MIAMI GEOLOGICAL SOCIETY MEMOIR 3

SYMPOSIUM ON SOUTH FLORIDA GEOLOGY

edited by Florentin J-M R. Maurrasse

Miami Geological Society
P.O. Box 144333
Coral Gables, Fl 33114

December 1987

THE HAWTHORN GROUP OF PENINSULAR FLORIDA

Thomas M. Scott
Florida Bureau of Geology
Tallahassee, Florida

Michael S. Knapp
South Florida Water Management District
West Palm Beach, Florida

ABSTRACT

The Hawthorn Group in peninsular Florida, a source of controversy since it was first described, has been defined and redefined numerous times. This paper will provide a regional overview of the Group, its occurrence, and lithostratigraphic framework in light of a data base recently enhanced by numerous continuous cores.

The Hawthorn Group occurs primarily in the subsurface and is present over much of the peninsula. It is absent only in the vicinity of the Ocala Uplift, the Sanford High, and the Kissimee Faulted Flexure where it has been removed by erosion. In northern peninsular Florida the Hawthorn dips and generally thickens to the east and northeast with a maximum thickness of nearly 500 feet occurring in the Jacksonville Basin. In southern peninsular Florida it dips and thickens to the southeast, south and southwest obtaining a maximum thickness in excess of 800 feet.

Lithologically the Group is quite heterogeneous and includes sands, clays, dolomites, and limestones. Phosphate is virtually ubiquitous throughout the unit ranging in amounts of less than 1 percent to greater than 50 percent. Specific lithologic criteria used to identify the upper contact of the Hawthorn vary regionally. The upper boundary is generally equated with sediments containing varying proportions of quartz sand and silt, phosphate, carbonate (dolomite, dolosilt, and limestone), and clay. The upper Hawthorn is generally greenish in color due to the clay minerals present. A unit of reworked Hawthorn sediments is often present at the top of the formation and is included with it. The base of the Hawthorn is generally a sandy, phosphatic dolomite, however, it varies locally.

The vertical sequence of sediments that comprise the Hawthorn Group also vary regionally. In northern Florida the section often consists of four parts: an upper reworked unit, a mixed carbonate-clastic unit, a predominantly clastic unit, and a lower predominantly carbonate unit. In southern Florida the sequence consists of an upper predominantly clastic unit and a lower predominantly carbonate unit. Phosphatic rubbles and brecciated carbonate frequently occur throughout the section in both areas.

The upper and lower boundaries of the Hawthorn Group are most distinct in northern Florida and least distinct to the south. In northern Florida the Hawthorn is overlain by sands and shell beds and underlain by the Suwannee Limestone and Ocala Group limestones that provide definitive boundaries. In southern Florida however, problems with defining the units above and below create difficulties in the placement of the formation contacts. The authors have included the lower clastic section (quartz and dolomite silts, quartz sands, clays, and phosphate) of the Tamiami Formation and the phosphatic sandy limestone formerly assigned to the Tampa Formation in much of southern Florida in the Hawthorn Group.

INTRODUCTION

The late Tertiary (Miocene-Pliocene) stratigraphy of the Southeastern Coastal Plain provides the geologist with many interesting and challenging problems. Much of the interest has been generated by the occurrence of common, though scattered, deposits of phosphorite from North Carolina to Florida. The existence of phosphate in the late Tertiary rocks of Florida was recognized in the late 1800's and provided the impetus to investigate these sediments. More recently the hydrologic importance of these units has led to further investigations of the stratigraphy and lithology to determine the formations effectiveness as an aquiclude and in some areas as an aquifer.

The Hawthorn "Formation" in Florida has long been a problematic unit. Geologists often are confused about the actual boundaries of the formation. The resulting inconsistencies have rendered accurate correlation virtually impossible. This is evident in the literature by the continual addition and removal of sediments from the Hawthorn. The complexity of the Hawthorn "Formation" has caused investigators to suggest raising it to group status (Brooks, 1966; Riggs, 1967). In this paper we discuss the Hawthorn as a group even though it is not formal at this time.

The biggest problem hindering the investigation of the Hawthorn Group has been the paucity of quality subsurface data. Since the mid 1960's the Florida Geological Survey has been gathering core data from much of the state. This provides a unique opportunity to investigate the extent of and facies relationships in the Hawthorn in the subsurface outside the outcrop areas.

This paper is an attempt to provide an understanding of the Hawthorn Group, its lithologies, stratigraphy and relation to adjacent units. A greater understanding of this group is fundamental to deciphering the late Tertiary geologic history of Florida.

PURPOSE AND SCOPE

The purpose of this investigation is to provide a coherent lithostratigraphic framework to help facilitate a better understanding of the Hawthorn Group in Peninsular Florida. The internal framework of the Hawthorn, its lateral continuity, and relation to overlying and underlying units were investigated in order to provide this knowledge.

The area covered by this study includes the Florida peninula to the Alaphaha and Withlacoochee rivers in the vicinity of Madison County. Data points outside the study area, particularly in Georgia, were used to assist in providing a more accurate picture within the Florida peninsula.

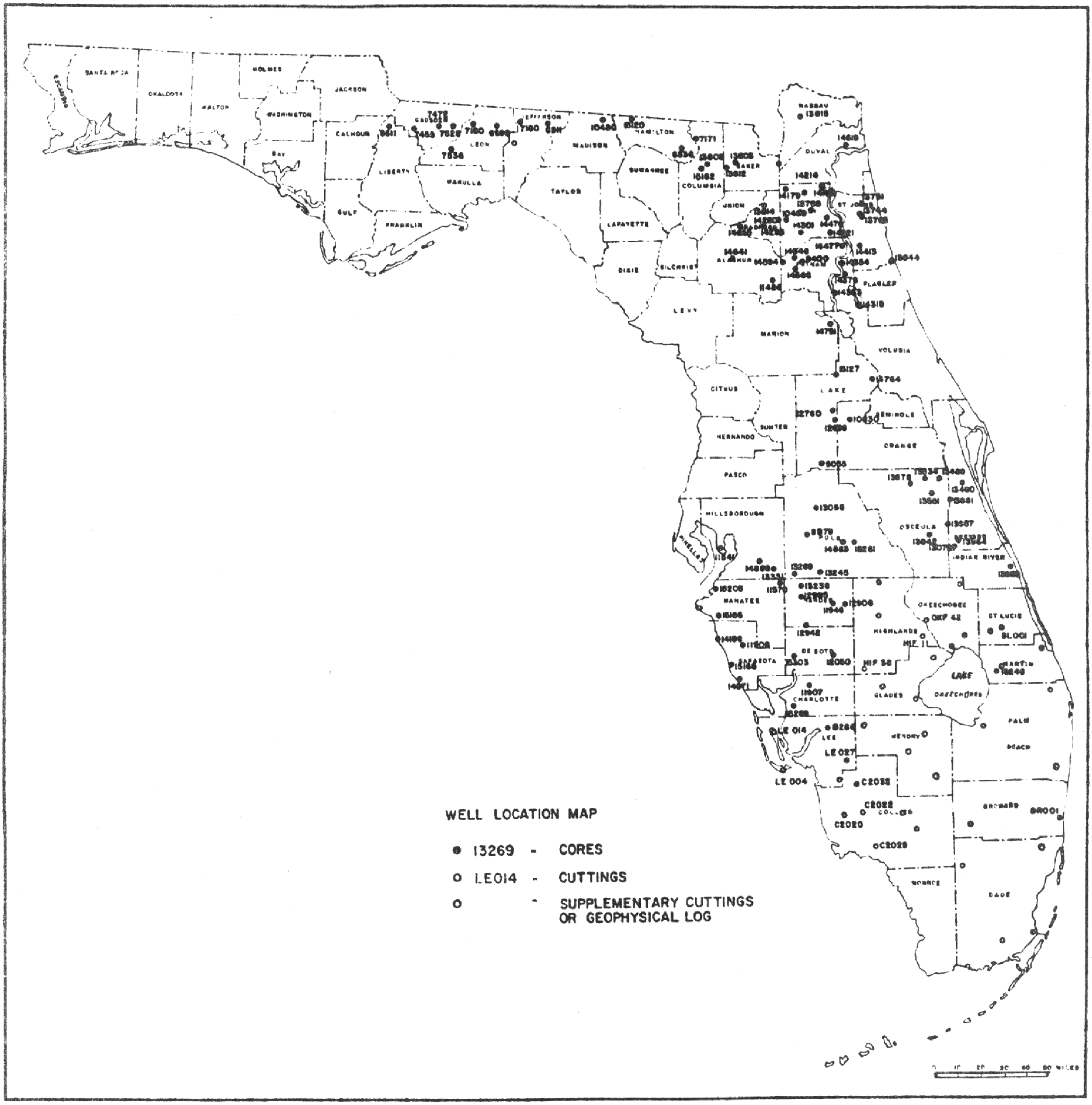
WELL LOCATION MAP
● 13269 - CORES
○ LE014 - CUTTINGS
○ - SUPPLEMENTARY CUTTINGS OR GEOPHYSICAL LOG

Figure No. 1

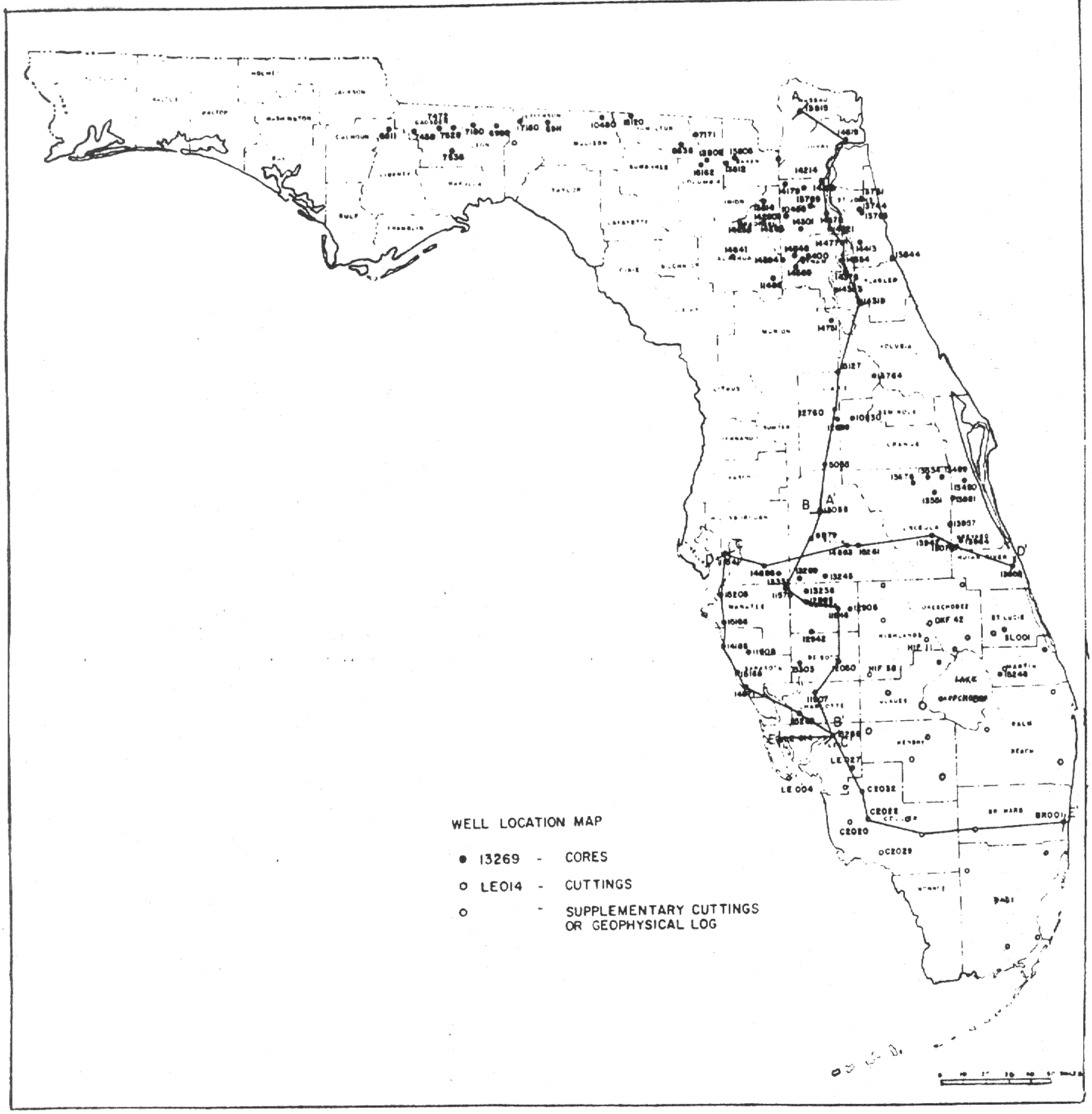
WELL LOCATION MAP
● 13269 - CORES
○ LE014 - CUTTINGS
○ - SUPPLEMENTARY CUTTINGS OR GEOPHYSICAL LOG

Figure No. 2

Over 150 cores, well cuttings and geophysical logs provided the data base for this study. The location of the data points are shown on figure 1 and the cross section locations on figure 2.

METHODS OF INVESTIGATION

The principal data source used in this tudy were the cores drilled by the Florida Geological Survey from 1964 through 1983. The cores were obtained using a falling 1500 Drill master with a capacity to drill in excess of 1000 feet. Under most conditions nearly continuous recovery of 1 3/4 inch cores were obtained. Losses in core recovery were minimized due to the expertise of driller Justin Hodges. The cores recovered were placed in boxes and are stored at the Florida Geological Survey in Tallahassee. All cores are available for inspection by the public.

The core data was supplemented by cutting samples obtained from wells drilled by private contractors. Unfortunately, the cuttings are not always representative of formation lithologies. This is due in large part to the loss of fine grained (clay to silt sized), poorly consolidated sediments during drilling operations. The removal of drill mud from the samples by washing also facilitates the loss of this material. The net result is to skew the sediment types toward sand and more indurated materials. The use of cuttings does, however, allow the extrapolation of lithologies and contacts in areas of limited core control. Water-well cuttings were thus used only to supplement core data

All cores and well cuttings were examined using a binocular microscope. Examinations were normally made at a magnification of 10x to approximate the use of a hand lens in field identification. Higher magnifications (up to 45x) were employed for the identification of the finer grained constituents of the sediments. Geological logs of the samples were recorded according to the format used by the Florida Geological Survey which aids in producing a concise and standardized lithologic description.

Natural gamma ray logs were run on most core holes. Numerous gamma ray logs run in water wells were also available for correlation purposes. Other geophysical logs which proved useful included 16 and 64 inch normal resistivity, 6 foot lateral resistivity, neutron, and spontaneous potential logs. All geophysical logs are on permanent file at the Florida Geological Survey and South Florida Water Management District and are open to the public.

PREVIOUS INVESTIGATIONS

The sediments of the Hawthorn Group and its related formations, the Bone Valley and Alachua, were first recognized and investigated largely as a result of their phosphate content. As interest in the phosphate grew, investigations into the stratigraphy of the units followed.

The discovery of phosphatic rock in Florida first occurred in the late 1870's near the town of Hawthorne in Alachua County, Florida (Day, 1886). By 1883 phosphatic rocks were being quarried and ground for fertilizer in this area by Dr. C.A. Simmons (Sellards, 1909). During the decade of the 1880's phosphate was also discovered in central Florida.

During the 1880's sediments of the Hawthorn Group were described by several geologists. Smith (1881) noted the rocks exposed along the Suwannee River from the Okeefenokee swamp downstream and were alligned of Vicksburg Age. Hawes (1882) in discussing the "phosphatic sandstones" from Hawthorne described them as containing shark's teeth and bones of Tertiary Age. Johnson (1885) applied the name Fort Harlee marl to the phosphatic sediments near Waldo in Alachua County. He mentioned the occurrence of Ostrea and silicified corals within the sediments. Johnson also reported that those rocks were rather widespread in the state. Smith

(1885) examined samples sent to him by L.C. Johnson and thought the phosphatic limestone at Hawthorne was of Eocene or Oligocene Age as the rest of the limestone in the peninsula was then perceived to be. However, fossiliferous samples from the Waldo area indicated to Smith that the rocks were of Miocene Age. Kost (1887) and Penrose (1888) both briefly discussed phosphatic rocks in Florida. Johnson (1888) named the Waldo Formation for the phosphatic sediments exposed in eastern Alachua County.

The first major contribution to the understanding of the Miocene phosphatic sediments of Florida was published by Dall and Harris (1892). Relying upon unpublished data by L.C. Johnson and field information gathered by the authors, Dall and Harris applied the name "Hawthorne beds" to the phosphatic sediments exposed and quarried near the town of Hawthorn. They reproduced sections and descriptions obtained from Johnson and placed the "Hawthorne beds" in the "newer" Miocene. Johnson's Waldo Formation was thought to be in the Older Miocene although Dall and Harris state (p. 111), "Old Miocene phosphatic deposits - These rocks were among those referred by Johnson to his Waldo formations, though typical exposures at Waldo belongs to the newer or Chesapeake Miocene." Dall and Harris assigned the "Hawthorne beds" to the Chattahoochee Group underlain by the Vicksburg Group and overlain by the Tampa Group (including the Tampa limestone which they felt was younger than the "Hawthorne beds".) The name "Jacksonville limestone" was applied by Dall and Harris to a "porous, slightly phosphatic, yellowish rock" first recognized by Smith (1885). They felt the "Jacksonville limestone" covered a large area from Duval County to at least Rock Spring in Orange County and placed it in the "newer Miocene" above the "Hawthorne beds".

Dall and Harris (1892) examined the sediments in the phosphate mining area on the Peace River and referred to the phosphate producing horizon as the Peace Creek bone bed. Underlying the producing zone was a "yellowish sandy marl" containing phosphate and mollusk molds which was named the "Arcadia Marl". Both units were considered to be Pliocene in age. Dall and Harris also named the "Alachua Clays." These clays "occur in sinks, gullies, and other depressions..." They placed the Alachua in the Pliocene based on vertebrate remains.

Matson and Clapp (1909) considered the Hawthorn to be Oligocene following Dall (1896) who began referring to the "older Miocene" as Oligocene. They considered the Hawthorn to be contemporaneous with the Chattahooche Formation of western Florida and the Tampa Formation of southern Florida. The Hawthorn was referred to as a formation rather than "beds" without formally making the change or designating a type section. Matson and Clapp placed the Hawthorn in the Apalachicola Group. Chert belonging to the Suwannee Limestone was placed in the Hawthorn Formation at this time.

Matson and Clapp (1909) named the Bone Valley Gravel replacing the Peace Creek bone bed of Dall and Harris (1892). They believed as did Dall and Harris that this unit was Pliocene. Matson and Clapp felt that the Bone Valley was predominantly of fluvatile origin and was derived from pre-existing formations especially the Hawthorn Formation. The Bone Valley gravels were believed to be younger than Dall and Harris "Arcadia Marl", older than the Caloosahatchee Marl and in part contemporaneous with the Alachua Clays.

Veatch and Stephenson (1911) did not use the term Hawthorn Formation in describing the sediments in Georgia. Instead, the sediments were placed in the Alum Bluff Formation and described as strata lying between the top of the Chattachoochee Formation and the base of the Miocene. Overlying the Alum Bluff sediments was an argillaceous sand that was in places a friable phosphatic sand which Veatch and Stephenson named the Marks Head marl. The Duplin Marl, a coarse phosphatic sand with shells, overlies the Marks Head or the Alum Bluff when the Marks Head is absent.

Sellards (1910, 1913, 1914, 1915) discussed the lithology of the sediments associated with hard rock and pebble phosphate deposits. He presented a review of the origins of the phosphate and their relation to older formations. Sellards (1915) published the section exposed at Brooks Sink in a discussion of the incorporated pebble phosphates.

Matson and Sanford (1913) dropped the "e" from the end of Hawthorne (as Dall and Harris had used it). They state (p.64) "The name of this formation is printed on the map as Hawthorne, the spelling used in some previously published reports, but as the geographic name from which it is derived is spelled Hawthorn, the final "e" has been dropped in the text." This began a debate of minor importance that continues to the present. Currently the Florida Geological Survey accepts the name without the "e".

Vaughan and Cooke (1914) established that the Hawthorn is not equivalent or contemporaneous with any part of the Chattahoochee Formation but is essentially equivalent to the Alum Bluff Formation. They suppressed the name Hawthorn and recommended the use of the term Alum Bluff Formation. The Alum Bluff remained in the Oligocene.

Matson (1915) believed that the Alum Bluff (Hawthorn) phosphatic limmestones formed the bed rock beneath the pebble phosphates of central Florida. This unit had previously been called the Arcadia marl (Dall and Harris, 1892). Matson added the sands of the "Big Scrub" in what is now the Ocala National Forest and the sands of the ridge west of Kissimmee (Lake Wales Ridge) to the Alum Bluff Formation. He felt also that the sequence of sediments called the Jacksonville Formation (formerly the Jacksonville limestone of Dall and Harris, 1892) contained units equivalent to the Alum Bluff Formation. Matson thought that the Bone Valley Gravel and Alachua Clays were Miocene. He based this on the belief that the elevation of the Bone Valley gravel was too high to be Pliocene.

Sellards (1919) considered the Alum Bluff to be Miocene rather than Oligocene based on the vertebrate and invertebrate faunas. He states (p. 294): "In the southern part of the state the deposits which are believed to represent the equivalent of the Alum Bluff formation are distinctly phosphatic." He felt that the deposits referred to the Jacksonville Formation are lithologically similar to the Alum Bluff sediments as developed in south Florida and contain similar phosphatic pebbles. According to Sellars (1919) phosphate first appears in the Miocene Alum Bluff rocks and that the Bone Valley Gravels and the Aluchua Clays represent accumulation of reworked Miocene sediments.

Mossom (1925, p. 86) first referred the Alum Bluff to group status citing "The Alum Bluff is now considered by Miss Gardner as a group...". Gardner did not publish this until 1926. Gardner (1926) in raising the Alum Bluff to a group also raised the three members, Shoal Rivers, Oak Grove, and Chipola, to formational status. Mossom (1926) felt the Chipola Formation was the most important and widespread subdivision of the group. He included the fuller's earth beds in north Florida and the phosphatic sands throughout the state in this formation. However, the phosphatic sands were generally referred simply to the Alum Bluff Group. Mossom believed also that the red, sandy clay sediments forming the hills in north Florida belonged in the Chipola.

The Hawthorn Formation was reinstated by Cooke and Mossom (1929) since Gardner (1926) had raised the Alum Bluff to group status. Cooke and Mossom (1929) defined the Hawthorn Formation to include the original Hawthorn "beds" of Dall and Harris (1892) excluding the "Cassidulus-bearing limestones" and chert which Matson and Clapp (1909) had placed in the unit. Cooke and Mossom believed the "Cassidulus-bearing limestones" and the chert should be placed in the Tampa Limestone (which at that time included the Suwanne Limestone). They included the Jacksonville Limestone and the Manatee River Marl (Dall and Harris, 1892) in the Hawthorn even though they felt the faunas may be slightly younger than typical Hawthorn. They also placed Dall and Harris' Sopchoppy Limestone in the Hawthorn. Cooke and Mossom felt that a white to cream colored, sandy limestone with brown phosphorite grains was the most persistent component of this unit.

Stringfield (1933) provided one of the first although brief descriptions of the Hawthorn Formation in central-southern Florida. He noted that the Hawthorn contained more limestone in the lower portion toward the southern part of his study area.

Cooke (1936) extended the Hawthorn Formation as far northeastward as Berkeley County, South Carolina. Cooke (1943, p. 90) states, "The Hawthorn Formation underlies an enormous area that stretches from near Arcadia, Florida, to the vicinity of Charleston, South Carolina." Cooke (1945) discussed the Hawthorn and its occurrence in Florida, and the only change he suggested (p. 192) was to tentatively place the Jacksonville Formation of Dall and Harris (1892) into the Duplin Marl, rather than in the Hawthorn as Cooke and Mossom (1929) had done. Cooke (1945) also believed that the Apalachicola River was the western boundary of the Hawthorn.

Parker and Cooke (1944) investigated the shallow geology of southern Florida. The plates accompanying the report showed the Hawthorn Formation ranging from -10 MSL to -120 MSL overlain by Tamiami Formation, Caloosahatchee Marl, and Buckingham Marl. Parker (1951) removed the upper sequence of sediments from the Hawthorn and incorporated them in the Tamiami Formation based on the fauna being Upper Miocene rather than Middle Miocene. This significantly altered the concept of Mansfields (1939) Tamiami Limestone and of the Hawthorn in southern Florida. Parker, et al (1955) continued this concept of the formations.

Cathcart (1950) and Cathcart and Davidson (1952) described the Hawthorn phosphates, their relationship to the enclosing sediments and the lithostratigraphy. He also mentioned the variation in lithologies and thickness of the Hawthorn within the land pebble district. An excellent description of the Bone Valley Formation was also presented by Cathcart (1950).

Vernon (1951) published a very informative discussion of the Miocene sediments and associated problems. Beyond providing data on the limited area of Citrus and Levy countries, Vernon provided a proposed geologic history of Miocene events. He felt that the Alachua Formation was a terrestrial facies of the Hawthorn and also was in part younger than Hawthorn.

Puri (1953) in his study of the Florida panhandle Miocene referred to the Middle Miocene as the Alum Bluff Stage. He considered the Hawthorn to be one of the four lithofacies of the Alum Bluff Stage.

Yon (1953) investigated the Hawthorn between Chattachoochee in the panhandle and Ellaville on the Suwannee River. Yon included in the Hawthorn the sands and clays now considered the Miccosukee Formation. These sands and clays were formally placed in the Miccosukee by Hendry and Yon (1967).

Bishop (1956) in a study of the groundwater and geology of Highlands County, Florida concluded that the "Citronelle" sands which overlie the Hawthorn, graded downward into the Hawthorn. He suggested that these sands be placed in the Hawthorn as a non-marine, continental facies deposited as a delta to a large river which existed in Florida during the Miocene.

Pirkel (1956 a, b; 1957) discussed the sediments of the Hawthorn Formation from Alachua County, Florida. He considered the Hawthorn as a unit of highly variable marine sediments which locally contained important amounts of phosphate. The sediments of the Alachua Formation were described as terrestrial reworked sediments ranging from Lower Miocene to Pleistocene. Later studies by Pirkle, Yoho and Allen (1965) and Pirkle, Yoho, and Webb (1967) characterized the sediments of the Hawthorn and Bone Valley formations.

The interest of the United States Geological Survey in the Hawthorn and Bone Valley formations for their economic deposits of phosphate and related uranium concentration resulted in a number of publications including Bergendal (1956), Espenshade (1958), Carr and Alverson (1959), Cathcart and McGreevy (1959), Kenter and McGreevy (1959), Cathcart (1963 a, b; 1964; 1966), Espenshade and Spencer (1964) and Altschuler, Cathcart and Young (1964). With the exception of Espenshade (1958) and Espenshade and Spencer (1963) the studies investigated the strata in the Central Florida Phosphate District and adjacent areas. Espenshade (1958) and Espenshade and Spencer (1963) conducted investigations in north Florida.

The work of Goodell and Yon (1960) provides a discussion of the lithostratigraphy of the post-Eocene rocks from much of the state, as well as a regional lithostratigraphic view of the Miocene sediments in Florida.

The occurrence of Mg-rich clays (palygorskite) within the Hawthorn Formation has been investigated by several authors. McClellan (1964) studied the petrology and occurrence of the palygorskite (attapulgite). Gremillion (1965) investigated the origin of the clays. Ogden (1978) suggested depositional environments and mode of formation of the clays.

Puri and Vernon (1964) summarized the geology of the Hawthorn. They discussed the status of the knowledge of the Hawthorn but added very little information.

Brooks (1966, 1967) suggested that the Hawthorn should be raised to group status in the future. He further discussed the existence of the Hawthorn across the Ocala Uplift and its subsequent erosional removal. Brooks believed that there was no Middle Miocene strata on the Ocala Uplift but was present downdip from the arch. He inferred that Lower Miocene beds were present on the arch.

Sever, Cathcart and Patterson (1967) investigated the phosphate resources and the associated stratigraphy of the Hawthorn Formation in north Florida and south Georgia.

Riggs (1967) suggested raising the Hawthorn Formation to group status based on his research in the phosphate district. The rocks of the Hawthorn Group were related by containing greater than one percent phosphate. The Bone Valley Formation was included as the uppermost unit of the group. Riggs and Freas (1965) and Riggs (1968) also discussed the stratigraphy of the central Florida phosphate district and its relation to the phosphorite genesis.

The geology and geochemistry of the northern peninsular Florida phosphate deposits were investigated by Williams (1971). Clark (1972) investigated the stratigraphy, genesis and economic potential of the phosphorites in the southern extensions of the Central Florida Phosphate District.

Weaver and Beck (1977) published a wide ranging discussion of the Coastal Plain Miocene sediments in the southeast. Emphasis was placed on the depositional environments and the resulting sediments particularly the clays. Wilson (1977) mapped the Hawthorn and part of the Tampa together. He separated the upper Tampa, termed the Tampa Limestone unit, from the lower "sand and clay" unit of the Tampa Limestone.

Missimer (1978) discussed the Tamiami-Hawthorn contact in southwestern Florida and the inherent problems with the current stratigraphic nomenclature. Peck, et al. (1979) felt that Parker's (1955) definition of the Tamiami added to the previously existing stratigraphic problems. Hunter and Wise (1980 a,b) also addressed this problem suggesting a restriction and redefinition of the Tamiami Formation.

King and Wright (1979) in an effort to alleviate some of the stratigraphic problems associated with the Tampa and Hawthorn formations redefined the Tampa and erected a type section from a core at Ballast Point. Their redefinition restricted the Tampa to the quartz sandy carbonates with greater than 10% quartz sand and less than 1% phosphate.

Riggs (1979 a,b; 1980) described the phosphorites of the Hawthorn and their mode of deposition. Riggs (1979a) suggested a model for phosphorite sedimentation in the Hawthorn of Florida.

Scott and MacGill (1981) discussed the Hawthorn Formation in the Central Florida Phosphate District and its southern extension. Scott (1983) provided a lithostratigraphic description of the Hawthorn in northeastern Florida. Both studies were in cooperation with the United States Bureau of Mines.

Scott (1981) suggested the Hawthorn Formation had covered much of the Ocala Arch and was subsequently removed by erosion. Scott (1982) designated cotype cores for the Hawthorn Formation and compared these to the cotype localities previously designated. Scott's (1982) discussion was limited to the northeastern part of the state.

Cyclic sedimentation in the sediments of the Hawthorn was proposed by Missimer and Banks (1982). Their study suggested that reccurring sediment groups appear within the formation in Lee County. Also Missimer and Banks followed the suggestions of Hunter and Wise (1980 a,b) in restricting the definition of the Tamiami. The same concept was adopted by Wedderburn, et al. (1982).

Hall (1983) presented a description of the general geology and stratigraphy of the Hawthorn and adjacent sediments in the southern extension of the Central Florida Phosphate District. An excellent discussion of the stratigraphy and vertebrate paleontology of this area was also provided by Webb and Crissinger (1983).

Silicification of the Miocene sediments in Florida has been the focus of a number of studies. Strom, Upchurch and Rosenzweig (1981), Upchurch, Strom and Nuckles (1982), and McFadden, Upchurch, and Strom (1983) discussed the origin and occurrence of the opaline cherts in Florida. Related to the cherts are palygorskite clays that were also discussed in these papers and by Strom and Upchurch (1983).

In addition, there have been a number of pertinent publications on various aspects of the Hawthorn Formation. These include McClellan (1962), Reynolds (1962), Isphording (1963), Michell (1965), Assefa (1969), Huang (1977), Liu (1978), King (1979), Rejk (1980), Leroy (1981), Peacock (1981), and McFadden (1982).

Furthermore, many water resource investigations which include a section on the Hawthorn Formation have not been included in the present study, because they did not add new data.

GEOLOGIC STRUCTURE

The geologic structures of peninsular Florida played an important role in the geologic history of the Hawthorn Group. These features affected the depositional environments as well as the post-depositional occurrence of the Hawthorn sediments. However, the nature of Tertiary sediments in peninsular Florida make it difficult to ascertain a true structural origin for some of these features. Depositional and erosional processes also played important roles in the development of the structural features.

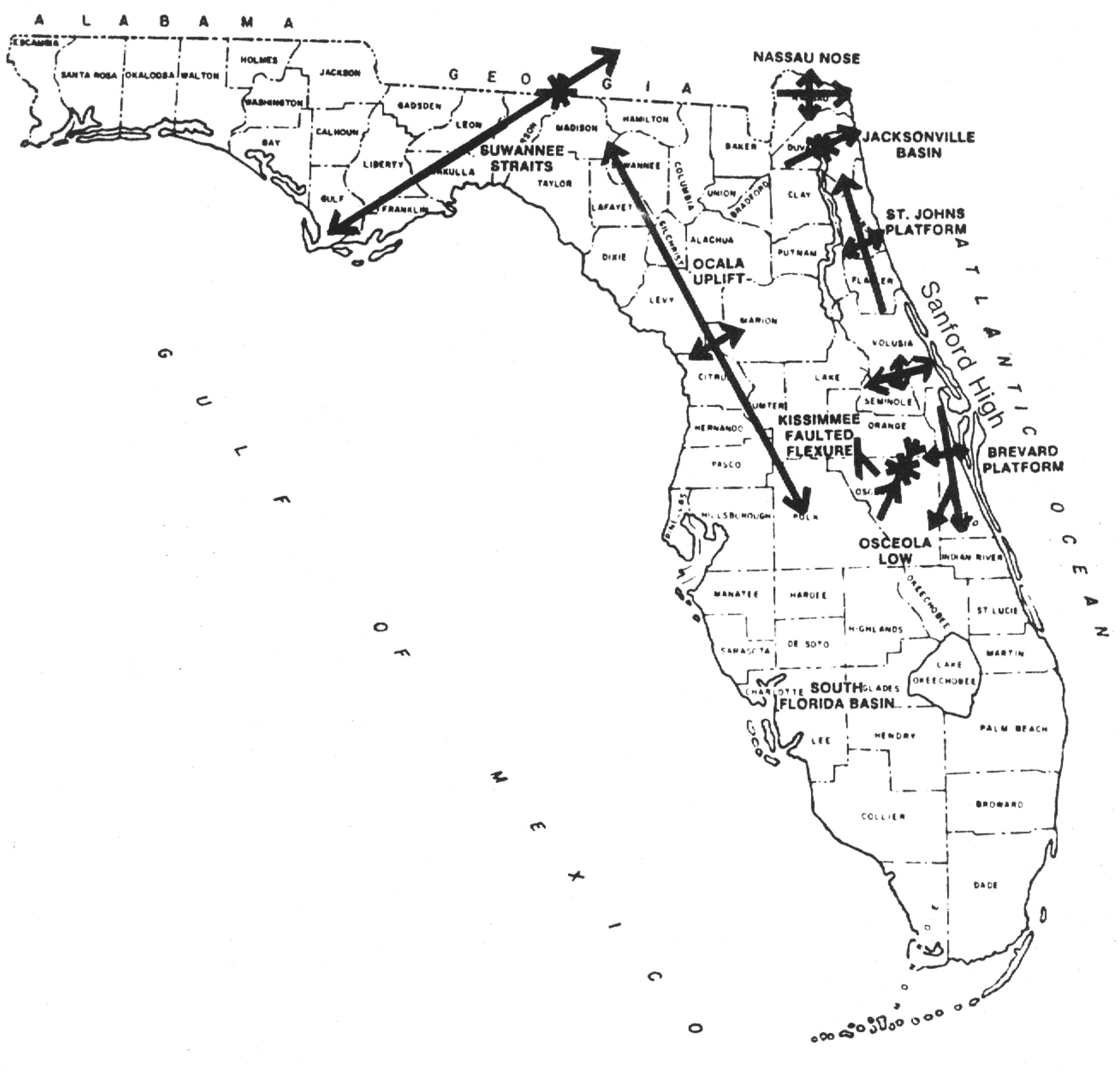

Figure No. 3 GEOLOGIC STRUCTURES OF PENINSULAR FLORIDA

The most prominent of the structures in peninsular Florida is the Ocala Uplift (often referred to as Ocala Arch) (figure 3). Originally named by O.B. Hopkins in a 1920 U.S.G.S. press release, the Ocala Uplift was formally described by Vernon (1951). He described it as a gentle flexure developed in the Tertiary sediments with a northwest-southeast trending crest. He also believed the crest of the uplift had been flattened by faulting. Vernon (1951) dated the formation of the uplift as being Lower Miocene based on the involvement of basal Miocene sediments in the faulting of the uplift and the wedging out of younger Miocene sediments against the flanks. Cooke (1945) argued that the warping began prior to Late Miocene or later. Kenter and McGreevy (1959) also suggested that the uplift formed prior to Late Miocene, because undeformed beds of Late Miocene overlie warped beds of the Ocala Uplift. Cooke (1945), Espenshade and Spencer (1963) and Scott (1981) believed the Hathorn covered most or all of the Ocala Uplift at one time, whereas Vernon (1951) indicated that the arch was an island area throughout much of Miocene, and the Hawthorn sediments did not extend across the structure. Brooks (1966) concurred with the idea that the arch formed prior to early Late Miocene, and also agrees with Pirkle (1956 b) that the Hawthorn once extended across the arch.

Riggs (1979a,b) stated that the Ocala Upland (his term for the Ocala Uplift) was a major structural feature controlling the formation and deposition of the phosphorites in the Florida Miocene. Remnants of these phosphorites are thought to be the hard rock phosphorites.

The Sanford High is another important positive feature of the northern half of peninsular Florida (figure 3). Vernon (1951) proposed the name for a feature located in Seminole and Volusia counties, Florida. He described the feature as "a closed fold that has been faulted, the Sanford High being located on the upthrown side." The Hawthorn Group and the Ocala Group are missing from the crest of the Sanford High. The Avon Park Limestone lies immediately below post-Hawthorn sediments the missing section presumably was removed by erosion. Meisburger and Field (1976) using high resolution seismic reflection profiling identified a structural high offshore from Daytona Beach in Volusia County. This feature is thought to be an offshore extension of the Sanford High. Meisburger and Field believed that the seismic evidence indicated the uplift that caused the high ended before Pliocene time. Vernon (1951) believed the Sanford High to be a pre-Miocene structure. Riggs (1979a, b) considred the Sanford High the "other positive element of extreme importance" in relation to phosphorite deposition.

Extending from the Sanford High are the St. Johns Platform to the north and the Brevard platform to the south (figure 3). Both are low broad ridges or platforms expressed on the erosional surface of the Ocala Group. The St. Johns Platform plunges gently to the north-northwest towards the Jacksonville Basin. The Brevard Platform plunges gently to the south-southeast and southeast. The names of both features were introduced by Riggs (1979 a,b).

The Jacksonville Basin located in northeast Florida is the most prominent low in the northern half of the state. In the deepest part of the basin the Hawthorn Group sediments exceed 500 feet in thickness. The name Jacksonville Basin was first used by Goodell and Yon (1960). Leve (1965) discussed the basin but did not apply any name to it. Leve felt the basin was at least in part fault controlled. Riggs (1979 a,b) also used the name Jacksonville Basin.

Previously many authors included the Jacksonville Basin as part of the Southeast Georgia Embayment. As more data became available, it became apparent that an eastward dipping, anticlinal feature, informally named the Nassau Nose (Scott, 1983), separated the Jacksonville Basin from the rest of the Southeast Georgia Embayment. The Jacksonville Basin should still be considered as a sub-basin of the larger embayment. The Southeast Georgia Embayment was named by Toulmin (1955) and appears to have been active from Middle Eocene through Miocene time (Herrick and Vorhis, 1963).

The Suwannee Straits or Channel extends from the Southeast Georgia Embayment to the Apalachicola Embayment (Chen, 1965) (figure 3). The Suwannee Straits effectively separated the clastic facies to the north from the carbonate facies to the south during Lower Cretaceous through Oligocene time. The trough began to fill in Late Oligocene through Miocene, allowing increasing amounts of clastic material to invade the carbonate environments of the peninsular area. Schmidt (1983) provides an excellent discussion of the history of the straits and the Apalachicola Embayment.

In central peninsular Florida between the southern end of the Ocala Uplift and the Brevard Platform are two important features in relation to the Hawthorn Group: The Osceola Low and the Kissimmee Faulted Flexure (figure 3) which were both named by Vernon (1951). Vernon considered the Kissimmee Faulted Flexure to be "a fault-bounded, tilted, and rotated block" with "many small folds, faults, and structural irregularities." The flexure is a high on the Avon Park surface with the Ocala and Hawthorn groups absent due to erosion.

The Osceola Low as described by Vernon (1951) is a fault-bounded depression with as much as 350 feet of Miocene sediments (figure 3). The senior author has investigated the Osceola Low using cores, well cuttings and geophysical data (Florida Geological Survey, unpublished data). The results of his studies (Scott and Hajishafie, 1980) indicate that the Osceola Low trends from north-south to northeast-southwest.

The South Florida Embayment or Basin as named by Pressler (1947) encompasses most of southern Florida (figure 3). It is an area of strata generally gently dipping to the south and southeast. Riggs (1979 a,b) referred to this area as the Okeechobee Basin. It has been postulated that there have been episodes of faulting (Sproul et al. 1972) and folding (Missimer and Gardner, 1974), within the basin.

LITHOSTRATIGRAPHY

The Hawthorn Formation of the past has long been considered a very complex unit. Puri and Vernon (1964) declared the Hawthorn "the most misunderstood formational unit in the southeastern United States". They further considered it as "a dumping ground for alluvial, terrestrial, marine, deltaic, and pro-deltaic beds of diverse lithologic units..." Pirkle (1956) found the dominant sediments to be quite variable stating "The proportions of these materials vary from bed to bed and, in cases, even within a few feet both horizontally and vertically in individual strata." The complex stratigraphy of the Hawthorn has caused many authors to suggest raising it to group status (Pirkle, 1956; Espenshade and Spencer, 1963; Brooks, 1966, 1967; Riggs, 1967). Riggs (1967) in his Ph.D. dissertation raised the Hawthorn to group status and named formations within the group. Unfortunately, Riggs never published this formally in accordance with the Code of Stratigraphic Nomemclature. Paul Huddlestun of the Georgia Geological Survey is currently working on a manuscript raising the Hawthorn to group in Georgia. Tom Scott with the Florida Geological Survey is preparing a manuscript on the Howthorn Group in Florida. Since the status change from formation to group is not yet formal, we will refer to the Hawthorn Group on an informal basis in this paper.

The formations of the Hawthorn Group are similar, yet different, in north, central, and south Florida. Also, within south Florida the group varies from east to west. As a result, the discussion of the Hawthorn will be presented separately for north, central, and south Florida. The sections on north and central Florida were written by Scott and the south Florida section by Knapp.

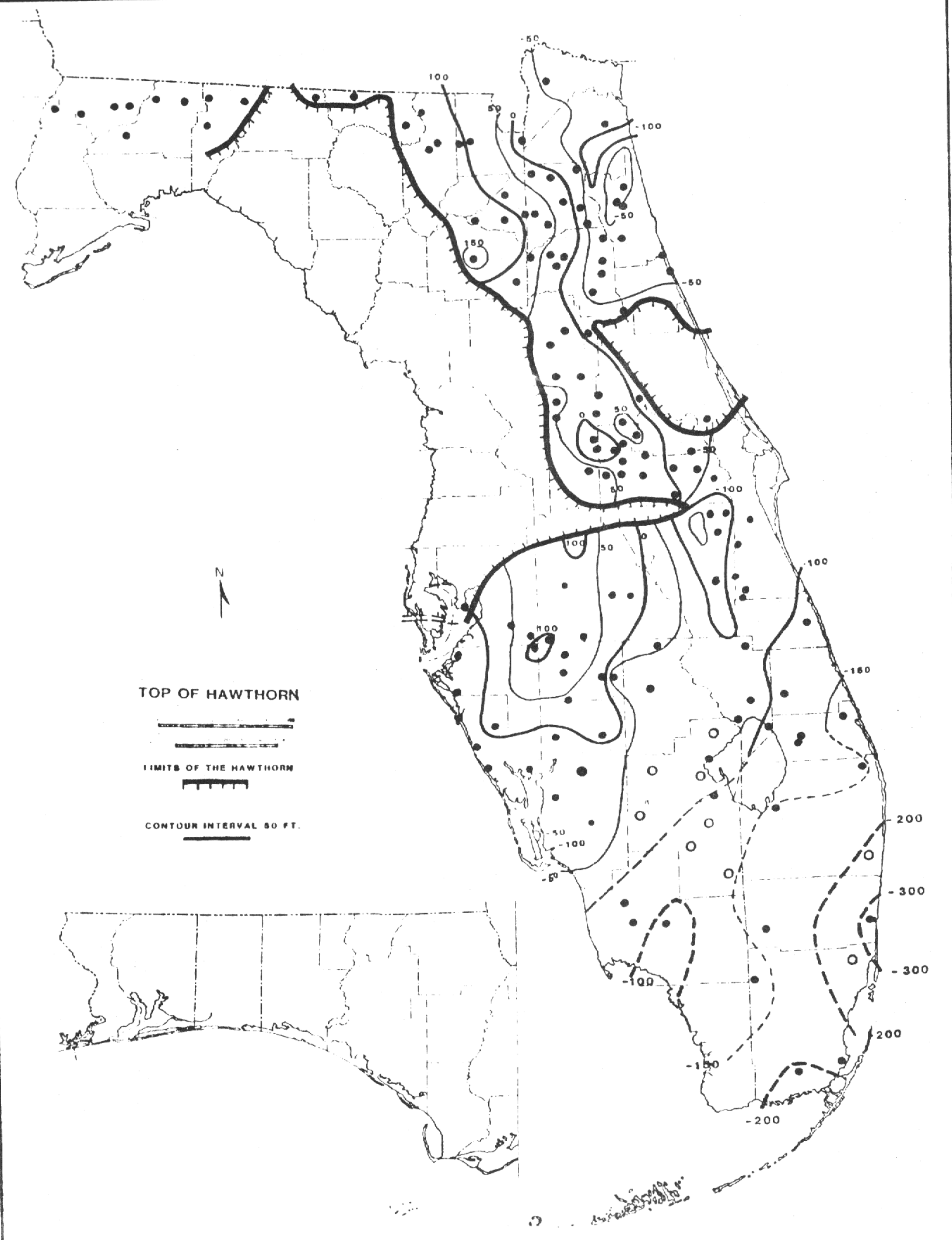
TOP OF HAWTHORN
LIMITS OF THE HAWTHORN
CONTOUR INTERVAL 50 FT.
N
-50
100
50
0
-100
150
-200
-300
200

Figure No. 4

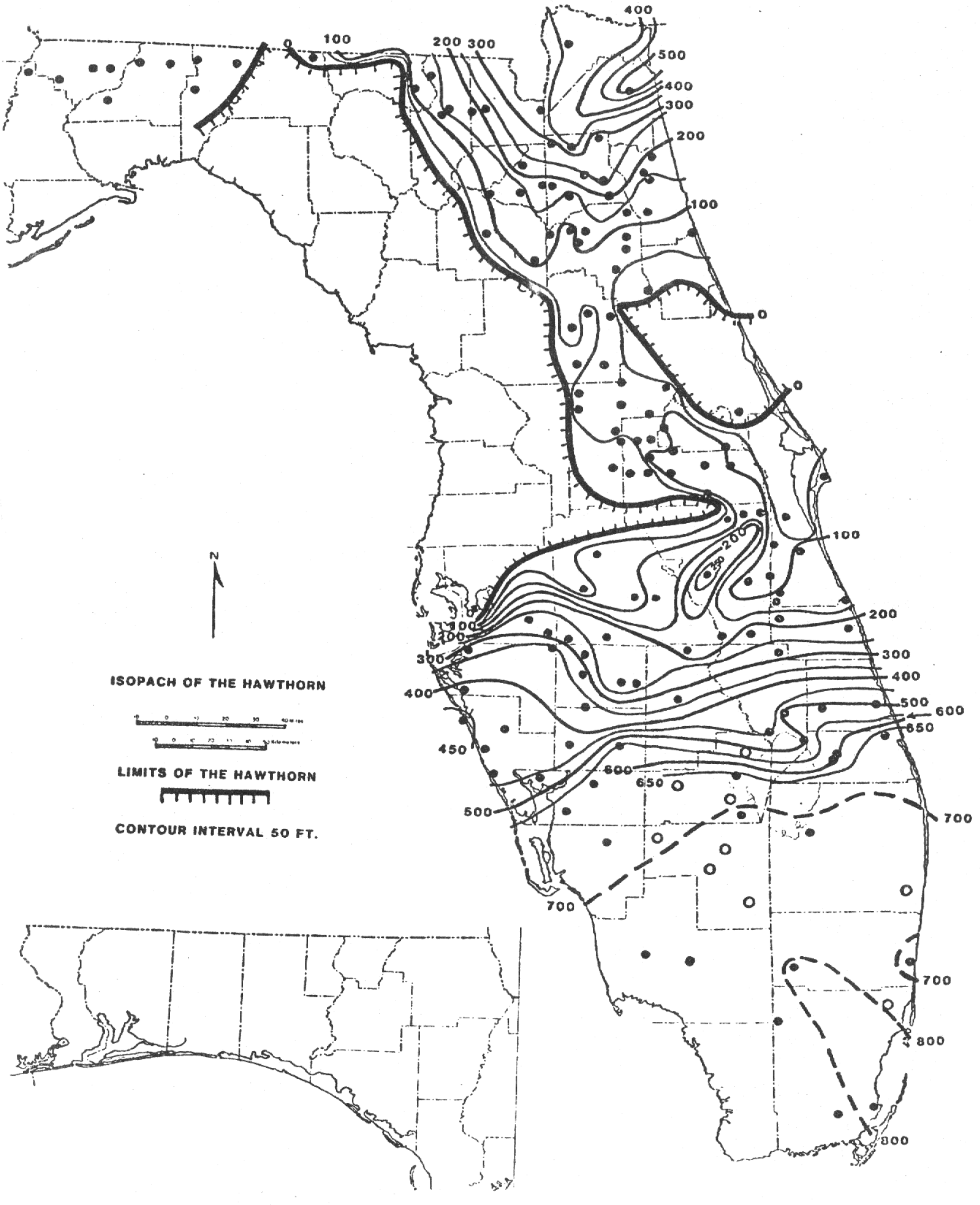
ISOPACH OF THE HAWTHORN
LIMITS OF THE HAWTHORN
CONTOUR INTERVAL 50 FT.
N
0
100
200
300
400
450
500
600
650
700
800

Figure No. 5