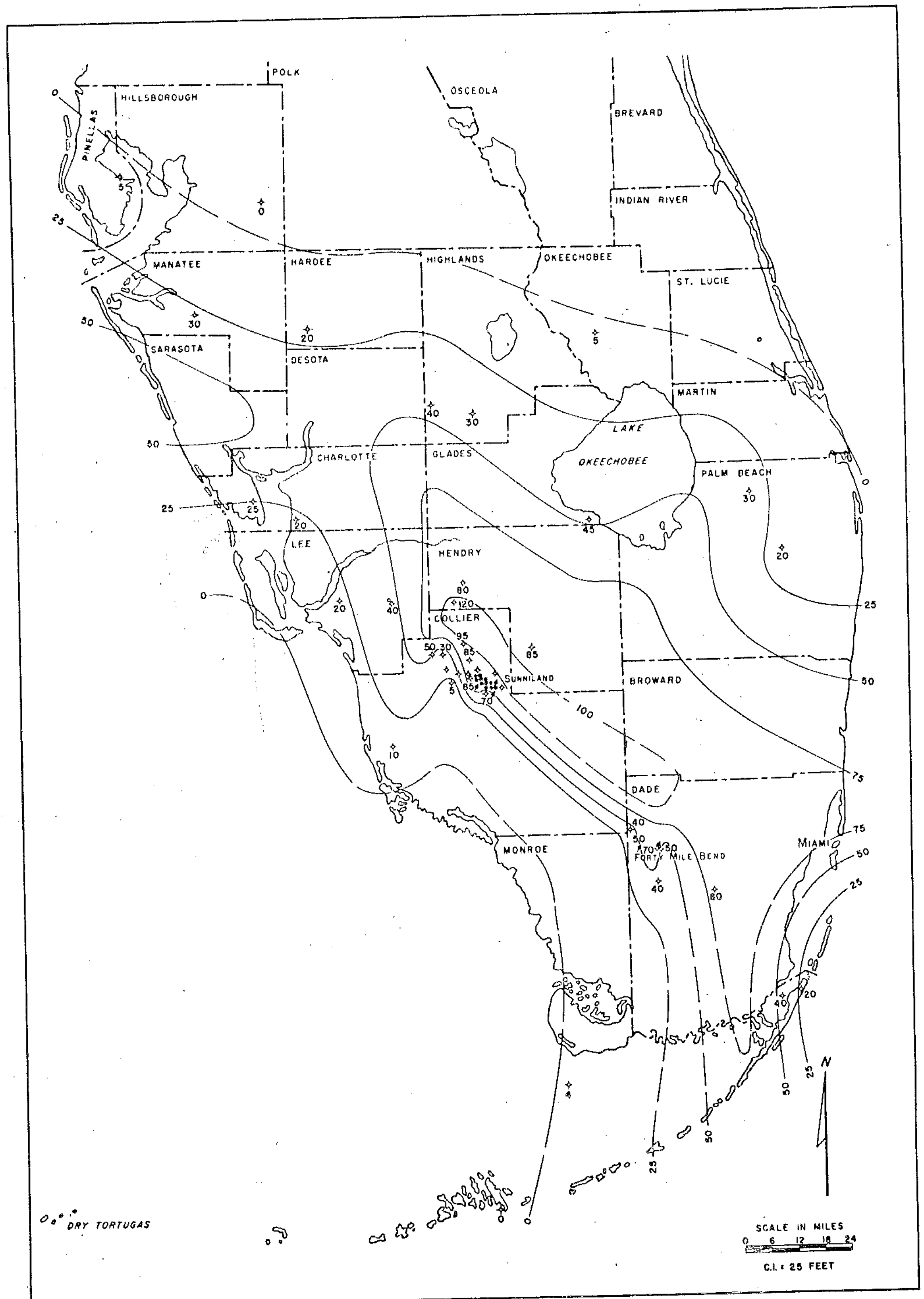

Fig. 10.—Porosity thickness map of the lower facies of the Sunniland formation.

OIL LEASE VALUES AND RECOMMENDATIONS
South Florida Acreage

The oil lease value of any South Florida land has been stable for the past ten years at about 50 cents per acre for commercial oil and gas leases without drilling obligations. This value is based on the following favorable facts applying to oil South Florida acreage.

1. Commercial oil has been found in South Florida.

2. Prolific oil production occurs in similar rocks in Mexico, the Middle East and West Texas.

3. There is a constant threat that large volumes of foreign oil may be lost to the markets of domestic companies.

4. Core drill and Seismic methods have found burried structures with prolific oil production under other flat coastal areas in Texas and Louisiana.

These facts have been known for 12 years, causing major companies to maintain seven million to eleven million acres under lease and to complete 1201 crew weeks of seismic work and 426 crew weeks of core drilling (Table III). The resulting seizmic and core drill tests have temporarily condemned the seismograph and core drill as discovery tools for South Florida but have not condemned any of the acreage.

Table III.--Acreage and geophysical activity in South Florida for the 12 years following the discovery of Sunniland Field. (Limited to South Florida south of and including Manatee, Hardee, Highlands, Okeechobee, and St. Lucie counties).

TABLE III. -- Acreage and geophysical activity in South Florida for the 12 years following the discovery of Sunniland Field. (Limited to South Florida south of and including Manatee, Hardee, Highlands, Okeechobee, and St. Lucie counties).

Year	Number of Acres Under Lease	Geophysical Crew Weeks				
		Seis	Core Drill	Gravity Meter	Magnetometer	'Total'
1944	4,640,000	29	11	163	26	229
1945	10,980,000	15	76	114	9	214
1946	11,220,000	48	80	15	0	143
1947	9,085,000	37	66	3	0	106
1948	9,260,000	0	0	0	23	23
1949	7,185,000	0	24	5	0	29
1950	7,320,000	0	0	51	0	51
1951	7,790,000	12	31	0	0	43
1952	9,290,000	223	24	0	0	247
1953	10,840,000	330	14	16	0	360
1954	10,455,000	344	51	0	0	395
1955	11,340,000	163	49	19	10	241
	TOTALS	1,201	426	386	68	2,081

Sunniland Trend Acreage

Major company drilling and that of Independents have outlined a large favorable area in which to prospect for Sunniland Oil. (Fig. 11) The market value of Sunniland trend acreage should be more than 50 cents per acre because only this South Florida acreage has the following favorable facts applying to it.

Fig. 11.--Lease map of Sunniland trend in South Florida.

1. Sunniland Field is now known to be profitable beacuse of its long life and low lifting cost.

2. Identical fossils have been identified from the Sunniland limestone and the El Abra Limestone of the Golden Lane of prolific production in Mexico proving a very close relationship between these two areas.

3. The gravity meter has now been adapted for detail exploration and is finding burried structures with oil. Since Sunniland Field is a gravity anomaly, this tool holds great promist in finding other Sunniland limestone fields.

4. Enough sub-surface information is now available to outline a Sunniland porosity trend and develop sub-surface prospects, such on Forty Mile Bend prospect. Citronelle is a sub-surface discovery in the same trend of Lower Cretaceous production. At present most of the Sunniland trend is leased.

Figure 11 shows the acreage held by other companies in the favorable area which has at least 200 feet of lower facies and 50 feet of estimated porosity in the Sunniland formation.

Humble Oil and Refining Company is actively leasing at 50 cents Bonus and 50 cents Rental for full interest 10 year leases. Considering that Coastal has only one large lease block in the fairway of the Sunniland porosity, Forty Mile Bend, the writers recommend that

Coastal bay additional leases or minerals, alone or jointly with others, paying up to 50 cents bonus and rental for full 7/8 leases and up to 4 dollars for full mineral acres. Also, we recommend that Coastal make the effort to obtain a 1/2 interest farm-out and drilling agreement involving Forty Mile Bend acreage.

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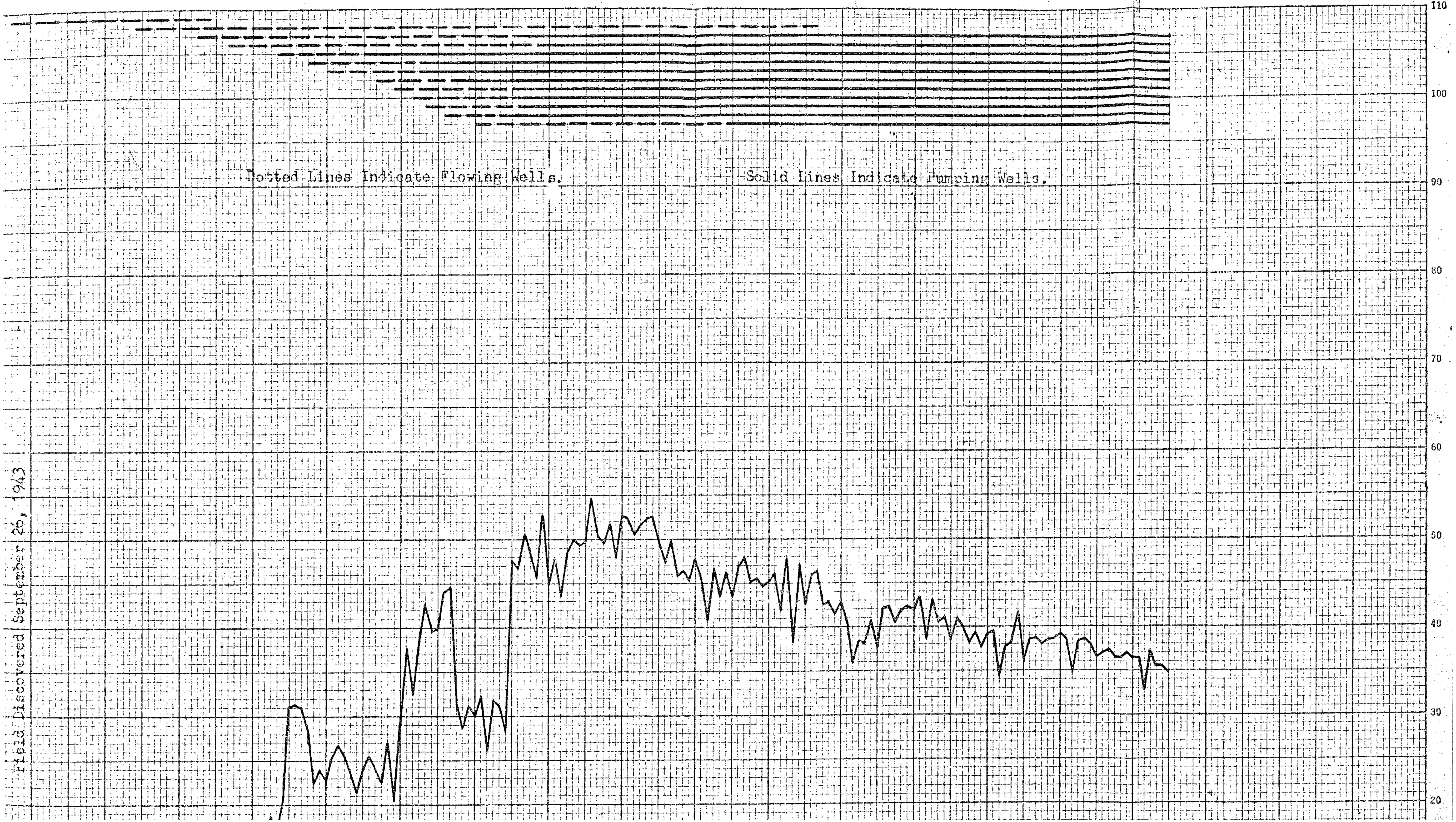

Dotted Lines Indicate Flowing Wells.
Solid Lines Indicate Pumping Wells.
Field Discovered September 26, 1943
110
100
90
80
70
60
50
40
30
20