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DEPOSITIONAL AND DIAGENETIC HISTORY OF
SELECTED MESOZOIC SEDIMENTS OF THE
SOUTH FLORIDA BASIN

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ABSTRACT

The uppermost Jurassic(?), and lower Cretaceous rocks of the South Florida Basin consist mainly of limestones, dolomites, and anhydrites, with a basal clastic unit. The carbonate sequence between the regionally occurring Punta Gorda Anhydrite and the basal clastic unit was deposited on a shallow water platform similar to the Bahama Platform of today. This carbonate sequence formed in a sabkha type environment similar to present day examples of the Trucial Coast of Arabia.

The dominant lithofacies identified are circulation-restricting barrier grainstones and associated transitional packstones, carbonate mudstones and wackestones deposited in both hypersaline and normal saline environments, and supratidal nodular anhydrites and associated penecontemporaneous dolomites. A bindstone facies of algal origin was also tentatively identified. Diagenetic alteration of these sediments is predominantly expressed by dolomitization, phreatic cementation, neomorphism, and other minor effects.

These conclusions were reached following petrographic study of sprinkle thin-sections of well cuttings from four on-shore south Florida oil tests. The cuttings were mounted in Bio-plastic mounting medium and conventionally thin-sectioned. This technique proved to be a workable method for studying well cuttings in carbonate provinces. However, if exact vertical facies changes are to be interpreted, a more detailed follow-up is needed because of the small volume of sample studied from a very large volume of well coverage.

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EXPLANATION OF PHOTOGRAPH CODES

Under each photograph in this thesis is a two part code. The first code is used for lighting; the second for scale. The following is the explanation for each code:

Lighting

P P L - plane polarized light

X P - crossed polarizers

Scale

V L P - very low power (x 1 objective) length of photograph 13.0 mm

L P - low power (x 2.5 objective) length of photograph 5.25 mm

M P - medium power (x 10 objective) length of photograph 1.30 mm

H P - high power (x 40 objective) length of photograph 0.33 mm

In the photograph description, the thin-section is identified by well code and depth.

INTRODUCTION

The South Florida Basin contains a thick sedimentary rock sequence composed predominantly of limestones, dolomites, and anhydrites. Few wells have penetrated this entire sequence. The majority of wells were drilled to penetrate the Cretaceous Sunniland carbonates, the only zone in south Florida proven to be economically productive. There remains a predominantly carbonate sequence of underlying Lower Cretaceous - Upper Jurassic(?) age rocks that has seen only token exploratory activity. Four wells that were drilled into or through this pre-Sunniland sequence of carbonate rocks comprise the data base for this study (Fig. 1). In this figure, codes appearing in parentheses following the well name were used to aid in the identification of samples during this study. These samples were borrowed from the Florida Bureau of Geology in Tallahassee, Florida. The intervals studied for all four wells can be seen in Table I.

The shallowest and most southerly well studied was the Gulf Oil Corporation, State of Florida Lease 373, #1; drilled to a total depth of 15455 ft on Big Pine Key, Monroe County (code: GMI). The well logged on October 2, 1975. The Bureau of Geology identifies this well by Permit #22, W #972.

Farther north is the Mobil Oil Corporation, R.M. Trien #1 (code: MT), drilled in Collier County to a depth of 16456 ft in December, 1972. This well is identified at the Bureau of Geology by Permit #596, W #11765.

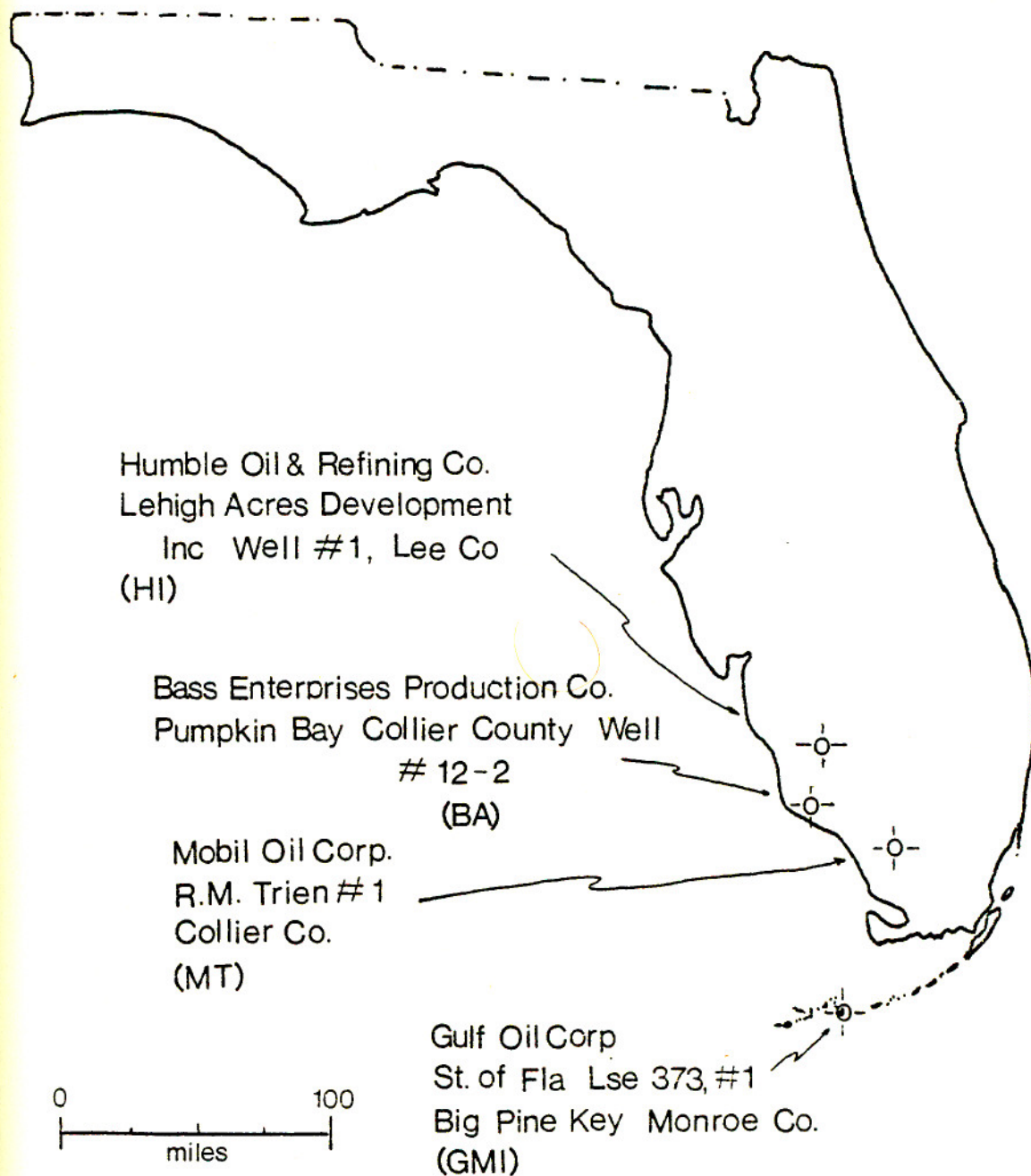


Figure 1. Location Map.

TABLE I
SAMPLE DISTRIBUTION

WELL CODE	FINAL SAMPLE INTERVAL	TOTAL FOOTAGE	NUMBER OF SAMPLES	AVERAGE INTERVAL STUDIED
HI	11900'-15710'	3810'	36	105.8'
MT	13300'-16490'	3190'	30	106.3'
BA	13000'-18660'	5660'	54	104.8'
*GM1	14300'-15450'	1150'	21	54.8'
TOTALS		13810'	141	

AVERAGE INTERVAL STUDIED: 92.9 ft/well.

* Due to the relatively short interval, no reduction in sample size was deemed necessary.

The Bass Enterprises Production Company, Pumpkin Bay, Collier County Well #12-2 (code: BA) was drilled to a total depth of 18671 ft. It was logged on October 2, 1975 and is identified at the Bureau of Geology by Permit #778, W #12838.

The northernmost well is the Humble Oil and Refining Company, LeHigh Acres Development Inc. Well #1, Lee County (code: HI). This well, logged on August 27, 1968 to a total depth of 15710 ft is identified by Permit #407, W #10566. Of the four wells studied, the Humble and the Bass wells penetrated basal clastics. The other two wells reached a total depth in the overlying limestone, dolomite, anhydrite sequence. All four wells were dry holes.

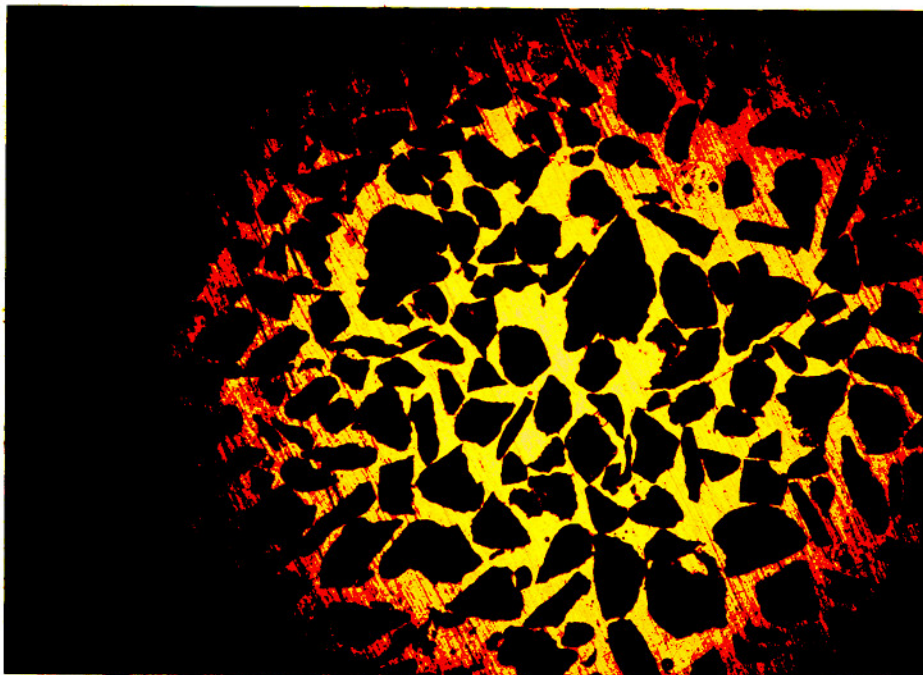
During drilling, samples were gathered at approximately 10 ft intervals. These samples consist of small rock fragments (cuttings) of approximately 1 cm or less in size that have been circulated up the hole in the drilling mud. After collection, these fragments were cleaned for study and storage. Due to the large intervals studied in these four wells, it was necessary to increase this sample interval for petrographic study. Initially, washed cuttings were sampled every 50 ft. A teaspoon or less was collected to conserve the available samples. Where visual examination detected a hydrocarbon show (accumulation of asphalt), the sampling interval was shortened to 10 - 20 ft.

A further reduction of sample size was accomplished after a visual examination of the cuttings. Changes in gross lithology, sample color, or texture were the parameters used to determine which

samples would be thin-sectioned. The final sample distribution which resulted from this reduction, can be seen in Table 1. The samples were then thin-sectioned for study (see Sample Preparation).

The purpose of this study is twofold. First, it was necessary to ascertain that lithology could be determined with accuracy by analyzing samples. This was accomplished by point counting individual lithologies and fabrics within each thin-section (Photo #1). From this data, a dominant lithology and fabric was determined. In a study that precisely determined these parameters in one well, the generalization that one fabric and lithology prevail throughout an entire 10 ft interval would be unacceptable. However, this study deals with regionally distributed, widely spaced samples. Therefore, this one fabric, one lithology assumption will not adversely effect the regional interpretation of the data. As will be pointed out in a subsequent section, the easily recognizable anhydrite units (both in thin section and on density log response) indicate that a dominant lithology, if not fabric, could be determined from a "sprinkle thin section".

Secondly, this study reveals a general history of deposition and diagenesis for the rocks below the Punta Gorda Anhydrite. The Punta Gorda lies just below the Sunniland carbonates, and is used as an upper marker for this study. All intervals sampled were taken from below this regional anhydrite unit. No attempt was made to determine the exact lower boundary for the Punta Gorda. Sampling commenced below the last anhydrite samples seen in cuttings below the known



P P L

V L P

Photo # 1. Example of chip distribution on an unidentified thin-section.

top of the Punta Gorda in each well. This last seen anhydrite may have been the basal Punta Gorda, or a closely underlying anhydrite.

This pre-Punta Gorda sequence has been referred to in the literature very generally as the Fort Pierce Formation. The Florida Bureau of Geology has recently introduced new pre-Punta Gorda nomenclature (see REGIONAL STRATIGRAPHY) (Applegate et al, 1981). For this thesis however, no formation names are used to subdivide the interval studied. This is because the regionally occurring anhydrites used to distinguish the new formations were not readily identifiable in the four thesis wells. Therefore, these sediments will be loosely referred to as pre-Punta Gorda carbonates.

PROCEDURE

Sample Preparation

By using Bio-plastic mounting medium, available from Wards Scientific, the cuttings can be conventionally thin sectioned. This mounting medium allows the aggregation of the cuttings into one mass, which can be glued onto a thin section slide like a rock fragment.

The procedure used requires a thin layer of chips from one sample to be placed in an ice-cube tray. The sample is covered with a .5 - 1.0 cm thickness of prepared Bio-plastic. By using a toothpick and gently stirring the chips, trapped air bubbles are released and the chips can be distributed evenly across the bottom of the block. After the Bio-plastic starts to solidify, sample identification codes can be scratched onto the top of each block. Curing time is usually about 24 hours, depending on the amount of catalyst used. After curing, block removal requires only a gentle tap on the bottom of the tray.

The next step involves sanding the sample side (bottom) of the block on commercially available wet-dry sandpaper, or on a diamond grinding wheel if available. Best results are obtained by using a sequence of medium, fine, and extra fine abrasives. Using a small amount of water on the sandpaper, which is taped to a table, the block can be sanded down until the maximum number of chips are exposed on the block face. By drying the block, the exposure of sample at

the surface can be easily seen. The chips will appear dull compared to the reflective mounting medium where the chips are exposed on the face of the block. Lastly, scratch marks on the sample surface can be removed by lightly sanding on fine and extra fine wet-dry sandpaper.

Acetate Peels

Acetate peels are useful when studying the very fine-grained carbonate muds. The peels commonly display very subtle textures which may be masked by diagenetic changes. Most commonly in this study the peels help to show the pelloidal texture of the carbonate muds.

Acetate peels are made from the ice-cube tray blocks. It is necessary to make the peel before the thin-section is made. Once the cubes have been destroyed by the conventional thin section preparation, additional peels cannot be made unless the entire process is repeated. The acetate peel method described by Boardman and Utgaard (1964) served as a guide for the peel preparation.

Satisfactory results are obtained by polishing the prepared blocks on a high speed polishing wheel with a mounted very fine polishing cloth (available from Wards Scientific). By using an empty squirt bottle, small amounts of water can be added to the polishing pad to allow lubrication during this process. By mixing one drop of liquid detergent and one teaspoon of .005 micron polishing powder with the water, only light pressure is needed for polishing. Best results are obtained by moving the block in a counter direction to

the spin of the wheel. These procedures were recommended by Dr. Ken McKinney, Appalachian State University, Boone, North Carolina. If these suggestions are followed, an almost mar-free surface will result.

Next, the sample is cleaned thoroughly for etching. This requires a 10% hydrochloric acid solution and an etching time of 2 to 15 seconds. The block must then be washed completely. If the sample is etched for too long, the block can be repolished and the process repeated.

The actual peel is made on clear, colorless cellulose acetate sheets (0.060 inch) cut down to thin-section size. As described by Boardman and Utgaard (1964), these sheets can be deeply scribed and broken easily into thin-section size slides. After the specimen is etched, mounting requires flooding the etched face with acetone. Then, with a smooth, rolling motion (to remove the air bubbles), the block is placed on the slide with little or no pressure. It is important to use as little acetone as possible. Excess acetone will warp the acetate sheet. The block is removed from the acetate sheet with a quick, snapping motion. Boardman and Utgaard (1964) recommended removing calcareous fragments adhering to the slide surface by immersing the slide in concentrated hydrochloric acid until the fragments are dissolved. The slide must then be washed and dried immediately to avoid warping.

Conventional Thin-Sections

Once the peel is produced, the thin section is made from the remaining block. Best results are obtained by lightly repolishing

the face of the etched block and allowing it to dry. The rest of the method involves conventional thin section preparation. Five (5) minute "Foxy Pox" epoxy made by Krazy Glue was used to speed slide preparation, and yielded satisfactory results. It is most important that when the cubes are glued onto the frosted slide that no clamps are used. Clamps will cause the cube to warp at the slide-cube interface. When the sections are cut to the final thickness, the warped area will be removed, leaving a sample-free section in the middle of the slide.

Staining

No cover glass is used on the slides so that Alizarin Red stain for calcite can be applied. After viewing the slide, the stain can be washed off with mild soap and water. This procedure is necessary when the stain conceals grain textures. A small drop of light oil on the surface of the thin section allows optimum viewing of the slide without the cover slip. This oil too can be washed off with mild soap and water if additional staining is necessary. When photographing the slides, no cover slip is needed if a thin film of oil is used.

EXPLORATION HISTORY and PRODUCTIVE OIL PLAYS of FLORIDA

The two productive hydrocarbon plays in Florida are the upper Jurassic Smackover in the panhandle of Florida and the south Florida lower Cretaceous Sunniland (Fig. 2). The development of these two productive areas is reflected in the exploration history of Florida.

Herman Gunter (1949) who was, at the time, Director of the Florida Geological Survey, summarized the early hydrocarbon exploration history in Florida. The earliest oil test was drilled in the Florida panhandle about 1900-1901 by the Escambia Oil Company. This well was drilled to a depth of 1320 ft in Pensacola, Escambia County. Nearby, two more wells were drilled to depths of 1702 ft and 1620 ft by the Pensacola Development Company. Due to lack of records, it is not known why this area was tested. Two wells drilled in Sumter County in 1903 lie within the region referred to as the Ocala Uplift, where upper Eocene limestones are exposed at the surface (Gunter, 1949). Neither of these wells was commercially successful.

At least 87 oil tests were drilled in Florida from 1900 through 1939. Major exploration interest was initiated after a 1939 test in Monroe County was drilled to 10006 ft. This well penetrated the top of the Early Cretaceous Trinity sediments and proved the existence of sedimentary rocks at a depth greater than 10000 feet (Feitz, 1976).

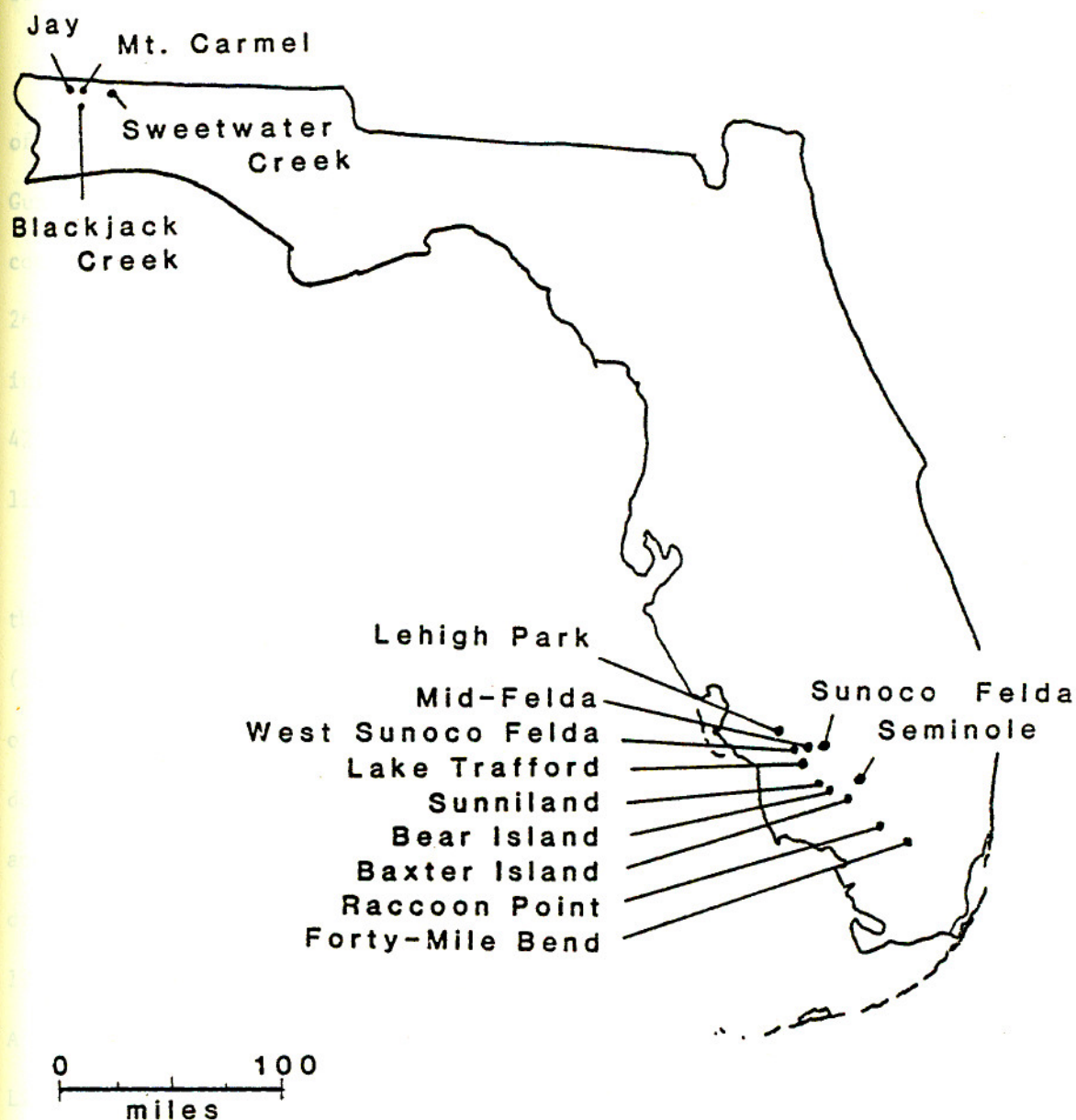


Figure 2. Oil fields in Florida
(from: Florida Dept. of Natural Resources -
Bureau of Geology, unpublished)

South Florida Sunniland Play

The first discovery in Florida occurred in the southern portion of the state at Sunniland Siding, Collier County (Pontigo et al, 1979; Gunter, 1949; Pressler, 1947). The Humble Oil and Refining Corporation completed the Gulf Coast Realties Corporation No. 1 well on September 26, 1943 at a depth of 11626 ft (Gunter, 1949). The well had an initial pumping production level of 97 barrels of 20^o gravity oil and 425 barrels of saltwater per day from a producing interval between 11613 - 11626 ft (Gunter, 1949; Pressler, 1947).

Pressler (1947, p. 1859) informally named the productive zone at the developing Sunniland Field as the Sunniland limestone. Applin (1960, p. B209) used this informal name to designate a subsurface unit of middle Trinity age in south Florida composed chiefly of limestone, dolomite, and shale overlying the "thick anhydrite" or "lower anhydrite" and underlying the so called "upper anhydrite". This "lower anhydrite" is now known as the Punta Gorda Anhydrite (Applin and Applin, 1965) (see Trinity Age Rocks - Punta Gorda Anhydrite, this paper). A description of the lithology and paleontology of the Sunniland Limestone from Sunniland Field was given by Applin and Applin (1965).

Eleven oil fields had been discovered through 1977 in the Sunniland trend (Fig. 2), of which the greatest reserves are at West Felda Field (Florida Bureau of Geology statistics, unpublished, pers. comm., 1980; Pontigo et al, 1979). The productive Sunniland interval at West Felda Field is primarily composed of rudistid reef deposits

with large quantities of algae, bioclastic debris, and pellets. Means (1976) described the producing Sunniland unit as one which had been formed in a normal marine environment and which contained rudists, fragmental rudists, red algae, Orbitolina, and bioclastic debris as the main faunal components. Pontigo et al (1979) stated that this field contains an estimated 142,857,000 barrels of oil in place, with recoverable reserves of 50,000,000 barrels. Productive area is 7500 acres.

Approximately five miles east of the West Felda Field is the Sunoco-Felda Field in Hendry and Collier Counties. Tyler and Erwin (1976) described the Sunniland interval here as a localized reef buildup of a portion of a regional carbonate bank. Production is from a stacked biostromal unit of algal-plate, foraminiferal, pelletal limestone. Means (1976) described the fauna in the field's producing zone as being composed of phylloid algal plates, gastropods, miliolids, intraclasts and a variety of bioclastic fragments. The environment of deposition was in protected, shallow water (Means, 1976). The trapping mechanism is an updip permeability barrier of miliolid-bearing carbonate mudstones and an overlying impermeable brown limestone (Tyler and Erwin, 1976). Farther south, Applin and Applin (1965) described the Sunniland Limestone from the Sunniland Field and the abandoned Forty Mile Bend Field as a series of moundlike features aligned along the basinward margin of the Florida shelf.

Exxon is presently planning development of its 1977 Raccoon Point oil discovery in Dade County (Kinney, 1981). Exxon's Oleum Corp. 34-2,

drilled to a true vertical depth (TVD) of 11412 ft, flowed 1000 barrels of oil per day (BOD) from Sunniland pay at 11355 ft TVD. Exxon anticipates the sustained producing rate for this Raccoon Point well to be substantially less (Kinney, 1981). Other wells in the field produced 10 - 120 BOD.

The Sunniland productive trend is approximately 145 miles in length, with an average width of 12 miles (Applegate et al, 1978). Through 1977, total production was 52,744,000 barrels of oil (Pontigo et al, 1979). Applegate et al, (1978) stated that, as of 1977, the ten Sunniland fields with original oil in place of 238,767,000 barrels, had 90,485,000 barrels of recoverable oil. This represents a 38% recoverability rate. Based on 1980 production data, the five most active south Florida fields produced approximately 12070 barrels of oil per day. West Felda Field had the largest average production of 5500 b/d (Kinney, 1981).

Northwest Florida Smackover Play

The most prolific oil and gas producing area in Florida is in the northwest corner of the state. Here, Jay and Blackjack Creek fields produced in 1979 approximately 89% of the state's oil and 98% of the state's gas (Annual Production Report, 1979; and L.D. Curry, Coordinator of Oil and Gas, Florida Bureau of Geology, unpublished report). A total of four fields have been found (Fig. 2); Mt. Carmel and Sweetwater Creek fields producing only small amounts of hydrocarbons.

Jay Field, the largest and most productive field, was discovered in 1970 by Humble Oil and Refining Company et al with the #1 St. Regis well near Jay, Florida. Production is from Jurassic dolomitized Smackover Limestone on a structural nose below 15500 ft (Ottmann et al, 1976; Oil and Gas in Florida-1977, unpublished report). According to Ottman et al (1976), the trapping mechanism is both structural and stratigraphic, with a 420 ft oil column extending over a 7 mi by 3 mi area. The updip trap is formed by a facies change from dolomitized grain carbonate rock to a dense micritic limestone (Ottman et al, 1976).

Production

Through December, 1981, cumulative oil production for the state of Florida was 415,307,000 barrels of oil and 419,720 million cubic feet of gas (Florida Bureau of Geology, December, 1981 Monthly Production Report). Of the eleven original Sunniland Fields, three have been abandoned, which are Forty Mile Bend Field, Baxter Island Field, and Seminole Field. Of the eight producing fields remaining in the Sunniland trend, Lake Trafford Field has produced the least amount of hydrocarbons (205,000 barrels of oil, no gas) while West Felda Field produced the most (32,633,000 barrels of oil, 2648 million cubic feet of gas) (Florida Bureau of Geology, December, 1981 Monthly Production Report).

In the northwest Florida Smackover trend, the Sweetwater Creek Field (the smallest Smackover Field) produced 3283 barrels of oil and 5384 million cubic feet of gas in 1979 (Florida Bureau of Geology,

1979 Annual Production Report). In 1981, Jay Field produced 301,361,000 barrels of oil and 373,920 million cubic feet of gas to lead Florida's production (Florida Bureau of Geology, December, 1981 Monthly Production Report).

STRUCTURAL SETTING

The four wells studied in this report are located in the South Florida Basin; an area of approximately 77000 sq mi which contains predominately Cenozoic and Mesozoic carbonates and evaporites, approaching 20000 ft in thickness (Winston, 1971; Oglesby, 1965; Pressler, 1947).

Pressler (1947) first designated this area of southern Florida as the South Florida Embayment of the Gulf of Mexico sedimentary basin. The southern boundary of this embayment was outlined by the Bahama and Cuba uplifts, and the northern border by the flanks of the Ocala Uplift (Pressler, 1947). The Ocala Uplift was believed to occur on a south - southeastward trending fold or arch, which was thought to form the axis of peninsula Florida (Gunter, 1921). Subsequent investigations summarized by Applin and Applin (1965) revealed that the structural deformation forming the Ocala Uplift proper probably began in Eocene to Miocene time. The uplift is now known to rest on the southwest flank of the older and dominant Peninsular Arch (Applin and Applin, 1965). The 275 mi long arch trends NW - SE and is the principle positive feature on the Florida peninsula (Rainwater, 1971; Applin and Applin, 1965).

Refinement of the geologic interpretation of south Florida by Applin and Applin (1965) permitted a division of the south Florida embayment. They recognized the south Florida shelf as a broad, relatively flat area of Comanchean rocks southwest of the Peninsula Arch. The south Florida shelf borders the south Florida embayment to

the northeast and is separated from the Peninsula Arch by the southeast plunging Comanchean age Broward Syncline (Applin and Applin, 1965).

Today, the most commonly used structural designation for this region of Mesozoic and Cenozoic sediments is the South Florida Basin, first named by Carsey (1950, p. 364). Owens (1960) defined the structural borders of this basin. The South Florida Basin is part of the larger Florida - Bahama Platform, extending from the Ocala uplift to the north to the Greater Antilles overthrust sheet to the south. The western edge of the Florida shelf and the Atlantic continental slope comprise the platform's western and eastern borders. The South Florida and Bahama Basins are the two dominant structural features of this platform (Owens, 1960).

Winston (1971) recognized the borders of the South Florida Basin as follows (Fig. 3). The northeast border of the basin is the Peninsula Arch; to the northwest is the Middle Ground Arch; and to the west and southwest is the Florida Escarpment, which Bryant et al (1969) postulated was built up or accentuated by a Lower Cretaceous barrier reef. The southern border of the basin is the Pine Key Arch (Winston, 1971). The South Florida Shelf of Applin and Applin (1965), mentioned earlier, is the eastern onshore portion of the South Florida Basin and is approximately coincident with the Sunniland producing trend (Palacas, 1978).

Several minor structural highs and lows, including the southern boundary Pine Key Arch, are present in the South Florida Basin

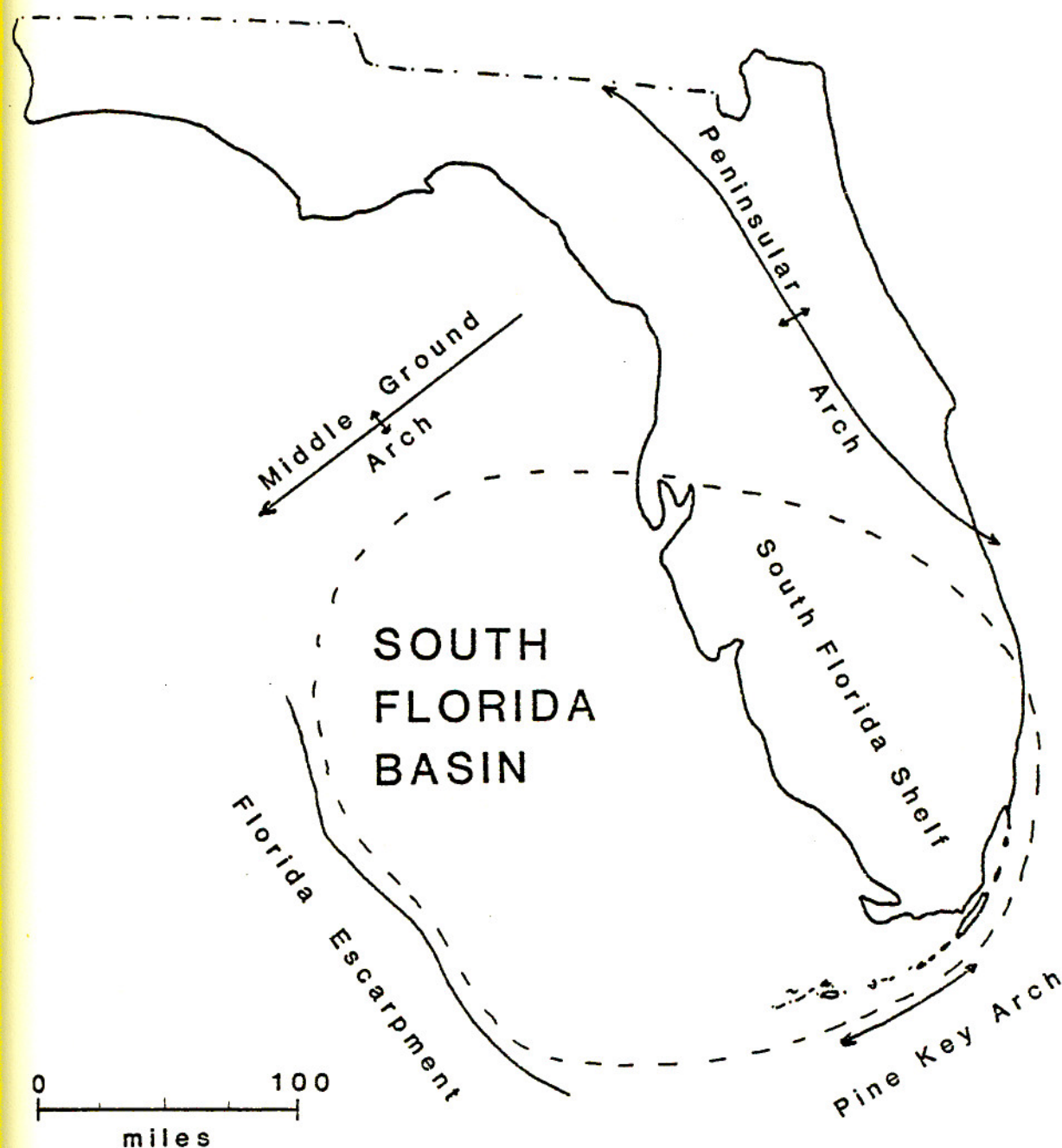


Figure 3. Major structural features of south Florida (adapted from Winston, 1971).

(Sheffield, 1978; Winston, 1971; Applin and Applin, 1965). The typical major faulting found in the Texas - Louisiana sediments is unknown in south Florida sediments (Banks, 1978).

GENERAL SOUTH FLORIDA BASIN STRATIGRAPHY

In the Upper Jurassic(?) - Lower Cretaceous Comanchean age carbonate - evaporite interval of the South Florida Basin, formation names and their detailed descriptions have not been formalized until recently. This report will not deal with particular formation names and descriptions, except for those commonly accepted in the literature. However, it should be noted that Applegate et al (1981) have recently subdivided the pre-Punta Gorda rocks (Fig. 4, and see the section on "Upper Jurassic(?) - Lower Cretaceous", this thesis).

Coastal Plain Floor

The coastal plain basement rocks of south Florida were named the Volcanic Complex by Banks (1978). This complex was dated as Triassic - Jurassic and was described briefly by Banks as including tuffs, agglomerates, rhyolites, basalts, and thin intrusions. The Mobil-Coastal oil test off Charlotte County, Florida in the Gulf of Mexico drilled at 13000 into spherulitic rhyolite, which Banks called volcanic basement. The Bass Enterprises well of this report encountered rhyolite at approximately 18610 ft, which Applegate et al (1981) has dated at 180 million years old. Banks postulated that the east-central Florida Avalon metamorphic complex, composed of granitic and metamorphic rocks formed as part of the Avalon orogenic event 550 - 650 million years ago, may underlie much of these younger volcanic

LOWER CRETACEOUS	COMANCHEAN GROUP	GLADES	Sunniland		dol. lms.	
			Punta Gorda 600'		anhy.	
		LEHIGH ACRES	Able Member 290'		lms. anhy.	
			Twelve Mile Member 320'		Brown Dolomite Zone	
			West Felda Shale		shale	
	COAHUILAN	Pumpkin Bay 1050'			lms. anhy. dol.	
		Bone Island 1300'			anhy. lms. dol.	
	?	?	Wood River 1700'			anhy. dol. lms.
	JURASSIC				basal clastics rhyolite basalt	
	TRIASSIC — JURASSIC					

Figure 4. Generalized geologic column of the Lower Cretaceous - Upper Jurassic(?) rocks of the South Florida Basin (after Applegate et al, 1981, p. 448).

rocks of southern Florida. As Milton (1972) pointed out, the term "basement" is used in different senses by different writers. It may be that the Avalon Complex is basement for south Florida. However, the Volcanic Complex should probably be considered economic basement for the region. Walper (1974) postulated that the foundation for the Florida Peninsula and the Bahama platform is composed of ignimbrites, generally rhyolitic, and is unaffected by regional metamorphism. Wood and Walper (1974) have considered the role of Florida geology in the breakup of Pangea. They suggest that the Florida Escarpment (western edge of the South Florida Basin) is fault controlled in that it was the line of initial rifting of Pangea in Triassic-Jurassic time.

Upper Jurassic(?) - Lower Cretaceous

The Fort Pierce Formation is the name given the sequence of Upper Jurassic(?) - Lower Cretaceous carbonate - evaporite rocks first described in the updip Amerada Cowles Magazine No. 2 well, P-259, St. Lucia County (Applegate et al, 1981; Applin and Applin, 1965). Here, approximately 2220 ft of carbonates, anhydrites, and mixed clastics were penetrated (Applin and Applin, 1965). Applin and Applin correlated this well with others, determining that farther to the southwest the Fort Pierce becomes more clastic free, until apparently none occur in the Gulf Oil Corporation (GMI) well of this thesis.

The Fort Pierce Formation is an approximate equivalent of the sequence of rocks studied for this thesis. Because of the great

thickness of the Fort Pierce, and the facies changes between wells, I will refer to these sediments simply as the pre-Punta Gorda carbonates. Applegate et al (1981) have recently subdivided these pre-Punta Gorda rocks. Figure 4 identifies the formation names now recognized by the Florida Bureau of Geology. Their criteria for formation boundaries are the regionally occurring anhydrites common in the South Florida Basin.

Cretaceous - Comanche Series

Comanchean rocks of south Florida consist of limestones, dolomites, anhydrites, and a few dark shales (Winston, 1971; Applin and Applin, 1965). Applin and Applin assigned Group names in their attempt to approximate synchronous units in Texas, which are the Trinity, Fredricksburg, and Washita Groups.

Trinity Stage

Four major named units are present in the Trinity. These are the "Brown Dolomite", the Punta Gorda Anhydrite, the Sunniland Limestone, and the "Upper Massive Anhydrite".

The composite log presented by Tyler and Erwin (1976) shows the Brown Dolomite directly underlying the Punta Gorda Anhydrite. They briefly described approximately 100 ft of crystalline porous dolomite with interbedded limestone. Several minor oil shows have been reported in this unit (Winston, 1971).

Applin and Applin (1965, p. 39) introduced the name Punta Gorda Anhydrite. This unit has been penetrated by many wells in central and south Florida. The Punta Gorda is composed chiefly of anhydrite and lesser amounts of irregularly bedded limestone, dolomite, and dark shale. Minor amounts of bedded salt are present in several scattered wells. Tyler and Erwin (1976) described the Punta Gorda from a Sunoco-Felda Field well as being a 500 ft massive gray anhydrite interbedded with irregular laminations of argillaceous limestone.

The Sunniland Limestone is just above the Punta Gorda Anhydrite (see South Florida Sunniland Play, this thesis). This unit is composed chiefly of limestone, dolomite, and shale (Applin, 1960). The Sunniland at Sunoco-Felda Field is divided into three zones by Tyler and Erwin (1976). The lowermost zone is the "Rubble Zone", consisting of 50 - 60 ft of dark brown, highly fractured, dense lithographic limestone that is oil productive in the one well Lake Trafford Field. Overlying the Rubble Zone is the Black Shale, a 30 - 40 ft section of black, very calcareous shale and/or carbonate mudstone. Tyler and Erwin (1976) identify this zone as the possible source rock in Sunoco-Felda Field. Overlying this zone is the Roberts Zone, the producing interval. This 150 ft interval has a lower portion of dense, miliolid-bearing, chalky limestone on which the highly porous, bioclastic, oil bearing patch reefs developed.

The Upper Massive Anhydrite is a commonly recognized, widespread unit, the top of which is the upper boundary of the Sunniland interval (Tyler and Erwin, 1976; Applin, 1960). This formation

is a sequence of irregularly bedded anhydrite and argillaceous limestone (Applin and Applin, 1965). This "upper anhydrite" or "massive" anhydrite thickens to the southwest to at least 300 ft in Collier County (Applin and Applin, 1965). Oglesby (1965) proposed the name this unit is also known by, the Lake Trafford Anhydrite. Above this formation, the Trinity is composed of dark, dense, argillaceous limestone, chalky limestone, and interbedded brown dolomite and shale (Applin and Applin, 1965). Some anhydrite beds were noted by Tyler and Erwin (1976).

Fredricksburg Stage

In the Fredericksburg, limestones and dolomites are common in the lower and middle sections, while chalky limestone occurs in the upper portions (Applin and Applin, 1965). Shale lenses occur in these units, as well as anhydritic limestones and dolomites. Anhydrite beds are common in the downdip wells (Applin and Applin, 1965).

Tyler and Erwin (1976) describe the Fredericksburgian strata at Sunoco Felda Field as consisting of 1330 ft of limestone and thin beds of anhydrites, dolomites, and shales. They note in the upper portion the existence of noncommercial asphaltic oil shows. This, coupled with excellent porosity and permeability of this zone seen in other wells, makes the upper Fredericksburg a good potential reservoir in South Florida (Tyler and Erwin, 1976).

Washita Stage

This section is composed of very fine grained calcitic dolomites interbedded with thin lenses of anhydrites, shales, and chalky limestones (Tyler and Erwin, 1976; Applin and Applin, 1965). Winston (1971) recognized that this sequence of rocks, which he calls the Naples Bay Group, is porous but lacks any oil shows.

Upper Cretaceous - Gulfian Series

At the base of the Gulfian, nearly all wells in south Florida as of 1965 have penetrated a bed of green marine shale (Applin and Applin, 1965). The thickness varies from a few inches to not more than a few feet. This shale is a readily recognizable stratigraphic marker in south Florida.

Except where replaced by the Card Sound Dolomite on Florida's southeast coast, the Gulfian is composed mainly of chalk (Tyler and Erwin, 1976; Winston, 1971). Palacas (1978) estimated the thickness of the Gulfian section at 3000 ft.

Lower Tertiary

Lower Tertiary rocks are present throughout the South Florida Basin. They are divided into a Paleocene dolomite/anhydrite/gypsum section and an Eocene fossiliferous limestone/dolomite section (Winston, 1971; Chen, 1965).

The Cedar Keys Limestone of Paleocene age was described by Tyler and Erwin (1976, p. 292) as approximately 2000 ft of soft, chalky, vuggy limestone and interbedded hard dolomites and limestones.

In northern and peninsular Florida, Eocene rocks are predominately dolomite and limestone, and minor amounts of gypsum and anhydrite (Chen, 1965). Dolomite dominates in the Peninsular Arch region, while limestone is prevalent in more southernmost Florida (Chen, 1965).

Upper Tertiary

In south Florida, upper Tertiary sediments (Oligocene and Miocene) contain many unconformities and facies changes (Winston, 1971). Winston (1971) pointed out that although the lithology is quite variable, calcarenitic limestone is usually overlain by loosely consolidated marls, shelly limestones, phosphatic sandy limestones, and clays. Unconformably overlying this sequence are Pleistocene sands, limestones, and reef rock.

ENVIRONMENT OF DEPOSITION

The following description of the various lithofacies found in the subject interval indicates a sabkha type, near shore - shoreline depositional sequence. Figure 5 illustrates diagrammatically the interpreted depositional position of the different facies. This figure has been adapted from a study of subsurface sabkha cycles in the Trucial Coast of Arabia by Wood and Wolfe (1969).

Depositionally and diagenetically (see DIAGENESIS), these South Florida sediments have three analogs. The sabkhas of the Trucial Coast of the Persian Gulf (Bathurst, 1975; Butler, 1969; and many others) are generally Holocene analogs for the depositional and initial diagenetic processes which formed these South Florida sediments. The Great Bahama Banks (Bathurst, 1975) represent another Holocene analog with regard to the oolitic shoals and the overall depositional area. The Great Bahama Banks area, consisting of a barely submerged platform, is interpreted as being similar to South Florida in the Lower Cretaceous. The seepage reflux processes described (but not established) for Bonaire Island (Deffeyes et al, 1965) best represent a Holocene, or at least a Plio - Pleistocene analog for the secondary dolomite observed in these pre-Punta Gorda sediments.

Basal Clastic Lithofacies

This lithofacies was penetrated by the LeHigh Acres and Bass

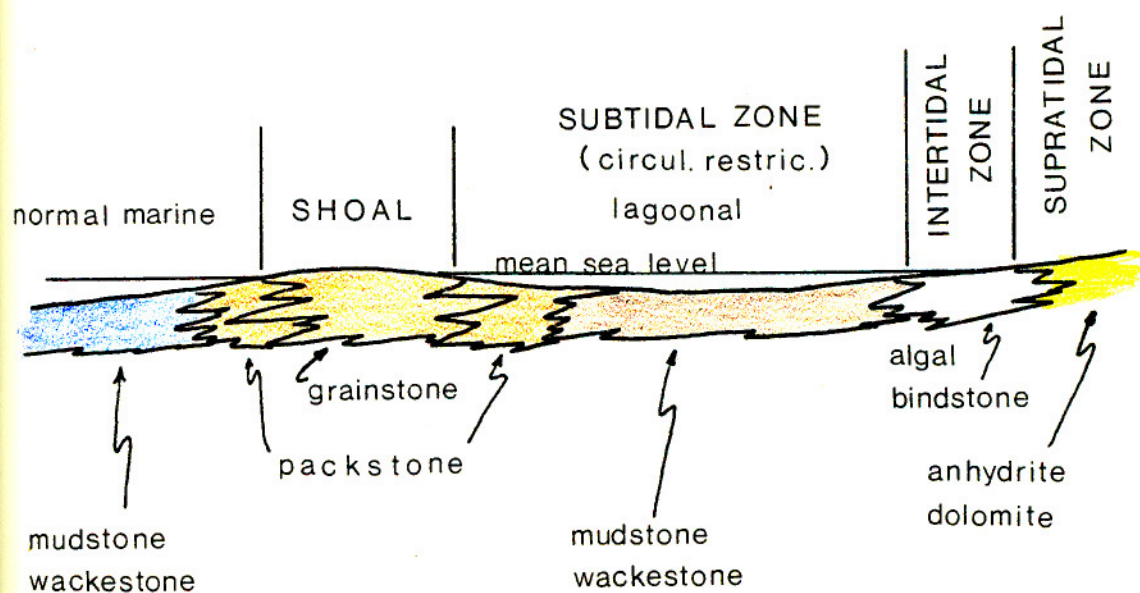


Figure 5. Interpreted lithofacies lateral distribution.
Does not include basal clastic lithofacies.
Not to scale.
(Modified from Wood and Wolfe, 1969).

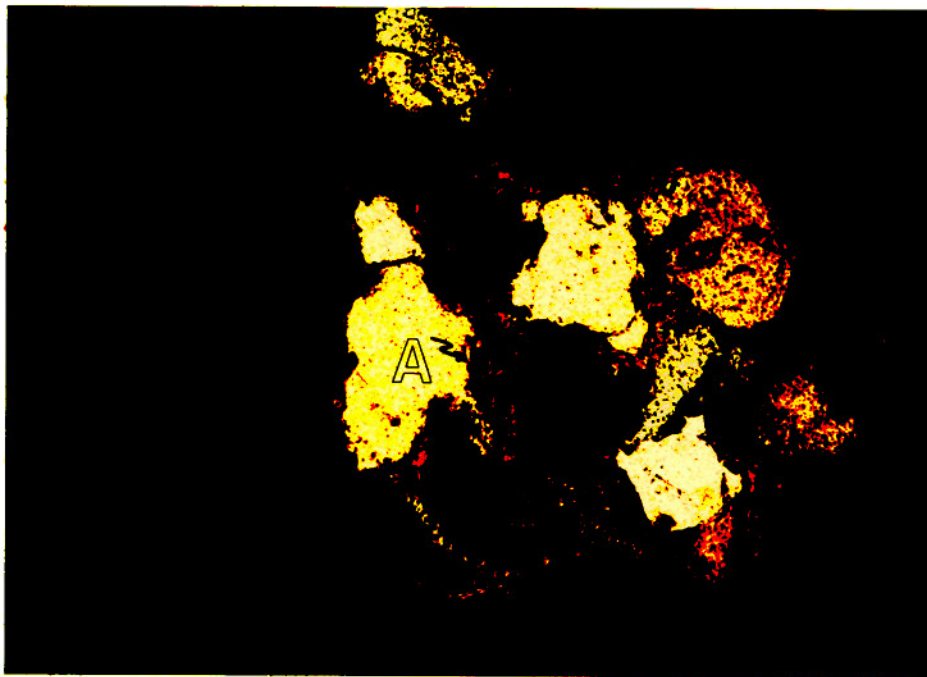
Enterprises wells. It is a basal red shale and sandstone lithofacies that was deposited on top of the metaigneous basement (see GENERAL SOUTH FLORIDA BASIN STRATIGRAPHY - Coastal Plain Floor). These sediments are probably derived from basement rocks which are up depositional dip and down section.

In the few samples viewed (HI 76, 77, 80; BA 125), fine-grained, quartz-rich sandstones are dominant, some of which have a calcareous cement (photo #2). The quartz grains generally are moderately well sorted, ranging in size from approximately 20 - 60 microns. Some of the quartz crystals exhibit silica overgrowths, indicating secondary silica diagenesis.

These rocks comprise a fairly thin unit with deposition probably taking place during a low stand of sealevel relative to the erosional surface. Immediately overlying these units in the BA and HI wells are zones of predominately coarse, secondary dolomite which in turn are overlain by the mixture of carbonate shelf sediments that is common to all four wells.

Carbonate Mudstones/Wackestones Lithofacies

As can be seen in Table II, Appendix II, and the electric log displays in Appendix III, this group of lithofacies dominates the carbonate sediments. The decision to include both normal marine and restricted marine mudstones and wackestones in a single group reflects the difficulty experienced in classifying an exact



X P

M P

Photo # 2. BA 125; 18600-10 ft. Subangular quartz sandstone with calcareous cement (A). Stained Alizarin Red for calcite.

TABLE II
FACIES AND OIL DISTRIBUTION PER WELL

WELL CODE	BROWN	BLUE	ORANGE	YELLOW	PURPLE	RED	GREEN	
HI	(6) 17%	(7) 19%	(6) 17%	(3) 8%	(2) 6%	(8) 22%	(4) 11%	(36)
MT	(9) 30%	(2) 6%	(6) 20%	(8) 27%	(0)	(5) 17%	(0)	(30)
BA	(18) 33%	(2) 4%	(7) 13%	(14) 26%	(2) 4%	(11) 20%	(0)	(54)
GMI	(12) 57%	(3) 14%	(1) 5%	(4) 19%	(0)	(1) 5%	(0)	(21)
TOTAL SAMPLES	45	14	20	29	4	25	4	(141)
TOTAL % FOR STUDY	32%	10%	14%	20%	3%	18%	3%	

() = number of samples

Colors represent dominant facies interpreted for each sample interval.
These same colors are used in Figure 5 and Appendix II.

BROWN: Restricted circulation lagoonal mudstones and wackestones

BLUE: Open marine mudstones and wackestones

ORANGE: Grainstone shoals

YELLOW: Supratidal anhydrites and very fine-grained dolomites

PURPLE: Basal clastics

RED: Late or secondary dolomite

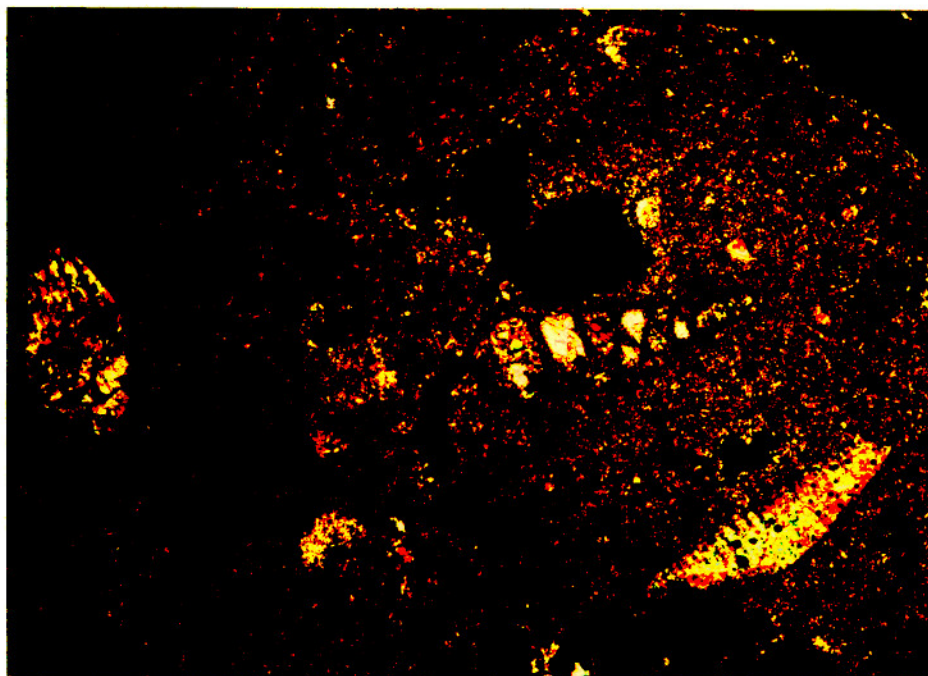
GREEN: One zone containing hydrocarbons (asphaltic tar); this zone
was sampled at close spaced intervals (see Appendix II, HI well)

depositional location for these sediments.

Both mudstones and wackestones which display any normal salinity marine fauna (see photos #3, #4, and #5) were assumed to have been deposited on the ocean - side of any circulation restricting barrier. Although normal marine salinity faunal debris is not abundant, it is sufficiently common to indicate that these samples may represent a non-restricted presumably open marine environment. These are indicated by the blue color on the electric logs (Appendix III). Even a few echinoderm chips are indicative of normal marine salinities. It is possible this faunal debris could have been washed into a restricted circulation environment, however,

All other lime muds were assumed to have been deposited in a subtidal, restricted circulation, lagoonal environment which was located between restricting oolite/oncolite shoals and supratidal mud flats. This is a very major assumption, but a necessary one, since core cuttings alone provide the data base, not conventional cores (see Appendix I).

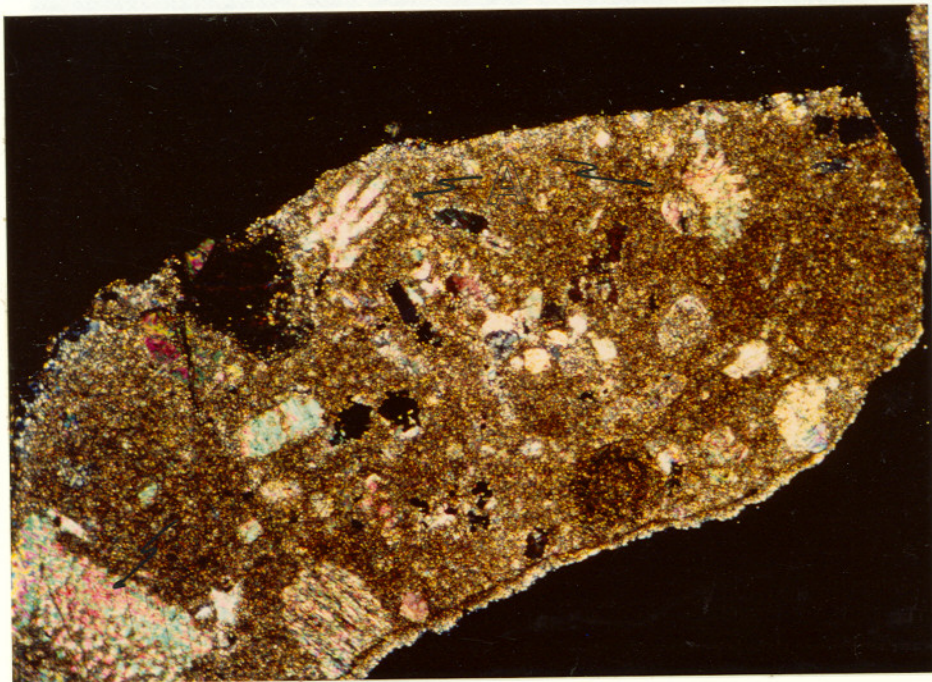
Acetate peels of these mudstones suggest the muds may actually be pelloid supported. The high degree of "micritization" present makes interpretation of the depositional fabric difficult. This "micritization" was caused either by aragonite pellets being re-crystallized and inverted to calcite, or by algal alteration of the pellets. Kirkland and Evans (1981) suggested that hypersaline environments can support large faunal colonies adapted to that environment. Therefore, these pelloid textures seen on acetate peels



X P

M P

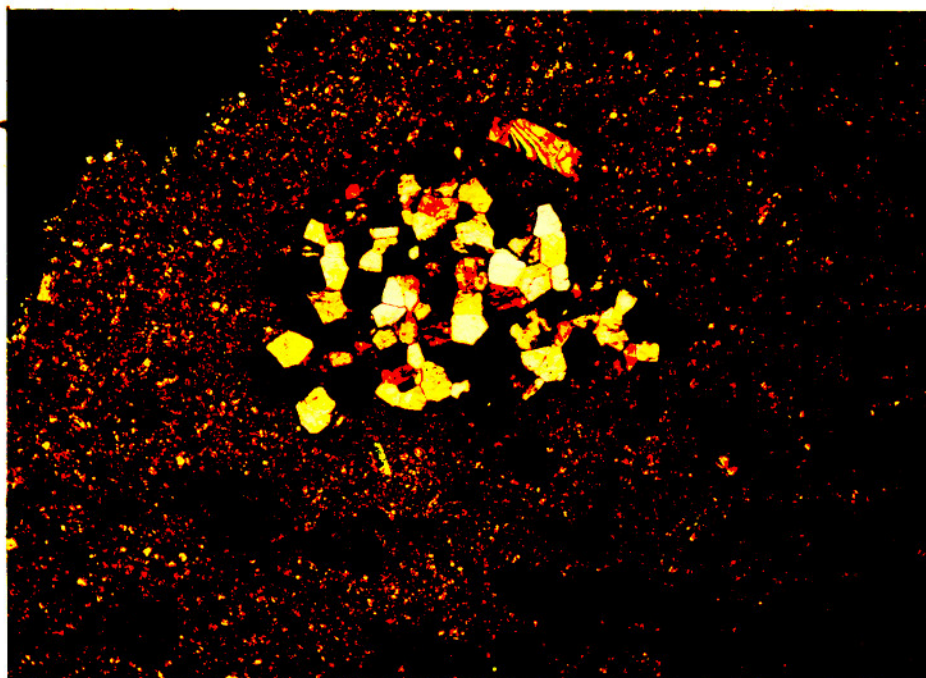
Photo # 3. HI 21; 12800-10 ft. Calcareous wackestone. Note syntaxial overgrowths associated with the echinoderm fragment (A). Matrix exhibits microspar texture. Porous zones formed during thin-section preparation.



X P

M P

Photo # 4. MT 3; 13300-10 ft. Calcareous wackestone. Note syntaxial overgrowths associated with the echinoderm fragments (A). Matrix exhibits microspar texture.



X P

M P

Photo # 5. BA 45; 14600-10 ft. Inoceramus fragments. Cut is near perpendicular to the C axis except for one separated prism. Calcareous mud matrix has a microspar texture.

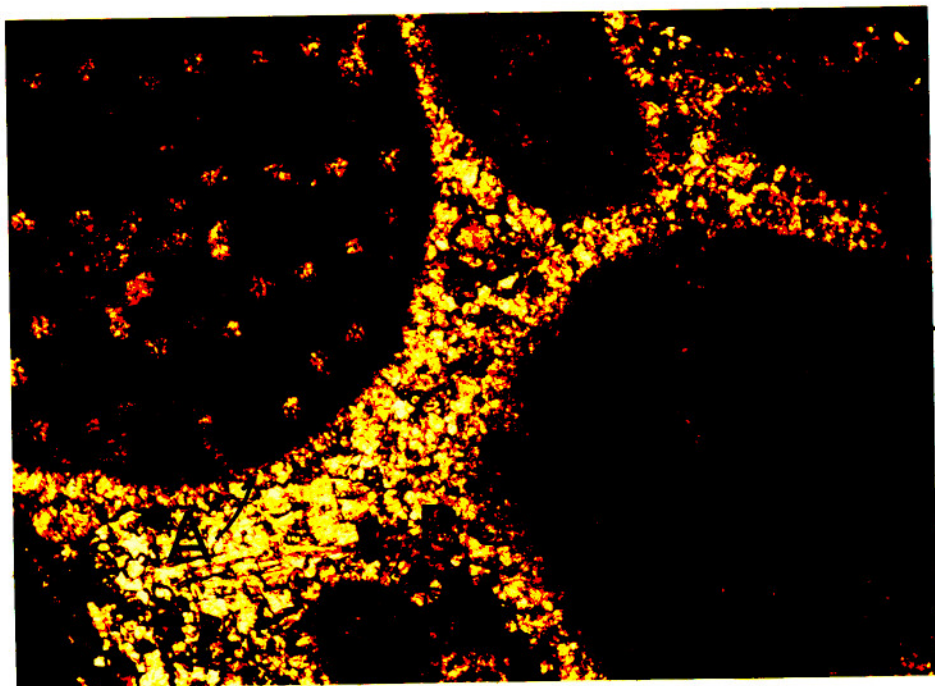
may actually represent original pellet deposition, and formation of a low energy grain supported facies. This neomorphic process, whereby aragonite is inverted to low-Mg calcite (Bathurst, 1971; Folk, 1965), makes the interpretation of the dominant lithofacies in this study uncertain, and highly subjective. Although the process is surely evident in all the lithofacies, these carbonate muds most easily lose the subtle texture necessary for interpretation of their grain composition and depositional history. Photo #6 illustrates undoubted pellets that were not destroyed by diagenetic or algal processes.

Grainstone/Packstone Lithofacies

This facies is interpreted as representing circulation restricting barrier shoals. The grain supported facies represents the main body of the shoals. The mud supported packstones are interpreted as marginal, transitional subfacies which were deposited between the migrating grainstone shoals and the underlying or laterally equivalent open marine mudstones and/or the lagoonal carbonate muds (photo #7). This facies represents 15% of the samples studied in the four wells (Table II and Appendix III).

Uncommon intraclasts of older grainstone facies are seen reworked into younger grainstones. These grainstones are probably storm indicators, in that a strong turbulence is required to rework these semi-lithified fragments.

Rare oncolite grainstones (photo #8) are also present in a few

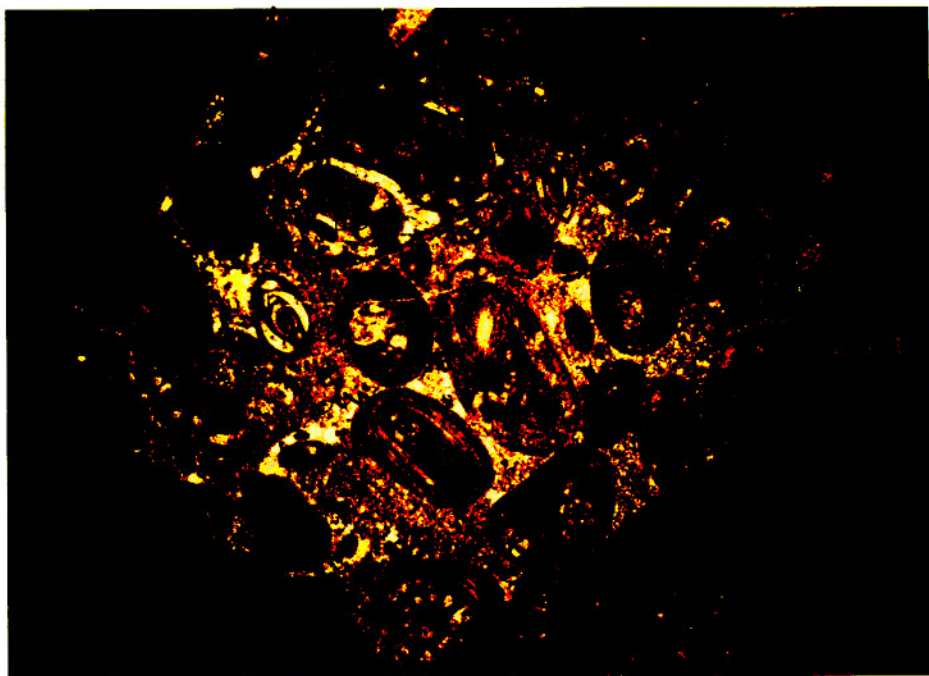


X P

H P

Photo # 6. HI 45; 13750-60 ft. Favreina sp. pelletal grainstone.

Pellet A is a transverse view. Pellet B is a
longitudinal view.

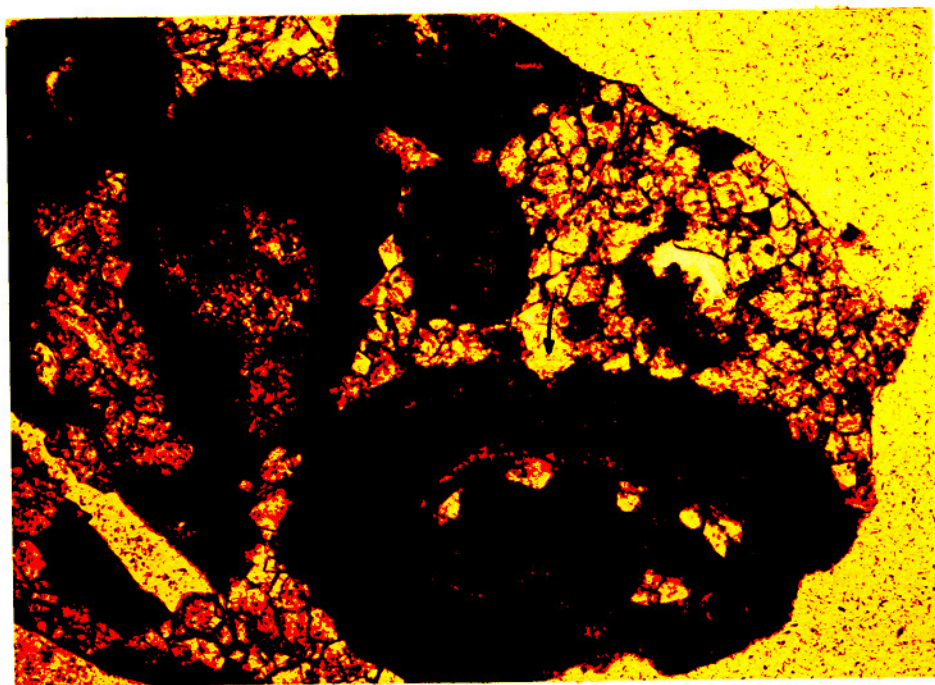


X P

L P

Photo # 7. BA 36; 14150-60 ft. Transitional packstone. Note
clast of previously deposited and lithofied grainstone (A).
(B) is a section through a gastropod test. Also note
foram test (C) nuclei in many of the coated grains.

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Tallahassee, FL 32304



P F L

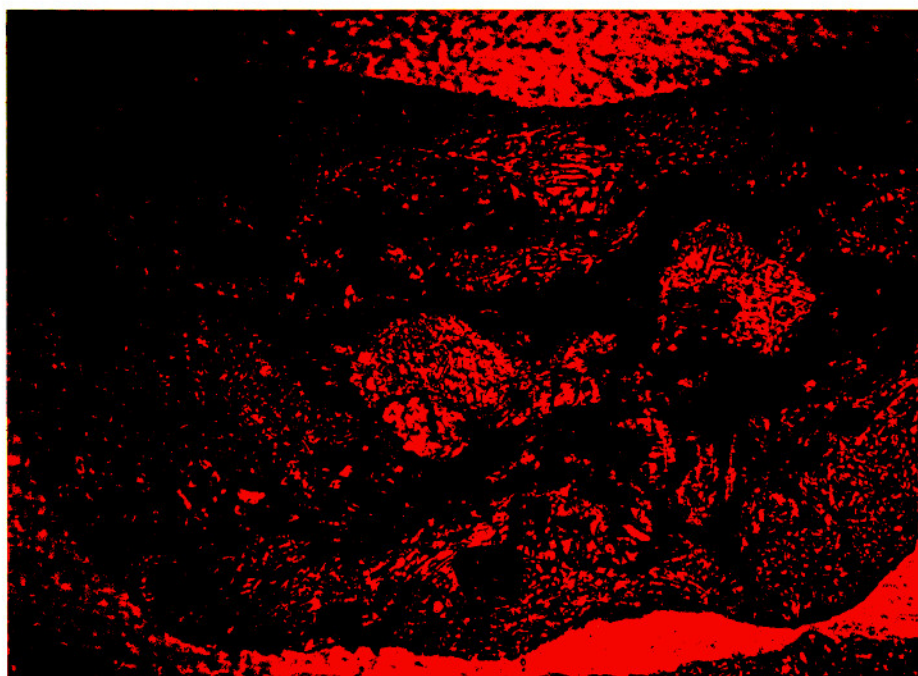
M P

Photo # 8. BA 94; 17050-60 ft. ? oncolite grain. Note matrix selective dolomitization and rhomb penetration.

samples. These are interpreted as forming in shallow waters of variable turbulence. Oncolites form by algal filaments trapping local detritus as the oncolites roll on the seafloor (Bathurst, 1975). This process is indicative of variable current energy and shallow water. Algae presumably would not survive in high energy environments where one would expect grain abrasion. This shallow water environmental interpretation is based on the assumption that most algal organisms must have light and thus shallow water to survive.

As in the Recent environments in the Bahamas (Bathurst, 1975), the ooids and other grainstones probably did not form in the grainstone lithofacies proper. Initial transportation of the grain nucleus came from the lower energy environment by action of tidal or storm currents. In more turbulent waters, growth of the ooids is possible. Therefore, the restricting shoals form and act as a tidal current buffer between open marine and the restricted lagoonal mud facies. It is interesting that Bathurst (1975, p. 135) referred to research by other authors which indicated that the Great Bahama Bank ooid growth is related to the passage of a thin layer of hypersaline water to and fro over the shallow shoals. This condition fits the depositional model postulated for the south Florida pre-Punta Gorda sediments, where hypersaline waters were abundant.

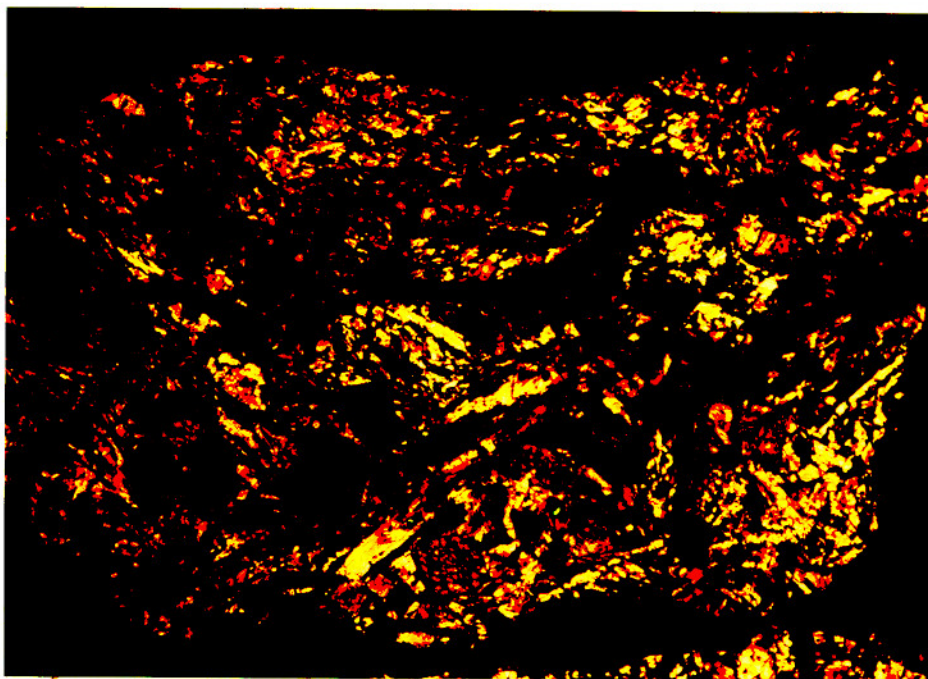
Grainstone petrography varies greatly. The ooid nuclei vary from the common faunal fragments (ex. milliolid, photo #7) to unidentifiable debris. Commonly pelloid grains are included in this grainstone facies, as are oncolites and intraclasts. Sizes for these



P P L

M P

Photo # 9. GM1-1; 14300-10 ft. Nodular anhydrite (A) with very fine-grained dolomite mudstone rims (B). Secondary dolomite rhomb (C) are also present.



X P

M P

Photo # 10. GMI-1; 14300-10 ft. Same as photo # 9. Note the fibrous to bladed texture of the anhydrite.

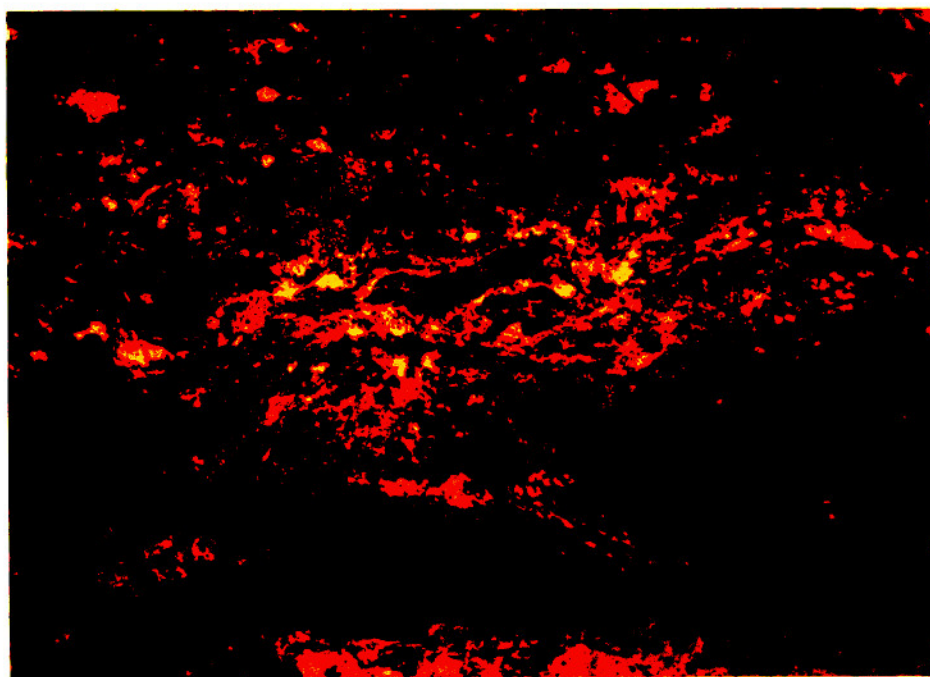
is analogous to nodular anhydrites of supratidal Holocene sabkhas, as described by Butler (1969), Kinsman (1969), Murray (1964), Curtis et al (1963), and many others.

Precipitation of this type of anhydrite is dependent on the dissolution of previously precipitated gypsum and/or the release of calcium during the penecontemporaneous formation of dolomite in the supratidal environment (Bathurst, 1975, p. 208). Murray (1964) draws the conclusion that nodular anhydrite is indicative of subaerial exposure of soft sediments. Within these sediments, CaSO_4 bearing waters evaporate, leading to anhydrite deposition. Regardless of the formation mechanism, it is generally agreed that nodular anhydrite is usually a supratidal lithofacies in sabkha environments.

Bindstone Lithofacies

A hint of algal bindstone facies was seen in sample HI 45. Here, several chips showed indications of algal laminated strata (photo #11). If the analogy with the Recent sabkhas of the Persian Gulf is complete, blue-green algal mats should be abundant. These algae are found in the intertidal and lower supratidal zones, and act as a buffer which absorbs the normal wave action.

Evidence indicating intertidal algal mats was not seen in the study except in this one interval. Relative to the volume of the other shelf sediments, this facies would probably be the least likely to be recovered and sampled by well cuttings. Also, algal laminations



P P L

M P

Photo # 11. HI 45; 13950-60 ft. Algal bindstone texture. Brown is either very fine-grained dolomite, clastic or volcanic derived muds. Red is calcite stained with Alizarin Red. Some angular quartz grains present (A), suggestive of volcanic origin. Black laminations interpreted as organic accumulations.

DIAGENESIS

Dolomitization

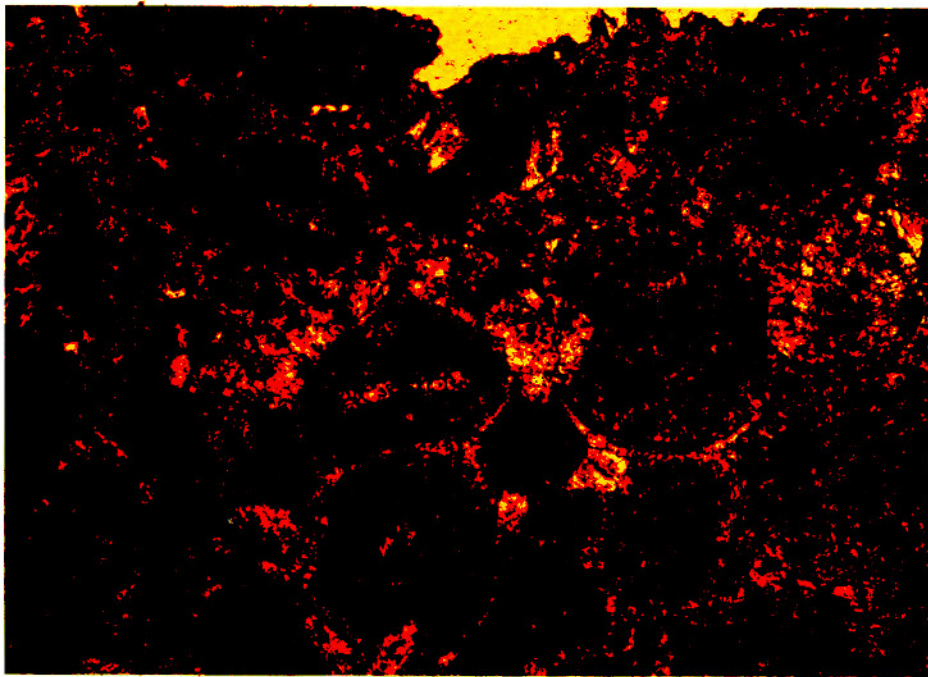
Two types of dolomite are recognized in the intervals studied. These are: 1) very fine-grained dolomite associated predominately with the supratidal anhydrite lithofacies; and 2) a coarser dolomite consisting of individual and clustered rhombohedral crystals. The very fine-grained dolomite rhombs are not resolvable even under high magnification (500x). The coarser dolomites consist of rhombs of approximately 30 - 50 microns diameter, which are easily seen in thin section. The coarser dolomites are commonly seen in all the sabkha lithofacies present in the wells, although dolomitization is not present in every sample. These two dolomite groups represent two distinct periods of dolomitization. It is assumed the supratidal dolomite is penecontemporaneous with the formation of the nodular anhydrites. The coarser-grained, late dolomite exhibits sediment replacement characteristics. These characteristics include both incomplete dolomitization and complete, which is evidenced by ghost textures such as displayed in photo #14.

As recognized also by Wood and Wolfe (1969) in their study of subsurface sabkha cycles in Arabia, there is a significant association between microcrystalline and crytocrystalline dolomite and evaporites. This same association is evident in south Florida. Photos #9 and #10 show a fine-grained dolomite film conforming to the growth surface

of the nodular anhydrite. Wood and Wolfe (1969) postulated that this dolomite forms by replacing washed-in aragonite muds deposited on the supratidal environment. Bathurst (1975) acknowledged that these fine-grained dolomites grow at the expense of aragonite. He pointed out that as the aragonite content falls, the dolomite and anhydrite content increases. Therefore, the sabkha supratidal environment is initially lime-mud dominated. With constant or near constant evaporation, magnesium ratios increase to the levels at which penecontemporaneous anhydrite and dolomites and other sulfate minerals are formed, probably at the expense of the aragonite muds. These muds are storm deposits and/or exposed tidal flat type lime muds. Either type is here assumed to be fecal in origin.

It is noteworthy that Bathurst (1975) postulated that dolomitizing fluids may move through the algal mats of the intertidal/supratidal environment. Photo #11 shows an interpreted blue-green algal mat chip which has been stained for calcite. The algal mat chip is predominately, though not entirely dolomite.

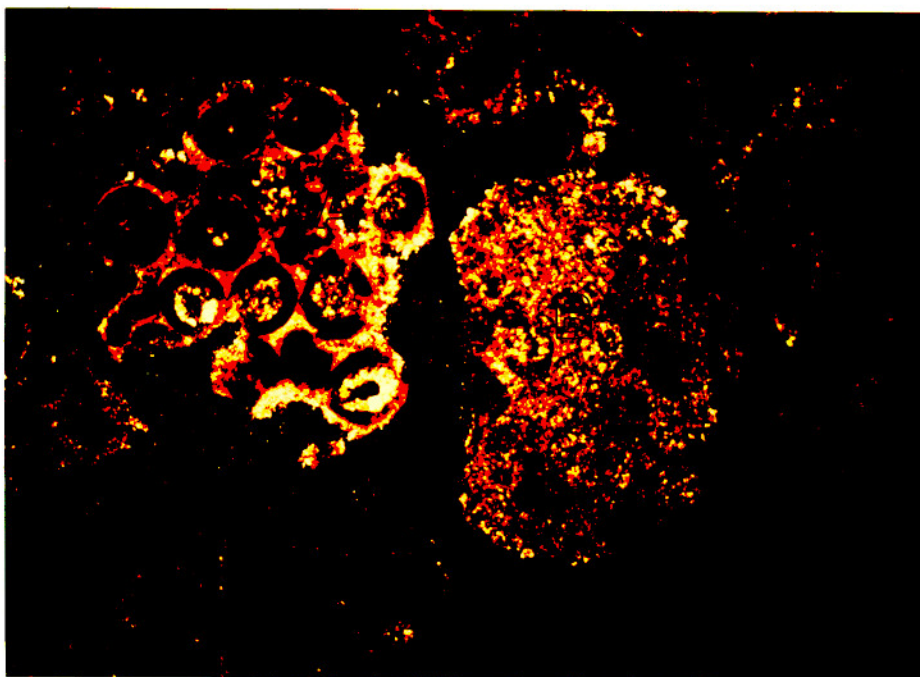
The second type of dolomite is coarser-grained, late dolomite. Photos #8, #12, #13 and #14 show examples of this. In the host rock, there are various degrees of this dolomitization, from the occasional rhomb to an interlocking rhombic mosaic. These dolomites are either fabric selective, matrix selective, or apparently non-selective. Matrix selective dolomite crystals commonly exhibit penetration into nondolomitized grains. Grain selective dolomitization is also observed, where only grains (or portions of grains) have been



P P L

M P

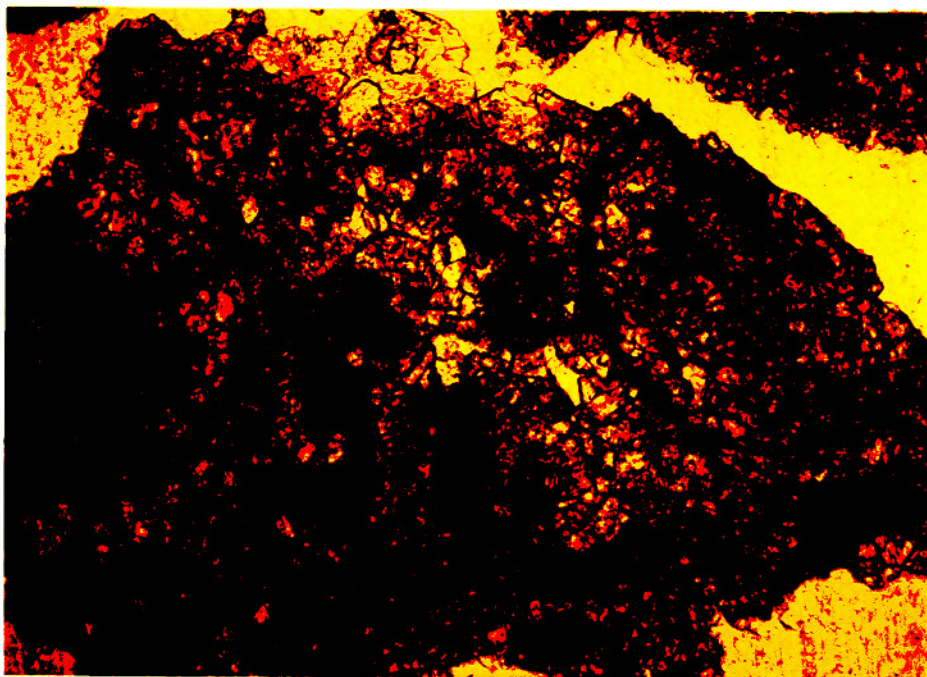
Photo # 12. MT 6; 13450-60 ft. Matrix selective secondary dolomitization (incomplete dolomitization) in an oolite grainstone. Note rhomb penetration (A) and deformed grain (B).



X P

L P

Photo # 13. BA 83; 16500-10 ft. Grain selective dolomitization in chip A. Note calcareous matrix stained red is not dolomitized. Non-selective or complete dolomitization is evident in chip B. Note ghost pelloids and remnant calcareous matrix.



P P L

M P

Photo # 14. MT 62; 12248-60 ft. Ghost ooid grains in the secondary crystalline dolomite.

dolomitized (photo #13, Chip A). Also commonly seen is non-selective dolomitization (or complete) (photo #13, Chip B), where the entire original rock fabric was dolomitized. Occasionally, as in photo #14, relict ghost structures are visible. Ghost structures and rhomb penetrations clearly demonstrate that this dolomite is secondary in origin.

A debatable mechanism, but one that might well apply to these sediments is seepage reflux put forth by Deffeyes et al (1965) for the island of Bonaire. Although the reflux model may not be an active Holocene process on Bonaire as originally thought, the process does explain secondary dolomites such as those in the Plio-Pleistocene on Bonaire Island and those observed in the subsurface of south Florida. Regardless of the mechanism, the coarse dolomites observed in this study appear to have been formed by magnesium rich brines moving through the various previously deposited sabkha lithofacies. The concentration of magnesium is presumably related to strong surface evaporation, either in supratidal pools or very restricted intertidal or subtidal shallows.

The secondary dolomite is found in all the sabkha lithofacies. It is most consistently found in the grainstones, although this observation may be biased since relict grainstone textures are the easiest to recognize in the completely dolomitized samples. The degree of secondary dolomitization varies from a few scattered rhombs to a very tightly packed dolostone. No unquestionable interrhomblitic porosity was identified in thin section. This is because the samples are

not impregnated with porosity identifying dye.

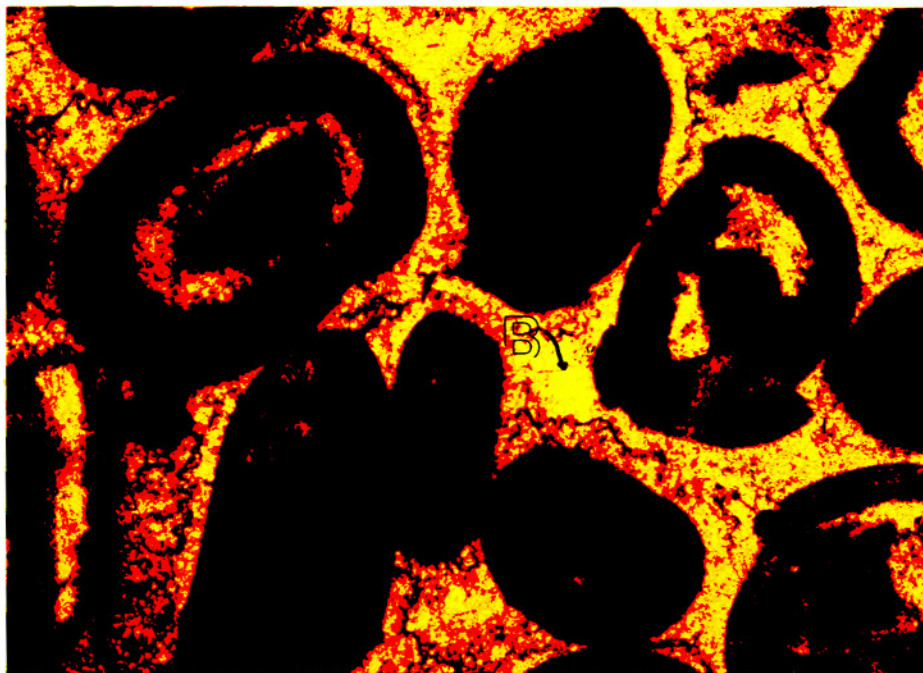
Regardless of the mechanism of formation for either type of dolomite seen in this study, the presence of dolomite supports an evaporitic sabkha depositional model. Evaporitic environments commonly have dolomites associated with them (Bathurst, 1975; Wood and Wolfe, 1969; Deffeyes et al, 1965; Kinsman, 1965; Curtis et al, 1963; and many others).

Cementation

Only phreatic secondary cements are recognized in these sediments. These cements consist of drusy, blocky, and syntaxial rim overgrowths. All are interpreted as having originated when the host sediments were saturated by meteoric waters.

Drusy and blocky cements are most common in the grainstone lithofacies (photo #15). This is to be expected since the initial depositional porosity permitted these grains to become saturated with phreatic waters and provided void space for cementation to take place. The lack of vadose zone meniscus cement and vadose silts is surprising. A possible explanation is that the grainstone shoals were very rapidly exposed to a freshwater lens. Vadose zone textures would then not have had time to form except in the upper portion of the "sand" body.

The drusy and blocky cements are as expected. The drusy cements consist of varying sizes of calcite prisms with their C axes pointing into the void space. Blocky cements are secondary to the drusy cements.



P P L

M P

Photo # 15. HI 42; 13800-10 ft. Compaction deformation of ooid grains. Note drusy cements (A) and blocky cements (B).

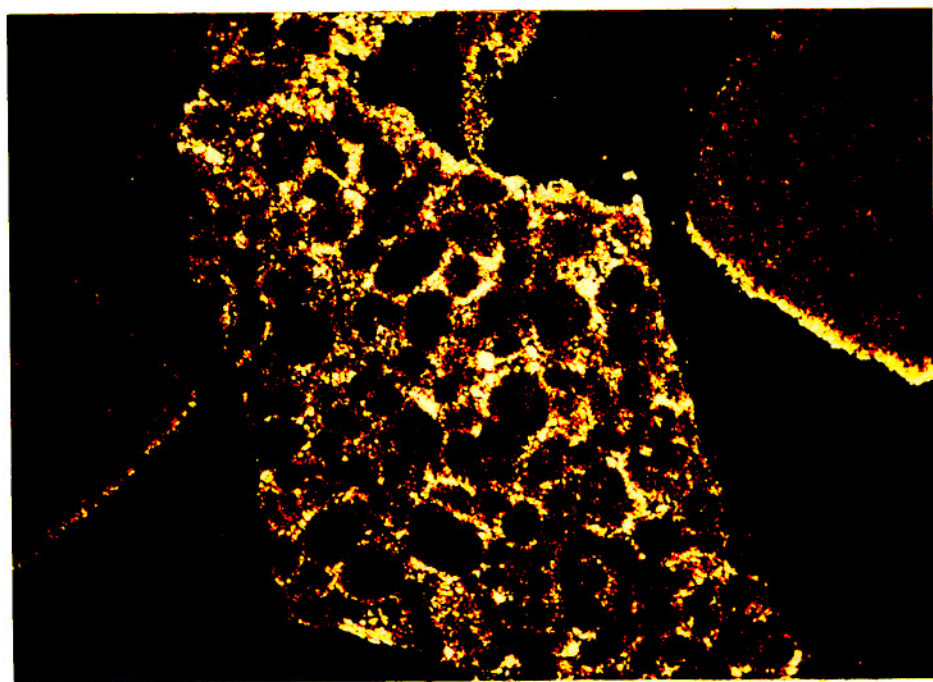
The blocky cement in almost all observed cases filled the remaining void space. Only a few chips exhibited any interparticle porosity. This non-cemented void space could possibly have been formed while the slides were being thin sectioned. These samples were not impregnated to determine porosity because the appropriate equipment was not available at the time of this study.

The third type of phreatic cement present is syntaxial rim cement associated with echinoderm fragments (photos #3 and #4). This cement displays uniform extinction and is usually indicative of early diagenesis (Scholle, 1978; Bathurst, 1975; Evamy et al, 1969).

Other Diagenetic Processes

As previously mentioned, lime mud textures may have been destroyed by inversion processes. If the lime mud was deposited as aragonite, then depositional textures were probably destroyed by the transformation of the aragonite to low Mg calcite (photo #16). These neomorphic processes are common in carbonate facies (Folk, 1965). As can be noted in several photographs (#3, #4, and #5), the lime mud often appears crystalline in nature, reflecting light off crystal boundaries. Although deposited as a lime mud, it is now a very fine-grained microspar.

Micritization caused by algal activity is another diagenetic process recognized in this study. Although rare, micrite envelopes were identified in some chips. Milliolid tests were commonly micritized,



X P

M P

Photo # 16. BA 66; 15650-60 ft. Pelloidal grainstone. Pelloids exhibit a microspar texture due to neomorphic processes.

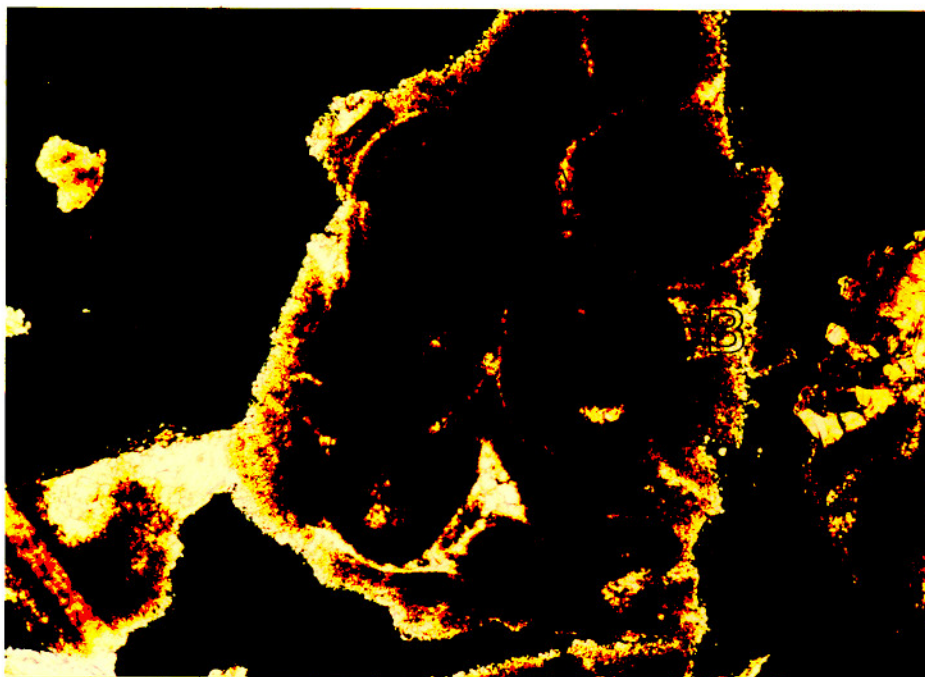
particularly those seen in the wackestone facies. Photo #17 illustrates micritized pelloids.

Lastly, two samples exhibited pressure solution features. Photo #17 illustrates microstylolites in the grainstone facies. In addition to this grain-to-grain suture, another stylolite was identified in a fine-grained lime mudstone.

Oil

Only the HI well showed indications of oil (Appendix III). The zone inclusive of samples HI 23, 23c, 23d, and 25 shows asphaltic tar balls in the cuttings sample bags. In thin section, this noncommercial tar prevented the identification of the rock matrix, although it appears to have accumulated in micropore spaces of less than 20 microns in a carbonate mudstone (photo #18). Although not all chips took Alizarin Red stain, this does not indicate that all the chips are calcareous. The oil may effectively keep the calcite stain from adhering.

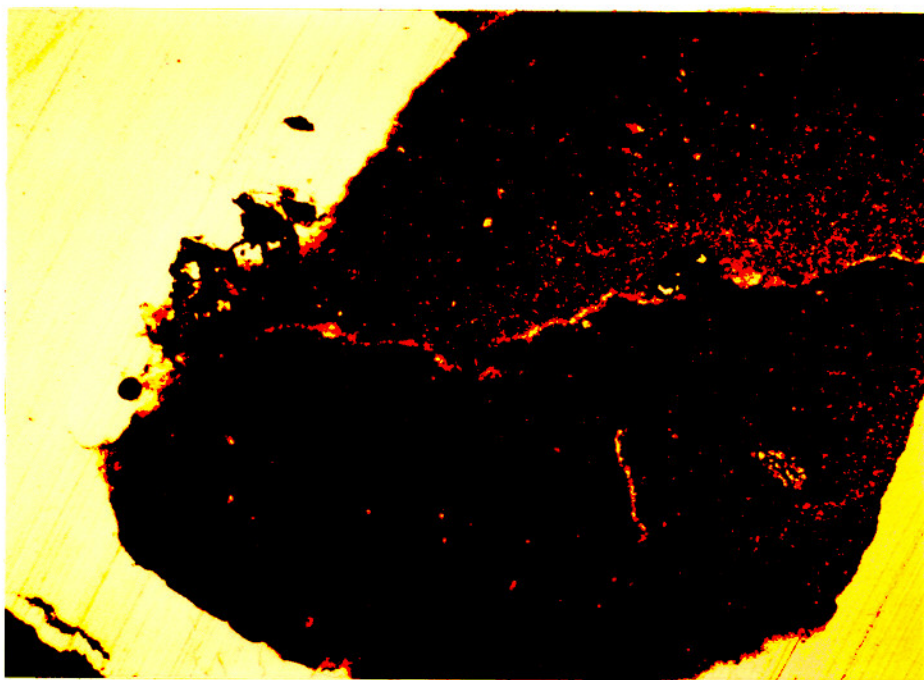
When the thin sections were being prepared, the Bio-plastic mounting medium was found to be an excellent solvent. Samplings containing this asphaltic material show a streaming cut in the Bio-plastic in normal light, which is a good indication of oil in the samples. A streaming cut is one in which the oil disperses into long streams in the Bio-plastic.



X P

M P

Photo # 17. HI 29; 13150-60 ft. Microstyolites (A) located at grain-to-grain contacts. Note micritized milliolid test (B).



P P L

M P

Photo # 18. HI 23d; 12940-50 ft. Oil stain in microlaminated calcareous(?) mudstone. Oil is opaque material.

A BIRDSEYE VIEW OF SOUTH FLORIDA IN THE LOWER CRETACEOUS

The South Florida Platform in the Lower Cretaceous resembled a combination of both the Persian Gulf and the Great Bahama Bank of today. As in both these Holocene areas, the south Florida sediments were deposited on a barely submerged platform in water less than 50 ft deep.

As on the Bahama Platform, tidal ranges in the mid-Bank area were probably negligible (Bathurst, 1975). This mid-Bank area consisted of either large or patchy areas of supratidal flats which, as in the Persian Gulf, consisted of in situ nodular anhydrites forming in aragonite mud host sediments. With minor fluctuations of sea level, the areal extent of these supratidal sediments varied tremendously.

Seaward of these supratidal flats, algal accumulations were probably present. These lower supratidal and intertidal algal mats are of unknown size due to the poor distribution of these sediments in the samples studied. However, if the sabkha model is applicable to these sediments, it is most likely that large blue-green algal accumulations were present.

Seaward of this bindstone facies in the peritidal zone, large accumulations of lime mud (probably pelletal) were being deposited in a restricted circulation environment. In the lagoonal area of the Trucial Coast Embayment (Bathurst, 1975), carbonate mud is abundant only in settling basins. Therefore, the large volume of lime mud in the Florida samples suggests that large areas of the South

Florida Platform were calm water settling basins (lagoonal). Perhaps grasses similar to Haloduli uninervis of the Trucial Coast (Bathurst, 1975) helped to stabilize these sediments and provide food for browsing miliolid forams and other organisms. Micritization could have destroyed the pelletal and skeletal remains of many of this faunal debris.

Migrating across these lagoonal sediments were higher energy grainstone shoals. These shoals, similar to the Great Bahama Bank shoals or the tidal oolite deltas of the Trucial Coast Embayment (Bathurst, 1975) were the main barriers restricting circulation. Such shoals in the Cretaceous may have looked similar to the Great Bahama Bank oolite shoals which exhibit megariipples. The abundance of phreatic cements indicates that these shoals actually were subaerially exposed barrier beaches at times. Fresh water lenses developed in these sediments during subaerial exposure.

Seaward of the shoals, the platform was slightly deeper and was covered with lime muds and normal marine fauna.

The stability of the platform over long periods of time is indicated by the abundance of supratidal nodular anhydrites. However, on this shelf, the different facies or facies edges were actively migrating. This migration was dependent on sealevel fluctuations, storms, and the abundance of sediment-producing organisms. The lack of clastic debris, except for some questionable clay muds and marls present in some cuttings, and rare quartz grains, indicates the likelihood that no "Florida Highland" was near. Thus, depending on

sealevel fluctuations, the only upper Jurassic(?) - lower Cretaceous land in south Florida consisted of patches of supratidal flats and the migrating, sometimes exposed grainstone shoals. This area of south Florida looked similar to the Great Bahama Bank except that the Holocene islands were represented in the Cretaceous by supratidal flats with abundant anhydrite.

CONCLUSIONS

The predominant lithology in the pre-Punta Gorda south Florida sedimentary sequence is carbonate mudstone, with associated shallow water grainstone and supratidal anhydrite. It is these associated facies which aid in the depositional interpretation for all the sediments. The supratidal nodular anhydrites and the high energy grainstones suggest shoreline or near shore depositional facies. Therefore, the mudstones by inference, and by studies of Holocene analogs, are probably shallow water sediments also. The abundance of dolomite also indicates a possible near shore, shoreline depositional environment since a mechanism such as evaporation is needed to concentrate magnesium ions. The best model for this data is a sabkha environment.

The method used to study this well data was successful. The anhydrite dominated samples show that well cuttings circulated up the hole can remain relatively free of contamination. Also, the samples are accurately labeled with respect to depth in the well. In the Appendix III is a copy of both the Induction and Density logs for the Mobil Treen well (MT). The density log anhydrite response tracks the curve at approximately the 3.0 grams/cc chart division. Schlumberger (1972, p. 46) indicates the log response value should be approximately 2.977 grams/cc. The yellow color on the induction log correlates satisfactorily with the anhydrite density log response, particularly in the MT 41 through 49 samples interval.

It is important to recognize that this study is very regional in scope. It draws broad, sweeping conclusions from less than a teaspoon of sample per thin section (most of which is ground away in the thin sectioning process). The average sample interval is approximately 93 ft vertically and maximum of approximately 100 mi horizontally. However, the lateral continuity of lithologies studied in the wells makes a strong case for a shallow water, sabkha type hypersaline depositional environment.

APPENDIX II

The following data was obtained by point-counting the cuttings from each thin-section. Whenever possible, 200 counts were made per thin-section. A percentage figure was then calculated for each textural fabric and/or lithology present.

Abbreviations include:

anhy/anhydrite; cal/calcareous; dol/dolomite or dolomitic;
mdstn/mudstone; wckstn/wackestones; pckstn/packstone; x'l/
 crystalline; grn/grain; v/very; fn/fine; frag/fragment; md/mud.

The data is listed as follows:

Sample #; interval depth; total # of point counts; fabric and/or lithology and percentage. Comments.

Amble Oil and Refining Co., LeHigh Acres Development Inc., Well #1

I)

- 3; 11900-10; 175; cal mdstn 34%; x'l dol 25%; anhy 16%; dol mdstn 12%; cal grnstn 7%; others 7%.
- 4; 11950-60; 188; x'l dol 38%; cal mdstn 25%; anhy 12%; dol mdstn 10%; cal pckstn 4%; others 11%; x'l dol rhombs range from 25-75 microns in length. Some residual lm mud in x'l dol. Echinoderm frag in cal mdstns.
- 8; 12150-60; 200; anhy 37%; x'l dol 27%; dol mdstn 20%; cal mdstn 14%; others 2%; Anhy bladed to fibrous.
- 10; 12250-60; 198; cal mdstn 51%; dol mdstn - x'l dol 29%; cal wckstn 9%; anhy 5%; other 6%. Cal mdstns contain a few blocky calcite replaced skeletal frags and some pelloids.

- HI 12; 12350-60; 200; x'l dol 29%; cal mdstn 22%; anhy 20%; cal wckstn 13%; others 16%.
- HI 15; 12500-60; 200; anhy 30%; x'l dol 22%; dol mdstn 22%; cal mdstn 12%; cal wckstn 7%; cal grnsth 4%; other 3%.
- HI 19; 12700-10; 200; cal mdstn 78%; x'l dol 10%; dol mdstn 7%; others 5%. Cal mdstn are generally grn barren. Several chips have a few random dol rhombs.
- HI 21; 12800-10; 194; cal wckstn 39%; detrital(?) mdstn 36%; cal mdstn 27%. Wckstn - mdstn skeletal debris is pred echinoderm frags and other skeletal frags (inoceramus prisms). Some fn qtz in mdstns.
- HI 22a; 12870-80; 200; dol-detrital(?) mdstn 45%; cal wckstn 21%; cal mdstn 9%; dol(?) pckstn 7%. Mdstns contain varying % of lm mud and skeletal debris. Some qtz grns present.
- HI 23; 12900-10; no counts; laminations present in these tar stained, dark mdstns.
- HI 23c; 12930-40; no counts, poor samples; Same as 23, but with some calcareous zones.
- HI 23d; 12940-50; no counts; same as 23c. Asphaltic residue present.
- HI 25; 12950-60; no counts; same as 23d. Matrix of mdstn questionable cal-dol-detrital(?).
- HI 26; 13000-10; 186; volcanic(?) mdstn 41%; cal-dol wckstn 26%; cal pckstn 16%; cal mdstn 15%; anhy 2%. Mdstns have qtz frags and skeletal frags such as echinoderms.
- HI 29; 13150-60; 200; cal grnsth 40%; dol mdstn-detrital(?) mdstn 20%; cal mdstn 20%; cal wck-pckstns 19%; others 1%. Grnstns pred pelloids, echinoderms, forams and oncolites. Drusy and blocky cements common. Mdstns oil stained(?).
- HI 32; 13300-10; 200; cal grnsth 42%; cal mdstn 28%; dol(?) mdstn 14%; x'l dol 6%; others 10%. Grnsth clasts pred coated and free forams, pelloids, oncolites, and other skeletal parts.
- HI 34; 13400-10; 225; poor sample, cal grnsth 20%; cal mdstn 20%; dol(?) mdstn 15%; x'l dol 15%; cal wckstn 10%; cal pckstn 8%; others 13%. Grnstns composed of coated and noncoated forams, pelloids, and other skeletal frags.

- HI 38; 13600-10; 275; cal mdstn 29%; cal pckstn 15%; dol mdstn 15%; cal grnstn 14%; cal wckstn 14%; others 13%.
- HI 41; 13750-60; 200; cal grnstn 35%; dol(?) mdstn 31%; cal wckstn 15%; cal mdstn 11%; others 8%. Grnstns composed of pellets (one recognizable Favreina sp), pelloids, 1m md intraclasts, and oncolites (one coated echinoderm frag).
- HI 42; 13800-10; 342; cal grnstn 23%; cal pckstn 21%; cal mdstn 21%; dol(?) mdstn 18%; anhy 13%; others 4%. Grns of oolites, oncolites (some crushed), and pelloids common. Pckstns may actually be grnstns. Slide thickness problem.
- HI 45; 13950-60; 200; dol(?) mdstn 28%; cal mdstn 26%; x'l dol 15%; cal wckstn 11%; cal grnstn 10%; others 10%. Mdstns contain angular to subangular qtz.
- HI 48; 14100-10; 298; dol(?) mdstn 40%; x'l dol 33%; cal grnstn 9%; cal mdstn 8%; anhy 8%; others 2%. Dense, dark mdstn, some showing algal laminations. Individual subangular qtz grns common as well as isolated 1m mud and calcite spar filled voids.
- HI 50; 14200-10; 200; cal mdstn 27%; cal grstn 21% x'l dol 18%; cal pckstn 17%; dol mdstn 8%; cal wckstn 8%; anhy 1%. Few pelloids present in the cal mdstns. Grnstns composed of oncolites, pelloids, and oolites.
- HI 52; 14300-10; 200; anhy 29%; cal mdstn 25%; cal grnstn 18%; x'l dol 10%; dol(?) mdstn 9%; cal wckstn 8%; others 1%. Bladed-fibrous anhy. Cal mdstn have a few faint pelloidal ghost. Some laminated solution seams.
- HI 55; 14450-60; 199; cal mdstn 63%; cal wckstn 16%; cal grnstn 9%; cal pckstn 7%; others 5%. Some pelloid ghost present in the cal mdstns. Cal wckstns contain foram grns, pelloids, and a few echinoderm frags.
- HI 57; 14550-60; 200; dol(?) mdstn 48%; cal mdstn 20%; x'l dol 16%; anhy 11%; cal pckstn/wckstn 8%; others 2%.
- HI 59; 14650-60; 200; cal grnstn 40%; x'l dol 30%; cal mdstn 19%; anhy 10%; cal wckstn 4%; others 6%. Cal grnstn composed of pelloids, oolites, oncolites, and minor foram and echinoderm debris. Cements are drusy, blocky, and poikilotopic(?) calcite.

- HI 62; 14800-10; 200; x'l dol 70%; dol mdstn 24%; other 6%. x'l dol rhombs range from 25 - 75 microns. Pelloid ghost present in the x'l dol. Dol mdstns are much finer grned, with occasional laminated chips.
- HI 66; 1500-10; 200; x'l dol 70%; dol(?) - mdstn 18%; anhy 8%; others 4%. Tightly packed x'l dol. Subangular qtz grns up to 250 present in some x'l dol chips.
- HI 68; 15100-10; 200; x'l dol 42%; dol(?) mdstn 30%; anhy 10%; cal mdstn 10%; others 8%. Coarse to fn grn x'l dol some showing very thin laminations highlighted by black insoluable residue. Pelloid ghost visible. Dol(?) mdstn yellowish brown in color, with some subangular qtz grains. Possibly volcanic ash.
- HI 71; 15250-60; 200; x'l dol 93%; dol(?) (ash?) mdstn 6%; others 1%. Some x'l dol chips contain pelloidal and skeletal(?) ghost, as well as solution seams.
- HI 73; 15350-60; 200; x'l dol 75%; (vol?) mdstn 20%; anhy 5%. Tightly packed x'l dol with random subangular qtz grns common. Mdstn chips have a yellowish brown matrix with random subangular qtz grns from 25 - 250
- HI 75; 15440-50; 200; x'l dol 83%; clastics 10%; dol(?) mdstn 4%; anhy 3%. Tightly packed x'l dol. Some chips display subangular qtz grns.
- HI 76; 15500-10; 175; Red shale - clastics 61%; x'l dol 26%; anhy 11%; others 2%. Red shales clastics contain subrounded to subangular qtz. Also present is the yellowish brown mdstns with qtz. Some poikilotopic anhy/gyp(?) cements.
- HI 78; 15600-10; 200; Red shale - clastics 59%; x'l dol 30%; dol(?) mdstn 9%; anhy 2%. Clastics composed of red shale with varying % of subangular to subrounded qtz. Other clastic chips composed of yellow-brown v fn grn matrix with some qtz grns.
- HI 80; 15700-10; 170; x'l dol 40%; red shale - clastics 24%; dol(?) mdstn 18%; anhy 9%; others 9%. X'l dol with pelloid and skeletal(?) ghost present and occasional qtz grns. Red shale clastics resemble previous thin section chips. Two questionable diabase chips present.

Bass Enterprises Production Co. Pumpkin Bay Collier County Well # 12-2.
(BA)

- BA 13; 13000-10; 200; anhy 89%; x'l dol 5%; others 6%. Bladed-fibrous anhy with thin deformed v fn grn dol mdstn.

- BA 15; 13100-10; 197; anhy 74%; dol mdstn 21%; others 5%. Blade-fibrous anhy often in contact with v fn grn dol mdstn bands which are contorted. Blocky anhy(?) pore filling cements in v fn grn dol.
- BA 20; 13350-60; 200; anhy 54%; x'l dol 44%; others 2%. Anhy assoc with minor amounts of v fn grn dol. Anhy blade-fibrous. Blocky anhy(?) cement assoc with z'l dol.
- BA 22; 13450-60; 200; x'l dol 69%; dol mdstn(?) 47%; anhy 19%. x'l dol dense with rhombs less than 50μ . Dol mdstn(?) has individual rhombs in a yellowish brown matrix. Some v fn grn dol present with blocky anhy(?) pore fill cement.
- BA 25; 13600-10; 200; x'l dol 57%; cal mdstn 22%; anhy 10%; others 11%. X'l dol has varying % of lm mud. Minor amounts of bladed anhy assoc with the dol also.
- BA 27; 13710-20; 200; cal mdstn 56%; x'l dol 36%; others 8%. Homogeneous mdstn with varying amounts of individual to aggregate rhombs of dol. Minor amounts of skeletal debris. Opaque insoluable residue outlines some grains.
- BA 28; 13740-50; 200; cal mdstn 59%; x'l dol 20%; anhy 8%; cal grnstn 8%; others 5%. Cal mdstn almost completely devoid of skeletal grains. Few pelloid ghost present with a few scattered dol rhombs.
- BA 30; 13850-55; 114; cal mdstn 98%, others 2%. Poor sample.
- BA 32; 13950-60, 200; cal mdstn 97%; x'l dol 3%. Poor sample. Few faint pelloids.
- BA 36; 14150-60; 200; cal pckstn 51% cal mdstn 20%; cal grnstn 18%; cal wckstn 5%; others 6%. In pckstn predominant grains are oncolites, forams and coated forams, pelloids, some grape-stones(?). Some oncolites are deformed by compaction and/or solution contacts. Drusy and blocky calcite cements present in both pckstns grain chambers and as matrix in grnstns. Pckstn matrix is recrystallized lm mud. Echinoderm frags present in wckstn.
- BA 38; 14250-60; 200; cal mdstn 59%; cal pckstn 16%; clay(?) 11%; others 14%. Pelloid ghosts and a few faint micritized foram test in mdstn. Grains in pckstn are coated skeletal frags and pelloids.

- BA 39; 14304-10; 200; detrital(?) mdstn 48%; cal pckstn 27%; cal mdstn 23%; others 2%. Yellow brown detrital mdstn with occasional single and aggregate rhombs of dol and some cal md. Grains in pckstn predominately millioids, pelloids, and oncolites-oolites.
- BA 40; 14350-60; 200; cal pckstn 43%; cal mdstn 33%; dol mdstn 13%; cal grnstn 8%; others 3%. In the pckstn, grains are pred lm mud lumps, pelloids, and some skeletal frags. The matrix is difficult to identify. It may be v fn calcite cement, or recrystallized lime md.
- BA 42; 14450-60; 194; cal mdstn 49%; dol mdstn 19%; cal-dol grnstn 15%; others 17%. Cal mdstns have varying amounts of dol rhombs.
- BA 43; 14500-10; 209; cal pckstn 43%; cal mdstn 36%; cal grnstn 9%; others 12%. In the pckstns and mdstns, conversion of lm mud to microspar makes grn identification difficult. Faint pelloids and some skeletal grns present. One echinoderm frag present. In grnstns, pelloids and some oncolites(?) present.
- BA 45; 14600-10; 200; cal mdstn 67%; cal grnstn 27%; others 6%. Mdstns show faint pelloids and micritized forams. Oolites, oncolites, pelloids, and coated forams are dominant clasts in grnstns. Several laminated chips noted.
- BA 48; 14750-60; 200; x'l dol 29%; anhy 24%; cal grnstn 21%; cal mdstn 19%; others 7%. X'l dol have cal mud and faint grains present. Dol rhombs less than 50 microns. Some poikilotopic textures noted in the grnstns.
- BA 51; 14900-10; 200; cal pckstn 40%; cal mdstn 26%; cal grnstn 22%; clay 6%; others 6%. Pelloids dominate grn. Intraclasts of lm mud as well as mud coated forams and recrystallized mud coated shell frags present. Echinoderm and inoceramus(?) frags present also.
- BA 52; 14950-60; 258; cal pckstn 38%; cal grnstn 29%; dol mdstn 14%; cal mdstn 10%; others 9%. Pckstn consist of compaction deformed oncolites, foram frags, shall frags with micrite envelopes (one inoceramus?). Minor solution compaction seams present.
- BA 53; 15000-10; 200; x'l dol 71%; cal mdstn 13%; anhy 10%; others 6%. Coarsest dol rhombs from 88 to 25 microns. Some lm mud present in x'l dol as well as blocky anhy(?) filling pore spaces. Pelloid ghost prominent.

- BA 55; 15100-10; 200; cal mdstn 38%; x'l dol 27%; anhy 11%; dol mdstn 11%; cal grnstn 7%; others 6%. Few faint pelloids in cal mdstns. Varying degree of dolomitization in cal mdstns. Several laminated mdstns present.
- BA 57; 15200-10; 200; anhy 68%; dol mdstn 13%; cal mdstn 12%; others 7%. Fibrous to bladed anhy in close assoc with dol mdstn.
- BA 60; 15350-60; 200; x'l dol 64%; anhy 20%; dol mdstn 12%; others 4%. X'l dol rhombs approx 50 microns or less in length. Blocky anhy/gyp(?) pore filling present. Blocked to fibrous anhy also present. 1-5% interrhombohedral porosity present if not formed during thin section prep.
- BA 62; 15450-60; 200; cal grnstn 71%; dol pckstn 9%; cal mdstn 7%; anhy 6%; others 7%. Grnstn pred oncolites, pelloids, grape-stones. Forams form the core of many oncolites, as well as other skeletal debris. Oncolites commonly deformed by compaction. Drusy and blocky cements common.
- BA 64; 15550-60; 200; cal mdstn 77%; dol mdstn-clay 12%; cal grnstn 6%; others 5%. Pelloidal cal mdstn. Faint pelloids and milliolid ghost. May actually be a pckstn. V fn drusy and blocky cements present in some foram chambers. In several clay(?) chips, several subrounded qtz grns are present.
- BA 65; 15600-10; 200; cal mdstn 56%; cal grnstn 36%; dol mdstn 6%; others 2%. Cal mdstns are basically fossil free, except for some faint pelloids.
- BA 66; 15650-60; 200; cal mdstn 72%; cal grnstn 24%; others 4%. Homogeneous cal mdstns with no visible grains. Grnstns composed predominately of pelloids (pellets) and coated forams and some coated bivalve shells.
- BA 68; 15750-60; 200; cal mdstn 46%; anhy 29%; cal grnstn 11%; dol mdstn 7%. Some faint pelloid ghost present in cal mdstns as well as several pelloid shaped calcite filled pore spaces. Some poikilotopic textures noted.
- BA 69; 15800-10; 195; cal mdstn 50%; cal pckstn 24%; x'l dol 13%; anhy 8%; others 5%. Poor sample cal mdstn shows faint pelloidal grns. Pckstn composed of pred pelloids, oncolites and minor coated skeletal debris.
- BA 71; 15900-10; 200; anhy 45%; x'l dol 17%; dol mdstn 15%; cal grnstn 12%; cal mdstn 9%; others 2%. Blade fibrous anhy assoc with v fn grn dol mdstn in several chips. X'l dol rhombs less than 50 μ . Grnstns composed of oolites-oncolites, with

selectively dolomitized cores in one chip. Styolites are also present in this chip.

- BA 74; 16050-60; 200; anhy 51%; x'l dol 34%; cal mdstn 13%; others 2%. Bladed to fibrous anhy assoc with v fn to fn grn dol mdstn. Poikilotopic textures noted in the x'l dol.
- BA 77; 16200-10; 200; x'l dol 79%; anhy 19%; others 2%. X'l dol has tightly packed rhombs of approx 25 - 50 microns in length. Blocky anhy(?) pore filling is common in the fine and coarse dol.
- BA 79; 16300-10; 200; anhy 38%; x'l dol 36%; dol mdstn 24%; others 2%. V fn grn dol mdstn assoc with bladed fibrous anhy.
- BA 80; 16350-60; 200; x'l dol 82%; dol mdstn 10%; cal grnstn 7%; others 1%. Tightly packed rhombs less than 50 microns in length. Several chips appear to be dolomitized grnstns with poikilotopic anhy/gyp secondary cements.
- BA 83; 16500-10; 200; dol grnstn 80%; dol mdstn 8%; x'l dol 5%; others 7%. The dol grnstns are slightly cal; grns are pred pelloid and oolites. Commonly pelloids have been replaced by x'l dol, while the matrix is lm md. Other chips have oolites with the inner portions of the oolite dolomitized. Cal cements are drusy and blocky. A few chips show complete dolomitization with pelloid ghost.
- BA 85; 16600-10; 200; anhy 49%; dol mdstn 39%; x'l dol 9%; others 3%. Anhy is bladed-fibrous and is directly in contact in several chips with fn grn dol mdstn.
- BA 86; 16650-60; 200; anhy 63%; dol mdstn 37%. Anhy is bladed - fibrous and assoc with fn grn dol.
- BA 88; 16750-60; 200; x'l dol 55%; dol mdstn 32%; anhy 11%; others 2%. x'l dol rhombs between 25 - 60 microns in length. Black pelloid ghost are present in some of the x'l dol chips, as well as some solution compaction seams. Blocky poikilotopic cement present.
- BA 91; 16900-10; 200; x'l dol 72%; dol mdstn 25%; others 3%. X'l dol rhombs approx 50 - 60 microns in length. Many of the x'l dol chips have dark organic appearing interrhombohedral material as well as pelloid ghosts highlighted by this same material.

- BA 93; 17000-10; 199; cal grnstrn 53%; cal mdstrn 22%; cal pckstrn 13%; x'l dol 5%; others 7%. In the cal grnstrns, oncolites, oolites, pelloids, and a few bivalve shell frags are the dominant grains. Many of the oncolites show compaction deformation and calcite replacement of portions of the cores. Micrite envelopes are common around the skeletal debris. Minor dolomitization is present.
- BA 94; 17050-60; 200; cal grnstrn 31%; cal pckstrn 19%; cal mdstrn 17%; cal wckstrn 8%; dol mdstrn 7%; dol pckstrn 7%; dol grnstrn 7%; others 4%. In the cal grnstrns, predominant grns are oncolites, pelloids, oolites, 1m md intraclasts, 1m mud coated forams, coated echinoderm frags and 1 micrite envelope enclosed bivalve frag. Cements are pred drusy and blocky calcite.
- BA 95; 17100-06; 200; anhy 55%; dol mdstrn 18%; cal mdstrn 14%; x'l dol 12%; others 1%. Fibrous - bladed anhy contact with v fn grn dol mdstrn.
- BA 98; 17250-60; 200; x'l dol 32%; dol mdstrn 30%; anhy 29%; cal mdstrn 7%; others 2%. Faint pelloid grns present, often highlighted by dark, insoluble residue in x'l dol.
- BA 100; 17400-10; 200; x'l dol 80%; anhy 7%; cal mdstrn 7%; cal grnstrn 4%; others 2%. X'l dol rhombs range in size from approx 25 to 50 microns in length. Small amount of 1m mud present as well as occasional pelloids.
- BA 104; 17550-60; 200; x'l dol 62%; dol mdstrn 18%; anhy 13%; cal mdstrn 5%; others 2%. Some coarse poikilotopic anhy/gyp(?) cements present in some x'l dol chips. Pelloidal ghost are present as well as dark material (organics?) which appear as thin interrhomblc laminations. Minor amounts of subangular to sub-rounded qtz grns present.
- BA 107; 17700-10; 191; cal mdstrn 39%; x'l dol 36%; dol mdstrn 14%; anhy 9%; others 2%. Cal mdstrn has single dol rhombs to aggregates of rhombs with some cal md to x'l dol.
- BA 112; 17950-60; 200; dol mdstrn 53%; x'l dol 27% anhy 17%; cal mdstrn 3%. V fn grn dol mdstrn in some chips are faintly laminated and in contact with bladed to fibrous only.
- BA 116; 18150-60; 200; x'l dol 85%; dol mdstrn 7%; cal mdstrn 4%; anhy 3%; others 1%. X'l dol rhombs range from 50 - 80 microns in length.

- BA 118; 18250-60; 200; cal mdstn 48%; anhy 18%; x'l dol 15%; dol mdstn 10%; cal grnstn 5%; others 4%. Cal mdstn has varying amounts of single to aggregate dol rhombs. Some solution seams present. X'l dol has minor amounts of lm mud.
- BA 119; 18300-10; 200; cal mdstn 30%; x'l dol 26%; anhy 17%; dol mdstn 13%; cal grnstn 13%; others 1%. Some cal mdstn chips show faint pelloid ghost with selective dolomitization of the matrix.
- BA 121; 18400-10; 200; x'l dol 70%; dol mdstn 11%; cal mdstn 9%; anhy 1%; others 3%. Pelloid ghost present in x'l dol. Interrombic porosity(?) 1-5% in the x'l dol.
- BA 122; 18450-60; 200; x'l dol 84%; anhy 9%; dol mdstn 3%; others 4%. Some type of prismatic silica(?) growth assoc with several x'l dol chips.
- BA 125; 18600-10; no counts, Red shale unit with some angular qtz grains Rhyolite(?) chips with qtz. Qtz microconglomerates with a lm md cement.
- BA 126; 18650-60; no count; Mixture microconglomerates, red shale and anhy.

Mobil Oil Corp., R. M. Trien #1 (MT)

- MT 3; 13300-10; 200; cal wckstn 41%; cal mdstn 26%; cal pckstn 13%; dol mdstn 13%; cal grnstn 6%; anhy 1%. Echinoderm frags common in wckstns.
- MT 5; 13410-20; 200; cal mdstn 35%; cal grnstn 26%; cal pckstn 20%; cal wckstn 17%; others 2%. Grnstn, pckstn, wckstn grns composed of micritized milliolid tests, pelloids, skeletal debris.
- MT 6; 13450-60; 200; dol-cal gnstn 78%; cal mdstn 16%; others 6%. Some oncolite-oolite cores and occasional matrix dolomitization. Drusy and blocky cements.
- MT 7; 13500-10; 200; cal grnstn 46%; cal mdstn 37%; marl(?) 11%; others 6%. Grnstns of oolites, oncolites, pelloids, forams, and microskeletal debris.

- MT 9; 13600-10; 200; dol cal pckstn 40%; cal mdstn 30%; cal grnstn 15%; others 15%. Pckstn grns pred. pelloids and milliolid forams. Minor yellow brown marls with v fn grn qtz.
- MT 14; 13850-60; 200; cal mdstn 89%; cal grnstn 6%; other 5%.
- MT 16; 13950-60; 200; anhy 83%; dol mdstn 4%; x'l dol 4%; others 9%. Anhy bladdered-fibrous with v fn grn dol mdstn rims.
- MT 17; 14000-10; 200; anhy 50%; cal mdstn 18%; dol-cal pckstn 10%; cal grnstn 8%; others 14%. Anhy same as MT 16.
- MT 19; 14100-10; 200; cal mdstn with x'l dol 80%; dol(?) mdstn 8%; x'l dol 6%; cal grnstn 6%. Cal mdstns and grnstns show varying degrees of rhombic dolomitization.
- MT 20; 14149-59; 200; x'l dol 48%; dol mdstn 26%; cal mdstn 15%; cal grnstn 4%; others 7%. X'l dol has some interrhombohedral cal mdstn. Pelloid ghost present in the x'l dol.
- MT 24; 14300-10; 200; cal mdstn 89%; x'l dol 6%; others 5%. Faint pelloids and minor echinoderm frags present in cal mdstn.
- MT 26; 14550-60; 200; dol mdstn 69%; anhy 21%; x'l dol 10%. Dol mdstn consist of highly packed fn grn rhombs less than 25 microns.
- MT 28; 14650-60; 200; anhy 51%; cal pckstn 15%; cal mdstn 14%; cal wckstn 7%; others 13%. Very poor sample.
- MT 32; 14770-80; 200; cal grnstn 91%; anhy 5%; others 4%. Micrite envelopes distinguish most of these vague, skeletal grns. Oncolites and oolites present. Rim and blocky cements
- MT 34; 14850-60; 200; cal mdstn - x'l dol 96%; others 4%. X'l dol replacement of cal mdstn-grnstns.
- MT 37; 15000-10; 200; cal mdstn 91% dol-cal wckstn 6%; anhy 3%. Cal mdstns show x'l dol replacement. Rhombs less than 50 microns.
- MT 39; 15100-10; 200; cal mdstn 89%; cal wckstn 6%; others 5%. Less dol than MT 37. Few grns of forams and echinoderms.
- MT 40; 15150-60; 200; x'l dol 70%; cal mdstn 18%; anhy 5%; others 7%. Tightly pack x'l dol with occasional blocky anhy(?). Other anhy is fibrous-bladed.

- MT 41; 15200-10; 200; very poor sample. V fn grn dol mdstn and fibrous-bladed anhy dominant.
- MT 43; 15300-10; 200; anhy 84%; dol mdstn 8%; x'l dol 8%. Bladed fibrous anhy.
- MT 46; 15450-60; 200; x'l dol 61%; anhy 36%; cal mdstn 3%. Tightly packed x'l dol with pelloid ghost. Poikilotopic anhy cement(?) and blocky pore filling anhy(?) cement common in the x'l dol. Other anhy fibrous-bladed.
- MT 49; 15600-10; 200; anhy 46%; cal mdstn 25%; dol mdstn 21%; cal grnsth 6%; x'l dol 2%. Bladed-fibrous anhy in contact with v fn grn dol mdstn.
- MT 52; 15750-60; 200; dol-cal grnsth 41%; cal mdstn 39%; cal wcksth 13%; others 7%. Grnsth composed of pelloids, lm mud intra-clasts, oolites-oncolites(?) and forams. Micritization dominant.
- MT 53; 15780-90; 200; x'l dol 96%; dol mdstn 2%; dol grnsth 2%. X'l dol rhombs range from 25 - 75 microns and are tightly packed. Some poikilotopic anhy-gyp(?) cement.
- MT 56; 15950-54; 200; x'l dol-cal mdstn 66%; cal-dol grnsth 25%; dol mdstn 7%; anhy 2%. Probably a dolomitized grnsth. This dol hides most textures.
- MT 57; 16000-10; 200; cal mdstn 30%; x'l dol 26%; dol-cal grnsth 22%; anhy 14%; dol mdstn 8%. Cal mdsth have varying degree of dolomitization. Some questionable interrhombohedral porosity (1-5%).
- MT 61; 16200-10; 200; anhy 50%; x'l dol 48%; dol-cal mdstn 2%. Anhy bladed-fibrous.
- MT 62; 16248-60; 200; x'l dol 97%; anhy 2%; cal mdstn 1%. Faint relict grn ghost in x'l dol. Appears pelloidal.
- MT 65; 16400-10; 200; x'l dol 50%; anhy 18%; cal-dol grnsth 17%; dol mdstn 15%. X'l dol show pelloidal ghost. Some black organic(?) laminations present.

Gulf Oil Corp. State of Florida, Lease 373 #1 (GM1)

- GM1 1; 14300-10; 200; anhy 68%; dol 19%; others 12%. Anhy fibrous-bladed. Dol v fn grn to x'l. Minor cal md.
- GM1 2; 14350-60; 113; cal mdstn 57%; dol mdstn 19%; cal wcksth 12%; others 12%. Drusy and blocky cements present, solution seams in some cal mdsth.

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- GM1 4; 14450-60; 200; cal mdstn 90%; others 10%. Calcite healed microfractures. 1 shell frag - prismatic structure(?).
- GM1 5; 14500-10; 132; dol 52%; cal mdstn 22%; anhy 20%; others 6%. Poor sample. Dol v fn grn to x'l with minor cal md.
- GM1 6; 14550-60; 200; cal mdstn - dol mdstn 62%; cal - dol wckstn 16%; others 22%. Dol are individual rhombs grading into aggregates of rhombs in a cal md matrix.
- GM1 7; 14600-10; 300; cal mdstn 53%; x'l dol 20%; dol mdstn 17%; others 10%. Cal mdstn contains faint pelloidal grns.
- GM1 8; 14650-60; 200; cal mdstn 100%. Few laminated mdstn; few dol rhombs; few skeletal frags and pelloids.
- GM1 9; 14700-10; 295; dol mdstn 45%; x'l dol 31%; cal mdstn 17%; anhy 5%; others 2%. Dol mdstn is v fn grn with few laminations. Questionable 1-4% porosity.
- GM1 10; 14750-60; 375; cal mdstn 70%; x'l dol 12%; wckstn - pckstn 12%; others 6%. Echinoderm frags and pelloids noted. X'l dol rhombs present.
- GM1 12; 14850-60; 200; cal mdstn 70%; cal wckstn 30%. Description from peel. Faint pelloids present in mdstns.
- GM1 13; 14900-10; 300; cal mdstn 73%; cal wckstn 26%. V fn grn microfossils in mdstns and wckstns. Echinoderm frags present.
- GM1 15; 15000-10; 300; cal mdstn 91%; others 8%. Minor dol rhombs. Few forams. Echinoderm frags present.
- GM1 16; 15050-60; 192; x'l dol 65%; cal mdstn 28%; others 7%. X'l dol rhombs up to 100 microns. (?) interrhombar porosity of 1-3% in
- GM1 17; 15100-10; 370; cal mdstn 65%; cal marl(?) 16%; x'l dol 12%; others 7%. X'l dol in cal mdstn. Marls are yellow brown and laminated.
- GM1 18; 15150-60; 200; cal mdstn 64%; cal wckstn 14%; cal marl(?) 11%; others 11%. Micritized forams and echinoderm frags present. Mdstns grn free and homogeneous.
- GM1 19; 15200-10; 364; cal grnstn 33%; cal pckstn 25%; cal mdstn 14%; cal wckstn 10%; x'l dol 8%; others 10%. Grns of foram debris, coated forams, pelloids, algal(?) frags and other skeletal parts. Drusy and blocky cements common.

- GM1 20; 15250-60; 200; anhy 70%; dol mdstn 17%; others 13%. Anhy fibrous-bladed.
- GM1 21; 15300-10; 200; anhy 56%; cal mdstn 28%; others 16%. Anhy appears fibrous-bladed, with convoluted outlines.
- GM1 22; 15350-60; 180; poor sample; cal mdstn 46%; cal wckstn 30%; cal grnstn 22%; others 2%. Cal mdstns show faint pelloids, as do the wckstns.
- GM1 23; 15400-10; 250; cal pckstn(?) 33%; cal mdstn 26%; cal wckstn 17%; anhy 10%; others 14%. (thin-section destroyed) Pelloidal mdstn may better describe this sample.
- GM1 24; 15440-50; 200; anhy 80%; dol mdstn 9%; cal mdstn 6%; cal mdstn-marl(?) 5%. Anhy bladed to fibrous in contact with v fn grn dol. Laminated marls(?) are yellow brown.