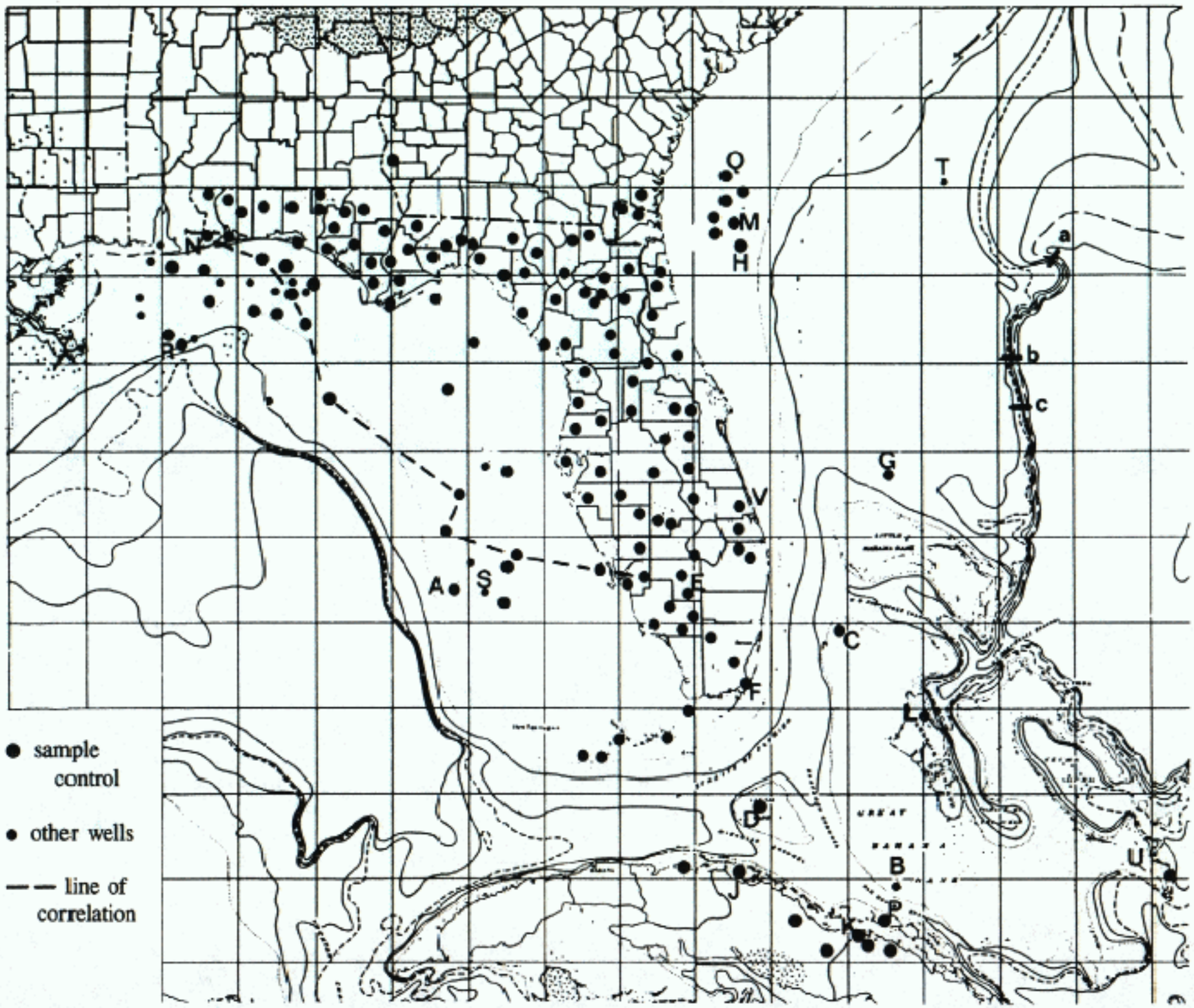
# ATLAS
## OF
## STRUCTURAL EVOLUTION
## AND
## FACIES DEVELOPMENT
## ON THE
## FLORIDA — BAHAMA PLATFORM —
## TRIASSIC THROUGH PALEOCENE

George O. Winston

Miami Geological Society
Coral Gables, Fl.
1991




**Well Control and Line of Correlation**

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All of the original data used to assemble the Atlas were acquired while preparing five non-exclusive reports on Florida for Petroconsultants S.A., Geneva, Switzerland. The author wishes to express his appreciation for their permission to publish this volume.

Last, but not least, the Atlas text would not have made it through the numerous revisions were it not for the patient word processing of my wife Mary.

Some of these maps were presented in large format as a Poster Session at the 1988 AAPG Convention.

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## ABSTRACT

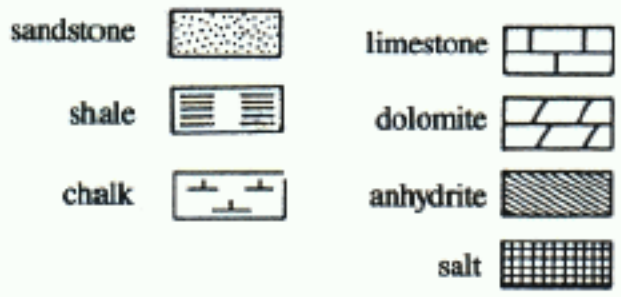
The Triassic through Paleocene lithology presented in this paper is based entirely on my top-to-bottom examination of drill cuttings from 161 wells on the Florida-Bahama Platform. As used herein, the Florida-Bahama Platform encompasses all of Florida on and offshore, the Blake Plateau, Great and Little Bahama Banks including channels and straits, and northern Cuba.

From the Upper Jurassic through Paleocene, three different structural regimes formed through time. During the Upper Jurassic-Coahuilan, the Northwestern Sedimentary Province contained the Middle Ground Arch separating the Tampa Basin from the DeSoto Salt Basin to the north. The Southeastern Sedimentary Province, which was separated from the Northwestern Province by the Sarasota and Peninsular Arches, contained no definable basins at that time. During the Comanchean, this Province developed into the South Florida, Bahama and Blake Plateau basins, separated respectively by the Cay Sal Arch and the Little Bahama High. Early in the Gulfian these basins were radically modified by tectonic activity centered in Cuba.

From the Upper Jurassic through the Comanchean, the continental margin of the Platform was occupied by a carbonate complex that restricted marine circulation in much of the area. In the Southeastern Sedimentary Province, this barrier caused the deposition of lagoonal carbonates and anhydrites. Deposition of these rock types ended at the close of the Comanchean with the break-up of the Florida-Bahama Platform and the destruction of the carbonate complex.

Early in the Gulfian, the rapid subsidence of the Blake Plateau basin to bathyal depths and the collapse of the Florida Straits accompanied tectonic activity in Cuba. Also in the early Gulfian, the Rebecca Shoal barrier reef appeared on the upthrown northern side of the Straits. By the end of the Gulfian the reef had expanded to encircle the Florida peninsula, causing deposition of the Cedar Keys (Paleocene) lagoonal dolomite and anhydrite.


LEGEND
GEOLOGIC COLUMNS



# INTRODUCTION

As used herein, the Florida-Bahama Platform encompasses all of Florida on and offshore, the Blake Plateau, Great and Little Bahama Banks including channels and straits, and northern Cuba.

## Purpose

The purpose of this publication is to present litho-paleogeographic maps that have been compiled for Triassic through Paleocene intervals. The accompanying text is included only for supplementary information.

## Presentation

The litho-paleogeographic maps are bound in their stratigraphic order: maps of older rocks are at the back and those of younger rocks are toward the front. Information pertinent to each map is presented on the facing page; thicknesses shown on accompanying geologic columns are averages. Reference wells are shown both on the map under discussion and on the well control map inside the front cover (see Table 2 for Well identification). The width of the color bands on the maps is of no numerical significance; the bands are intended only to show the approximate mixture of lithologies present in a given area.

It will be noted that the maps of Upper Jurassic-Coahuilan have lithology projected into the Bahamas area, whereas the Comanchean maps do not. As there are no control wells in the central Great Bahama Bank, peripheral Wells D, C, and P are used to indicate the presence of Upper Jurassic-Coahuilan carbonate-evaporite lithologies beneath the Great Bahama Bank. These same wells suggest that in Comanchean beds the area may be all dolomite, perhaps with anhydrite stringers. As Wells D and C are on the Cay Sal Arch, and Well P is within the Continental Margin Carbonate Complex, the Comanchean lithology in these wells is probably not typical of the section beneath the central Great Bahama Bank.

## Previous Investigations

Significant studies involving Jurassic, Cretaceous and Paleocene rocks have been published only on parts of the Platform. The first regional study was the pioneering paper of Applin and Applin (1944) which described Upper Cretaceous and Cenozoic rocks using sparse shallow sample control in north and central peninsular Florida. Extensive deep drilling over the next 15 years allowed the same authors to acquire data for their studies of the Upper Cretaceous of northern Florida and southern Georgia (1967) and the Lower Cretaceous of the Peninsula (1965). Chen (1965) described the Eocene and Paleocene rocks of onshore Florida and presented paleogeographic maps. Applegate, Winston and Palacas (1981) investigated the Pre-Punta Gorda rocks of south Florida. Other contributions to the Jurassic through Paleocene stratigraphic literature are minor or very limited in both area and time.

## Method of Investigation

This paper is based on my examination of all available cuttings from some 161 deep oil tests (front cover) and selected short intervals on 390 more. Besides onshore wells in Florida, many wells from offshore Florida, the Bahamas, and northern Cuba were examined. Although no deep wells have been drilled on the Blake Plateau, I was able to examine scattered Lower Cretaceous samples collected by submarine from the eastern margin on the Blake Escarpment (a, b, c, front cover).

Drill cuttings and rare core chips were examined using a 10x stereoscopic microscope. Cenozoic and Upper Cretaceous carbonate rocks and all clastics were examined dry. Lower Cretaceous-Upper Jurassic carbonates were examined wet to bring out the texture.

Foraminifera of stratigraphic significance in the studied section are rare. They can only be used to establish occasional time-equivalent regional intervals.

## Correlations

On the inside of the back cover is a correlation chart showing the relationship of Panhandle and South Florida formations. North and south of the Sarasota Arch there are no common lithologic markers in the Coahuilan-Upper Jurassic rocks. My subdivision of the southern section is based on assigning intervals proportional to the formations north of the Arch. Presence of a Haynesville equivalent in south Florida is supported by the occurance of salt beds both in the basal Haynesville formation of the western Florida Panhandle and in the Lower Wood River formation in southern Florida (Wells C, D, and E).

Correlating lithologic and wire-line logs in a line across the West Florida Shelf (inside front cover) places the top of the Paluxy formation (as defined in Well N in the western Panhandle) within the upper third of the Marco Junction formation in south Florida. The base falls within the lower third of the Lake Trafford formation. The Ferry Lake formation is equal to the lower third of the Punta Gorda formation. These equivalencies are probably correct within plus or minus one hundred feet.

The Pine Island shale and the West Felda are direct correlatives.

## Structure

Except for northern Cuba, non-salt-related Mesozoic and Cenozoic structural movement on the Florida-Bahama Platform was entirely negative. Florida arches were formed *not* by uplift, but by subsiding more slowly than contiguous basin areas. These high features could be called "laggard highs". Positive orogenic movement was confined to northern Cuba on the southern edge of the Platform, where collision of the Caribbean plate with the North American plate at the end of the Lower Cretaceous produced a narrow band of reverse faults and anticlines.

## Note to Readers:

Turn to the last page at the back of the volume and work forward through the book.

**TABLE 1**

| STRUCTURE | PZ | TR | LJ | MJ | UJ | Coa | Com | Gulf | Pal | Eo | U Cen | Now |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sarasota Arch | ?- - | — | — | — | — | — | — | — | — | — - ? | | |
| Wakulla Graben | | — | — | | | | | | | | | |
| Florida Bahama Platform | | | | — | — | — | — | | | | | |
| Apalachicola Embayment | | | | | — | — | — | | | | | |
| DeSoto Salt Basin | | | | — | — | — | — | — | — | | | |
| SE Sedimentary Province | | | | | — | — | | | | | | |
| CMCC | | | | | — | — | — | — | | | | |
| Middle Ground Arch | | | | | — | — | — | — | — | — - ? | | |
| Peninsular Arch | ?- - | — | — | — | — | — | — | — | — | — | — | — - ? |
| Little Bahama High | | | | | | | — | — | — | — | — | — |
| Bahama Depocenter | | | | | | | — | — | — | — | — | — |
| South Florida Basin | | | | | | | — | — | — | — | — | — |
| Cay Sal Arch | | | | | | | — | — | | | | |
| Blake Plateau Basin | | | | | | | — | — | | | | |
| Cuban Tectonic Activity | | | | | | | | — | — | — | — | |
| Florida Straits | | | | | | | | — | — | — | — | — |
| Rebecca Shoal Reef | | | | | | | | — | — | | | |
| Blake Plateau | | | | | | | | — | — | — | — | — |
| Suwannee Strait | | | | | | | | | — | — - ? | | |
| SE Georgia Embayment | | | | | | | | | | — | — | |

Duration of structural features through time

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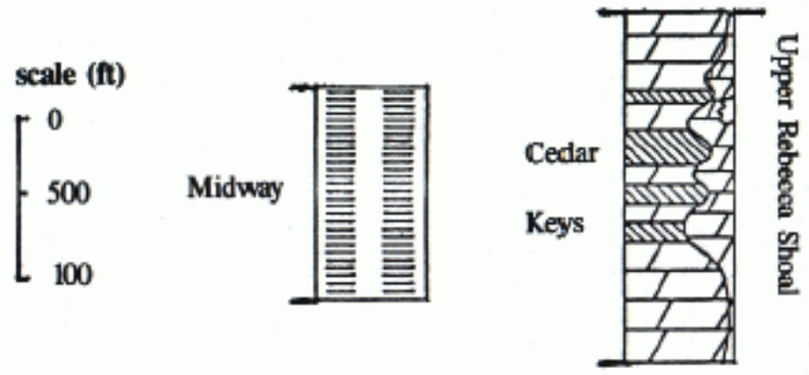
## Cedar Keys

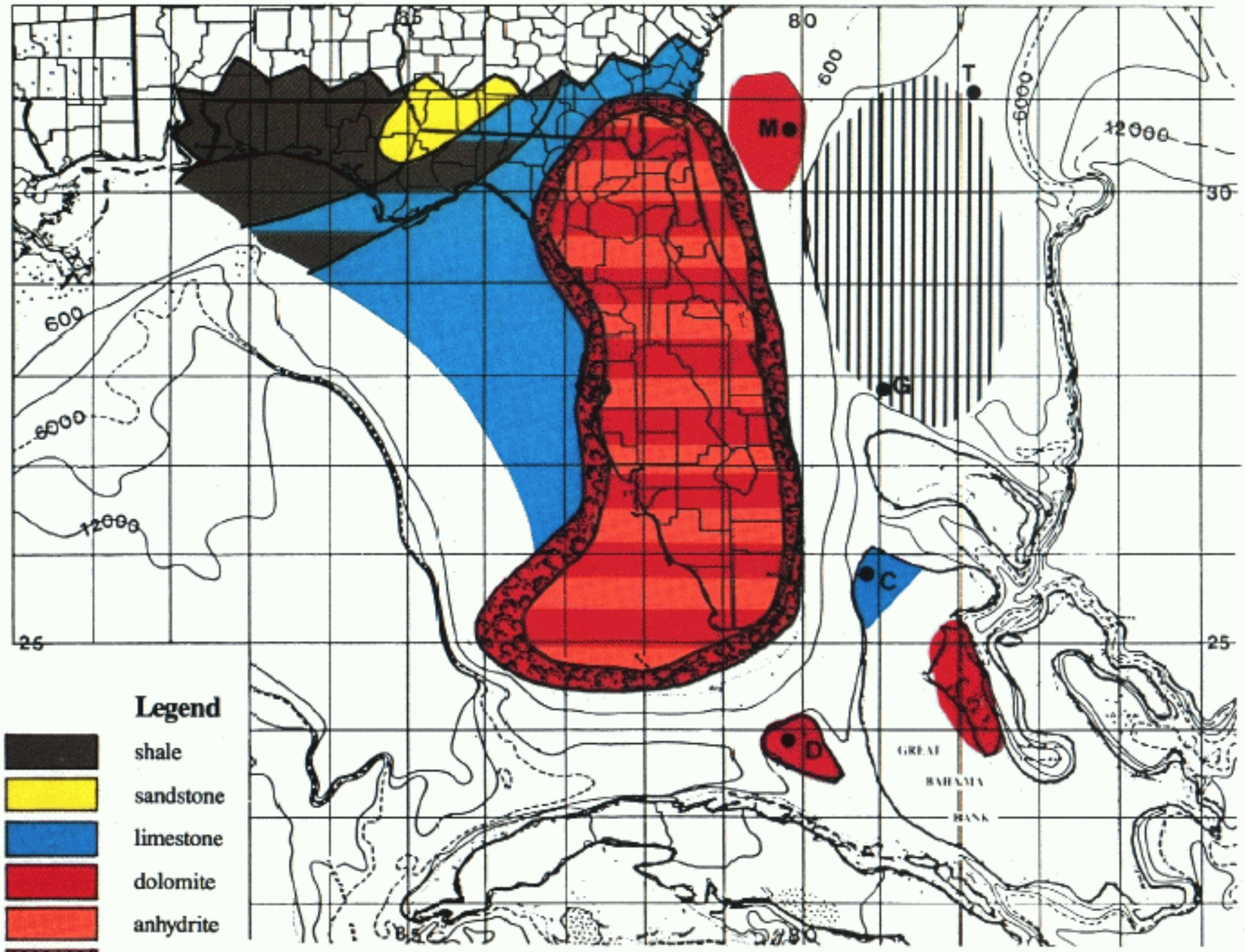
This formation, a microcrystalline euhedral dolomite with interbedded anhydrite, was deposited behind the Rebecca Shoal Barrier reef. Offshore, the equivalent beds on the West Florida Shelf are cherty micritic limestone.

In the eastern Panhandle the equivalent is an unnamed limestone interbedded with gray and brown shale. Farther west, an unnamed sandstone occurs. Still farther west is the Midway formation, composed of gray and brown shale. Outside the barrier reef, on the East Florida Shelf, the equivalent in Well M is anhedral dolomite and cherty limestone.

On Cay Sal (Well D) the equivalent interval is interbedded limestone and dolomite. On the Great Bahama Bank (Well C), it is a light gray limestone. On the now-foundered Blake Plateau, deep water limestone and terrigenous clays (Charm et al., 1969) were encountered in shallow-penetration offshore test (Well T), and at Well G (Leg 101, 1988).





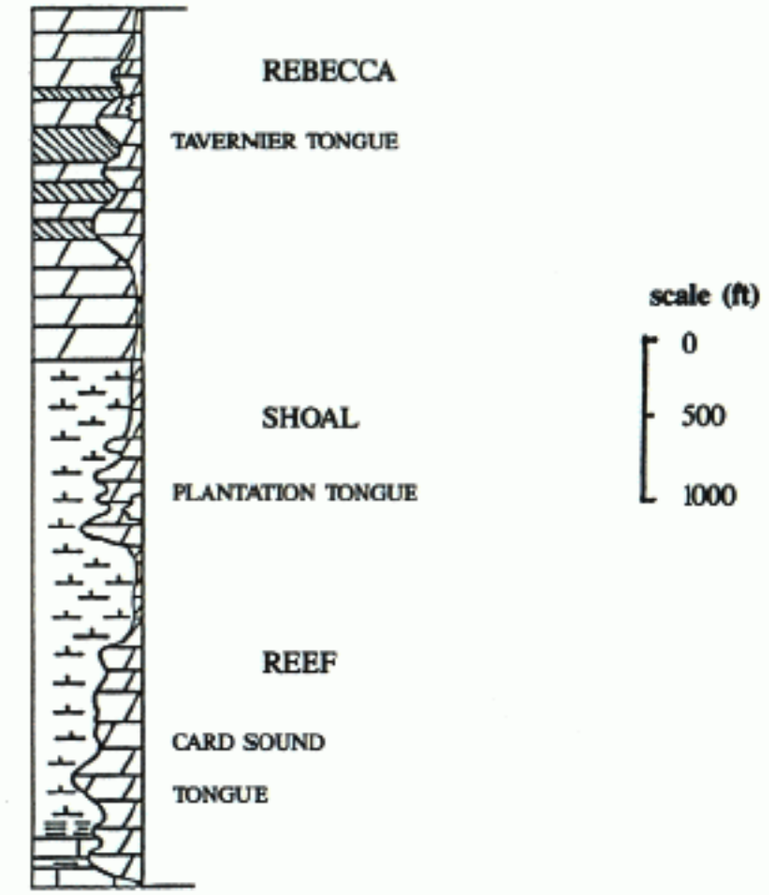



**Facies of the Cedar Keys and Equivalents**

## Rebecca Shoal Barrier Reef

Shortly after the beginning of Tuscaloosa deposition in southern Florida, there appeared in Wells F and S the beginnings of the Rebecca Shoal barrier reef. During the Upper Cretaceous the reef grew vertically and horizontally along the Keys, along the Sarasota Arch (Well S), and up the Florida east coast shelf edge (Well V). The reef continued expanding, until near the beginning of the Paleocene it had completely surrounded the Peninsula, forming a giant atoll. Reef growth apparently was not interrupted across the Cretaceous-Cenozoic extinction event. Some 44 wells have penetrated the reef on and offshore.

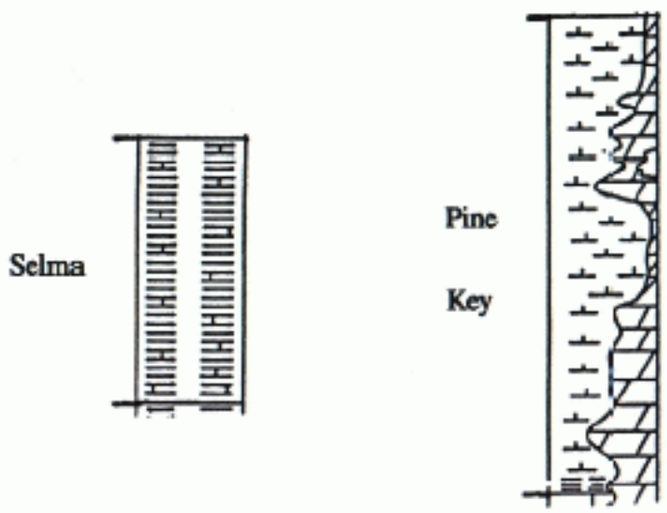
The Rebecca Shoal reef rock on the seaward side is a fine to medium crystalline, porous, light gray or tan euhedral dolomite. Immediately behind the porous reef rock is a back-reef section of cryptocrystalline or anhedral, non-porous, light gray dolomite.

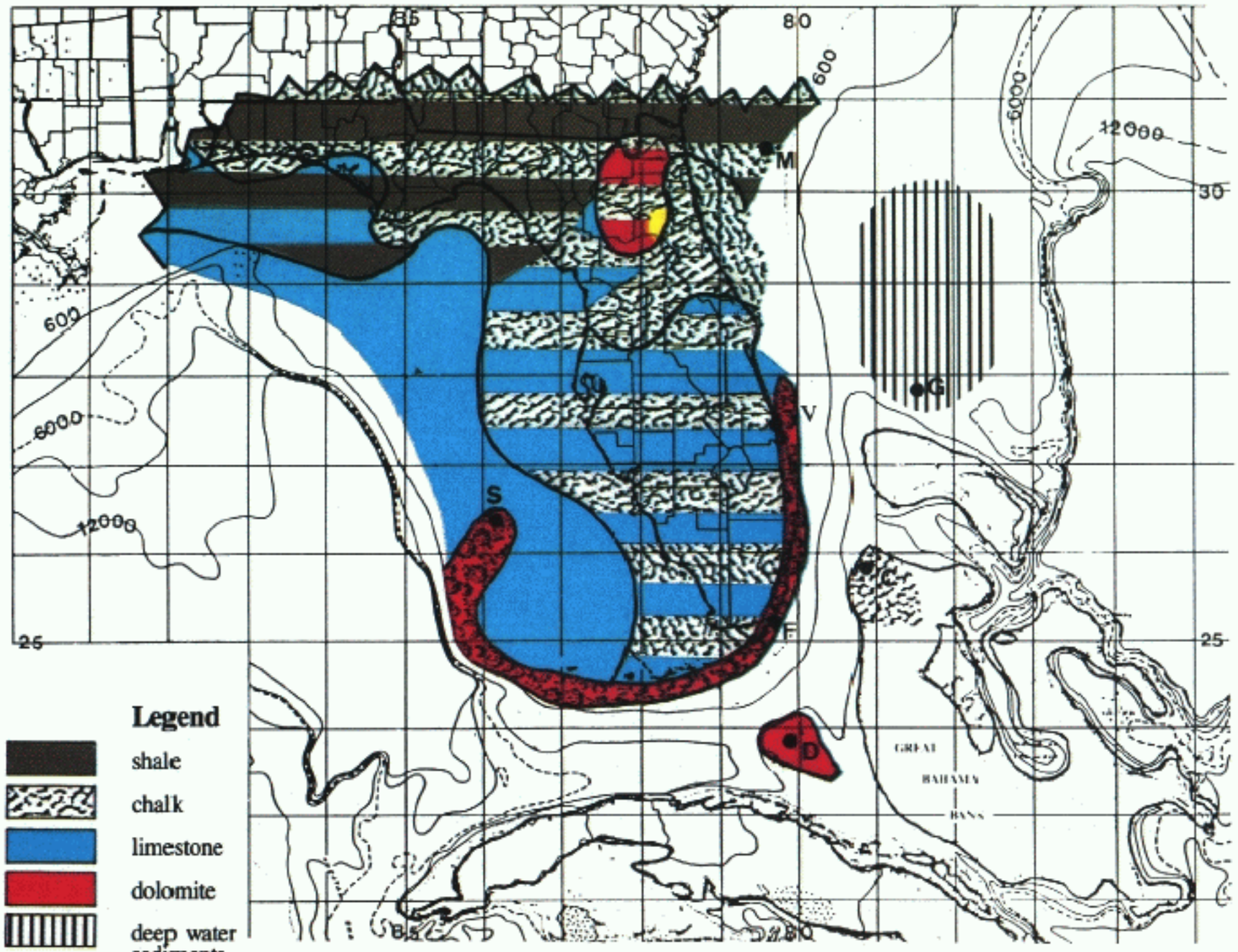



## Pine Key

In central and southern Florida, both on and offshore, the Pine Key section is composed of shallow-water white chalk and chalky limestone. In the north part of the Florida Peninsula, the Panhandle, and contiguous offshore areas, the equivalent formation (Selma) consists of a chalky gray shale. On the crest of the Peninsular Arch a medium grain calcareous sandstone is present at the base of the Selma.

In the Bahamas, chalk in Well C and interbedded limestone and dolomite in Well D comprise the equivalent section. On the west flank of the Blake Plateau Basin, (Well M) the equivalent section is composed of a basal gray shale overlain by white chalk. At Well G, deep water sediments are present (Leg 101, 1988).





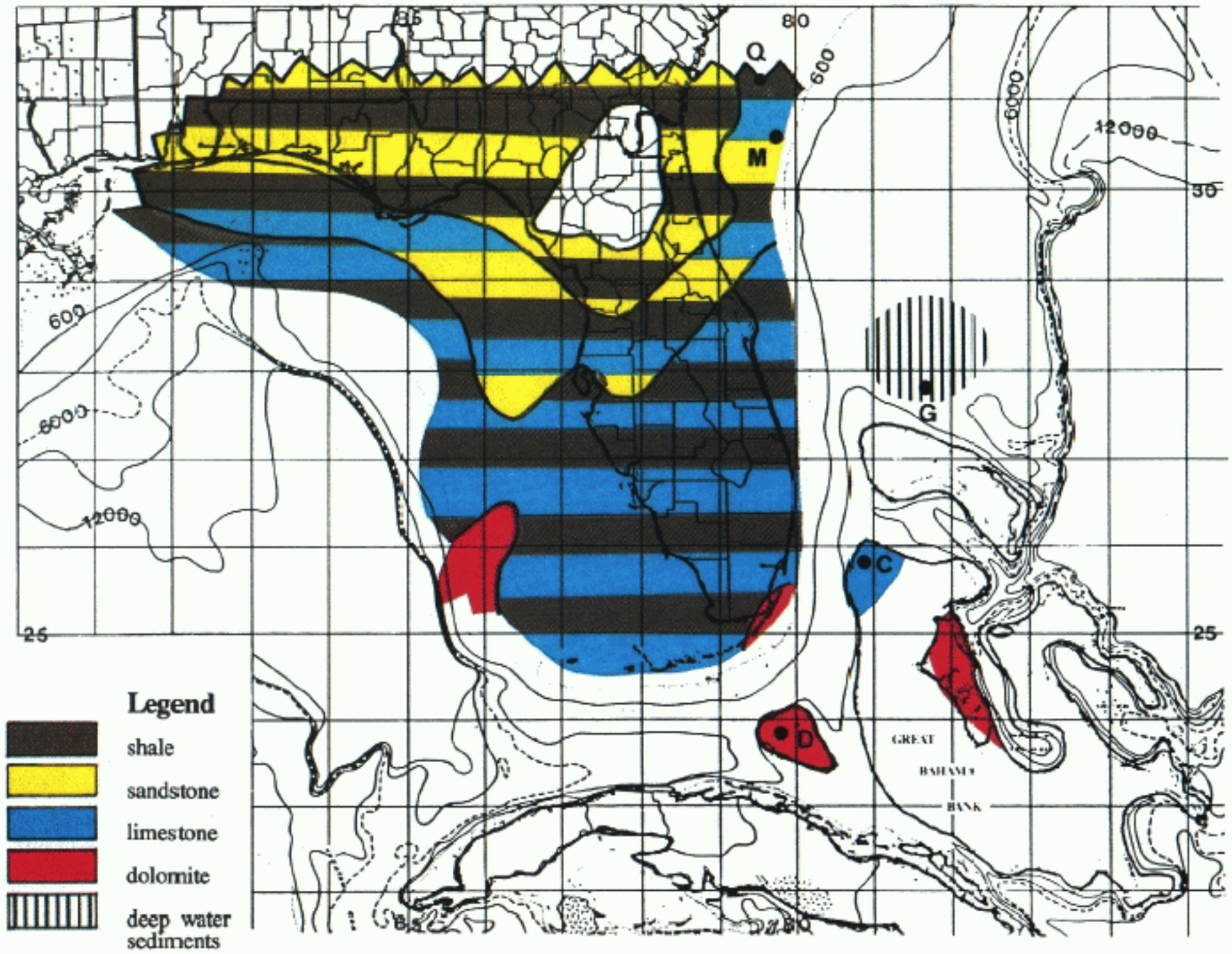

**Facies of the Pine Key and Equivalents**

## Tuscaloosa

Onshore in the Panhandle, the Tuscaloosa is as much as 1800 ft (550 m) thick, but thins rapidly southward to 300 ft (100 m) in the Tampa and south Florida area. In the Panhandle it is composed of glauconitic sandstone and gray shale. The Tuscaloosa did not overwhelm the exposed remnants of the Peninsular Arch. Southward, as the Tuscaloosa thins (both offshore and on the Peninsula), sandstone is replaced by white, glauconitic limestone; gray shale remains a constituent. In south Florida, part of the basal Pine Key is possibly equivalent to the Tuscaloosa.

In the Bahamas, the equivalent section in Well D is dolomite and in Well C it is limestone. In Well M on the west flank of the now-foundered Blake Plateau Basin, a 900-foot (300 m) Tuscaloosa section is composed of interbedded glauconitic limestone, gray and green shale and fine-grained sandstone. Northwestward, the limestones disappear and the sandstones become coarse (Well Q). On the southern edge of the Blake Plateau, the equivalent section in Well G is a deep-water marl (Leg 101, 1988).






**Facies of the Tuscaloosa and Equivalents**

## Upper Cretaceous-Paleocene Structural Provinces

At the close of Lower Cretaceous deposition a great re-ordering of the regional geology took place. Simultaneously with or because of these boundary events, the 65 my old CMCC ceased to grow. Where exposed to the ocean along the Florida and Blake Escarpments, the CMCC was subsequently removed by submarine erosion.

During the re-ordering, subaerial erosion removed some Lower Cretaceous beds in the northern Peninsula and in the Panhandle; in the central Panhandle, as much as 800 ft (260 m) of Post-Paluxy beds were removed. This interval was filled with a similar thickness of Lower Tuscaloosa sand.

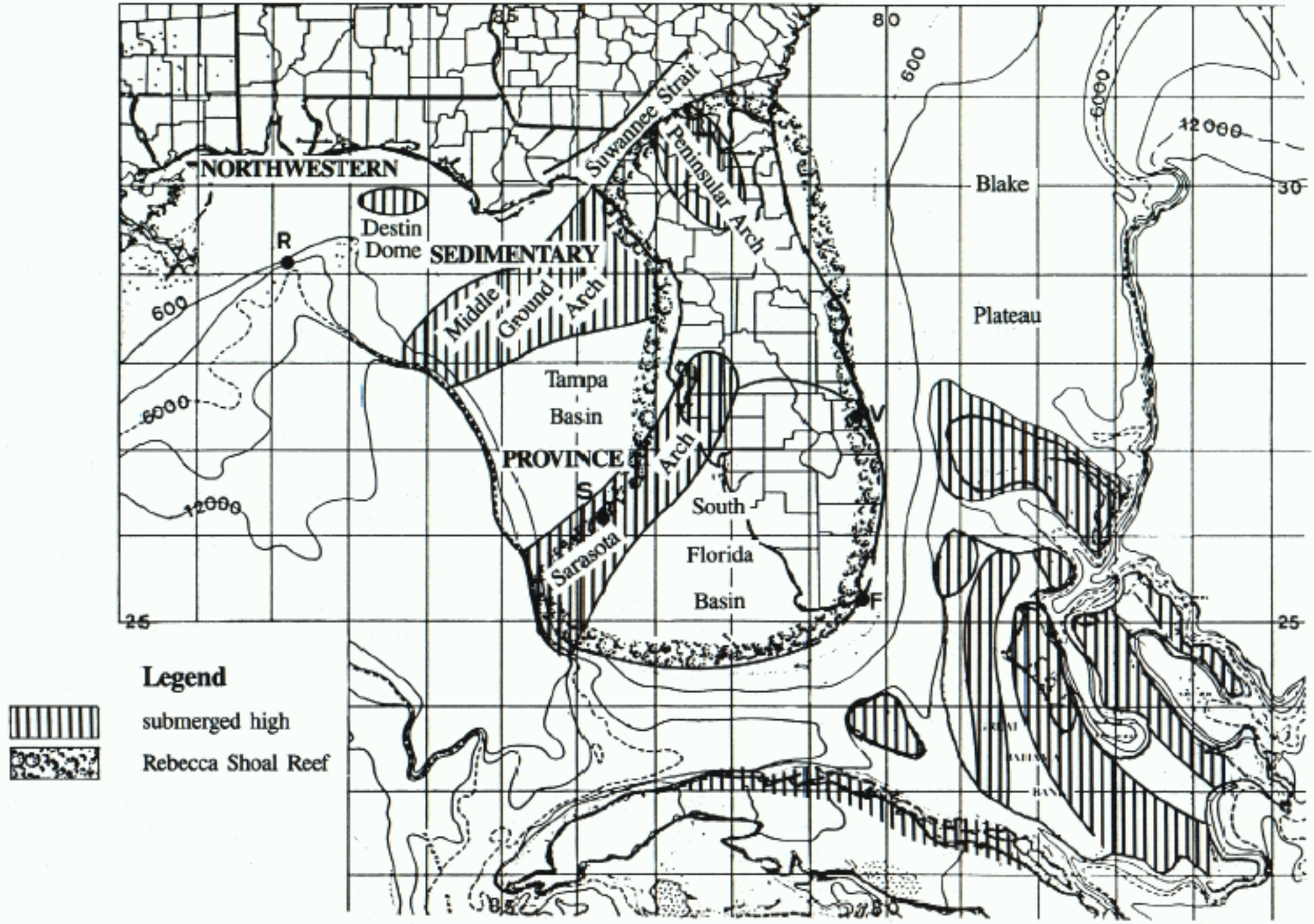
In the southern Peninsula, no loss of section is discernible, but a thin, green, waxy shale occurs at the top of the Lower Cretaceous. I have found this type of shale to be associated with unconformities on carbonates. A similar green shale and an accompanying pale green medium crystalline, euhedral dolomite also occur within the upper 100 feet of the Lower Cretaceous in wells in the offshore Main Pass area at Well R.

As part of the regional re-ordering, downfaulting produced the Florida Straits, thus separating northern Cuba and the Bahamas from Florida, and relocating the present southern and eastern edge of the South Florida Basin to its present position. The Santaren, Nicholas and Old Bahama Channels south and east of Cay Sal were also probably formed at this time. Whether the filled-in channels within the Great Bahama Bank shown by Eberli and Ginsburg (1988) originated in the Triassic, or as a part of this later channel-forming collapse, could not be determined with their limited seismic data. Also associated with this regional collapse, the Blake Plateau Basin foundered to become the present deep-water Blake Plateau. All these structural movements combined to allow the Gulf Stream to assume its modern course.

The formation of the Florida Straits in the earliest Gulfian is demonstrated by the appearance of the Rebecca Shoal barrier reef (Well F) on the northern flank of the Straits. The reef continued to grow along the Straits to Wells S and V through the Upper Cretaceous and Paleocene.

Thinning of the Upper Cretaceous Tuscaloosa section across Destin Dome offshore in the Northwestern Sedimentary Province indicates that much of the salt movement there occurred in the earliest Gulfian.

According to Hull (1962), the Suwannee Strait is an area where uppermost Cretaceous rocks are missing or very thin. He attributes this to erosion. The Strait, connecting the Gulf of Mexico and the Atlantic and bounded on the south side by the Rebecca Shoal barrier reef, was filled by Lower Tertiary sediments.




**Upper Cretaceous and Paleocene Structural Provinces**

## Post-Paluxy

The rock term Post-Paluxy is herein substituted for the time term Washita-Fredericksburg commonly used for this unit.

Onshore, in the Northwestern Sedimentary Province, the updip facies is still dominated by coarse sandstone and red shale. Downdip the sandstone becomes fine-grain with gray shales replacing most of the red shales. Whether or not the Post-Paluxy clastics covered the Peninsular Arch and were then eroded cannot be determined with present data. Offshore, carbonates again transgressed northward from the CMCC. Onshore in the southwestern corner of the Panhandle (Well N), mottled white and black limestones reappear and are interbedded with clastics.

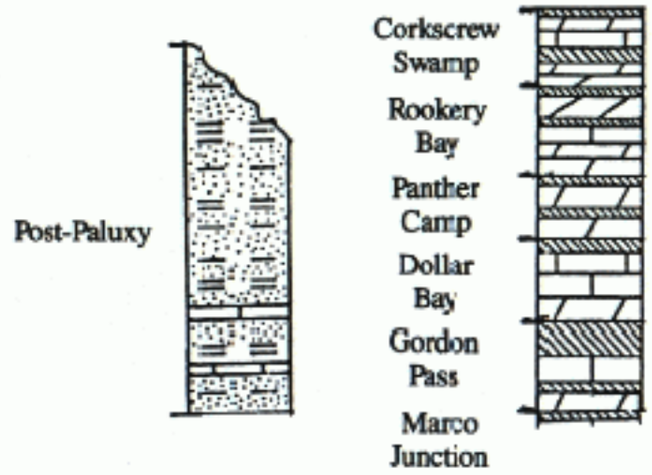
In the Tampa Basin area, the Post-Paluxy consists of limestones, dolomites and anhydrites similar to those of south Florida.

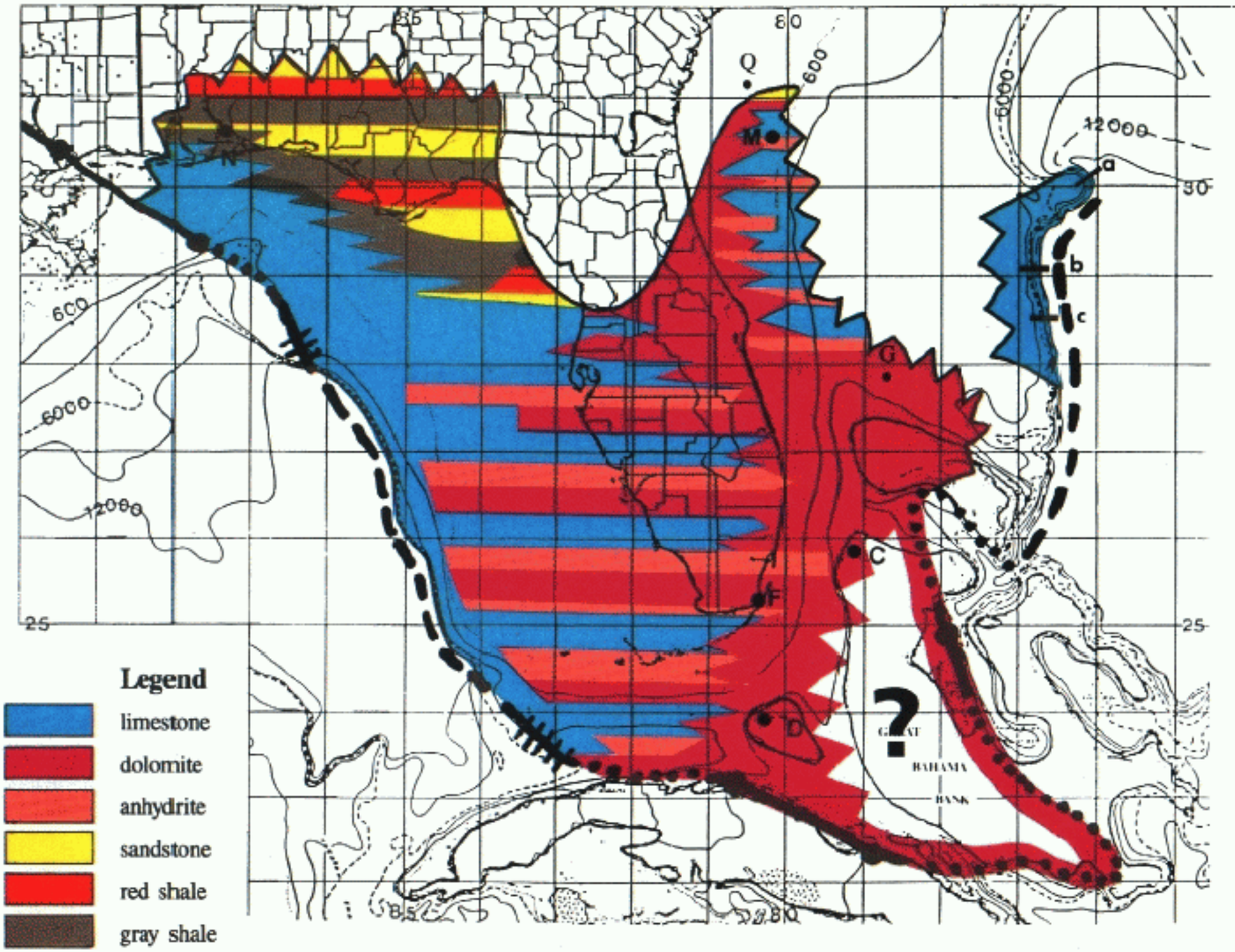
In the Southeastern Sedimentary Province, the anhydrite and limestone lithologies characteristic of older beds in the Proto-South Basin were gradually replaced through time with dolomite.



The Cay Sal Arch and the Little Bahama High were well established, as indicated by both the dominant dolomite lithology and the high structural position of the controlling wells (C,D,F). The lithology of the Post-Paluxy on the Great Bahama Bank is unknown, but is probably dolomite with a few thin anhydrite beds. To the north, Well G (ODP 627) penetrated a few feet of possibly eroded Lower Cretaceous dolomite at a very high structural position, thus firmly establishing the presence of the Little Bahama High.

On the western margin of the Blake Plateau Basin,Well M is characterized by the presence of dolomite, limestone and anhydrite. The top of this section appears to be missing in Well Q. The presence of a South Florida-type rock suite in these youngest transgressing Lower Cretaceous beds suggests that basinward in older units, the same suite is probably present. Rocks sampled by submersible from the Blake Escarpment are all shallow-water lagoonal limestone (a, b, c).






**Facies of the Post-Paluxy and Equivalents**

## Paluxy

The Paluxy is the most regressive unit in the Northwestern Sedimentary Province. Clastics spread seaward at the expense of carbonates. Onshore, coarse sandstones are present updip, becoming finer-grain downdip. A little gray shale is present, but most shale is red. Shoreward from the CMCC, tan micritic limestone interfingers with a mottled black and white limestone, which in turn interfingers with clastics.

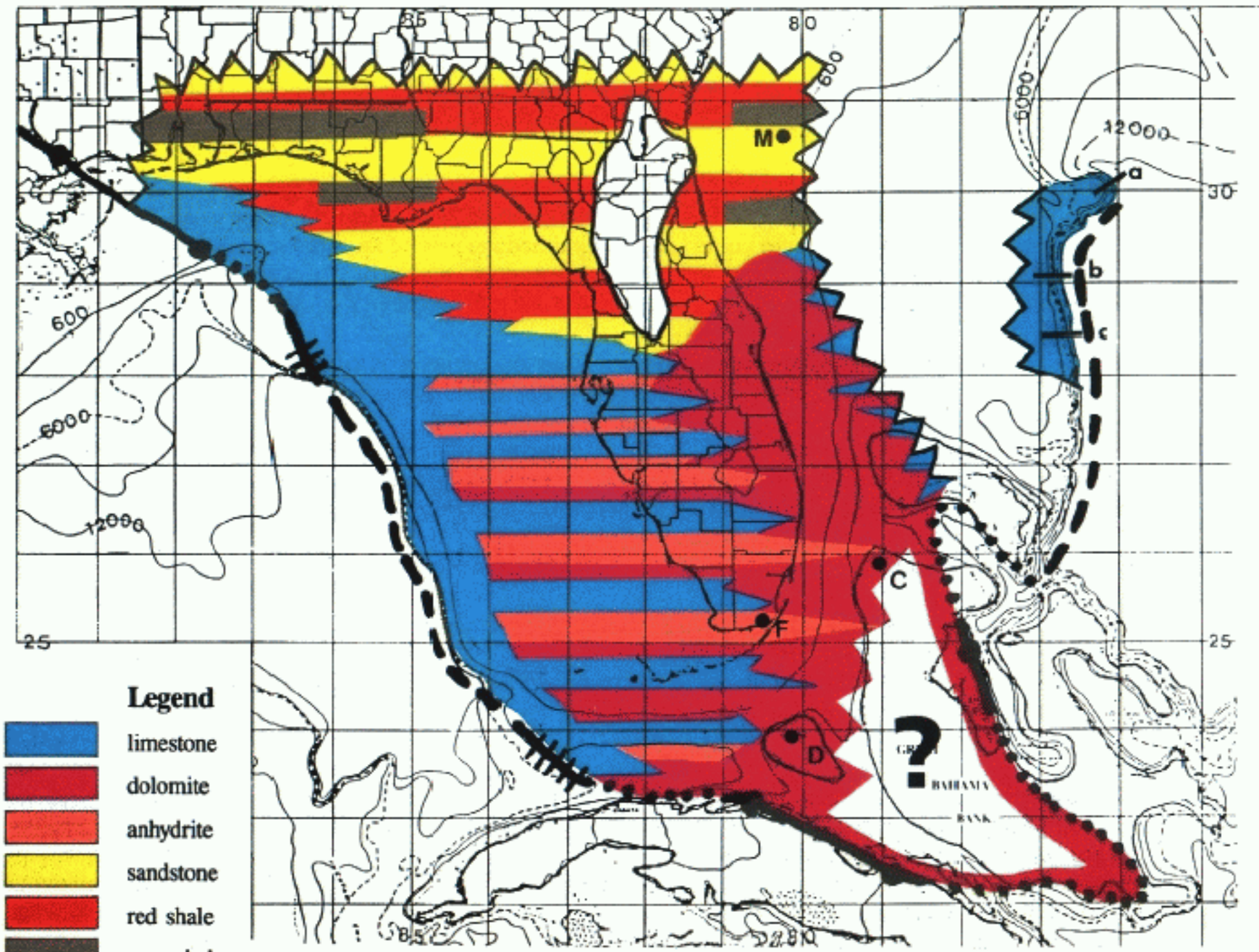
In the Tampa Basin area, the Paluxy equivalent is tan, micritic limestone, anhydrite, and brown dolomite.

In the Southeastern Sedimentary Province, the rocks in the Proto-South Florida Basin are light-colored micritic limestone, dolomite and anhydrite. A lesser amount of anhydrite and the absence of dark limestone in the interval suggests that the basin was shallower, and that the rate of subsidence had slowed. The Cay Sal Arch is well established as shown by the predominately dolomite lithology in Wells D, F and C.

The lithology in the central Great Bahama Bank is indeterminate, as all well control is on the margins.

Shallow water limestones were collected by submersible on the Blake Escarpment (a,b,c). On the west flank of the Blake Plateau Basin red shale and fine-grained sandstone are present in Well M. In the deeper Basin, the section is probably limestone, dolomite and anhydrite.






**Facies of the Paluxy and Equivalents**

## MFR

In the southwestern Panhandle (Well N), the Ferry Lake Anhydrite lies between the Mooringsport and Rodessa formations. To the east over the rest of the Panhandle, the Ferry Lake is missing; therefore for regional mapping purposes, the three units have been combined and designated MFR, the initials of the formations involved.

Updip in the Panhandle, the MFR is sandstone and red shale. The sandstones are finer than those in older units; occasionally thin beds of sandy cryptocrystalline dolomite are present. Downdip, gray shales wedge in. They are more widespread and are present further updip than in older units. Limestones appear in the Florida Panhandle (Well N) for the first time since the Smackover. They are of two types: one is a white micrite mottled with black skeletal debris, and the other is tan and micritic, a type typical of South Florida. Offshore the MFR is mainly tan micritic limestone; anhydrite beds occur throughout, but are most prevalent in the Ferry Lake interval. The Mooringsport interval in the MFR is the most transgressive unit of the Upper Jurassic-Lower Cretaceous sequence.

The thin gray Pine Island—West Felda shale at the base of the MFR is present in both the Northwestern and Southeastern Sedimentary provinces. In Well M on the west flank of the Blake Plasteau Basin, the only gray shale in the otherwise red shale section of the Lower Cretaceous-Upper Jurassic occurs at the appropriate interval to be correlated as Pine Island, thus tying the Mesozoic sections east and west of the Peninsular Arch.

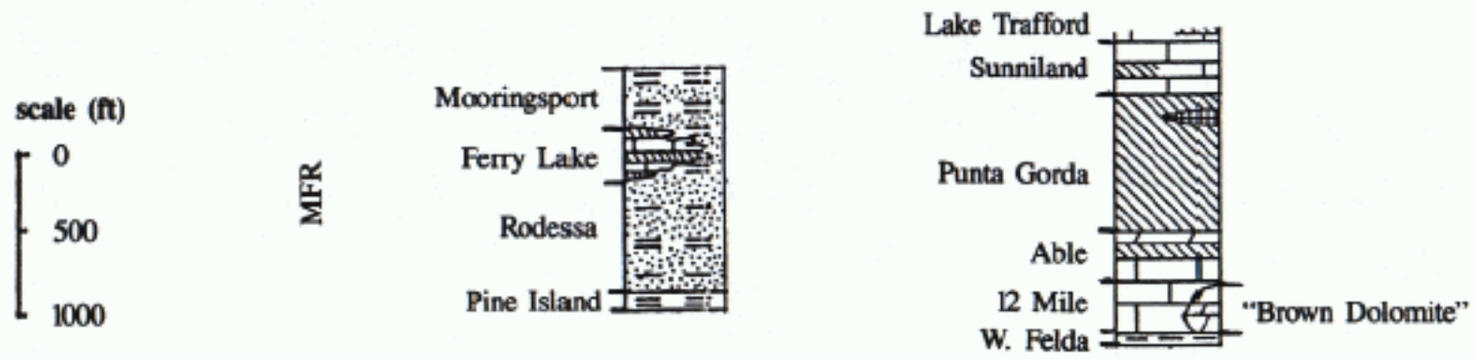


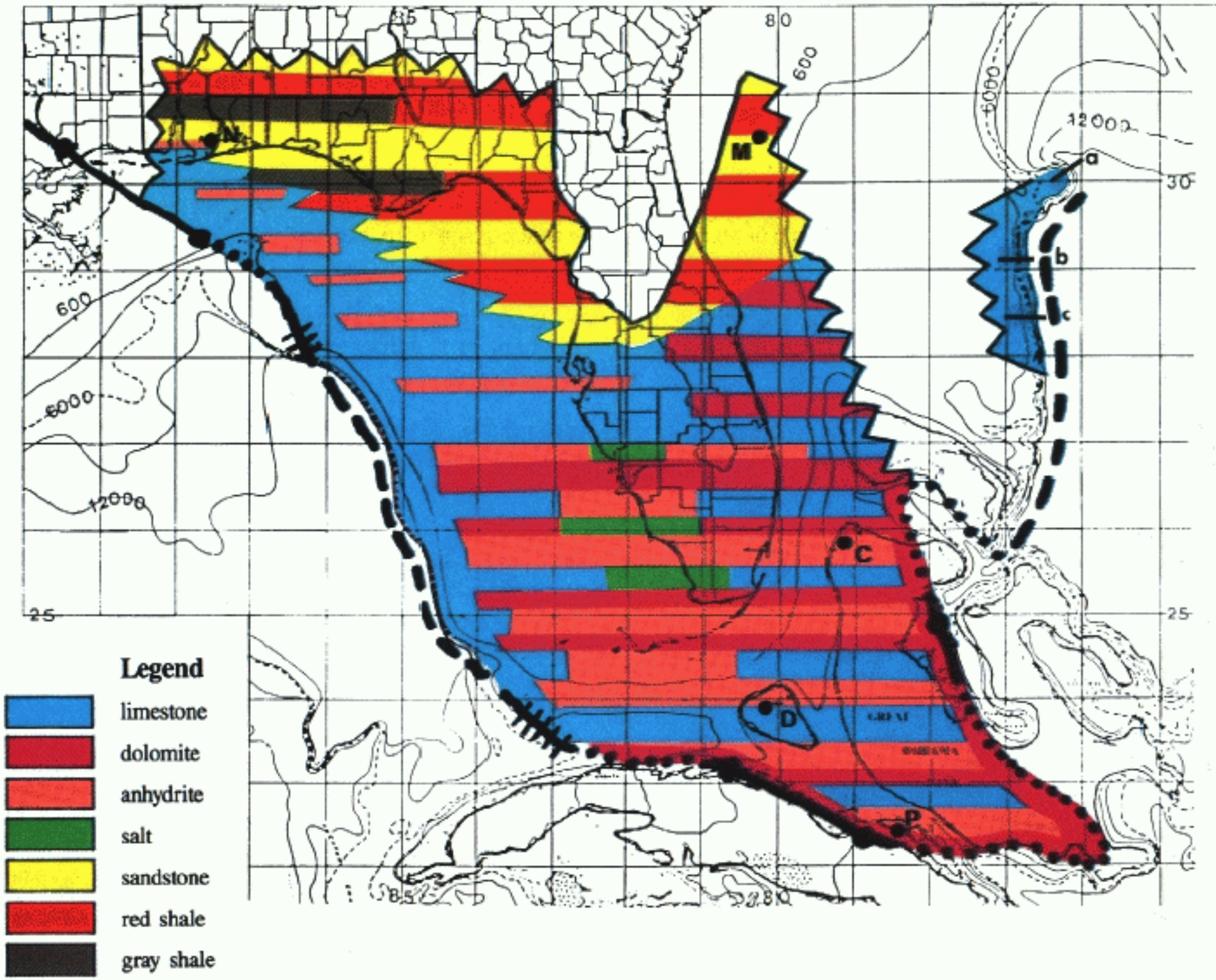
In the Tampa Basin, the MFR is composd of tan micritic limestone and anhydrite with a few dolomite beds.

In the Southeastern Sedimentary Province, the central part of the Proto-South Florida Basin is characterized by thick anhydrite and black limestone with one thin salt bed. Updip in all directions, anhydrite decreases and the carbonate beds become lighter in color.

In the Bahamas area, control is lacking except around the periphery; based on the section in Wells D, C and P, the interval probably consists of dolomite, possibly with interbedded anhydrite and limestone,

On the northwest flank of the Blake Plateau Basin in Well M, the MFR consists of sandstone overlain by a section of red and green shale. Updip, the sandstone is coarse, downdip to the east it becomes fine-grained. A carbonate-anhydrite facies is probably present deeper in the Basin. On the Blake Escarpment, lagoonal limestones were recovered by submersible sampling at a, b and c.






**Facies of the MFR and Equivalents**

## Comanchean Structural Provinces

Early in the deposition of the Comanchean, the old undifferentiated Southeastern Sedimentary Province began to evolve into smaller provinces.

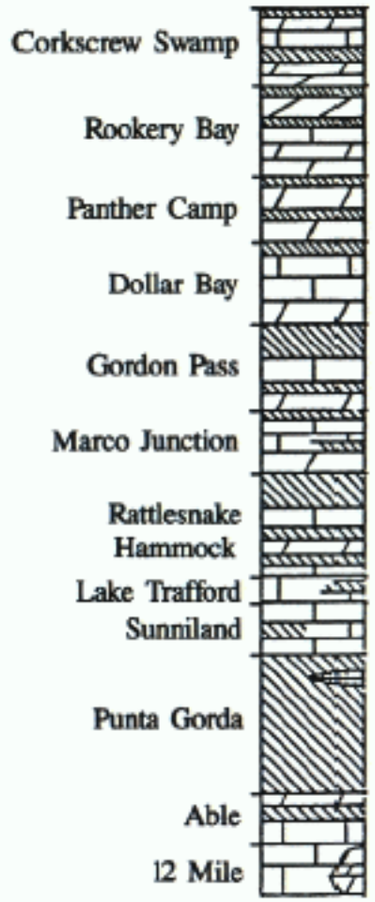
The South Florida Basin has had two forms. The Proto-South Florida Basin appeared in the Comanchean, with the southern boundary located at the CMCC in northern Cuba. This boundary was later shifted to the north flank of the Florida Straits by the collapse of the Straits at the end of the Comanchean. The Proto-South Florida Basin sank rapidly during deposition of the Able and Punta Gorda formations as shown by their thick anhydrite and dark limestone beds. Subsidence continued at a somewhat slower pace during deposition of the Sunniland and Lake Trafford formations, which in the central basin area are similar lithologically being half anhydrite and half black limestone.

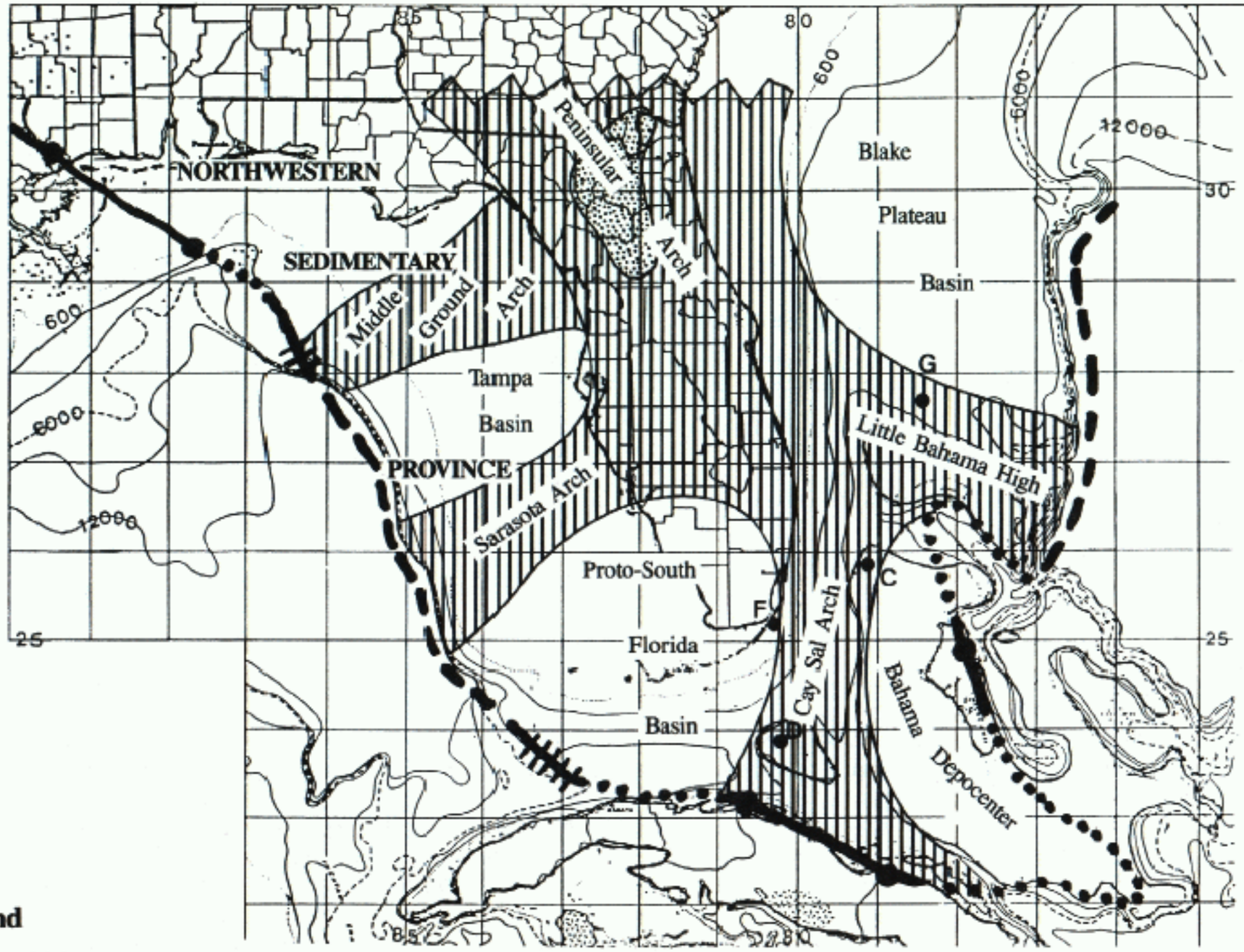
In Well D on the southeast flank of the Basin, anhydrite in all Comanchean units is much less prevalent, and above the Rattlesnake Hammock the Comanchean section is entirely dolomite. In the South Florida Basin dolomite is concentrated on structurally high areas and anydrite in structurally low areas. These lithologic associations suggest that Well D was located on a high during the deposition of post-Rattlesnake Hammock rocks. The presence of the Cay Sal Arch is further substantiated by Well F which is high structurally and has large quantities of dolomite. In Well C at the northern end of the Arch, the carbonate portion of the post-Punta Gorda section is entirely dolomite with a few anhydrites.

The area of the present Great Bahama Bank became a separate feature during the Comanchean; whether a basin or a dolomite-dominated plateau developed here cannot be determined by well control, which is all on the periphery of the area.

To the north is the Little Bahama High, which was first inferred from early gravity investigations. The very high subsea elevation of the Lower Cretaceous in ODP 627 (Well G), substantiates its presence. No other subsurface data are available.

The Blake Plateau Basin, north of the Little Bahama High, also became a separate feature in the Comanchean. This Basin remained a shallow water depocenter until the end of the Lower Cretaceous, when it foundered along with the Florida Straits.






**Comanchean Structural Provinces**

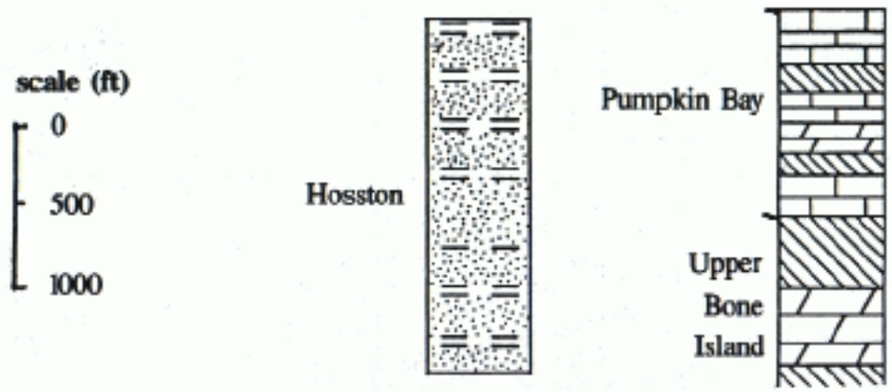
## Hosston

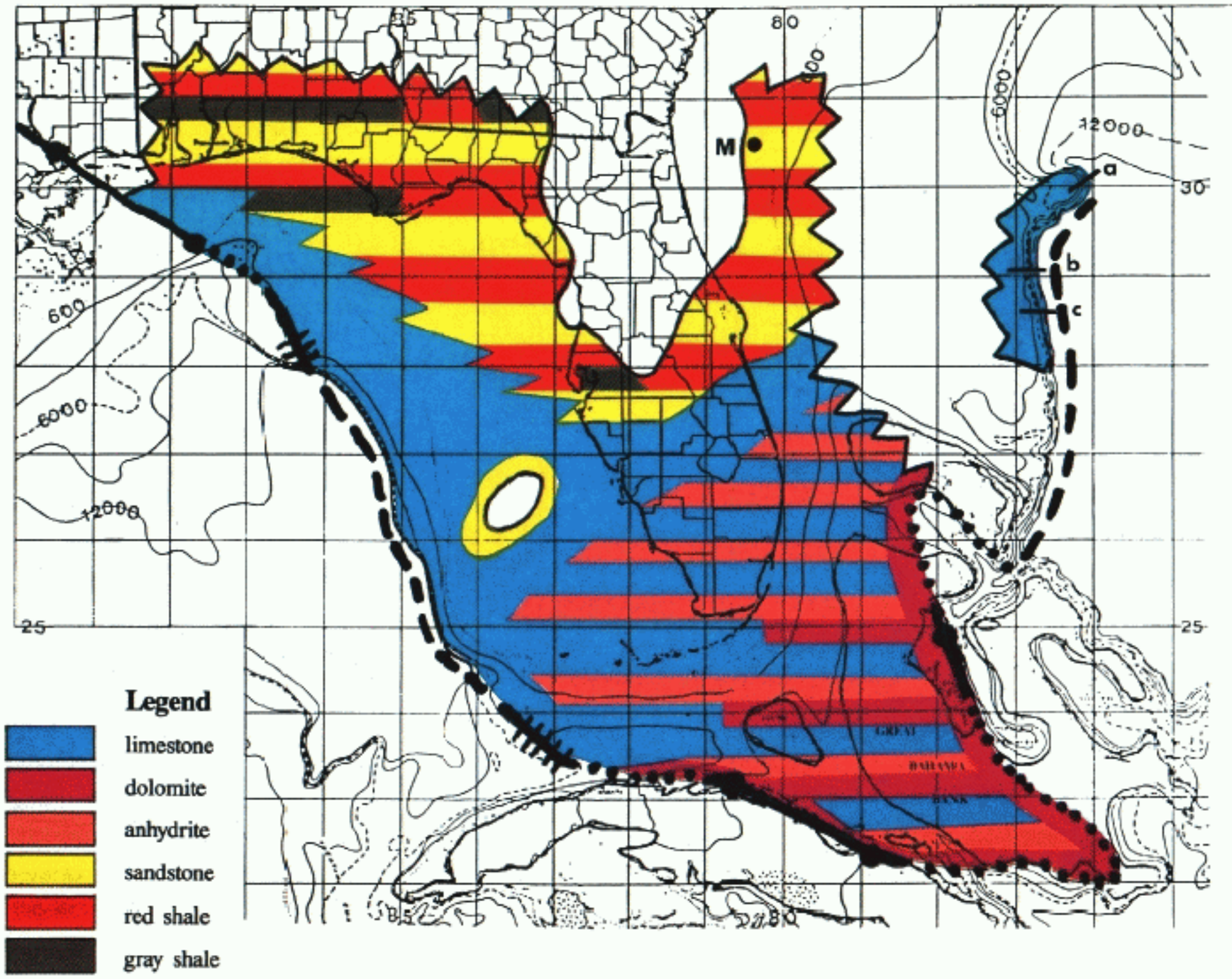
By the end of Hosston deposition, only a small island remained emergent on the Sarasota Arch. In the Northwestern Province, clastic and limestone character are similar to those of Cotton Valley rocks; updip, the clastics are characterized by coarse grain sandstone accompanied by red shales; downdip, fine grain sandstones and red shales interfinger with gray shale and tan micritic limestone.

In the Southeastern Sedimentary Province, the equivalent section (upper Bone Island and Pumpkin Bay) consists mainly of limestone with some anhydrite and a few dolomite beds. The limestone is brown and tan, micritic to lithographic, and frequently contains miliolids.

On the northwestern flank of the Blake Plateau Basin (Well M), red and green shales with variegated, fine to medium grain sandstones comprise the section. To the east, a carbonate-anhydrite section is probably present deeper in the Basin. On the Blake Escarpment, lagoonal limestones were recovered at a, b and c by submersible sampling.








**Facies of the Hosston and Equivalents**

## Cotton Valley

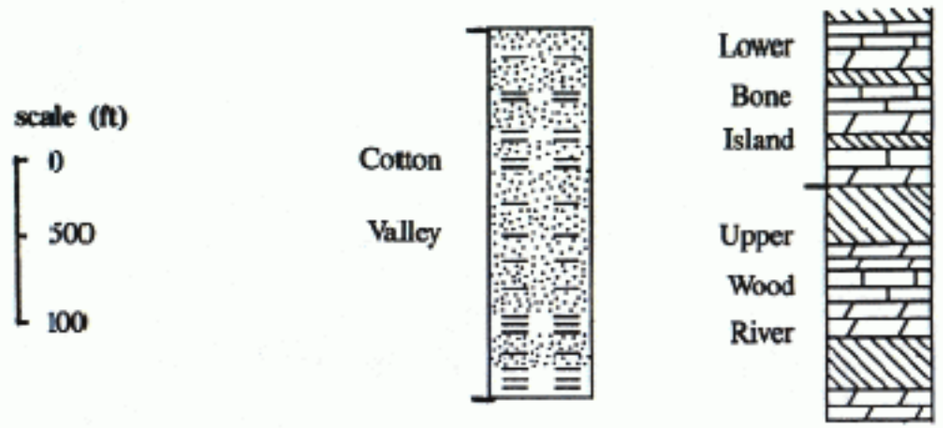
During Cotton Valley deposition, the seas gradually encroached on the Middle Ground, Sarasota and Peninsular Arches. The connecting sag between the latter two was flooded, leaving the emergent part of the Sarasota Arch as an island.

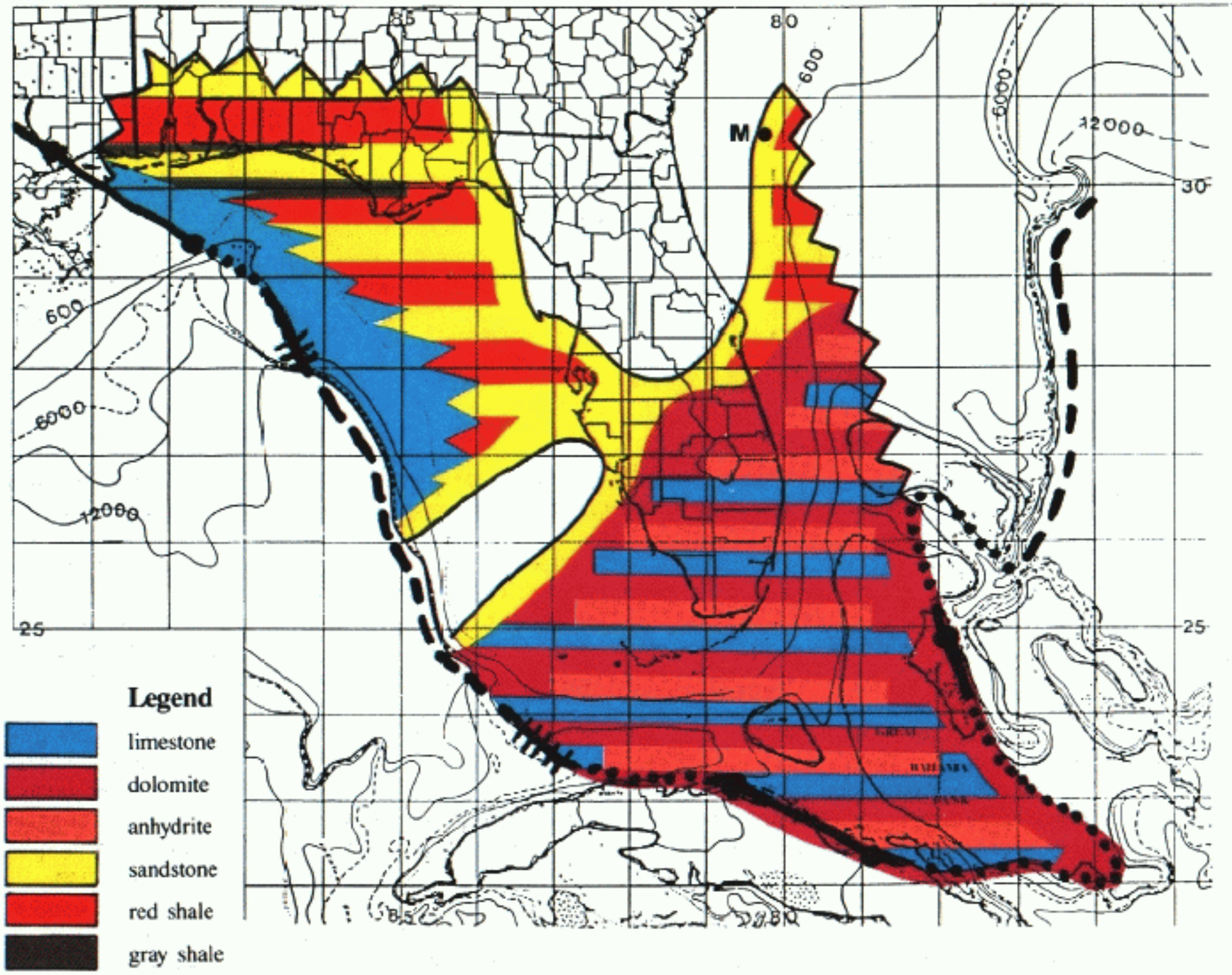
In the Northwestern Sedimentary Province, the brown micritic limestone facies behind the CMCC advanced shoreward at the expense of the clastics. Onshore in the Panhandle, the updip clastic facies is characterized by coarse grain sandstone accompanied by red shales; downdip, sandstones become fine grain, and along with red shales, interfinger with gray shales and limestones.

In the Southeastern Province, the equivalent section (upper Wood River and lower Bone Island) consists of thick beds of anhydrite and dolomite with more limestone present than in the underlying Wood River section.

On the northwestern flank of the Blake Plateau Basin (Well M), variegated coarse grain sandstones and variegated shales characterize the Cotton Valley. To the east, a carbonate-anhydrite section is probably present in the deeper Blake Plateau Basin. A major north-south normal fault may exist between Well M and other offshore wells to the west. This is suggested by the presence of some 2200 feet (720 m) of Cotton Valley and Hosston rocks resting on Pre-Cambrian argillites in Well M, compared to the situation in the wells some 10 miles (15 km) to the west, where a few hundred feet of younger Mooringsport-Ferry Lake-Rodessa (MFR) rocks rest on Ordovician quartzites.








**Facies of the Cotton Valley and Equivalents**

## Haynesville

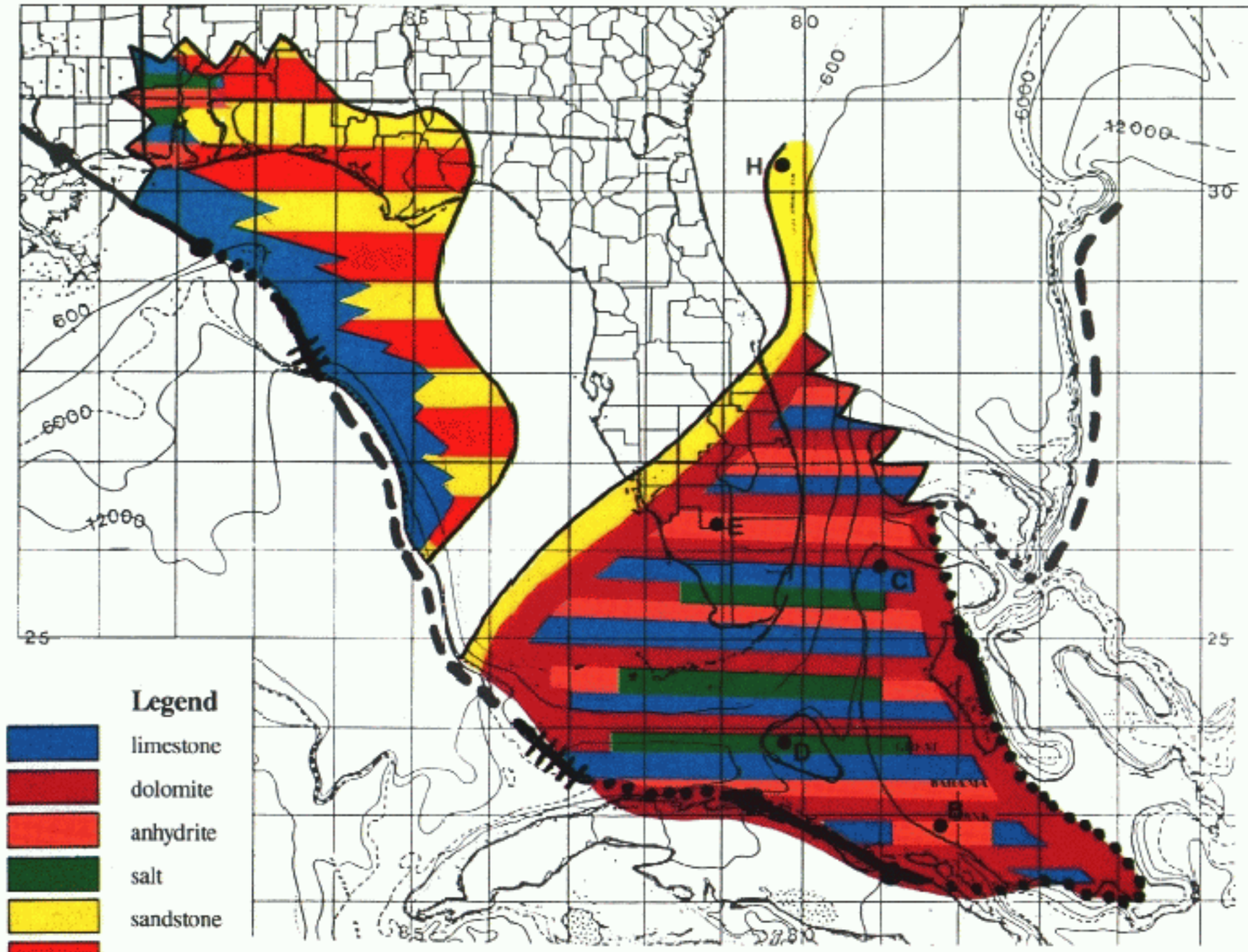
Transgression of the Pre-Upper Jurassic erosion surface was rapid during Haynesville deposition, the first unit to cover an appreciable portion of the Platform. The speed of Haynesville transgression would imply that the two sedimentary provinces were low-angle ramps; transgression of four-fifths of the Platform took place in about 10 my, whereas the remaining one-fifth took some 60 my.

In the Northwestern Sedimentary Province, the Haynesville consists of updip clastics and downdip carbonates. Updip in the Panhandle, sandstones are coarse-grained, and contain exotics derived from older igneous and sedimentary rocks. Shales are red. Downdip, the sandstones are fine grain. Offshore, limestones extend shoreward from the CMCC and interfinger with clastics. Limestones are dark brown, brown, tan and cream, micritic, and occasionally lithographic, with varying percentages of skeletal, oolite, pellet grains, and miliolids. In the western Panhandle and Alabama, salt and anhydrite are present in the lower Haynesville.

In the Southeastern Sedimentary Province, the equivalent of the Haynesville is the lower Wood River. It is composed of thick anhydrites and dolomites with a few limestone beds. The dolomite is brown and microcrystalline, with relic oolites. Limestone is brown and micritic. Salt stringers are present in the basal section of Wells C, D and E. Well B, the deepest in the Southeast Sedimentary Province, is reported to have bottomed at 21740 feet (6625 m) also in carbonate rock with salt stringers.



In Well H, on the west flank of the Blake Plateau Basin, Haynesville rocks are red shales and fine to pebble-size sandstones, which occasionally are dolomitic.




**Facies of the Haynesville and Equivalents**

## Upper Jurassic-Coahuilan Structural Provinces

In the Mesozoic, there are two general sedimentary provinces: the Southeastern Sedimentary Province and the Northwestern Sedimentary Province. These are separated by the combined Sarasota and Peninsular Arches.

During the Coahuilan-Upper Jurassic, the Northwestern Sedimentary Province contained two depocenters: the Tampa Basin, separated by the Middle Ground Arch from the DeSoto Salt Basin to the north. In the Southeastern Sedimentary Province, the lithologies and thicknesses of Coahuilan-Upper Jurassic formations in the few control wells available do not indicate the presence of local structural features.

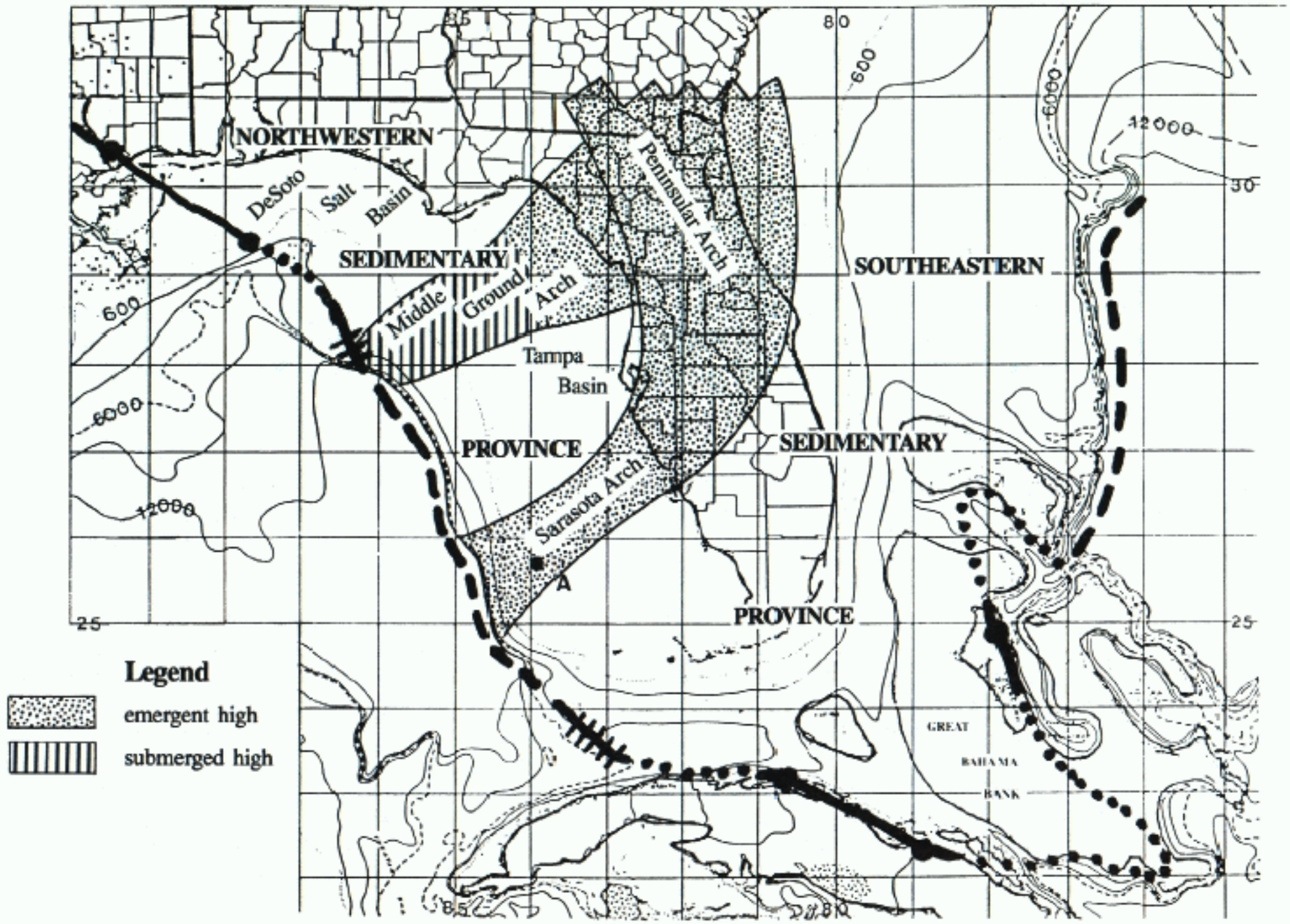
The Peninsular Arch is a broad southward-plunging feature that dominates the Florida Peninsula. The arch influenced sedimentation from the beginning of Haynesville deposition through the Cenozoic.

The Middle Ground Arch is a broad, very low swell, plunging southwest from the Peninsular Arch and becoming more pronounced near the Florida Escarpment. The Middle Ground Arch was present during Haynesville deposition and remained an influence on sedimentation into the Middle Cenozoic, as shown on seismic sections (Ball et al. 1991).



The Tampa Basin also was present during Haynesville deposition, and remained a negative feature into the Cenozoic.

The Sarasota Arch underlying the West Florida Shelf was discovered by Mobil in 1981 (Well A) when basement rock was encountered at 10,000 feet (3000 m), much higher than expected from seismic data. From near the Florida Escarpment, the Arch plunges gently to the northeast, until it merges with the Peninsular Arch onshore. The Sarasota Arch influenced sedimentation from Haynesville deposition at least through the Paleocene. As no samples of Eocene through Neogene rocks are available on the Arch, its influence on these younger beds cannot be assessed.




**Upper Jurassic and Coahuilan Structural Provinces**

## Continental Margin Carbonate Complex (CMCC)

Although not a true reef, this feature was formed by organic activity. The lagoonal and evaporitic character of the Upper Jurassic-Lower Cretaceous rocks in the Southeastern Sedimentary Province establishes that the CMCC was present and acting as a barrier to normal marine circulation as far back as Jurassic Haynesville deposition.

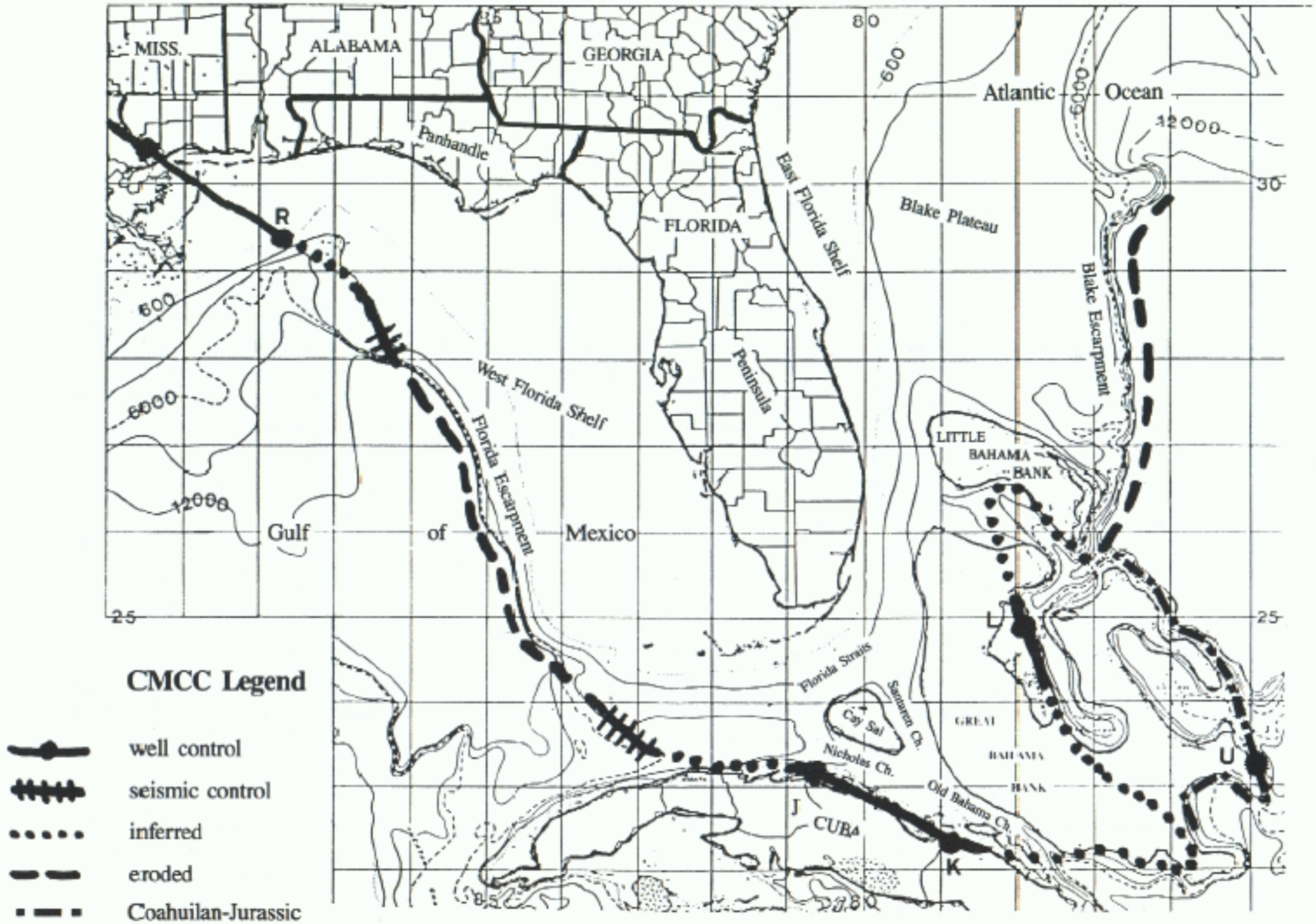
The CMCC has been penetrated by Wells J, K, L and R. At Location R, a thickness of 8700 feet (2800 m) of limestone was penetrated without reaching the base. Here the rocks consist of thick mounds of finely ground-up rudistid debris interbedded with brown, micritic, occasionally shaly limestone. A Hosston equivalent was probably reached.

In Cuba at localities J and K, the CMCC is almost entirely dolomite, with many zones of talus visible in cores. In Well J, some 9000 ft (3000 m) of CMCC (including possible repetitions) were penetrated without reaching the base. Correlations are uncertain, but definite Coahuilan and possibly Upper Jurassic rocks were reached. At location L in the Bahamas, the section is also mostly dolomite; talus could not be identified as no diamond cores were available. Some 6500 feet (2100 m) were penetrated without reaching the base. Comanchean and possibly Coahuilan rocks were reached.

A published seismic section east of the Blake escarpment shows an older CMCC offset seaward from the Cretaceous CMCC (Dillon et al. 1979); this is probably Upper Jurassic, but may also be Coahuilan. A similar seaward positioning of an older CMCC occurs in Texas and Louisiana (the upper "Glenn Rose Reef" and the lower "Sligo Reef").

The lower 4500 feet (1370 m) in Well U on the southeastern Great Bahama Bank is a brown euhedral dolomite similar in texture to that found in Cuban Wells K and J. It is overlain by 13000 feet (3960 m) of light-colored open marine limestone with occasional dolomite beds. The presence of this CMCC dolomite lithology in the lower fourth of Well U could imply the presence westward of an evaporite lagoonal facies in the eastern Great Bahama Bank behind this older (Coahuilan-Jurassic ?) CMCC, later displaced westward in the Comanchean. This condition would also parallel the displacement shoreward in Texas and Louisiana of the Comanchean "Glen Rose Reef" in relation to the older Coahuilan "Sligo Reef".

Along both the Florida and Blake Escarpments erosion by unknown processes (Paull & Dillon 1980, Freeman-Lynde 1983) has removed the CMCC, leaving the "back-reef" lagoonal rocks exposed to the present ocean.




**Continental Margin Carbonate Complex (CMCC)**
**and**
**Geographic Locations**

## Smackover, Norphlet and Louann

The Louann Salt was deposited in the DeSoto Salt Basin on the northwest part of the Platform. The rest of the Platform was emergent.

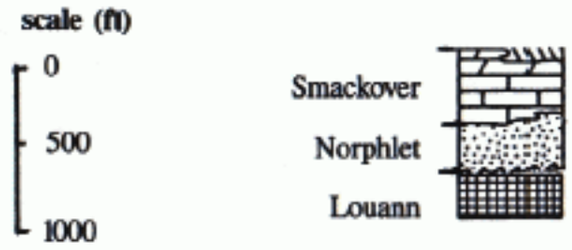
As salt is highly mobile, no original maximum thickness probably now exists, but some 8000 feet (2600 m) has been estimated for the Mississippi Salt Basin. Although faunal evidence is lacking, the stratigraphic position of the Louann suggests a Middle Jurassic age. At the southern limit of the Platform in northern Cuba, salt diapirs indicate the presence of thick bedded salt (Meyerhoff and Hatten 1968). A feature suggestive of a diapir appears on a published seismic profile in the southern Blake Plateau area (Sheridan et al., 1981).

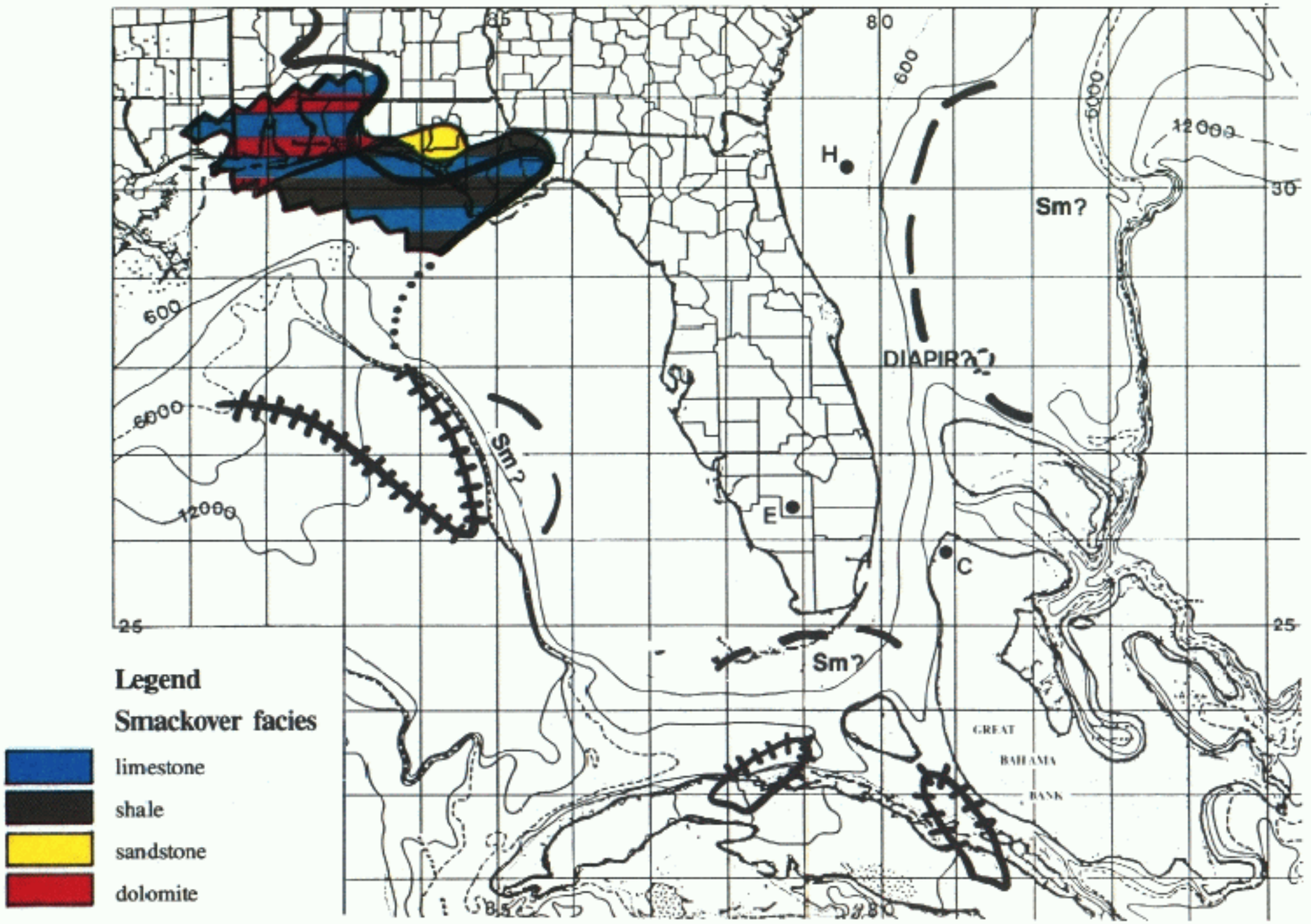
Overlying the Louann is the Upper Jurassic Norphlet sandstone, whose limit generally conforms to that of the overlying Smackover. Updip near the limit, it is coarse grain to pebble in size; downdip it becomes fine grain. The average thickness onshore is some 300 feet (100 m). Offshore the thickness varies widely to a maximum of 1000 feet (300 m) in dunes.

Overlying the Norphlet is the Smackover formation. In the western Panhandle it averages some 350 feet (110 m) thick. Updip it consists of grainstone; downdip it is dark micritic limestone interbedded with microcrystalline dolomite containing relic pellet and oolite grains. Onshore in the central Panhandle and offshore, the Smackover reaches a thickness of some 1000 feet (300 m). Here it is mostly gray shale with a few thin limestone and sandstone beds.



No beds of equivalent age have as yet been penetrated elsewhere in Florida, or in northeastern Cuba. The possible presence of a Smackover-Norphlet equivalent in the western Tampa Basin is suggested by the presence on a seismic profile (Ball et al. 1991) of a section below the Cotton Valley-Haynesville. In the Southeastern Sedimentary Province, Haynesville equivalents are resting on basement in Wells H, E and C. This suggests that in the deeper portions of the Province, Smackover equivalents may be present.






**Louann Salt Limits and Smackover Facies**

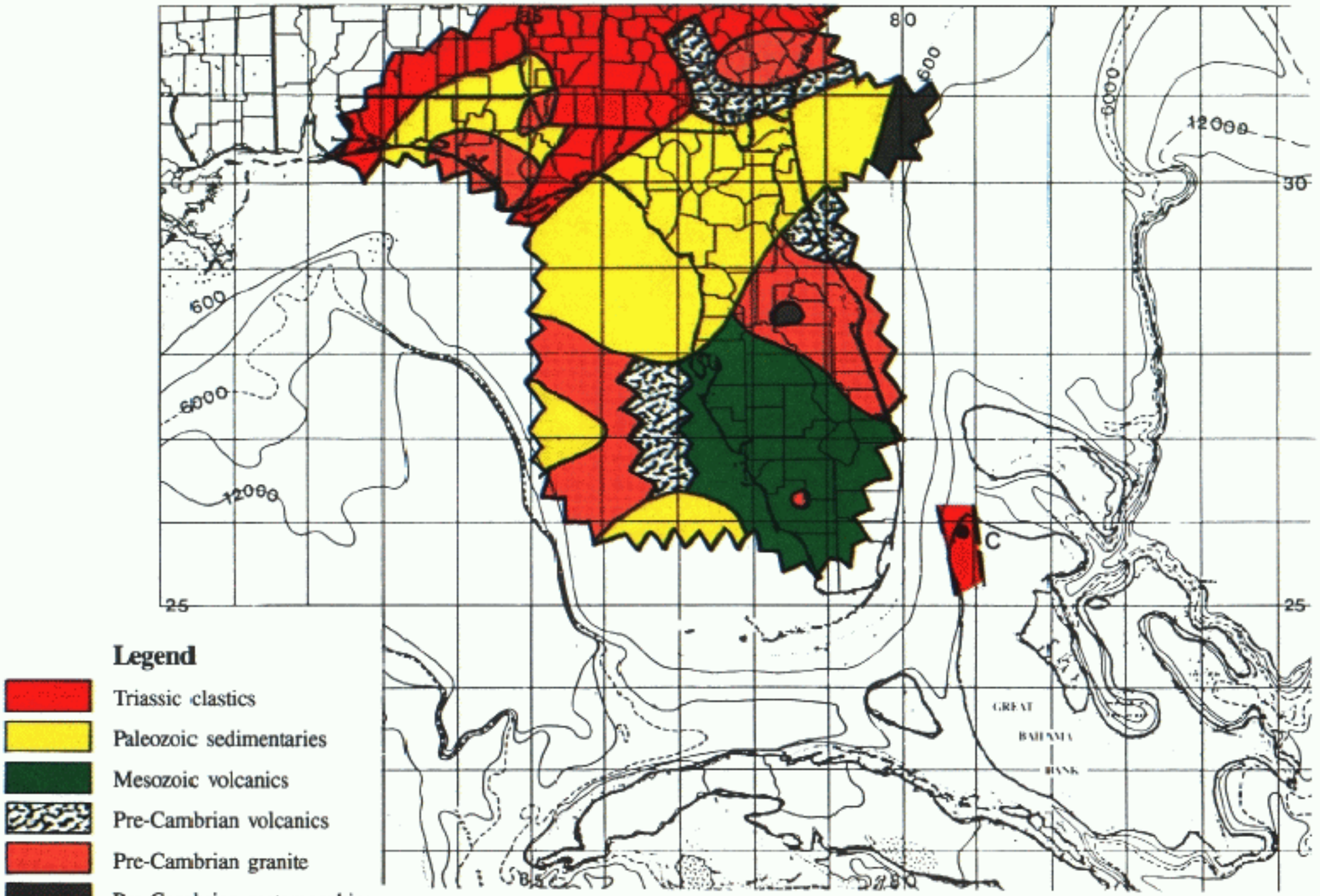
## Pre-Middle Jurassic Areal Geology

During the Paleozoic, all of the present Florida-Bahama Platform was attached to West Africa. The lithologic sequence and sparse fossils of the Paleozoic sedimentary rocks of Florida clearly indicate the relationship (Villeneuve 1984). Deposition ceased in the Late Devonian, when North America and West Africa collided to form the super-continent of Pangea.

Pangea survived as a single continent until the Triassic, at which time North America began to break away from West Africa in the vicinity of the Blake Escarpment (p. 33), taking with it the part which now comprises the Florida-Bahama Platform. The grabens which formed along the east coast of North America during this event also extend into Panhandle Florida and onto the West Florida Shelf. In Panhandle Florida the graben was filled by red shales and a few fine-grain sandstones; conglomerates accumulated along the eastern wall of the graben. No fossils have been reported from these red beds in either Georgia or Florida. In the Bahamas, the volcaniclastics and red shales encountered in the bottom of Well C were probably deposited in a Triassic graben.

In south Florida, Lower Jurassic rhyolite and basalt were extruded over the eroded "African" Paleozoic-Proterozoic surface. The diabase dikes and sills which cut Triassic and Paleozoic beds in north Florida and Georgia are of the same age (Chownes and Williams 1983; Arthur 1988).

The deep channels in the eastern Great Bahama Bank may have originated by Triassic graben faulting, remaining as lows through time because carbonate sedimentation was unable to keep pace with continuing subsidence.

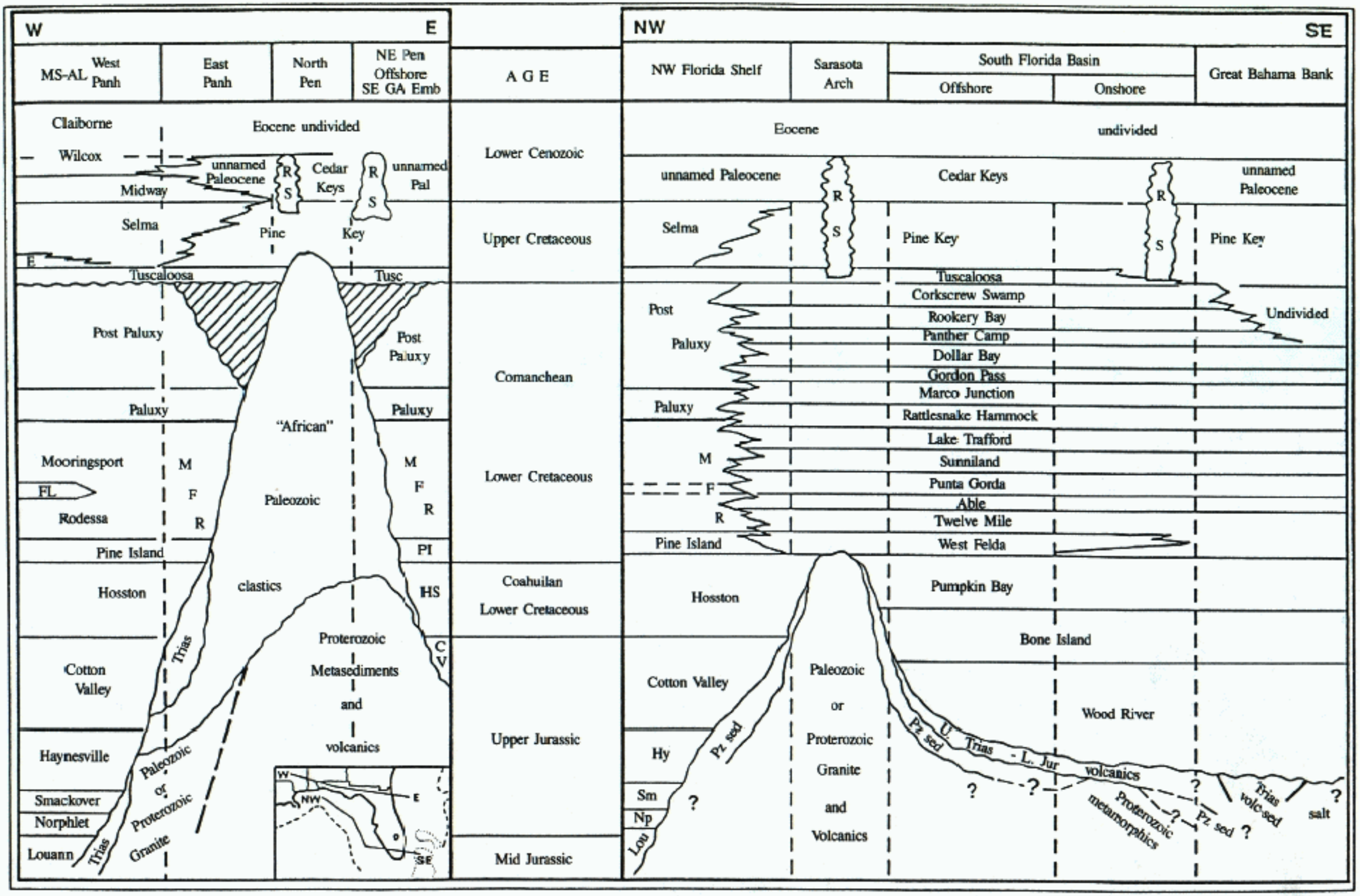



**Pre-Middle Jurassic Areal Geology**

## TABLE 2

## LIST OF WELLS CITED

| Well | Permit/ OCS/ Country | Operator | No. | Name | Location |
|---|---|---|---|---|---|
| A | OCS 3903 | Mobil | 1 | Vernon 654 | 26/18N 84/05W |
| B | Bah | Tenneco | 1 | Doubloon-Saxon | 22/50N 78/22W |
| C | Bah | Chevron | 1 | Great Isaacs | 26/00N 79/10W |
| D | Bah | Chev-Gulf | 1 | Cay Sal | 23/49N 80/12W |
| E | P 565 | Phillips-Mobil | 1 | Seminole | 28-48S-33W |
| F | P 148 | Sinclair | 1 | Williams | 24-59S-40W |
| G | Blake | Leg 101 | 627 | ODP | 27/38N 78/18W |
| H | OCS 3705 | Exxon | 1 | Jax'ville 564 | 26/03N 80/15W |
| J | Cuba | Gulf | 1 | Blanquizal | 23/05N 80/21W |
| K | Cuba | Kewannee | 1 | Collazo | 22/22N 73/50W |
| L | Bah | Superior | 1 | Andros | 24/52N 78/02W |
| M | Blake | COST-GE | 1 | Jacksonville | 30/37N 80/59W |
| N | P 256 | Brooks | 1 | Caldwell | 31-2S-31W |
| P | Cuba | Estrella | 1 | Cayo Coco | 22/28N 78/37W |
| Q | OCS 3664 | Getty | 1 | Brunswick 913 | 31/05N 80/26W |
| R | many OCS | Chevron-Shell | — | Main Pass | 29/24N 87/53W |
| S | OCS 4950 | Shell | 1 | Char Har 622 | 26/20N 83/44W |
| T | Blake | JOIDES | J-4 | — | 31/02N 77/43W |
| U | Bah | Gulf/Mobil | 1 | Long Island | 23/00N 74/50W |
| V | P 259 | Amerada | 2 | Cowles-Magazine | 19-36S-40E |
| | | | | | |
| a | | Alvin submarine sampling traverse A | | | 30/10N 76/00W |
| b | | Alvin submarine sampling traverse B | | | 29/02N 76/44W |
| c | | Alvin submarine sampling traverse C | | | 28/24N 76/38W |




E = Eutaw
FL = Ferry Lake

RS = Rebecca Shoal Reef