

**A PALEOECOLOGICAL RECONSTRUCTION
OF PIGEON KEY, FLORIDA BAY**

by

Jennifer Anne Thibeau

Bachelor of Arts
Colgate University, 1995

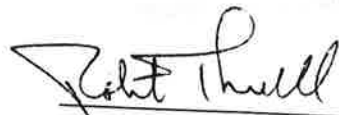
QE
3 11 82
1999
.T455

Submitted in Partial Fulfillment of the
Requirements for the Degree of Master of Science
in the Department of Geological Sciences
University of South Carolina

1999



Department of
Geological Sciences
Director of Thesis



Department of
Geological Sciences
2nd Reader



Department of
Geological Sciences
3rd Reader



Dean of The
Graduate School

University of
L

Thomas

THOMAS COOPER LIBRARY
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, S. C. 29208

ACKNOWLEDGEMENTS

This project was funded by a grant from the Everglades National Park (CA 5280-8-9031). I would like to thank the Everglades National Park for the use of their facilities and equipment. In particular, I would like to thank Dr. T. Armentano. Thanks go to Dr. Arthur Cohen, my thesis advisor, Dr. Willard Moore's lab, for performing ^{210}Pb analyses, and students who participated in field trips to Pigeon Key, assisting with fieldwork.

ABSTRACT

Over the past 5,000 years, sea level has risen, flooding most of Florida Bay. In the process, peatlands, which may have occupied a significant portion of the land surface before 5,000 years before present (ybp), were replaced by bay sediments (mostly marine carbonates). Small, basal, erosional remnants of these original peatlands can be found throughout the bay today. One exception to this scenario is Pigeon Key, which contains the only known complete sequence of peat. The purpose of this study was to perform a detailed analysis of the peat deposit at Pigeon Key in order to gain a better understanding of the history of the island and Florida Bay. Ten cores were obtained from the key in order to perform a detailed analysis of the deposit. Petrographic and palynologic data indicated that a series of environments has occupied Pigeon Key in the past 4,300 years. The area was first occupied by an intermittently ponded, fresh water setting. This setting was replaced by an Everglades-like, fresh water emergent aquatic marsh and tree hammock environments. Over time, the marsh became increasingly saline, yielding a brackish mangrove environment, and finally a marine, coastal mangrove environment, as exists at Pigeon Key today. Evidence in the cores suggests two possible slight regressions within the overall transgression.

Table of Contents

1. INTRODUCTION.....	1
1.1. Purpose and Scope.....	12
1.2. Geology	12
1.4. Physical Setting	15
1.5. Pigeon Key	18
2. MATERIALS AND METHODS	22
2.1. Field Methods.....	22
2.1.1. April 1997.....	22
2.1.2. November 1997	24
2.1.3. October 1998	24
2.2. Laboratory Methods	27
2.2.1. Preparation of Micropetrographic Sections	27
2.2.2. Preparation of $^{210}\text{Pb}/^{137}\text{Cs}$ Samples	30
2.3. Micropetrographic Analysis	30
3. MICROPETROGRAPHIC CHARACTERISTICS OF PEATS.....	32
3.1. Diagnostic Components.....	32
3.2. Peat types	35
3.2.1. Emergent Aquatic Peat	42
3.2.2. <i>Cladium</i> - <i>Sagittaria</i> Peat	44
3.2.3. Hammock Peat.....	46
3.2.4. <i>Cladium</i> Peat.....	51
3.2.5. Transitional peat	53
3.2.6. <i>Rhizophora</i> Peat.....	56
3.2.7. <i>Avicennia</i> Peat	60
4. STRATIGRAPHIC RELATIONSHIPS	65
4.1. Petrography	65
4.2. Palynology.....	72
4.2.1. Palynologic Analyses of a Core from Pigeon Key by Davies (1980).....	77
5. PALEOECOLOGICAL INTERPRETATION	81
5.1. Geographic Trends and Correlation Between Cores	84
6. DISCUSSION.....	86
7. CONCLUSIONS	102
8. REFERENCES	105
9. APPENDIX 1. Micropetrographic Data Sheets.....	109
10. APPENDIX 2. Protocol for Pollen Preparation.....	220

List of Figures

Figure 1: Location of transect from Brown and Cohen (1995).....	8
Figure 2: Carbonate-Peat relationships from Brown and Cohen (1995).....	9
Figure 3: Stratigraphy of a typical core from Florida Bay (Panhandle Key).....	10
Figure 4: Stratigraphy and location of Pigeon Key.....	11
Figure 5: Paleogeography of peninsular Florida during Sangamon interglacial time.....	14
Figure 6: Regional features and sources of fresh water inflow to Florida Bay.....	17
Figure 7: Location of Pigeon Key.....	19
Figure 8: Aerial view of Pigeon Key and Key Largo.....	21
Figure 9: Core locations on Pigeon Key.....	23
Figure 10: Photomicrograph of a foraminifer.....	33
Figure 11: Photomicrograph of a radiolarian with a sponge spicule.....	33
Figure 12: Photomicrograph of "Phytolith Type A".....	33
Figure 13: Photomicrograph of a fungal sclerotium.....	33
Figure 14: Photomicrograph of a fungal hypha and fungal spores.....	33
Figure 15: Photomicrograph of framboidal pyrite.....	34
Figure 16: Photomicrograph of euhedral pyrite crystals.....	34
Figure 17: Photomicrograph of charcoal.....	34
Figure 18: Photomicrograph of three fecal pellets.....	36
Figure 19: Photomicrograph of algal material.....	36
Figure 20: Photomicrograph of "resin globs" in peat.....	36
Figure 21: Petrographic data for Pigeon Key core PK-5-97.....	39
Figure 22: Petrographic data for Pigeon Key core PK-8-97.....	40
Figure 23: Petrographic data for Pigeon Key core PK-10A-97.....	41
Figure 24: Photomicrograph of emergent aquatic peat.....	43
Figure 25: Photomicrograph of <i>Cladium-Sagittaria</i> peat.....	45
Figure 26: Photomicrograph of a striated fungal spore.....	47
Figure 27: Photomicrograph of a charaphyte oogonium.....	47
Figure 28: Photomicrograph of typical hammock peat.....	48
Figure 29: Photomicrograph of <i>Cladium</i> peat.....	52
Figure 30: Photomicrograph of transitional peat.....	54
Figure 31: Photomicrograph of <i>Rhizophora</i> peat.....	57
Figure 32: Photomicrograph of a <i>Rhizophora</i> anther.....	59
Figure 33: Photomicrograph of <i>Avicennia</i> peat.....	61
Figure 34: Photomicrograph of a marine sponge spicule.....	63
Figure 35: Photomicrograph of the pseudochitinous inner walls of a foraminifer.....	63
Figure 36: Stratigraphy of cores from Pigeon Key.....	66
Figure 37: Occurrence of peat and carbonate at Pigeon Key.....	67
Figure 38: Stratigraphy of Pigeon Key cores from Davies (1980).....	71
Figure 39: Pollen data for PK-10A-97.....	73
Figure 40a: Pigeon Key pollen data from Davies (1980).....	78
Figure 40b: Pigeon Key pollen data from Davies (1980).....	79
Figure 40c: Pigeon Key pollen data from Davies (1980).....	80
Figure 41: Sea level fluctuations on three time scales.....	87
Figure 42: Davies' (1980) model for sea level rise and island development in Florida Bay.....	89
Figure 43: ²¹⁰ Pb data for core PK-10A-97.....	94
Figure 44: Salinity v. time in Florida Bay.....	95
Figure 45: Hypothetical development of Pigeon Key.....	98

1. INTRODUCTION

A significant portion of South Florida is blanketed by a layer of peat, representing one of the largest single bodies of organic soil in the world (Stephens, 1956). Furthermore, remnant, discontinuous peat layers beneath the carbonate sediments of Florida Bay suggest that this blanket once extended beyond the mainland and into Florida Bay (Davies, 1980). The spatial distribution, composition, and origin of the peats of the mainland have been described in some detail in a variety of studies (Davis, 1940; Davis, 1946; Cohen, 1968; Spackman et al., 1976; Davies, 1980; Davies and Cohen, 1989; Gleason and Stone, 1994). However, because of the incompleteness of the sedimentary record, much less is known about the peats of Florida Bay.

In 1910, Harper noted the existence of peat on some of the Florida Keys and characterized the peat-forming environments of the region. The presence of peat in Florida Bay was not reported. Davis (1940) reported a 61 cm layer of reddish-brown, fibrous peat at Murray Key in Florida Bay. The peat was located below recent marl and above firm, unconsolidated calcareous sediment. The type of peat was not identified. In 1946, however, Davis completed an extensive study of peat deposits of mainland Florida. He determined the nature of the peats – distinguishing different types of peat, examining

their characteristics and composition. He studied the connection between peat type and its environment of deposition, as well as what peats may tell us about the geologic history of an area, with particular regard to changes in climate and sea level. In studies conducted by Ginsburg (1956; 1957; 1964), Ginsburg and Lowenstam (1958), and Ginsburg et al. (1954), basal peats from Florida Bay were reported. However, these reports were primarily studies of the hydrology of the bay and the composition of its calcareous sediments. Plants comprising the peat were not definitively identified.

A number of subsequent investigations recognized the presence of peats as commonplace in the sedimentary sequence of Florida Bay (Taft and Harbaugh, 1964; Scholl, 1966; Scholl and Stuiver, 1967; Scholl et al., 1969; and Spackman et al., 1976). While these investigators recognized the presence of peat, it was not until Cohen (1968), and Craighead (1969; 1971) that the peat was examined in greater detail.

As part of a study of peat deposits of the Florida mainland by Cohen (1968), a single core was taken at Murray Key in Florida Bay. The core consisted of approximately 46 cm of peat overlain by marine marl. In addition to discovering peat at one of the islands of Florida Bay, as a part of this study, Cohen developed a paraffin impregnation technique which allowed for the production of relatively undisturbed, oriented microtome sections of the peat (Cohen and Spackman, 1977). Following microscopic analysis, Cohen correlated the microscopic composition of the slides with depositional environments. This method was used in subsequent studies (Cohen and Spackman, 1977; 1980; Davies, 1980; Davies and Cohen, 1989). From Cohen's 1968 work, microscopic study of the

peat layer at Murray Key revealed the presence of a thin, basal, brackish-to-freshwater (*Rhizophora-Acrostichum-Cladium*) peat, overlain by a freshwater carbonate mud, a brackish water (*Rhizophora-Acrostichum-Cladium*) peat, and then a marine (*Rhizophora*) peat.

Craighead (1969) also recognized the existence of freshwater sediment beneath the bay. His study described sedimentary sequences from sites in Florida Bay as well as from freshwater environments in the Everglades. He showed a zone of freshwater "basal mud and freshwater peat" beneath brackish and marine sediment (Craighead, 1969). While he recognized the presence of peat as part of the basal freshwater zone, he did not distinguish specific peat types.

The discovery of fresh water peats underlying marine sediments in Florida Bay was the impetus for a number of studies examining sediments from Florida Bay with regard to changes in sea level. Differentiating between peat types, and recognizing that one may be deposited on top of another allows for the possibility of a detailed study of a particular location and any changes in its environment.

Work completed by Cohen and Spackman (1977, 1980) involved microscopic analysis of peats throughout southern Florida. A total of 13 peat types were identified. These peats were classified based on the plant species comprising the peat, as well as other characteristics such as the presence of tanniniferous cell fillings, granular debris, fungal remains, pollen and spores, fecal pellets, pyrite, and charcoal (Cohen and Spackman,

1977). The occurrence of these items in the peat was used to classify the peats into different types, and relate these types to various depositional environments. The same authors, in a later study (Cohen and Spackman, 1980), focused on the degradation of the plant tissues within the peat, and the possible correlation of peats to various coal macerals.

Enos and Perkins (1979) looked at changes in sea level in Florida Bay. They reported that the sedimentary record, including both peat and calcareous sediments, of Florida Bay consisted of a transgressive sequence followed by a regressive sequence. They broke these changes down into a succession of stages: freshwater pond, mangrove swamp, shallow bay, mud bank, and supratidal island. No freshwater peat sediment was recognized.

Gleason et al., (1984) investigated Holocene sediments in South Florida and their significance regarding changes in environment. For the most part, the study was restricted to the Everglades. Sediments from the area were classified and distinguished based on microscopic and chemical analyses. These sediments included peats as well as calcitic muds. Each type of sediment was related to its depositional environment. The relationships and juxtapositions of these sediment types in various cores was examined in order to determine the origin of tree hammocks as well as the history of Taylor Slough, a major conduit for flow of water from the Everglades into Florida Bay.

On a larger scale, changes in depositional environment, as represented by the interfingering of peats and carbonates or the succession of numerous peat types, were examined in terms of sea level fluctuations and climate. While the authors described evidence for a transgression over the past 5,000 years, inconclusive data were presented with regard to the possibility of small regressions within the larger transgression (Gleason et al., 1984).

The microscopic method developed by Cohen (1968) was employed in an extensive study of sediments in Florida Bay by Davies (1980) and Davies and Cohen (1989). The study was largely based on Davies' (1980) Ph.D. dissertation. Cores were taken throughout the bay along a grid pattern with a spacing of 1.9 km (one nautical mile). Most of the cores were found to be almost entirely calcareous mud, but occasionally basal peats were encountered. Of 622 sites sampled, 130 were found to include basal peat layers beneath the carbonate muds, suggesting that the blanket of peat overlying bedrock on the mainland may have extended to cover Florida Bay as well (Davies and Cohen, 1989). Radiocarbon dates indicated an unconformity between the basal peats and the overlying carbonate sediments (Davies, 1980). Davies also found that the ages of the basal peats varied spatially in the bay. That is, the older, deeper peats were located in the southwestern portion of the bay, while the youngest peats were discovered in the northeastern portion (Davies, 1980).

Following petrographic analysis of the cores, twelve peat types were distinguished, each diagnostic of a depositional environment. Based on the succession of these peat types,

Davies and Cohen (1989) concluded that much of Florida Bay once consisted of fresh water, peat-producing environments, corresponding to modern depositional settings in the Everglades. These types included typical shallow water sawgrass habitats (*Cladium* and *Acrostichum-Cladium* Peats), deeper water (ponded) habitats (*Cladium-Nymphaea* Peat), tree hammock settings (*Cladium-Cephalanthus*, and *Cephalanthus* Peats), and fresh water carbonate flats (with *Helisoma* snails, algal mat, and probably *Eleocharis*) (Davies and Cohen, 1989). The presence of such fresh water sediments at the base of each core, and the absence of any basal mangrove peat challenged the old theory that mangroves "built out the land" (Davis, 1940 in Davies and Cohen, 1989). The peat deposits in the bay represented a succession of environments (fresh water to brackish to marine), as the bay was inundated with marine waters accompanying a rise in sea level over the past 5,500 years (Davies and Cohen, 1989). This study supported the concept of a recent marine transgression over the coastal margins of southern Florida, an idea which had previously been concluded by a number of authors (Spackman et al., 1964; Scholl and Stuiver, 1967; Cohen, 1968; Enos and Perkins, 1979; Gleason et al., 1984; Davies and Cohen, 1989).

Of the twelve peat types identified in this study, three were representative of marine depositional environments (*Avicennia*, *Rhizophora*, and *Avicennia-Rhizophora* peat). Davies and Cohen (1989) discovered that cores that contained *Avicennia* peat rarely contained *Rhizophora* peat, and a succession of one of these peat types to another was very uncommon. Based on these findings, and Cohen's 1968 study of southern Florida, in which he discovered *Avicennia*-containing peat at certain marine-carbonate-dominated sites on Cape Sable only, Davies and Cohen (1989) concluded that peats within Florida

Bay containing *Avicennia* were highly significant. They suggested that such peats may represent conditions which were highly saline for an extended period of time, or, possibly, areas of rapid detrital marine carbonate accumulation (Davies and Cohen, 1989). In this study, the stratigraphy of fifteen sites in Florida Bay was detailed.

A 1995 study conducted by Brown and Cohen involved the examination of cores from a transect from Florida Bay to Whitewater Bay (**Figure 1**). Based on facies changes with depth, an overall marine transgressive sequence was observed; however, this transgression was interrupted by what appeared to be a minor regression (Brown and Cohen, 1995). The transgressive-regressive-transgressive sequence is illustrated in (**Figure 2**), and proceeds from base to present as follows: basement limestone, freshwater carbonate, freshwater peat, brackish peat, freshwater peat, brackish peat, mangrove peat, and marine carbonate (Brown and Cohen, 1995).

Figure 3 depicts the stratigraphy of a core from Panhandle Key, located in central Florida Bay. The majority of the core is composed of calcareous sediment, while the lower portion is peat. This core is representative of the sediments found in Florida Bay Keys throughout much of the bay. However, unlike the Panhandle Key core, one site was encountered in the Davies and Cohen study that consisted almost entirely of peat, with only minor amounts of carbonate (Spackman et al, 1976; Davies and Cohen, 1989). The site was Pigeon Key, located just northwest of Key Largo (**Figure 4**). Davies (1980) investigated one core on this key, and one core offshore.

Figure 1. Location of transect from Brown and Cohen (1995).

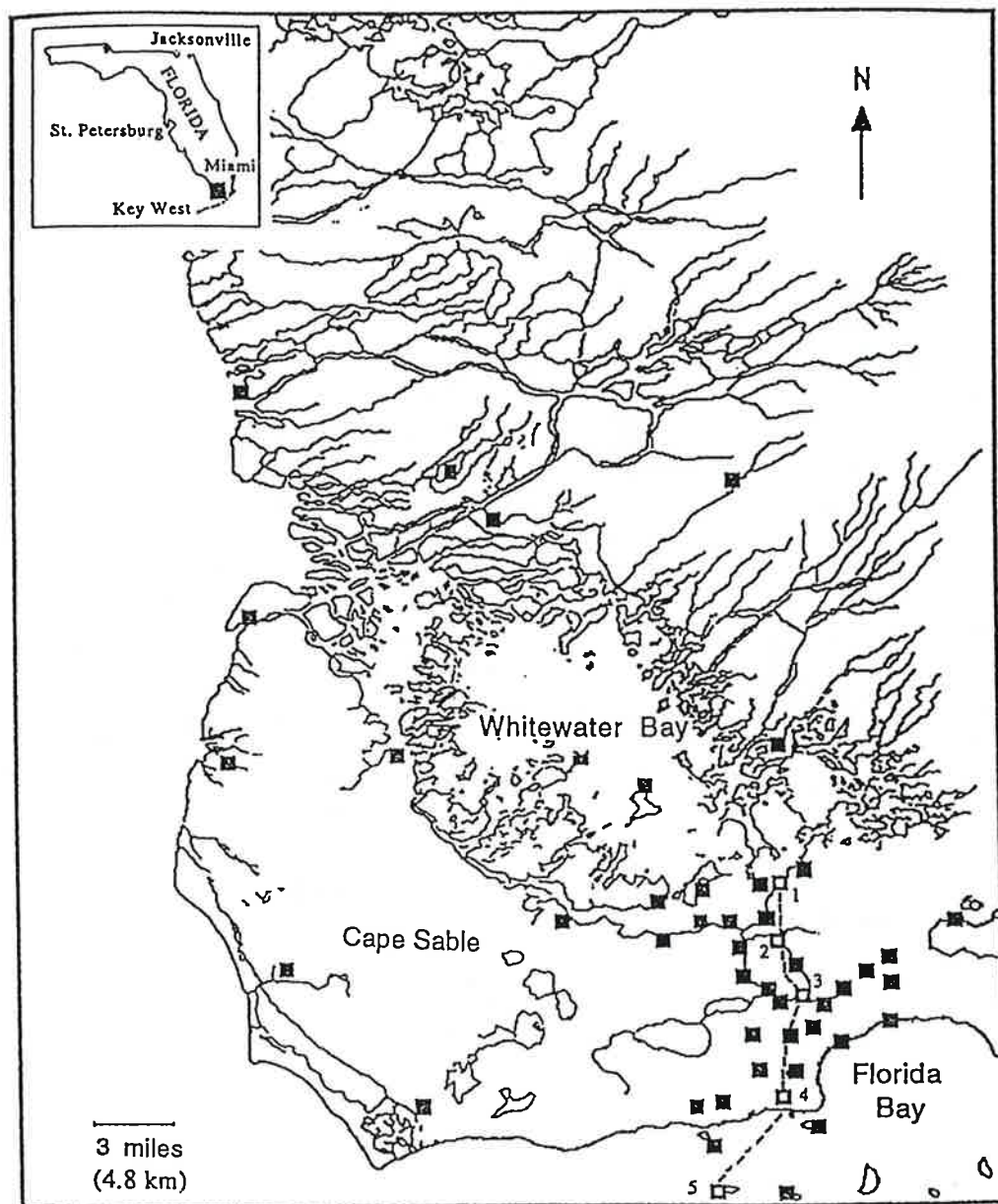


Figure 2. Carbonate-Peat relationships

(from Brown and Cohen, 1995)

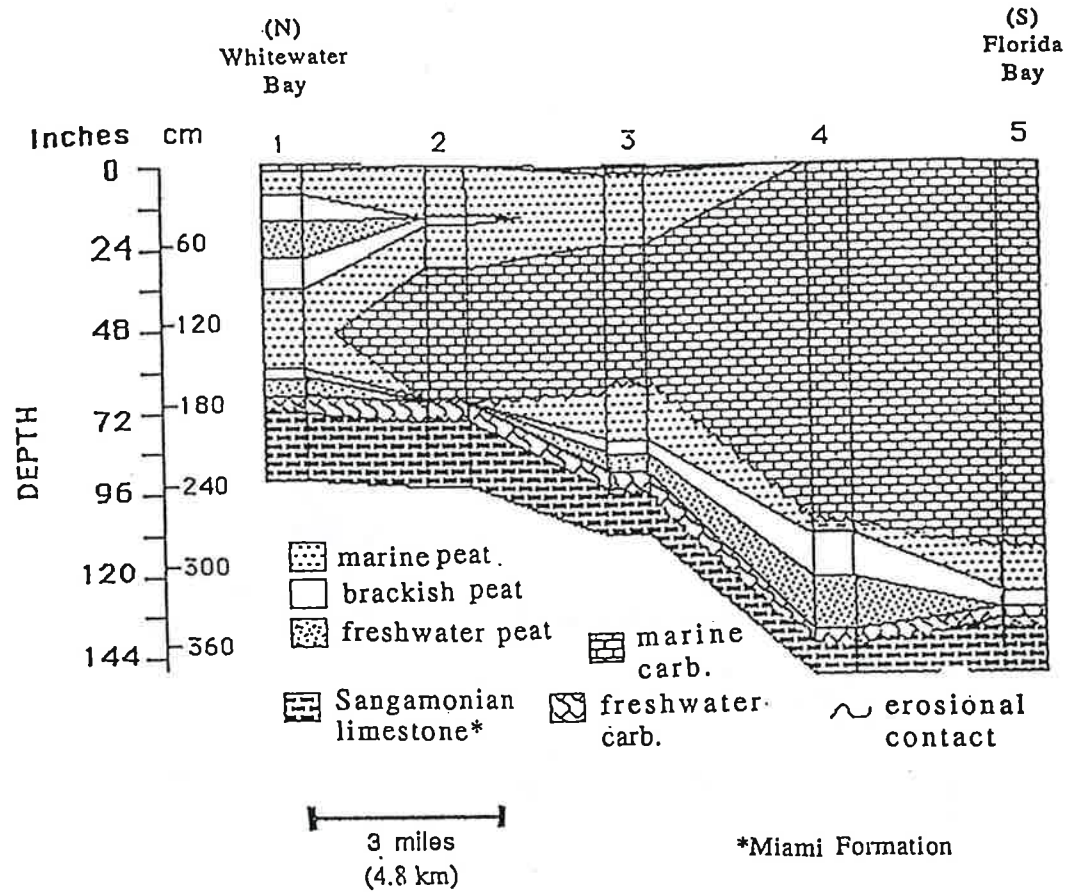
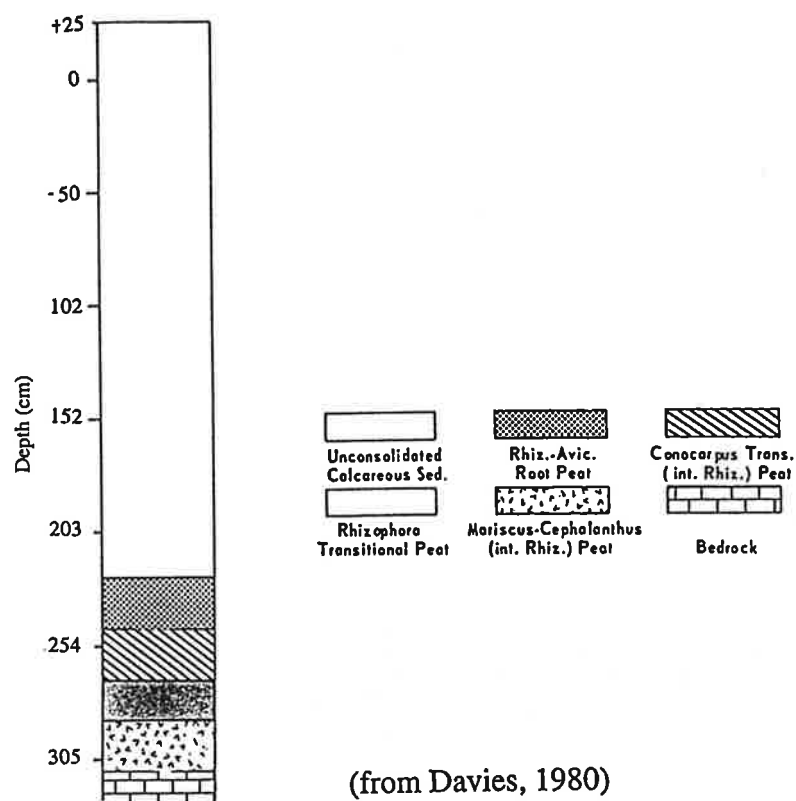


Figure 3. Stratigraphy of a typical core from Florida Bay
(Panhandle Key)



(from Davies, 1980)

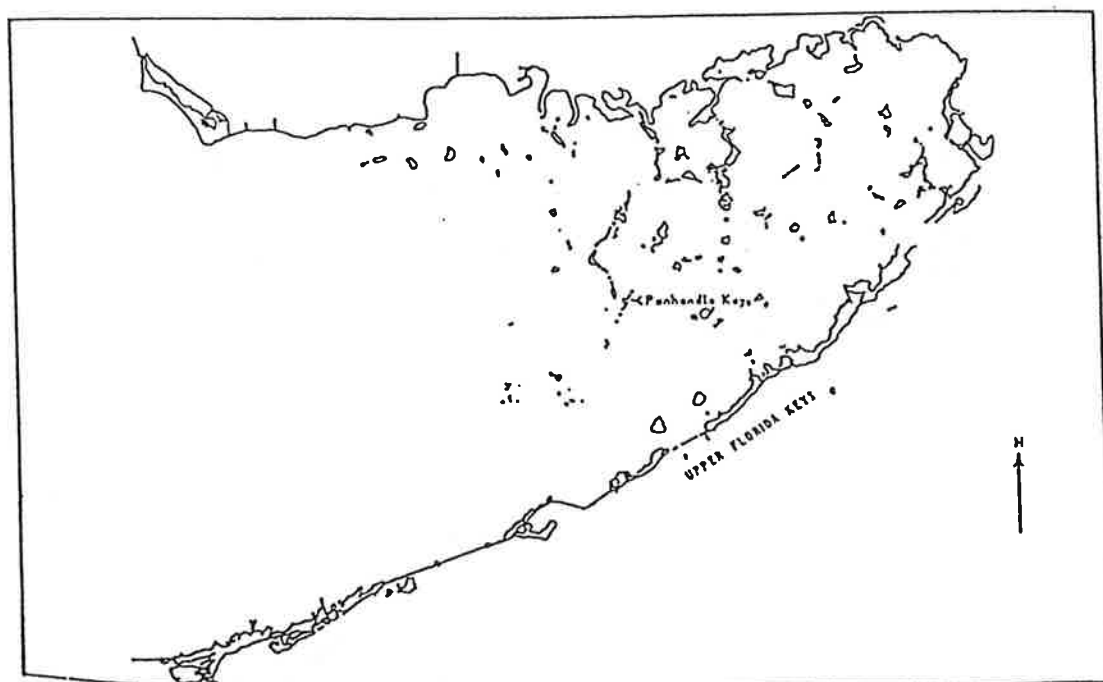
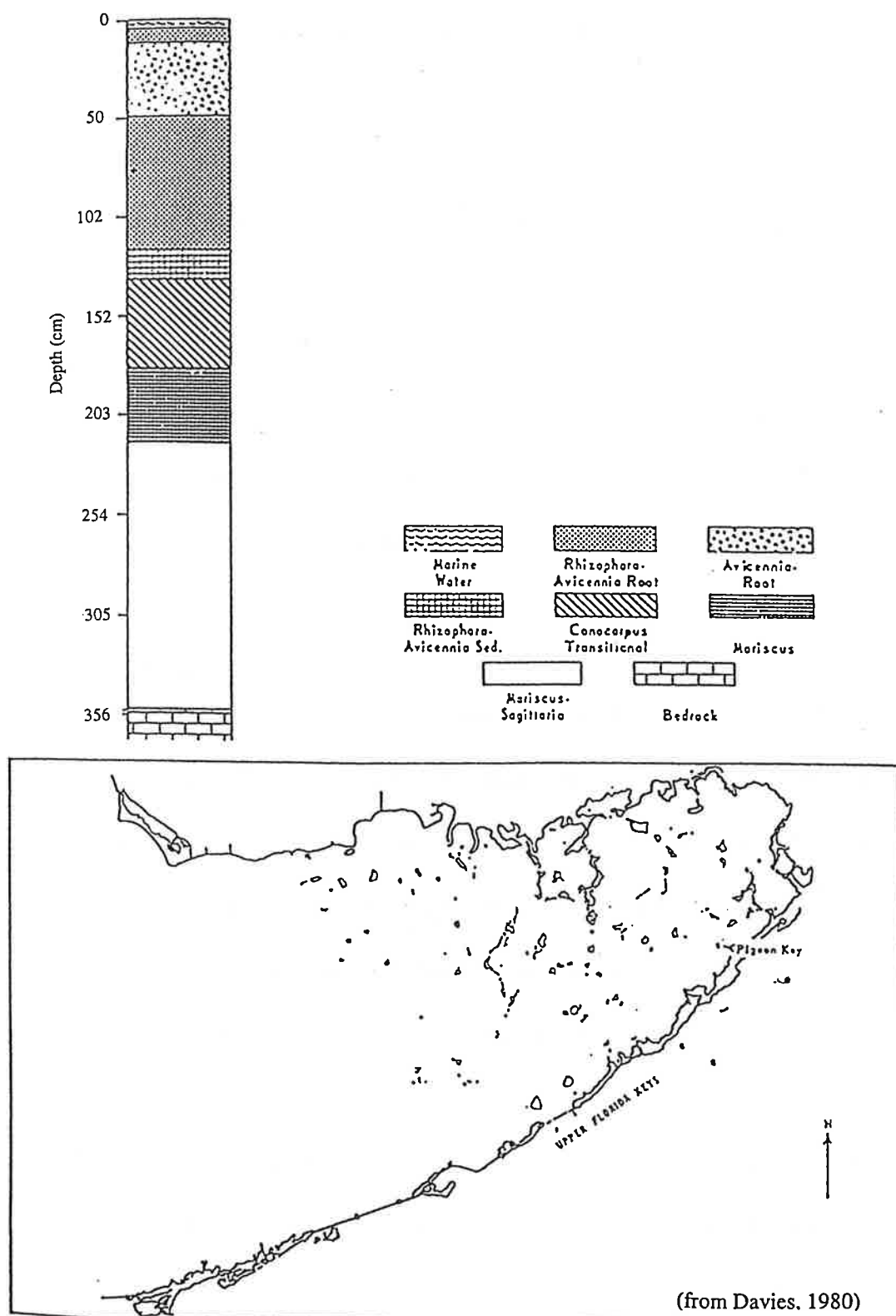


Figure 4. Stratigraphy and location of Pigeon Key



1.1. Purpose and Scope

The discovery by Davies of the existence of a site containing a continuous peat sequence offers the potential to investigate what is possibly the only relatively continuous remnant of the former peat blanket that may once have covered Florida Bay. It is possible, then, that detailed analysis of the peat deposit at Pigeon Key may provide some new insights into the history of the bay. These might include insights relative to paleoecological changes, changes in sea level, as well as information needed to assess recent, anthropogenically derived changes in the Florida Bay ecosystem. To achieve these goals, a series of cores was investigated by micropetrographic techniques utilizing very closely spaced samples in their upper portions and wider spacing with depth. These analyses were supplemented by ^{210}Pb , and ^{14}C dating.

1.2. Geology

The peninsula of Florida is located along the eastern edge of a large submerged plateau, the Floridian Plateau. Florida occupies only a small portion of the plateau, and is itself part of a larger region of carbonate deposition – the Florida-Bahama Province (Ginsburg, 1956). This province underlies South Florida, the Bahama Banks, and the northern coast of Cuba. Carbonate deposition in the region has been occurring since the Jurassic and consists of several distinct limestone units (Owens, 1960).

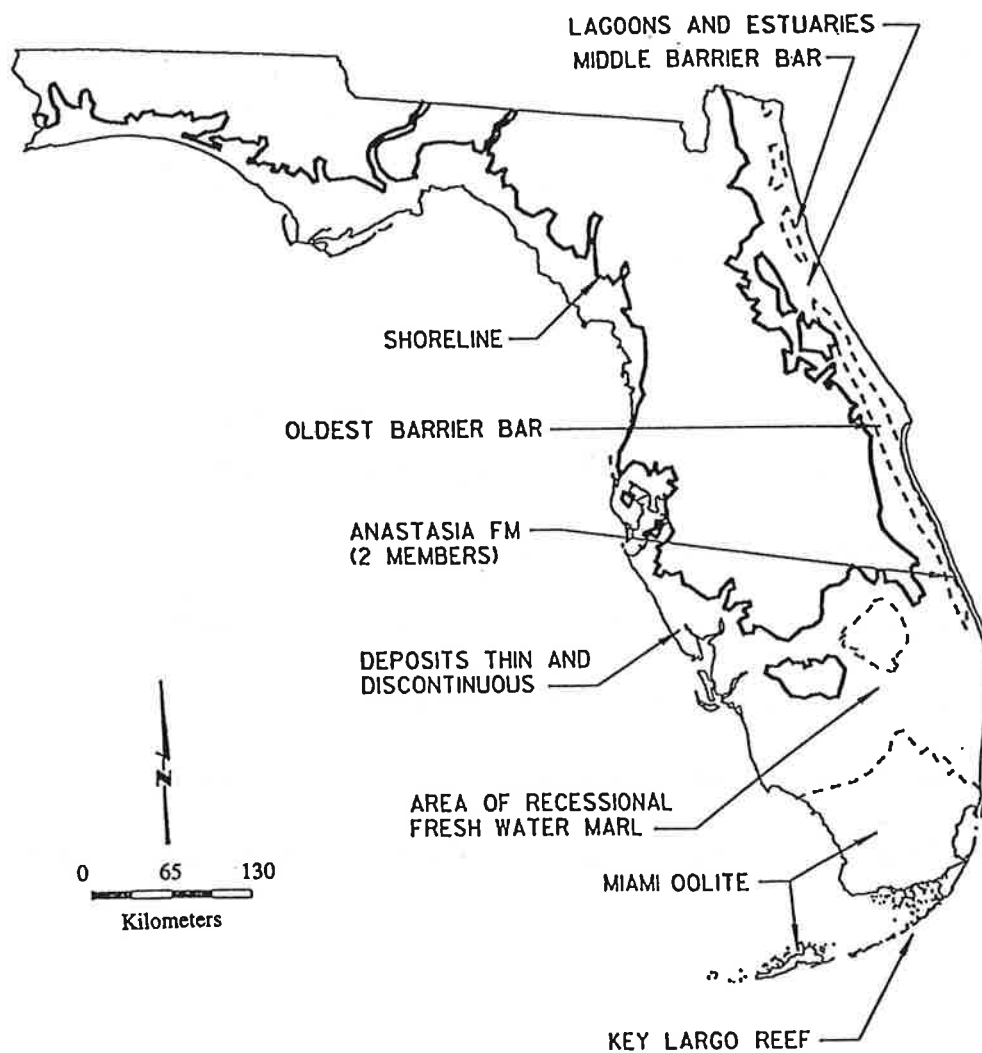
During the last interglacial period in the late Pleistocene, sea level was approximately 7.6 m (25 ft) higher than present, flooding the lower third of the peninsula (Hoffmeister,

1974) (**Figure 5**). At this time, what is now the upper Florida Keys was a living coral reef, and what is now Florida Bay was part of a broad, deep lagoon. In this lagoon, unconsolidated calcareous sediments were deposited. Immediately north of the reef, sediments formed from "oolite" bodies and bryozoan remains. These sediments lithified to form the oolite and bryozoan facies of the Miami Formation, which underlies much of South Florida and Florida Bay. Florida Bay is primarily underlain by the Miami Oolite.

During the last glacial period, the global climate grew colder. As more water was bound in ice at the poles, sea level dropped approximately 120 m (394 ft), exposing many areas which had previously been submerged, including a large portion of what is now South Florida and Florida Bay (Hoffmeister, 1974). No longer protected by the cover of the ocean, these newly exposed areas were subjected to weathering and erosion.

Approximately 15,000 years before present, the ice sheets and glaciers receded as the climate grew warmer. As temperatures rose and ice melted, sea level began to rise (Marmer, 1949; White, 1970). Eventually, water levels rose high enough to again submerge the majority of the Floridian Plateau, and begin filling in Florida Bay. Recent sediments were deposited disconformably upon the surface of the Miami Formation. The Miami Oolite slopes gently to the southwest, at a gradient of approximately 0.06 meters per kilometer (0.3 ft/mile) (Davies, 1980). This limestone does not have any appreciable relief. However, its surface is highly irregular, containing many shallow (0.3 - 0.9 m, 1 - 3 ft) depressions (Davies, 1980). The oldest sediments overlying Pleistocene bedrock are peats dating to approximately 5,500 years

Figure 5. Paleogeography of peninsular Florida during Sangamon interglacial time (from Brooks, 1968 in Gleason and Stone, 1994)



before present (Davies, 1980). Structurally, South Florida is located in a shallow basin. Tectonic activity in this basin is relatively minor (Missimer, 1984).

1.3. Climate

Florida Bay and South Florida experience a humid, subtropical climate. Annual rainfall ranges from 102-165 cm/year (40-65 inches) and temperatures range from 16°C (60°F) in winter to approximately 27°C (80°F) in summer (McPherson and Halley, 1996). Average annual conditions for the northeastern portion of Florida Bay, examined in this study, consist of approximately 122-132 cm of precipitation (48-52 inches) and temperatures of approximately 75°F (24°C) (McPherson and Halley, 1996).

1.4. Physical Setting

Florida Bay is a 1,220 km² triangular area located directly south of the mainland. With the exception of tidal channels, the bay is almost completely closed off to the east and south by the coralline Florida Keys, but is open to the Gulf of Mexico to the west. The bay itself is relatively shallow; water depths range from 1-4 m, with an average depth of less than 1 m. The floor of the bay is dissected by an anastomosing pattern of carbonate mudbanks and mangrove islands (Wanless and Tagett, 1989). Seagrass meadows are common.

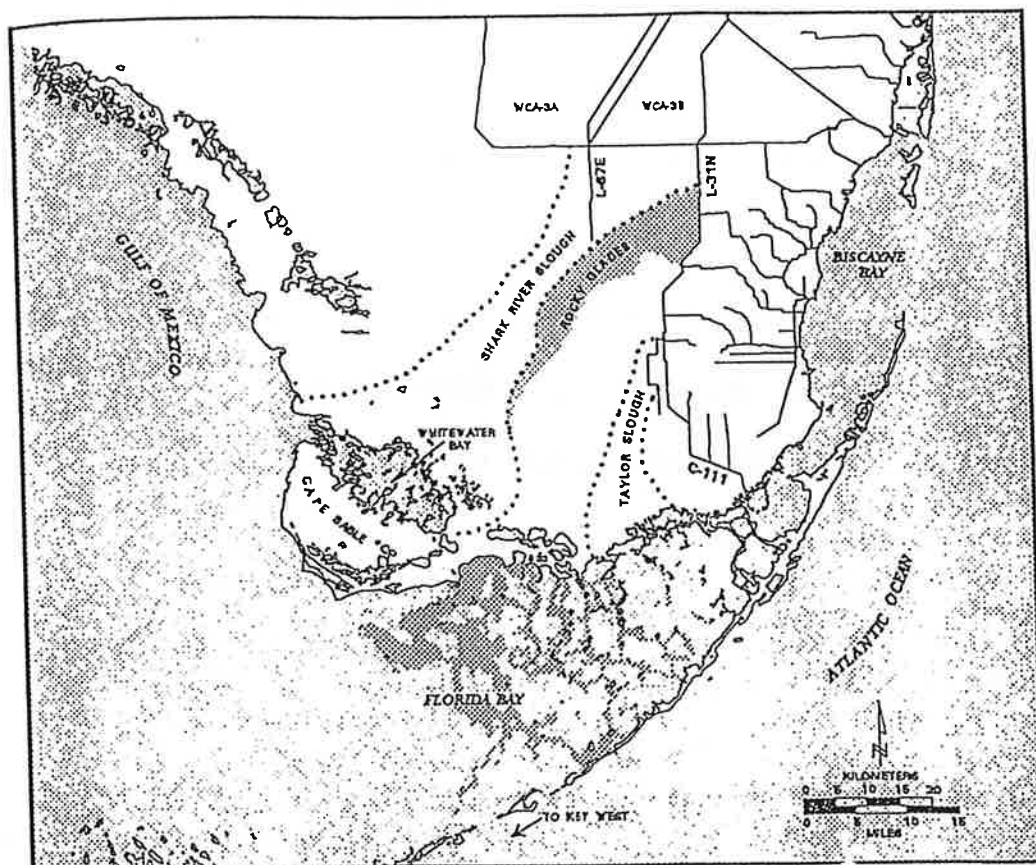
The average tidal range for the Atlantic side of the Florida Keys and at Cape Sable is approximately 60 cm. However, the system of mudbanks in the bay provides a barrier to tidal currents, dampening tides to a range of 15 cm (Wanless and Tagett, 1989). In some

parts of Florida Bay, tidal variation is so insignificant that strong, prolonged winds associated with cold fronts, may effect greater changes in water level than the tides (Enos and Perkins, 1979).

Florida bay is an estuarine environment. The Gulf of Mexico acts as the main source of marine water, as influx from the east is limited by the Florida Keys. Fresh water enters the bay from the north. The majority of South Florida is drained by the Everglades which empties primarily into the Gulf of Mexico and to a lesser extent into the northern part of Florida Bay. Direct inflow of fresh surface water occurs in the form of sheet flow across marl prairies of the southern Everglades as well as from approximately 20 creek systems fed by Taylor Slough (McIvor et al., 1994). Water from Shark River Slough, the largest drainage in the Everglades, flows into Whitewater Bay and then into the Gulf of Mexico. Some portion of this water may also flow around Cape Sable and into western Florida Bay (McIvor, et al., 1994).

In the last century, much of the freshwater of South Florida has been diverted by a network of canals established for flood control as well as agricultural and urban use. Since the beginning of canal construction and the implementation of water management in South Florida in the early 1900s, the natural flow of water from the Everglades to Florida Bay has been greatly altered. Now, much of the fresh water entering the bay does so via the C-111 canal (**Figure 6**) (Light and Dineen, 1994). Diversion of this water from Shark River Slough and Taylor Slough has dramatically reduced the volume and rates of flow of fresh water entering the bay. Compared to premanaged conditions, fresh water

Figure 6. Regional features and sources of fresh water inflow to Florida Bay (from Schomer and Drew, 1982 in McIvor et al., 1994)



flow from Shark River Slough to Florida Bay has diminished significantly (McIvor et al., 1994).

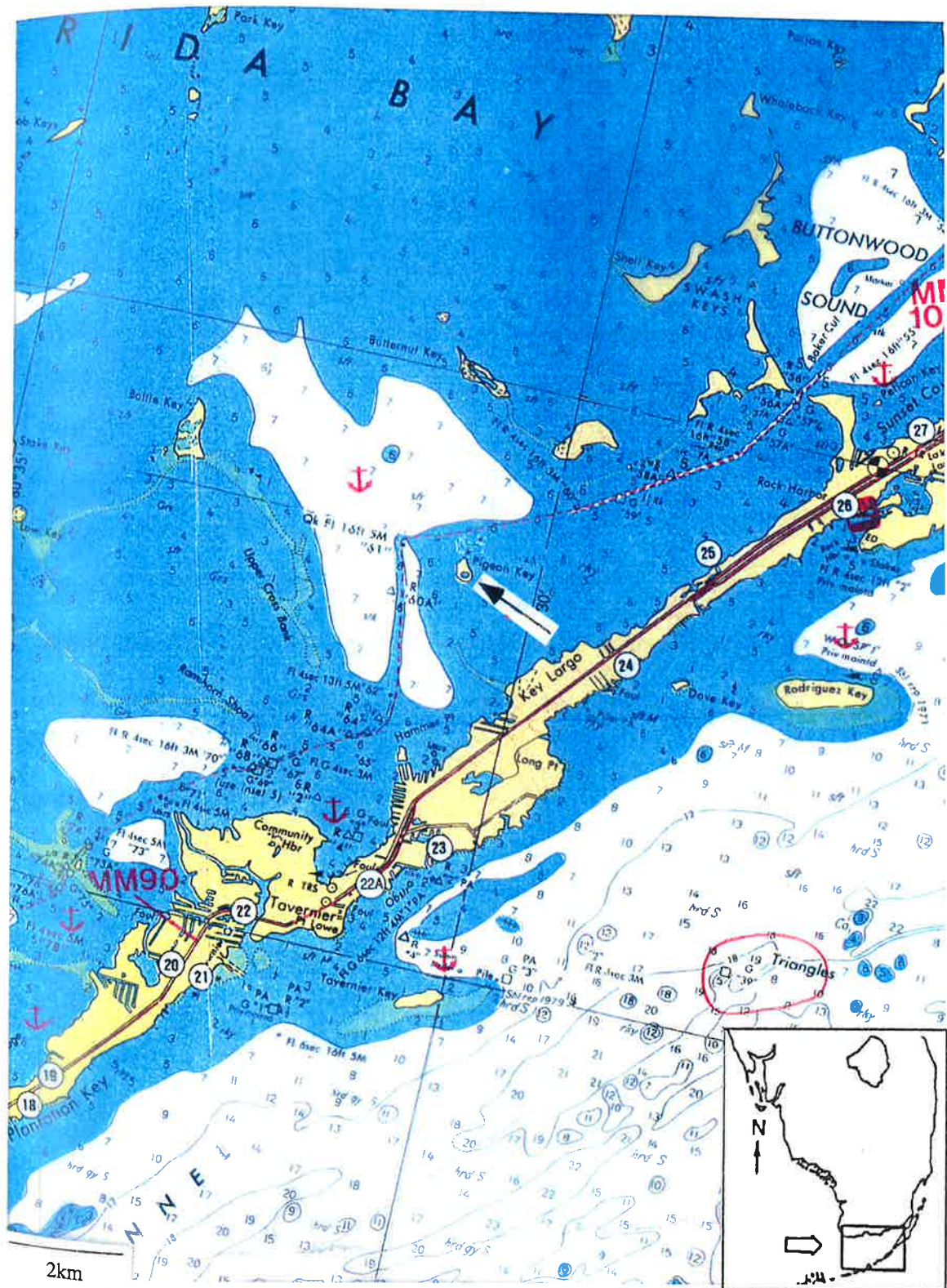
In the early 1900s (1910-1911), the Flagler Railroad was constructed along the Florida Keys (McIvor et al., 1994). One aspect of construction involved the filling in of passes and shallow banks along the railroad's route. Such construction further limited the already restricted exchange of water between Florida Bay and the Atlantic Ocean.

In addition to the Florida Keys acting as a barrier to the east, the maze of mudbanks and islands has divided the bay into a series of shallow basins. With little to no tidal influence from the Atlantic in the east, reduced fresh water input from the north, and a series of banks lining the floor of the bay, circulation of waters within the bay is rather poor. The western bay experiences tidal flushing from the Gulf of Mexico, but the extent of its influence is very limited. The combination of these factors has caused salinity levels in Florida Bay to rise, often becoming hypersaline (McPherson and Halley, 1996).

1.5. Pigeon Key

Pigeon Key is one of the many small islands which dot Florida Bay. Pigeon Key is located in the northeastern part of the bay approximately 3.2 km (2 miles) northwest of Key Largo, immediately southeast of marker #61 of the Intracoastal Waterway (25°03'22"N, 80°30'40"W) (**Figure 7**). The island is slightly oval in shape and is approximately 338 m (1,110 feet) long and 198 m (650 feet) wide, along north - south and east - west transects of the island through its center. From aerial photographs and

Figure 7. Location of Pigeon Key

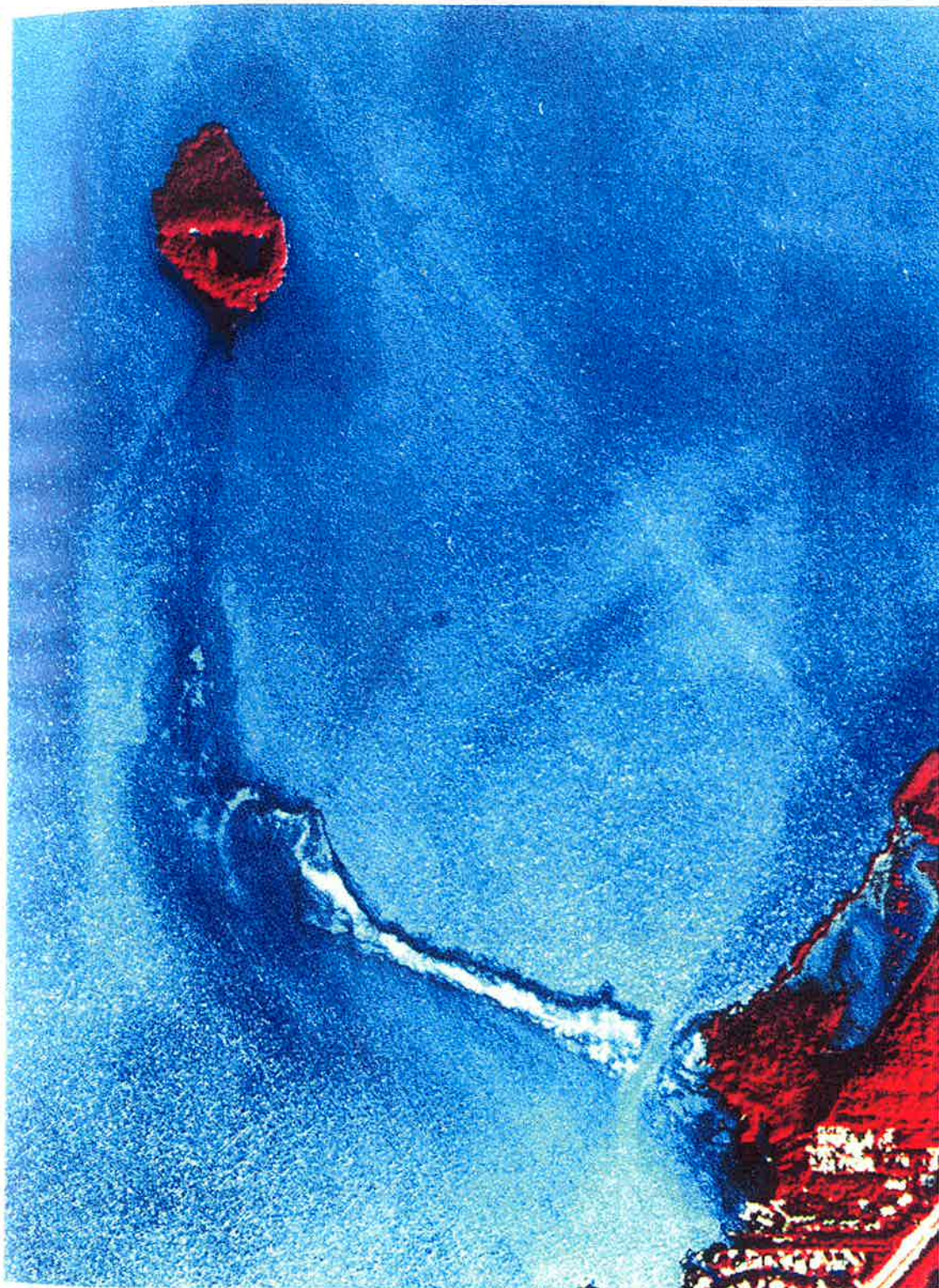


maps, it appears as if there is a small lake in the center of the island, as is found on many islands within the bay (**Figure 8**). However, this "lake", which is used as a rookery by many species of birds, is open to Florida Bay to the south. It may appear to be closed off due to the fact that the island is ringed by red mangrove (*Rhizophora mangle*) trees.

As was noted by Davies (1980), the northern end of the island is eroding while the southern end is accreting. The northern part of the island is eroding peat, while the southern end is accreting carbonate muds, which form a shoal extending out into the bay from the island. In general, waters surrounding the key do not exceed 1.8 m (6 ft) in depth. There is a sharp drop into the water along the edge of the island.

The key is uninhabited and vegetated largely by mangroves, primarily red (*Rhizophora mangle*) and black (*Avicennia nitida*), with some white (*Laguncularia racemosa*), in addition to pickle weed (*Batis maritima*). There is little topography to the island.

Figure 8. Aerial view of Pigeon Key and Key Largo.



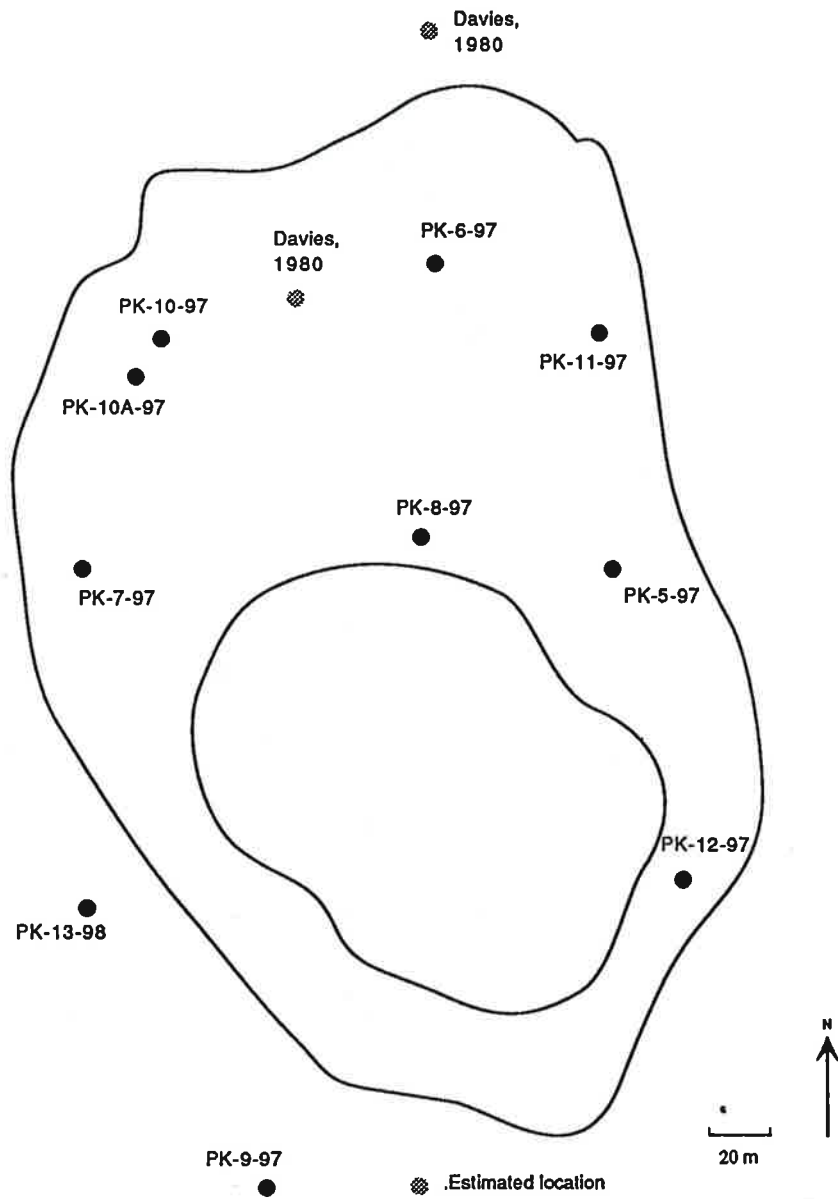
2. MATERIALS AND METHODS

2.1. Field Methods

2.1.1. April 1997

In April 1997, eight locations on Pigeon Key were cored. These areas are designated as PK-5-97 through PK-12-97. The locations of these cores are given in **Figure 9** (and **Table 1**). Cores PK-5-97, PK-6-97, PK-8-97, and PK-10-97 were retained for petrographic analysis while PK-7-97, PK-9-97, PK-11-97, and PK-12-97 were collected for description only, their contents discarded. All cores were obtained using a Macauley peat sampler, which allows for minimal disturbance of the stratigraphic orientation of the cores. The device produces half-cylinder-shaped 30.48 cm (1 foot) segments of core, which are 5.08 cm (2 inches) in diameter. Macroscopic properties of the peat, such as color, texture, and the presence of any large fragments were noted. To retain a core segment, the sample was gently eased off of the sampler and into a longitudinally cut section of PVC pipe. Vertical orientation of the sample was noted. After being placed in the labeled PVC section, a plastic label was laid upon the sample. The sample was then tightly wrapped in a layer of plastic wrap followed by duct tape in order to prevent drying. All core sections were then placed in a cooler to further reduce the risk of desiccation.

Figure 9. Core locations on Pigeon Key



In addition to collecting samples, surface vegetation was noted at each site. Dimensions of the island were also measured with a measuring tape through the approximate center of the island along North - South and East - West transects.

Table 1. Location of Cores at Pigeon Key

Core	Coordinates
PK-5-97	25°03'58"N, 80°30'52"W
PK-6-97	25°03'45"N, 80°30'68"W
PK-7-97	25°03'39"N, 80°30'75"W
PK-8-97	25°03'48"N, 80°30'65"W
PK-9-97	25°03'17"N, 80°30'41"W
PK-10, 10A-97	25°03'43"N, 80°30'75"W
PK-11-97	25°03'40"N, 80°30'64"W
PK-12-97	25°03'25"N, 80°30'65"W
PK-13-98	25°03'22"N, 80°30'39"W

2.1.2. November 1997

Adjacent to PK-10-97, PK-10A-97 was cored in order to obtain samples for ^{137}Cs and ^{210}Pb dating (**Figure 9**). Approximately 60 cm of peat were retained using the Macauley peat sampler and the method described above. Duplicate samples were obtained in order to ensure that a large enough sample was present for analyses.

2.1.3. October 1998

2.1.3.1. Collection of Radiocarbon Samples

Five samples were collected for ^{14}C dates. Basal peat samples were obtained from the locations of PK-5, PK-8, and PK-10. Initially, PK-10A was to be sampled for radiocarbon analyses. However, upon arrival at Pigeon Key, the precise location of PK-10A could not be ascertained. It is probable that recent inclement weather either damaged or removed the marker identifying the site. Thus, PK-10 was sampled instead, as its location is adjacent that of PK-10A.

Additional radiocarbon samples were obtained from important contacts from core PK-5. This core contains an approximate 185 cm intrusion of carbonate mud sandwiched between peat above and below it. Two samples for ^{14}C dating were collected: a carbonate sample from the peat-carbonate boundary at the base of the intrusion, peat at the carbonate-peat contact at the top of the intrusion. These samples were obtained using a Macauley sampler. As this area had been cored and described in detail previously, it was not necessary to core continuously. Rather, samples were taken at specific depths. Once the core segment was retrieved, the increment to be dated was cut out of the core with a clean spoon. A new/clean spoon was used for each sample. The sample was tightly wrapped in aluminum foil, and placed in a labeled plastic bag, which was then sealed in an additional plastic bag. For the peat samples, in order to have enough material for a viable sample, three separate samples were obtained with the Macauley sampler, each at the same depth, within close proximity to one another. These samples were then combined and placed in the aluminum foil and plastic bags. Prior to each sampling effort the Macauley sampler was cleaned, in an attempt to reduce the possibility of sample

contamination. Radiocarbon samples were sent to Geochron Laboratories in Cambridge, Massachusetts for dating (sample numbers GX-24880 to GX-24884).

2.1.3.2. Collection of Samples for ^{210}Pb Dating

Three samples were obtained for ^{210}Pb and ^{137}Cs dating. In order to obtain an intact, pristine sample, at each location (PK-5, PK-6, and PK-8), a clean, 7.5 cm diameter piece of aluminum irrigation tubing was slowly pushed into the sediment. Prior to entering the field, the lower end of each tube was sharpened with a file. The top of each tube had two holes cut into it, directly across from one another. This allowed for the placement of a dowel across the top of the tube, for use as a handle. In order to obtain each sample, the tube was slowly pushed in a rotating manner through the sediment. Sharpened ends allowed for greater ease in pushing the tube through the peat as well as the ability to cut through any roots obstructing its path without compressing the sample. The tubing was pushed to a depth of 60 cm, or until resistance was encountered. Once the aluminum tube reached the desired depth, filled with the sample, a plastic cap was placed over the top of the tubing, and the sediment surrounding the tube was removed with a shovel and/or by hand. Once the base of the tube was reached, a cap was placed over the lower end of the tube. The tube, remaining vertical, was then removed from the hole and the bottom cap further stabilized with a hose clamp. After the bottom of the tube was secured, the cap on the top of the tube was removed. The depth/level of the sample within the tube was noted, and the tube was cut with a tubing cutter just above the sample level. A clean cap was

then placed on the top of the tube. The tube was labeled and secured in a carrying case/rack constructed for the purpose of holding such samples upright for transportation.

In addition to the collection of samples for ^{210}Pb , ^{137}Cs , and ^{14}C dating, the Macauley sampler was used to investigate the substrate off of the southwestern shore of Pigeon Key. This location has been designated as PK-13-98 on **Figure 9**. The core was taken in approximately one meter of water. No samples, only descriptions were noted for the majority of the core, except for the lower 0.5 m, which was kept.

2.2. Laboratory Methods

2.2.1. Preparation of Micropetrographic Sections

Three of the four complete cores retained have been processed into thin sections. The method used is based on that described by Cohen and Spackman (1972). Following removal from the PVC section, cubes of peat (approximately 1.5 cm X 1.5 cm) were cut from the larger sample with a razor blade. Samples were taken from the center of each interval within the core, in order to avoid contamination. As each sample was cut, care was taken to preserve the orientation of the peat as well as avoid compressing the tissues comprising the peat. These cubes were placed in a box constructed of copper mesh screening (100 mesh) and then "fixed" in a solution of alcohol, acetic acid, and formaldehyde (Cohen and Spackman, 1972). Each cube of peat was then dehydrated gradually in a series of ethanol and tertiary butyl alcohol solutions. Once completed, the sample was embedded in paraffin, cut into a 15 μm thick vertically oriented thin section

with a sliding microtome, and mounted in Elvacite (a bioplastic dissolved in xylene).

Duplicates for each sample were produced. **Table 2** lists the process of sample preparation in full detail.

Table 2.

Procedure for Embedding Samples of Peat for Sectioning on a Microtome

1. A piece of copper 100-mesh sieve screen is cut in a manner such that it may be folded up into a box.
2. The screen is bent around a wooden block and sewed with a needle and thread around the block to form an open cage.
3. The wooden block is removed from the open end of the cage and carefully replaced with an uncompressed, oriented cube of wet peat.
4. The cage is sewed firmly around the peat and label is attached to the upright flap of screen.
5. The cage containing the peat sample is placed in a "killing and fixing" solution (F.A.A.) and aspirated slowly to remove all air. F.A.A. is prepared by mixing 1 part formaldehyde, 1 part acetic acid, 10 parts ethyl alcohol, and 10 parts distilled water. For best results, killing and fixing should be done as quickly as possible after removal of the peat sample from the sealed core or sample bag. The sample should be treated in F.A.A. for not less than one hour and not more than two days at room temperature. Note that in all steps in this procedure as many as 30 samples may be prepared at the same time.
6. The sample is removed from F.A.A. with tweezers and placed in a solution of 50% distilled water and 50% ethyl alcohol for 15 minutes.
7. Step 6 is repeated two more times with fresh solution.
8. The sample is placed in a series of dehydrating solutions as follows:
 - A. 50% water, 40% ethyl alcohol, and 10% tertiary butyl alcohol -- 2 hours.
 - B. 30% water, 50% ethyl alcohol, and 20% tertiary butyl alcohol -- overnight.
 - C. 15% water, 50% ethyl alcohol, and 35% tertiary butyl alcohol -- 1 hour.
 - D. 45% water, 55% ethyl alcohol -- 1 hour.
 - E. 25% water, 75% ethyl alcohol -- 1 hour.
 - F. 100% tertiary butyl alcohol -- 1 hour.
 - G. 100% tertiary butyl alcohol -- overnight.
 - H. 100% tertiary butyl alcohol (TBA) -- 1 hour.
9. Sample is placed in a mixture of 100% TBA and paraffin oil (50:50) for one hour.
10. "Embedding paraffin" is melted in an oven and poured into the bottom of a glass jar so that the fluid is at least 1.5 cm deep. The paraffin is allowed to harden.
11. The sample from step 9 is lifted from the TBA/paraffin oil solution and placed on top of the hardened paraffin, which had been prepared in step 10. The paraffin oil/TBA solution from step 9 is quickly poured back over the sample until it just barely covers the peat in the cage. The jar is then placed in an oven and the paraffin is allowed to melt. The sample remains in this jar at least one hour after the paraffin has melted.
12. Place the sample in pure paraffin in a vacuum oven for one hour and slowly aspirate to remove any air.
13. Repeat step 12 in new paraffin but leave in vacuum oven overnight.
14. Repeat in new change of paraffin for one hour.
15. Pour molten paraffin into a paper cup or "paper boat" and quickly place sample (s) from oven into this container (before paraffin begins to harden). Carefully but quickly place cup with samples into a tub of ice water so that paraffin will harden rapidly.
16. After hardening, the samples are cut from the paraffin block with a "hot knife".
17. The oriented cube of embedded peat is carefully removed from the copper mesh cage by cutting with a razor blade. Care is taken to retain original orientation of the sample. About 1 mm of sample is carefully trimmed from all edges of the block to remove any contamination or distorted areas. The block is then mounted with paraffin on a wooden block for microtome sectioning.
18. Microtome sections are generally cut 15 microns in thickness using a sliding microtome.
19. Cutting and mounting on microscope slides is done following the standard procedures used for making other botanical slides. As in other biological procedures, the paraffin is dissolved from the mounted slice of peat with xylene and a permanent slide is made with Canada balsam.

(From Cohen, 1983)

A total of 194 samples were prepared using this method. From each core, thin sections were made at intervals of 2 cm for the upper 30 cm of the core, and every 5 cm for the

remainder. This process was used only for the peat portions of the cores. The carbonate included in PK-5 was not processed. The cores range in depth from 394 to 292 cm.

2.2.2. Preparation of $^{210}\text{Pb}/^{137}\text{Cs}$ Samples

As previously described samples PK-5, PK-6, and PK-8 were sampled with aluminum irrigation tubing. In order to remove the peat from the tubing, the aluminum tubing was cut open without disturbing the sample. After removing the hose clamp from the lower cap, the tube was placed in a wooden box with a slit running lengthwise. The box was designed so that the blade of an electric, rotary hand saw could pass through the slit, nearly cut through the tubing, but not into its contents. The tubing was then rotated 180° and cut again in the same manner. Next, the tubing was pried open, revealing the undisturbed core. Once removed from the tubing, samples were divided into 2 cm increments with a razor blade. Portions of the samples that touched the pipe or tubing were discarded to ensure a pristine sample. Samples were placed into pre-weighed plastic petri dishes, labeled, and sealed with tape. The samples were then given to the lab to perform the necessary analyses. The samples were dated at the University of South Carolina under the direction of Dr. Willard Moore. The above procedure was followed for samples from PK-5 and PK-8. Samples from PK-6 were not dated.

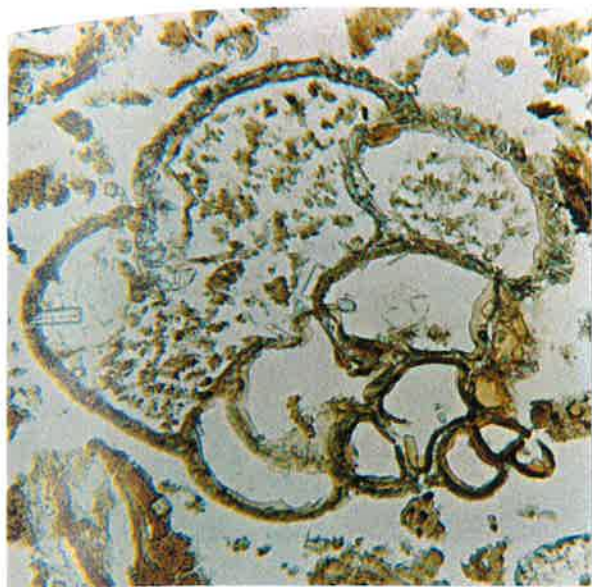
2.3. Micropetrographic Analysis

A total of 98 samples were petrographically analyzed. For the upper 30 cm, samples were reviewed in 4 cm intervals. Based on sedimentation rates calculated from ^{210}Pb data, these upper intervals correspond to approximately 16 years of deposition. For the remainder of each core, samples were examined in 10 cm intervals. As previously stated, thin sections were prepared of peat samples only. Zones of carbonate were generally excluded from the processing, although carbonate was a constituent of several slides. Slides were scanned under powers ranging from 100X to 400X and the abundance of the elements comprising each slide were noted, based on a scale of 0 to 5. A rank of zero indicates that the particular item was absent from the sample, while a value of five denotes that the particular item was present in such great abundance that the thin section included little else. Items noted include plant species, roots, rootlets, leaves, bark, foraminifera, radiolaria, sponge spicules, fungal hyphae, fungal sclerotia, algal material, insect parts, fecal pellets, pyrite, charcoal, fungal spores, and pollen. Data from these relative counts are presented in **Appendix 1**.

3. MICROPETROGRAPHIC CHARACTERISTICS OF PEATS

3.1. Diagnostic Components

A number of different components from each thin section was noted in order to classify the peats into different peat types. In addition to the species of vegetation present, the composition (roots, leaves, rootlets, etc.) of the vegetation, and the overall color of the peat were noted. As Florida Bay consists largely of carbonate-rich sediment and peat, the relative abundance of these two components in the samples was of particular importance. Microorganisms such as foraminifera and radiolaria, along with sponge spicules, were noted, as these are (with the exception of certain sponge spicules) excellent indicators of a marine environment (**Figures 10, 11**). Another siliceous body, termed Phytolith Type A, as its origins are undetermined, occurred in several samples (**Figure 12**). Three main categories of fungal bodies were noted: hyphae, sclerotia, and spores (**Figures 13, 14**). The presence and/or absence of pyrite and charcoal were also recorded. Pyrite occurred in two major forms in the thin sections – framboids and euhedral crystals (**Figures 15, 16**). Pyrite is worthy of note as it may provide information regarding the geochemistry of the peat. Similarly, charcoal is an important component in that conditions must be relatively dry for charcoal to form, as it is the result of a fire (**Figure 17**). Along with the items listed above, fecal pellets, insect parts, algal material, and “resin globs” were noted



____ 20 μ m
Figure 10. Photomicrograph of a foraminifera.



____ 5 μ m
Figure 11. Photomicrograph of a radiolarian with a sponge spicule.



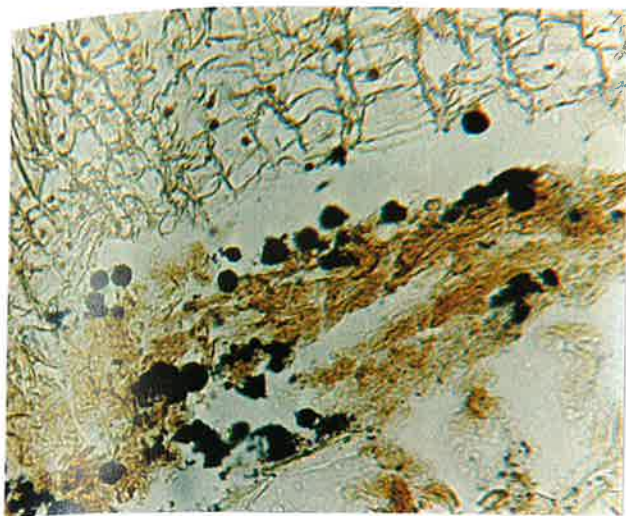
____ 10 μ m
Figure 12. Photomicrograph of "Phytolith Type A".



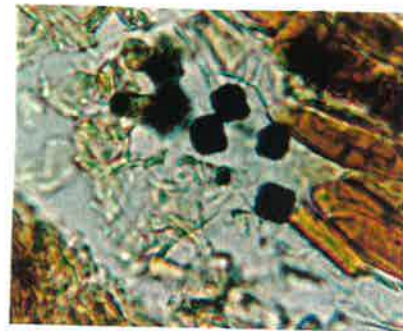
____ 5 μ m
Figure 13. Photomicrograph of a fungal sclerotium.



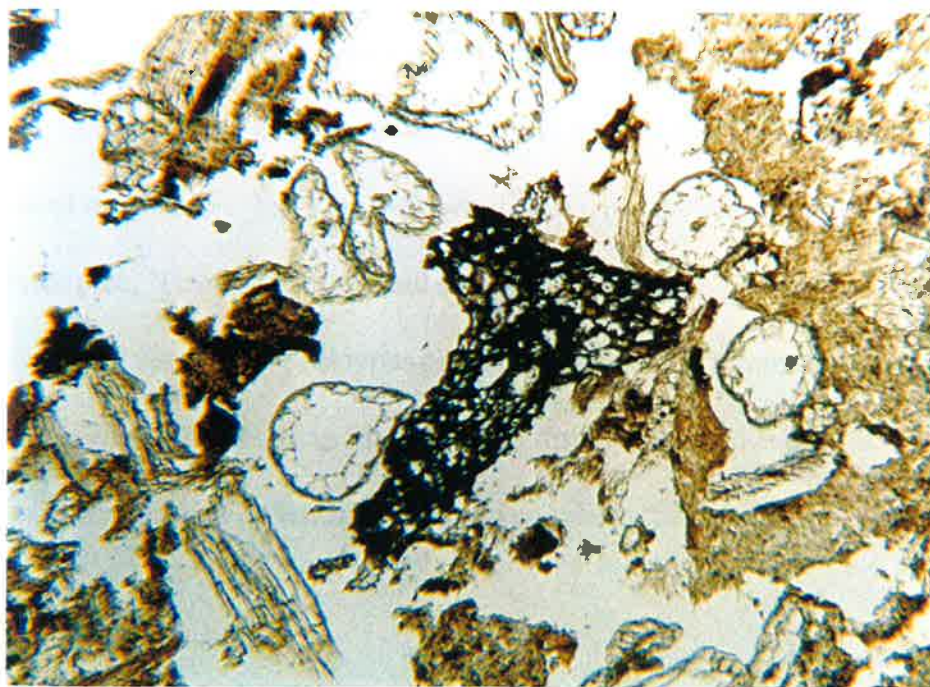
____ 10 μ m
Figure 14. Photomicrograph of a fungal hypha and fungal spores.



_____ 5 μ m
Figure 15. Photomicrographs of framboidal pyrite.



_____ 10 μ m
Figure 16. Photomicrograph of euhedral pyrite crystals.

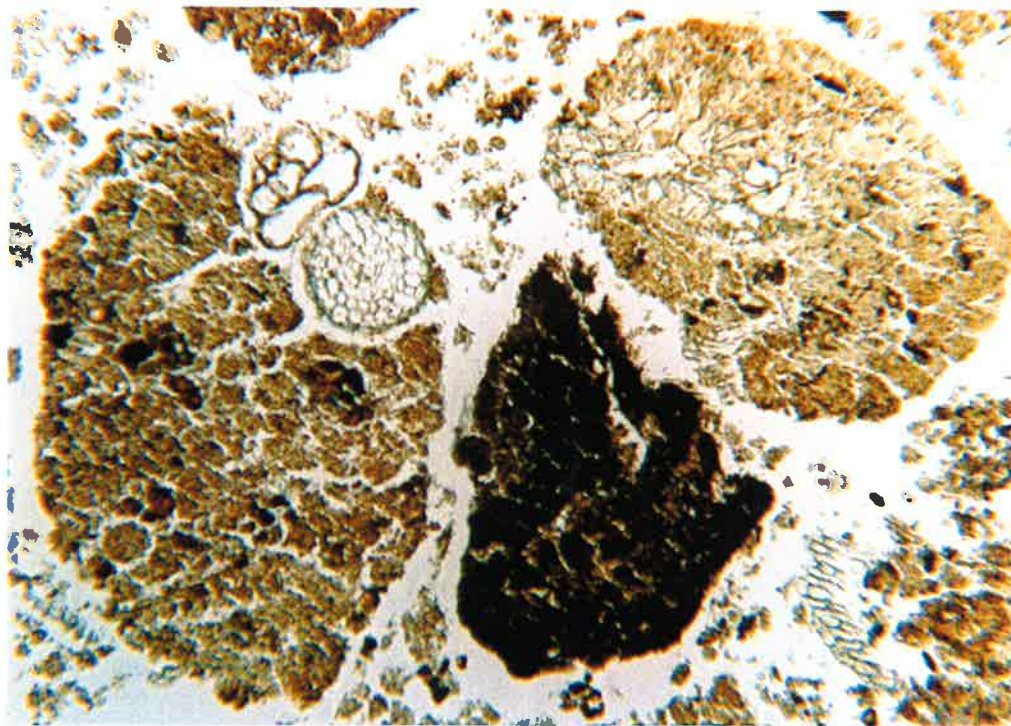


_____ 20 μ m
Figure 17. Photomicrograph of charcoal.

(Figures 18, 19, 20). Finally, in addition to any palynomorphs present in the thin sections, a crude pollen analysis was completed of samples spaced throughout the core PK-10A. Protocol for producing the pollen slides is included in **Appendix 2**. In addition to the various components of the thin sections, any sedimentary structures within the sections were noted.

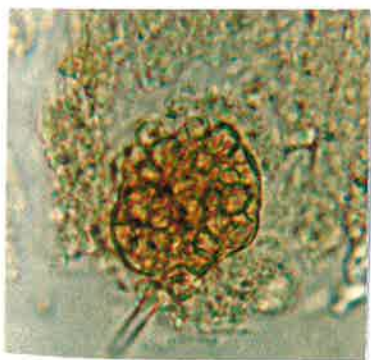
3.2. Peat types

Based on the microscopic analysis of the thin sections, seven major peat types were determined in the cores from Pigeon Key, named for the dominant vegetation present. Two marine, one transitional (brackish), and four fresh water peat types were identified. The marine peats include *Avicennia* peat and *Rhizophora* peat. The brackish water peat has been termed "Transitional peat" as there was not one specific plant species which dominated the samples. The four fresh water peat types include *Cladium* peat, *Cladium-Sagittaria* peat, "Hammock peat", and emergent aquatic peat. In addition to the brief descriptions of each of the peat types given below, **Table 3** summarizes the microscopic qualities of each type. **Figures 21, 22, and 23** display the relative abundance of the various components of each thin section and correlates the data to the different peat types.



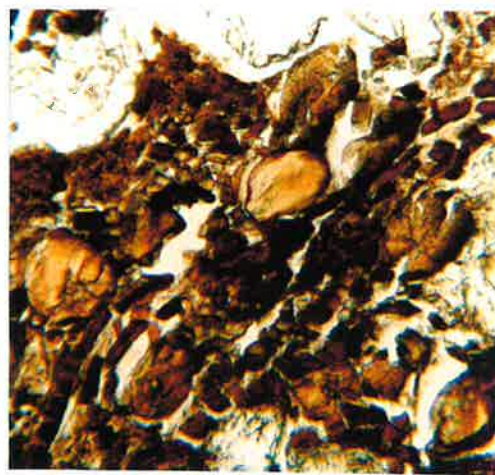
— 20 μ m

Figure 18. Photomicrograph of three fecal pellets, one containing the remains of a foraminifera.



— 10 μ m

Figure 19. Photomicrograph of algal material in peat matrix.



— 20 μ m

Figure 20. Photomicrograph of "resin globs" in peat.

Table 3. Summary of Petrographic Features of Peat Types from Pigeon Key

Peat Type	Dominant Species	Secondary Species	Composition	Carbonate	Sponge Spicules	Foraminifera	Radiolaria	Phycolith Type A
Avicennia	Avicennia nitida	Rhizophora mangle	Primarily rootlets	none to abundant	moderate to high	moderate to high	occasional	occasional
		Acrostichum aureum Batis maritima	with some roots, occasional leaves	present in two of three cores				
Rhizophora	Rhizophora mangle	Avicennia nitida Acrostichum aureum	Primarily rootlets with some roots, very few leaves	none to few, one core has small chunks of carbonate interspersed	none to high	none to moderate	none to moderate	none
Transitional	Conocarpus erecta Laguncularia racemosa	Acrostichum aureum Rhizophora mangle (intl.) Other sedge Cladium jamaicense (1 sample)	Primarily rootlets, some roots, occasional leaves	none	none to occasional	none to few	none	none
Cladium	Cladium jamaicensis	Conocarpus erecta Sagittaria spp. Rhizophora mangle (intl.)	Primarily rootlets, some roots, few leaves	none to very minor amounts (one core)	none to few	none	none	none
Hammock	Salix, Myrica, Persea	Possible Cephalanthus Cladium jamaicensis Sagittaria spp.	Primarily rootlets, roots, moderate leaves	none	none	none	none	none
Cladium-Sagittaria	Cladium jamaicensis, Sagittaria spp.	Other sedge	some roots, few leaves	none to very minor amounts (one core)	none to few	none	none	none
Emergent Aquatic	Pontederia, Eleocharis	Sagittaria spp. Other sedge	Primarily rootlets, some roots, leaves absent	none	none	none	none	none

Table 3. Summary of Petrographic Features of Peat Types from Pigeon Key (Continued)

Peat Type	Fungal Bodies	Pyrite	Fecal Pellets	Charcoal	Insect Parts	Algal Matter	Resin	Pollen	Palynomorphs
<i>Avicennia</i>	hyphae: few to moderate sclerotia: none to moderate spores: none to occasional striated spores: none	none to moderate	none to high	none, with the exception of one sample	none to moderate	occasional	none	<i>Avicennia</i> , <i>Rhizophora</i> , <i>Acrostichum</i> , <i>Batis</i> , <i>Conocarpus</i> , <i>Laguncularia</i> , <i>Chenopodiaceae</i> , <i>Myrica</i> , <i>Poaceae</i> , <i>Quercus</i> , <i>Alnus</i> , <i>Pinus</i> , <i>Cyperaceae</i> , <i>Compositae</i> , <i>Unidentified</i>	<i>Dinoflagellates</i> , <i>Concentricysts</i>
<i>Rhizophora</i>	hyphae: none to high sclerotia: none to high spores: none to occasional striated spores: none	few to high	none to high	none	none to moderate	none to moderate	none	<i>Rhizophora</i> , <i>Avicennia</i> , <i>Acrostichum</i> , <i>Batis</i> , <i>Laguncularia</i> , <i>Pinus</i> , <i>Chenopodiaceae</i>	<i>Dinoflagellates</i>
Transitional	hyphae: few to high sclerotia: none to high spores: none to high striated spores: none	few to high	few to moderate	none to moderate, increasing with depth	none to moderate	none to few	none to occasional	<i>Laguncularia</i> , <i>Conocarpus</i> , <i>Rhizophora</i> , <i>Avicennia</i> , <i>Acrostichum</i> , <i>Batis</i> , <i>Poaceae</i> , <i>Salix</i> , <i>Myrica</i> , <i>Cephalanthus</i> , <i>Cladium</i> , <i>Compositae</i> , <i>Chenopodiaceae</i> , <i>Palmae</i> , <i>Pinus</i> , <i>Ulmus</i> , <i>Typha</i> , <i>Unidentified</i>	<i>Unidentified spore</i>
<i>Cladium</i>	hyphae: few to moderate sclerotia: none to moderate spores: none to moderate striated spores: none	few to high	none to occasional	none to moderate, increasing with depth	none to occasional	none to high	none to moderate	<i>Pinus</i>	none
Hammock	hyphae: mod. to high sclerotia: mod. to high spores: mod. to high striated spores: few to occasional	none to high	low to high	high	low to moderate	none	abundant	<i>Salix</i> , <i>Myrica</i> , <i>Ilex</i> , <i>Cladium</i> , <i>Sagittaria</i> , <i>Pinus</i> , <i>Ulmus</i> , <i>Chenopodiaceae</i> , <i>Poaceae</i> , <i>Cyperaceae</i> , <i>Compositae</i> , <i>Polypodiaceae</i> , <i>Cephalanthus</i>	<i>Dinoflagellates</i> , <i>Oxidites</i> , <i>Zygnemataceae</i> , <i>Concentricysts</i>
<i>Cladium-Sagittaria</i>	hyphae: few to high sclerotia: none to high spores: none to moderate striated spores: few to occasional	none to high	none to high	none to high	none to moderate	none to few	none to high	<i>Sagittaria</i> , <i>Cladium</i> , <i>Salix</i> , <i>Chenopodiaceae</i> , <i>Ulmus</i> , <i>Myrica</i> , <i>Cyperaceae</i> , <i>Compositae</i>	none
Emergent Aquatic	hyphae: none to occasional sclerotia: none spores: none to few striated spores: none	moderate to high	none	none	none	none	none	<i>Chenopodiaceae</i> , <i>Portulacaria</i> , <i>Pinus</i> , <i>Cyperaceae</i> , <i>Poaceae</i> , <i>Typha</i> , <i>Compositae</i> , <i>Ficus</i> , <i>Sagittaria</i> , <i>Nuphar</i> , <i>Salix</i> , <i>Eleocharis</i> , <i>Cephalanthus</i>	<i>Botryococcus</i>

Figure 21.
Petrographic Data for Pigeon Key Core
PK-5-97

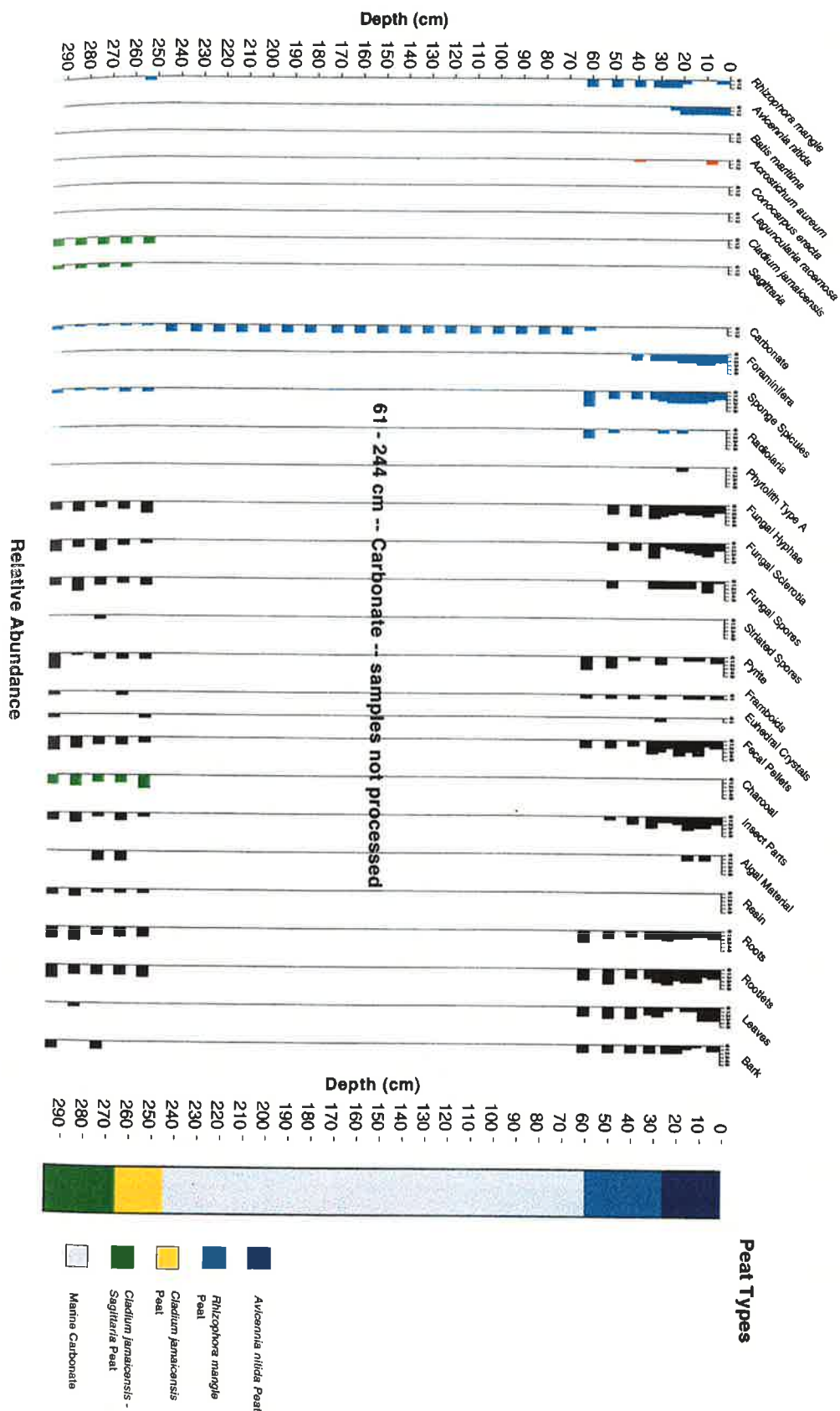


Figure 22.
Petrographic Data for Pigeon Key core PK-8-97

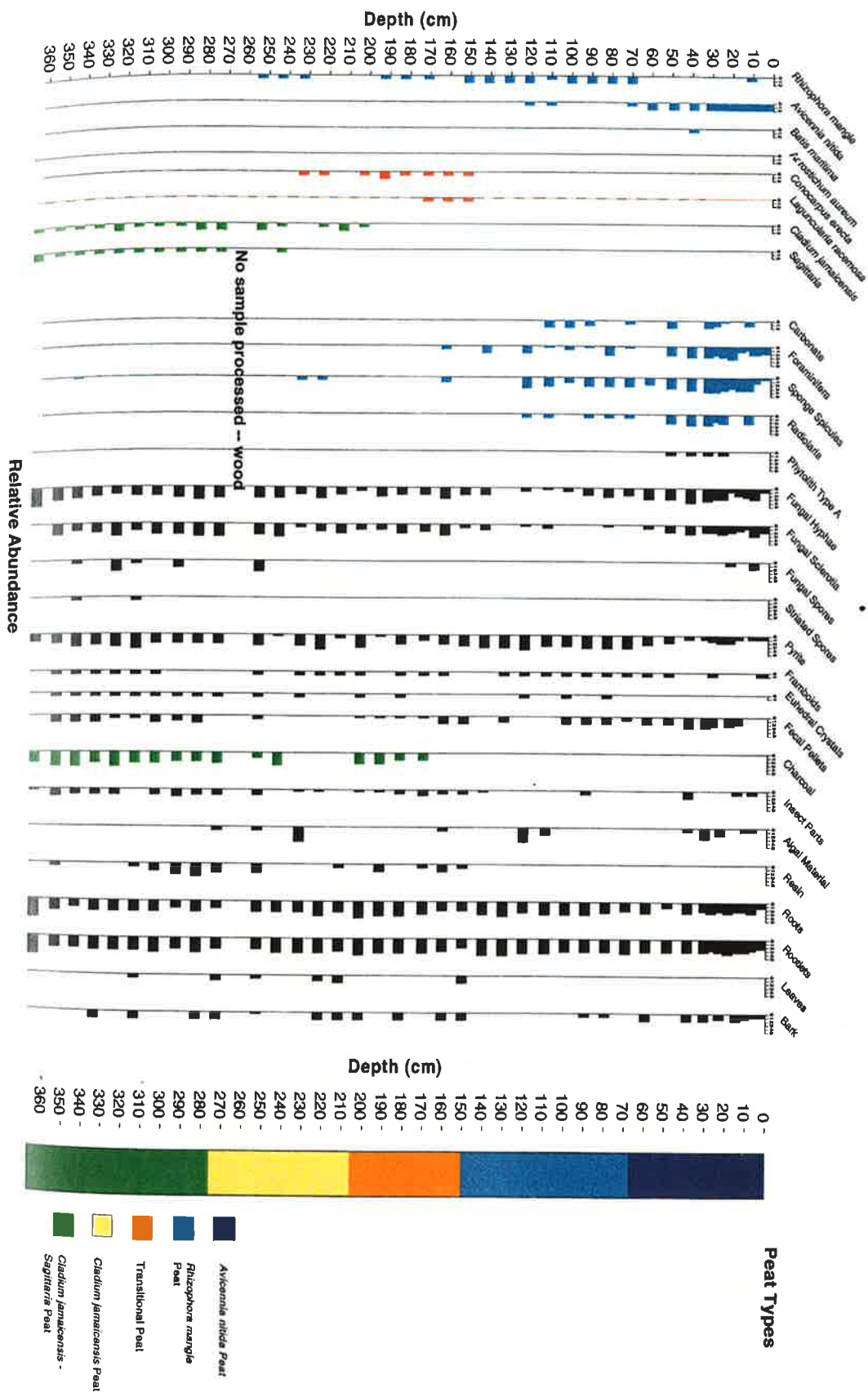
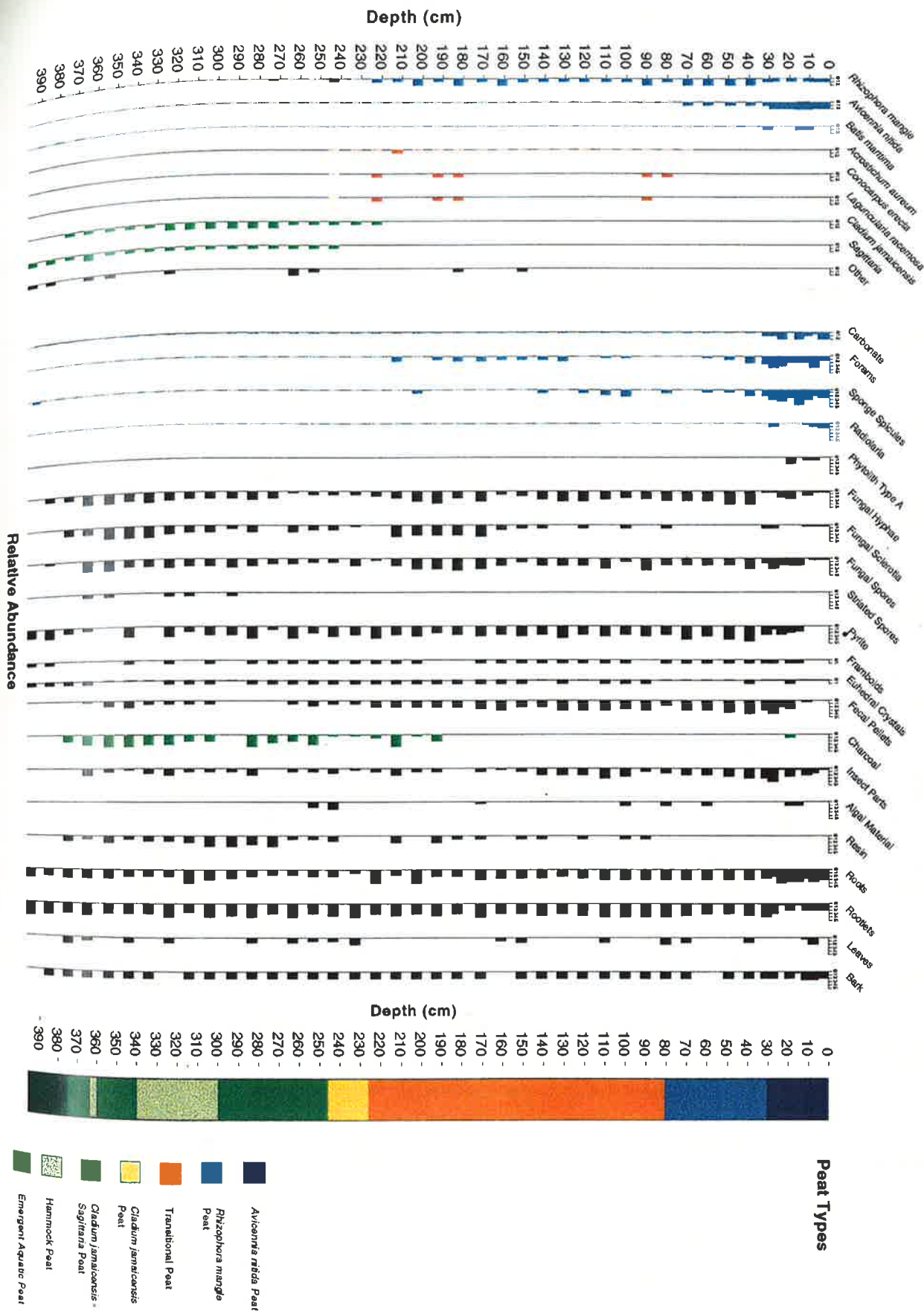


Figure 23
Petrographic Data for Pigeon Key Core
PK-10A-97



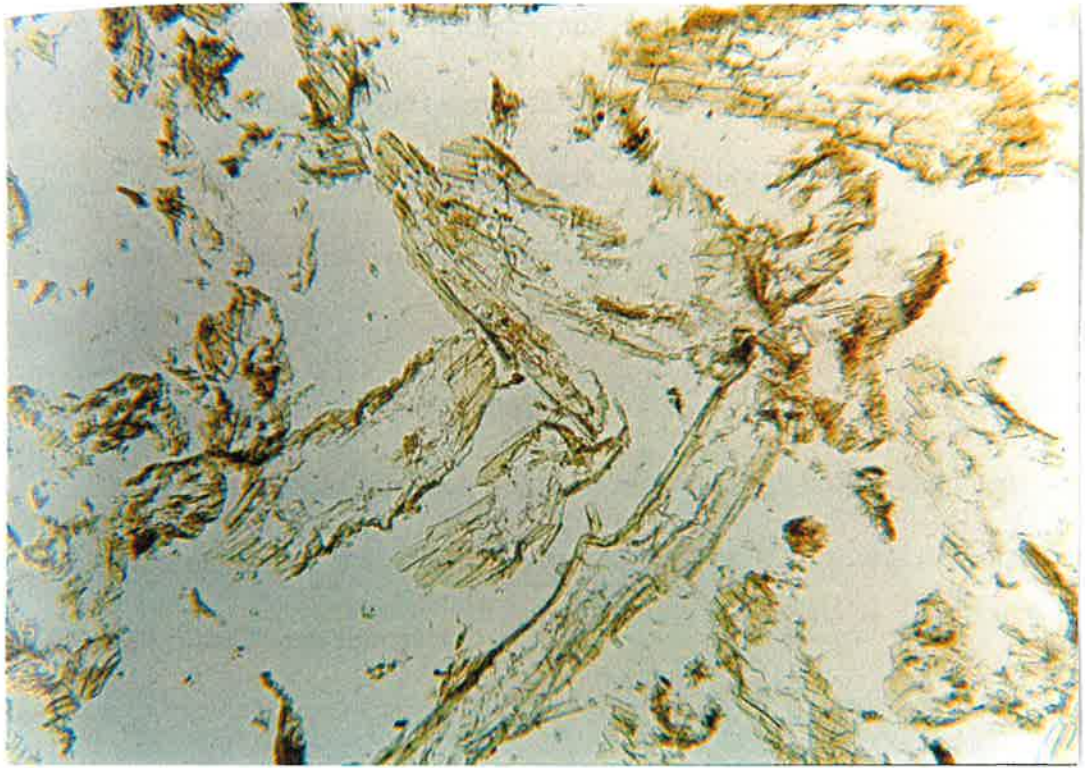
3.2.1. Emergent Aquatic Peat

3.2.1.1. Petrographic Characteristics

This peat was dominated by *Sagittaria* spp., *Pontedaria*, or *Eleocharis*, or a combination thereof. This peat was very "clean" in appearance in that it contained very little matrix material or fine-grained debris (**Figure 24**). The peat contained rootlets and roots, extremely minor amounts of fungal bodies and pyrite. Both framboidal and euhedral forms of pyrite were present. All plant tissues were moderately degraded, and a number included a gelatinous material in the intracellular areas. Few sponge spicules were present. Pollen found in the peat included *Chenopodiaceae*, *Pontedaria*, *Sagittaria*, *Pinus*, *Cyperaceae*, *Eleocharis*, *Poaceae*, *Typha*, *Compositae*, *Nuphar*, *Salix*, *Ficus*, and possible *Cephalanthus*. Also present were a number of unknown species and the alga *Botryococcus*.

3.2.1.2. Environment of Deposition

The very "clean" nature of the peat, virtually no matrix, low levels of fungal bodies, lack of charcoal, all suggest this peat was deposited in an intermittently ponded setting. The vegetation was dominated by *Pontedaria*, *Sagittaria*, or and *Eleocharis*, all of which are fresh water species which grow under relatively ponded conditions. Those samples with dominant *Eleocharis* probably correspond to environments in the Everglades where the fluctuating water table encourages the precipitation of algal mat-derived, fresh water carbonates.



____ 20 μm

Figure 24. Photomicrograph of emergent aquatic peat.

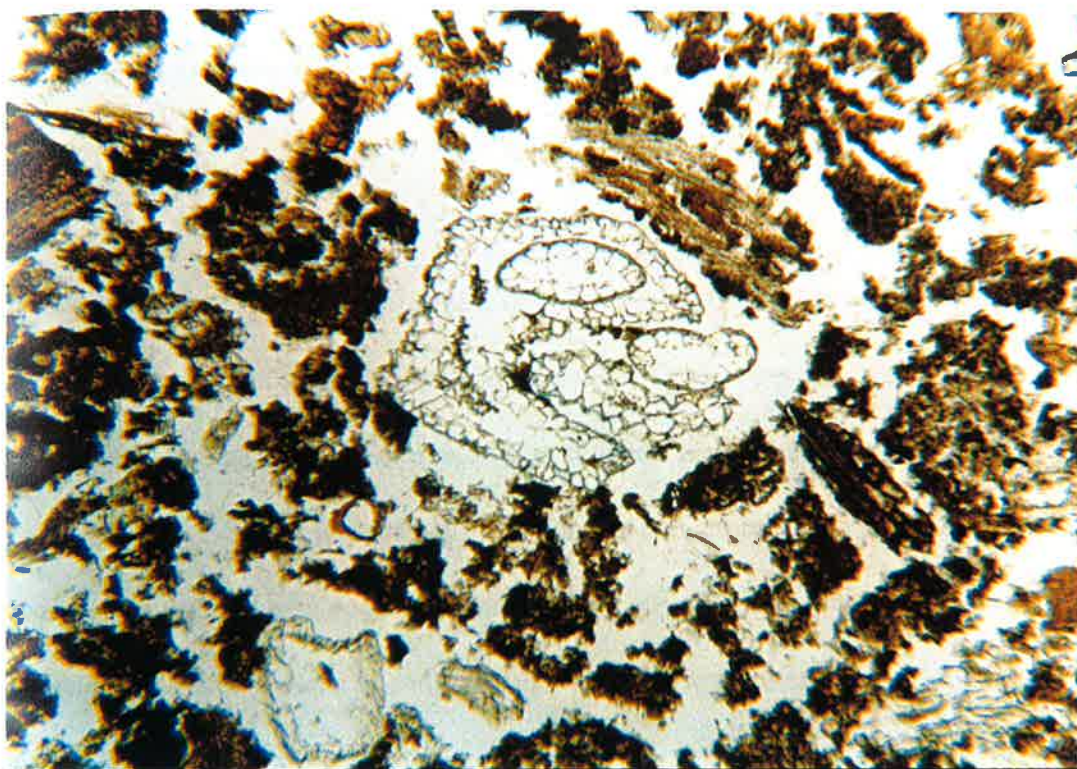
3.2.2. *Cladium - Sagittaria* Peat

3.2.2.1. Petrographic Characteristics

The peat was composed primarily of rootlets and roots, with the occasional leaf (**Figure 25**). These tissues, along with the occasional rhizome, were bound in a fine-grained, highly oxidized matrix. Tissues within the peat were highly degraded. Dominant species in the peat were *Cladium jamaicensis* and *Sagittaria* spp..

In addition to these plants, an unidentified species of sedge was also present. In general, the color of the peat ranged from light, yellowish brown to dark brown, and many samples were a mottled combination of the two. A number of *Sagittaria* tissues had been gelified. Cell fillings were abundant.

In general, carbonate and sponge spicules were absent with the exception of three samples. Foraminifera, radiolaria, and Phytolith Type A were absent. Fungal bodies were relatively abundant, including a striated spore (**Figure 26**) which was found in several samples. This spore appeared to be most common in, if not unique to, the *Cladium - Sagittaria* peat. In a study by Cohen and Spackman (1977), similar spores were found in a *Cladium-Nymphaea-Sagittaria* peat. Fecal pellets were present in moderate to high levels. Pyrite occurred in slightly higher levels, in both framboidal and euhedral forms. Charcoal was abundant. Low to moderate levels of insect parts were



— 20 μ m

Figure 25. Photomicrograph of *Cladium-Sagittaria* peat with *Sagittaria* rootlets in the center.

present. Algal material occurred infrequently in the matrix. "Resin globs" were abundant. Also included in the peat were seeds, species unidentified, and a charaphyte oogonium (**Figure 27**). Pollen species identified from this peat included *Cladium*, *Sagittaria*, *Pinus*, *Chenopodiaceae*, *Salix*, *Myrica*, *Ulmus*, and *Cyperaceae*. A number of unidentified pollen species, and dinoflagellates were also noted.

3.2.2.2. Environment of Deposition

The environment of deposition for the *Cladium* - *Sagittaria* peat is comparable to that of the *Cladium* peat. Both *Cladium* and *Sagittaria* are fresh water species. The lack of foraminifera, sponge spicules, and radiolaria suggests the environment is beyond any marine influence. The abundance of fungal bodies and charcoal indicates aerobic conditions. Finally, chara oogonium thrive in brackish and fresh water habitats. The presence of these organisms in conjunction with fresh water marsh species of vegetation provides evidence for a fresh water environment.

3.2.3. Hammock Peat

3.2.3.1. Petrographic Characteristics

The peat was composed of rootlets and roots, with moderate amounts of leaves, and an occasional piece of wood (**Figure 28**). A fine-grained, highly oxidized matrix bound these tissues, which were highly degraded. Roots of *Cladium jamaicensis* and *Sagittaria* spp. were included in the peat; however, unidentified shrub species dominated the samples. Based on the morphology of the roots and leaves, as well as the palynology, it



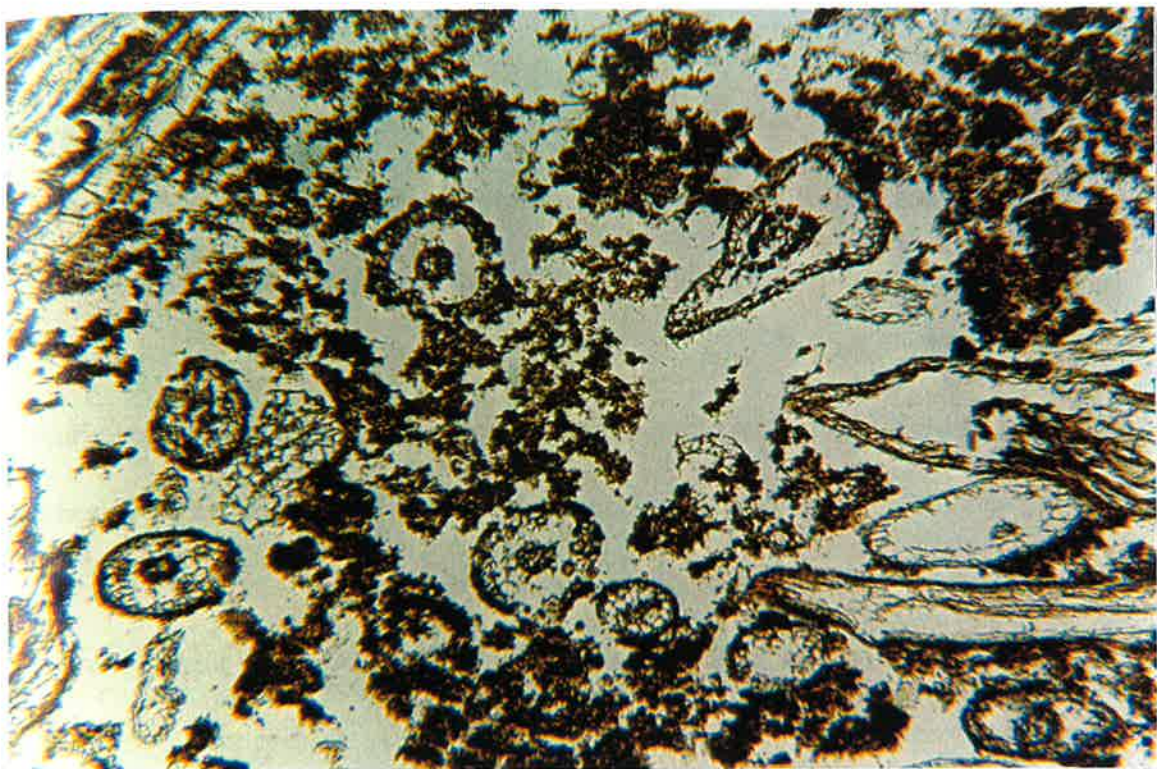
— 10 μm

Figure 26. Photomicrograph of a striated fungal spore.



— 5 μm

Figure 27. Photomicrograph of a charaphyte oogonium.



_____ 5 μ m
Figure 28. Photomicrograph of typical hammock peat.

is most likely that these shrub genera included *Salix*, *Persea*, *Myrica*, and *Cephalanthus*. More precise taxonomic assignments were not possible because of the degraded nature of these tissues. Due to the high degree of degradation within the tissues, it was not possible to positively identify each species.

In general, the color of the peat ranged from light, yellowish brown to dark brown, and many samples were a mottled combination of the two. Cell fillings and "resin globs", most likely derived from *Persea* tissues, were abundant.

Marine carbonate, foraminifera, sponge spicules, radiolaria, and Phytolith Type A were absent. Fungal bodies were abundant, including striated spores. Moderate levels of fecal pellets were present. Pyrite occurred in both framboidal and euhedral forms, however, it was not present in every sample. Charcoal was abundant. Low to moderate levels of insect parts were present. Algal material was not present. Pollen species identified from this peat included *Salix*, *Myrica*, *Ilex*, *Cladium*, *Sagittaria*, *Pinus*, *Chenopodiaceae*, *Ulmus*, *Poaceae*, *Cyperaceae*, *Polypodiaceae*, *Compositae*, and possibly *Cephalanthus*. A number of unidentified pollen species, dinoflagellates, and algal forms (*Concentricystes*, *Ovoidites*, and *Zygnemataceae*) were also noted.

3.2.3.2. Environment of deposition

The type of environment which commonly produces such a peat is one of a low, round or tear-drop shaped, fresh water, tree or shrub hammock (Davies and Cohen, 1989). In this

case, the hammock would have been dominated by *Myrica* (wax myrtle), *Ilex* (dahoon holly), and *Salix* (willows), with an understory of *Cladium* (sawgrass). Another species that was probably common in this hammock assemblage was *Persea borbonia* (red bay). However, its pollen are never found in ancient sediments because they are extremely fragile and readily decomposed.

Although commonly found above depressions in bedrock, the surface of the peat in such hammocks is most often at a higher elevation than the surrounding marsh. During dry periods, the surface of the hammock would be well aerated. Such conditions are recorded in the composition of the peat. That is, the peat contained tissues which were highly degraded, and bound in a fine-grained, oxidized, matrix. Charcoal and fungal bodies were abundant, and fecal pellets were present throughout the horizon.

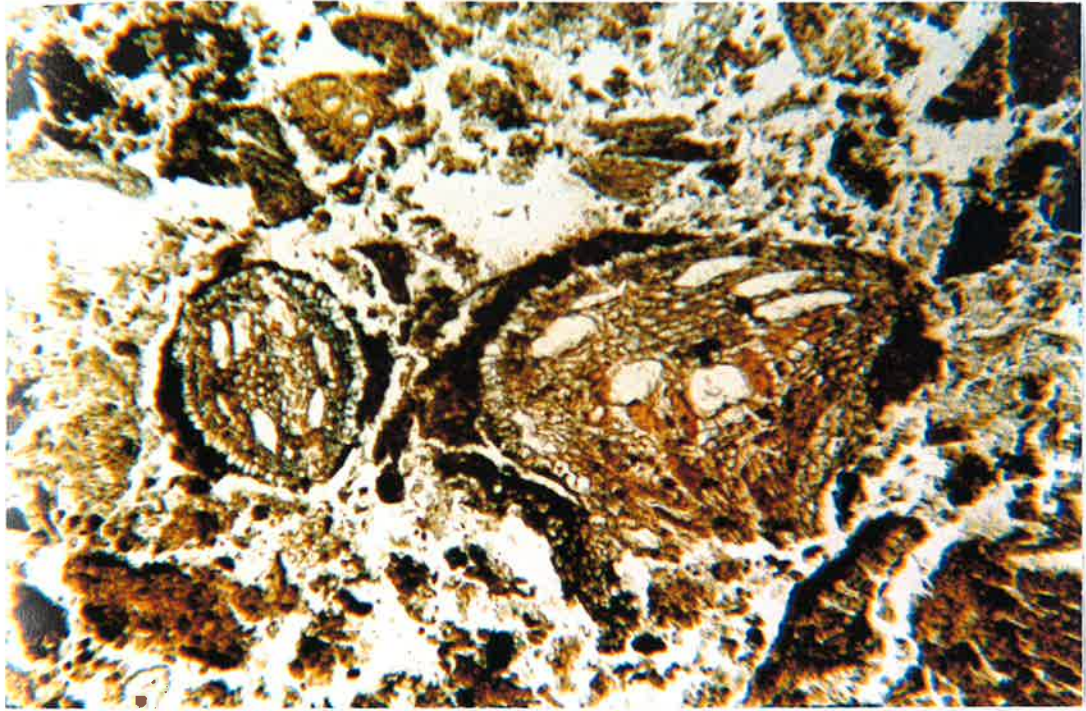
The possible presence of *Cephalanthus* in the peat would suggest a slightly different depositional environment. *Cephalanthus* is a plant often associated with hammocks. However, it rarely grows in the hammock itself. Rather, it prefers the "pre-hammock" or "hammock-fringe" environment (Davies and Cohen, 1989). *Cephalanthus* is one species of shrub which is first to colonize the "pre-hammock" (Cypert, 1972, Gleason et al., 1984, Davies and Cohen, 1989). While this setting is drier than the surrounding marsh, it is not as elevated as the tree hammock. Sedges such as *Cladium* often inhabit this environment, along with some small shrubs (Davies and Cohen, 1989).

3.2.4. *Cladium* Peat

3.2.4.1. Petrographic Characteristics

The composition of this peat was largely rootlets and fine-grained debris (Figure 29). Occasional roots and leaves were also present along with rare pieces of wood, perhaps derived from small shrubs, such as *Myrica cerifera* (wax myrtle) or *Cephalanthus occidentalis* (button bush). Most tissues were highly degraded and oxidized. In addition to *Cladium jamaicensis* (sawgrass, formerly known as *Mariscus jamaicensis*) other species occurring in minor amounts are *Conocarpus erecta*, *Rhizophora mangle*, and *Sagittaria* spp.. *Rhizophora* tissues were most often better preserved than the surrounding tissues, suggesting they were not present when the surrounding peat was deposited. Rather, the *Rhizophora* rootlets had intruded down into the *Cladium* peat. Also included in the peat were *Cladium* rhizomes. The peat was dark brown to a mottled light and dark brown in color.

Overall, this peat was devoid of carbonate. However, it did appear in minor amounts in three samples. Foraminifera and radiolaria were absent. Very few sponge spicules were present in a limited number of samples. Low to moderate levels of fungal bodies, fecal pellets, and charcoal were present. Pyrite, present in both framboidal and euhedral form, occurred in variable levels ranging from low to high. Occasional insect parts and algal material (in matrix) were present. Also included in the peat were seeds. Moderate levels of "resin globs" were present. Very few pollen grains were found in the *Cladium* peat samples. In fact, with the exception of a few *Pinus*, the slides were barren.



— 20 μ m

Figure 29. Photomicrograph of *Cladium* peat with two partially decomposed *Cladium* roots located in the center.

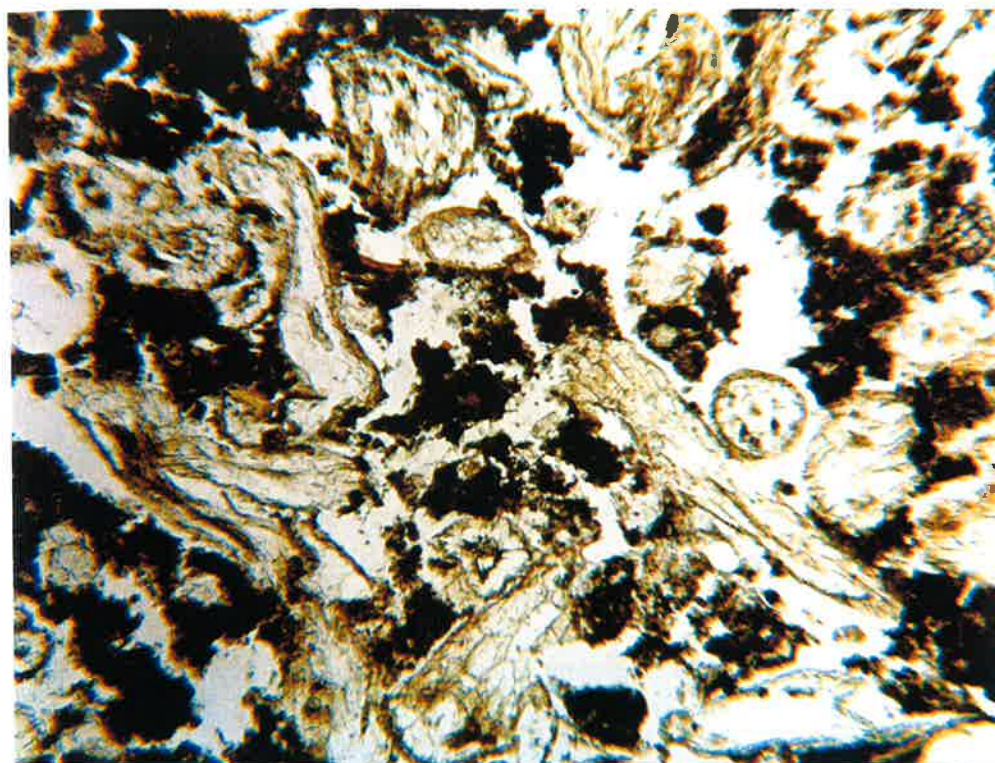
3.2.4.2. Environment of Deposition

The environment of deposition of this peat corresponds to the *Cladium-Sagittaria-Panicum* community described by Loveless (1959). In this fresh water environment, *Cladium jamaicensis* may appear in pure stands or, more commonly, in association with *Sagittaria*, *Panicum hemitomom* (maidencane), *Pontedaria lanceolata* (pickerel weed), or *Typha* spp. (cattails). Abundance and density of the various species is dependent upon the water level of the environment (Loveless, 1959). The lack of foraminifera and radiolaria suggests that this environment lies beyond marine influence. The presence of fungal bodies and charcoal indicates a relatively dry, aerobic environment, at least for certain times of the year. Pollen data suggested shrub forms of vegetation, such as *Myrica*, *Salix* (willow) and *Cephalanthus*, were located in surrounding areas.

3.2.5. Transitional peat

3.2.5.1. Petrographic Characteristics

In general, the composition of the peat was primarily rootlets, with some roots and occasional leaves in a dark, granular, matrix (**Figure 30**). Sporadically, pieces of wood were included. Plant tissues were highly degraded, and the peat contained an abundance of fine-grained debris. The color of the peat ranged from light brown to reddish brown to dark brown. Vegetation present in the Transitional peat was dominated by *Conocarpus erecta* and *Laguncularia racemosa*. *Acrostichum aureum*, *Rhizophora mangle*, and an unidentified species of sedge were found in several samples. *Cladium jamaicensis* was



— 20 μm

Figure 30. Photomicrograph of transitional peat.

present in one sample. Several root tips and cortical tissue of *Rhizophora* were included in the peat. In general, the *Rhizophora* tissues were not as highly degraded as the others, suggesting the Red Mangrove roots had intruded into the Transitional peat from an above horizon. Many of the plant tissues contained cell inclusions, including secondary cell fillings. Carbonate, radiolaria, and Phytolith Type A were not present in this peat. Foraminifera and sponge spicules were only present in approximately half of the samples. Where present, their numbers were significantly low. Fungal bodies were relatively abundant, particularly hyphae and sclerotia. Fungal spores appeared in moderate abundance. Pyrite was present in all samples, in relative abundance. Both framboids and euhedral crystal occurred. Moderate numbers of fecal pellets were found throughout the peat. Charcoal, although absent from the upper samples in the peat horizon, was present at greater depths. Insect remains were found throughout the peat. Algal material was rare. Also present were "resin globs". Pollen species identified from the Transitional peats included *Chenopodiaceae*, *Batis*, *Rhizophora*, *Avicennia*, *Poaceae*, *Conocarpus*, *Laguncularia*, *Compositae*, *Pinus*, *Acrostichum*, *Salix*, *Palmae*, *Myrica*, *Cladium*, *Cephalanthus*, *Typha*, and *Ulmus*.

3.2.5.2. Environment of Deposition

Conocarpus erecta and *Laguncularia racemosa* are two species of trees typically restricted to the landward fringe of the mangrove community (Tomlinson, 1986).

Conocarpus erecta "prefers" fresh water environments, but is tolerant of high salinity and rather dry soil. Typically, the transitional environment consists of an open stand of trees

and shrubs such as *Conocarpus*, *Laguncularia*, and/or *Rhizophora*. In addition to these trees and shrubs, various marsh plants such as *Cladium* and *Acrostichum* are common (Cohen and Spackman, 1977). The presence of foraminifera and sponge spicules suggests a marine influence in this zone. However, the fact that they are present in very low numbers indicates that marine waters reach this area only during extreme high tides. The common occurrence of fungal bodies and the presence of charcoal suggest the surface environment was relatively dry and aerobic. Such an environment would have been hospitable to fungal decay and fires. The abundance of fecal pellets suggests active bioturbation, contributing to the highly degraded nature of the tissues.

3.2.6. Rhizophora Peat

3.2.6.1. Petrographic Characteristics

This peat type was primarily composed of highly degraded rootlets in a fine matrix (Figure 31). In general, the samples contained abundant debris. However, there were a very limited number of samples in which the peat was simply a rootlet hash. Roots appeared frequently and leaves were rare. Symbiotic fungi (as per Cohen, 1968) were observed on a number of *Rhizophora* roots. In the samples that did contain leaves, corkwarts were present. Orange cortical tissue (red mangrove) was found in several samples.

The color of the peat varied from red-brown to light to dark brown. While the peat was dominated by *Rhizophora mangle*, both *Avicennia nitida* and *Acrostichum aureum* also

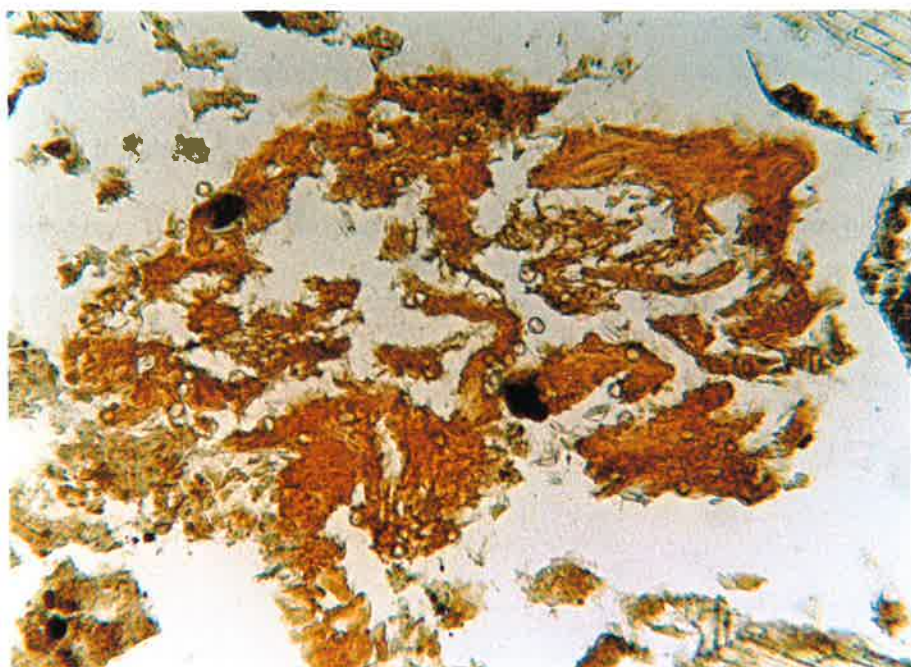


— 20 μ m

Figure 31. Photomicrograph of *Rhizophora* peat.

occurred. Carbonate was rare, and where it did occur, it was most often present in the form of small masses, infrequently occurring in the matrix. In the samples which contained foraminifera and sponge spicules, these appeared in moderate abundance in the upper portion of the peat horizon. With depth, their numbers diminished significantly, and in many cases, they were absent from the lower samples. Radiolaria were present, yet reasonably sparse, following the same trend of decreasing abundance with depth. Shell fragments were present in a number of samples.

In general, fungal bodies were included in the peat in moderate abundance. However, their occurrence was highly variable among the various forms (hyphae, sclerotia, spores), and between cores (refer to **Figures 21, 22, and 23**). Cell inclusions were abundant in both the plant tissues as well as in the matrix. Pyrite was abundant, predominantly as framboids. Fecal pellets, of varying colors and textures, were present in moderate abundance. Charcoal and resinous material were absent from the peat, and algal matter was present in only minor amounts. The abundance of insect parts was variable between cores. However, overall, they were present in moderate abundance, although they were absent from several samples. One sample included a *Rhizophora* anther bound in a fecal pellet. The anther was filled with *Rhizophora* pollen (**Figure 32**). Other pollen identified from the samples included *Acrostichum*, *Avicennia*, *Laguncularia*, *Pinus*, *Chenopodiaceae*, and *Batis*. Dinoflagellates were also identified in the samples.



_____ 5 μ m
Figure 32. Photomicrograph of a *Rhizophora* anther with abundant pollen.

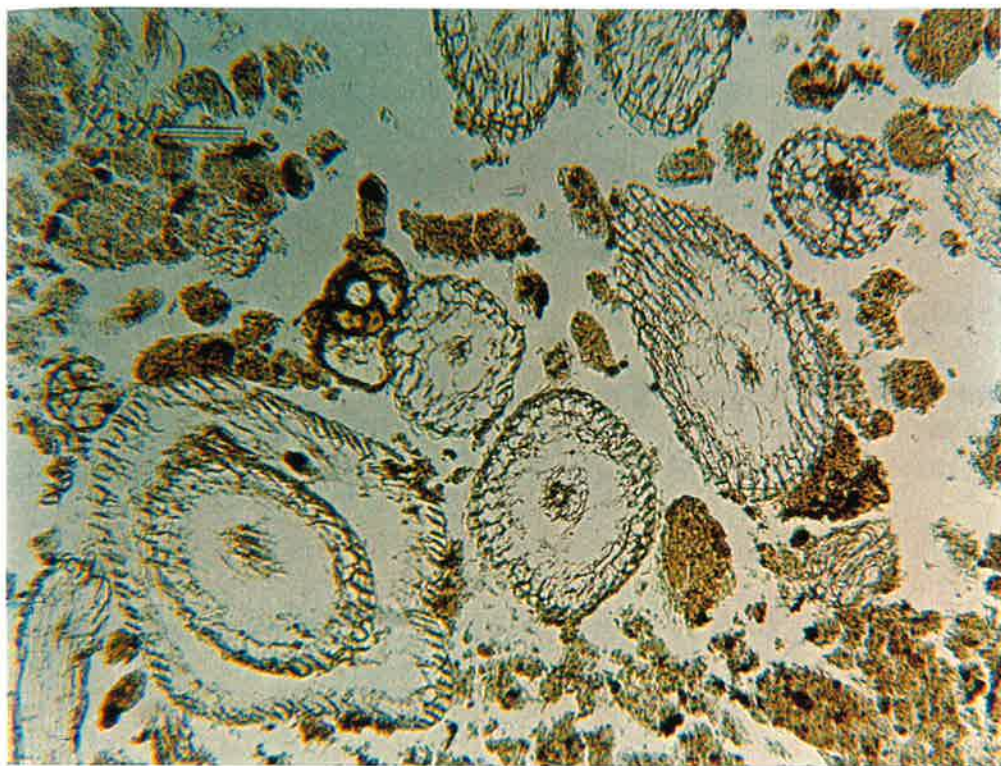
3.2.6.2. Environment of Deposition

Rhizophora mangle, or the red mangrove, is commonly found in subtropical to tropical marine to brackish coastal regions. Able to withstand a broad range in salinity, *Rhizophora* are often found in exposed coastal regions as well as in brackish to nearly fresh water regions at the headwaters of coastal streams (Cohen and Spackman, 1977). The structure of the tree, primarily the prop-roots, enables it to withstand the pounding of waves along the shore. *Rhizophora* may occur in pure stands or with other species. In more saline regions, *Rhizophora* are often found with *Avicennia nitida* (particularly in regions of high inorganic sedimentation, e.g. marine carbonate), *Batis maritima* (pickle weed), *Salicornia perennis*, *Sesuvium portulacastrum*, and *Dondia linearis*. In less saline regions, *Rhizophora* are often associated with *Acrostichum aureum* and *Cladium jamaicensis* (Cohen and Spackman, 1977).

3.2.7. *Avicennia* Peat

3.2.7.1. Petrographic Characteristics

This peat was primarily composed of rootlets in a fine-grained matrix (**Figure 33**). A few larger roots and leaves were occasionally also present. Few pieces of wood were included. Most plant tissues were degraded, and the microscopic color of the peat ranged from brown to light brown to gray. While the dominant species was *Avicennia nitida* (black mangrove), *Rhizophora mangle* (red mangrove), *Acrostichum aureum* (leatherleaf fern), and *Batis maritima* (pickle weed), were also associated with this peat type.



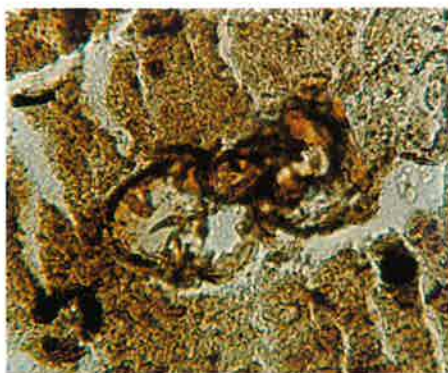
5 μ m
Figure 33. Photomicrograph of *Avicennia* peat, showing rootlets, sponge spicules and foraminifera.

Carbonate was common in very small lenses as well as in the matrix of the peat. In areas including carbonate, plant tissues appeared to have undergone a higher degree of degradation. Sponge spicules, foraminifera, and radiolaria were found in all of the samples of *Avicennia nitida* peat. A number of the spicules were barbed, characteristic of marine sponges (**Figure 34**). Unlike in the other peat types, foraminifera retained their calcareous tests in the *Avicennia* peat. In other peats, the tests were dissolved, leaving only their pseudochitinous interior walls (**Figure 35**). Fungal bodies (hyphae, sclerotia, spores) were present in the peat in relatively low abundance. On average, their presence was the lowest in the upper 5-10 cm of the peat horizon, where they were often nearly absent. Phytolith Type A was found in a number of the samples, as was algal material. Algal material was present in the matrix of the peat, often in conjunction with carbonate. Fecal pellets were included in the majority of the thin sections. However, in general, their abundance increased with depth, and they were completely absent, or present only in very minor amounts, in the upper portion of the peat horizon.

Pyrite was present in low to moderate amounts. Often absent in the upper portion of the horizon, pyrite levels increased with depth. In all but one sample, pyrite was present in the form of framboids. Similarly, charcoal was absent from the *Avicennia* peat, with the exception of one sample. Insect parts were present in extremely minor to moderate levels. No "resin globs" were discovered. Pollen species present in the peat included *Avicennia*, *Rhizophora*, *Chenopodiaceae*, *Acrostichum*, *Pinus*, *Batis*, *Alnus*, *Laguncularia*, *Poaceae*, *Compositae*, *Quercus*, *Cyperaceae*, *Conocarpus*, and *Myrica*. In



_____ 5 μ m
Figure 34. Photomicrograph of a
 marine sponge spicule.



_____ 5 μ m
Figure 35. Photomicrograph of the pseudochitinous
 inner walls of a foraminifera.

addition to these species, an unidentified triporate, scabrate form and tetrad were found, along with dinoflagellates, and the algal *Concentricystes*.

3.2.7.2. Environment of Deposition

Avicennia nitida is a mangrove native to subtropical to tropical, coastal, marine environments. Purest stands of *A. nitida* are found in regions of high salinity and relatively high rates of marine lime mud deposition (Cohen and Spackman, 1977).

Avicennia are generally found growing in association with *Rhizophora mangle*, *Laguncularia racemosa* (white mangrove), and *Conocarpus erecta* (buttonwood mangrove). In general, *Avicennia* inhabit areas of higher elevation and salinity than *Rhizophora*.

4. STRATIGRAPHIC RELATIONSHIPS

4.1. Petrography

As described in the previous section, seven types of peat were found in the cores from Pigeon Key. The distinct qualities of each peat type are largely the result of local salinity and water level. Peat types/environments ranged from fresh water environments (i.e. fresh water marsh represented by emergent aquatic and *Cladium-Sagittaria* peats) to highly saline (i.e. *Avicennia* environment) (**Figure 36**).

While Davies (1980) and Davies and Cohen (1989) stated that there was no marine carbonate at Pigeon Key, this is not necessarily the case. Of the ten cores studied from Pigeon Key, only one core, PK-10, was completely devoid of marine carbonate (**Figure 37**). While PK-9 appears to be composed entirely of marine carbonate, the core is incomplete. At 274 cm, coring ceased prior to reaching bedrock due to technical difficulties in the field. However, evidence from other cores in the area would suggest that some small increment of basal peat may reside in the missing lower section. Along the eastern coast of the island, core PK-5 contained a rather large interruption in the peat sequence (approximately 185 cm) by marine carbonate. In the other cores, however, the marine carbonate lenses are considerably smaller.

Figure 36. Stratigraphy of cores from Pigeon Key

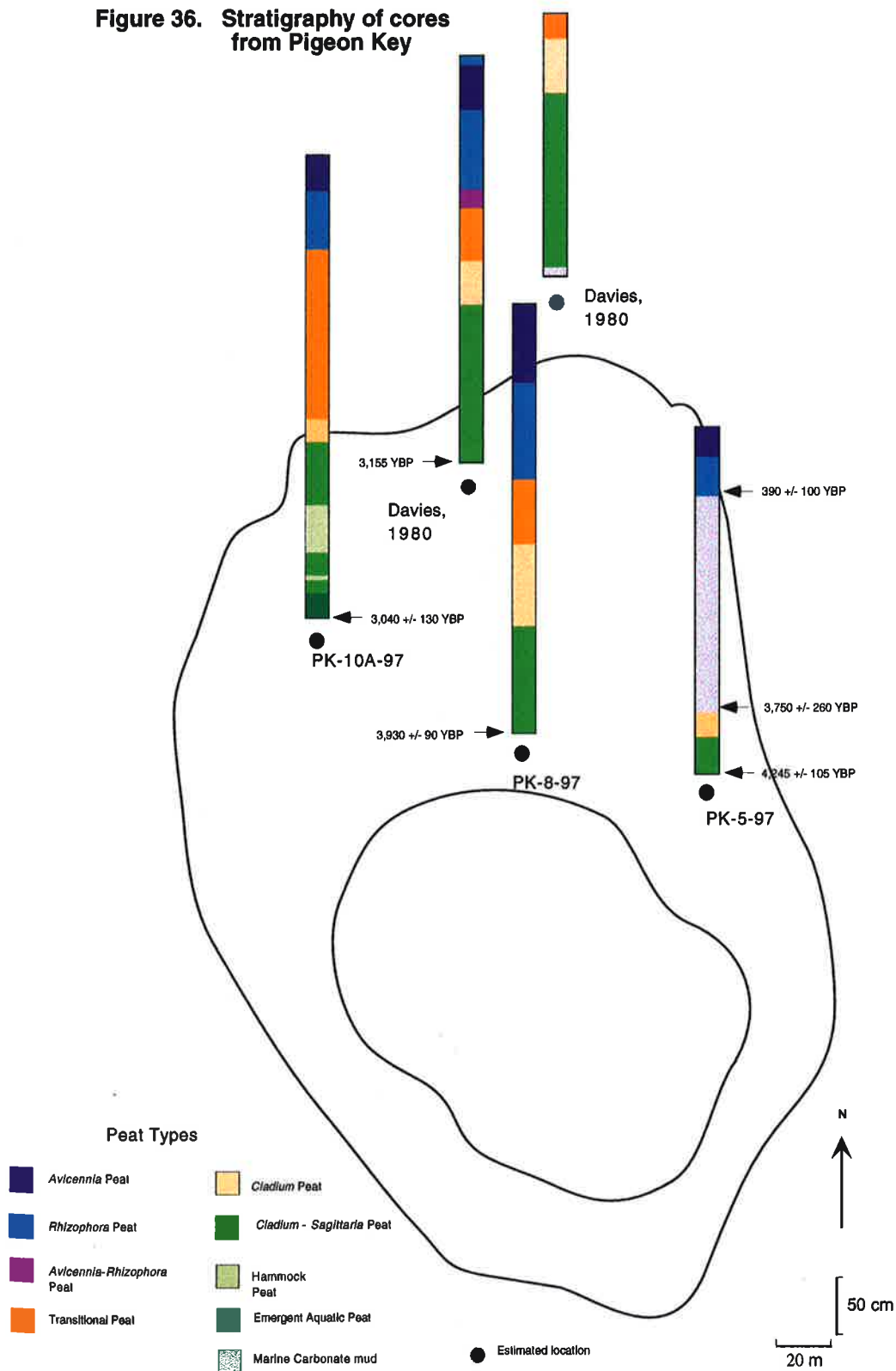
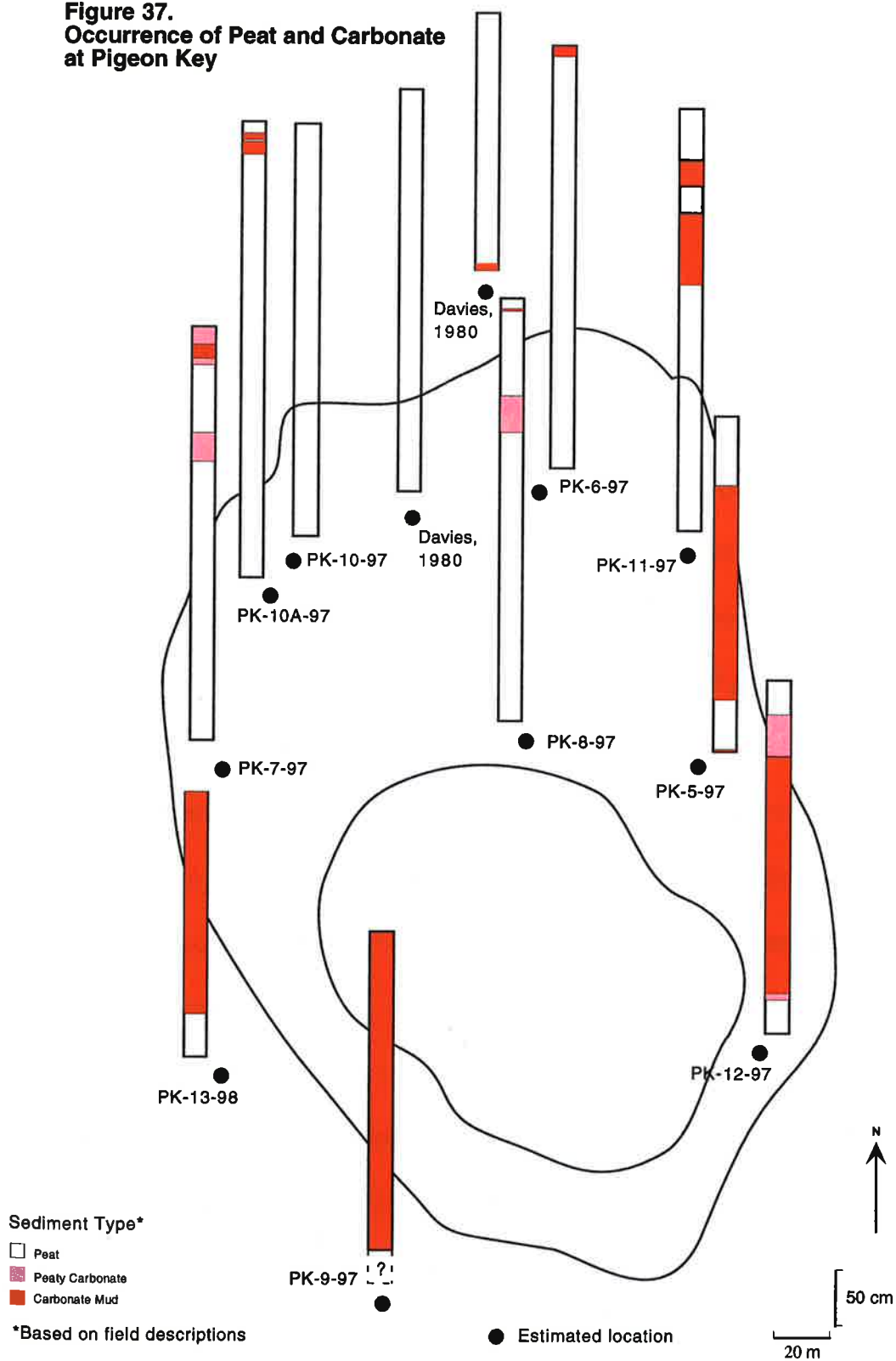


Figure 37.
Occurrence of Peat and Carbonate
at Pigeon Key



Despite the interruption of some of the peat sequences by marine carbonate, there does appear to be an overall trend imprinted upon all of the core sequences. That is, the salinity of the depositional environment tended to increase over time. Fresh water peats were found at the base of each core, grading into brackish peats, and finally into marine peats at the top.

Cores PK-5 and PK-8 consisted of *Cladium-Sagittaria* peat at their bases, which dated at 4,245 years before present (YBP) $\pm$ 105 years and 3,390 YBP $\pm$ 90 years, respectively. Core PK-5 contained a very thin lens of fresh water carbonate between this peat and bedrock. Basal sediments for core PK-10A consisted of emergent aquatic peat, dating to 3,040 YBP $\pm$ 130 years, which was overlain by *Cladium-Sagittaria* peat. As core PK-10A is over 30 cm deeper than cores PK-5 and PK-8, it is possible that PK-10A was located in a depression, and when initial deposition occurred, conditions were consequently more favorable for occupation by purer stands of *Sagittaria*. The basal sample at PK-10A may also contain some fresh water carbonate, as indicated by the presence of "*Eleocharis* flat"-type vegetation, indicative of a fresh water carbonate generating environment.

In addition to the presence of *Sagittaria* peat at the base, Core PK-10A also differs from cores PK-5 and PK-8 in that the *Cladium-Sagittaria* peat was interrupted by two horizons of hammock peat (**Figures 23, 37**). A thin lens of the peat was present at a depth of 365-360 cm, and a thicker zone was found at 340-300 cm. Above, below, and in between these zones was *Cladium-Sagittaria* peat. The presence of this peat suggests that water

levels ~~wavered~~, allowing for a very brief, and then a more extended time period of higher and drier conditions at PK-10A. Hammock peat was not encountered in core PK-5 or core PK-8.

In all three cores, *Cladium* peat was found on top of the *Cladium-Sagittaria* peat. Based on these peat types, and previous work of Davies (1980), it is evident that Pigeon Key was initially a fresh water marsh, occupying a slightly irregular substrate of eroded limestone. Fresh water hammock vegetation occupied this site intermittently some time after marsh development.

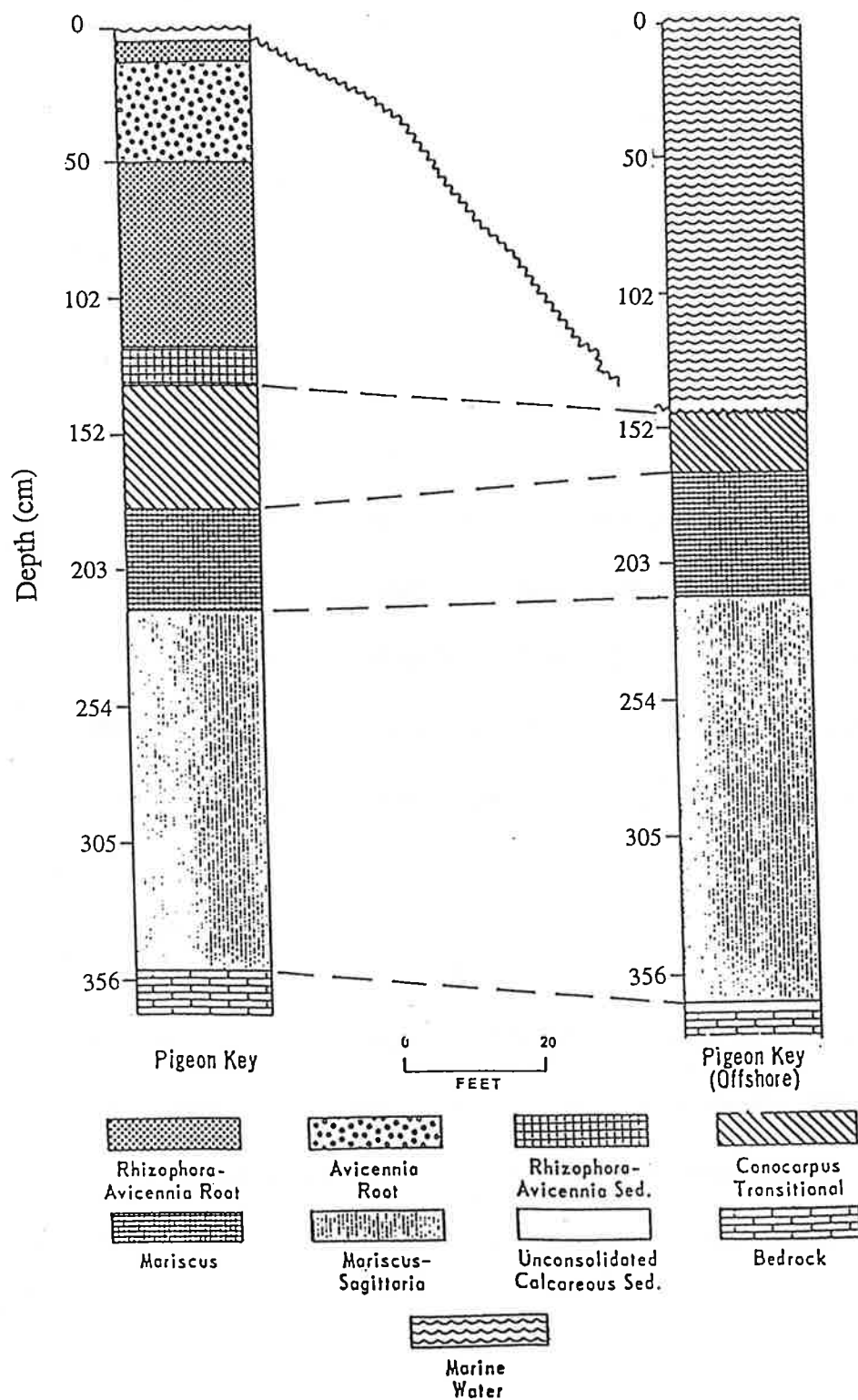
In contrast to core PK-5, where the fresh water peat was eroded and covered by marine carbonate, the basal fresh water marsh peats at core locations PK-8 and PK-10A were overlain by a transitional peat, representing a brackish water environment.

Immediately above the transitional peat at sites PK-8 and PK-10A was *Rhizophora* peat, which was overlain at all localities by *Avicennia* peat. Together, these two peat horizons represent a coastal, marine environment. In general, the succession from fresh water peats to marine peats indicates a marine transgression over time. However, the superposition of *Avicennia* peat on *Rhizophora* peat suggests a slight regression, as *Avicennia* tends to prosper at slightly higher and drier elevations than *Rhizophora*. The reestablishment of peat sedimentation above the marine carbonate at site PK-5 might also argue for a slight regression (or halt) in sea level rise.

Similar sequences of peat types were observed by Davies (1980) and Davies and Cohen (1989). **Figure 38** shows two cores included in those studies. One core was taken from the northern end of the island, and the other approximately 23 m offshore, north of the key. While the upper portion (147 cm) of the offshore core was absent, presumably eroded, the sequence of peat types present corresponds with those found in cores PK-5, PK-8, PK-10A (fresh water peat overlain by brackish peat, overlain by marine peat). The base of the offshore core also included fresh water carbonate (Davies, 1980).

The two major differences in Pigeon Key stratigraphy described in work completed by Davies (1980) and Davies and Cohen (1989) and that found in the current study are the presence of hammock peats within the fresh water zone (PK-10A), and *Avicennia* peat at the surface. Davies (1980) did not identify a hammock peat in his petrographic analysis of the Pigeon Key cores. However, as will be discussed below, an abundance of hammock species were identified in the palynology. In addition, while *Avicennia* peat was found at the surface for cores PK-5, PK-8, and PK-10A, Davies (1980) found a thin layer of *Rhizophora* peat at the surface of his core from the northern end of the island. However, this peat was underlain by *Avicennia* and *Rhizophora* peats. Davies (1980) also determined there to be a horizon of *Avicennia-Rhizophora* peat between the *Rhizophora* and the transitional peats. In general, however, the sequence determined by Davies (1980) is comparable to that discussed above. The slight differences may reflect slight differences in vegetational communities within the region from one site to another.

Figure 38. Stratigraphy of Pigeon Key cores (from Davies, 1980)



As part of this study, one core, PK-13, was taken off the southwestern shore of the island, in approximately 1 m of water (**Figure 37**). The upper portion of the core consisted of 190 cm of marine carbonate mud. Underlying the calcareous sediment was 11 cm of peat. The peat was not analyzed petrographically as part of this study. However, its presence is significant as it supports Davies' and Cohen's (1989) theory that a blanket of peat once existed over most of Florida Bay. At the very least, the presence of these peats suggests that Pigeon Key was once much larger than it is today.

4.2. Palynology

Palynologic data from core PK-10A are presented in (**Figure 39**). Data presented represent the relative abundance of species, as precise pollen counts were not performed on the slides. Based on this data, the core can be divided into three zones: a basal fresh water zone (396-225 cm), an intermediary brackish zone (225-85 cm), and a marine zone extending to the surface (85-0 cm). These zones roughly correspond with those determined by micropetrographic analyses (**Figure 23**), except that the transitional zone is significantly compressed.

The fresh water zone extends from a depth of 200 cm to the base of the core. Comprising this zone are three major subzones, representing (1) a ponded community, (2) fresh water marsh, and (3) tree hammock environments (**Figure 39**). The ponded community is located at the base of the core, underlying the fresh water marsh. The hammock environment appears as two



interruptions to the marsh setting. Zones of hammock assemblages were found at depths of 365-360 cm and 340-300 cm. Above, below, and in between the hammock zones, fresh water marsh assemblages were present.

Fresh water, ponded assemblages comprise the base of the core, and the lower 20 cm of the fresh water zone. Species present include *Chenopodiaceae*, *Pontedaria*, *Pinus*, *Cyperaceae* (*Eleocharis*), *Poaceae*, *Typha*, *Compositae*, *Sagittaria*, *Nuphar*, *Salix*, *Ficus*, and possible *Cephalanthus*. Also present were a number of unknown species and the alga *Botryococcus*. The lowermost samples, dominated by *Chenopodiaceae* and *Cyperaceae*, most likely represent an *Eleocharis* flat, which possibly contained fresh water carbonate. Such a setting would have been located near ponds, with scattered shrubs and cattail (*Typha*). The upper portion of this zone consisted of fresh water, ponded aquatic vegetation, most likely dominated by *Pontedaria*.

Species comprising the fresh water marsh zone (376-365 cm, 360-340 cm, 285-200 cm) include *Cladium*, *Sagittaria*, *Pinus*, *Chenopodiaceae*, *Salix*, *Myrica*, *Ulmus*, and *Cyperaceae*. Species comprising the tree hammock zone (365-360 cm, 340-285 cm) include *Salix*, *Myrica*, *Ilex*, *Cladium*, *Sagittaria*, *Pinus*, *Chenopodiaceae*, *Ulmus*, *Poaceae*, *Cyperaceae*, *Compositae*, *Polypodiaceae*, *Compositae*, and possibly *Cephalanthus*. A number of unidentified pollen species, dinoflagellates, and algal forms (*Concentricystes*, *Ovoidites*, and *Zygnemataceae*) were also present.

At the top of the final zone of hammock vegetation, and in the samples just above the hammock in the marsh, the slides were practically barren of pollen (287-236 cm).

Whether this is indicative of particular environmental factors, or of improper processing is unclear. Based on petrographic data, this zone is composed of hammock peat, *Cladium-Sagittaria* peat, and *Cladium* peat. At this depth, these peat types displayed an abundance of charcoal and fungal material, suggesting an oxidizing environment. It is possible that the oxidizing nature of the environment had an effect on the degree of preservation of the pollen within the samples.

At the very top of the fresh water zone, pollen again appeared in abundance, and included considerable numbers of *Myrica* (a hammock tree), while all marsh species were absent (**Figure 39**). A somewhat smaller increment of this core was previously identified from the micropetrographic analysis as having hammock vegetation. This would suggest that hammock vegetation was nonetheless nearby during this entire increment so that its pollen was readily blown into this area. Another notable quality about this fresh water horizon is that the grains present in the sample were poorly stained, perhaps again, suggesting a highly oxidizing environment (Cohen, 1998).

Overlying the fresh water zone, the transitional zone extended from a depth of approximately 200 cm to 120 cm. This zone was characterized by the presence of a brackish water, terrestrial pollen assemblage consisting of *Conocarpus*, *Laguncularia*, *Acrostichum*, *Chenopodiaceae*, and *Compositae*. Fresh water species such as *Cladium*, *Poaceae*, *Myrica*, *Salix*, and *Cephalanthus*, were present in the lower portion of the zone, and then replaced by marine species at the top. Such marine species included *Avicennia*, *Batis*, and *Rhizophora*. Other plant species found in the zone consisted of *Typhae*, *Pinus*, *Ulmus*, and *Palmae*.

The upper 120 cm of the core constitute a third zone, representing a coastal, marine environment. In addition to pollen, dinoflagellates, characteristically marine, were present, particularly in the uppermost portion. The lower 70 cm of the zone is dominated by the coastal mangroves, *Avicennia* and *Rhizophora*, and *Batis*. Other species present include *Acrostichum*, *Chenopodiaceae*, *Poaceae*, and *Pinus*.

The upper portion of the zone (a depth of 50 cm to the surface) included all of the aforementioned species. However, there were some significant additions. Starting at a depth of 33 cm, brackish assemblages were present in the form of *Conocarpus* and *Laguncularia* (**Figure 39**). From 25-17 cm depth, the fresh water species *Myrica* was also present. In this same horizon, *Rhizophora* was replaced by *Avicennia* as the dominant mangrove. Dinoflagellates were absent, while the fresh water algae *Ovoidites* was present.

The replacement of *Rhizophora* with *Avicennia* indicates that the plants were growing at a slightly higher elevation, with higher salt pan-like salinity, suggesting a slight regression, or stabilization of sea level, as was indicated by the micropetrography.

4.2.1. Palynologic Analyses of a Core from Pigeon Key by Davies (1980)

Davies (1980) performed pollen analyses of a core from the northern end of Pigeon Key, although the exact location was not indicated. He divided his core into three zones: fresh water, brackish, and marine (**Figures 40a, b, and c**). His fresh water zone was subdivided to include basal fresh water marsh species, with near-hammock assemblages above (Davies, 1980). In his study, however, Davies found a greater abundance of *Cephalanthus*, and the presence of *Annona* (pond apple), which was not found in core PK-10A. The abundance of *Cephalanthus* and presence of *Annona* suggests that the location of his core was either along the outer ring of a tree hammock, or that the core includes "pre-hammock" vegetation which colonized the site prior to full development of the hammock.

In the upper 50cm of his core, Davies found that *Rhizophora* was replaced by *Avicennia* as the dominant mangrove (Davies, 1980). It should be noted, however, that Davies' core was sampled at 15 cm increments, not a close enough sample spacing to allow detection of the short-term regression proposed to have been present in the upper 30 cm of core PK-10A (which was sampled at 4 cm increments).

Figure 40a. Pigeon Key pollen data (from Davies, 1980)

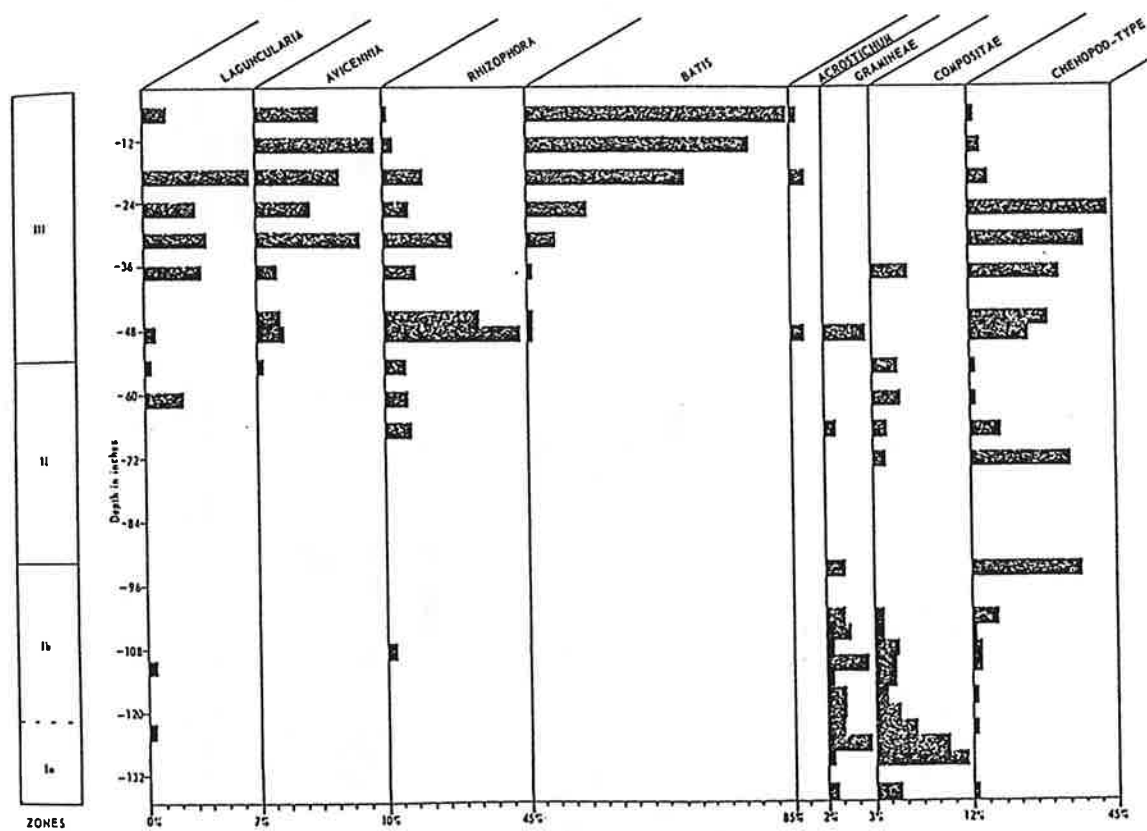


Figure 40b. Pigeon Key pollen data (from Davies, 1980)

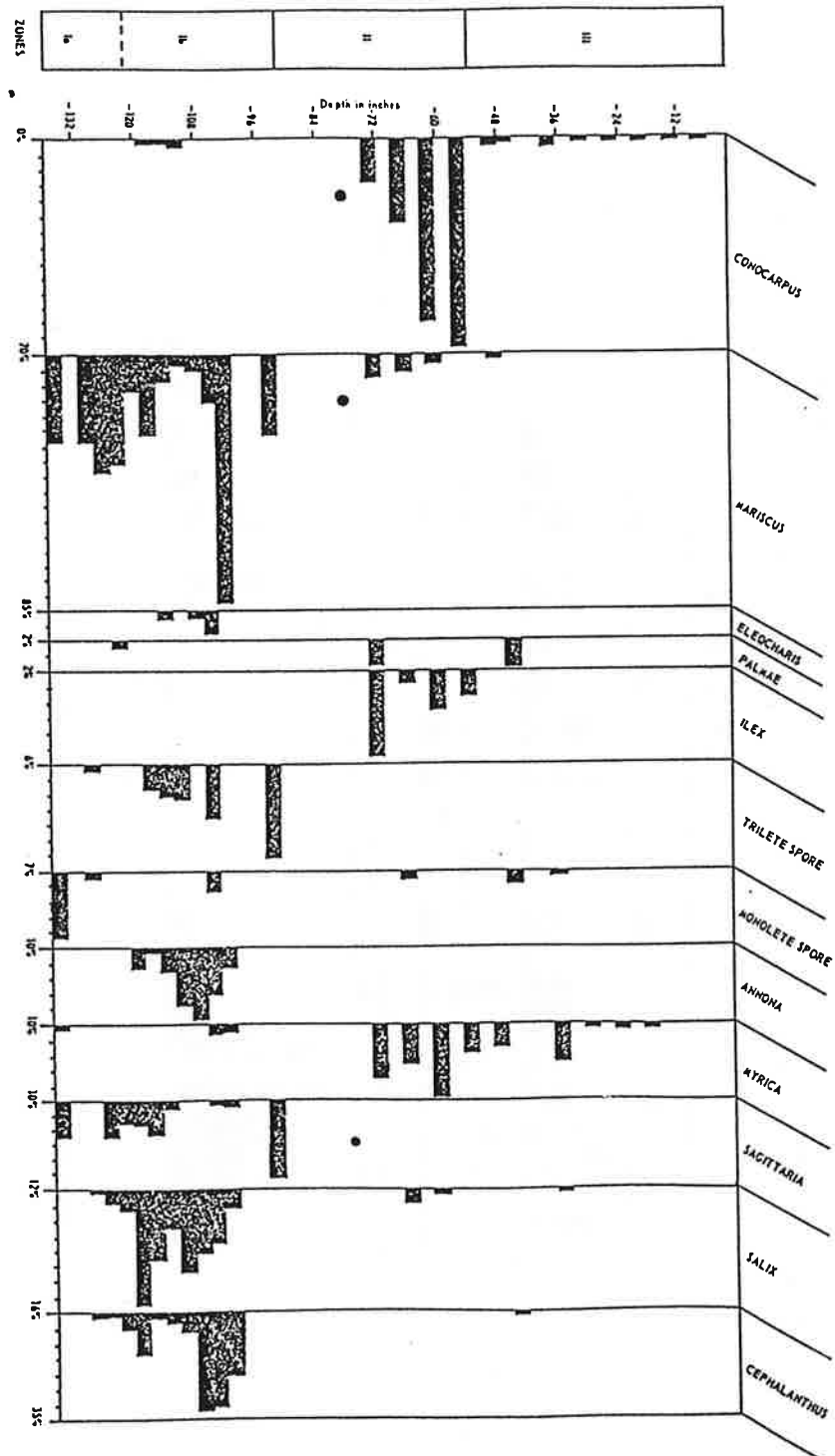
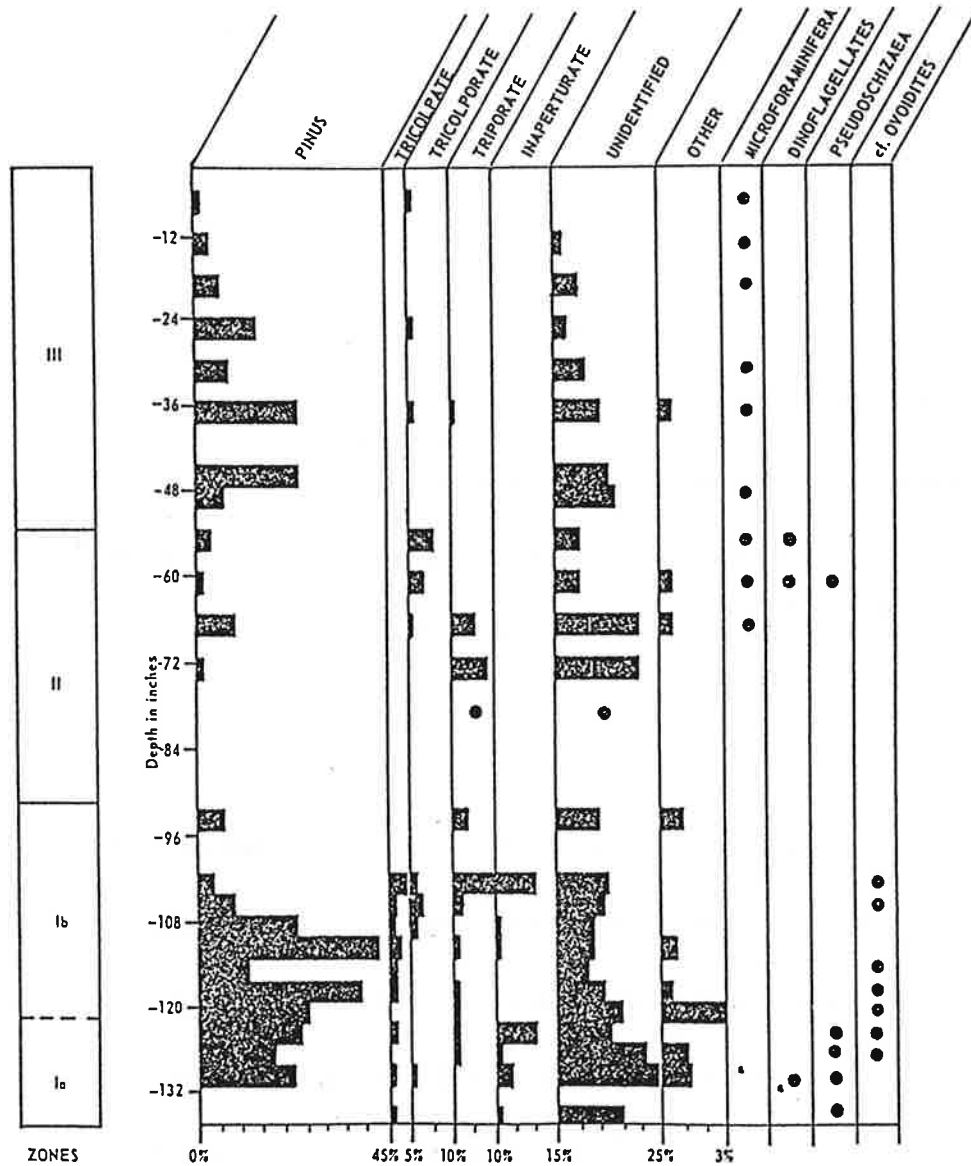


Figure 40c. Pigeon Key pollen data (from Davies, 1980)



5. PALEOECOLOGICAL INTERPRETATION

Combining the micropetrographic and palynologic data from all cores analyzed in this study and data from Davies (1980), it is evident that a series of different depositional environments have occupied Pigeon Key over approximately the past 4,300 years.

Initially, the area of Florida Bay currently occupied by Pigeon Key was an *Eleocharis* flat/algal mat, and/or a ponded fresh water setting. This is suggested by the presence in cores PK-5 and PK-10A of fresh water calcareous sediment and emergent aquatic peat at the base. The emergent aquatic peat was a very "clean" peat, with little to no matrix or oxidized material, suggesting ponded conditions.

As peat sediment accumulated and water depths decreased, other fresh water marsh species encroached, and eventually dominated the area for a considerably long period of time. However, during that time, hydroperiods fluctuated. Initially, the marsh became slightly drier, and *Cladium* was introduced to the marsh, yielding the *Cladium-Sagittaria* peat. The drier character of this environment is reflected in the highly oxidized nature of the peat (presence of charcoal, fungal remains, and humified tissues).

For a brief period of time, sediment accretion outpaced water level rise, providing a higher and drier setting for a tree hammock to develop. Hammock species colonizing the site included *Salix*, *Myrica*, *Ilex*, and *Persea*. The aerated nature of the hammock was recorded in the peat, which was highly oxidized, including an abundance of fungal material, fecal pellets, and charcoal.

After a brief period of drier conditions, water levels increased, flooding the hammock, and reintroducing fresh water marsh vegetation (predominantly *Cladium* and *Sagittaria*). Following this period, there was another shift from marsh to hammock, as water levels dropped. This period of drier conditions was of a considerably longer duration than the previous transition to a hammock setting. However, again, water levels rose, replacing hammock vegetation with that of the fresh water marsh. While remaining a marsh, water levels dropped slightly, and the vegetation shifted from an abundance of both *Cladium* and *Sagittaria* to dominantly *Cladium*. It is during this transition that pollen from core PK-10A were poorly stained and many slides were barren, suggesting changes in the environment, particularly an increase in oxidation.

The sawgrass (*Cladium*) marsh was then subjected to limited contact with marine waters, causing brackish species, particularly *Laguncularia*, *Conocarpus*, and *Acrostichum*, to invade the area. In addition to a shift in vegetation, it is at this time that marine indicators

such as foraminifera, sponge spicules, and radiolaria were first encountered in the peat, along with the decline and disappearance of charcoal (**Figure 23**). Over time, the fresh water species disappeared altogether.

As Florida Bay was flooded with marine waters, the environment at Pigeon Key became increasingly saline. Transitional species were replaced by marine vegetation, primarily *Rhizophora*, *Avicennia*, and *Batis*. Together with the abundance of foraminifera, sponge spicules, and radiolaria, the presence of such species indicates that at this time Pigeon Key was an island, or at the very least, a coastal, marine community.

Once engulfed by marine waters, water levels at Pigeon Key dropped, or the peat or marine carbonate became mounded in the center of the island, creating slightly higher, drier, and perhaps more saline conditions (evaporitic). This change is reflected in the shift in the dominant form of vegetation from *Rhizophora* to *Avicennia*, *Batis*, and *Chenopodiaceae* (*Salicornia*?). Today, *Rhizophora* ring the island; whereas the interior is dominated by *Avicennia*.

Following the shift in vegetation, there was a very brief period of lower salinity at Pigeon Key. This influence was recorded in the pollen and peat record at a depth of 25-17 cm. The palynological record indicated the presence of *Myrica*, a hammock species, and an

increase in transitional shrubs (*Conocarpus* and *Laguncularia*). It is possible that *Myrica* was misidentified, as it closely resembles other species. However, the presence of the fresh water algal form *Ovoidites*, suggests fresher water conditions, as does the lack of dinoflagellates, and also the increase in grasses, sedges, and composites (**Figure 39**). Additionally, the petrographic data reveal the presence of charcoal in core PK-10A, as well as a sharp decrease or absence of carbonate, foraminifera, and radiolaria at this depth in cores PK-5 and PK-8 (**Figures 21, 22**).

5.1. Geographic Trends and Correlation Between Cores

Included within the changes in settings described above, were a number of events recorded throughout the island, as indicated by correlation of the cores.

As previously described, core PK-5 contained a large (185 cm) intrusion of marine calcareous mud. The base of this intrusion occurred at a depth of 245 cm. It is interesting to note that changes in the peat of cores PK-8 and PK-10A occurred at this same approximate depth. Pyrite was dramatically reduced in these cores, while charcoal and fungal bodies peaked (**Figures 22, 23**). It is also at this depth that the pollen from core PK-10A disappeared or were scarce. These factors suggest an increasingly oxidizing environment. The connection between a highly oxidizing environment and the occurrence of carbonate at PK-5 is unclear.

At the upper boundary of the carbonate intrusion at PK-5 (60 cm), pollen was again scarce in core PK-10A. Also at this approximate depth in cores PK-8 and PK-10A, there was a brief break in the presence of marine carbonate, foraminifera, and radiolaria (**Figures 22, 23**). These items were present above and below this depth, but just below 60 cm, in each core, these items were absent.

6. DISCUSSION

Since the last glacial maximum approximately 18,000 ybp, global sea level has risen approximately 120 m, drastically altering landscapes worldwide (**Figure 41**) (Maul and Martin, 1993). In the past 5,000 years, marine waters have invaded Florida Bay.

Radiocarbon dates in conjunction with petrography and palynology indicate that such changes in the environment have been recorded in the peat deposits at Pigeon Key.

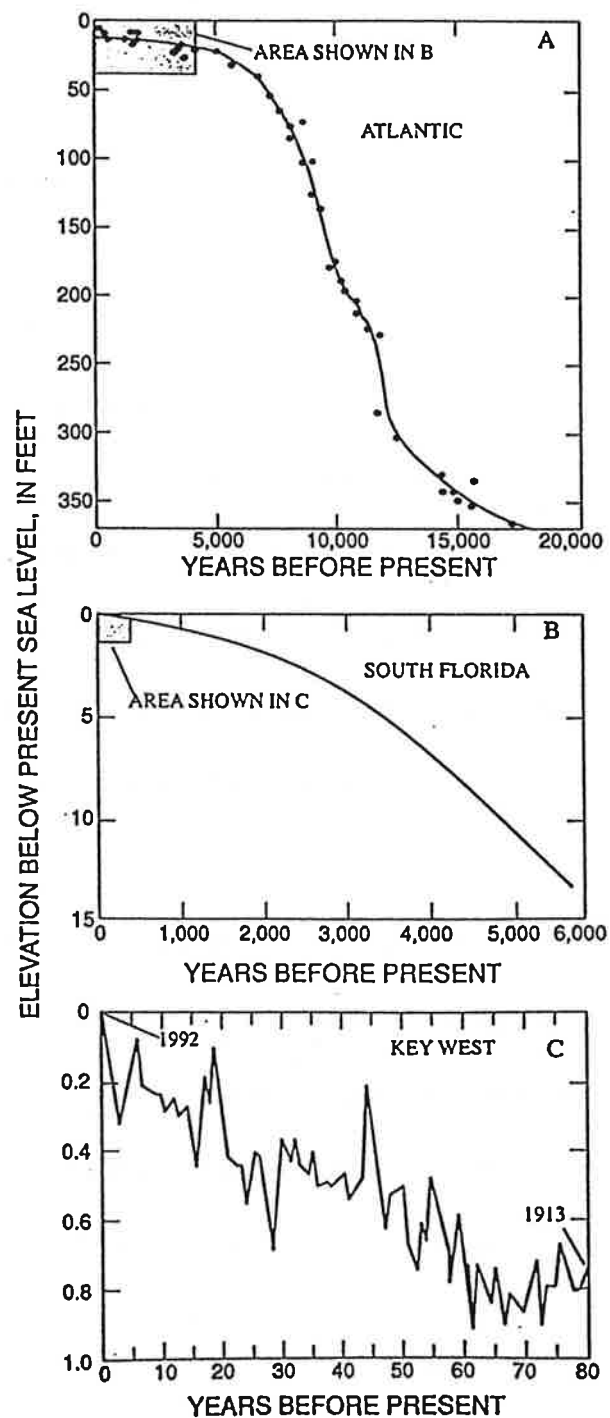
Table 4 presents all radiocarbon dates from this study.

Table 4. Radiocarbon Dates from Pigeon Key

Core Location	Depth of Sample	Type of Sediment	¹⁴ C years before present*
PK-5	64-66 cm	peat (overlying carbonate)	390 +/- 100 years
PK-5	241-244 cm	marine carbonate	3,750 +/- 260 years
PK-5	290 cm	basal peat	4,245 +/- 105 years
PK-8	352 cm	basal peat	3,930 +/- 90 years
PK-10A	411 cm	basal peat	3,040 +/- 130 years
Davies (1980)	348 cm	basal peat	3,155 years

*Samples are ¹³C corrected. Age referenced to 1950 AD.

Figure 41. Sea level fluctuations on three time scales (from Fairbanks, 1989 (a), Scholl et al., 1969 (b), and Maul and Martin, 1993 (c))

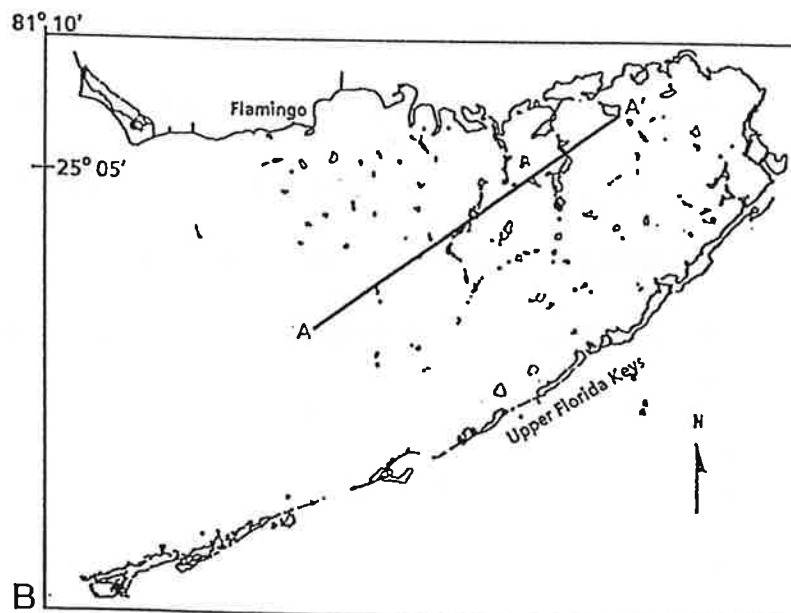
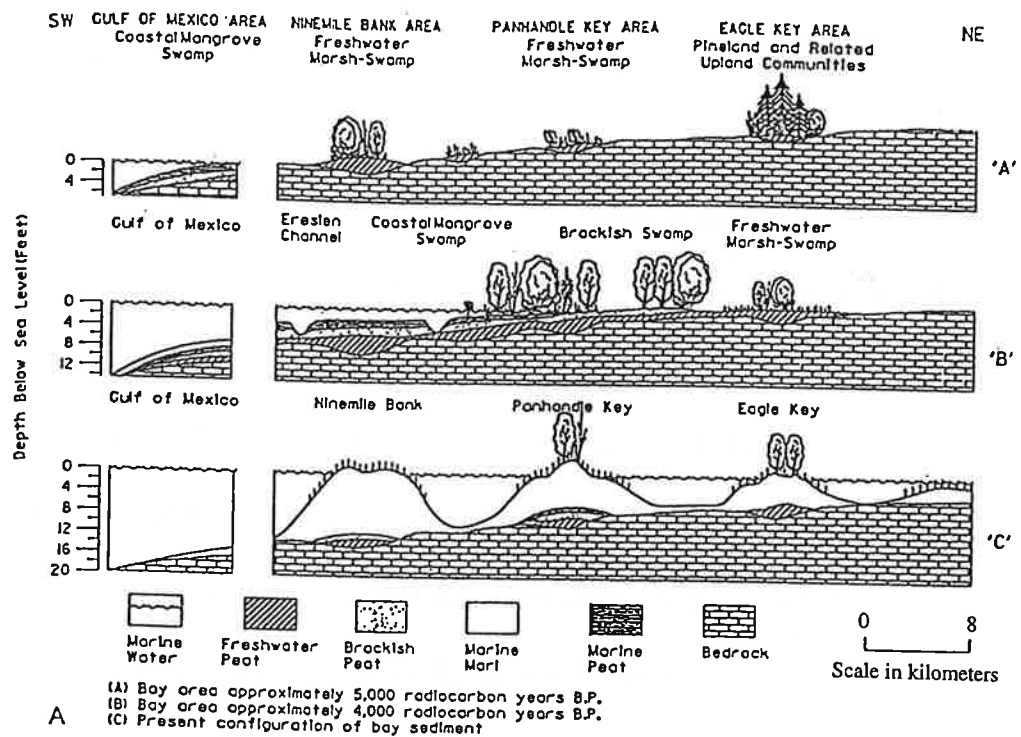


Approximately 4,245 to 3,040 ybp, the increase in sea level caused the water table to rise, resulting in an area occupied by an intermittently ponded, fresh water setting. This setting was replaced by a fresh water, emergent aquatic marsh. Over time, the marsh became increasingly saline, yielding a brackish mangrove environment, and finally a marine, coastal mangrove environment, which exists today.

This succession of environments corresponds to a model for sea level rise in Florida Bay presented by Davies (1980) (**Figure 42**). Based on radiocarbon dates from basal peats throughout the bay, Davies concluded that approximately 5,000 ybp the majority of what is now Florida Bay was not filled with water, as sea level was approximately 3.7 m lower (Davies, 1980). At this time, only the southwestern boundary of the current Florida Bay, along the Gulf of Mexico, was occupied by coastal mangrove swamps. The western and central bay were occupied by fresh water marsh-swamp complexes, with water levels decreasing to the northeast. The northeastern bay was occupied by pinelands and other related upland communities (Davies, 1980).

According to this model, approximately 4,000 ybp, the coastal mangrove swamps along the Gulf of Mexico and the western bay became completely submerged. At this time, the central bay was occupied by coastal mangrove swamps, and the northeastern bay by fresh water marshes and swamps, brackish swamps occupying the area in between (Davies, 1980). It is during this stage that the emergent aquatics and *Cladium-Sagittaria* peats were first deposited at Pigeon Key.

Figure 42. Davies' (1980) model for sea level rise and island development in Florida Bay (from Gleason and Stone, 1994)



With the rise of sea level, marine waters flooded the bay (Davies, 1980) (**Figure 42**). Brackish and then marine environments migrated northeast through the bay. The progression of these increasingly marine environments/settings is recorded in the peat deposits of Pigeon Key: fresh water marsh peats are overlain by brackish peats which are overlain by coastal mangrove peats.

Petrographic and radiocarbon data from Pigeon Key strongly support the model developed by Davies (1980). However, the history of Pigeon Key is more complicated than that presented in the model. According to the model, at 5,000 ybp, the northeastern bay was colonized by pinelands and other upland communities (**Figure 42**). The sedimentary record at Pigeon Key does not support the existence of such an assemblage. The earliest sediments, as previously described, the oldest dating to 4,245 +/- 105 ybp, consisted of the emergent aquatic and fresh water marsh peats.

Davies (1980) largely based this model on petrographic (and palynologic) data from three locations: Ninemile bank, Panhandle Key, and Eagle Key, with Eagle Key as the northeastern limit of the transect (**Figure 42**). While both Eagle Key and Pigeon Key are located in the eastern bay, Eagle Key is located considerably further north. Eagle Key is located within two kilometers of the mainland, while Pigeon Key is within two kilometers of the Florida Keys. It is possible that this difference in latitude may have contributed to the differences between Davies' (1980) model and basal sediments from Pigeon Key. In addition to geographical discrepancies, the elevation/depth to bedrock at these two keys differs. At Eagle Key, the bedrock is located at a depth of 233 cm,

compared to 396 cm at Pigeon Key (Davies, 1980). It is possible that between 5,000 and 4,000 ybp, while pinelands were developing at Eagle Key, the lower elevation, and presumably more ponded conditions, at Pigeon Key were more hospitable to other communities.

While Davies' (1980) model provides a good description of large scale changes in Florida Bay in the past 5,000 years, a number of small scale changes were observed at Pigeon Key which are not accounted for in such a model. Some of these differences may result from the more closely spaced vertical sampling intervals of this study, and some may result from the wider distribution and greater number of cores analyzed herein.

Early in the history of Pigeon Key, when the northeastern bay was a fresh water marsh, two periods of tree hammock development were observed. Stratigraphic data from core PK-10A indicates a repeated pattern of transitions from marsh to hammock and back again. Hammocks are commonly found over depressions in bedrock. However, they also can develop 1.) over topographic highs, 2.) as the result of floating masses of peat, or 3.) on a mound created by an alligator nest. Essentially, hammocks develop where enough peat or other sediment has accumulated to raise the surface above the water table and allow the development of shrubs.

One possible mechanism for the transitions from marsh to hammock and back again at Pigeon Key would be slight changes in climate. A series of dry years would have initiated hammock formation, and then an increase in local precipitation would have

flooded the hammock, yielding a return to marsh conditions. These changes from wet to dry account for more time in the sedimentary record than could merely be attributed to seasonal variation. However, it is possible a rather dry summer followed by a very wet winter could have instigated such changes. Finally, changes/alterations in the pattern/path of any streams feeding water into the marsh may have caused water levels to fluctuate.

Another theory regarding the marsh-hammock-marsh sequence involves the destruction of hammocks by fire. It has been observed that once a hammock is destroyed by fire, the hammock does not necessarily return to recolonize the site. Often, the hammock is replaced by *Cladium* marsh. In the case of Pigeon Key, however, the upper boundary of the hammock peat and the lower portion of the *Cladium* peat overlying the hammock peat do not contain an overwhelming abundance of charcoal, as compared to surrounding samples. Therefore, it appears unlikely that fire would have initiated the replacement of a hammock with a fresh water marsh.

Another observation about Pigeon Key that is reinforced at all core sites was a marked transition from *Rhizophora* to *Avicennia* dominated environment toward the top of all cores. *Rhizophora* are largely coastal mangroves, growing directly on the shoreline, whereas *Avicennia* are unable to tolerate the high-energy environment of the coast. *Avicennia* most often seek shelter further inland, but where the salinity is often somewhat higher. The superposition of *Avicennia* peat over *Rhizophora* peat indicates a change from a higher energy, coastal setting to a better protected, more saline environment.

As described by many authors, Florida Bay, particularly the northeastern bay, has become increasingly saline and often exhibits hypersaline conditions (McPherson and Halley, 1996; McIvor, et al., 1994). It is possible, then, that of the two mangroves, *Avicennia* is better suited to such saline conditions, and has replaced *Rhizophora* everywhere except along the island's perimeter, as *Avicennia* are less well equipped to tolerate wave activity.

Two of the cores examined in this study exhibited changes suggesting an influx of fresher water to the island for a very brief period in the last century. Based on sedimentation rates calculated from ^{210}Pb values, this change in environment occurred between 1893 and 1930 (**Figure 43**). During this time period, great alterations to the environment of South Florida and Florida Bay were taking place. For example, the Flagler Railroad was constructed along the Florida Keys (1910-1911) and canal construction and water management began in the Everglades (McIvor, et al., 1994). However, it is curious that there would be a decrease in salinity during this time, as these factors have been cited as contributors to the increasing salinity of Florida Bay. A possible explanation for this change in salinity is a slight drop in sea level, or pause in its rise. Normal rainfall would then cause the surface of the island to be less saline. Evidence supporting this hypothesis comes from two sources: 1.) stable isotope data from corals in Florida Bay indicate a slight decrease in salinity (**Figure 44**) (Swart et al., 1996); and 2.) sea level measurements at Key Wets suggest a possible stabilization at this time (**Figure 41 c**) (Maul and Martin, 1993).

Figure 43. ^{210}Pb data for core PK-10A

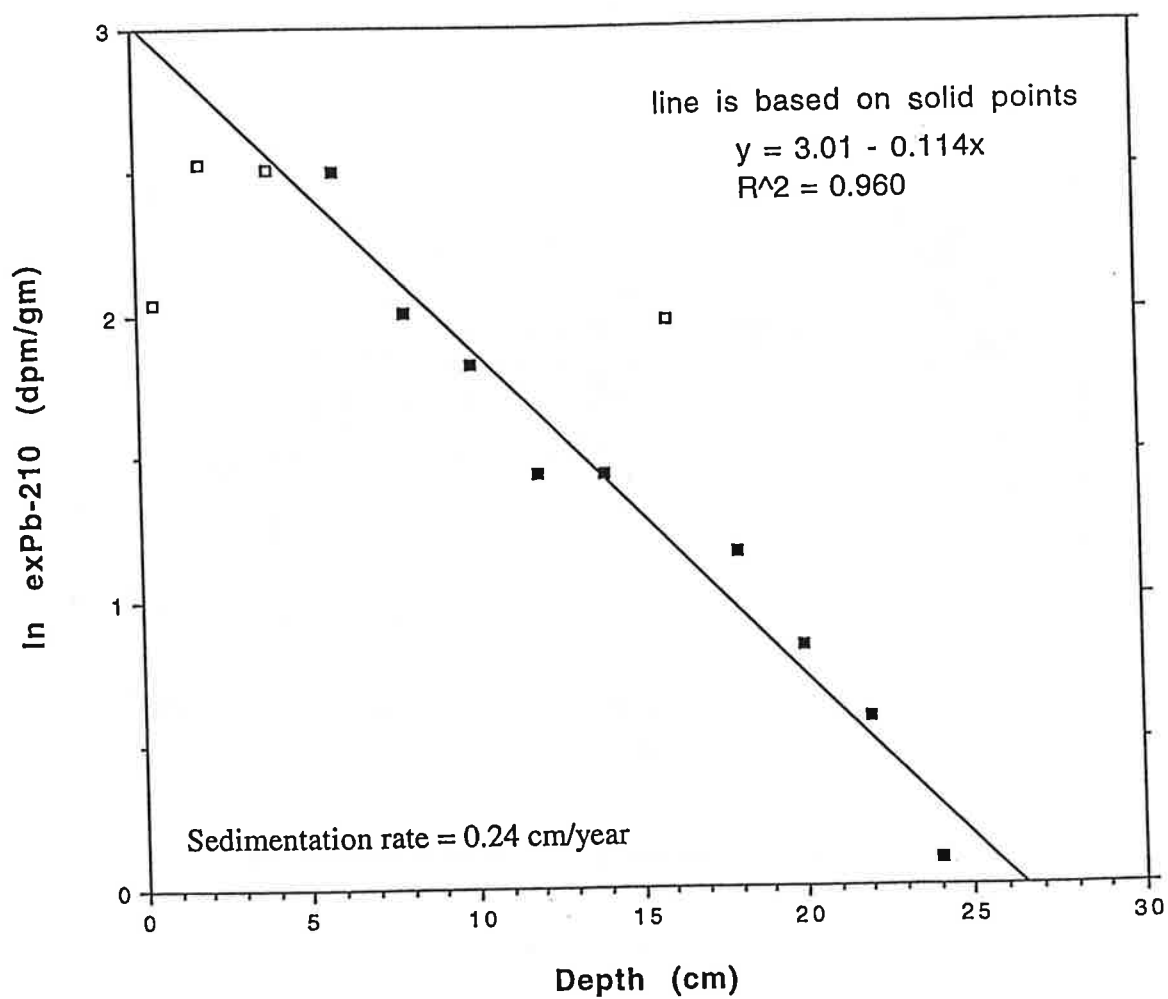
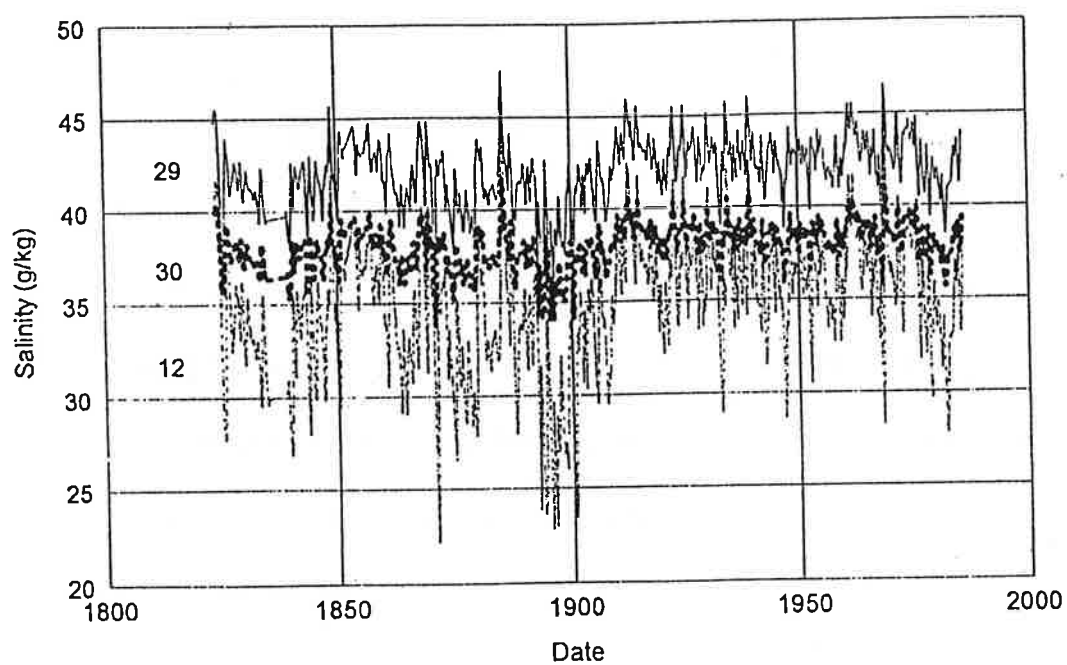


Figure 44. Salinity v. Time in Florida Bay



Pigeon Key is included in area 12. (from Swart et al., 1996)

According to Davies' (1980) model and various studies on Florida Bay, as marine waters invaded the bay, much of the peat throughout the bay was eroded and replaced with marine carbonate. The stratigraphy of the majority of the islands throughout Florida Bay consists of basal peats overlain by meters of carbonate muds. However, except for its eastern edge at (PK-5) Pigeon Key is essentially a block of peat with minor carbonate intrusions (**Figure 37**). The majority of these lenses of carbonate may be explained as storm deposits.

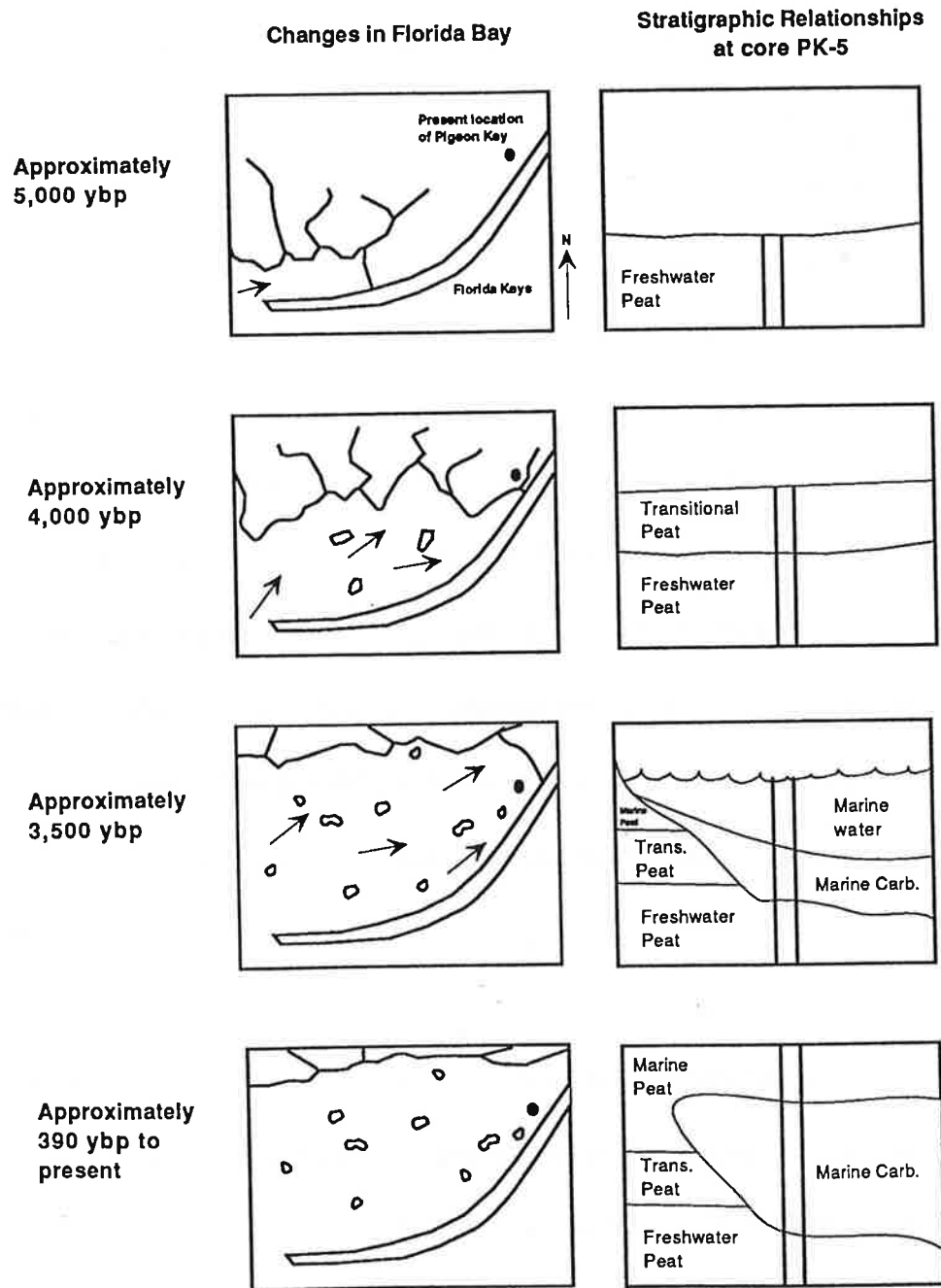
Based on radiocarbon dates, marine carbonate deposition at PK-5 began approximately 3,750 +/- 260 ybp, and peat deposition on top of the carbonate began approximately 390 +/- 100 ybp. The lower contact of the carbonate intrusion is erosional. The peat underlying the carbonate is fresh water marsh peat (*Cladium-Sagittaria* and *Cladium* peat). It is possible that additional peat was originally present, but was eroded prior to carbonate deposition. The upper surface of the carbonate grades into *Rhizophora* peat, which is then overlain by *Avicennia* peat.

While it is unclear exactly what processes brought about the deposition of marine carbonate at site PK-5, it is likely that whatever was occurring affected the entire island, and not just the area of PK-5. At depths comparable to the upper and lower boundaries of the carbonate intrusion in core PK-5, the petrographic data for cores PK-8 and PK-10A indicate changes to the local environment (at 245 cm, pyrite dropped, charcoal and fungal material peaked, and pollen were scarce; at 60 cm marine carbonate, foraminifera, and radiolaria were absent, and pollen was scarce).

The absence of widespread carbonate throughout Pigeon Key suggests that the island was never fully submerged. In order to avoid inundation by marine waters, the island must have remained at a higher elevation than its surroundings. Perhaps the presence of a tree hammock at Pigeon Key was integral to its survival. Tree hammocks are areas of a higher (and drier) elevation than the surrounding marsh. Although this site was also occupied by wetter settings, it is possible that the tree hammock environment persisted until the area was flooded with sea water. Although not reflected in the petrography, it is possible that the tree hammock was the last fresh water stage at Pigeon Key, prior to the development of a brackish setting, and the deposition of the transitional peat. The presence of *Myrica* pollen at the contact between the fresh water and transitional peat in core PK-10A suggests a hammock may have been present, or nearby, at that time.

Another possible means for the preservation of peat at Pigeon Key is that the island was part of a much larger body of peat, which has eroded. The key that is present today is only a small portion of the original peat body from that site. Various studies (Davies, 1980, Davies and Cohen, 1989, Gleason and Stone, 1994) have concluded that Florida Bay was once a vast, fresh water, peat-producing environment, comparable to much of the modern Everglades. Such an environment would have produced large quantities of peat. As sea level rose, the area would have first been invaded by marine waters via tidal channels. It is likely that such channels carved out much of the marsh, determining which areas would be eroded and filled with carbonate first. **Figure 45** depicts a possible

Figure 45.
Hypothetical Development of Pigeon Key



series of stages of sea level rise in Florida Bay which could have resulted in the distribution of peat and carbonate observed at Pigeon Key today.

With that in mind, the following is a possible scenario for the preservation of the peat and deposition of carbonate at Pigeon Key. As sea level rose, channels carved their way through the marsh, just as a number of channels penetrate the southeastern Everglades. At this time, the marsh contained fresh water, and possibly transitional peats. Channels invading the marsh eroded these peats. Over 3,750 ybp such a channel cut through the northeastern marsh (modern Florida Bay), cutting across what is now Pigeon Key. Based on the present boundaries of the island, such a channel would have cut across the southern end of the island, running southwest-northeast, eroding peats from the locations of cores PK-12 and PK-5. Approximately 3,200 to 3,500 ybp, the rate of sea level rise decreased dramatically (Scholl et al., 1969; Wanless, 1982; Parkinson, 1989). Based on radiocarbon dates from Pigeon Key, carbonate deposition at PK-5 began approximately 3,750 +/- 260 ybp. It is possible, at this time, that any channels cutting through the area may have ceased to erode the substrate, and instead, became areas of carbonate deposition.

Both cores PK-5 and PK-12 include a large intrusion of carbonate between peat deposits (**Figure 37**). PK-12 was not petrographically analyzed, but analyses of core PK-5 revealed that the peats overlying the carbonate muds are marine (*Rhizophora*). This sequence of peat-carbonate-peat was not observed by Davies (1980) or Davies and Cohen (1989) in their studies of Florida Bay. However, such a sequence was observed in a later

study by Brown and Cohen (1995) in the coastal areas near Flamingo, Florida Bay, and Coot Bay at the southeastern contact of the Florida mainland and Florida Bay. **Figure 2** shows the occurrence of this peat-carbonate-peat sequence in two cores. In these cores, approximately 100 cm of marine carbonate mud was sandwiched between layers of marine peat. In the core located further inland (core #2), marine peat above the carbonate is overlain by brackish peat, and then an additional layer of marine peat (Brown and Cohen, 1995) (**Figure 2**). Brown and Cohen (1995) concluded that this sequence of sediments represented a minor regression in the overall transgression of the area. It is possible that the sequence of peat-carbonate-peat at Pigeon Key represents a minor regression as well (and/or possibly the same one).

If sea level dropped slightly, or slowed considerably, such conditions could have allowed for the introduction of *Rhizophora mangle* trees to the surface of the carbonate.

Rhizophora spp. are viviparous plants whose seedlings are able to colonize soft substrates such as carbonate muds, due to the rapid development of many lateral roots (Lawrence, 1949 in Tomlinson, 1986). Such processes are currently occurring at the southern end of Pigeon Key. If sea level rise were halted or reversed for a brief period of time, the shallow muds would have been settled by *Rhizophora*. Once established, the *Rhizophora* would have most likely endured the rigors of the coast (waves, tides, etc.), as their structure is suited for such an environment. Over time, the coastline would have become more stabilized, and *Rhizophora* peat would have developed above the carbonate.

Minor fluctuations in sea level are quite common. Often sea level curves appear to be smooth due to the resolution of the data available. Upon examining high-resolution data for sea level rise, it is often found that the record is not a smooth curve. Rather, it is a series of sharp movements (**Figure 41**). It is possible that data from this study which suggest minor regressions in the overall transgression of sea level in Florida Bay represent such steps.

7. CONCLUSIONS

1. Pigeon Key contains a complete peat sequence, documenting the rise of sea level in Florida Bay. This sequence is composed of a variety of fresh water, brackish, and marine peats, each unique to a particular setting. Overall, these sequences were found to fit well into a model for sea level rise in the bay described by Davies (1980). However, the petrography and palynology of peats from Pigeon Key reveal a more complex history. Additionally, two new types of peat were discovered: a hammock peat, confirming indirect evidence presented by Davies (1980), and a long hydroperiod, emergent aquatic peat.
2. In addition to the identification of representative plant genera in each peat type, certain characteristic petrographic features were identified in this study:
 - A. Striated fungal spores were only found in *Cladium-Sagittaria* peat.
 - B. "Phytolith type A" was unique to *Avicennia* peat.
 - C. "Resin globs" were present only in transitional and fresh water peats (and were especially common in *Cladium*-dominated peats and hammock peats).

- ▲ D. Although foraminiferal remains were found in most marine and brackish peats, only the high-carbonate *Avicennia* peats contained forams with the calcareous portions of their tests intact.
 - E. Charcoal was found to be a good indicator of fresh water (or transitional) peats.
3. Definitive hammock layers were found only in core PK-10A, suggesting that a hammock was located only at the northern end of the island.
 4. The presence, on the east side of the island, of peat overlain by marine carbonate overlain by peat suggests a slight regression in the overall transgression. This data may be related to a similar regressive sequence on the mainland of Florida as presented by Brown and Cohen (1995).
 5. Radiocarbon dates indicate that basal peats at Pigeon Key range in age from 4,245 +/- 105 ybp (PK-5) to 3,040 +/- 130 ybp (PK-10). A basal sample from PK-8 was dated at 3,930 +/- 90 ybp. The deposition of marine carbonate muds at PK-5 began at 3,750 +/- 260 ybp and ceased prior to 390 +/- 100 ybp, when peat accumulation resumed.
 6. Based on ^{210}Pb dating of the upper portion of two cores, the rate of sedimentation at Pigeon Key is approximately 0.25 cm/year.

7. It is possible that *Avicennia* peat, which often contains a much more significant component of inorganic sediment than *Rhizophora* peat, represents the beginning of the replacement of peat by marine carbonate.
8. A small change in salinity of the vegetation of Pigeon Key was found for the time period somewhere between 1893-1930. This decrease in salinity may have an anthropogenic cause, or may reflect natural events, such as increased precipitation or slight sea level regression. Studies of corals in Florida Bay corroborate the possible influx of fresh water during this time period (Swart et al., 1996).

8. REFERENCES

- Brooks, H. K., 1968, The Plio-Pleistocene of Florida with special references to the strata outcropping on the Caloosahatchee River, *in* Perkins, R. D., ed., Late Cenozoic Stratigraphy of Southern Florida – A Reappraisal, 2nd Annual Fieldtrip of the Miami Geological Society, Miami Geological Society, Miami, Florida, p.3-64, 103-110.
- Brown, K.E. and Cohen, A. D., 1995, Stratigraphic and micropetrographic occurrences of pyrite in sediments at the confluence of carbonate and peat-forming depositional systems, southern Florida, USA: *Organic Geochemistry*, v. 22, p. 105-126.
- Cohen, A. D., 1968, The petrology of some peats of southern Florida (with special reference to the origin of coal): Unpublished Ph.D. thesis, the Pennsylvania State University, 352 p.
- Cohen, A. D., 1983, Obtaining more precise descriptions of peats by use of oriented microtome sections, *in* Testing of Peats and Organic Soils Symposium, ASTM special publication 820, p. 21-36.
- Cohen, A. D. and Spackman, W., 1972, Methods in peat petrology and their application to reconstruction of paleoenvironments: *Geological Society of America Bulletin*, v. 83, no. 1, p. 129-142.
- Cohen, A. D. and Spackman, W., 1977, Phytogenic organic sediments and sedimentary environments in the Everglades-mangrove complex, Part II, The origin, description and classification of the peats of southern Florida: *Paleontographica, Abt. B*, v. 162, p. 71-114.
- Cohen, A. D., Spackman, W., 1980, Phytogenic organic sediments and sedimentary environments in the Everglades - Mangrove complex of Florida. Part III: The alteration of plant macerals in peats and the origin of coal macerals: *Paleontographica, Abt. B. Bd.*, p. 172.
- Craighead, F. C., 1969, Vegetation and recent sedimentation in the Everglades National Park: *Florida Naturalist*, v. 42, no. 4, p. 157-166.
- Craighead, F. C., 1971, The trees of South Florida: Coral Gables, Florida, University of Miami Press, 212p.

Cypert, E., 1972, Origin of houses in the Okefenokee prairies: *Amer. Midl. Nat.*, v. 87, p. 448-458.

Davies, T. D., 1980, Peat formation in Florida Bay and its significance in interpreting the recent vegetational and geological history of the bay area, [Ph.D. dissertation]: University Park, Pennsylvania State University, 315 p.

Davies, T. D., and Cohen, A. D., 1989, Composition and significance of the peat deposits of Florida Bay: *Bulletin of Marine Science*, v. 44, p. 387-398.

Davis, J. H., 1940, The ecology and geologic role of mangrove in Florida: Carnegie Institute, Publ. 517, Papers from Tortugas Laboratory, v. 32, p. 303-412.

Davis, J. H., 1946, The peat deposits of Florida: *Florida Geological Survey Bulletin* 30, p. 1-247.

Enos, P., Perkins, R. D., 1979, Evolution of Florida Bay from island stratigraphy: *Geological Society of America Bulletin*, Part 1: v. 90, p. 59-83.

Ginsburg, R. N., 1956, Environmental relationships of grain size and constituent particles in some South Florida carbonate sediments: *Bulletin of American Association of Petroleum Geologists*, v. 40, no. 10, p. 2384-2427.

Ginsburg, R. N., 1957, Early diagenesis and lithification of shallow water carbonate sediments in South Florida: *in* LeBlanc, R. J., and Breeding, J. C., eds., Regional aspects of carbonate deposition, Society of Economic Paleontologists and Mineralogists, Special Publication no. 5, p. 80-100.

Ginsburg, R. N., 1964, South Florida carbonate sediments, Guidebook Field Trip No. 1: Geological Society of America Annual meeting, 1964. Institute of Marine Science, University of Miami, Florida, 72 p.

Ginsburg, R. N. and Lowenstam, H. A., 1958, The influence of marine bottom communities on the depositional environment of sediments: *Journal of Geology*, v. 66, p. 310-318.

Ginsburg, R. N., 1954, Carbonate deposits in South Florida: Southeastern Geological Society Field Trip No. 8 Guidebook, October 21-23, 1954, p. 5-14.

Gleason, P. J., Cohen, A. D., Brooks, H. K., Stone, P., Goodrick, R. Smith, W. G., and Spackman, W., 1984, The environmental significance of Holocene sediments from the Everglades and saline tidal plain, *in* Gleason, P. J., ed., Environments of South Florida: Present and Past, Memoir 2, Miami Geological Society, Miami, Florida, 452 pp.

Gleason, P. J., Stone, P., 1994, Age, origin, and landscape evolution of the Everglades peatland, *in* Davis, S., Ogden, J. ed., *Everglades: The Ecosystem and its Restoration*: Delray Beach, Florida, St. Lucie Press, p. 149-197.

Hoffmeister, J. E., 1974, *Land from the Sea*: Coral Gables, Florida, University of Miami Press, 142 p.

Light, S. S., Dineen, J. W., 1994, Water control in the Everglades: A historical perspective, *in* Davis, S., Ogden, J., eds., *Everglades: The Ecosystem and its Restoration*: Delray Beach, Florida, St. Lucie Press, p. 47-84,

Loveless, C. M., 1959, A study of the vegetation in the Florida Everglades: *Ecology*, v. 40, no. 1, p. 1-9.

Maul, G. A., and Martin, D. M., 1993, Sea level rise at Key West, Florida, 1846-1992: America's longest instrument record? *Geophysical Research Letters*, v. 20, number 18, p. 1955-1958.

Marmer, H. A., 1949, Sea level changes along the coasts of the U.S. in recent years: *Trans. American Geophysical Union*, v. 30, no. 2, p. 201-204.

McIvor, C. C., Ley, J. A., Bjork, R. D., 1994, Changes in freshwater inflow from the Everglades to Florida Bay including effects on biota and biotic processes: A review, *in* Davis, S., Ogden, J. ed., *Everglades: The Ecosystem and its Restoration*: Delray Beach, Florida, St. Lucie Press, p. 47-84.

McPherson, B. F., and Halley, R., 1996, *The South Florida Environment: A region under stress*, US Geological Survey Circular 1134, p. 1-61.

Missimer, T. M., 1984, The geology of South Florida, *in* Gleason, P. J., ed., *Environments of South Florida: Present and Past*, Memoir 2, Miami Geological Society, Miami, Florida, p. 385-404.

Owens, H., 1960, Florida-Bahama Platform: *American Association of Petroleum Geologists Bulletin*, v. 44, p. 1254.

Parkinson, R. W., 1989, Decelerating Holocene sea-level rise and its influence on southwest Florida coastal evolution: a transgressive/regressive stratigraphy, *Journal of Sedimentary Petrology*, vol. 59, No. 6, p. 960-972.

Scholl, D. W., 1966, Florida Bay: a modern site of limestone formation, *in* Fairbridge, R. W., ed., *Encyclopedia of earth science*: New York, McGraw-Hill, p. 282-288.

Scholl, D. W., and Stuiver, M., 1967, Recent submergence of southern Florida: a comparison with adjacent coasts and other eustatic data: Geological Society of America Bulletin 78, p. 437-454.

Scholl, D. W., Craighead, F. C., and Stuiver, M., 1969, Florida submergence curve revised: its relation to coastal sedimentation rates: Science, v. 163, p. 562-564.

Schomer, N. S., and Drew, R. D., 1982, An ecological characterization of the lower Everglades, Florida Bay, and the Florida Keys, FWS/OBS-82/58.1, office of Biological Services, US Fish and Wildlife Service, Washington, D.C., 246 pp.

Spackman, W., Dolsen, C. P., and Riegel, W. L., 1976, Phytogenic organic sediments and sedimentary environments in the Everglades-mangrove complex, part 1: evidence of a transgressing sea and its effects on environments of the Shark River area of southwest Florida: Paleontographica, Abt. B, 117, p.135-152.

Spackman, W., Cohen, A. D., Given, P. H., and Casagrande, D. J., 1976, The comparative study of the Okefenokee swamp and the Everglades mangrove swamp-marsh complex of southern Florida, *in* Field Trip Guidebook, Coal research section: State College, Pennsylvania, The Pennsylvania State University, 403 pp.

Stephens, J. C., 1956, Subsidence of organic soils in the Florida Everglades: Soil Science of America Proc., v. 20, p. 70-80.

Swart, P. K., Healy, G. F., Dodge, R. E., Kramer, P., Hudson, J. H., Halley, R. B., and Robblee, M. B., 1996, The stable oxygen and carbon isotopic record from a coral growing in Florida Bay: a 160 year record of climatic and anthropogenic influence: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 123, p. 219-237.

Taft, W. H., and Harbaugh, J. W., 1964, Modern carbonate sediments of southern Florida, the Bahamas, and Espiritu Santo Island, Baja, California: Stanford, California, Stanford University, Geological Science Misc. Pub. 8, 133 pp.

Tomlinson, P. B., 1986, The Botany of Mangroves: Cambridge, Massachusetts, Cambridge University Press, 413 pp.

Wanless, W. R., 1982, Editorial: Sea level is rising – so what? Journal of Sedimentary Petrology, v. 52, p. 1051-1054.

Wanless, H. R., Taggett, M. G., 1989, Origin, growth, and evolution of carbonate mudbanks in Florida Bay: Bulletin of Marine Science, v. 44, p. 454-489.

White, W. A., 1970, The geomorphology of the Florida peninsula: Florida Geologic Survey Bulletin no. 51, p. 22-30.

9. **APPENDIX 1. Micropetrographic Data Sheets**

Core PK-5-97

PK-5-97

Depth (cm) 0-2				Date 10/7/98
				Completed by TAT
Color	dk brown			Power 10x
Carbonate	1/3 H/E			
Matrix				
Framework				
PLANTS	Roots	Rootlets (2)	Leaves	Bark
BLACK MANGROVE some PM degraded	BM - possibly white (2) mass.	BM (2) few RM (1-2)	large leaf -NOT BM, PM white mang? possibly leaves BM (3-4)	(rust) (1-2)
Forams	chitinous	carb.	chitin/carb	
few (dogshit) (2-3)			✓	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	1 (2)	1 (2)	1 (0-1)	1 (2-3)
S. Spicules	Radiolaria	Charaphytes	Algal	
1 (2)	0	/	/	
Charcoal	Insect parts	Fecal Pellets	Pollen	
0	1 2	(2) large one ↑	1	
Pyrite	framboids	euhedral		
(1-2)	1			
Other mostly	leaves w/ rootlets			
leaf litter				

surface litter

PK-5-97

Depth (cm)	4.6	(12 m d)		Date	10/7/98
Color	brown - dk/rd brown -> light brown @ base			Completed by	JAT
Carbonate	NONE			Power	10%
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM	1-2	2 margone - NOT RED	Achromidium leaf margone 3-4	/	
Achromidium	no RM	other			
Forams (3)	chitinous	carb.	chitin/carb		
1 highly corroded	/		//		
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	11.11 (3)	abundant (3-4)	13)	(3)	
S. Spicules	Radiolaria	Charaphytes	Algal		
(2-3) rare	/		matrix		
Charcoal	Insect parts	Fecal Pellets	Pollen	"chitinous"	
/	11.11 (3)	(1-2)	/	..	
Pyrite	framboids	euhebral		SEED X-section	
/					
Other	lots of debris	matrix - fire-grained	lighter color -> ALGAL		
Mainly ->	degraded leaves w/ some greater concentration of	rootlets (B.M.)	roots @ base of sample		

more fire-grained than above

PK-5-97

Depth (cm) 8-10				Date 10/7/98
Color	dark brown			Completed by JAT
Carbonate	NONE			ADC
Matrix Framework				Power 10X
PLANTS	Roots	Rootlets	Leaves	Bark
B ² M ² B ² M ² dark brown	large BM root other 1-2 (large)	RM BM (small) 3-4	(1-2)	(1-1)
Forams	chitinous	carb.	chitin/carb	
"highly corroded (3)	/		/	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	// (2-3)	3		//// 3-4
S. Spicules	Radiolaria	Charaphytes	Algal	
/	/			
(3)				
Charcoal	Insect parts	Fecal Pellets	Pollen	u. to 4-5
/	/// 3	4 large	/	
Pyrite	framboids	euhedral		
(1)	/			
Other	fecal pellets & roots/rootlets (mostly rootlets w/ occasional root)			
Chunk of wood				

WOOD

higher % RM than above

PK-5-97

Depth (cm) 12-14				Date 10/1/98
Color	Brown / Gray (light brown)			Completed by T2
Carbonate	NONE			Power 100
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
BM done	large BM 2-3	few RM 3rd done 3-4	1	(wt) 1
Forams	chitinous	carb.	chitin/carb	
lightly corroded (2-3)	1		1	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	1 (2-3)	(2-3)	1 (2-3)	1 3-4
S. Spicules	Radiolaria	Charaphytes	Algal	
1 (3)	1		2 light possible algal	
Charcoal	Insect parts	Fecal Pellets	Pollen	
1	1 (3-4)	1 (3)	1	
Pyrite	framoids	euhedral	Silica	Seed
1	1		1 (1)	
Other	Root bark			
lighter in color - than upper samples matrix - very light (non-carb); leaf content much lower				

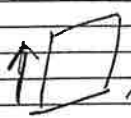
PK-5-97

R-3-97		Date 12/9/98		
Depth (cm)	16-18 cm	Completed by JAT		
Color	B.M.M.	Power 1.5x		
Carbonate	NONE			
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
DM RM ↓ mostly with, no rib BM > RM	possible B.M.M. root RM 2	(30.3, 101.0) not B.M.M. RM. ?? 3	 (high in ... with sclerotin) Coral Warts	on roots
Forams	chitinous	carb.	chitin/carb	
2-3				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2	2-3	2	
S. Spicules	Radiolaria	Charaphytes	Algal	
3	1			
Charcoal	Insect parts	Fecal Pellets	Pollen	Phytolite
0	2	abundant 4		1
Pyrite	framboids	euhedral		
0	0	0	(28.7, 101.5) Batis? Sag? → 	
Other	fecal pellets look w/ roots penetrating (23.2, 100.9) - oxidized material, but doesn't look like pyrite & too shallow for charcoal???			

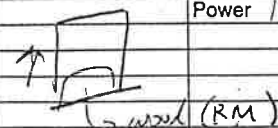
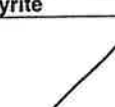
PK-5-97

Depth (cm)	10-22 cm			Date	12/9/98
Color	Brown → dk brown			Completed by	JA-7
Carbonate	None			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
✓ RM	RM 2-3	4	1 RM leaf	on roots (RM)	
Forams	chitinous	carb.	chitin/carb		
/					
2					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	✓ 2-3	✓ 1-2	2	/	
S. Spicules	Radiolaria	Charaphytes	Algal		
✓ more than above 3	/	/	/		
Charcoal	Insect parts	Fecal Pellets	Pollen ✓		
/	/	/	pinus		
	1-2	2-3			
Pyrite	framoids	euhedral			
/			(31.0, 98.0) type of plant?		
Other	darker, P.M. content decreasing oxidized material present				
	↑ 52% particles decrease w/ depth → more fecal pellets @ top				

PK-5-97

Depth (cm)	24-26 cm			Date 12/9/78
Color	red-brown			Completed by JAT
Carbonate	NONE			Power 10X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
EM-down OTHER darker imp. w/ EM	✓	✓	✓ 2-3	
		3-4		
Forams	chitinous	carb.	chitin/carb	
2				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	✓ 3	✓ 1	✓ 2	
S. Spicules	Radiolaria	Charaphytes	Algal	
✓ large / thick 2-3	✓ 1	✓	✓	
Charcoal	Insect parts	Fecal Pellets	Pollen	
✓ 0	✓ 1-2	✓ 3	(29.6, 97.6)	
Pyrite	framboids	euhedral		
✓ 2	✓ some loosely del.	✓		
Other				
orange	cortical tissue??	oxidized material (cortical tissue of root)		

PK-5-97

Depth (cm)	28-30 (#21)			Date 12/9/98
Color	Brown (dark orange)			Completed by JAT
Carbonate	NONE			Power 10X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
RM down	✓	-	✓	on roots
small sp. other		2-3	2	2
Forams	chitinous	carb.	chitin/carb	
low - highly corroded 2-3				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	3-4	✓ (very small) 4 ABUNDANT	2	Spores (in wood) appearing hyphae 8
S. Spicules	Radiolaria	Charaphytes	Algal	
✓ include bored 2				
Charcoal	Insect parts	Fecal Pellets	Pollen	
	3	3-4	in fecal pellet pollen in Anther (RM)	
Pyrite	framboids	euhedral		
			"gelified" material (orange) → spores in fecal pellet	
Other	★ abundance of cell inclusions perfectly spherical cell fillings → most likely secondary cell fillings			★

WOOD → RM

→ product of processing

PK-5-97

Depth (cm)	35-40 cm			Date 12/9/88
Color	BROWN			Completed by JRT
Carbonate	NONE			Power 10V
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
RM (Acrostichum?)	RM 1-2	RM 2-3	NST RM (Acrostichum?) long, narrow leaf 3	on roots completely surrounded by RM rootlets
Forams	chitinous	carb.	chitin/carb	
2	1			
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	3	2		1
S. Spicules	Radiolaria	Charaphytes	Algal	
2				
Charcoal	Insect parts	Fecal Pellets	Pollen	
1	2	1		
Pyrite	framboids	euhedral		
1-2 loose	✓	cell fillings w/ pre-pyrite	actinomyces coated w/ hydrothermalite	
Other				
	Hash of rootlets - RM			

PK-5-97

Depth (cm)	45-50			Date 12/9/98
Color	BROWN (mottled)			Completed by JAT
Carbonate	114%			Power 10X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
RM	fewer w/ internal cell fillings in inner cortical area 2	4	more than 35-40 RM 3	m roots
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2-3	2	2	/
S. Spicules	Radiolaria	Charaphytes	Algal	
2	1 broken 1	/	/	
Charcoal	Insect parts	Fecal Pellets	Pollen	
/	1	/ very fine grained 2	Anus pollen → RM	Anther w/ abundant
Pyrite	framoids	euhedral		
✓ 3 loose xthls	✓	cell filling converting to framoids "gelified" mass		
Other	leaf fragments			
	↑  large root	RM dominated debris		

PK-5-97

Depth (cm)	55-60 (40-2)			Date 12/10/98
Color	light brown / gray (slide 1 & slide 2)			Completed by JAT
Carbonate	Small chunks present → Predominantly prot			ADC 12/11/98
Matrix				Power 10x
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
RM			fragments (RM)	on roots
	3	3	2-3	
	RM	RM		
Forams	chitinous	carb.	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
S. Spicules	Radiolaria	Charaphytes	Algal	
large radiolaria branched 4	2-3			
Charcoal	Insect parts	Fecal Pellets	Pollen	Phytoplankton
				NONE
Pyrite	framboids	euhedral	MISC. MINERAL matter	
✓ scattered throughout loose 3-4	✓		→ birefringent → throughout slide	
Other				or RESIN??
- mass of mystery stuff - non birefringent			not always birefringent	
- more densely packed @ base				

mining →

shell
frag @
top of
corals

→ coloration??

SHELL FRAGMENTS?? - curved fragment
- other pieces as grains

PK-5-97

Depth (cm)				Date
				Completed by
Color				Power
Carbonate				
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Forams	chitinous	carb	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
S. Spicules	Radio-lar	Charaphytes	Algal	
Charcoal	Insect parts	Fecal Pellets	Pollen	185 cm
Pyrite	framboids	euhedral		
Other				

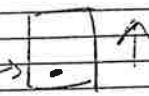
60 cm -

245 cm

CARBONATE

1st sample below CARB.

PK-5-97

Depth (cm)	245 - 250cm			Date	12/14/92
				Completed by	MA-7
Color	DARK BROWN				11.8/92
Carbonate	NONE, 0.001 → 			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Clad? (pass. Ach. 100)	Cladonia phyllopora 1.5 2.0	3 few RM	0		
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous 3	
		1		Blowhard fungal residue 100%	
S. Spicules	Radiolaria	Charaphytes	Algal		
1	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
leaf charcoal 3-4	1	1-2	(29.2, 101.1) (24.5, 109.5)	abundant	
Pyrite	framoids	euhedral			
✓ 1.2 (?) carb lenses → full of pyrite		very small vials			
Other					
orange → central hole Lots of debris					

CHARCOAL??

PK-5-97

R-3-97		Date 12/14/98	
Depth (cm)	255-260 cm	Completed by JH	
Color	orange/brown	11/13/99 ALZ	
Carbonate	fine	Power 10X	
Matrix			
Framework			
PLANTS	Roots	Rootlets	Leaves
	large skeletal not branching reluctant large dark, scaly [] 1 clast? 2-3	fine and fine 2-3	0
Forams	chitinous	carb.	chitin/carb
	0		
Fungal	Hyphae	Sclerotia	Spores
	2	1-2	1-2
S. Spicules	Radiolaria	Charaphytes	Algal
1	0		algal material greenish-yellow
Charcoal	Insect parts	Fecal Pellets	Pollen
✓ 2-3	2	2	✓ Sae? 1
Pyrite	framboids	euhedral	
1-2	✓		
Other	abundant debris		
orange = control?	more fine debris		

PK-5-97

Depth (cm)	265-270 cm			Date	12/14/98
				Completed by	SA7
Color	BROWN			1/1/99	ASC
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sag. w/ S C. ...	SG Sag 2	2-3	0	moss	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	1-2	✓ many in matrix 3	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
1 (glass?) 7/1	0		✓ in matrix	 1-2 1-2 1-2	
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
✓ 2	1	2	✓ much more abundant than above	✓	
Pyrite	framboids	euhedral			
✓ 1-2 pods			str. ... fungal spores		
Other	lots of debris NSH: 60% w/ ... (about 10%)				

oxidized material →
mostly charcoal, but
both charcoal & pyrite present

must be good material than above

PK-5-97

PK-5-97			Date 12/14/98	
Depth (cm)	275-280 cm		Completed by JAT	
Color	mottled → light (orange) & dark (brown)		1/12/99 P.S.	
Carbonate	None		Power 10X	
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Cladium ↳ dominant Sag.	Rhizome - large 3-4  rhizome → matrix	2-3 Clad. few Sag	1 → Rhizome  → Rootlet - flush (↳ filled w/ resins)	0
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2-3	✓ 2	3-4	
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
✓ 3	2-3	3		esp. in 2 rhizome
Pyrite	framboids	euhedral		
? 0-1	none	none		
Other	less debris than above sample glass fragments □ (in open space) cortical tissue (clad) → matrix			

oxidized material throughout (4)
→ matrix structure like pyrite

PHOTO → rhizome (small one) (clad?) root
Rhizome → PHOTO → rhizome

PK-5-97

Depth (cm)	285-289			Date	12/14/98
Color	Brown - dk brown w/ dark patches small chunk @ base			Completed by	pt-7
Carbonate	p. surface			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Cladium (large central) SPEI	 3	3-4	0	1 root	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2	✓ 3-4	2		
S. Spicules	Radiolaria	Charaphytes	Algal		
1 w w/ pyrite	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
✓ 2-3	2	3-4	Pinus	✓	
Pyrite	framboids	euhedral			
4	✓	✓			
Other	285-289 - small dk brown patch 289 - 290 - small dk brown patch				

FW CARB @ Base (?) → Pinifringit

Core PK-8-97

PK-8-97

Depth (cm)	0-2			Date 11/6/99
Color	Brown → Dk brown			Completed by JAT/ADC
Carbonate	NONE			Power 16x
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
BM				passing from roots
no RM	1-2	2-3		1
Forams (2)	chitinous	carb.	chitin/carb	
✓ occasionally degraded				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
		(2)		
S. Spicules	Radiolaria	Charaphytes	Algal	
very few -1	0		0	
Charcoal	Insect parts	Fecal Pellets	Pollen	
0	0	0	0	
Pyrite	framboids	euhedral		
1-2				
Other				
roots of fine-grained material	pyroliths (?) in center of roots			

on degraded spicules?

PK-8-97

Depth (cm)	4-6 cm			Date 11/4/98
Color	Brown			Completed by JAT/ADC
Carbonate	NONE			Power 16
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
BM	abundant 3-4 cell inclusions in larger roots	abundant 3-4	none 0	on large roots 1
Forams	chitinous	carb.	chitin/carb	
no 2:1 mass ✓ 2-3 porroded 1	✓			
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	some in root(s), ✓ some free	3 ✓	3 (2)	
S. Spicules 1-2	Radiolaria	Charaphytes	Algal	
very few (more than 0-2) -slightly degraded	0		? 17.3 96.0	
Charcoal	Insect parts	Fecal Pellets	Pollen	
✓	1	0		
Pyrite	framboids	euhedral		
✓ 1				
Other	abundance 3 fungi → high degradation			

PK-8-97

Depth (cm)	8-10 cm			Date	11/6/98
Color	light brown / grey			Completed by	JAT/ADC
Carbonate	lower 2/3 of slide post-carb contact = carb matrix irregular center			Power	15x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM - dominant degraded RM BM & RM	BM 2-3	3-4 BM & RM, both present RM	/	Large root @ base of sample 1-2	
Forams	chitinous	carb.	chitin/carb		
1	-				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2-3	1			
S. Spicules	Radiolaria	Charaphytes	Algal		
Monobactam fossil preserved 3-4	2-3		//		
Charcoal	Insect parts	Fecal Pellets	Pollen		
/	/	/	/		
Pyrite	framboids	euhedral			
NONE					
Other	Pests in carb - degraded				
contact - matrix - carb rich	mark of roots				

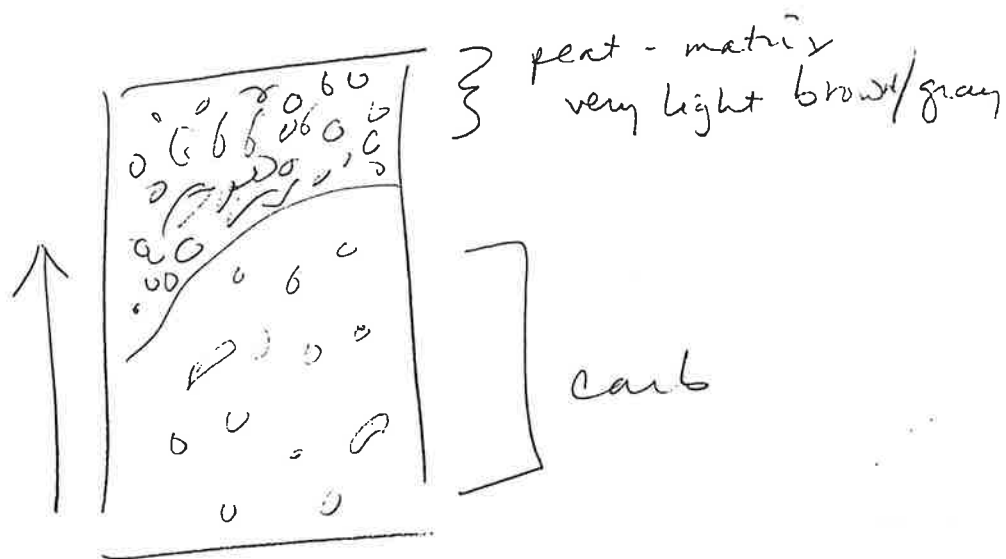
many
fossils
throws

HIGHLY DEGRADED [] post-carb matrix very light brown & grey
post-carb matrix - denser than post-carb

PK-8-97

11/11/88

8-10 cm



Root density $\rightarrow$ greater in

upper (peatier) portion

$\hookrightarrow$ more of a root (rootlet) hash

HIGHLY DEGRADED

many RM rootlets $\rightarrow$ all that remain are inclusions.

PK-8-97

Depth (cm)	12-14			Date 11/6/98	
Color	BROWN			Completed by JAT/ADC	
Carbonate	NONE			Power 10X	
Matrix					
Framework					
PLANTS		Roots	Rootlets	Leaves	Bark
BM	TWIG 2-3 17.5, 109.5 large root contributed by rootlets NO DIA	3-4			on large roots & twig
Forams		chitinous	carb.	chitin/carb	
/ few 1-2	/				
Fungal		Hyphae	Sclerotia	Spores	Miscellaneous
	// 2		1-2		
S. Spicules		Radiolaria	Charaphytes	Algal	
3-4	/	/	/	/	
Charcoal		Insect parts	Fecal Pellets	Pollen	
/	1	2-3	/		
Pyrite		framboids	euhedral		
/					
Other	matrix - increases toward base of sample				

PK-8-97

Depth (cm)	16-18 cm			Date	11/6/98
Color	BROWN			Completed by	JAT/ADC
Carbonate	NONE			Power	16x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM	3	4			
N 2M			NONE		
Forams	chitinous	carb.	chitin/carb		
abundant 3-4					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	-	2	-		
S. Spicules	Radiolaria	Charaphytes	Algal		
very few 3	NONE				
Charcoal	Insect parts	Fecal Pellets	Pollen		
		2-3			
Pyrite	framboids	euhedral			
2'					
Other	Roots of very fine grained matrix w/ very some sponge spicules				

PK-8-97

Depth (cm)	20-22 cm			Date	11/6/98
Color	light brown			Completed by	JAT/ADC
Carbonate	light in color more carb → possibly carb in matrix			Power	100
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM	smaller more degraded - rootlets protruding 2-3	3-4/		Bark 1 1-2	
1/2 BM			NONE		
Forams	chitinous	carb.	chitin/carb		
3					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	" 3	" 2-3			
S. Spicules	Radiolaria	Charaphytes	Algal		
ABUNDANT 3-4	" 2-3		" 2		
Charcoal	Insect parts	Fecal Pellets	Pollen		
Pyrite	framboids	euhedral			
~~Pyrite~~ 1 2					
Other					

OK

PK-8-97

Depth (cm)	24-26 cm			Date	11/6/98
Color	light brown			Completed by	JAT/ADC
Carbonate	carb. matrix			Power	12v
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
B11 10 cm	✓ 3	✓ 3 light dark	✓	✓	
Forams	chitinous	carb.	chitin/carb		
2-3 Corrodol					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	3	✓ 2			
S. Spicules	Radiolaria	Charaphytes	Algal		
ABUNDANT 4	✓ 2				
Charcoal	Insect parts	Fecal Pellets	Pollen		
	✓	✓ various 2-3	23.5/6 97.4	Chenopod.?	
Pyrite	framboids	euhedral			
1-2	✓				
Other	Root penetrating light matrix → fine-grained				

PK-8-97

R-57		Date 11/11/98		
Depth (cm)	28-30		Completed by	
Color	gray/brown		JAT/ADC	
Carbonate	✓ ABUNDANT carb of algae		Power 10x	
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
BM w RM	✓ 2-3	✓ 3-4	✓	on roots
Forams	chitinous	carb.	chitin/carb	
✓ 3 highly elongated	✓			
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	✓ 3-4	✓ 2		
S. Spicules	Radiolaria	Charaphytes	Algal ?	
" 4 small	✓ 3		✓ (21.8, 109.8)	
Charcoal	Insect parts	Fecal Pellets	Pollen	✓ phytolites
		✓ 3	Pinus (19.2, 101.5) ↳ chrysodineae?? Chrysodineae??	
Pyrite	framoids	euhedral		
✓ 1				
Other	Plants → highly degraded			
hash of fecal pellets (pod) - peatier @ base - grayer toward top				

- think of carb → HIGH number of spores

PK-8-97

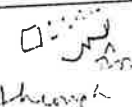
Depth (cm)	35-40			Date 11/11/98
Color	BROWN			Completed by JAT/HDC
Carbonate	NONE			Power 12, 16X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
See Spa BM ND SW	3	3-4		✓
Forams 3	chitinous	carb.	chitin/carb	
✓	✓	✓	✓	
Fungal	Hyphae 4	Sclerotia 2-3	Spores	Miscellaneous
	✓	✓		
S. Spicules	Radiolaria	Charaphytes	Algal ??	phytoliths
mosses 3-4	✓ 3		✓	✓
Charcoal	Insect parts	Fecal Pellets 3	Pollen	
✓	✓ 2	✓ more f.p.s @ base	Chenop. d. (3)	(7.4, 103.5)
Pyrite	framboids	euhedral		
✓ 1				
Other	agglutinating green → sponge spicules			

OTHER PLANTS (see notes for more details)
→ sponge spicules or other green(?)

PK-8-97

Depth (cm)	45-50 cm			Date	11/11/98
Color	GRAY			Completed by	ATC / JPT
Carbonate	ABUNDANT			Power	100
Matrix Framework	 CHITIN, KIMMERLE CARB in matrix (not as pure)				
PLANTS	Roots	Rootlets	Leaves	Bark	
1-1	1-2	3-4	/	/	
Forams	chitinous	carb.	chitin/carb		
2-3					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
✓	✓ 3	✓ 2			
S. Spicules	Radiolaria	Charaphytes	Algal		
✓	✓ in carb 2-3	/	/		
Charcoal	Insect parts	Fecal Pellets	Pollen	Phytoplankton	
/	/	/	(20, 9, 103, 13) → chemoorganotrophic? → Blurry (2)	-	
Pyrite	framboids	euhedral			
✓ 2	"pseudo" framboids				
Other	Carb w/ roots, occasional chunks of plant				

PK-8-97

Depth (cm)	55-60			Date 11/18/93
Color	light brown			Completed by R. C. J. A. F.
Carbonate	NONE			Power 10x
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
BM	3	3-4	0	R, 10
Forams	chitinous	carb.	chitin/carb	
0 ?				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
✓ 3		1		
S. Spicules	Radiolaria	Charaphytes	Algal	
2	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	
0		✓ 2	Chenopodiaceae (M. alba) S. alba S. alba	
Pyrite	framboids	euhedral		
✓ 2-3	loosely packed - 1 not distinct few distinct		→  through chain loose chain	
Other				
more framboids				

PK-8-97

Depth (cm)	05-70			Date	11/1/97
Color	BROWN			Completed by	JH: PSC
Carbonate	→ some in matrix?? (check → petro scope)			Power	10K
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM 2-3	2-3	4 abundant	0 110'/?		
Forams	chitinous	carb.	chitin/carb		
0-1					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2	0			
S. Spicules	Radiolaria	Charaphytes	Algal		
2-3	1				
Charcoal	Insect parts	Fecal Pellets	Pollen		
		1			
Pyrite	framboids	euhedral			
abundant 3-4	/				
Other					
Dinner in progress rocks were densely packed by (likely abundant) roots					

PK-8-97

Depth (cm)	75-80 cm			Date	11/18/97
Color	BROWN - DK. BROWN			Completed by	JR. FSC
Carbonate	none			Power	100
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
FIN	3	3-4 abundant in C rich in	0 poor in rich in	Lamp Sagittaria arrow root	
Forams	chitinous	carb.	chitin/carb		
✓ 2-3 highly corroded					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	✓ 2-3	0-1			
S. Spicules	Radiolaria	Charaphytes	Algal		
✓ 2-3	✓ 1	✓	✓		
Charcoal	Insect parts	Fecal Pellets	Pollen		
✓		✓ 2-3			
Pyrite	framboids	euhedral			
✓ 3-4	loosely packed ✓	(25, 9, 100.0) ✓			
Other					

PK-8-97

Depth (cm)	85-10			Date 11/11/88
Color	GRAY / BROWN			Completed by J. H. C.
Carbonate	MATRIX - high carb. %	proliferating carb.	Power 10X	
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
PM	Roots 2-4 young roots in matrix 3-4 abundant cell fillings	3-4		✓
Forams	chitinous	carb.	chitin/carb	
0-1				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2			
S. Spicules	Radiolaria	Charaphytes	Algal	
2-3	in carb 1		✓	
Charcoal	Insect parts	Fecal Pellets	Pollen	
	1 (in part of top of sample)	✓ toward top of sample		
Pyrite	framboids	euhedral		
3-4	✓		Plant fragments more highly degraded in carb @ base of sample	
Other	Clusters of lighter fossil pellets in brown matrix → different color than matrix material small pellets of dense carb.			

✓ Root in situ
✓

PHOTO - SHELLS

PK-8-97

Depth (cm)	95-100			Date	11/11/97
Color	GRAY			Completed by	JRT, JBC
Carbonate	ABUNDANT!			Power	10x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	3-4	3-4			
Forams	chitinous	carb.	chitin/carb		
	1				
	few → highly corroded				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	1				
S. Spicules	Radiolaria	Charaphytes	Algal		
1-2 few					
Charcoal	Insect parts	Fecal Pellets	Pollen		
Pyrite	framboids	euhebral	shell fragments	23.2, 99.7??	
3-4	loosely packed				
Other	Shells plucked out from slicing			similar fragments in other spot on sample	
Matrix - rich in roots	Roots scattered in carb				
Arms w/ all carb, no roots					

PK-8-97

root fresh w/ no carb

Depth (cm)					Date 11/11/97
Color	gray/tan				Completed by
Carbonate	✓				Power
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RI 2-2	3-4	4	/	/	
Forams	chitinous	carb.	chitin/carb		
✓ 0-1					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	0-1	1			
S. Spicules	Radiolaria	Charaphytes	Algal		
✓ large 2-3	1		✓ in carb (brown)		
Charcoal	Insect parts	Fecal Pellets	Pollen		
/	/	/	chitin/algae		
Pyrite	framboids	euhedral			
✓ 3	/		✓ siliceous	→ highly corroded spin. fragments?	
Other	major matrix carb				
	Roots - HIGHLY DEGRADED				

PK-8-97

Depth (cm)	1.5-2.0 (2)			Date	11/1/97
Color	(NO CHANGE) LIGHT BROWN			Completed by	ALIST
Carbonate	NONE			Power	
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	/ 3	4			
Forams	chitinous	carb.	chitin/carb		
2	direct parts or forams fragments??				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
		5			
S. Spicules	Radiolaria	Charaphytes	Algal		
3	1		✓ 4		
Charcoal	Insect parts	Fecal Pellets	Pollen		
6	1	0	✓		
Pyrite	framboids	euhedral			
4	✓	✓		both → adjacent (14.0, 99.0)	
Other				color → darkens	
* red as light → very fine grains				toward top	
up of algal	ALGAL MAT (?)			9 sample	

dark particles scattered throughout → NOT XTALS
D 11/1/97

PK-8-97

Depth (cm)				Date 11/1/97
				Completed by
Color	ORANGE/BROWN			Power 14V
Carbonate	NONE			
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
RM	u last 5 RM small	4-5		4/50 (RM)
Forams	chitinous	carb.	chitin/carb	
?				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
S. Spicules	Radiolaria	Charaphytes	Algal	
Charcoal	Insect parts	Fecal Pellets	Pollen	
		✓ 1-2		
Pyrite	framboids	euhedral		
✓ 3-4	✓			
Other	Compressed - 1/2 - out of processing?? essentially RM & Pyrite w/ some fecal pellets			

PK-8-97

Depth (cm)	12.5 - 15 cm		very light color	Date 11/11/97
Color	dk (orange-brown)		light color	Completed by JPT/DOC
Carbonate	NONE		6 Rock	Power 100
Matrix Framework			in situ	
PLANTS	Roots	Rootlets	Leaves	Bark
RM		4.5	possible	
	Root (RM)	✓	✓	
Forams	chitinous	carb.	chitin/carb	
2 ³				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	✓	✓		
	2	1-2		
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	
	0-1?	0	0	
Pyrite	framboids	euهدral	color →	DARKER toward top
3-4				
Other	very little matrix →	lots of matrix →	interpenetrating	
unbroken				

PK-8-97

Depth (cm)	145-155 cm			Date	11/12/97
Color	Brown / Gl-Orange / White			Completed by	JAN ASC
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Coniferous RM	✓	✓	✓	✓	
RM	2	2	2		
Forams	chitinous	carb.	chitin/carb		
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	✓ 2	✓ 1			
S. Spicules	Radiolaria	Charaphytes	Algal		
	✓	✓	✓		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
	1	2			
Pyrite	framboids	euhedral			
✓ replant cell lining					
Other	lots of central material (orange color) - most likely highly degraded				RM

differs in your hole

TRANSITIONAL

PK-8-97

Depth (cm)	155 - 160			Date 11/12/92
Color	v. dark brown			Completed by JAT/ADC
Carbonate	112/12			Power 10X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
?	- intruded roots	3-4	0	
Forams	chitinous	carb.	chitin/carb	
1				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
		✓		
S. Spicules	Radiolaria	Charaphytes	Algal	
1-2				
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
0		2		✓
Pyrite	framboids	euhedral		
✓	large			
Other	TRANSITIONAL			
- very dark matrix - intruded roots - few roots (conspicuous) in matrix				

PK-8-97

Depth (cm)	165-170				Date 11/12/93
Color	V dark brown				Completed by JAT/ABC
Carbonate	110/15				Power 10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	abundant RM: 110/15	4			
CONTINUED					
Forams	chitinous	carb.	chitin/carb		
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
S. Spicules	Radiolaria	Charaphytes	Algal		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
✓ 2		2-1		✓	
Pyrite	framboids	euhedral			
1-2	✓				
Other					
resin glob fusinite	Asp. spores	Younger	substantially	abundant	

PK-8-97

Depth (cm)	175 - 180			Date	11/12/98
Color	v. dark brown			Completed by	JAT/ABC
Carbonate	NONE			Power	10%
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	4	4	0	roots	
CONCENTRATED	many small roots				
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2	2-3			
S. Spicules	Radiolaria	Charaphytes	Algal		
0					
NONE					
Charcoal	Insect parts	Fecal Pellets	Pollen		
✓ 2	1	0-1 (matrix?) 5			
				large root w/ fecal pellets inside	
Pyrite	framboids	euhaldral			
✓ 2-3	loosely packed	✓ (small)			
Other					
very dark matrix, lots of roots					

PK-8-97

Depth (cm)	125 - 190 (2)			Date 11/12/98
Color	dk brown			Completed by JAT/PJC
Carbonate	NONE			Power 12V 16K
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Coniospora EM (✓)	4 4 Poss. temporary discoloration above coniospora root			
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2-3	✓		
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	
✓ 3	2-3	0-1		
Pyrite	framboids	euhrdal		
0-1			Resin globs 2 —	
Other				
	Possible BAY roots (Resin)			

— R. M. J. S. —

PK-8-97

Depth (cm)	195-200			Date 11/12/98
				Completed by
Color				SKT/ALC
				Power 10%
Carbonate	1/2-1/2			
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
SAWGRASS	Sawgrass			
CLAMP	CLAMP			
Forams	chitinous	carb.	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
		✓ 1-2		
S. Spicules	Radiolaria	Charaphytes	Algal	
Charcoal	Insect parts	Fecal Pellets	Pollen	
✓ 3	0-1	0-1		
Pyrite	framboids	euhedral		
3-4	-	✓✓		
Other	large piece of oxidized ——— (detrital, not penetrating) very little matrix			

the roots - from 6 cm level → penetrating Saw grass

PK-8-97

Plato

PK-8-97

Depth (cm)	215-270			Date	11/12/92
Color	BROWN (some very fine, dk brown)			Completed by	JK/ASC
Carbonate	NONE			Power	10x
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	4	4		on roots	
Forams	chitinous	carb.	chitin/carb		
	0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	3				
S. Spicules	Radiolaria	Charaphytes	Algal		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0		0	0		
Pyrite	framboids	euhedral			
4					
abundant → xstals loosely packed from slicing					
Other					
degraded cortical matrix → fine-grained yellow-orange mixture of many types of its					

(~ layer above sample)

PK-8-97

Depth (cm)	225-230 CM			Date	11/12/97
Color	light brown			Completed by	JAT/ABC
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	3 small roots in matrix many small Roots 2d - well preserved macroscopic	4	0	0	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2	1			
S. Spicules	Radiolaria	Charaphytes	Algal	spores	
1	0		✓	No spores	
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	0-1	0	✓ <i>tricolpate</i>	✓ possibly algal spore (not tricolpate) scattered	
Pyrite	framoids	euhedral			
3 ✓	1	✓	4		
Other	Symbiotic fungi → in core (deep) fine organic matter w/ all structure			ALGAL MATRIX	

?
Arthropod?

PK-8-97

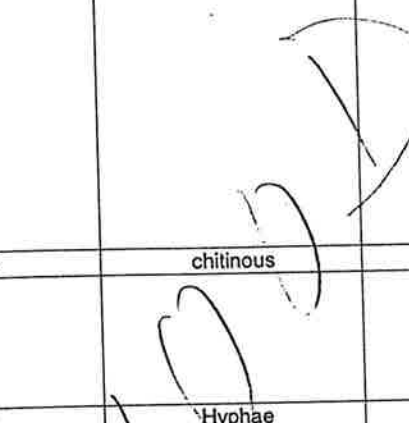
Depth (cm)	235-240			Date	11/12/98
Color	dark brown			Completed by	JAT/ABC
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
8-12 mm narrow b. fragments		4	○	○	
Forams	chitinous	carb.	chitin/carb		
○					
Fungal ✓	Hyphae	Sclerotia	Spores	Miscellaneous	
✓	✓ 3	✓ 3-4 large area		3	
S. Spicules	Radiolaria	Charaphytes	Algal	Sed. (sedge?)	
○	○	○	○		
Charcoal ✓	Insect parts	Fecal Pellets	Pollen		
✓ 3-4 scattered throughout matrix		○	chenopodium - abundant 3		
Pyrite	framboids	euhedral			
		○			
Other					

silica particles → particles of chert

PK-8-97

Depth (cm)	245-250			Date 11/12/98
Color	BROWN → DARK BROWN			Completed by JAT
Carbonate	NONE			Power 10X
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
SPONGES Red many absent	Sponges many (12/10/97)	Rootlets 3	Leaves many absent	Bark many
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	3	1 12/10/97	2	2
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	1	many	
Charcoal	Insect parts	Fecal Pellets	Pollen	RESINS
✓ many absent	1-2	1	Charaphytes	many absent
Pyrite	framboids	euhedral		
3 Secondary (post dep)	✓	✓ large many	(28.6, 97.2) framboids adjacent to euhedral H ₂ O	
Other				
tissues well	preserved (than upper samples)			

PK-8-97

Depth (cm)	765-212			Date
Color				Completed by
Carbonate				Power
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
				
Forams	chitinous	carb.	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
S. Spicules	Radiolaria	Charaphytes	Algal	
Charcoal	Insect parts	Fecal Pellets	Pollen	
Pyrite	framboids	euهدral		
Other	NO THIN SECTION			

PK-8-97

Depth (cm)	245-270			Date 11/17/93
Color	DARK BROWN			Completed by JAT/ADC
Carbonate	none			Power 10x
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Stomach	✓		1-2	2
SG > SG	2		1-2	
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
✓ (in dark matrix)		3-4		
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0		✓	
Charcoal	Insect parts	Fecal Pellets	Pollen	REASON
✓ 3	1-2	0	0	✓ 2-3
Pyrite	framboids	euhedral		Seed
2-3		✓		✓ densely packed
Other	dark - mineral by light (approx. 100x)			

Stomach - trapped at 245-270 cm. leaves preserved

PK-8-97

Depth (cm)	275-280			Date 11/17/93
Color	Thottled → light & dark brown			Completed by JAT/AD
Carbonate	NONE			Power 10x
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Savanna 2-1	5	4	0	2
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	3-4	3-4	5	
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	0	
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
✓ 2-3	1-2	2		
Pyrite	framboids	euhedral		
✓ 2-3		✓		Calcareous sponges (Calcareous sponges)
Other	orange (ish) central bone			

light = crystalline
dark = fibrous

PK-8-97

Depth (cm)	295-297 cm			Date 11/17/88
Color	mottled → (light + dark brown)			Completed by JAT, JSC
Carbonate	none			Power 10X
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
2-3	2-3	3		0
Forams	chitinous	carb.	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	1 3	1 3	2	2
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
✓ 2-3	✓ 2	1-2	charophytes	3
Pyrite	framboids	euhrdal		
✓ 2-3	0	✓		
Other				
	Increasing % Sagittaria			

PK-8-97

Depth (cm)	295-300			Date 11/17/98
Color	WATHER - light & dark brown			Completed by JET/ABC
Carbonate	NONE			Power 12V
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
	3	4		
Forams	chitinous	carb.	chitin/carb	
	0			
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2-3	3		2
S. Spicules	Radiolaria	Charaphytes	Algal	
	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
✓ 3	1-2	2		✓ 2
Pyrite	frambolds	euhedral		SP/NGG
✓ 2-3		✓		rel. to sp. etc.
Other				
more sig. than above orange (ish) color due to cortical tissue				

PK-8-97

Depth (cm)	305 - 310			Date 11/17/77
Color				Completed by JHT/ADC
Carbonate	NONE			Power 10X
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Sawgrass	3	3-4	1	
Forams	chitinous	carb.	chitin/carb	
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
	2-3	2	1	
S. Spicules	Radiolaria	Charaphytes	Algal	
0-1 (fragments of glass from site?)				
Charcoal	Insect parts	Fecal Pellets	Pollen	KELVIN
✓	0	1		✓
Pyrite ✓	framboids	euhedral		
abundant ✓ 4	✓	✓		0 ✓
Other				
lamellae				

PK-8-97

Depth (cm)	315-320			Date	11/17/98
Color	Brown → DK BROWN			Completed by	SP/AFSC
Carbonate	1/10%			Power	100
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Soft Tissue + Sponges SG >> Sg.	3	3-4	0	0	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	1 2	2-3	3	3	
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	/	/		
Charcoal	Insect parts	Fecal Pellets	Pollen		
✓ 4 throughout	1-2	1	0		
Pyrite	framboids	euhedral			
✓ 3-4 not as abundant as (315-318 cm)	large framboid	✓ dominant	5 ✓		
Other					
HIGHLY OXIDIZED → abundance of charcoal & fine-grained carbonate					

PK-8-97

Depth (cm)	225-330			Date	11/17/97
Color	BROWN → DE BROWN			Completed by	JAT/ABC
Carbonate	NONE			Power	10x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
<i>Sargassum</i> <i>Phragmites</i> <i>Sagittaria</i>	3	3-4	/	on roots	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	2-3	2-3 ✓			
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0				
Charcoal	Insect parts	Fecal Pellets	Pollen		
3	✓ 1-2	✓ 2		○ ✓	
Pyrite	framboids	euhedral		RESIN/	
✓ 3	✓	✓			
Other					
orange → fish,	critical material?				

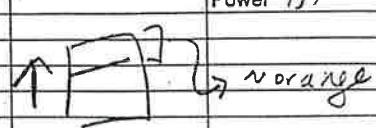
JAT 11/17/97

PK-8-97

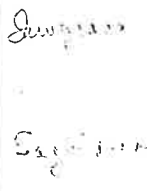
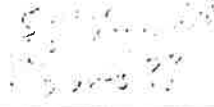
Depth (cm)	335-340			Date	11/17/92
Color	Brown → dk brown			Completed by	J.T. / A.D.
Carbonate	NONE			Power	10x
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sagittaria Cladium	2	3			
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	13-14	2	11	3	
S. Spicules	Radiolaria	Charaphytes	Algal		
1 (14.6, 98.0)	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen		
✓ 4	1-2	2			
Pyrite	framboids	euohedral			
3-4	✓ (a few)	✓ charcoal fragments?			
Other					
granular, highly degraded					

SPP orange → critical marker?

PK-8-97

Depth (cm)	2.15 - 3.50			Date	11/1/97
Color	mottled → light & dark brown			Completed by	PK-8-97
Carbonate	N, NE			Power	12V
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	3	3-4	/	/	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous	
	3-4	3			
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen	Pollen ✓	
4	2	2	0		
Pyrite	framboids	euhedral			
2-3		✓			
Other	(hard to discern between pyrite & charcoal) matrix lighter than above occasional quartz (?) grains highly degraded some areas w/ very little matrix				

PK-8-97

Depth (cm)	200 - 300			Date 11/17/11
Color	Dark & light grey			Completed by JH/ABC
Carbonate	NONE			Power 100
Matrix Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
	5	5	/	/
Forams	chitinous	carb.	chitin/carb	
				
Fungal	Hyphae	Sclerotia	Spores	Miscellaneous
				4
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	
✓ 3	0-1	0	6	
Pyrite	framboids	euhedral		
2				
Other	EXTREMELY FIBROUS; almost NO MATRIX			
~ laminated	IDMATIC - 20			
CD mixed	both on light & dark			

light - 200

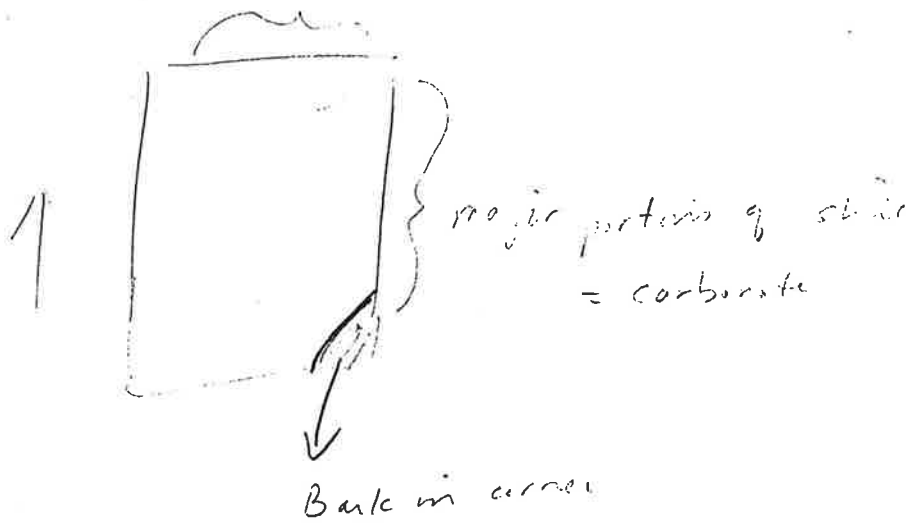
lens - 200

Core PK-10A-97

PK-10A-97

Depth	0-2			Date	10/5/98
Color	brown/grey			Completed by	JAT
Carbonate	abundant			1/12/99	120
Matrix	1091	MIF = 2.96			
Framework	369				
PLANTS	Roots	Rootlets	Leaves	Bark	
Ailanthus (BV) Eriogonum (BV)	BM → more prevalent than RM BM - moderate abundance RM - common Roots more prevalent than other plant parts	✓ Ailanthus Eriogonum RM	None	↑ Bark X-section of wood	
Forams	chitinous	carb.	chitin/carb		
in general, large forams (mostly L. form)	✓	small, large, moderate, scattered, low			
Fungal	Hyphae	Sclerotia	Spores		
	0 - low		2 - low		
S. Spicules	Radiolaria ✓	Charaphytes	Algal		
present throughout, but not abundant	low		10/15		
Charcoal	Insect parts	Fecal Pellets	Pollen		
None	few	None	10/15		
Pyrite	framboids	euhedral			
None	none pre-framboids dark spheres	None			
Other					
- tracheids w/ spiral thickening (in xylem) - vessels w/ perforated plates w/ many tiny pits					

PK-10A-97
0-2 cm slide 1



PK-10A-97

Depth 4-6cm				Date 10/6/97
Color	brown (darker than 2-4)			Completed by JAT
Carbonate	very little (0-1)			Power 15X
Matrix				
Framework				
PLANTS	Roots (3-4)	Rootlets	Leaves	Bark
BM RM	BM (dom) (3-4) RM (2)	✓	(2) RM leaves	✓ (2-3)
Forams	chitinous	carb.	chitin/carb	
various sizes (3-4) magnified	mod chitinous than 2-4		low	
Fungal	Hyphae	Sclerotia	Spores	
	0-1	0-1	✓✓	(2)
S. Spicules	Radiolaria	Charaphytes	Algal	
✓ (2)	✓ 1		0	
Charcoal	Insect parts	Fecal Pellets	Pollen	
none	" (1-2)	0-1	0	
Pyrite	framboids	euhedral		silicon 2-3 (0)
none				1
Other	greater sense of horizontal layering than previous slides denser → more of root bark than others (0-2, 2-4)			

- more preserved than upper samples, but still moderate

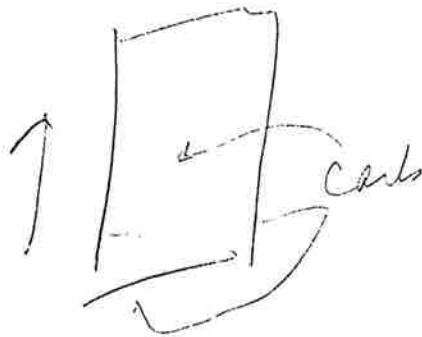
PK-10A-97

Depth	p-10 cm			Date	10/6/98
Color	light brown/grey			Completed by	PA
Carbonate	little present - 1 mm dip = chunk			Power	by
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
highly degraded BM calat? many + 1	BM few many 2-3	1	25% highly degraded	1	
	(2-3)	(2)	10-1	(2-3)	
Forams	chitinous	carb.	chitin/carb		
highly degraded (3)	1	11			
Fungal	Hyphae	Sclerotia	Spores	MISC.	
	1 (1-2)	1 (0-1)		11 (2)	
S. Spicules	Radiolaria	Charaphytes	Algal	lots of det.	
1 (3)	0-1			(2-3)	
Charcoal	Insect parts	Fecal Pellets	Pollen		
1 1	14-1 (2)	0-1			
Pyrite	framboids	euhedral	Siderite	1	
NONE					
Other	very high degree of degradation no det. = 100				

Bark & roots w/ a lot of fr. & animal debris, some carb/ann.

PK-10A-97 8-10cm
side!

10/6/90



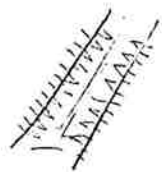
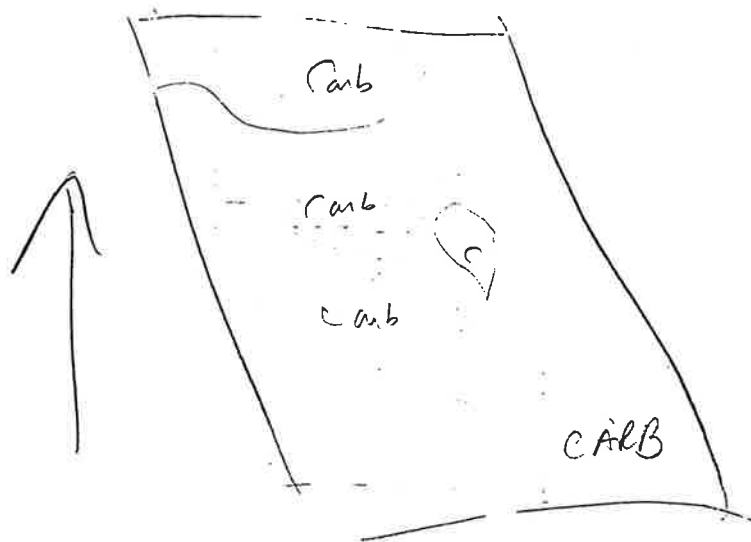
PK-10A-97(1)

Depth	12-14 cm			Date	10/6/98
Color	gray			Completed by	JAT
Carbonate	majority of shell = carbonate			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM dominant (3-4) Beds possibly few RM	not well preserved whitish → bed 1 2				
Forams	chitinous	carb.	chitin/carb		
highly corroded (2)					
Fungal	Hyphae	Sclerotia	Spores	PLWC	
	0	0	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
4	0		✓		
Charcoal	Insect parts	Fecal Pellets	Pollen		
	1 0-1	0	0		
Pyrite	framboids	euhedral			
(15.1, 12.6) 11	← different probably				
Other	Roots, etc. w/in carb. matrix → highly degraded; little more than lumps Abundant shell fragments				

PK - 10A - 97

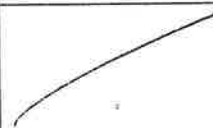
10/6/98

12-14 cr



Good to find some roots

PK-10A-97

Depth 16-18 cm				Date 10/6/98
Color	gray / light brown			Completed by JAT
Carbonate	very little → none			1/15/99 FDC
Matrix				Power 10x
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
	BM - dom RM (2)	BM RM (2)		(on roots) (2)
Forams	chitinous	carb.	chitin/carb	
few, highly corroded (2)				
Fungal	Hyphae	Sclerotia	Spores	Misc
	HP (2-3)		(2)	HP (2-3)
S. Spicules	Radiolaria	Charaphytes	Algal	
1 marine (2-3)			✓	
Charcoal	Insect parts	Fecal Pellets	Pollen	
1	III (2-3)	III (2-3)		
Pyrite	framboids	euhedral	PS	silicem. sp.
(2)	HP		1 (1)	III (2)
Other				
(3)	(26.2, 104.2) Root - very dark, lots of inclusions (?)			

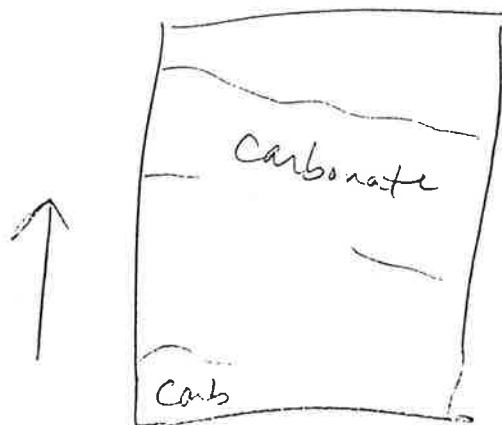
highly degraded → very small particles

PK-10A-97

Depth	20-22 cm				Date	10/16/98
Color	gray/brown				Completed by	JAB
Carbonate	~ 45% of slide (layers) fine grained				1/12/99	APC
Matrix					Power	10X
Framework						
PLANTS						
	Roots	Rootlets	Leaves	Bark		
BM	large BM roots					
	(4)	0-1 BM				
Forams	chitinous	carb.	chitin/carb			
3						
Fungal	Hyphae	Sclerotia	Spores	MISC		
			!!!	!!!		
	(2)		(2)	(3)		
S. Spicules	Radiolaria	Charaphytes	Algal			
3-4						
Charcoal	Insect parts	Fecal Pellets	Pollen			
	0-1	(2)				
Pyrite	framboids	euhebral	u-f-h-d			
	!!!					
12-3)			(1)			
Other						
more	issues than above					

PK-10A-97
20-22 cm

10/6/98



PK-10A-97

Depth 24-26 cm				Date 10/7/98
Color	gray/brown			Completed by JFT
Carbonate	matrix			Power 12V
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark (2)
RM, BM BM dominant	BM RM - large (2) Some neg. size	RM (3)		✓ (2.5)
Forams	chitinous	carb.	chitin/carb	
✓ highly corroded (3-4)	-			
Fungal (4)	Hyphae (0-1)	Sclerotia (1)	Spores (3)	Misc. (14)
			" "	4
S. Spicules (3)	Radiolaria (1)	Charaphytes	Algal	
(3)	1			
Charcoal	Insect parts	Fecal Pellets	Pollen	"letho do"
	1/1 (4)	- (4)		" "
Pyrite (1)	framoids (1)	euhedral		
Other	Lignin RM 90 than previous slides			
	roots - degraded mostly BM			

PK-10A-97

Depth 28-30				Date 10/7/98
Color	gray/brown			Completed by JAT
Carbonate	NONE (to very little)			11/18/91 ACC
Matrix Framework				Power 10X
PLANTS	Roots	Rootlets (4)	Leaves	Bark (2)
RM = BM BATS	Two large RM & BM RM (2) BM (2) fungi attached / growing out of roots	RM BM	/	((Roots))
Forams (2-3)	chitinous	carb.	chitin/carb	
Fungal	Hyphae 0-1	Sclerotia 1	Spores 1-2	MISC
	/	1	1 (trunk) [?]	" (3)
S. Spicules (2-3)	Radiolaria	Charaphytes	Algal	
	/			
Charcoal	Insect parts	Fecal Pellets	Pollen	
/	" (3)	" (3)	/	
Pyrite (2-3)	framboids	euhedral	" tetrahedra "	
Zone - rich in pyrite	1/1	/	(1)	
Other	mostly rootlets w/ few large roots			

up ↑  Rootlet cross section increase

PK-10A-97

Depth	35-40 cm			Date	12/16/98
Color	brown (light → red brown)			Completed by	JAT
Carbonate	None			Power	10x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	✓	✓	RM (H ₂ O suspension)	on roots	
1.2	large root	5-4	1-2		
	3	abundant RM	debris?		
			NO CW		
Forams	chitinous	carb.	chitin/carb		
✓	✓				
2					
Fungal	Hyphae	Sclerotia	Spores	misc	
	abundant	0	3	3	
	4				
S. Spicules	Radiolaria	Charaphytes	Algal		
✓	1				
23-					
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	3	4	0		
Pyrite	framoids	euhedral			
✓	✓				
4.5					
low					
Other	more red-brown				
	(darker than above)				
	abundance of debris				
	abundant cell inclusions				

PK-10A-97

Depth	45-50 cm			Date	12/16/98
Color	Red-brown			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
pm pm above	large root → one side 3	3 pm	0	roots large low 1.5m	
Forams	chitinous	carb.	chitin/carb		
(see is 1 for spines?) chambering					
Fungal	Hyphae	Sclerotia	Spores	MISC	
	abundant	0	2	3	
S. Spicules	Radiolaria	Charaphytes	Algal		
few 1	0	✓	✓		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	✓ 2-3	✓ 3-4			
Pyrite	framboids	euhedral			
✓ 4	✓ dom.	few			
Other					
abundant and abundant	debris cell fillings leaf	pyrite	few		

SAA



thick
wall → Sarcodina??

1
2

PK-10A-97

Depth	55-60 cm (#2)			Date	12/16/98
Color	light brown → RED-BROWN			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM BM	✓ center → large root (RM?) 3	✓ 3 RM			
Forams	chitinous	carb.	chitin/carb		
0-1					
Fungal	Hyphae	Sclerotia	Spores		
	3		2		
S. Spicules	Radiolaria	Charaphytes	Algal		
1	0		algal mat → fine matrix		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	2	1	123.0, 108. (23.9, 101.2)		
Pyrite	framboids	euhedral			
✓ (in particles) 3	✓				
Other	loby matrix wall in piece w/ roots/ rootlets penetrating by fine-grained				

PK-10A-97

Depth	65-70 (#2)			Date	12/16/98
Color	brown - dk red/brown			Completed by	JAT
Carbonate				Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
BM			□	roots	
pm	3	in 3-4	1-2?		
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	3	0	2		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	8				
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	2	✓ large 3			
Pyrite	framboids	euhedral			
✓ 4					
Other					
abundance of cell inclusions Central fissure??	texture → artifact of slide prep.				

PK-10A-97

Depth	75-80 cm			Date	12/10/98
Color	Brown → dk brown			Completed by	JAT
Carbonate	none			Power	105
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	large root 3	4 RM	2 1	no b	
Forams	chitinous	carb.	chitin/carb		
	0				
Fungal	Hyphae	Sclerotia	Spores		
	✓ 3	1	2		
S. Spicules	Radiolaria	Charaphytes	Algal		
✓ 1	0		algal mat @ base		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	✓	1-2	0		
Pyrite	framboids	euhedral			
✓ 2-3	✓				
Other	Bottom of sample → darker than above making a algal mat				

PK-10A-97

Depth	85-90 cm			Date	12/17/98
Color	Brown ~ yellow brown			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix Framework	focal & matrix denser, ~ yellow				
PLANTS	Roots	Rootlets	Leaves		
	large roots				roots
	RM - abundant TRANS	3	4 cm		
Forams	chitinous	carb.	chitin/carb		
	0				
Fungal	Hyphae	Sclerotia	Spores	MISC	
	✓ (mainly in areas w/ acid pellets) 2-3	0	3-4		
S. Spicules	Radiolaria	Charaphytes	Algal		
	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
	1	✓ large 3	0	1	
Pyrite	framboids	euhedral			
	3				
Other	very small xtal abundance of cell inclusions in particular tissues oxidized material - not quite charcoal, but no distinct xtal				

↑ → ?? fungal? opal? ...

PK-10A-97

Depth	95-100 cm			Date	12/17/98
Color	BROWN w/ red, yellow			Completed by	JH7
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	few large roots - compressed & intruded. 3	4	possible leaf fragments - highly degraded ✓	roots	
RM		RM			
Forams	chitinous	carb.	chitin/carb		
possible - pieces for species					
Fungal	Hyphae	Sclerotia	Spores	MISC	
	✓	1	1-2	✓	
S. Spicules	Radiolaria	Charaphytes	Algal		
1	0		~~algal~~ (1)		
2					
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
0	✓ 2-3	Variety of sizes 2-3		1	
Pyrite	framboids	euhedral			
✓	✓ 2-3 → isolated patches (in tissues)	TINY XTALS			
Other	rod cuticle tissue oxidized material → no xtal structure	very fibrous			

(21.4, 99.2) → insect parts or smashed forams?

PK-10A-97

Depth	105-110 cm (#2)			Date	12/17/98
Color	light/dark brown			Completed by	JAT
Carbonate	NONE			Power	100 1/2/98
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	 3	4 cm	few fragments 1-2 0 CW	roots	
Forams	chitinous	carb.	chitin/carb		
0-1					
Fungal	Hyphae	Sclerotia	Spores		
	2-3 (s.p. w) f.p.	0	2		
S. Spicules	Radiolaria	Charaphytes	Algal		
1-2	0				
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	3	3			
Pyrite	framboids	euhedral			
3		(very small)			
ox. short xtd structure → "pre-pyrite"? more abundant in one ag pellets & debris					
Other					
typical RM peat					

PK-10A-97

Depth	115-120cm (#2)		Date 12/17/98	
Color	brown → dk brown		Completed by JHT	
Carbonate	NONE		ADC 1/21/99	
Matrix Framework			Power 10X	
PLANTS	Roots	Rootlets	Leaves	Bark
	✓ 2-3	✓ 3-4 LMA		
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	MISC.
	✓ 3	✓ 1	✓ 3	
S. Spicules	Radiolaria	Charaphytes	Algal	Residue
1	0			✓
Charcoal	Insect parts	Fecal Pellets	Pollen	
0	✓ 2	✓ large & small 3	0	
Pyrite	framboids	euhedral		
✓ 2-3 x. material w/o xtal structure	✓			
Other	lighter matrix fecal pellets → common in RM pellets			

PK-10A-97

Depth	125 - 130 cm			Date	12/17/98
Color	Brown - mottled w/ red & dark brown			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM	2	3.4 RM	0	roots	
Forams	chitinous	carb.	chitin/carb		
in fecal pellets only					
1-2 0)					
Fungal	Hyphae	Sclerotia	Spores		
	✓	0	2		
S. Spicules	Radiolaria	Charaphytes	Algal	MISS	
0	0	✓	✓		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	✓	✓ LARGE fecal pellet gut insect leg & brain very ORANGE euهدral	0	pellet w/ leg, etc.	
Pyrite	framoids				
✓ loose xrb.	✓	✓			
Other	oxidized material throughout - little discernable structure				
orange → cortical?		///	→ artifact of processing (silencing w/ microscope)		

insect parts at root in fecal pellets

PK-10A-97

Depth	135-140 cm			Date	12/17/88
Color	brown → dk brown			Completed by	JAT
Carbonate	ADNE			1/2/89 hsc	Power 10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
off? RM	2-3	3-4 RM	2	roots	
Forams	chitinous	carb.	chitin/carb		
1					
Fungal	Hyphae	Sclerotia	Spores	MISC	
	2-3	1	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
1	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
?	2	2-3	0	✓	
Pyrite	framboids	euhedral			
2-3					
Other	abundance of debris				

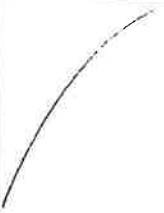
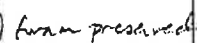
PK-10A-97

Depth	145 - 150 cm			Date	12/18/98
Color	brown			Completed by	J.T.
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
other - unidentifiable	large root w/ rootlets penetrating		leaf debris in matrix?	roots	
2-3		3	1-2		
Forams	chitinous	carb.	chitin/carb		
(32.9, 109.0) degraded foram? ☒					
Fungal	Hyphae	Sclerotia	Spores		
1-2	1 - small & degraded	1	1		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
0	1	large 2-3		1	
Pyrite	framboids	euhedral			
3	few	small masses			
Other	loose xtls. more widely dispersed in clusters in tissues				
tissues highly degraded					

PK-10A-97

Depth	155-160 cm			Date	12/18/98
Color	BROWN			Completed by	217
Carbonate	NATIVE			Power	10x
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
	2-3	3	(21, 7, 98, 9) CW2 1.		
Forams	chitinous	carb.	chitin/carb		
Fungal	Hyphae	Sclerotia	Spores	MNC	
	1	1-2	2		
S. Spicules	Radiolaria	Charaphytes	Algal		
	0				
Charcoal	Insect parts	Fecal Pellets	Pollen		
	0	Large - RED 3			
Pyrite	framboids	euhrdal small xthls			
	2-3				
Other	ox. mat. w/ and xtal structure SNA				

PK-10A-97

Depth	165-170 cm			Date	12/18/98
Color	Brown - darker than above samples			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
RM other	1  large, dark root	4 RM		mt	
Forams	chitinous	carb.	chitin/carb		
1-2 highly degraded (23, 2, 97, 6)					
Fungal	Hyphae	Sclerotia	Spores		
	3	3-4/	3		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0		in matrix 0-1 		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
0	1	2-3 		✓	
Pyrite	framboids	euhedral		SEED	
3-4	few	small xtals			
Other	symbiotic fungi on RM roots few cell fillings				

PK-10A-97

Depth	175-180 cm			(wood)	Date 12/18/98
Color	RED 175-178 = dk brown like			large	Completed by JAT
Carbonate	NONE			1/21/99	Power 10X
Matrix				↑	
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Conifer Lignin other ~~Amorphous~~ em-dom	2	3 pm	debris in matrix? few cells	resin ↑	
Forams	chitinous	carb.	chitin/carb		
✓ 1-2	✓ highly corroded				
Fungal	Hyphae	Sclerotia	Spores	MIC abundant	
	2	3	3-4		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	/		
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin	
0	0	✓ 2	0	1	
Pyrite	framboids	euhedral			
✓ 2-3		clusters			
Other	abundance of cell inclusions & bursals ↳ pri. MIT from Red Merg.				

PHOTO

PK-10A-97

Depth	185-190 cm			Date 12/18/98
Color	Reddish			Completed by JH7
Carbonate	11/11			1/21/99 AC
Matrix				Power 10X
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Coar/orig Sawgrass Rm - p... 100 Jacker material		3-4  212		1000
Forams	chitinous	carb.	chitin/carb	
1				
Fungal	Hyphae	Sclerotia	Spores	Misc
	3-4	3 variety of sizes	3	4
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	/	/	
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin
2	1	✓ red box 2-3	/	✓ 11th 2nd or cell filling
Pyrite	framboids	euhedral		Sawgrass (root/leaf fragment)
Other				
Similar to 175-180 cm, but darker in color oxidized material - not charcoal but no xtal structure				

slide too thick?? → should
be ...?

↑  large red root
root or leaf fragment?

PK-10A-97

Depth	195-200cm			Date	12/18/98
Color	Red-brown			Completed by	JAT
Carbonate	NONE			Power	OX
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
possible (mineral)	large root (s) mineral w/ rootlets 	(dense w/ where present) 3 PM	debris → matrix?	root	
PM, 4					
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	3	OXIDIZED (not all, but most)	3	fungal	
S. Spicules	Radiolaria	Charaphytes	Algal	MISC	
1	0			4	
Charcoal	Insect parts	Fecal Pellets	Pollen		
0-1	1	2			
Pyrite	framboids	euhedral			
3 loose xhals		large			
Other					
secondary oil fillings - PHOTO					

oxidized sclerotia??



check available ✓ OK

PK-10A-97

Depth	205-210 cm			Date 12/19/98
Color	BROWN			Completed by JAT
Carbonate	NONE			1/21/99
Matrix				Power 10X
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
	1-2 [?] intruded by Logunov? RM	3-4 [?] RM	/	not
Forams	chitinous	carb.	chitin/carb	
In fecal pellets 1-2 [?] ↑				
Fungal	Hyphae	Sclerotia	Spores	MISC
	2	3-4 in matrix some oxidized	2	2
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	1	
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
3-4 scattered	2	2 [?] ↑	chenopod. (18.6, 98.6) (2)	2
Pyrite	framboids	euhedral		SEED?
2-3				R
Other				

abundance of debris RM penetrating EVERYTHING
oxidized material scattered throughout
RM w/out cell fillings?
older basal
charcoal
[scribbled out text]
RM tip

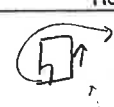
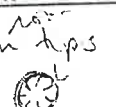
PK-10A-97

Depth	215-220 cm			Date 12/19/98
Color	BROWN			Completed by RAT
Carbonate	NONE			11/21/99
Matrix	WOOD			Power 10X
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Sawgrass Laguncularia racemosa 4 rm penetrating		3		Poss.
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	
	1-2	0	0-1	
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	0	
Charcoal	Insect parts	Fecal Pellets	Pollen	
1	✓ 1	✓ 2	0	
Pyrite	framboids	euhedral		
abundant in tissues many with no distinct xtals	✓	✓		
Other	abundance of wood/root (long-section) in slide			

oxidized material
building up in cell walls

PK-10A-97

#1 → darker (thick??)

Depth	225-230 cm (#2)			Date 12/19/98
Color	Red/brown			Completed by JH 7
Carbonate	NONE			1/21/99 AC
Matrix Framework				Power 100
PLANTS	Roots	Rootlets	Leaves	Bark
Lycop.? Cladonia ✓ (dark patch) fm - high	 large not det.? some det.? 1	 fm tips 4 fm	✓ p. thin but degraded (100% fm) non Sp. det. 2	roots 100%
Forams	chitinous	carb.	chitin/carb	
D				
Fungal	Hyphae	Sclerotia	Spores	
	1	1 ~~scribble~~	2	
S. Spicules	Radiolaria	Charaphytes	Algal	
D	D	1	1	
Charcoal	Insect parts	Fecal Pellets	Pollen	
0-1	0-1	1	1	
Pyrite	framboids	euhedral		
✓	✓	1 *		
2-3	some loose @			
Other	small bubbles from processing remaining on slide greater leaf content @ base of sample - very little matrix - red ~ network of cells → type?  * DHTO* - some rust  CLADIA?			

PK-10A-97

Depth	235-240 cm (#2)			Date	12/19/98
Color	mottled light & dark brown			Completed by	JH-7
Carbonate	NONE → matrix ~ yellow			Power	12X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
✓ Clad. RM	2-3 Cladonia [0] 2nd yr roots	RM roots ③ 3-4' RM	1 "mat" cells of Clad? debr. → in darker matrix	roots	
Forams	chitinous	carb.	chitin/carb		
(24.9, 101.8) or part of sclerite?					
Fungal	Hyphae	Sclerotia	Spores		
	1	1-2	1		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	6	/	Algal mat material 3	Pouch DATA!	
Charcoal	Insect parts	Fecal Pellets	Pollen		
0-1	1-2	pocket of pellets 1-2 [P] ↑	Pinus	Seed ↑ [P]	
Pyrite	framboids	euhedral		RESIN ✓ 1 2	
3 ix. material throughout → tiny x tabs?					
Other	Considerably more matrix than underlying sample - lighter & browner in color				

↑ [P] - rhizome? SANGRASS (ALGAL → PROTID)
C-100

PK-10A-97

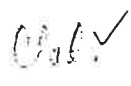
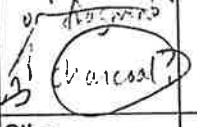
Depth	245-250 cm			Date 12/19/98
Color	yellow-brown w/ dk brown spots			Completed by JAT
Carbonate	NONE			Power 5X
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Other edge ? - junco? -? clad - probably NOT pm per... above	tiny ~~Rootlets~~ → 12cm 2 clad -	3	undecid → clad	Roots
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	
	1	✓ 1-2	1	
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	★ multic	probably sponges
Charcoal	Insect parts	Fecal Pellets	Pollen	
3-4	1	1-2	0	Seed ✓ multiple → diffident lesion
Pyrite	framboids	euhedral small		1
2 ✓	✓	✓		
Other				
~ 235-240 cm				

□ bifractal → carb
?? SEED coat
in water bag?

PK-10A-97

Depth	255-260 cm			Date	12/19/98
Color	mottled yellow/brown & dk brown			Completed by	JAT
Carbonate				Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
down other Clad other? 1-2 Clad Clad	4 Clad	1-2 typical ridge	roots		
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	0-1	2	1-2		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0				
Charcoal	Insect parts	Fecal Pellets	Pollen		
✓ 3	1	1			
Pyrite	framboids	euhedral		lesser	
✓ 3-4	✓	✓		✓ 1	
Other					
	Rhizome? leaf (moss, etc)				

PK-10A-97

Depth	265-270 cm			Date	12/19/98
Color	DARK BROWN			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
 Sap highly degraded em (less than above)	1-2 1-2 large included	3 3 (more)	0	Roots	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	MISC	
	2	0	1-2	3	
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	✓			
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin	
✓	0	0		3	
hard to differentiate b/w charcoal & dead-degraded					
Pyrite	framboids	euhedral			
 charcoal?					
Other					


 textured yellow ?? Charaphyte

PK-10A-97

Depth	275-280 cm			Date 12/20/97
Color	dk brown (w/ light patches)			Completed by JH-1
Carbonate	N/A			1/22/99 AC
Matrix				Power 10x
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Sag Clad-down dark-clad light: Sag	2 Clad	Sag ✓ 4	debris ✓ 1-2 wet cells	Roots
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	
	2-3	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal	MISC
0	0	6	0	✓
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
✓ 3-4 small large pieces	2	6	? O algal? yellow (17.4, 98.2)	✓
Pyrite	framboids	euhedral		Silica (?) → due to etching slide?
✓ secondary 3-4	few	✓ X		
Other	abundance of oxidized material gelatinization, Sag			Seed

red cortical (?) material
↑ ↑

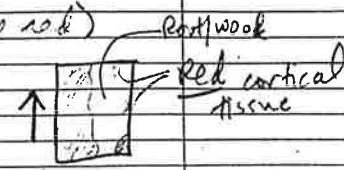
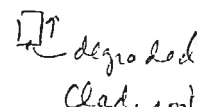
PK-10A-97

Depth	285-290cm			Date	12/20/98
Color	dk brown			Completed by	MD 1/3/99
Carbonate	NONE			Power	10X
Matrix					
Framework					
					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sag. Clad.	large 1-2 2-3	3-4	 Clad. vascular bundle??	on roots/under	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	MISC	
	/	1	cluster (20.7, 107.9) 2-3	2-3	
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	/	/		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
hard to see due to thickness	1	0	(19.1, 110.0)  probably a spore?	✓ 3	
Pyrite	framboids	euhedral			
				seed	
Other	SAA				
	abundance of oxidized debris abundance of cell-filling/preserving material				

* Slide quality = POOR (#2-incomplete)

PK-10A-97

#1 incomplete

Depth	295-300 cm (#2)			Date	12/20/98
Color	dk brown (w/ some red)			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sag Clad	 3	4	1	roots	
Forams	chitinous	carb.	chitin/carb		
	0				
Fungal	Hyphae	Sclerotia	Spores	MISC	
	2	2	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
✓ 2	✓ 1	✓ 1	(145, 107, 11) reticulate (multiple)	✓ 3 Some ~ texture	
Pyrite	framboids	euhedral			
✓ 2-3	✓	✓ few			
Other	abundance of oxidized material oxidized resin				

PK-10A-97

7#1 sp. good

Depth	305-310 cm (#2)			Date	12/20/98
Color	dk brown / Lt. (no. 100)			Completed by	JAT
Carbonate	NONE			1/27/99	Power 10x
Matrix				7 - large sort	
Framework				2 - light	
				W.M. Matrix	
PLANTS	Roots	Rootlets	Leaves	Bark	
Sage ✓ Oak ✓ Maple ✓ Honeylocust ✓	large x-section in center of slide. ~ 1 cm diam.? too light in color for Chlorophyll 4	2-3		Roots	
Forams	chitinous	carb.	chitin/carb		
Fungal	Hyphae	Sclerotia	Spores	Misc	
	2	2	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin	
2	1	1	SAT - multiple	2	
Pyrite	framboids	euhedral			
✓ 1-2 in tissues of light plant - center of slide		✓			
Other					
mixture of beautiful	root-type cell fillings				

PK-10A-97

Depth	315 - 320 cm			Date	12/20/98
Color	mottled light/dark brown			Completed by	JAT
Carbonate	NONE			1/22/99	AGC
Matrix Framework				Power	10X
PLANTS	Roots	Rootlets	Leaves	Bark	
Sag ✓ Oak ✓ other	dead! 2	 4	✓ 1-2 dead long, thin, 1-2?		
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	' 2-3	" large	2-3 multiple		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin	
' 3	' 2	' 1	5-10 ↳ few - in fecal pellets & matrix	1-2	
Pyrite	framboids	euhedral			
✓ 3	'	✓ small			
Other					
chunk of wood (unk.)					

PK-10A-97

Depth	325-330cm			Date 12/20/98
Color	mottled light/dk brown			Completed by JAT
Carbonate	NONE	little to no matrix		11/20/99 12
Matrix Framework				Power 10X
PLANTS	Roots	Rootlets	Leaves	Bark
Sag Clad	Clad. 2	Sag 3	0	Roots
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	MISC
	✓ 3	3-4	2	2
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0			
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin
3	✓ 1-2	1	8A+	✓ 1-2
Pyrite	framoids	euهدral		
0				
Other	Empty spaces - wood - on slide #2, but slide 2 is thicker than 15um → misleading/dark, difficult to see some tissues/structures.			

matrix - ^{more} red than previous sample

PK-10A-97

Depth	335 - 340 cm			Date	12/20/98
Color	BROWN - mottled lt/dk			Completed by	JAT
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Clad ✓ Sph. ✓ Clad 2 1.1 det. 2nd in		3	Clad det. 2nd	Roots	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores	Misc	
	2-3	3-4	2	2	
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0				
Charcoal	Insect parts	Fecal Pellets	Pollen	Resin	
3-4	0-1	2	SAA	1	
Pyrite	framboids	euhedral			
3					
esp. in light-colored tissues					
Other	abundance of fungus & debris red critical tissues				

Highly degraded & oxidized

PK-10A-97

Depth	345-350 cm (#12)			Date	12/20/98
Color	Brown → dk brown, matrix red			Completed by	JAT
Carbonate	ADIVE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
petiole covered Sag ✓ Clad ✓ Her? ✓ Cephalanthus (?)	2-3 Clad	3	/	Roots	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	3	3-4	3		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN	
3-4	1	1-2	1	2	
Pyrite	framboids	euhedral			
0					
Other SAA					
abundance of debris					

(21.8, 103.8)

pollen? (spore? or of g.l?)

PK-10A-97

Depth	355-360 cm			Date 12/25/98
Color	(brown) dk brown			Completed by JAT
Carbonate	NONE			1/22/99 AC
Matrix				Power 10x
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Portulacaceae (?) (P. ...) Sag ✓ A.L. unbr.	2-3 Rhizome clad	3-4	(25, 2, 102, 9) 17 1	not
Forams	chitinous	carb.	chitin/carb	
0				
Fungal	Hyphae	Sclerotia	Spores	Misc
	3	2-3	(29.1) 99.2) 13	2
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	0	
Charcoal	Insect parts	Fecal Pellets	Pollen	Plant
3	2	0-1	SAA	81
Pyrite	framboids	euhedral		
0		✓		
Other	(No cell hillocks - dead water) abundance of oxidized mat.			
Rhizome (?) ↑	[]			

gelified / thickening → intercellular
good examples of charcoal ↓ pass. (Not ...)

PK-10A-97

Depth	3105 - 370 cm (#2)			Date 12/21/92
Color	BROWN - mottled - various shades (FI - air bubbles)			Completed by JAT
Carbonate	NONE (incl. red dk) slightly lighter @ base			Power 10x
Matrix				
Framework				
PLANTS	Roots	Rootlets	Leaves	Bark
Swg	2-3		matrix	Roots
Coal	↑ 1/2 large root (det?)	3	-	
Forams	chitinous	carb.	chitin/carb	
	0			
Fungal	Hyphae	Sclerotia	Spores	
	1-2	2		
S. Spicules	Radiolaria	Charaphytes	Algal	
0	0	0	0	
Charcoal	Insect parts	Fecal Pellets	Pollen	RESIN
2				1-2
Pyrite	framboids	euhedral		
1-2			? sand grains? or product of pyritization?	
Other	less oxidized material than matrix - more red lighter in color			355-360 cm

~~more oxidized material~~

PK-10A-97

Depth	375-380 cm			Date	12/21/98
Color	very light brown/yellow			Completed by	JET
Carbonate	NONE			Power	10X
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sag other?	2	3-4 Gelatinous rootlets		none	
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	1-2	0	0-1		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	0	0	0		
Pyrite	framboids	euhedral			
✓ 3	✓	✓			
Other	PART LITISH				
Considerable change in color. highly degraded little to no matrix					

gel-like substance in intra-cellular areas *DI*

PK-10A-97

Depth	385-390 cm			Date	12/21/98
Color	light brown			Completed by	JH-7
Carbonate	N/A/E			Power	XX
Matrix					
Framework					
PLANTS	Roots	Rootlets	Leaves	Bark	
Sage	✓	✓	✓	✓	
Other?	2.3	4			
Forams	chitinous	carb.	chitin/carb		
0					
Fungal	Hyphae	Sclerotia	Spores		
	0	0	0		
S. Spicules	Radiolaria	Charaphytes	Algal		
0	0	0	0		
Charcoal	Insect parts	Fecal Pellets	Pollen		
0	0	0	0		
Pyrite	framboids	euhedral			
✓	✓	✓			
Other	root hairs				
SAX					

Sage roots w/ gelatinous material

10. APPENDIX 2. Protocol for Pollen Preparation

PROCESSING SAMPLES FOR POLLEN EXTRACTION

1.) TREATMENT WITH 10% HCL AND WASHING

Weigh out about 20.0 g of sample and place in a labeled beaker. Place the beaker under the fume hood and add 10% HCL (enough to cover entire sample plus a little). If there is a lot of carbonate in the sample, and it starts to foam up, a few squirts of acetone will calm the foaming action down. Place the beaker on a hot plate on medium heat. Do not leave the sample unattended. Stir the sample occasionally with a wooden stirrer. When the sample begins to boil, turn the heat down enough to keep the sample just barely boiling... add more HCL if necessary to react with all of the carbonate. Once it looks as though all activity has ceased (10-30 minutes), the sample can be placed equally into as many 50 ml centrifuge tubes as are needed for the amount of sample (liquid and all) being used. Seal all of the tubes and place into the centrifuge so that the load is balanced. Centrifuge at 1500 rpm for 10-15 minutes. Decant liquid into waste container and refill tubes with distilled water. Centrifuge for same amount of time and decant liquid into the sink. Repeat washing once more.

2.) TREATMENT WITH KOH

****** This step is only to be used if the raw sample is peat. If it is not a peat, then skip to step 2b. Place the sample into the labeled beaker used in step 1. Fill beaker with 10% KOH solution to about the 250-ml mark and heat on the hotplate. Once the sample starts to boil, lower the heat so that it remains at a low boil for 10 minutes. As the sample boils, the solution will evaporate. Keep adding water to the sample to keep the level between 200-250 ml. While the sample is boiling, wash a 200 micron mesh screen and burn it dry over the flame from a burner. Be careful not to burn a hole in the screen. Hold the screen over the flame long enough to dry it. This process burns any pollen on the screen that could contaminate the sample. After 10 minutes of boiling in 10% KOH, place the screen over a beaker and strain the sample to remove large organic debris. Wash the debris on the screen with distilled water and place the liquid into centrifuge tubes and spin at 2000 rpm for 10 minutes. Decant liquid into a waste receptacle and rinse the sample with distilled water twice.

2.) TREATMENT WITH HF

Decant the liquid very carefully. Use protective gloves, apron, and shield. Slowly add HF to each centrifuge tube (3-5 ml). Do not put caps on these tubes. Place the tubes into a Teflon beaker with approximately an inch of water in it. Warm the samples on the hot plate. You do not want to boil the samples. You just want to warm them to expedite the reaction of HF with any silica that might still be in the residue. If the sample was not very sandy, let it sit for about twenty minutes. If the sample was sandy, let it sit longer and add more HF after an hour. Try not to leave the samples unattended.

Once you think the HF has removed all of the silica, fill each tube with distilled water and centrifuge for 10 minutes at 2000 rpm. Decant the HF into the waste HF container and rinse the sample three more times with distilled water.

3.) BLEACHING AND STAINING

After pouring off the rinse-water from the previous step, add approximately 3 ml of bleach to each tube and seal them. Gently shake the tubes to insure that the sample freely mixes with the bleach. There should not be any kind of lump in the sample. Flicking your finger at the tip of the tube usually can do this. Let the tubes stand for 5 minutes in pure bleach. Then, add distilled water to fill each tube. Do not let the sample stand in pure bleach for more than 5 minutes. The bleach will oxidize any pollen and destroy it. Centrifuge for 10-15 minutes at 2000 rpm and carefully decant the liquid. Rinse with distilled water 2 more times. Add 4 drops of Sarafin-O stain to each tube and seal. Be sure there are no clumps in the sample to insure complete mixing. Let the samples stand for 8 minutes. Fill each tube with distilled water and centrifuge for 10 minutes at 2000 rpm and carefully decant the liquid. Add approximately 1 ml of distilled water to each sample.

4.) MOUNTING IN ELVACITE

In this process, the mounting medium is a clear plastic that does not need to be sealed after drying. This is a good medium because it has a refractive index close to that of water. It is good to use if the slide will be photographed.

Turn on the slide-warming tray to 50°C. Using a disposable eyedropper, swirl the sample in and out of the dropper to insure thorough mixing and retain some of the sample in the dropper. Place a coverslip on plain white paper in front of you. Put on eye drop of residue in one corner of the coverslip. Put one drop of Clearcol on the coverslip in the opposite corner being very careful not to let the two drops mix yet. After closing the Clearcol, use a toothpick to mix the two drops together thoroughly on the coverslip. Use the toothpick to spread the mixture over as much of the surface of the coverslip as possible without letting the mixture go

over the edge of the coverslip. Take the coverslip to the slide warmer and gently transfer the coverslip to the warmer without disturbing the sample. Use the same disposable eyedropper to transfer the remaining residue to a labeled, screw-cap vial. Add one drop of 1% Phenol solution to preserve it. Close the lid and store the remaining residue. Let the sample on the warming tray covered until the Clearcol dries completely (15-20 minutes). During that time, label the slides that will be used for mounting. Once the Clearcol has dried, place one drop of Elvacite on the slide. Put the top back on the Elvacite and gently pick up the coverslip with the sample on it. Do not touch the exposed surface of the sample. Turn the coverslip upside down and place it on the drop of Elvacite at an angle slowly so that no air bubbles get trapped underneath. Watch to make sure that the Elvacite completely fills in the space under the coverslip and that the coverslip is straight with respect to the sides of the slide. Carefully place the slide on the slide-warmer and let it sit for 24 hours. At that time the slide is completed. The mount is permanent.