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A Regional Analysis of the Oligocene-Eocene Section of the Peninsula Using Vertical Lithologic Stacks

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

FORWARD

Between the base of the phosphatic Miocene Hawthorn and the top of the Paleocene Cedar Keys, is a 2000-foot limestone-dolomite section which contains a few local formations. In the central and southern Peninsula, distinguishing them on logs is always difficult, and usually impossible without back-up drill cutting data, which frequently is not available. In southern Florida, it is even difficult to distinguish them in drill cuttings, as their lithologic characters converge, and faunal clues become vague or disappear altogether.

The Oldsmar formation, present in the lower Eocene section of the northwestern Peninsula (Fig. 9e), is not identifiable elsewhere because it is not overlain by the anhydritic dolomite facies of the PINco Suite Avon Park. In addition, the characteristic faunal zone is absent (Fig. 13 and p. 33), and the limestones of the Avon Park and Oldsmar become indistinguishable. Where the Oldsmar cannot be identified, neither can the base of the Avon Park.

In the northeastern Peninsula, an "Oldsmar" formation is occasionally identified, but it is only partially equivalent to the type section (Cross-section C-D, Well 28).

In the face of all these correlation difficulties, I decided in preparing this regional study to abandon the horizontal formation concept and organize this 2000-foot section into distinctive vertical stacks, herein designated "Suites". These rock stacks, along with their characteristic mineralogic associations are restricted to specific areas (Fig. 3).

ABSTRACT

This report is based on my descriptions of numerous sample sets from various stratigraphic investigations in Florida (Winston 1977, 1978, 1990, 1991, Puri & Winston 1974 and Winston & Puri 1975). In order to make paleogeographic interpretations of some 2500 feet of diverse carbonate lithologies without regional paleontologic or lithologic marker beds, I have organized these rocks into VERTICAL stacks based on similar lithologies, herein designated "Suites". These Suites cross stratigraphic boundaries.

All of the Suites of the Black Point Format include Oligocene and Eocene age rock between the base of the phosphatic Miocene Hawthorn and the top of the Paleocene Cedar Keys-Rebecca Shoal dolomite complex (Winston 1977, 1978, 1989 & 1991). The MADco Suite, which belongs to the Perdido Bay Format of the Panhandle (Winston 1993), extends into the geographic Peninsula province. The MADco Suite includes beds of Paleocene age in addition to Oligocene and Eocene rocks.

The MADco Suite is a light-colored skeletal, open marine wackestone which contains glauconite, chert and some dolomite. The PINco and ORco Suites are mostly tan and brown dolomite, with the PINco being differentiated by the presence of varying amounts of anhydrite.

The CHAco, DAco and LAFco Suites are characterized by a predominance of light-colored, chalky skeletal limestone, and subsidiary brown dolomite. In the DAco Suite, dolomite is a relatively minor constituent, whereas in the CHAco Suite it is a major component. The LAFco is differentiated from these Suites

by the presence of both glauconite and chert.

All of the Black Point Suites were deposited on a tableland created by the underlying Paleocene Rebecca Shoal barrier reef atoll and its lagoonal carbonate-evaporite facies, the Cedar Keys Formation. The dolomite PINco and ORco Suites of the central tableland are encircled on the north, east and south by the dominantly limestone LAFco, CHAco and DAco Suites.

In the southeastern Peninsula the absence of the Ocala Limestone can be explained by a change of facies of that unit into upper Avon Park lithology, without invoking a short-lived uplift to permit erosion of this unit. Drill cutting data from wells in Dade County strongly suggest continuous deposition from the Avon Park through the Suwannee.

Four zones of Helicostegina gyralis occur in the northern Peninsula; the type Oldsmar top in the PINco Suite is associated with Zone III (see Fig. 13).

INTRODUCTION

Definitions

Definitions are presented at the beginning of this volume as discussion of various aspects of the Suites herein introduced occasionally involves new or unfamiliar terms.

Suite - A Suite is a vertical stack of rocks whose uniqueness in lithologic character, arrangement of beds, or mineral components differentiates it from its neighbors. Suites cross both time and rock-stratigraphic units.

Format - (Dictionary of Geological Terms, 1986, p. 193) "Informal rock-stratigraphic unit bounded by marker horizons believed to be isochronous surfaces that can be traced across facies changes, particularly in the subsurface, and useful for correlation between areas where the stratigraphic section is divided into different formations that do not correspond in time value."

Black Point Format - Defined as the interval between the base of the Miocene Hawthorn Group and the top of the Cedar Keys Formation (Appendix 5). This unit is a general lumping term which combines the LAFco, ORco, PINco, CHAco, and DAco Suites into one "tableland" (see below) unit.

T-1, T-2 and T-3 - In locating minerals, fauna or other geologic features within the Black Point Format Suites, a tripartite subdivision is used, with T-1 representing the upper third, etc.

This device avoids awkward and confusing references such as "the lower third of the upper third...."

Boulder Zone - Term applied to various cavernous dolomites in the Black Point Format or upper Cedar Keys. When caverns are drilled into, large pieces of the roof frequently break off ahead of the bit and fall into the hole. Also, in zones of highly fractured dolomite, large pieces break off the wall and fall into the hole. These fragments are then rolled around by the bit, which led the early drillers to believe that they were drilling in-place boulders - hence the name. (See Kohout 1965).

Tableland - As used herein, refers to the submarine plateau created by the Rebecca Shoal Barrier reef and its lagoonal Cedar Keys equivalent, on which the Black Point Format rocks were deposited. This term is used instead of "Platform" or "Plateau" to avoid possible confusion with the Floridan Platform or the Blake Plateau.

Method

This report is based on numerous sample descriptions accumulated during my various stratigraphic investigations since 1970 (Puri & Winston 1974, Winston & Puri 1975, & Winston 1977, 1989 & 1990).

The base of the Black Point Format is the top of the Cedar Keys, the top of which was first established in the rare wells where both sample and log control were available (Winston 1993 in prep). This contact was then extended throughout the Peninsula by E-log correlation and the sparse lithologic data which were occasionally available.

That samples are not usually present in oil tests over this contact is due to the almost universal loss of circulation in the Lower & Middle Eocene section during conventional rotary drilling operations; however, today samples from this interval are recovered from municipal wastewater injection wells, due to the use of reverse circulation air drilling. Many of these wells completely penetrate Black Point Format rocks along the coastal areas.

In the early years of oil exploration, when the potential for shallow oil accumulations was unknown, E-logs were run in the Black Point section. Today in south and central Florida, logs are generally not run in oil tests until after casing has been set in the Cedar Keys to shut off the various Black Point lost circulation zones.

The prefix M indicates a well which appears on the maps. The prefix P is the Florida Geological Survey permit number, and W the file number of wells for which no permit was issued. Control well locations are shown on Fig. 17, and are identified in Table 1.

PREVIOUS REGIONAL INVESTIGATIONS

The first regional study of the Eocene, which was based on only a few wells, was presented by Applin & Applin in 1944. In this paper they introduced the Avon Park, Lake City and Oldsmar formations, based on foraminifera zones in cuttings from the oil tests and water wells then available.

Puri (1957) discussed Ocala outcrops and presented an extensive list of water wells penetrating the formation. Data from some of these wells were used to construct two regional cross-sections, but he did not discuss the lithology of the subsurface Ocala.

Chen (1964) discussed the Eocene and Paleocene rocks in both the Peninsula and Panhandle, and presented cross-sections and facies maps of the diverse units.

Puri & Winston (1974), unable to divide the Eocene of the southern Peninsula into the established formations, used a tripartite subdivision in presenting cross-sections and facies maps, as well as in lithologic discussions. Emphasis of the paper was on the high transmissivity "Boulder Zones".

Miller (1986) merged the Lake City formation into the Avon Park formation. He presented paleontologic and generalized lithologic data on the Eocene and Oligocene over Florida and parts of contiguous states. Included was an extensive history of the nomenclature and a summary of regional correlation problems.

While not regional in coverage, Duncan et al (in review) present valuable detailed data on Eocene lithology and environments of deposition in Brevard County (Fig. 1).

LITHOLOGIC SUITES

General

The Suites of Peninsular Florida are: LAFco, PINco, ORco, CHAco, DAco and MADco.

Although each Suite is different, there are similarities between them. In the case of PINco and ORco, both are dolomite, but the presence of anhydrite differentiates the PINco Suite. The CHAco, DAco and LAFco Suites are characterized by a limestone-dolomite composition. In the DAco Suite, dolomite is a minor constituent, whereas in the CHAco Suite it is a major component. The LAFco Suite is differentiated from the CHAco and DAco Suites by the presence of glauconite and chert.

Transition zones between Suites appear to be some five miles wide and exhibit characteristics of both adjoining Suites.

The extension of the ORco Suite to the north in Marion and Alachua counties (Fig. 4) where no samples are available, is based on the higher quantities of dolomite in adjacent LAFco Wells 24 and 12. This condition is similar to the higher dolomite content of the LAFco in the Brevard County injection wells (Fig. 15), which were drilled near the boundary of the dolomite ORco Suite. In addition, the E-log character of wells within the Marion-Alachua area supports this extension of the ORco Suite.

ORco dolomite tends to "mushroom" over adjoining Suites. PINco Suite rocks tend to wedge northward into the LAFco Suite.

Data on each Suite is presented below in tabular form for easy reference.

A summary of established formations within the Black Point Format is included in Appendix 2.

Examination of a continuous Eocene core from Well W-10252 (M39) led to the establishment of a cyclic sequence of deposition (Puri & Winston 1974) (Fig. 16) which is seldom complete.

In wells near the east coast of the Peninsula, the grainstones of bed 4 tend to be much thicker than in wells inland. This cycle can only be identified in cores as the lithologies are so thin that several appear in a 10-foot interval of drill cuttings.

The Black Point Format was introduced to supply a name with which to encompass the entire section represented by all of the tableland Suites. The MADco Suite, which belongs to the Perdido Bay Format of the Panhandle (Winston 1973), extends eastward into Madison and Taylor Counties in the geographically defined Peninsula. It is also present in offshore wells east of Duval County.

The potable water lens of the Floridan Aquifer (Fig. 6) normally occupies 1000 feet or less of the Upper Black Point Format. The presence of an extra 1000 feet of potable water in the area of the ORco Suite can be attributed to its very porous and vertically permeable euhedral dolomite lithology. To the west, the upper PINco Suite is composed of the same type of dolomite and contains potable water, but in the middle and lower PINco section, the dolomite is plugged with selenite and anhydrite nodules.

LAFco Suite (Fig. 3)

Type Well: Sun 1 Crapps (P 4, M 9), 25-6S-12E, Lafayette County (Fig. 5)

Type Interval: 0-1295 feet E-log; 0-1300 feet samples

Name Derivation: Lafayette County

Thickness Range: 1300 feet to 2275 feet

Description of contained lithologies: The LAFco is 70-80% limestone; near the boundary with the PINco Suite, it is only 60% limestone (Wells 11,14 & 15). Wells 12 & 24 (Fig. 4) and the Brevard County wells (Fig. 15) are also high in dolomite indicating the nearby presence of the ORco Suite.

The predominant limestone consists mostly of skeletal wackestones, packstones and chalky micrite. Skeletal grains are very fine to coarse and are usually embedded in a chalky matrix. Colors are cream and tan. Occasionally fine to coarse skeletal grainstones are present.

Fine grain oolites and dolomite crystal inclusions may occur in T-3. Dolomite, occasionally calcareous, is euhedral, anhedral or cryptocrystalline, and tan or orange-tan in color. The euhedral variety is microcrystalline to fine crystalline. Occasionaly medium crystalline dolomite and fine to coarse grain relic skeletal dolomite grainstones are present. Dolomite beds are usually less than 100 feet thick, but may occasionally reach 200 feet. Cherty beds are present in most wells, but not in large quantities. Glauconite is typical of this Suite, particularly in T-3. Anhydrite nodules are occasionally present in a thin interval in T-3. Lignite is rare, but peaty partings are common.

Comments: Along the east coast an "Oldsmar" formation is identified by the occurrence of *H. gyralis*. Here the occurrence is Zone IV (see Appendix 3 & Fig. 13), whereas the type Oldsmar is defined by Zone III. The east coast "Oldsmar" therefore is not a direct equivalent of the type Oldsmar.

This Suite contains the type well of the abandoned Lake City formation.

Distribution: The LAFco Suite is found in the northern Peninsula, and in a thin strip down the east coast into Palm Beach County (Fig. 3). PINco lithology overlaps LAFco in Wells 10, 11 & 14.

Upper Boundary: Defined when not outcropping by the change from phosphatic dolomite, limestone, sandstone or clay of the Miocene Hawthorne above, to non-phosphatic limestone or dolomite of the LAFco Suite below.

Lower Boundary: Usually this is defined by the change from an orange-brown anhedral dolomite of the basal LAFco above, to a gray anhedral or cryptocrystalline lithographic dolomite of the Cedar Keys below. In some areas of the northeastern Peninsula, limestone instead of dolomite overlies the Cedar Keys.

In St. Lucie, Martin & northeastern Palm Beach Counties, the basal LAFco brown anhedral dolomite is underlain by cream or orange/tan euhedral and cryptocrystalline dolomite of the Rebecca Shoal complex.

Age: Eocene and Oligocene.

PINco Suite (Fig. 3)

Type Well: Coastal 1 Wright (P 75, M 28) 7-30S-17E, Pinellas County (Fig. 5)

Type Interval: Top 195 feet samples (no E-log for top); base 3100 feet E-log, 3115 feet samples.

Name Derivation: Pinellas County

Thickness Range: 1800-2950 feet

Description of contained lithologies:

In T-1 the upper several hundred feet are limestone, composed of light-colored skeletal grainstones and packstones of the Suwannee and/or Ocala. Beneath is a thick section of tan, cream and orange-brown dolomite (Avon Park) of euhedral, anhedral or occasionally cryptocrystalline texture. The euhedral variety is microcrystalline to fine crystalline or chalky. Occasional very fine to fine grain relic skeletal dolomites occur.

In T-2 and upper T-3, thin beds and nodules of anhydrite appear in the dolomite, with selenite and gypsum filling dolomite porosity. Peat and lignite beds are present, as well as occasional peaty partings and cherty beds.

The lower one-fourth of the Suite in the type well is the co-type interval for the Oldsmar formation (Winston 1977). The limestone fraction of this formation consists of cream, tan and white very fine to fine grain skeletal wackestone with occasional dolomite crystal inclusions. White, tan and gray-brown chalky micrite is common. Oldsmar dolomite, occasionally calcareous, is euhedral, anhedral and occasionally cryptocrystalline. The euhedral variety is chalky to medium crystalline. Colors are tan and orange-brown.

Comments:

To the north, PINco lithology overlaps LAFco lithology in Wells 10, 11 & 14.

The Oldsmar formation is only recognizable when overlain by the thick anhydritic Avon Park dolomite of the mid-PINco. Oldsmar is occasionally identifiable by correlation in the western LAFco area; rock equivalents to the Oldsmar occur in the other Suites.

Identification of the Oldsmar formation is based on the appearance of H. gyralis Zone III (Fig. 13).

Distribution:

West-central Peninsula and offshore to the west (Fig. 3).

Upper Boundary:

Defined, when not outcropping, by the change from phosphatic sandy chalky micrite and light-colored skeletal wackestone of the Miocene Hawthorne above, to white to cream skeletal grainstone and packstone of the Suwannee or Ocala below.

Lower Boundary:

Defined by the change from brown and orange-brown or tan anhedral dolomite of the basal PINco Suite above to gray cryptocrystalline or anhedral dolomite of the Cedar Keys below.

Age: Eocene and Oligocene.

ORco Suite (Fig. 3)

Type Well: Sand Lake 1 Injection (W-13287, M-56), 32-33S-29E, Orange County (Fig. 5)

Type Interval: Top 190 feet samples, 180 feet GR log; base 1983 feet samples, 1975 feet GR log; no E-log available

Name Derivation: Orange County

Thickness Range: 1300-2200 feet

Description of contained lithologies:

The ORco Suite is 80-90% dolomite which is mostly euhedral with anhedral and cryptocrystalline textures occasionally present. Euhedral dolomite is very fine microcrystalline to fine crystalline with abundant relic skeletal packstone lithologies. Colors are brown, tan and orange-tan.

Subordinate limestone consists of very fine to fine grain skeletal packstone, grainstone and chalky micrite. Colors are cream, tan and brown. Limestone occurs mainly in the upper (Ocala) and in the lower ("Oldsmar") sections; the Suwannee is mostly absent. Limestone is occasionally present in the upper Avon Park below the Ocala.

Cherty beds are minor; glauconite is present only in Well 25.

Boulder Zone cavities can occur anywhere in this thick dolomite Suite.

Comments: The ORco Suite overlaps the LAFco Suite in Well 15 and in the Brevard County wells (Fig. 17).

Due to the prevalent Boulder Zone cavities, loss of circulation and cuttings is common throughout the ORco area.

A vague "Oldsmar" limestone section is present in Lake, Orange and Osceola Counties.

Distribution: The ORco Suite is located in the central Peninsula area (Fig. 3).

Upper Boundary: Defined, where not outcropping, by the change from phosphatic dolomite, sand or clay of the Miocene Hawthorne above, to non-phosphatic white to cream limestone packstone of the Ocala or Suwannee below.

Lower Boundary: Defined by the change from brown anhedral dolomite above, to gray cryptocrystalline or ahnedral dolomite of the Cedar Keys below.

Age: Eocene and Oligocene.

CHAco Suite (Fig. 3)

Type Well: Gulf 1 Vanderbilt (P 178, M 36), 35-41S-21E, Charlotte County (Fig. 5)

Type Interval: 705 feet samples (no E-log of top); base 3180 feet samples and E-log

Name Derivation: Charlotte County

Thickness Range: 2200-2400 feet

Description of contained lithologies: The CHAco Suite is 60-70% limestone. The limestone is usually a very fine grain skeletal wackestone or packstone with a chalky matrix. Occasional zones of grainstone with fine to medium grains are present. Colors are tan or cream. Chalky cream-colored micrite is common. Dolomite crystal inclusions are frequently present in T-3.

Dolomite is anhedral, euhedral or cryptocrystalline. The euhedral variety is usually microcrystalline to fine crystalline, but when lining Boulder Zone cavities in anhedral dolomite, the crystal size can be medium to coarse. Colors are tan, orange-brown and dark brown.

Comments: The CHAco Suite differs from the LAFco in lacking glauconite and, with the exception of Wells 35 & 6 near the LAFco boundary, it also lacks chert. CHAco differs from DAco in having more dolomite, and in particular, containing a 100-200 foot thick regionally persistent Boulder Zone dolomite in T-2.

Boulder Zone cavities develop as pockets in anhedral dolomite; Boulder Zones never develop in limestone.

Distribution: The CHAco Suite occurs as a 100-mile wide band extending east-west across the southern Peninsula (Fig. 3).

Upper Boundary: Defined by the change from phosphatic limestone, dolomite or sandy limestone of the Miocene Hawthorne Arcadia above, to white, tan or cream skeletal packstone of the Suwannee, Ocala or Avon Park below.

Lower Boundary: Defined by the change from basal CHAco brown anhedral or coarse crystalline euhedral dolomite above, to gray cryptocrystalline or anhedral dolomite of the Cedar Keys below.

Age: Eocene and Oligocene.

DAco Suite (Fig. 3)

Type Well: MDWS 5 Injection (W-13768, M 57), 21-56S-40E, Dade County (Fig. 5)

Type Interval: Top 1030 feet samples, 1035 GR log; base 3160 feet samples, 3165 feet GR log

Name Derivation: Dade County

Thickness Range: 1900-3000 feet

Description of contained lithologies:

The DAco Suite is 90-95% limestone. In T-1 and T-2, the limestone is tan and cream (white in the upper Suwannee) grainstone and packstone. There is little wackestone or micrite. Foraminifera are common, with the "cone" fauna (Appendix 4 & Fig. 14) extending downward to within 500 feet of the base of the Suite in the southeastern Peninsula. Grain size is fine to medium and occasionally coarse.

In T-3, the limestone is essentially the same, but with more chalky matrix and occasional zones of dolomite crystal inclusions. At the base is a zone of anhedral dolomite with pockets of euhedral. The euhedral variety is fine to medium crystalline, and occasionally coarse crystalline. Cryptocrystalline lithographic dolomite is frequently present in the southeastern Peninsula.

Chert is present only in Wells 45 and 46 on the east coast Fig. 12).

Comments: In the Keys, differentiating the limestone of the Miocene Hawthorn (which here may be non-phosphatic), from the Suwannee is difficult. As a result, part of the Hawthorn may occasionally be included in the DAco Suite. The chert in Wells 45 & 46 suggests the presence of LAFco lithology offshore to the east.

Well MDWS 5 is also the type for the Black Point Format.

Distribution: Southern Peninsula and the Keys (Fig. 3)

Upper Boundary: Defined by the change from white fossiliferous limestone (when phosphatic) of the Miocene Hawthorne Arcadia above to the white skeletal limestone of the Suwannee below. Where the Miocene lacks phosphate, it is indistinguishable from the Suwannee.

Lower Boundary: Except in injection wells, the samples covering the lower boundary are everywhere missing due to lost circulation. In the injection wells the boundary is defined by the change from brown and tan anhedral dolomite above to gray anhedral or cryptocrystalline lithographic dolomite of the Cedar Keys below. Picking this boundary is aided by regional correlation using gamma ray logs.

Age: Eocene and Oligocene (occasionally may include Miocene).

MADco Suite (Fig. 3)

Type Well: Hunt 1 Gibson (W-1596, M 2) 6-1S-10E, Madison County (Fig. 5)

Type Interval: 0-2350 feet E-log, 0-2380 feet samples

Name Derivation: from Madison County

Thickness Range: 2380 feet in the northwestern Peninsula, 2850 feet in the offshore Jacksonville Well Cluster (see Fig. 2).

Description of contained lithologies:

The MADco is 80-90% limestone, which consists of wackestones and packstones with very fine to fine skeletal grains in a chalky matrix. Colors are cream, white, tan and light gray. Dolomite crystal inclusions are common.

Dolomite, occasionally calcareous, is euhedral, microcrystalline to occasionally medium crystalline, cream and tan. Occasional relic dolomite skeletal packstones may be present. Dolomite is most prevalent in T-2.

Cherty beds are scattered throughout the section, but are most common in the T-3 (Paleocene) section. In the Jacksonville Well Cluster glauconite is prevalent throughout, but in the northwestern Peninsula only a few glauconite beds are present (usually in T-2 and T-3).

Comments:

The Eocene-Paleocene boundary in this Suite is not identifiable by lithology; only a rough correlation by E-log is possible.

In the northwestern Peninsula, the Suwannee-Ocala interval at the top of the MADco is near the surface. Samples are not usually available here, nor is the interval logged.

In the Jacksonville Well Cluster (M 53 & 54), the Miocene is usually a phosphatic limestone. If present, the underlying Suwannee is not identifiable by lithology. In the nearby offshore JOIDES holes (Charm et al 1969) the Oligocene is described as a thin ooze. Cluster wells to the east (downdip) are more dolomitic than those nearer the Cedar Keys-Rebecca Shoal platform to the west.

Distribution:

The MADco occurs in the eastern third of the Panhandle, and extends into the northwest corner of the Peninsula. It is also present offshore on the East Florida Shelf (Jacksonville Well Cluster). MADco lithology is present offshore on the northern West Florida Shelf (Cross-section C-D) beneath the PINco Suite lithology.

Upper Boundary:

Onshore, when not outcropping, it is defined by the change from Miocene phosphatic dolomites, clays, or other sediments of the Hawthorne to non-phosphatic carbonate. Offshore in the Jacksonville Well Cluster, phosphatic Miocene overlies MADco limestone. On the West Florida Shelf, basal MADco lithology is overlain by Eocene PINco lithology (Cross-section C-D).

Lower Boundary:

Defined by the change from dolomitic, skeletal, cherty packstone above to a white chalk, chalky skeletal wackestone, or micrite containing inoceramos prisms of the Pine Key-Selma below.

Age: Includes Paleocene, Eocene and Oligocene.

GEOLOGIC HISTORY

Regional Setting

After the collapse of the Florida Straits at the end of the Lower Cretaceous, the Rebecca Shoal dolomite reef appeared in the Upper Cretaceous along the north side of the Florida Straits. It extended westward to the Sarasota Arch on the West Florida Shelf (Fig. 2), and northward up the east coast of the Peninsula. The reef continued to grow northward along both coasts until in the Paleocene it eventually encircled the Peninsula (Fig. 2), producing a giant atoll. The presence of this atoll was responsible for the evaporite-dolomite character of the lagoonal Cedar Keys formation (Winston, 1991 & 1993 in prep).

Other than the lithology of the reef itself, further evidence for the presence of this feature is the open marine character of the off-reef lower (Paleocene) MADco cherty limestone lithology to the west and east of the Upper Rebecca Shoal dolomite (Fig. 3 and Cross-section A-B).

At the end of Cedar Keys-Rebecca Shoal deposition, a giant submarine tableland had been created (Cross-Section A-B & C-D). The Black Point Formation Suites are confined to this tableland except for the PINco Suite. Oddly, this Suite extends beyond the tableland to the west (Cross-section C-D), where it overlies a generally Paleocene-age lower MADco cherty open marine limestone.

The Peninsular Arch does not appear to have influenced the lithologic character of the Lower and Middle Eocene beds. An isopach of these beds (Fig. 7) does show that the Arch was still

forming by a slow subsidence of its eastern and western flanks. The gently subsiding South Florida Basin is shown as a generally thicker area.

In the northern Peninsula the unconformities at the top of the Avon Park, Ocala and Suwannee were probably due to sea-level fluctuation. The missing Suwannee in the eastern Peninsula (Fig. 9a) could be the result of a slight tilting to the west, which could have caused either non-deposition or erosion of the unit in the late Oligocene (Winston 1976).

Lithologic Development of Suites in the Eocene

Following deposition of the Paleocene Cedar Keys gray dolomite, deposition of Black Point T-3 rocks began with a regionally persistent orange-brown dolomite. This dolomite bed ranges from 100 to 300 feet in thickness and contains one of the Eocene cavernous Boulder Zones. In the LAFco Suite of the northeastern Peninsula, scattered control shows Black Point limestone instead of dolomite resting on the Cedar Keys. A 200-300 foot section, mostly limestone (Oldsmar equivalent), then covered the entire tableland to complete the T-3 interval.

In the T-2 and T-1 interval, the interbedded limestone and dolomite lithology characteristic of the LAFco, CHAco and DAco Suites encircled the central-tableland dolomite complex of the ORco and PINco Suites, to the north, east and south.

In the Eocene, the climate was warmer than at present, and as a consequence the easterly trade wind belt would have been located farther north than at present. These prevailing winds would have pushed normal marine waters westward into the interior

of the tableland, where evaporation would have concentrated the salts. Increasing salinity of the westward-moving waters would have induced dolomitization of the original ORco and PINco grainy limestones (Cander 1991). In the central area of the tableland, the salinity appears to have become sufficiently high to induce the deposition of anhydrite minerals characteristic of the PINco Suite.

To the north, normal marine waters moving in a clockwise direction from the Gulf of Mexico probably crossed the northern Peninsula into the Atlantic. This normal marine water as well as an influx of fresh water from the continental hinterland to the north, would have prevented a rise in salinity and thus inhibited deposition of the thick dolomite and anhydritic dolomite sections characteristic of the ORco and PINco Suites to the south. in this area the limestone-dolomite LAFco Suite was deposited.

In the northern Peninsula in the upper T-1, upper Middle Eocene rocks were exposed, probably by a fall in sea-level. Following this hiatus, the Upper Eocene Ocala was deposited as sea-level rose. In south Florida, deposition was probably continuous, with the typical Ocala coquina changing facies into upper Avon Park wackestones and grainstones (see Appendix 1).

Later in north Florida, the Upper Eocene Ocala was in turn exposed to erosion, again probably by a fall in sea-level. Deposition of the Oligocene Suwannee limestone followed this hiatus. From recently acquired data in Dade County, the Suwannee lithology appears to grade downward into a similar upper Avon Park lithology. As this would imply the lack of an

unconformity, it would further support the concept of a change in facies of the Ocala into the Avon Park (see Appendix 1).

In the late Oligocene, according to some paleontologic data (pers. comm.), a major unconformity developed over the entire Black Point Format, which was followed by deposition of the phosphatic carbonates or clastics of the Hawthorn.

CONCLUSIONS

1. The concept of the Suite enables one to predict the general vertical sequence of carbonates in areas of no control. For instance, in Brevard County (Fig. 15), I had interpreted the presence of LAFco Suite rocks before acquiring the data of Duncan et al; from this data, only a slight modification of the ORco-LAFco boundary was necessary (Figs. 3 & 15).

2. Viewing the Black Point Format as a whole led to the hypothesis (Appendix 1) linking the fauna of the Avon Park and Suwannee by way of a change of facies of the Ocala lithology into Avon Park lithology.

3. In the CHAco Suite, the basal Boulder Zone dolomite is always present; in local areas, two higher Boulder Zones occur in the section.

4. Although one or more Boulder Zones have been reported in local areas of the ORco Suite, virtually the entire section is occupied by potable water; therefore, this Suite is unsuitable for waste injection.

5. The middle section of the CHAco and DAco Suites, considered by many to be a hydrologically-defined confining bed, can in local areas be a porous grainstone.

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Appendix 1

HYPOTHESIS RELATING THE SUWANNEE, OCALA & AVON PARK FORMATIONS

The absence of typical Upper Eocene Ocala coquina and fauna in the southeastern Peninsula (Fig. 9b) has in the past been explained by a short episode of uplift (possibly in association with tectonic activity in Cuba), with erosion of the Ocala followed by subsidence and deposition of the Suwannee Limestone in the Oligocene.

The southern Florida Peninsula and environs have been dominated by negative movement (including the Florida Straits graben) from Upper Jurassic to the Present. Considering the shape of the area of missing Ocala (Fig. 9b), the uplift and erosion hypothesis is no longer tenable.

No regional stratigraphic investigations have been made in the southern Peninsula which would definitely establish the presence of unconformities between the Suwannee, Ocala and Avon Park Formations. In southern Florida the acceptance by geologists of unconformities between these units is based on the presence of unconformities in the updip area of the Northern Peninsula.

If no major unconformities were to exist in south Florida, and deposition was more or less continuous, a simple facies change from the Ocala coquina to Avon Park grainstone, packstone and wackestone would account for the absence of Ocala fauna and lithology, without the need for tectonic activity. Furthermore, such a change of facies would bring the "cone" fauna of the Avon

Park into contact with the overlying Suwannee, allowing the Coskinolina floridana and Dictyoconus cookei forminifera to migrate directly into the Suwannee (Fig. 8) where they are also present (Puri 1957 and Miller 1986). The wells at site 50 in southern Dade County contain abundant "cones" in the Suwannee.

In considering the lack of an unconformity between the Suwannee and underlying Eocene beds in south Florida, the following quote is of interest. Miller (1986 p. 33) declares:

> "The Bumpnose [Oligocene] in the type area [Panhandle] is very likely a transitional unit between the Late Eocene [Ocala] and the Early Oligocene".

If this is so in the thin updip Panhandle Oligocene, why not a similar transitional condition in the southern Peninsula where the Oligocene (Suwannee) is considerably thicker?

I have examined the drill cuttings from several closely spaced wells across the Hawthorn-Suwannee-Avon Park interval at the Miami-Dade Water & Sewer Authority plant in southern Dade County (M 50). Here there is a marked unconformity between the Hawthorn and Suwannee, but the Suwannee lithology appears to merge directly into the underlying Avon Park lithology, as would be expected from this hypothesis.

Appendix 2

SUMMARY OF LOCAL SUITE FORMATIONS

Miller (1986 p. 18-35) gives extensive historical summaries of the formations listed below. None occur throughout the Peninsula (Fig. 9), although rocks equivalent to the Avon Park (expanded), Oldsmar, and possibly the Ocala (see Appendix 1) are present throughout the Peninsula. The top of the Avon Park is everywhere present but the base can only be identified in the PINco area (Fig. 9d) where the Oldsmar is also identifiable.

Suwannee Limestone

The Suwannee occurs in two separate areas (Fig. 9a). In the northern Peninsula it is very thin, and represents the eastward extension of the Panhandle Marianna-Suwannee; it is mostly an outcropping formation. In the southern Peninsula, it is a subsurface formation. The usual lithology here is a white, skeletal packstone or grainstone, with occasional micrites.

In several south Florida wells, an Oligocene fauna has been reported from phosphatic limestone overlying this lithology. My recent investigations using injection well data show that this phosphatic limestone belongs to the basal Hawthorn Arcadia Formation, and not to the Suwannee.

In the southernmost Peninsula, the lower contact of the Suwannee with the Ocala or Avon Park is difficult to impossible to pick in cuttings, as the lithologies are quite similar, and diagnostic fauna are absent.

The "Suwannee" reported by Bermes (1958) and Lichtler (1960) in St. Lucie and Martin Counties near the coast is actually the Arcadia Formation. This is shown by data from the newly-drilled wells 62 and 63 in the same area.

Ocala Limestone

The Ocala outcrops in the northern Peninsula. It is missing in several local areas in the central Peninsula, and is not present, at least in its classic form (see Appendix 1) in the southeastern Peninsula (Fig. 9b). The subdivisions established on the outcrop have been abandoned by the Florida Geological Survey (pers. comm.), as they are not identifiable in the subsurface, and frequently not even on the outcrop (Miller 1986). The Survey has also assigned any basal dolomite facies in the Ocala to the underlying Avon Park (pers. comm.); thus the Ocala in the Peninsula is now almost entirely a limestone unit.

Typically, the Ocala is a cream-colored coquina of foraminifera and skeletal debris in the upper part, and a cream chalky micrite in the lower section. When the Ocala lacks its common diagnostic fossils such as Lepidocyclina and Operculinoides, it is difficult or impossible to separate it from the overlying Suwannee, particularly in the southern Peninsula. When the underlying Avon Park here is also a micrite or wackestone, it is impossible to identify the lower contact in cuttings.

Avon Park Formation (expanded)

In 1986 Miller combined the Avon Park of Applin & Applin (1944) with their underlying Lake City Formation (see below). The base of the expanded Avon Park formation at its new type locality is a dolomite and can only be identified in the PINco and northwestern LAFco area (Fig. 9c), where it is underlain by identifiable Oldsmar limestone (Fig. 9e). Elsewhere the Avon Park is a limestone; the top can be identified lithologically, but the base cannot (see Oldsmar).

Lake City Formation (abandoned)

The type Lake City (Fig. 6d) of Applin & Applin (1944) consisted of chalky skeletal packstone and wackestone with a few thin dolomite beds. Its identity was dependent on the presence of certain foraminifera at the top and base. Unfortunately, when more control became available, these fossils were found to occur in both underlying and overlying formations (Miller 1986). Miller therefore formally abandoned the Lake City as unidentifiable.

Oldsmar Formation

This formation was originally set up from poor cuttings in a shallow oil test drilled in 1923. In the co-type well (M 28, Winston 1977), it consists of white, chalky limestone, light-colored skeletal packstone and wackestone, and a basal euhedral brown dolomite.

It can be identified only in the PINco and northwestern LAFco area (Fig. 9e) where is associated with H. gyralis Zone III (Fig. 13). Locally along the central east coast area, an interval in the basal Black Point Format appears to be similar to the Oldsmar, but it is associated with H. gyralis Zone IV and thus is not a direct equivalent.

Cedar Keys Formation

The base of the Black Point Format is the top of the Cedar Keys Formation. This formation, or its correlative the upper Rebecca Shoal dolomite reef, is present throughout the Peninsula, except in Taylor and Madison counties (Figs. 1 & 3). The Cedar Keys is usually identified by the appearance of a gray to dark gray anhedral or cryptocrystalline lithographic dolomite, in

contrast to the brown anhedral dolomite of the basal Black Point Format.

Bedded anhydrite is never present at the top of the Cedar Keys, but in the south-central Peninsula, it occurs 30 to 50 feet below the top (Winston 1993 in prep). Elsewhere anhydrite may not be encountered for several hundred feet.

Appendix 3

SUITE MINERALS

Anhydrite (Fig. 10)

Occurrence - In the PINco Suite it is characteristic of T-2, occurs occasionally in lower T-1, and rarely in T-3. In the LAFco Suite it occurs rarely in T-3. In the MADco Suite of the northwestern Peninsula, it occurs rarely in T-2 and T-3.

Form - Mostly as nodules but occasionally as beds in the PINco Suite; selenite or gypsum pore filling is common in PINco T-2.

Glauconite (Fig. 11)

Occurrence - Most common in LAFco and MADco. In the LAFco Suite it is common in T-3 and occurs occasionally in T-1; in the MADco Suite it is common in T-2 and T-3. There are rare occurrences in the T-3 section of the ORco and PINco Suites.

Form - Granules of various sizes and microfossil replacement.

Chert (Fig. 12)

Occurrence - Chert is characteristic of the entire MADco Suite. It is common in the T-3 of LAFco. There are rare occurrences in PINco (T-2 & T-3) and in of ORco; in CHAco and DAco it is present only in T-3 in a few wells along the east coast.

Form - Nodules; occasional beds occur in LAFco and MADco.

Peat

Occurrence - Peat is present in all Suites, but is most common in LAFco, PINco and ORco. In these Suites it is prevalent in T-1, common in T-2 and rare in T-3.

Form - Occurs as horizontal partings and flakes; occasionally very thin peat beds are present in PINco and ORco.

Lignite

Occurrence - Present only in PINco and northwestern CHAco. In PINco it occurs in T-2 and in CHAco in T-3.

Form - Thin to thick beds.

Appendix 4

NOTES ON SUITE FORMATION FAUNA

Helicostegina gyralis - (distribution shown on Fig. 13) Originally used by Applin & Applin (1944) to define the top of the Oldsmar (Fig. 9e). Cole & Appin (1964), Winston & Puri (unpublished 1975), and Miller (1986) have all observed the presence of this foraminifer in the lower Avon Park formation in a number of wells.

Well 5 is the only one containing all four H. gyralis Zones. Zone I and II are located in the Avon Park, 300 feet and 550 feet respectively below the top. Zone III and IV are located in the Oldsmar 450 feet and 200 feet respectively above the Cedar Keys.

Dictyoconus americanus - (distribution shown on Fig. 14b) Originally used by Applin & Applin (1944) to define the top of the now abandoned Lake City formation. Miller (1986 p.26) reports seeing this foraminifer in the Applins' Avon Park formation, as high up as 20 feet from the top of that unit. The distribution of this foraminifer in the limestone facies of the expanded Avon Park is shown on Fig. 14b.

Coskinolina floridanus - (distribution shown on Fig. 14a) One of Vernon's "cone" fauna was originally used to characterize the restricted Avon Park formation of Applin & Applin (1944).

Dictyoconus cookei - In southern Florida this foraminifer extends downward in several wells from the Suwannee to within a few hundred feet of the base of the the Black Point Format. D. Cookei along with Coskinolina floridanus, make up Vernon's "cone" fauna.

Appendix 5

Black Point Format

Type Well: MDWS 5 Injection (W-13768, M57) 21-56S-40E Dade County

Type Interval: Top 1030 feet samples, 1035 feet GR log; base 3160 feet samples, 3165 feet GR log

Name Derivation: from Black Point on Biscayne Bay, one mile east of the type well

Thickness Range: 1170 to 2735 feet

Description of contained lithologies: Highly variable - includes light-colored chalky micrite, dense micrite, skeletal wackestone, packstone and grainstone, orange-brown and tan euhedral, anhedral and occasionally cryptocrystalline dolomite. Euhedral dolomite ranges from very fine microcrystalline to medium crystalline.

Comments: Used to refer to the carbonate interval between the base of the Miocene Hawthorn and the top of the Paleocene Cedar Keys regardless of Suite; includes Suwannee, Ocala, Avon Park, Oldsmar formations and their lateral rock equivalents.

The Black Point Format includes the LAFco, PINco, ORco, ChAco and DAco Suites.

Distribution: Entire Peninsula except for Madison and Taylor Counties.

Upper Boundary: Defined, when not outcropping, by the change from the phosphatic carbonates and clastics of the Miocene Hawthorne above to non-phosphatic carbonates of the Black Point Format below.

Lower Boundary: Defined by the change from orange-brown anhedral dolomite above to gray anhedral or cryptocrystalline lithographic dolomite of the Cedar Keys below. Identifying this boundary is aided by regional correlation using gamma ray logs. In the northeastern Peninsula limestone instead of dolomite overlies the Cedar Keys.

Age: Eocene and Oligocene (may include some Miocene in the Keys).

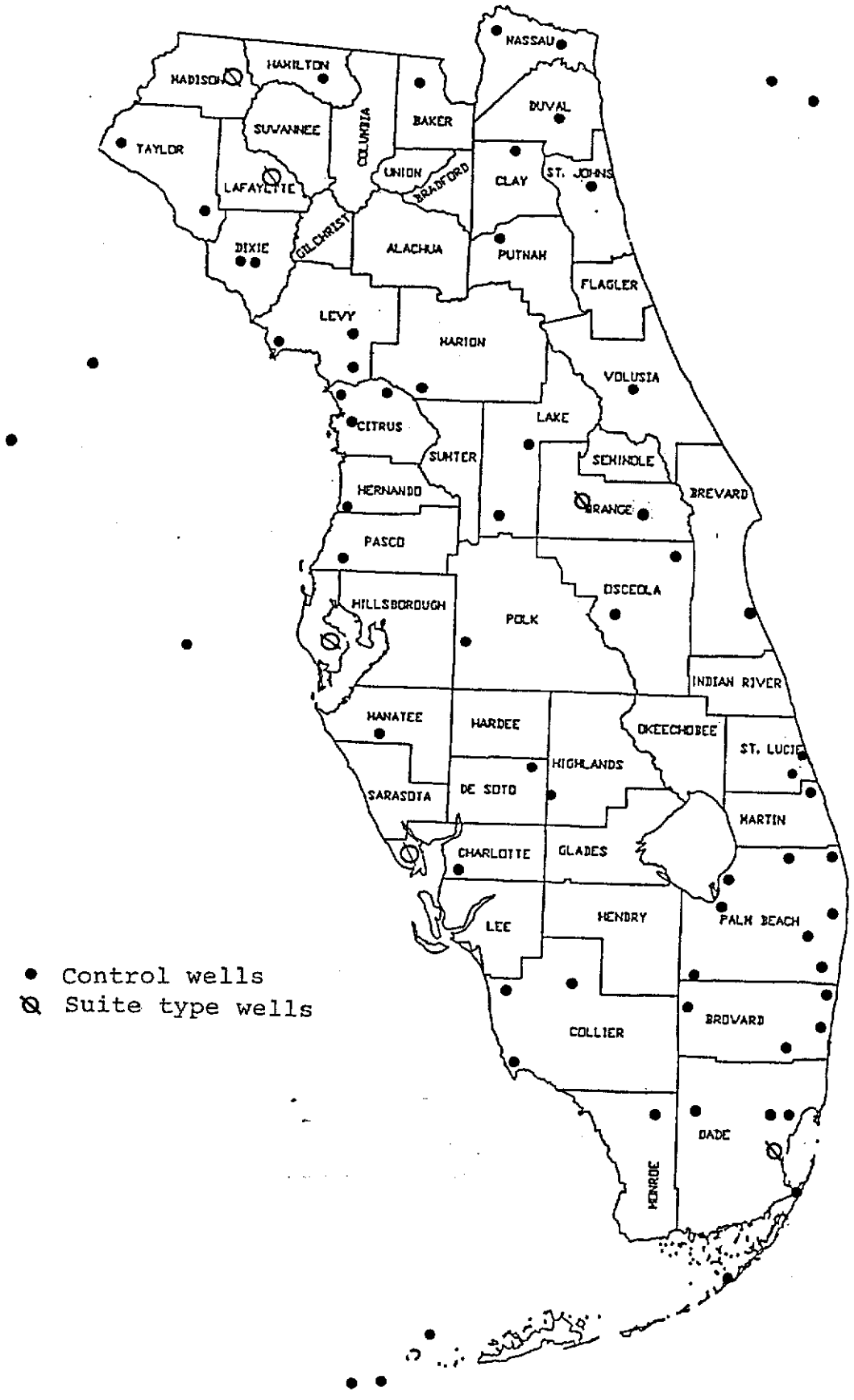
TABLE 1

Well List

Map	P/W/OCS	Operator	Lease	
1	309	Matalliano	2-A	Buckeye
* 2	W-1596	Hunt	2	Gibson
3	W-7053	Occidental	1	Fee
4	59	Hunt	1	Baker
5	W-336	St Marys	1	Hillard
6	449	Amoco	2	Rayonier
7	W-7996	USGS	-	D-425
8	W-11940	USGS	-	test well
* 9	4	Sun	1	Crapps
10	W-1567	Sun	D-4	core test
11	W-636	Florida Oil	1	Putnam
	11	Stanolind	1	Forest
12	W-6443	Hudson	1	Pulp Fee
13	435	Carolina	1	Cummer
14	66	Coastal	1	Ragland
15	13	Sun	1	Goethe
16	105	Humble	1	Robinson
17	353	Mobil	1	Harband
18	350	Mobil	1	Garby
19	358	Mobil	1	Camp
20	W-18	Ocala	1	York
21	W-3	Dundee	1	Bushnell
22	W-275	Oil Development	1	Arnold
23	574	Hamilton	1	Keen
24	19	Sun	1	Powell
25	230	Warren	1	Terry
26	1	Ohio	1	Hernasco
27	608	ARCO	1	Starkey
*28	75	Coastal	1	Wright
29	597	Kaiser	1	Fee
30	539	ARCO	1	Bronson
31	81	Hunt	2-A	Peavy-Wilson
32	236	Magnolia	1	Schroeder
33	679	Amoco	1	Knight
34	225	Conoco	1	Carlton
35	W-16039	GDU North Port	1	Injection
*36	178	Gulf	1	Vanderbilt
37	--	Belle Glade	1	Injection
38	W-13000	W.Palm Beach	5	Monitor
39	121	Humble	16	GCRC
	W-10252	US Gypsum	1	Sunniland
40	W-15304	Ft. Lauderdale	3	Injection
41	W-455	Peninsula	1	Cory
42	167	Commonwealth	1	Wisehart
43	W-11321	Pen Utilities	1	Kendale Lakes
44	W-10245	Pen Utilities	1	Sunset Park
45	148	Sinclair	1	Williams
46	108	Coastal	1	State 363
47	275	Gulf	1	State 826Y
48	284	Calco-Gulf	OCS	Blk 28
49	296	Calco-Gulf	OCS	Blk 46

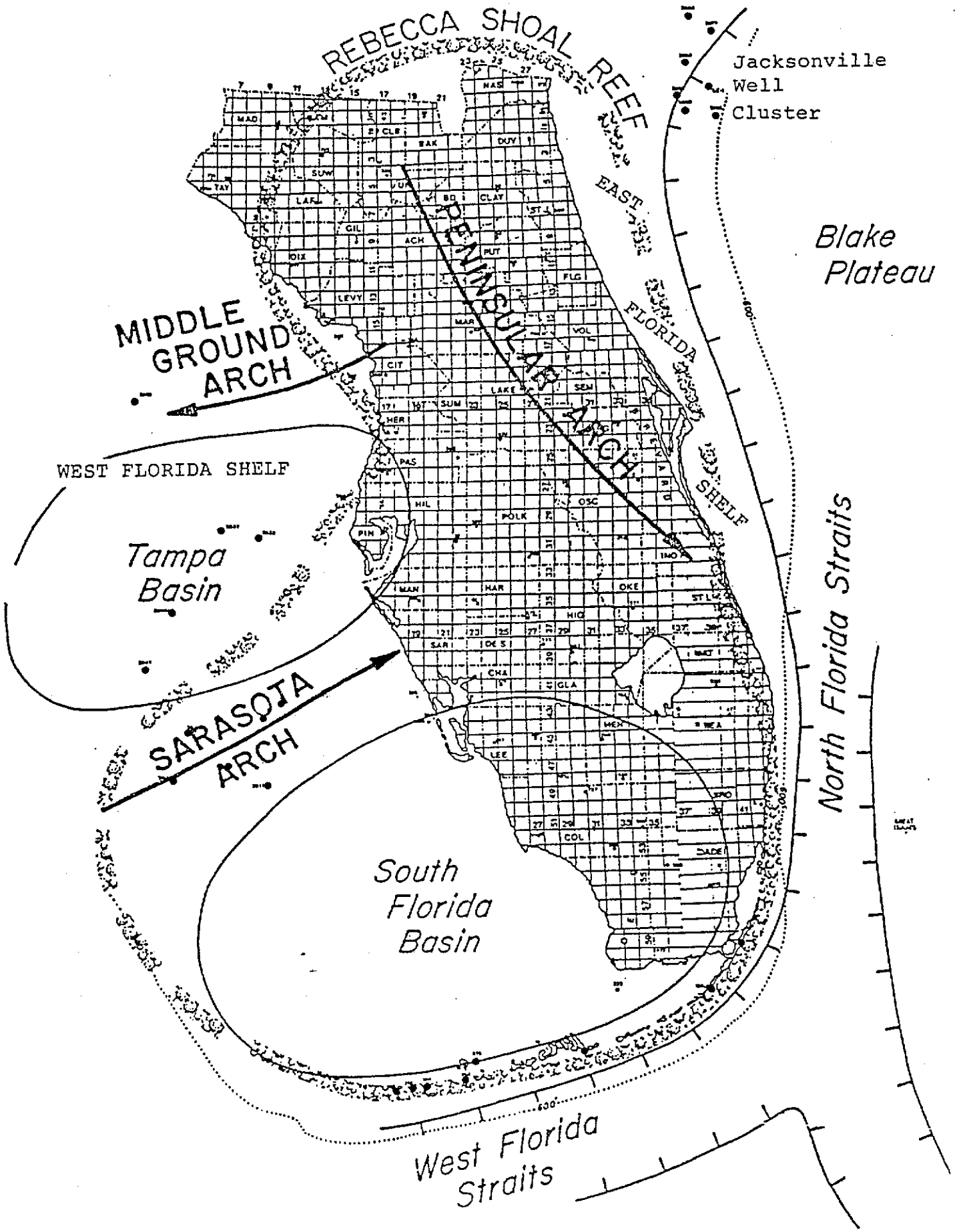
50	2523	Texaco	OCS	Blk 100
51	2516	Texaco	OCS	Blk 252
52	6456	Sohio	OCS	Blk 707
53	3699	Exxon	OCS	Blk 472
54	3705	Exxon	OCS	Blk 564
55	--	Pembroke Pines	2	Injection
*56	W-13287	Sand Lake	1	Injection
*57	W-13768	M-D Water & Sewer	5	Injection
58	W-15890	South Beaches	1	Injection
59	--	Pahokee	1	Injection
60	--	North Broward	2	Injection
61	W-14132	Encon	1	Injection
62	--	Ft. Pierce	1	Injection
63	W-16067	Jensen Beach	1	Injection
64	W-14913	Alligator Alley	1	Monitor
65	265	Humble	1	State 1004
66	W-16735	Marco Island	1	Injection
67	--	North Collier	1	Injection
68	W-16849	Zemel Road	1	Injection
69	W-11920	Acme	1	Injection
70	W-15748	Pratt & Whitney	1	Injection
71	W-15886	PB System 9	1	Injection
72	W-10253	US Gypsum	1	core hole

* Suite type well



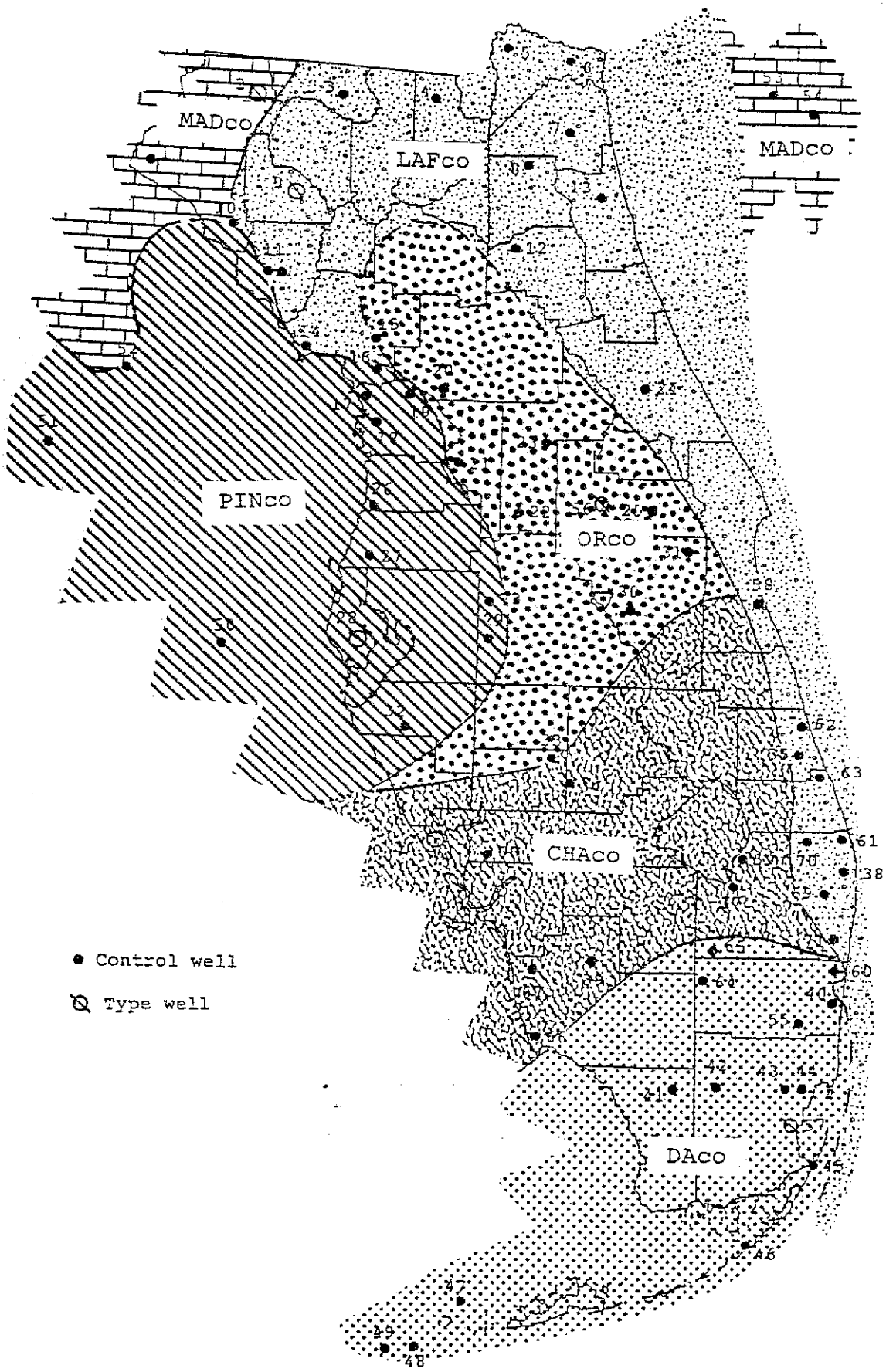
Counties of Peninsular Florida

Fig. 1



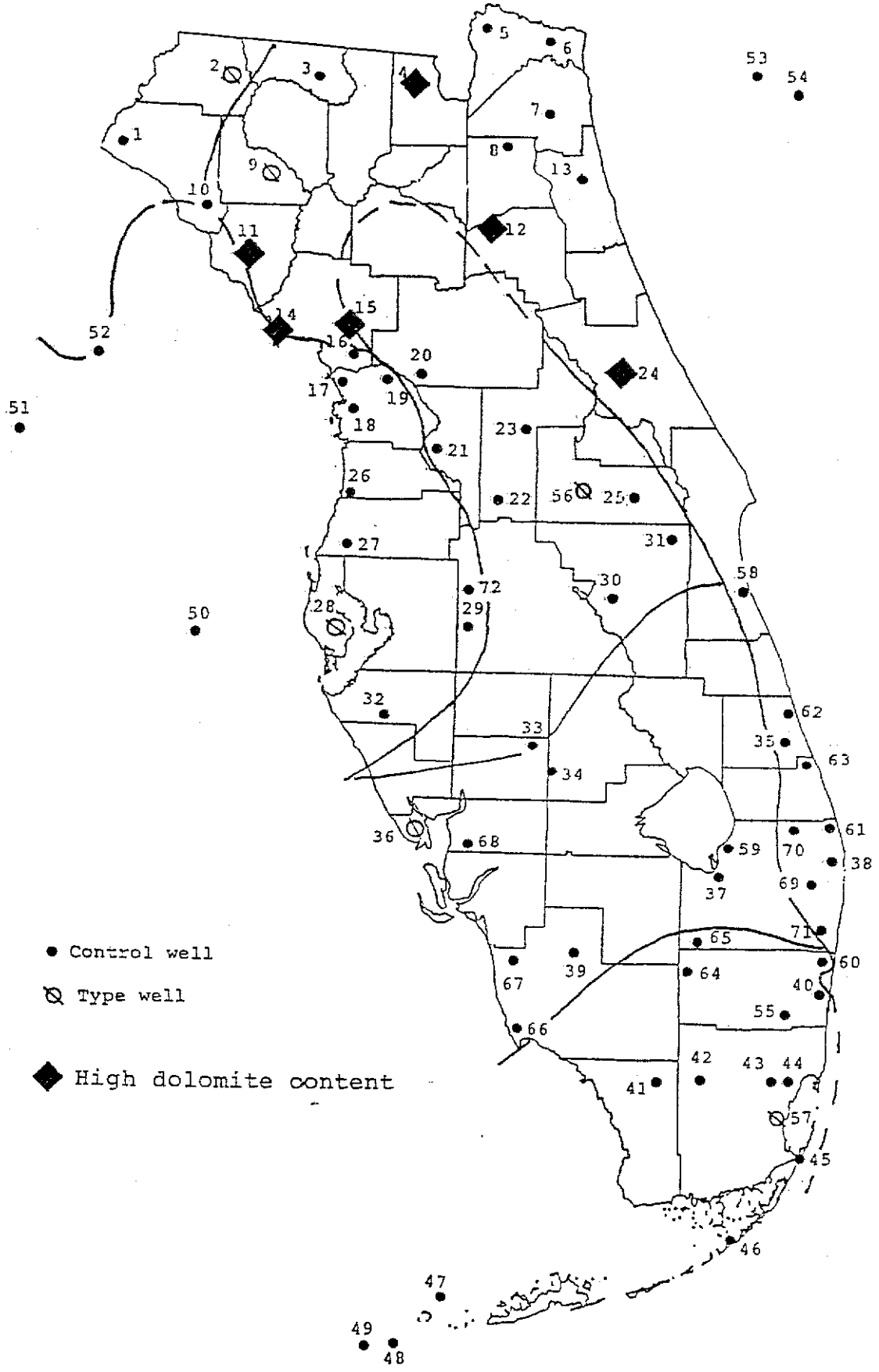
Regional Structure

Fig. 2



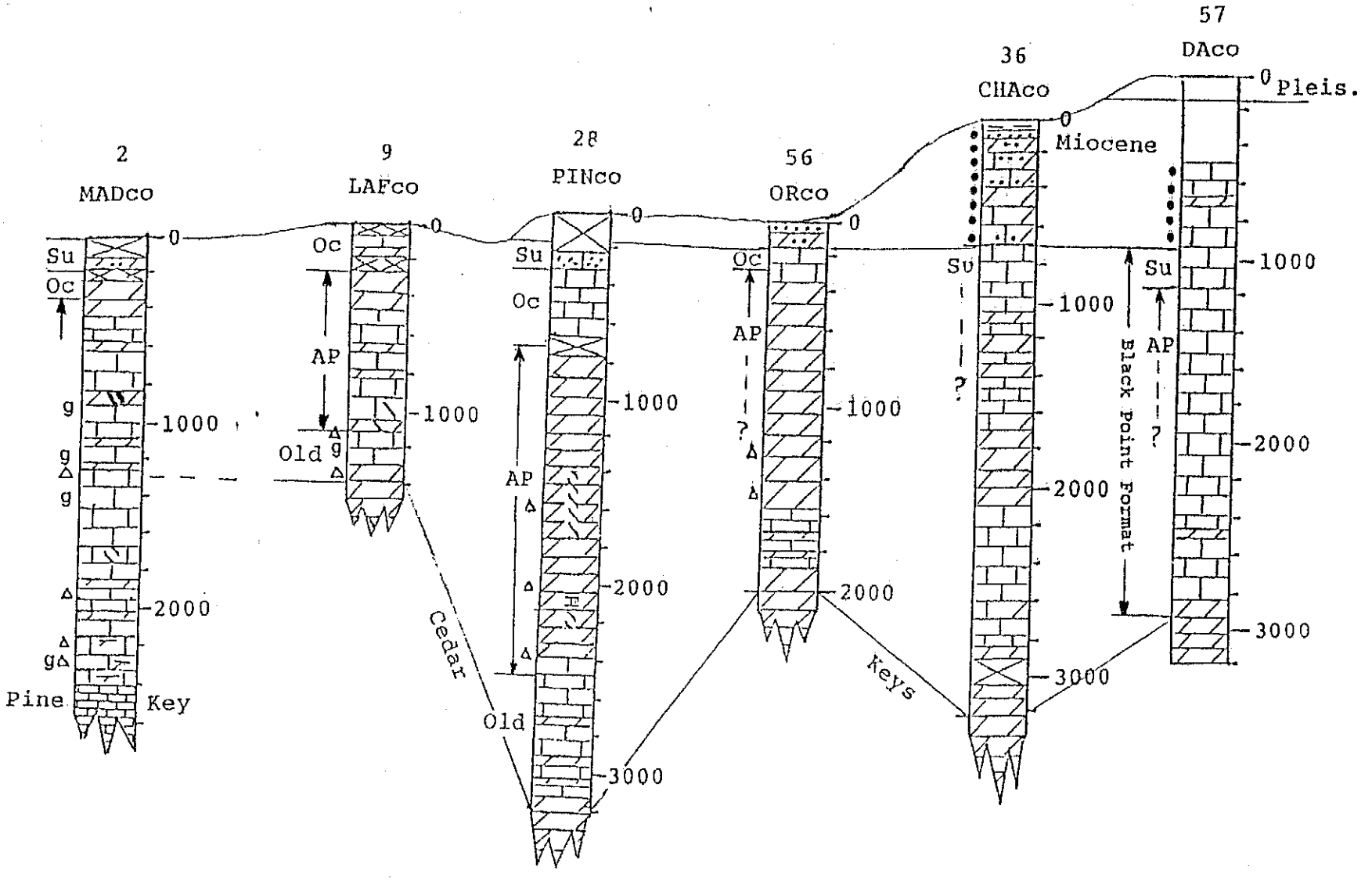
Areal Extent of the Suites

Fig. 3



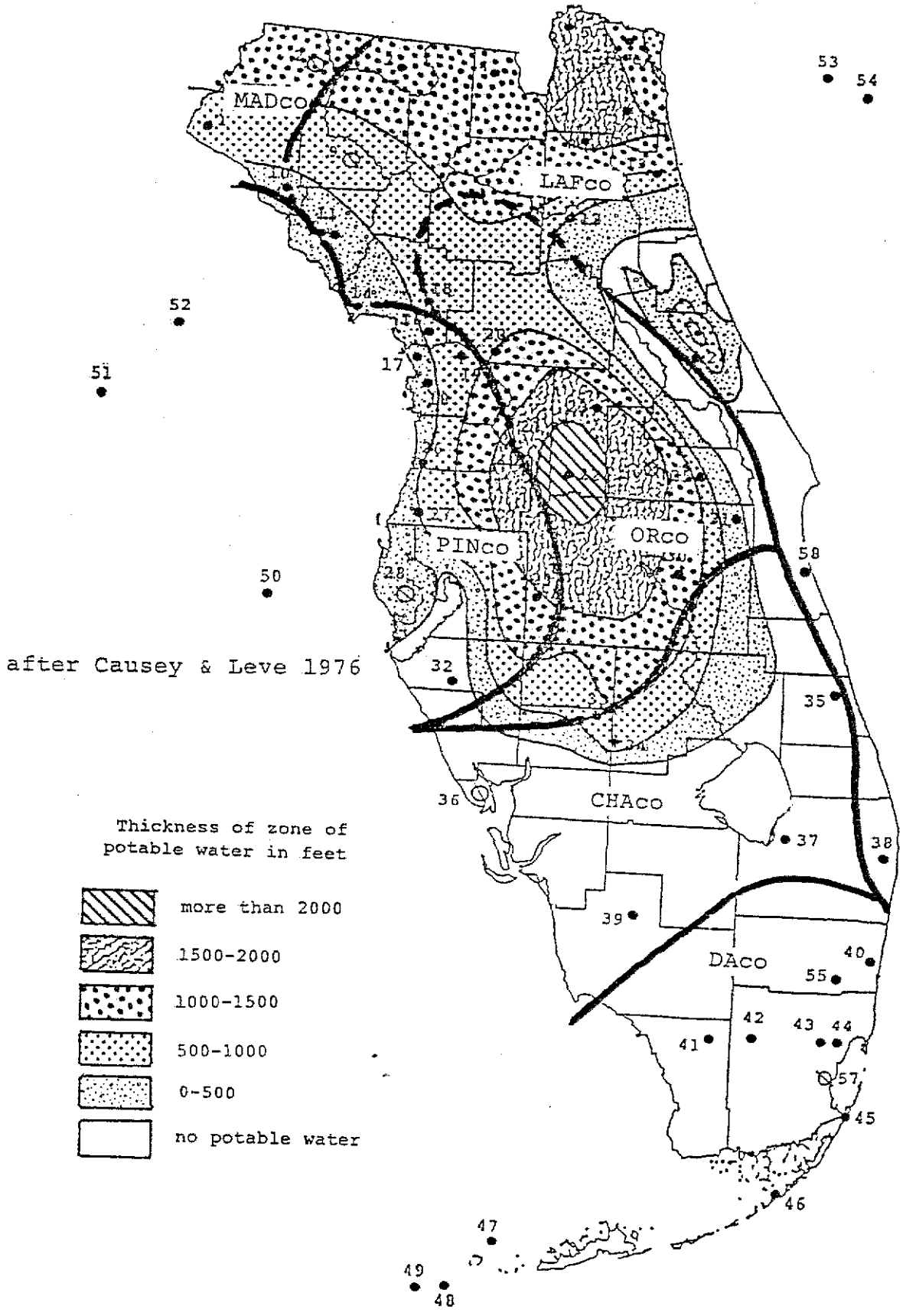
LAFco Wells with a Predominance of Dolomite

Fig. 4



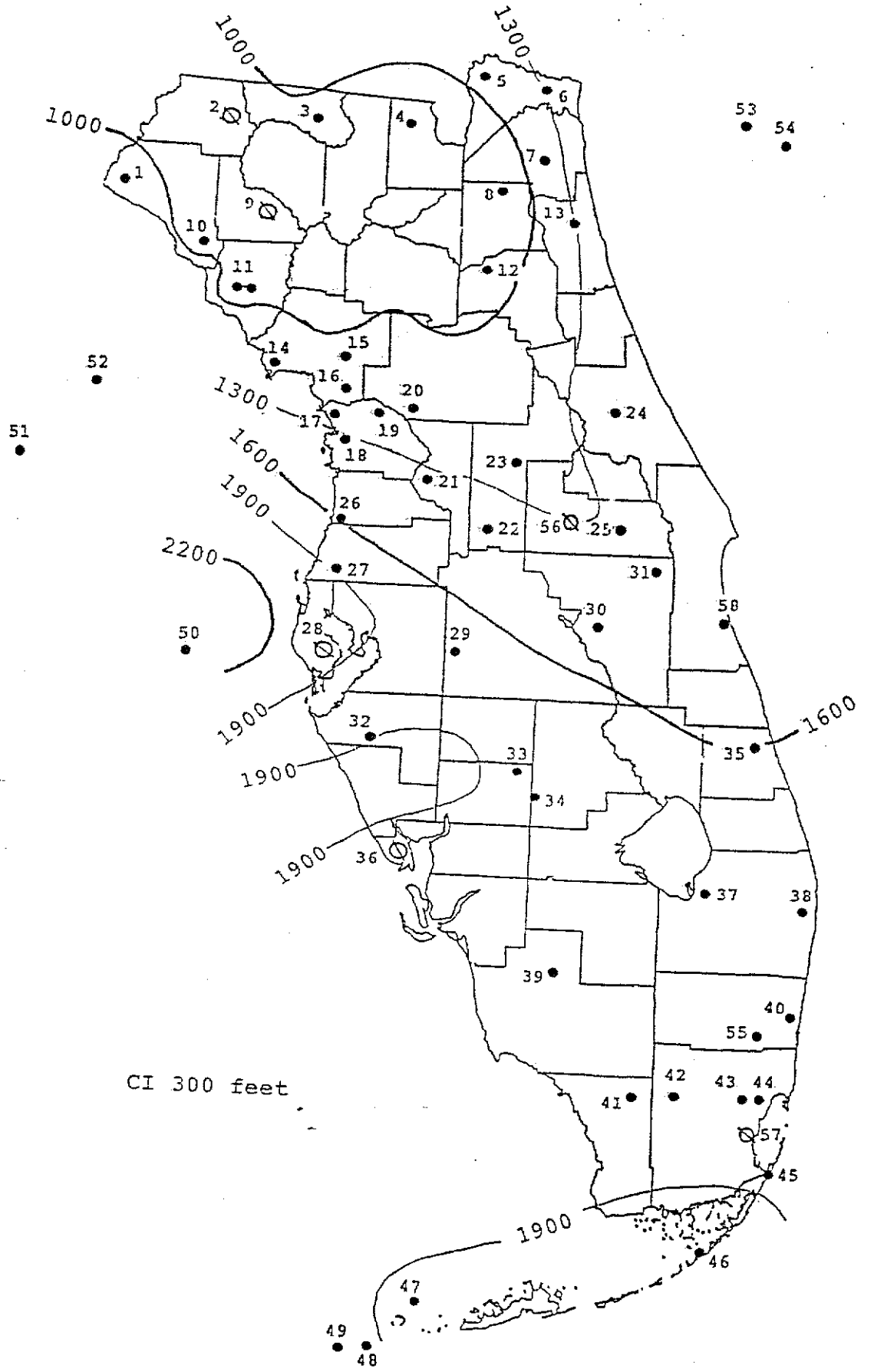
Lithologic Columns of Suite Type Wells

Fig. 5



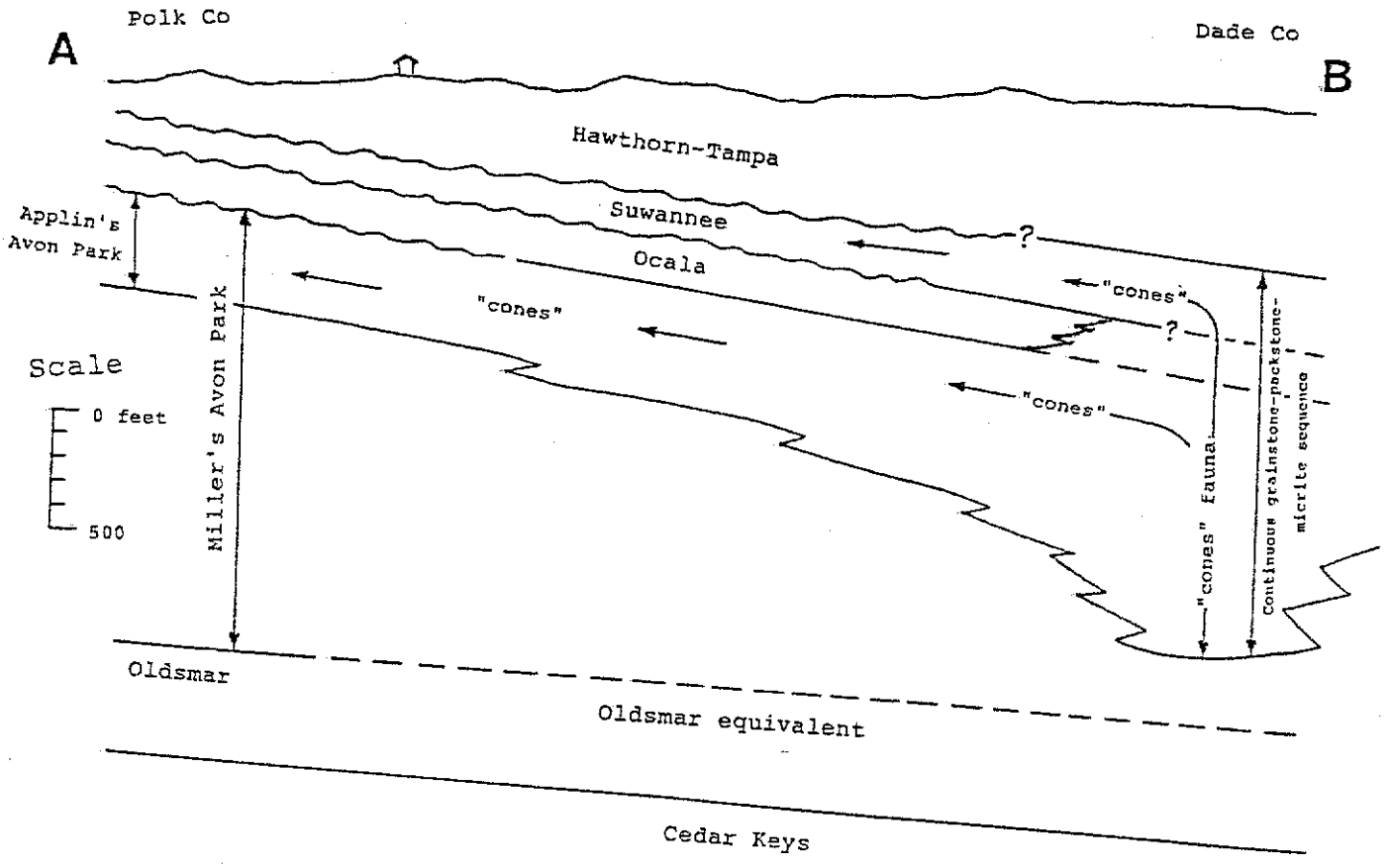
Relationship of Potable Water Lens to Suites

Fig. 6



Isopach of Lower amd Middle Eocene

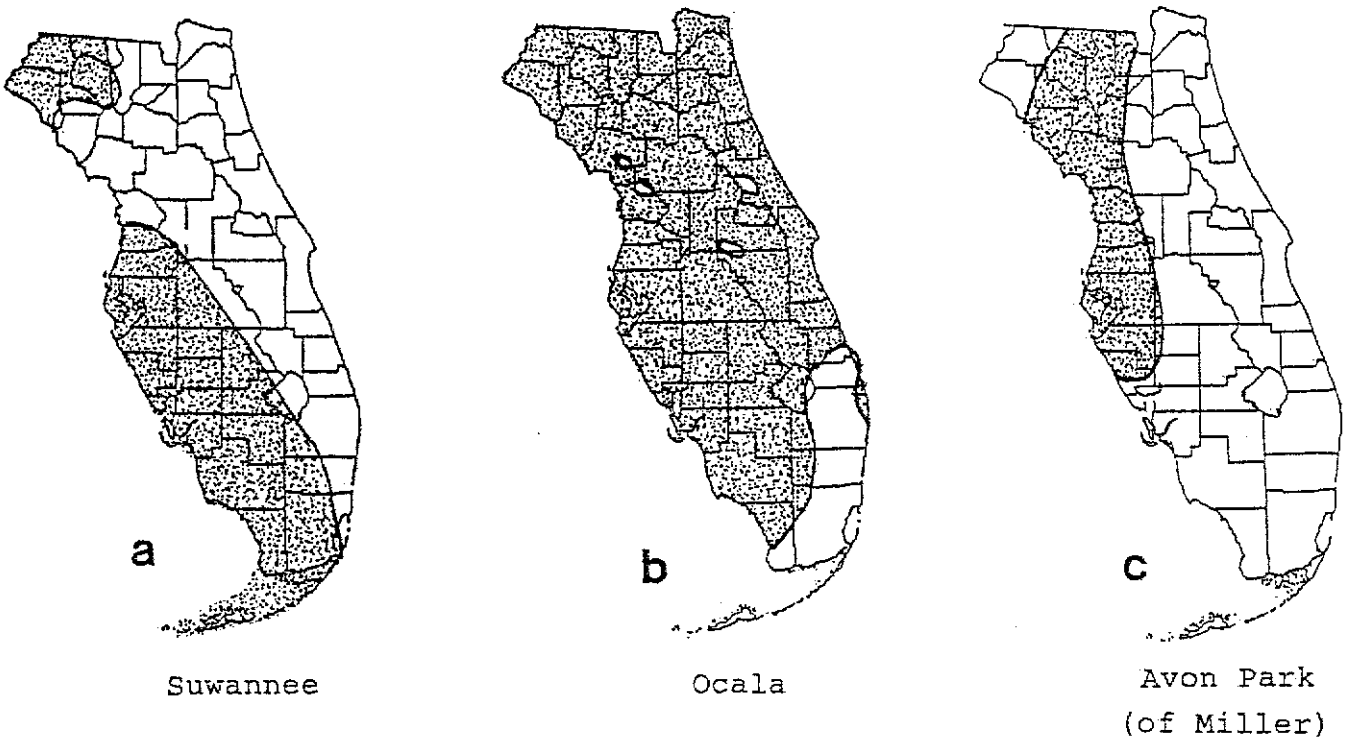
Fig. 7



Eocene Cross-section Showing Hypothetical Relationship between

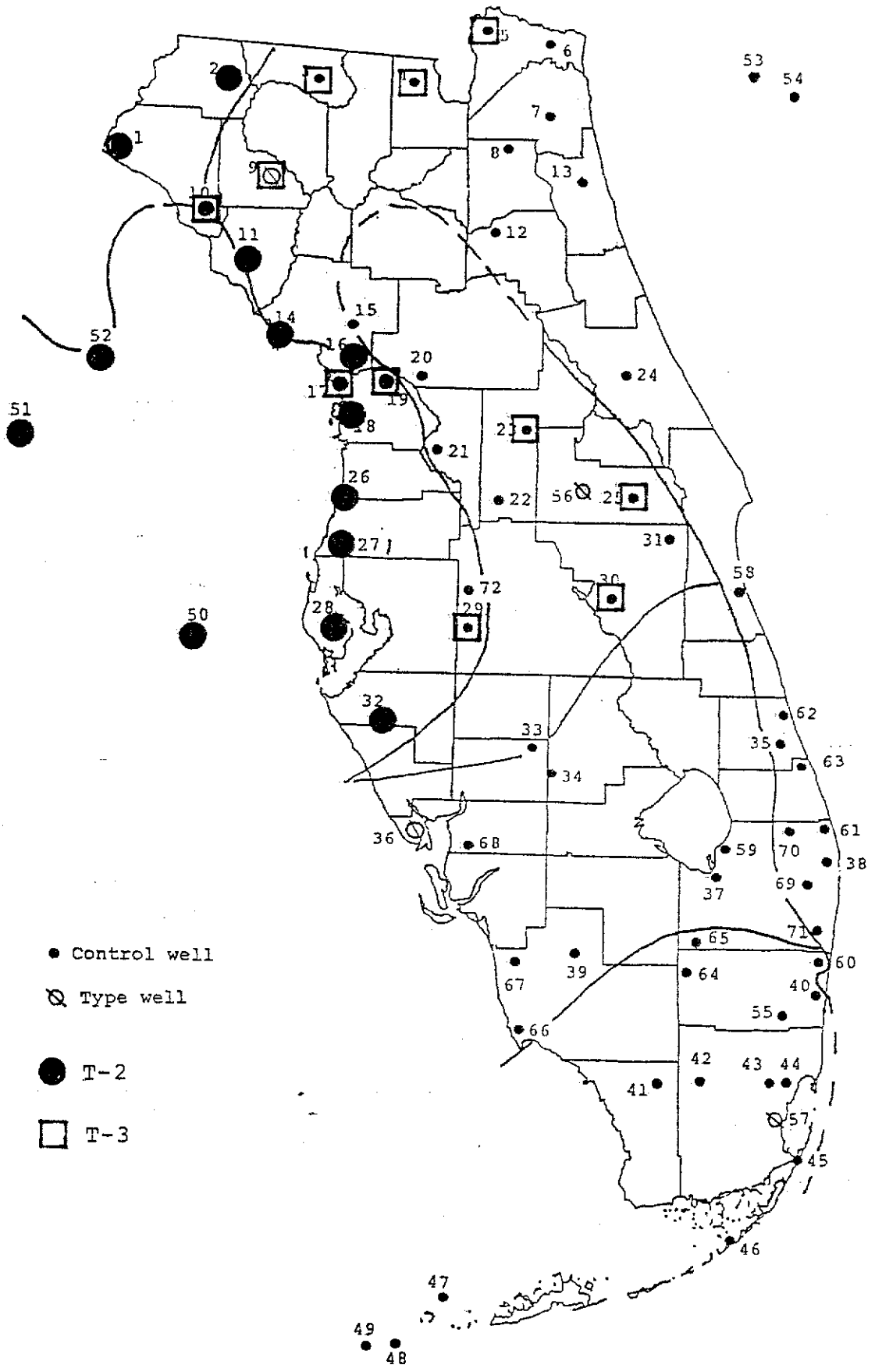
Suwannee, Ocala and Avon Park Formations

Fig. 8



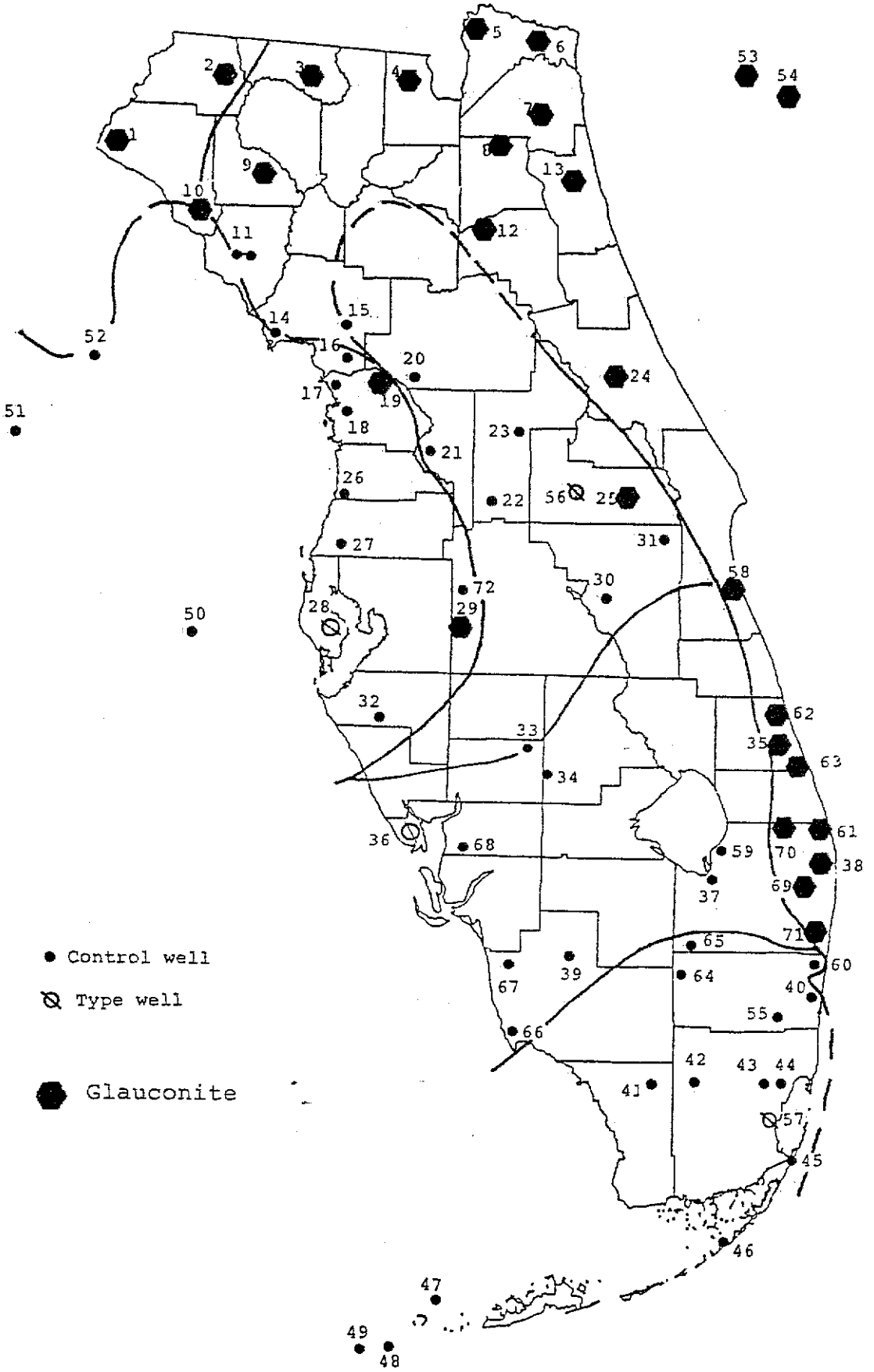
Extent of Identifiable Suite Formations

Fig. 9



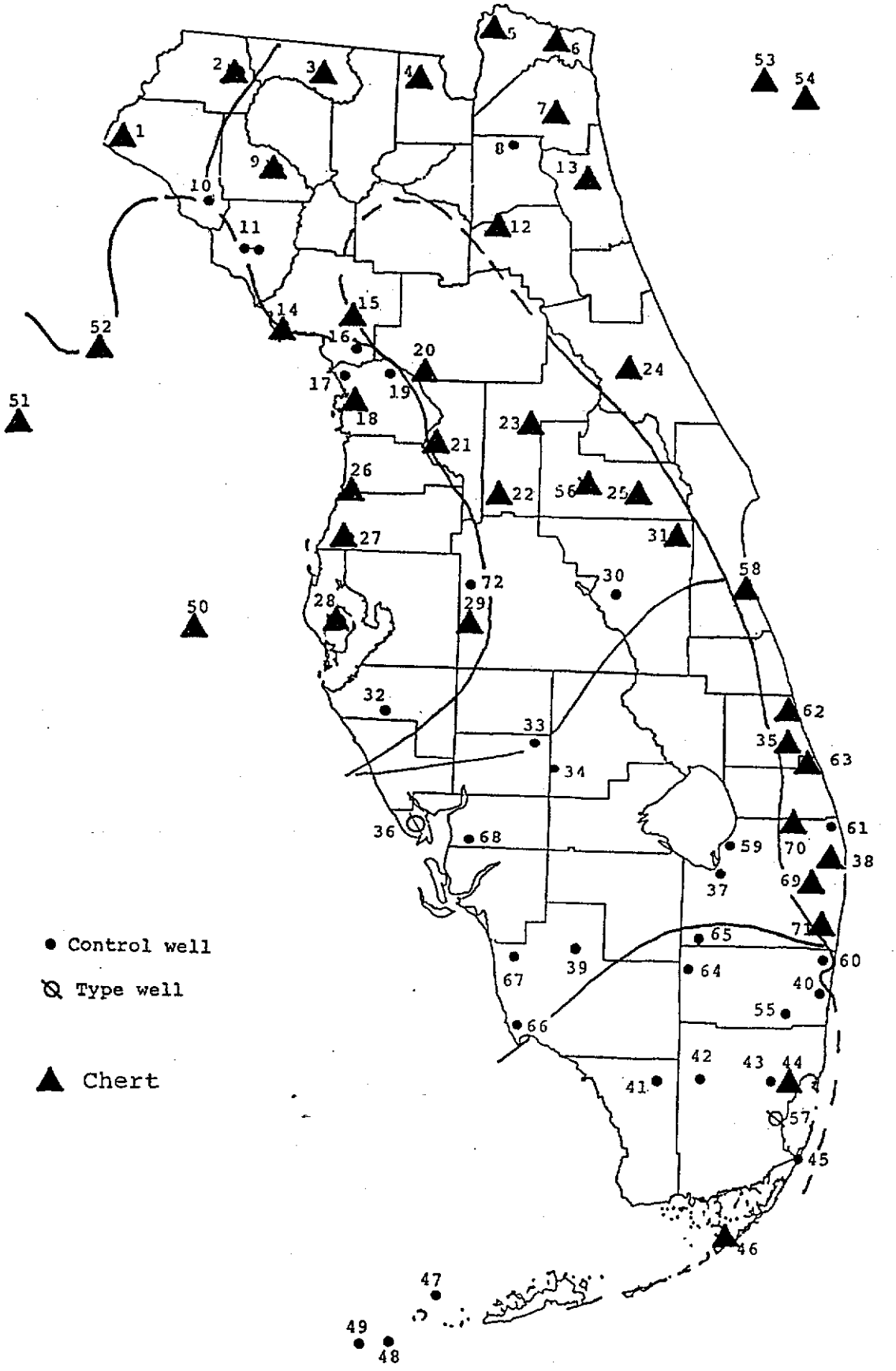
Distribution of Anhydrite

Fig. 10



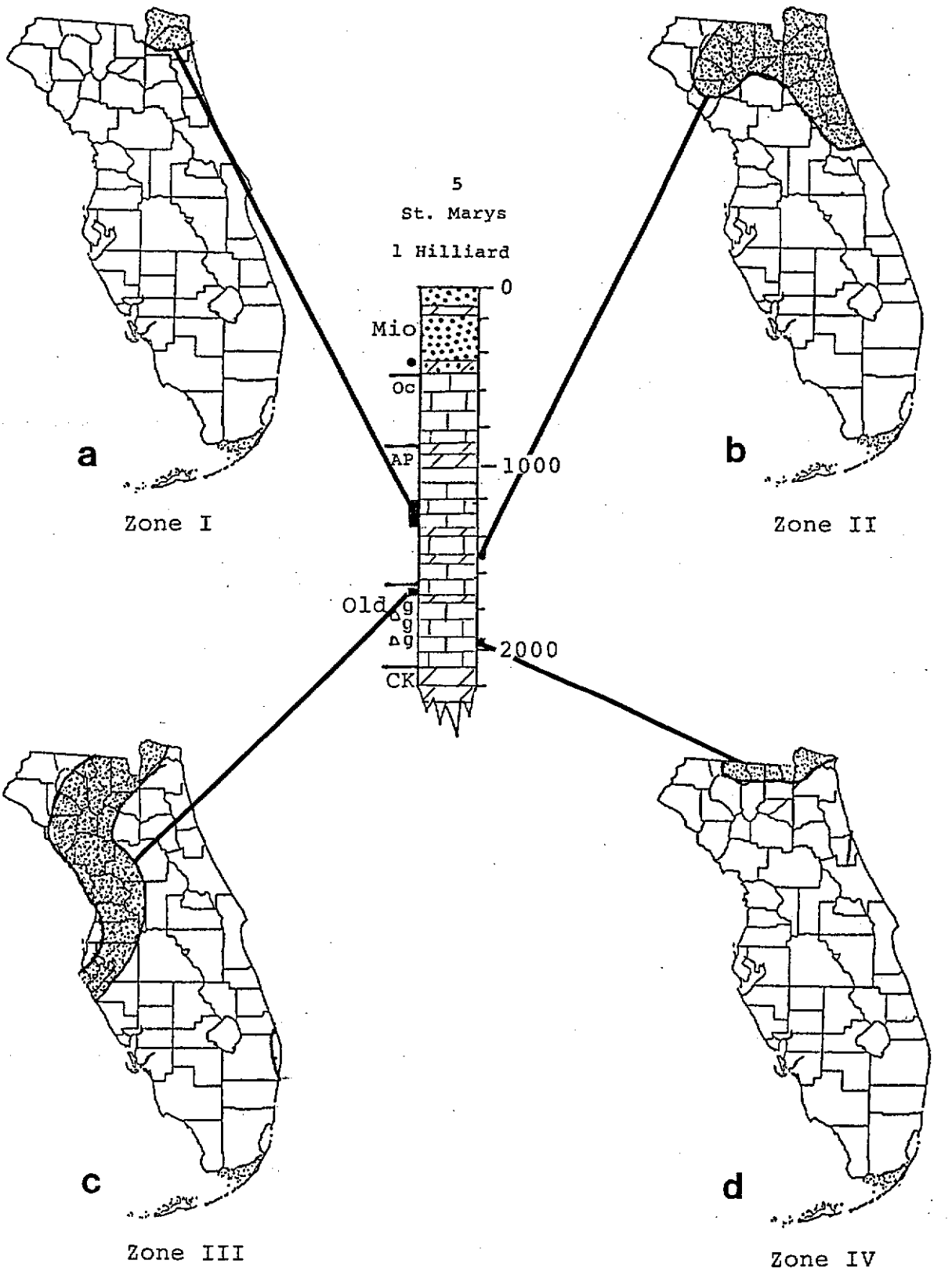
Distribution of Glauconite

Fig. 11



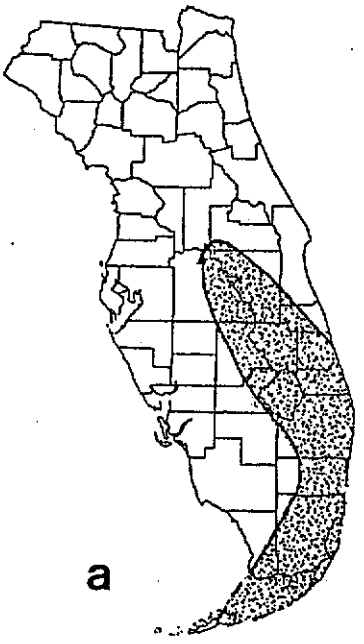
Distribution of Chert

Fig. 12

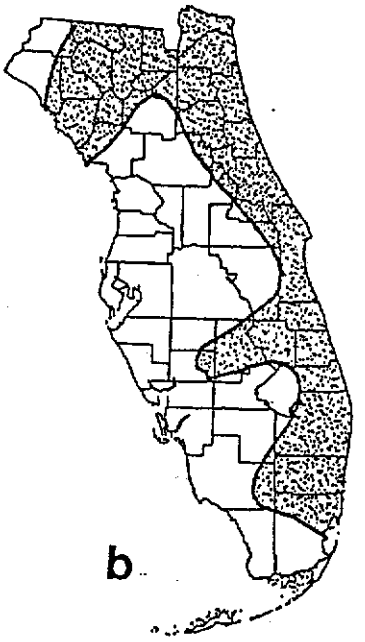


Distribution of Helicostigina gyralis

Fig. 13



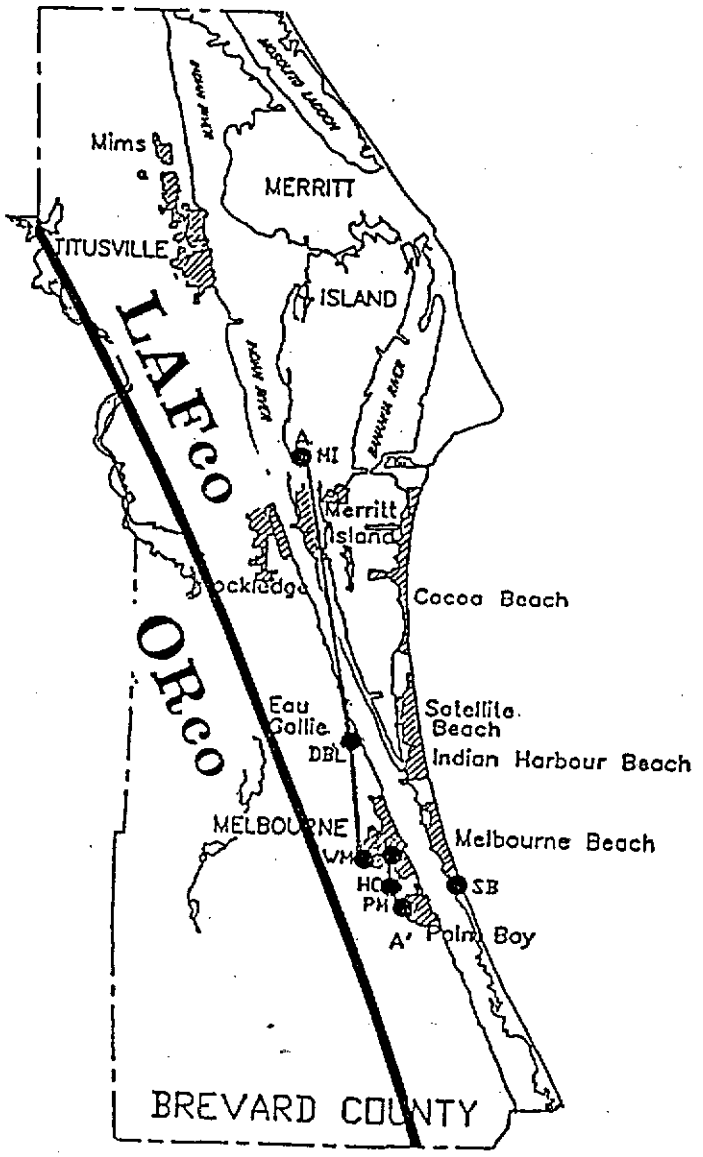
Limestone containing
Coskinolina f.



Dictyoconus a.

Distribution of
Coskinolina f. & Dictyoconus a.

Fig. 14



LEGEND

● WELL LOCATION

after Duncan et al

Brevard County Injection Well Locations

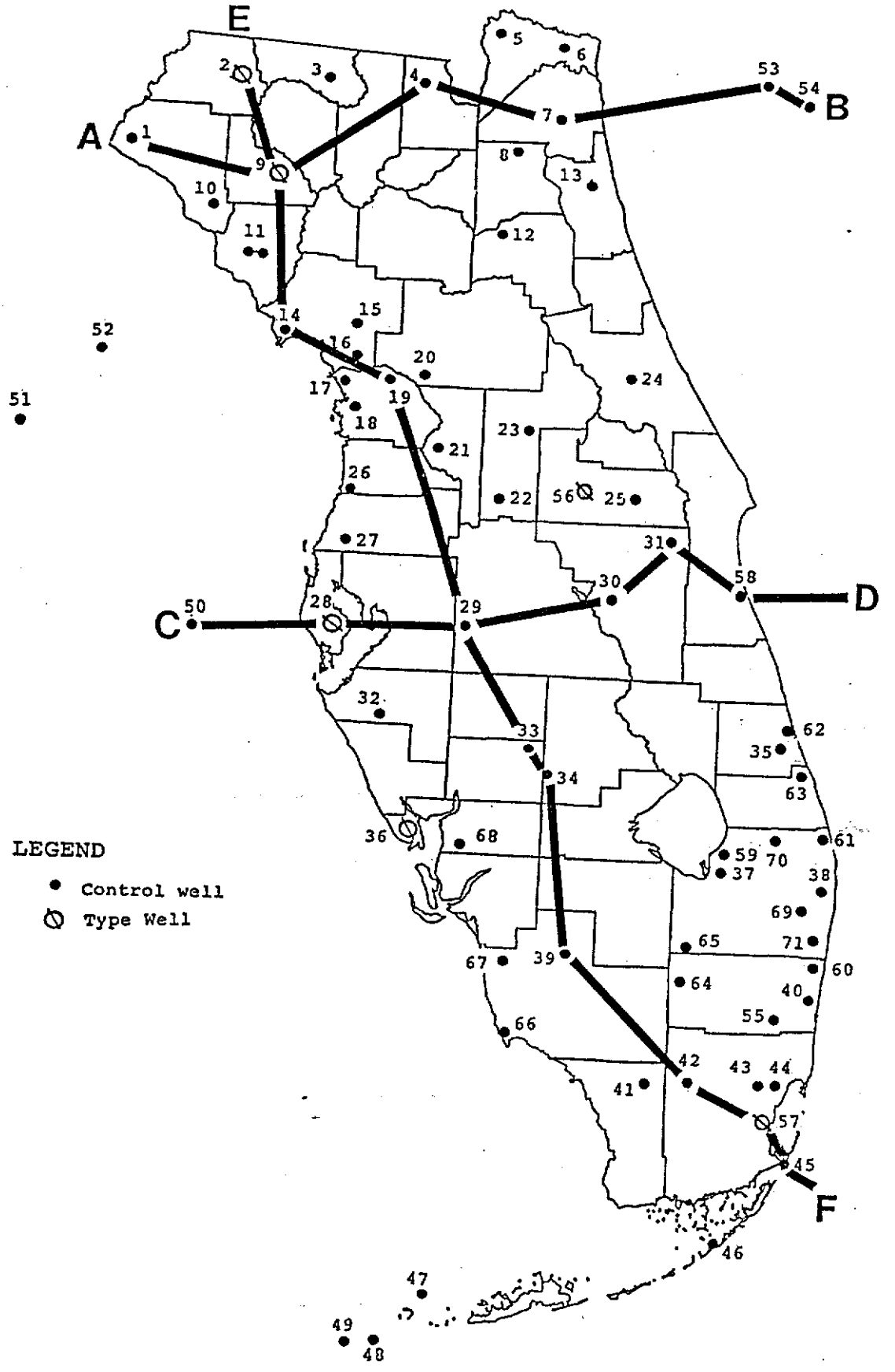
Fig. 15

BED	LITHOLOGY	CYCLE OF DEPOSITION	POROSITY
1		Limestone, white micritic, dense.	——
2		Limestone, white micritic, chalky.	Chalky
3		Packstone, white calcarenite 70% of skeletal grains 25% chalky matrix	5% granular & chalky
4		Grainstone, tan calcarenite 80-100% of fine to medium skeletal grains; many Foraminifera	10-20% granular
3		Packstone, white calcarenite 70% of skeletal grains 25% chalky matrix	5% granular & chalky
2		Limestone, white micrite, chalky.	Chalky
1		Limestone, white micrite, dense.	——

Puri & Winston 1974

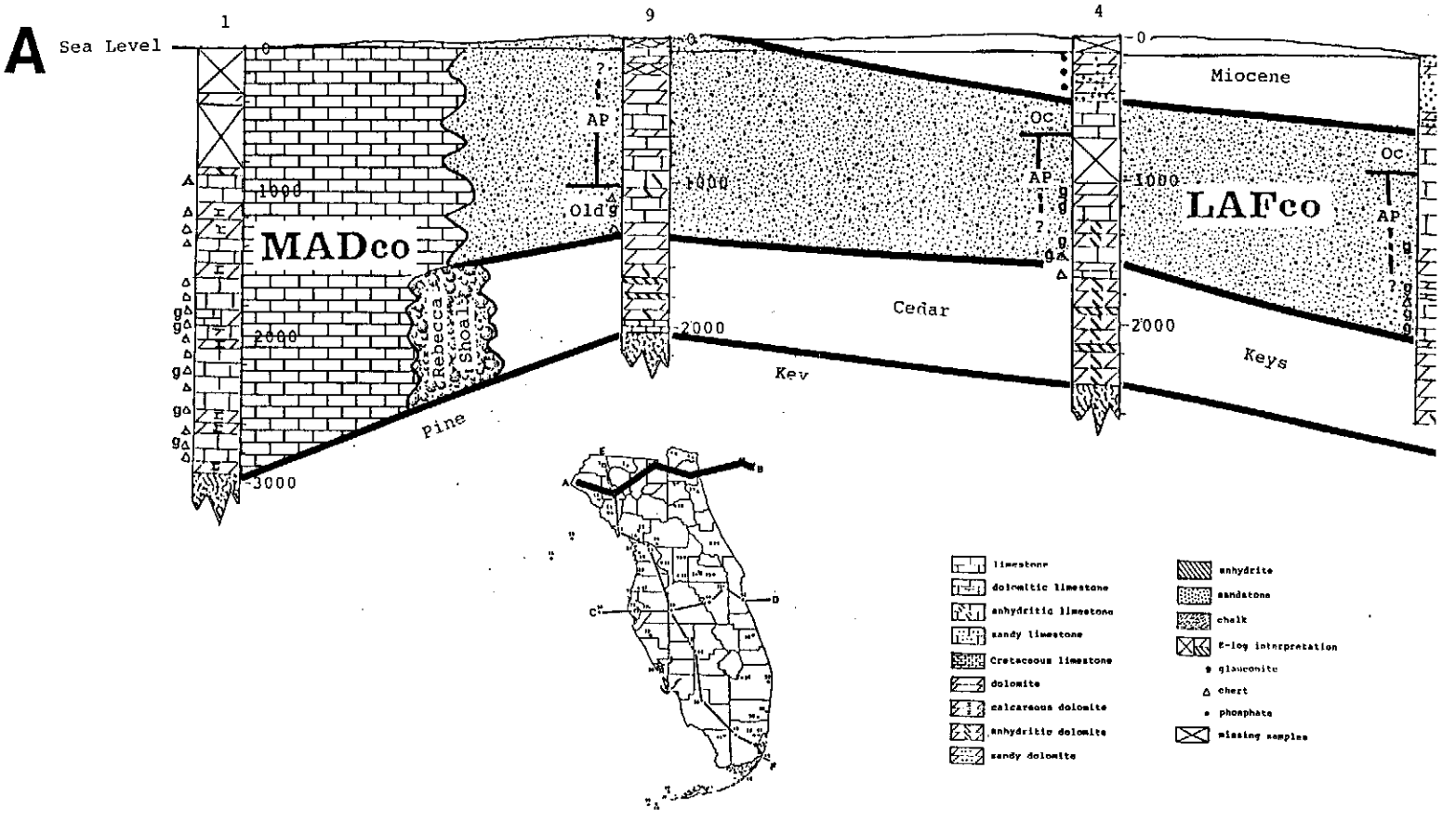
Lower and Middle Eocene Cycle of Deposition

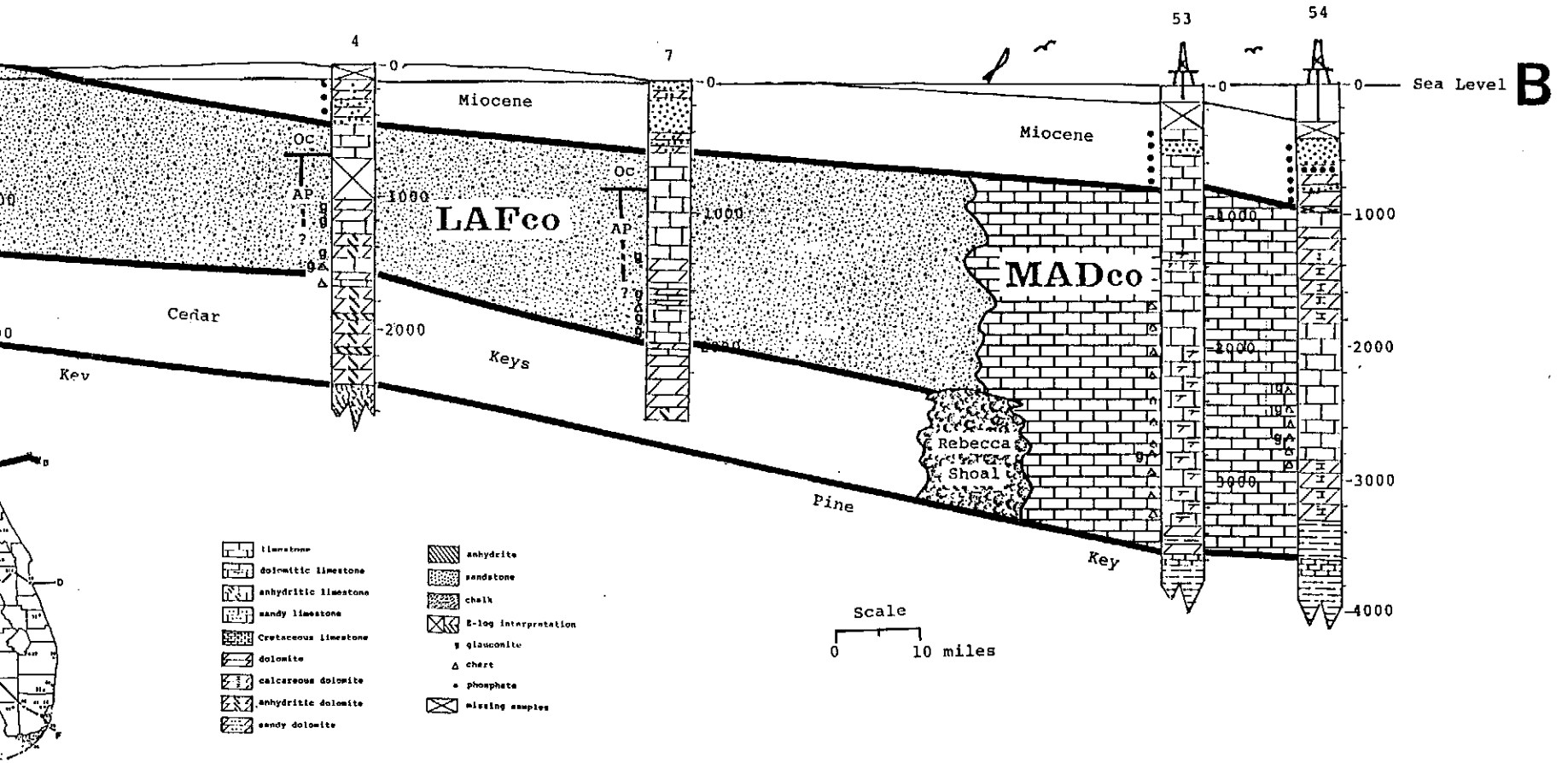
Fig. 16



Control Well Map and Cross-section Index

Fig. 17


A
Sea Level
1
9
4
0
1000
2000
3000
MADco
LAFco
Miocene
Oligocene
Eocene
Rebecca Shoals
Pine Key
Cedar Keys
AP
OC
limestone
dolomitic limestone
anhydritic limestone
sandy limestone
Cretaceous limestone
dolomite
calcareous dolomite
anhydritic dolomite
sandy dolomite
anhydrite
sandstone
chalk
E-log interpretation
glauconite
chert
phosphate
missing samples


4
7
53
54
Miocene
Miocene
Oc
AP
LAFco
MADco
Cedar
Key
Keys
Rebecca
Shoal
Pine
Key
Sea Level
B
0
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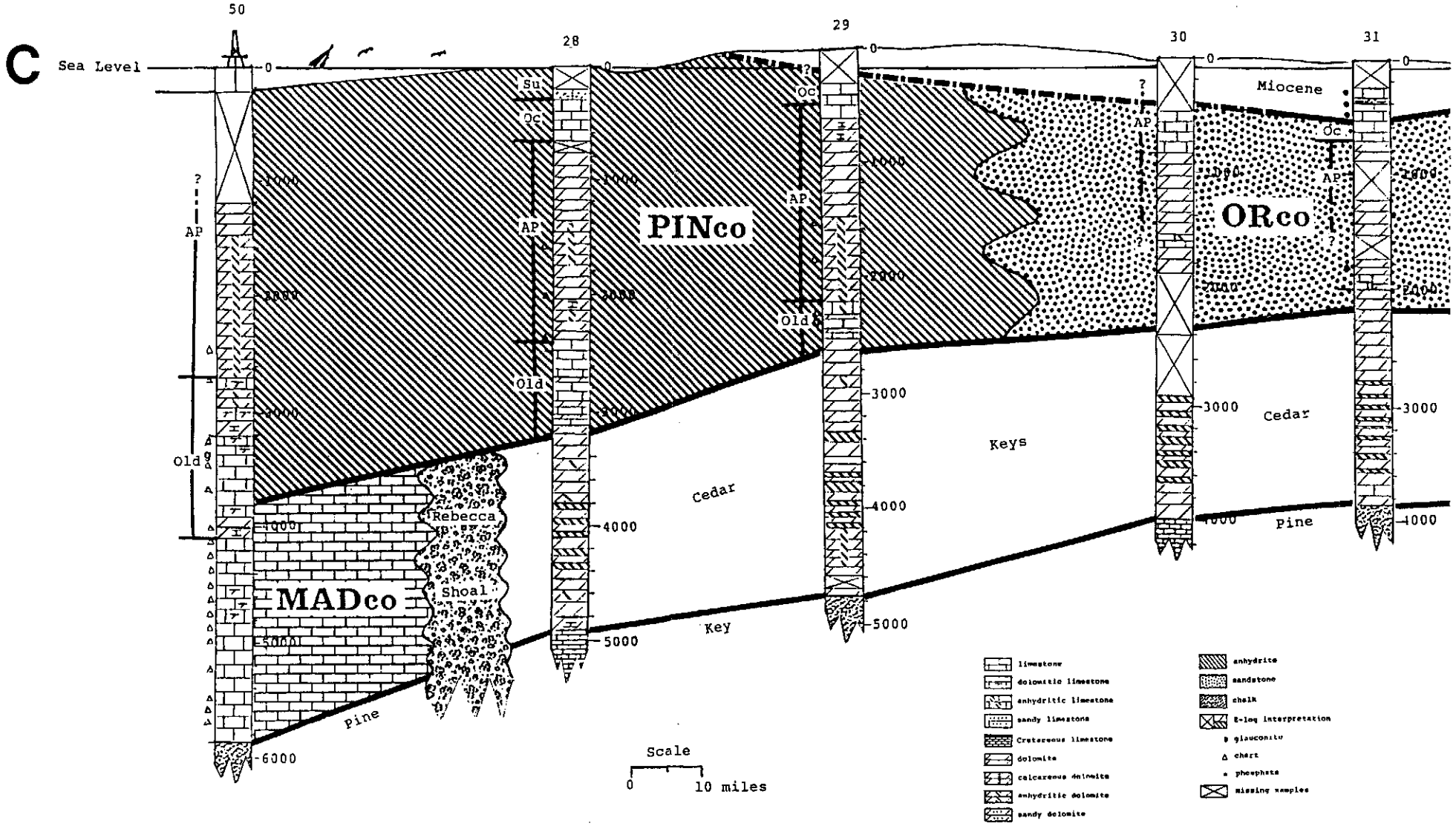
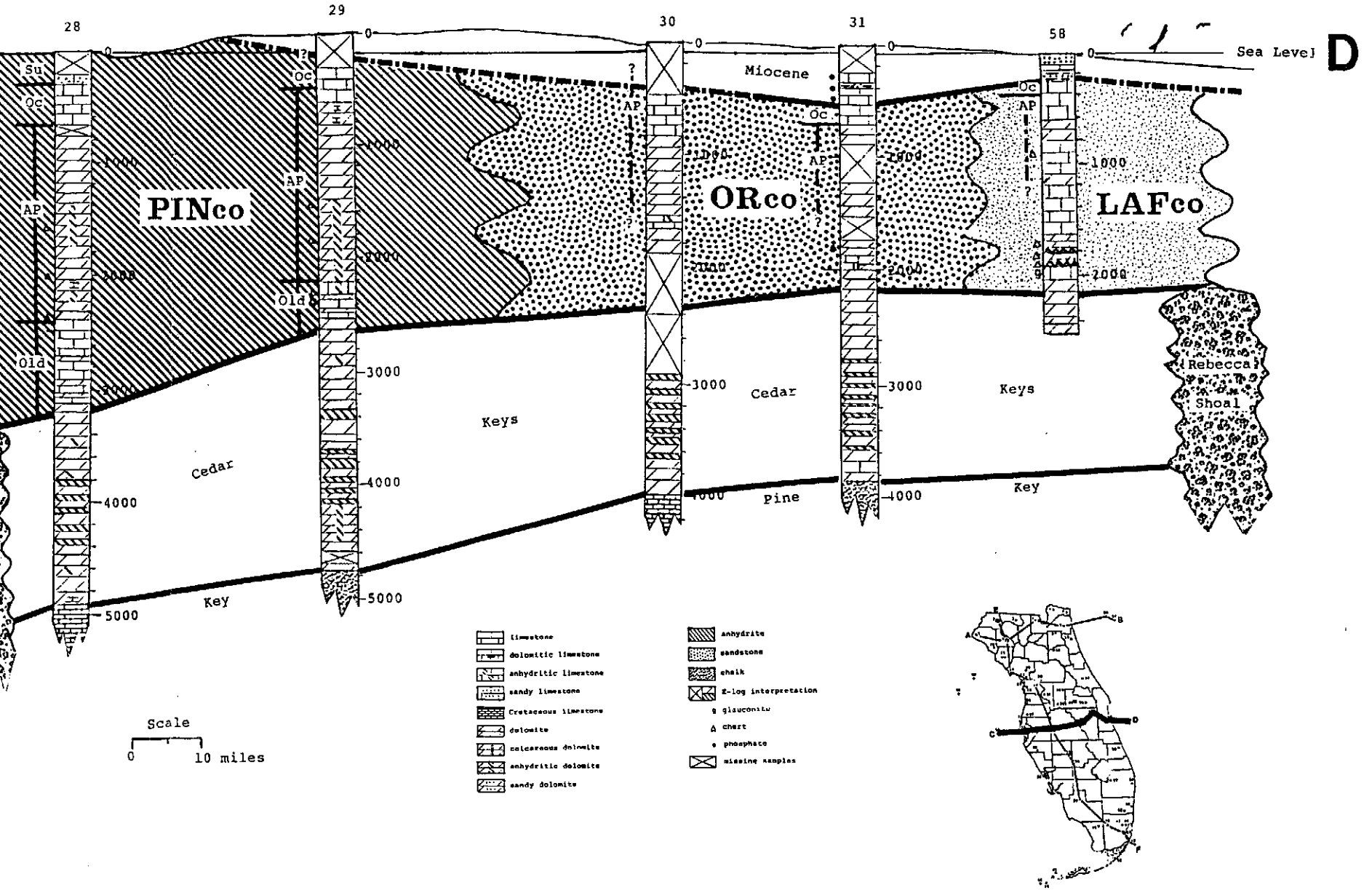
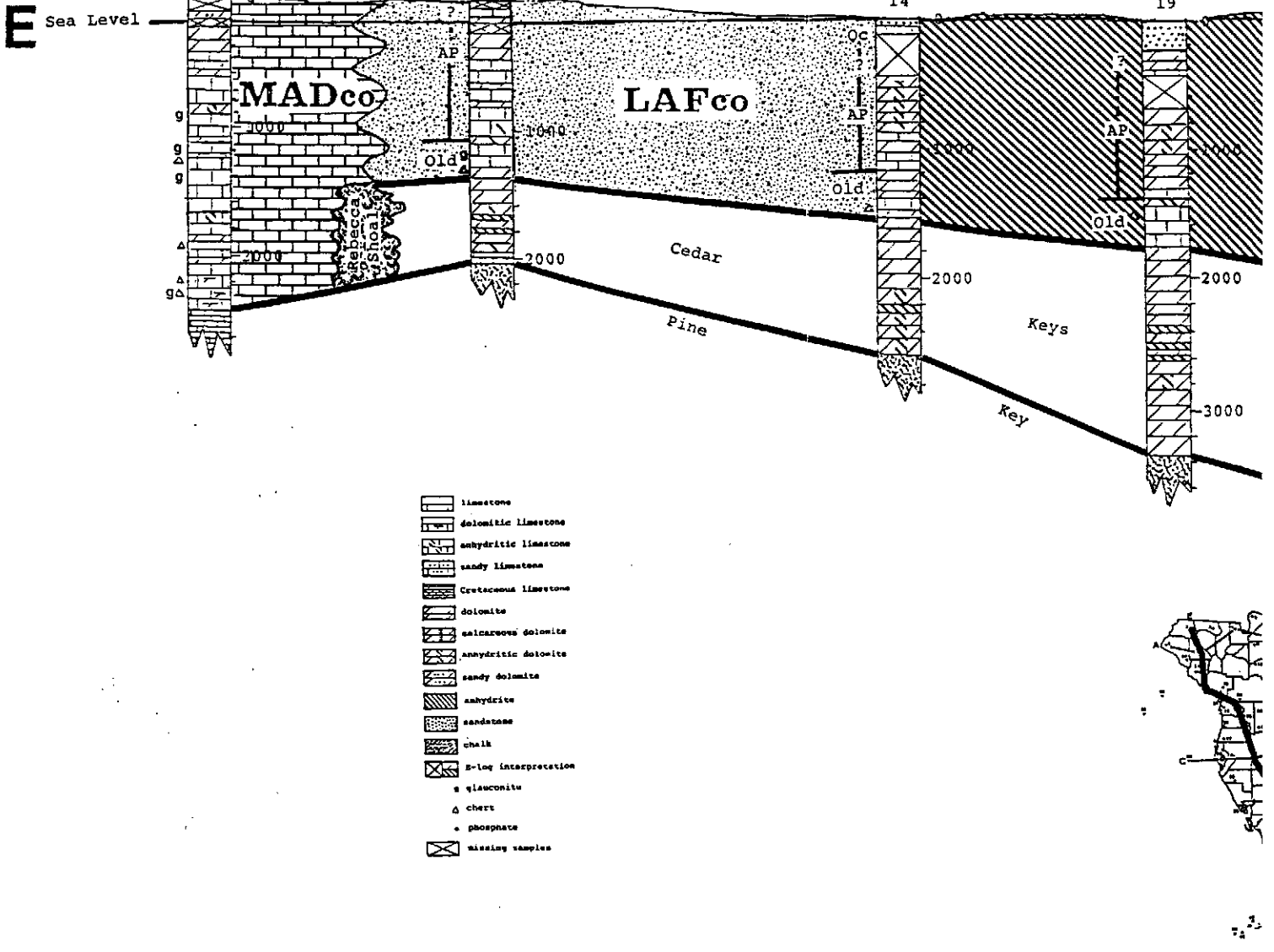
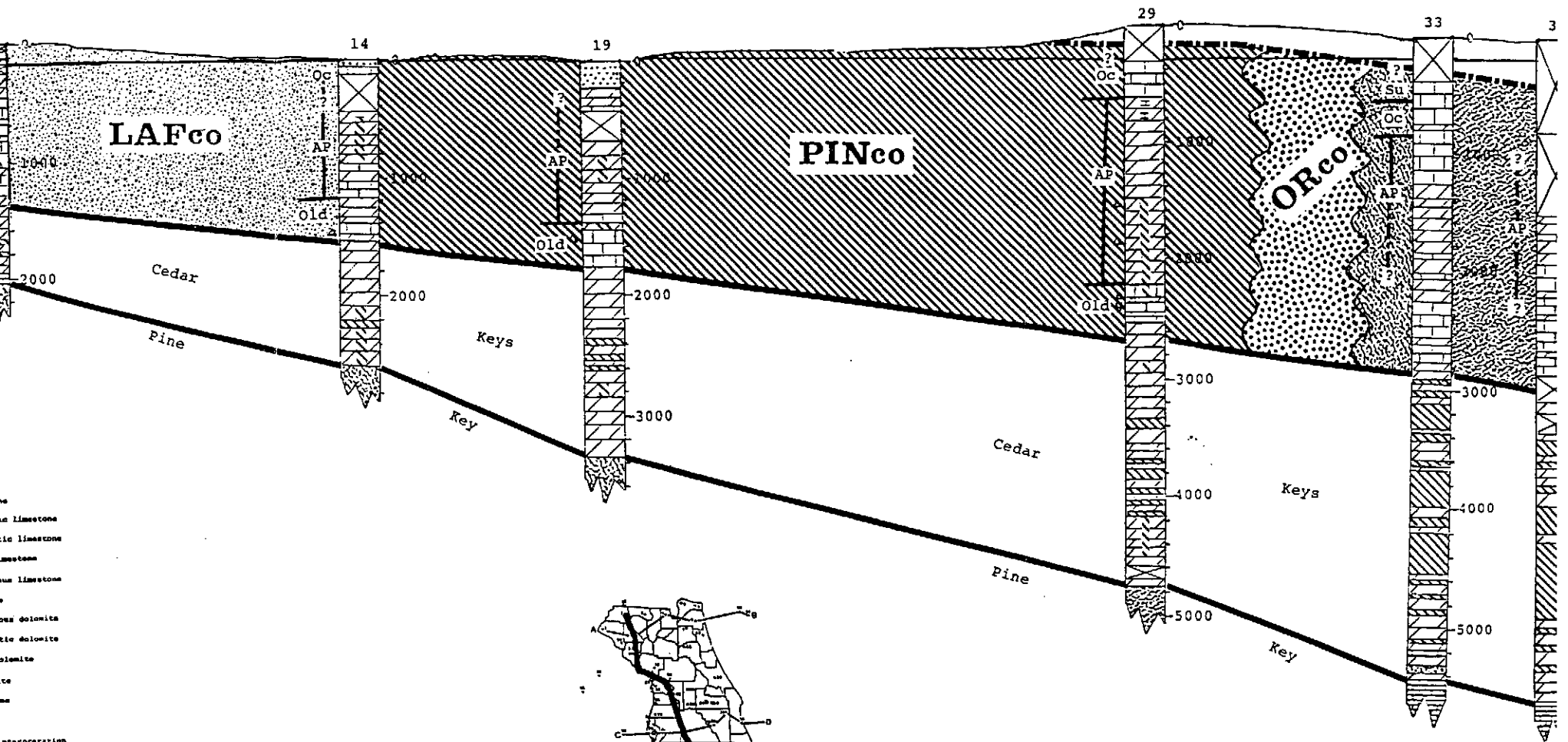
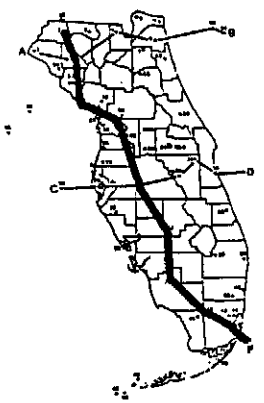
-2000
-3000
-4000
Scale
0
10 miles
limestone
dolomitic limestone
anhydritic limestone
sandy limestone
Cretaceous limestone
dolomite
calcareous dolomite
anhydritic dolomite
sandy dolomite
anhydrite
sandstone
chalk
E-log interpretation
glauconite
chert
phosphate
missing samples


C
Sea Level
50
28
29
30
31
Su
Oc
AP
Old
PINco
ORco
MADco
Miocene
Rebecca
Shoal
Cedar
Keys
Key
Pine
Scale
0
10 miles
limestone
dolomitic limestone
anhydritic limestone
sandy limestone
Cretaceous limestone
dolomite
calcareous dolomite
anhydritic dolomite
sandy dolomite
anhydrite
sandstone
chalk
E-log interpretation
glauconite
chert
phosphate
missing samples


28
29
30
31
58
Sea Level
D
Su
Oc
AP
Old
PINco
ORco
LAFco
Miocene
Cedar
Keys
Pine
Key
Rebecca
Shoal
1000
2000
3000
4000
5000
Scale
0
10 miles
limestone
dolomitic limestone
anhydritic limestone
sandy limestone
Cretaceous limestone
dolomite
calcareous dolomite
anhydritic dolomite
sandy dolomite
anhydrite
sandstone
chalk
E-log interpretation
glauconite
chert
phosphate
missing samples

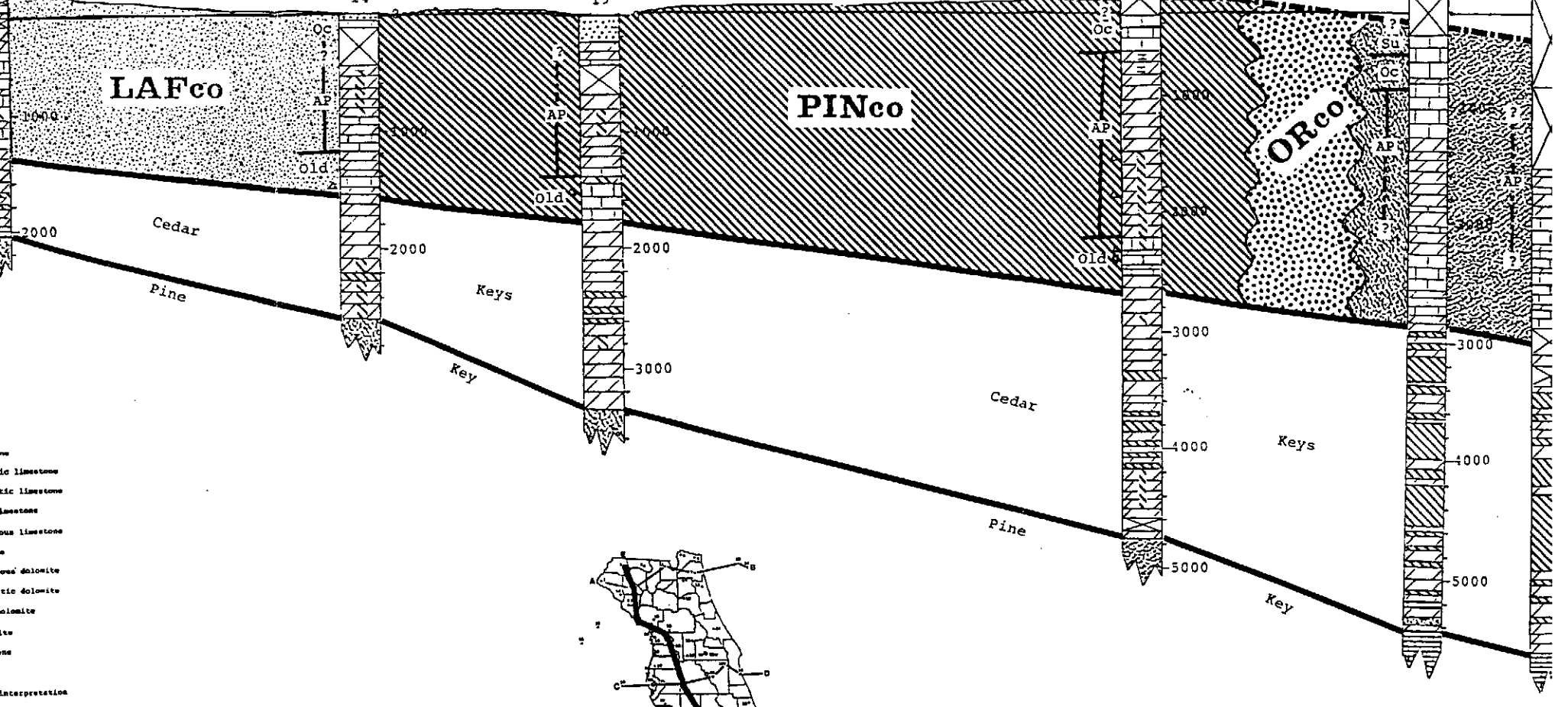

E
Sea Level
MADco
LAFco
AP
Old
Oc
Reefa
Shoal
Cedar
Pine
Keys
Key
1000
2000
3000
14
19
limestone
dolomitic limestone
anhydritic limestone
sandy limestone
Cretaceous limestone
dolomite
calcareous dolomite
anhydritic dolomite
sandy dolomite
anhydrite
sandstone
chalk
E-log interpretation
glauconite
chert
phosphate
missing samples

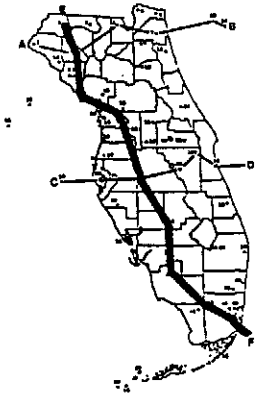




CROSS-SECTION NOTES

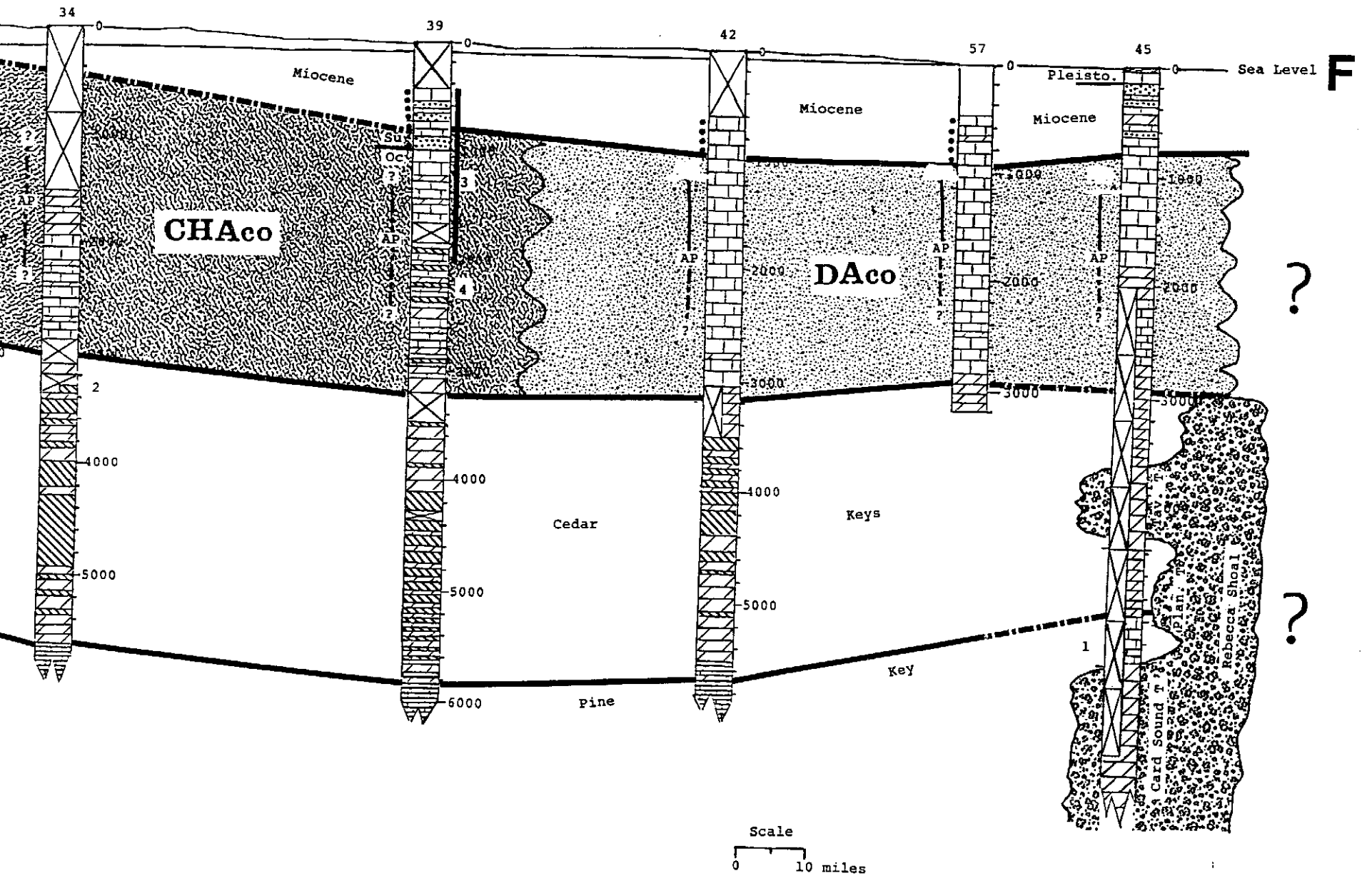
1. Presence of Habana Shoal Tavernier Terrane interpreted from E-log and backed up by sporadic cores from the same interval in an earlier well 4 miles west.
2. Anhydrite in missing section interpreted from E-log.
3. P 121 composited with W-1052 US Gypsum 1 Stratiland; core interval 411-2054 feet with skips.
4. The eocene anhydrites are associated with the Boulder Zone cavern collapse interval.





CROSS-SECTION NOTES

1. Pressure of Subcore Shoal Transverse Torque interpreted from B-leg and tacked up by syngenetic cores from the Asses interval in an earlier well 4 miles west.
2. Anhydrite in missing section interpreted from B-log.
3. P 121 composited with W-1057 US Gypsum 1 Sunniland; core interval 411-2056 feet with skips.
4. The Sunnee anhydrites are associated with the Boulder Zone Cenozoic collapse interval.


34
39
42
57
45
F
Sea Level
Miocene
Pleisto.
Miocene
Miocene
CHAco
DAco
Su
Oc
AP
AP
AP
AP
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1000
2000
3000
4000
5000
6000
2
3
4
1
Cedar
Keys
Key
Pine
?
?
Scale
0
10 miles