FLORIDA PALEONTOLOGICAL SOCIETY

FIELD TRIP GUIDEBOOK

DECEMBER 6, 2003

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CAVE PASSAGE ORIENTATION AND DEVELOPMENT WITHIN FLORIDA CAVERNS STATE PARK; JACKSON COUNTY, FLORIDA

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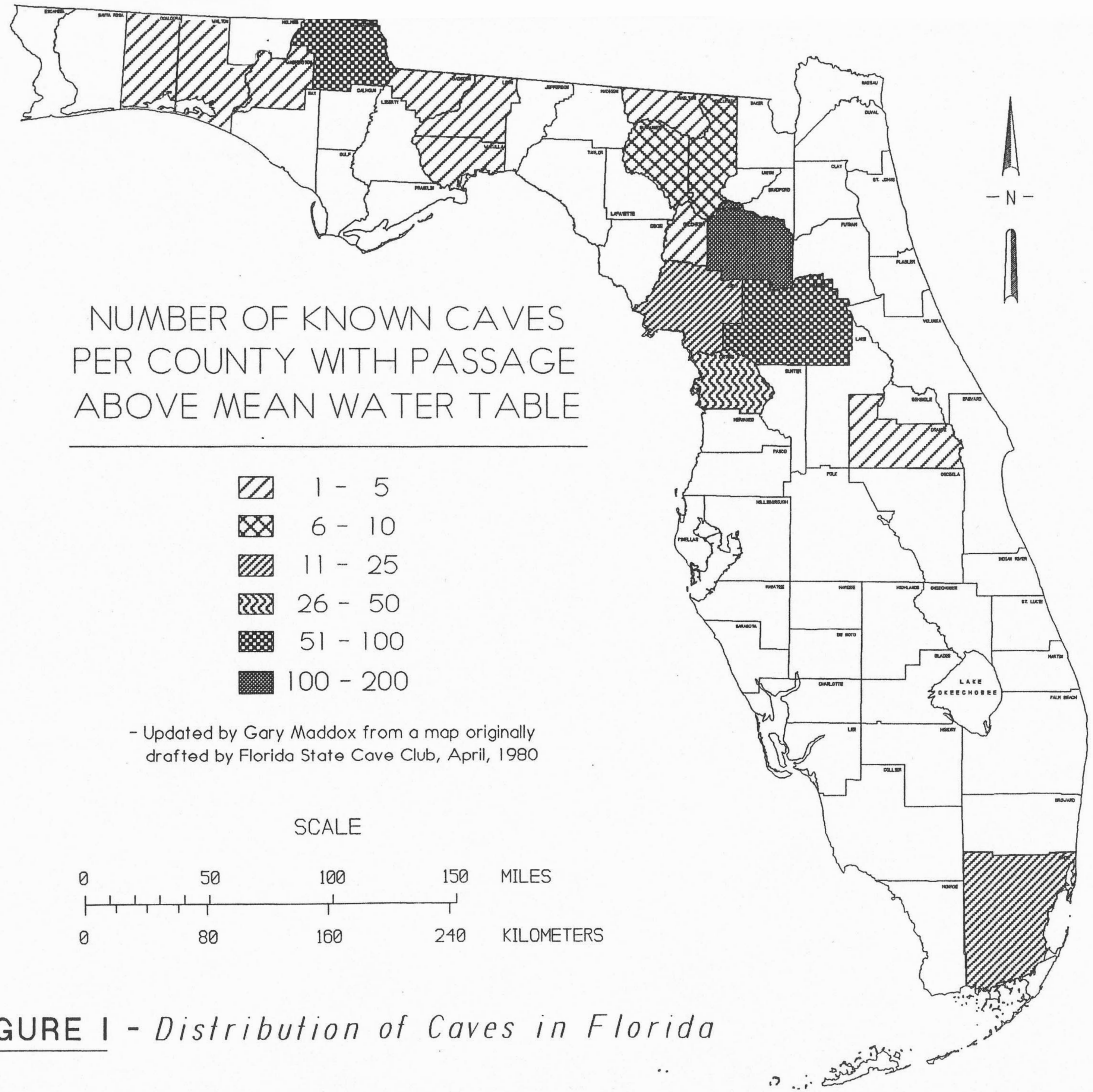
INTRODUCTION

Cave development in Florida Caverns State Park is primarily the result of vadose solution within the upper Eocene Crystal River formation of the Ocala Group. Fluvial erosion and the resultant lowering of the Chipola River valley through the uplifted Tertiary limestones provides the gradient and successively lower water table elevations responsible for development of dry cave passages. Passage orientation is controlled by two predominant vertical joint sets, combined with solution along bedding plane-parallel horizons. The caves are mature karst features, containing profusely decorated chambers.

CAVE DISTRIBUTION IN FLORIDA

Cave distribution by county is shown in Figure 1. From this map, one can see that Alachua County leads the state, with over 150 known caves. Jackson County is second, with about 80 known caves. These numbers reflect to some degree the intensity of exploration in known cave areas; other areas in adjacent counties may hold similar potential for new discoveries. Several new caves are found and mapped every year throughout Florida, mostly by cavers affiliated with organized chapters (grottos) of the National Speleological Society. An excellent summary of karst processes and features in Florida, including cave development, is presented by *Lane (1986)*.

Major vadose cave development in Florida is associated with two positive regional structural features: the Ocala Arch and the Chattahoochee Anticline. A majority of the larger caves in Florida occur in these two areas (Figure 2). Caves found along the axis of the Ocala Arch are developed in Eocene Ocala Group limestones, and display a variety of morphological influences, including joint and bedding plane control. These caves are primarily the result of solution along vertical fractures and joints, extending downward to the water table. At this point, horizontal passages are developed at current or past elevations reflecting the juncture of the saturated zone with the vadose zone. Many of these lower horizontal passages contain pools of standing water, reflecting the upper potentiometric surface of the Floridan aquifer system. These caves and smaller karst conduits provide direct pathways for recharge to the aquifer. Most of these caves are relatively short lengthwise, and contain few



- Updated by Gary Maddox from a map originally drafted by Florida State Cave Club, April, 1980

FIGURE I - *Distribution of Caves in Florida*

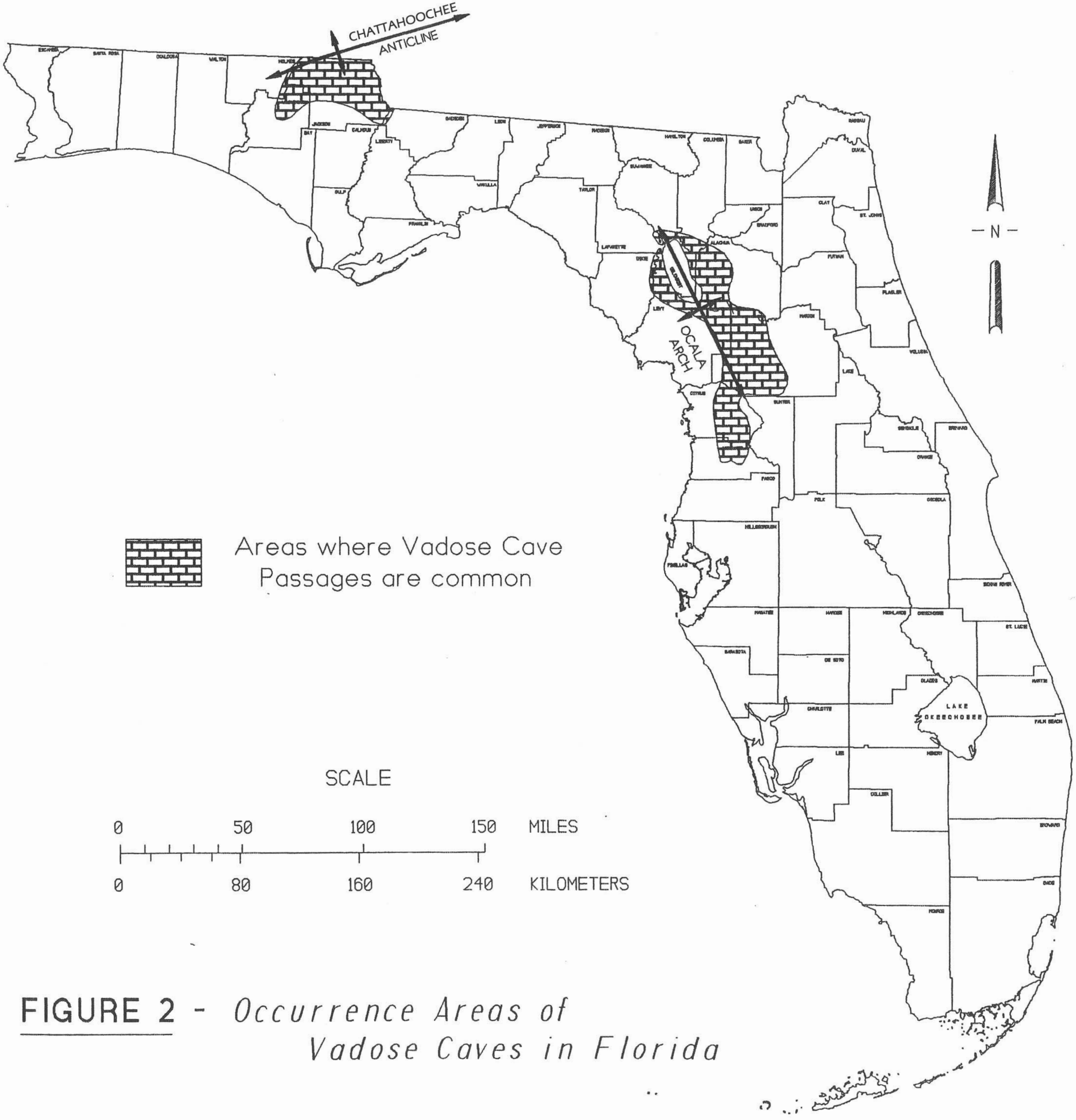


FIGURE 2 - *Occurrence Areas of Vadose Caves in Florida*

speleothems. Warren's Cave (Alachua County), the longest known dry cave in the state (Table 1), occurs just east of the major peninsular cave zone. It is a modified network maze cave (*White, 1988*), developed within an anomalously thick carbonate zone in the Hawthorn Group.

TABLE 1: *Florida's Longest "Dry" Caves*

1)	Warren's Cave, Alachua County.......	6005 m	(19,700+ ft)
2)	Boyer's Discovery, Jackson County...	1219 m	(4000 ft)
3)	Ellis Cave, Jackson County.........	1097 m	(3600 ft)
4)	Hollow Ridge Cave, Jackson County...	1006 m	(3300 ft)
5)	Florida Caverns, Jackson County.....	884 m	(2900 ft)

SOURCE: *Pease, Young and Zymowski, 1993*

Development of significant horizontal cave passage requires the existence of a gradient through which ground water must pass. This gradient can be dynamic, such as the steep elevational changes associated with phreatic cave development in the deep mountain caves of Mexico or along the margins of the Appalachian Plateau. In Florida, this gradient is much less dynamic, consisting of a chemical horizon at the local water table and extending upward along fractures and joints within the vadose zone. Chemical dissolution along vertical joints and horizontal bedding planes at and above the water table is the primary mechanism responsible for cave development. The process in Florida, though less dynamic in a physical sense, is very effective nonethless, primarily due to the relatively granular and porous nature of the Tertiary limestones exposed in uplifted regions of the state.

CAVE DISTRIBUTION AND DEVELOPMENT IN JACKSON COUNTY

Uplift along the southern flank of the Chattahoochee Anticline in the late Tertiary (*Schmidt and Coe, 1978*) has elevated Oligocene and older marine carbonates to an average elevation of 45 m (150 ft) above mean sea level in northern Jackson County. These elevated carbonates, thinly mantled by Pleistocene and younger sediments and dipping gently southward, enabled the development of mature karst features in the area. The northeastern portion of the Jackson County is a mature karst plain, underlain by upper Eocene Crystal River limestone. Shallow dolines, mostly cover subsidence sinks, are widely distributed throughout the region. Surface streams are rare; the area is mostly internally drained. In many ways this area appears to be geologically similar to, and perhaps the southwestern extension of the Dougherty Karst Plain of southwestern Georgia (see *Beck and Arden, 1984*).

Dry caves in the Marianna region occur primarily in a series of remnant limestone ridges adjacent to and roughly paralleling the Chipola River, downdip at the southern margin of the northern Jackson County karst plain. Successive downcutting of the Chipola River channel has eroded the uplifted Tertiary limestones, providing a vertical component for ground water movement. The existence of many springs along the Jackson County portion of the Chipola River demonstrates that this process continues today. The elevation of the Chipola River valley floor in the vicinity of Florida Caverns State Park is about 21 m (70 ft). Horizontal cave development along formerly higher water table horizons has caused development of most of the larger caves of the area. This development is most pronounced in the Bumpnose member of the Crystal River formation. The development of cave passage at the upper juncture of former saturated zones may have been influenced by higher Pleistocene sea level stillstands, which would influence the ability of the Chipola River to deepen and widen its valley. Inundation of some cave passages by clastic fill during periods of higher sea level may have also occurred (*Boyer, 1975b*).

Horizontal vadose passage development benefits from the existence of a resistant caprock. In the Marianna area, most large caves are developed in the upper Bumpnose member of the Crystal River formation, a soft, white fossiliferous limestone characterized by abundant *Lepidocyclina (Nephrolepidina) chaperi*. It is very soft and granular, owing to the presence of many bryozoa and foraminifera (*Moore, 1955*). Overlying the Bumpnose member is the more resistant Oligocene Marianna limestone, a hard to soft cream to white fossiliferous limestone containing highly indurated zones and characterized by the occurrence of *Lepidocyclina (Lepidocyclina) mantelli*. Marianna limestone was once quarried in the area for use as a building stone. The Marianna limestone acts as a caprock, protecting horizontal cave development in the softer underlying limestones of the Ocala Group. The distribution of major caves in Jackson County, therefore, occurs in a generally northwest-southeast trending band centered along and passing through Florida Caverns State Park (Figure 3). This band roughly corresponds to the outcrop pattern of the Marianna limestone along and adjacent to the Chipola River (see geologic map of Jackson County in *Moore, 1955*). Interestingly, the Marianna limestone has been eroded and is largely absent from most of the cave-bearing ridges within Florida Caverns State Park.

Besides the Park caves and those of similar morphology in the Marianna area, two other types and areas of cave development exist. A small number of caves are located along the Chattahoochee River corridor in eastern Jackson County (Figure 3). These are primarily short, vadose stream caves with secondary phreatic solution enlargement. Most are contained within the lower Miocene Chattahoochee formation.

There are many underwater caves present in the county. Most are associated with springs discharging into the Chipola River or its tributaries, particularly Merritt's Mill Pond and Spring Lake. These underwater caves are generally larger in section and much longer than their "dry" counterparts. Many display well-developed passage at particular depth horizons parallel to bedding. Many of these were possibly "dry" water table caves during past advances of continental glaciation, when sea level and ground water levels were lower, as evidenced by possible relict vadose features.

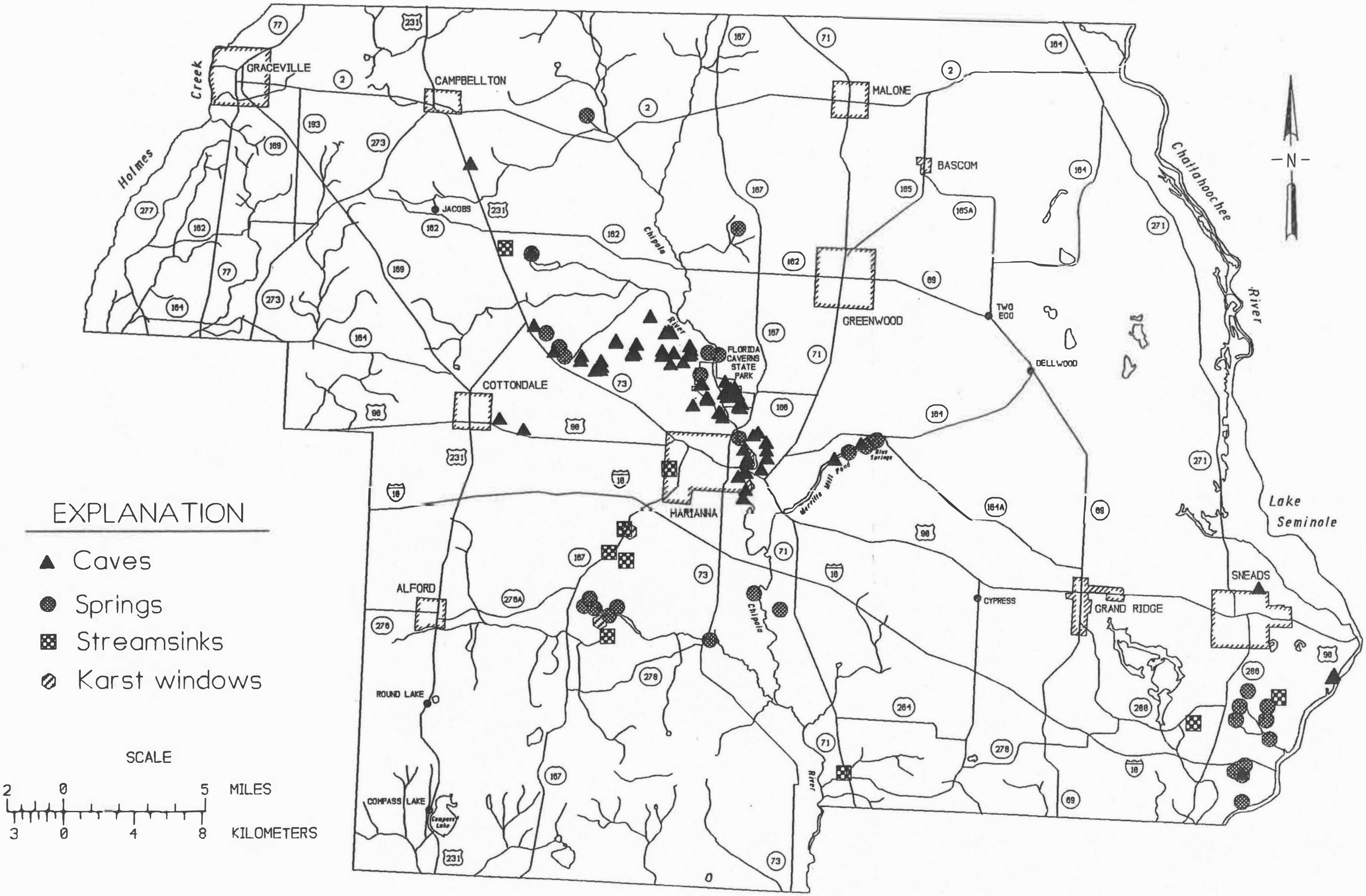


FIGURE 3 - *Distribution of Some Major Karst Features in Jackson County, FL*

CAVE PASSAGE ORIENTATION

Caves within Florida Caverns State Park and surrounding areas display preferential development along three planes: two vertical joint directions at roughly right angles to each other, and a horizontal direction parallel to bedding.

The predominant vertical controlling joints of the region strike at approximately N.30° W. This major orientation is responsible for development of the largest and most predominant vadose cave passages in the Park. China, Tunnel, Miller's and Dragon's Tooth Caves display this preferential development orientation exceptionally well, as shown on Figure 4. The western half of Miller's Cave, the "Dragon's Belly" room in Dragon's Tooth Cave and the "Vandal Room" in Pottery Cave are all developed along the same joint. "Dragon's Belly", the largest single cave room in the Park, is dimensionally approximately 41 m (135 ft) long, 17 m (55 ft) wide and 6 m (20 ft) high. This north-northwest trending fracture orientation may also be responsible for controlling the course of the Chipola River, which is oriented in the same direction.

A conspicuous secondary vertical joint orientation strikes at approximately N.60° E. Passages developed along these joints can be seen in Boyer's Discovery, China and Miller's Cave. These passages are usually lower than the passages developed along the primary joints, and more poorly defined. They often form low connector passages between the larger north-northwest trending chambers.

A third vertical fracture or joint orientation of approximately N.20°E. is well developed in China Cave and Bobby Hall's Cave. This orientation is rarely manifest in preferential passage development in other Park caves.

Virtually all caves within the Park contain areas of low, wide passage parallel to bedding. These lower passages are most likely best developed along the unconformity separating the Ocala Group Bumpnose Member of the Crystal River formation from the underlying lower Crystal River formation. Because most of these passages contain significant clastic infill, this relationship is difficult to investigate. Morphological features, such as certain conduit cross-sections, suggest that some of these passages may have initially developed as phreatic conduits, which were later modified through vadose solution. Dum Cave and Windy Crawl both possess excellent examples of bedding plane parallel passage development.

Many Park caves are located along the limestone scarp above the Chipola River floodplain. Some of these are relict cave segments, remnants of larger systems which have been destroyed by enhanced solution and mass wasting along the scarp. Pottery Cave is a good example of this, displaying truncated passage, "dead" speleothems and multilevel cave development. At least three distinct levels have developed in this cave. Other related karst landforms, such as rock shelters and natural bridges, can also be seen along the scarp.

CAVES OF FLORIDA CAVERNS STATE PARK

JACKSON COUNTY, FLORIDA

Tape, compass and inclinometer surface survey made from 1979 - 1985 by members of the FLORIDA STATE CAVE CLUB, Grotto 175 of the National Speleological Society.

Bobby Hall's, Boyer's Discovery, China, Dragon's Tooth (historic), Dum, Florida Caverns, Little Miller's, Miller's, Pavilion, and Windy Crawl caves mapped by Dr. Paul Boyer and the FORT RUCKER-OZARK GROTTO of the National Speleological Society.

All-In, Alice extension of Bobby Hall's, Dragon's Belly portion of Dragon's Tooth, Frye's Bughole, Ooid, Platform, Pottery, Walt's Misery and Yogi Bear caves mapped by members of the FLORIDA STATE CAVE CLUB.

Original map drafted by Gary Maddox in October, 1986, with revisions in November, 1986, January, 1990 and October, 1993.

Revised map digitized by Gary Maddox in October, 1993.

© 1993 by the Flint River Grotto of the National Speleological Society.

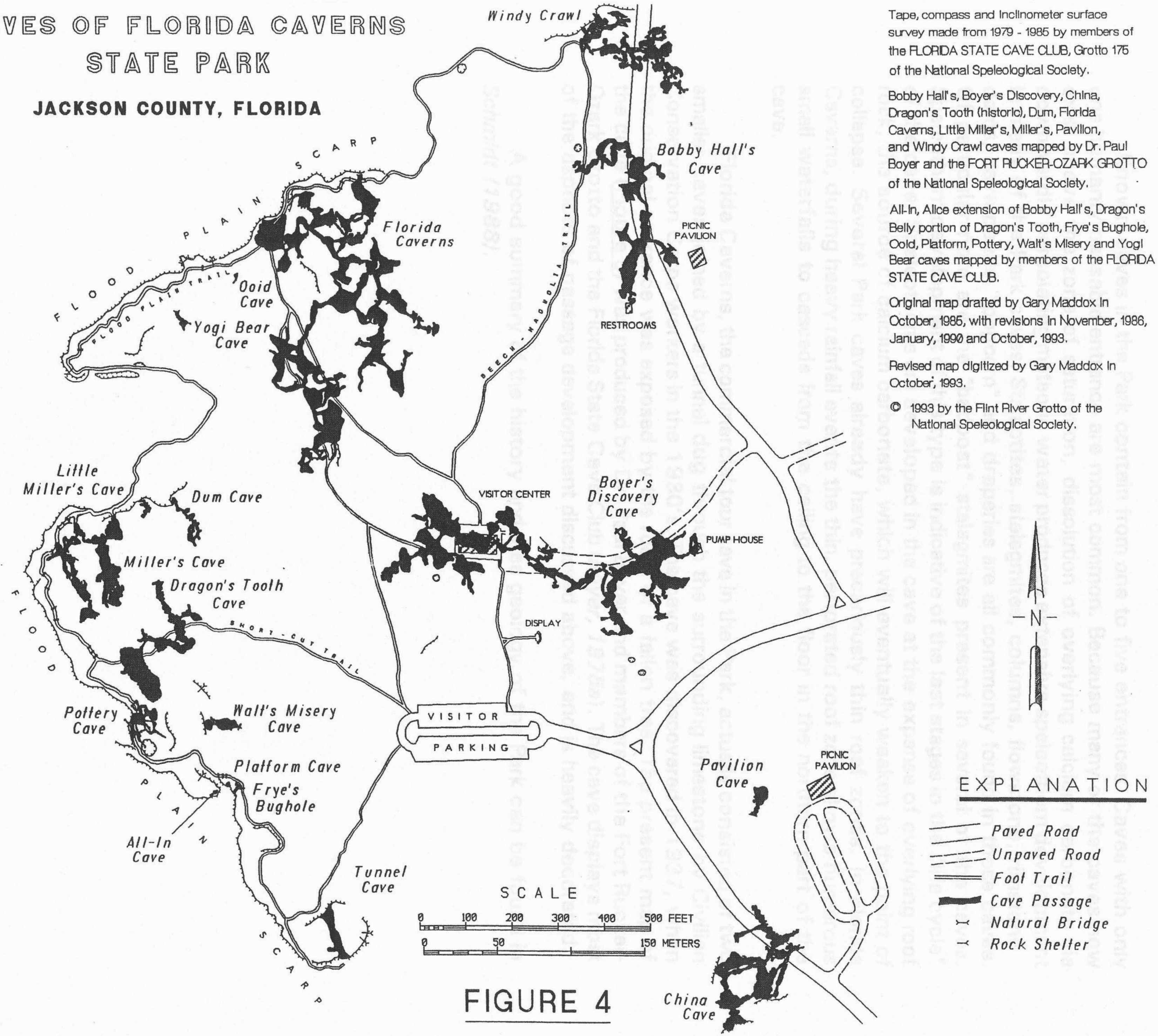


FIGURE 4

Known caves in the Park contain from one to five entrances. Caves with only one humanly passable entrance are most common. Because many of the caves now exist above the zone of saturation, dissolution of overlying calcium carbonate via downwardly percolating meteoric water produces extensive speleothem development in many of the Park caves. Stalactites, stalagmites, columns, flowstone, rimstone dams, cave pearls, "popcorn" and draperies are all commonly found in these caves. Of particular note are the "bedpost" stalagmites present in several of the caves. Speleothem development of this type is indicative of the last stages in the "life cycle" of the cave. Speleothems are developed in the cave at the expense of overlying roof rock, the source of calcium carbonate, which will eventually weaken to the point of collapse. Several Park caves already have precariously thin roof zones. In Florida Caverns, during heavy rainfall events the thin, perforated roof zone allows numerous small waterfalls to cascade from the ceiling to the floor in the northern part of the cave.

Florida Caverns, the commercial tour cave in the Park, actually consisted of two smaller caves joined by a tunnel dug through the surrounding limestone by Civilian Conservation Corps workers in the 1930's. The cave was discovered in 1937, when the original entrance was exposed by the roots of a fallen tree. The present map of the cave (Figure 5) was produced by Dr. Paul Boyer and members of the Fort Rucker-Ozark Grotto and the Florida State Cave Club (*Boyer, 1975a*). The cave displays most of the aspects of passage development discussed above, and is heavily decorated.

A good summary of the history and area geology of the Park can be found in *Schmidt (1988)*.

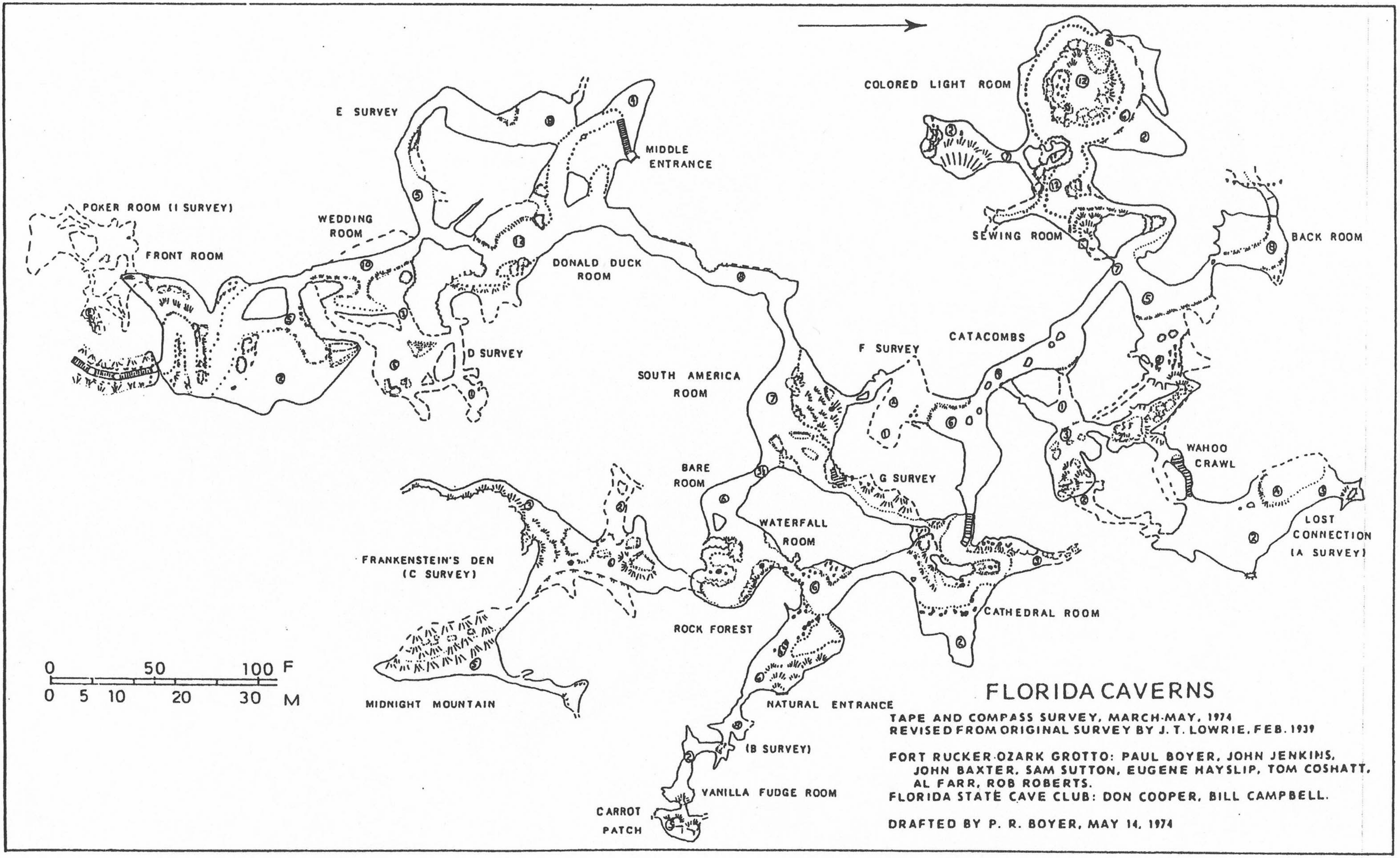


FIGURE 5 -*Planimetric Map of Florida Caverns*

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Introduction to the Geology of the Upper Apalachicola River Basin

By

Harley Means

Florida Geological Survey

The upper Apalachicola River basin provides an excellent setting for studying the local geology because it harbors numerous outcrops, one of which is the tallest in the state. These outcrops are uncharacteristic for Florida, which is known for its lack of topographic relief. The Apalachicola River begins where the Flint and Chattahoochee Rivers merge, just north of the Florida/Georgia state line. The Jim Woodruff Dam (Figure 1), which was built in the late 1940's, is located about 300 yards downstream of the original confluence of the Flint and Chattahoochee River (Hendry and Yon, 1958). Water within the Jim Woodruff Reservoir, which is held by the dam, now covers the historic confluence.

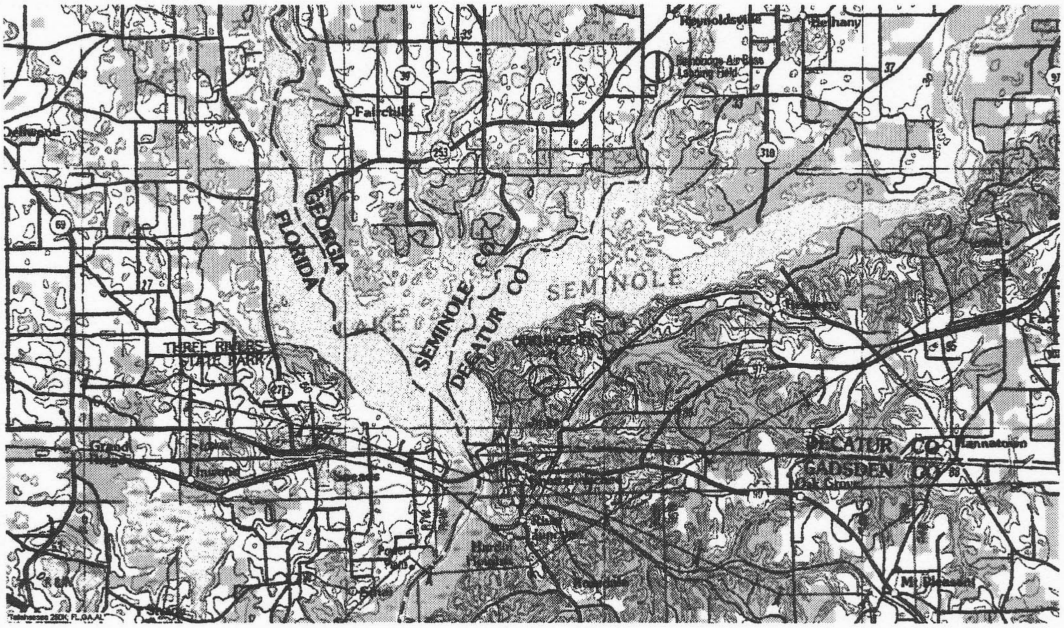


Figure 1 – Jim Woodruff Dam and Reservoir

LOCATION

Localities for this field trip are located between the US 90 bridge in Bristol at the southern most location up to the Jim Woodruff Dam to the north. We will begin by looking at the type locality of the Chattahoochee Formation, located near the boat landing in Chattahoochee and work down river where we will finish at Alum Bluff, which is located just north of Bristol (Figure 2).

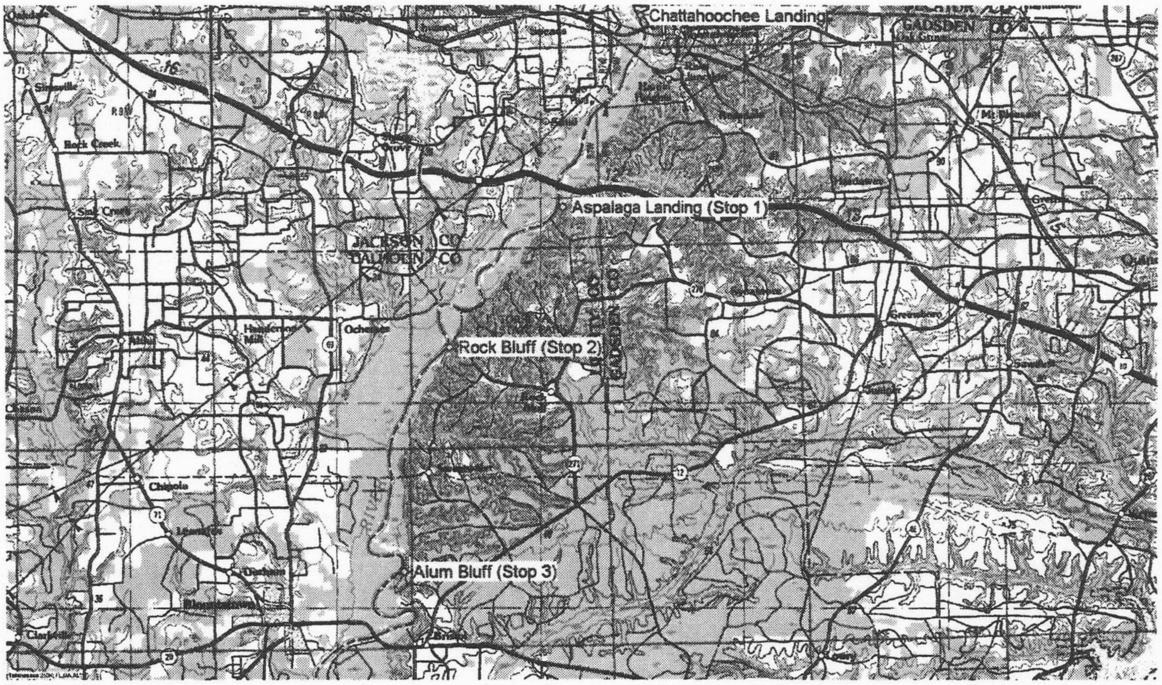


Figure 2 – Field trip localities.

Each locality is accessible by land; however we will access them by water. The Chattahoochee boat landing and Aspalaga Landing (Stop 1) are located on public land. Rock Bluff (Stop 2) is part of Torreya State Park, and Alum Bluff (Stop 3) belongs to the Nature Conservancy. Access to the later two, via land, can be obtained from the owners. Access from the water is not limited.

NOMENCLATURAL HISTORY

For a detailed discussion of the nomenclatural history of the vicinity see Schmidt, 1983. The S.E.G.S last investigated this area in October, 1983, and produced the S.E.G.S. Guidebook 25, entitled: Cenozoic Geology of the Apalachicola River Area Northwest Florida. This volume contains detailed geologic information about this area. In an attempt to avoid redundancies, this author will concentrate on specific outcrops north of the Bristol Landing, and update the nomenclature where needed.

STRUCTURAL FEATURES

A negative feature in the panhandle (Figure 3), trending NE-SW, represents a boundary that has existed between sedimentary depositional environments since the Late Cretaceous. The older feature, known as the Suwannee Straight, existed from Late

Cretaceous to Middle Eocene, and the younger feature, known as the Gulf Trough, existed from Middle Eocene to Middle Miocene (Randazzo, 1997). These two features may reflect the underlying zone of flexure at the suture between the North American basement and the African basement, or are a surficial expression of the Tallahassee Graben, which is a Triassic feature (Bryan, 1991).

The Apalachicola Embayment is the dominant geologic structural feature influencing the sediments in the central portion of the Florida panhandle (Schmidt, 1984). The axis of this feature trends SW, and sediment thickening occurs toward the Gulf of Mexico. As the Gulf Trough was filled or bridged, the migration of siliciclastics down the peninsula began. Since the Pliocene, sediments have accumulated and completely filled in the Apalachicola Embayment.

To the northeast of the Gulf Trough lies a positive feature previously called the Chattahoochee "Anticline" (Puri and Vernon, 1964). This feature is identified by the presence of Eocene and Oligocene carbonates near the surface with younger units pinching out against its flanks. Considerable argument as to the origin of this feature has taken place and various interpretations ranging from faulting to preferential erosion have been hypothesized. Schmidt (1984) discusses the pros and cons of each and the reader is referred there for a more detailed discussion.

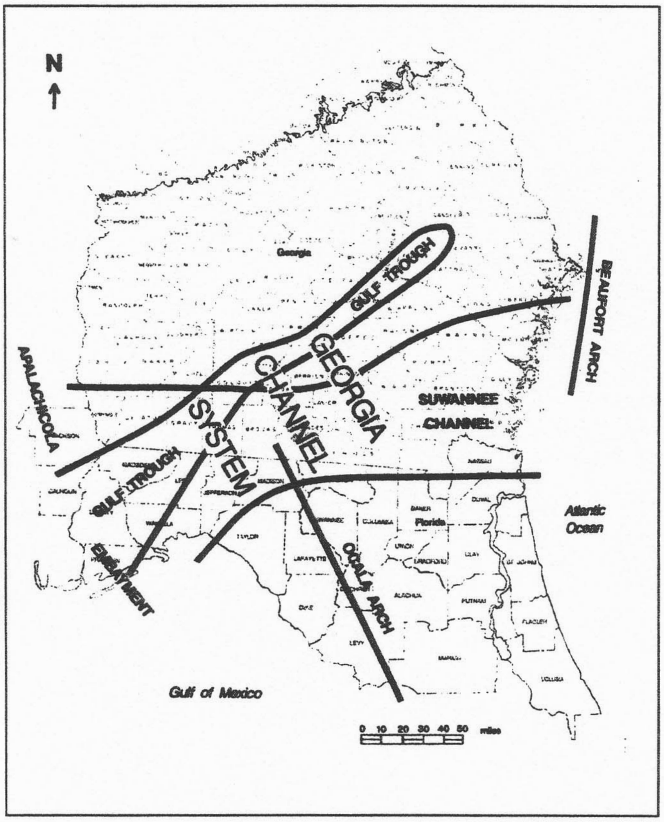


Figure 3 – Regional structure. From Huddleston, 1988.

GEOMORPHOLOGY

The upper Apalachicola River basin is encompassed by several geomorphic districts: The Dougherty Karst Plain District, Sneads Hills Province to the west, and the Tifton Upland District, Tallahassee Hills Province to the east, and just above Bristol, the Apalachicola River Delta District, High Level Delta and River Terrace Province (Scott, in prep). This is reflected in the diversity of geomorphic land forms that occur in the area, and include springs, karst topography, hills, floodplain, and steepheads.

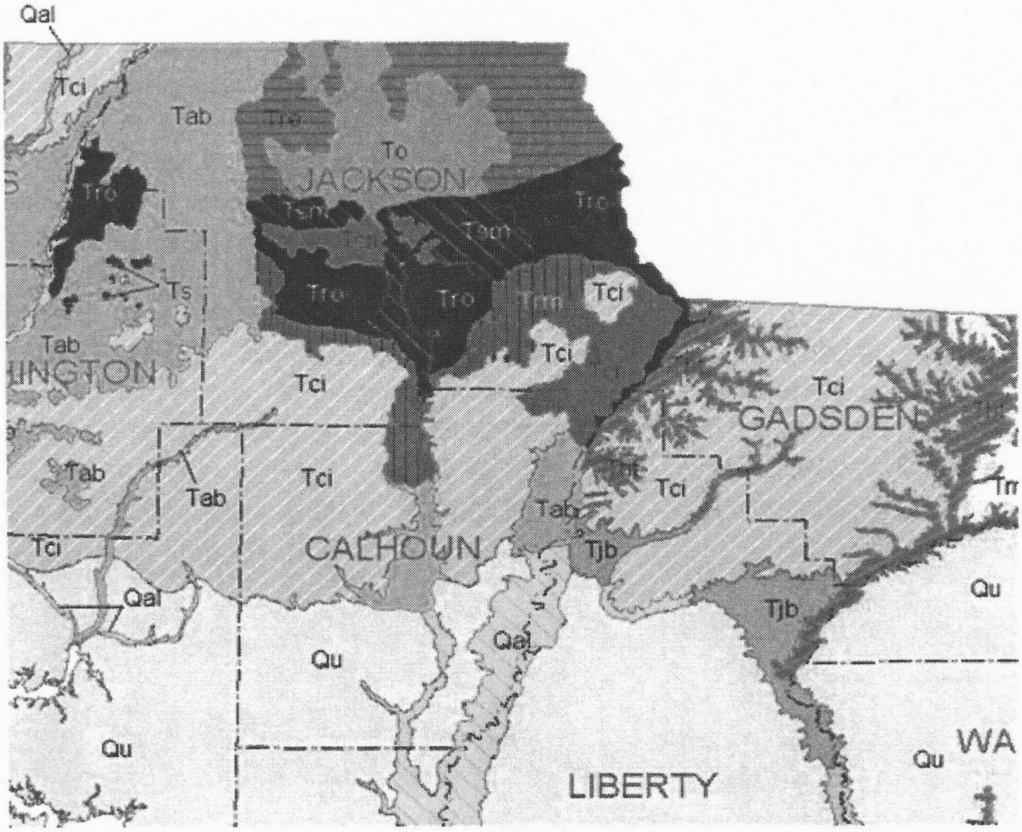
The Apalachicola Bluffs and Ravines Province borders the floodplain from the Georgia border to just north of Bristol. The sandy highlands of this province have been incised by streams that flow toward the Apalachicola River. This has produced some spectacular topography. Siliciclastic sediments of the Citronelle Formation provide the sandy overburden which caps the Oligocene to Miocene carbonates exposed in the upper reaches of the river. Near Alum Bluff, the Citronelle Formation overlies the clayey Jackson Bluff Formation, which is an effective aquaclude. This is where some of the best examples of steepheads occur (see B. Means later chapter).

Near the Jim Woodruff Dam, scattered throughout the floodplain and in the riverbed, are numerous karst features including springs and sinkholes which are sometimes obscured by the river, especially during times of high water. Not much is known about the rate of discharge or water quality of the springs since, for the most part, they vent directly into the bed of the Apalachicola River. Some water quality work was done on a spring that issues from the western side of the river near the dam, which showed that the source of water from the spring was lake water from Lake Seminole. Water held behind the Woodruff Dam has created enough head pressure to drive the flow in this spring system. A similar situation occurs just below the dam, on the west side below the dam lock. A large boil can be seen on the water surface which represents an area of spring discharge. It is unknown whether this system is venting lake water or aquifer water.

The floodplain of the Apalachicola varies in width from about one mile in its upper reaches to over 8 miles near its mouth. The upper portion of the river, above Bristol, meanders little relative to the lower portion, and may be degrading its channel (Bishop, 1983). The upper portion of the river, where the floodplain is relatively narrow, is where most of the exposures and outcrops occur.

STRATIGRAPHY

The surficial geology of the upper Apalachicola River has been studied and mapped by many previous authors. Most recently, Scott et al, 2001, produced an updated state geologic map of which a portion is reproduced below (Figure 4). This map shows the distribution of stratagraphic units that occur at or near the surface in the vicinity of the upper Apalachicola River. From it one can see that Oligocene and Miocene units occur in this area and each unit will be discussed in detail below.



LEGEND

Quaternary

Holocene

Qh	Holocene Sediments

Pleistocene/Holocene

Qal	Alluvium
Qbd	Beach Ridge and Dune
Qu	Undifferentiated

Pleistocene

Qa	Anastasia Fm
Qk	Key Largo Fm
Qm	Miami Ls
Qtr	Trail Ridge Sands

Tertiary/Quaternary

Pliocene/Pleistocene

TQsu	Shelly Sediments of Plio-Pleistocene
TQu	Undifferentiated TQ Sediments
TQd	Dunes
TQuc	Undiff. reworked Cypresshead Sediments

Tertiary

Pliocene

Tc	Cypresshead Fm
Tci	Citronelle Fm
Tmc	Miccosukee Fm
Tic	Intracoastal Fm
Tjb	Jackson Bluff Fm
Tt	Tamiami Fm

Miocene/Pliocene

Thcc	Hawthorn Gp, Coosawhatchie Fm, Charlton Mbr
Thp	Peace River Fm
Thpb	Hawthorn Gp, Peace River Fm, Bone Valley Mbr

Miocene

Trm	Residuum on Miocene Sediments
Tab	Alum Bluff Gp
Th	Hawthorn Gp
Thc	Coosawhatchie Fm
Ths	Statenville Fm
Tht	Torreya Fm
Tch	Chattahoochee Fm
Tsmk	St Marks Fm

Oligocene/Miocene

Tha	Hawthorn Gp, Arcadia Fm
That	Hawthorn Gp, Arcadia Fm, Tampa Mbr

Oligocene

Tro	Residuum on Oligocene Sediments
Ts	Suwannee Ls
Tsm	Suwannee Ls - Marianna Ls Undiff.

Eocene

Tre	Residuum on Eocene Sediments
To	Ocala Ls
Tap	Avon Park Fm

NOTES

This map was created using FDEP databases and data obtained from the Florida Geological Survey. It was completed October 10, 2001, by the Florida Department of Environmental Protection, Division of Resource Assessment & Management, Florida Geological Survey, GIS sub-section. This document was prepared for the presentation of the geologic (or hydrogeologic, etc...) information shown and is not intended to replace site-specific or use-specific investigations. The Florida Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for inappropriate change of scale or interpretations or decisions based thereon.
See OFR-80 for stratigraphic details.
For more information please contact:

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Figure 4 – Surficial geologic map of the field trip area. From Scott, et al (2001).

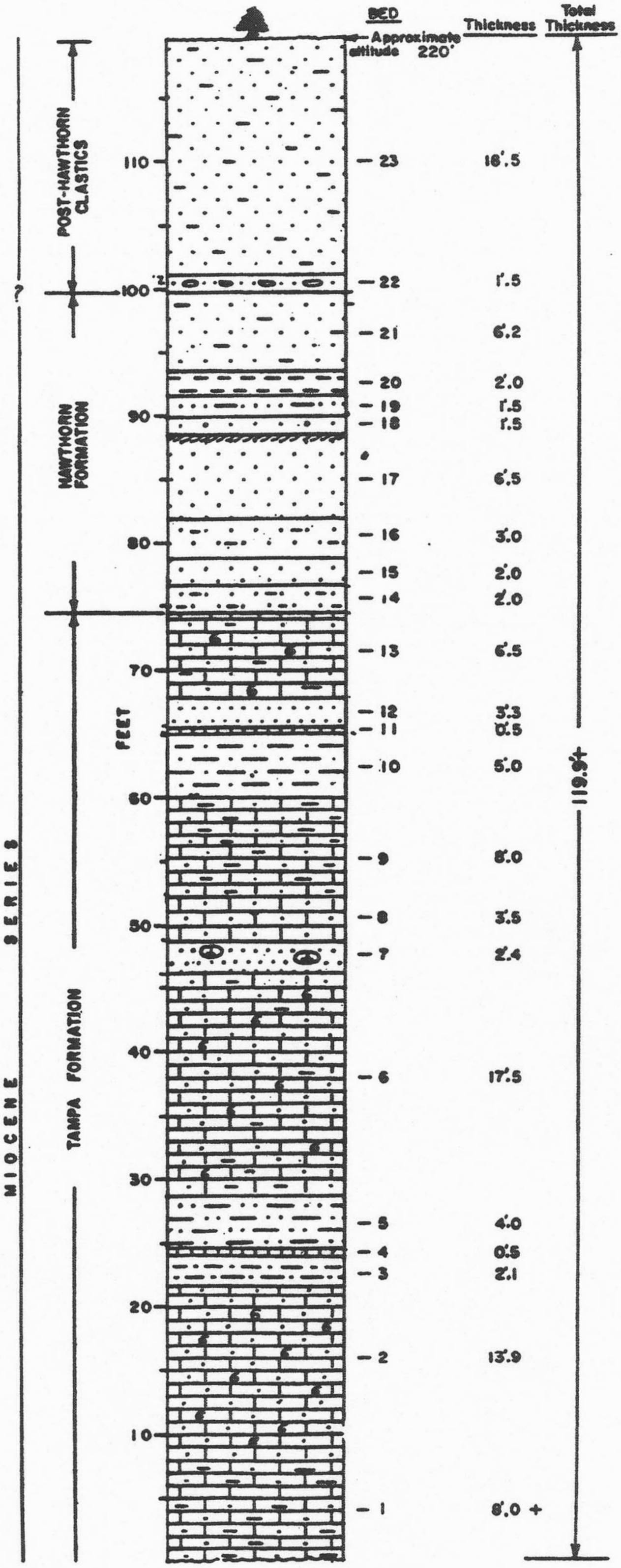

Figure 5 – Geologic column at Chattahoochee. From Gremillion (1966).

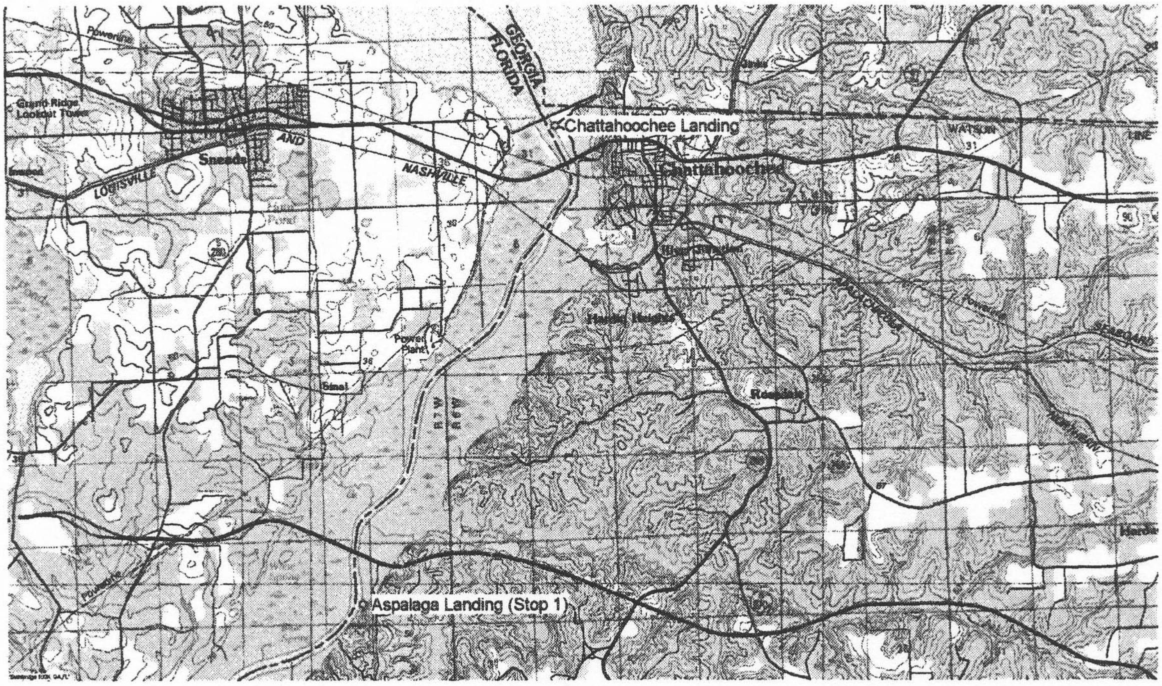

Figure 6 – Aspalaga Landing (Stop 1).

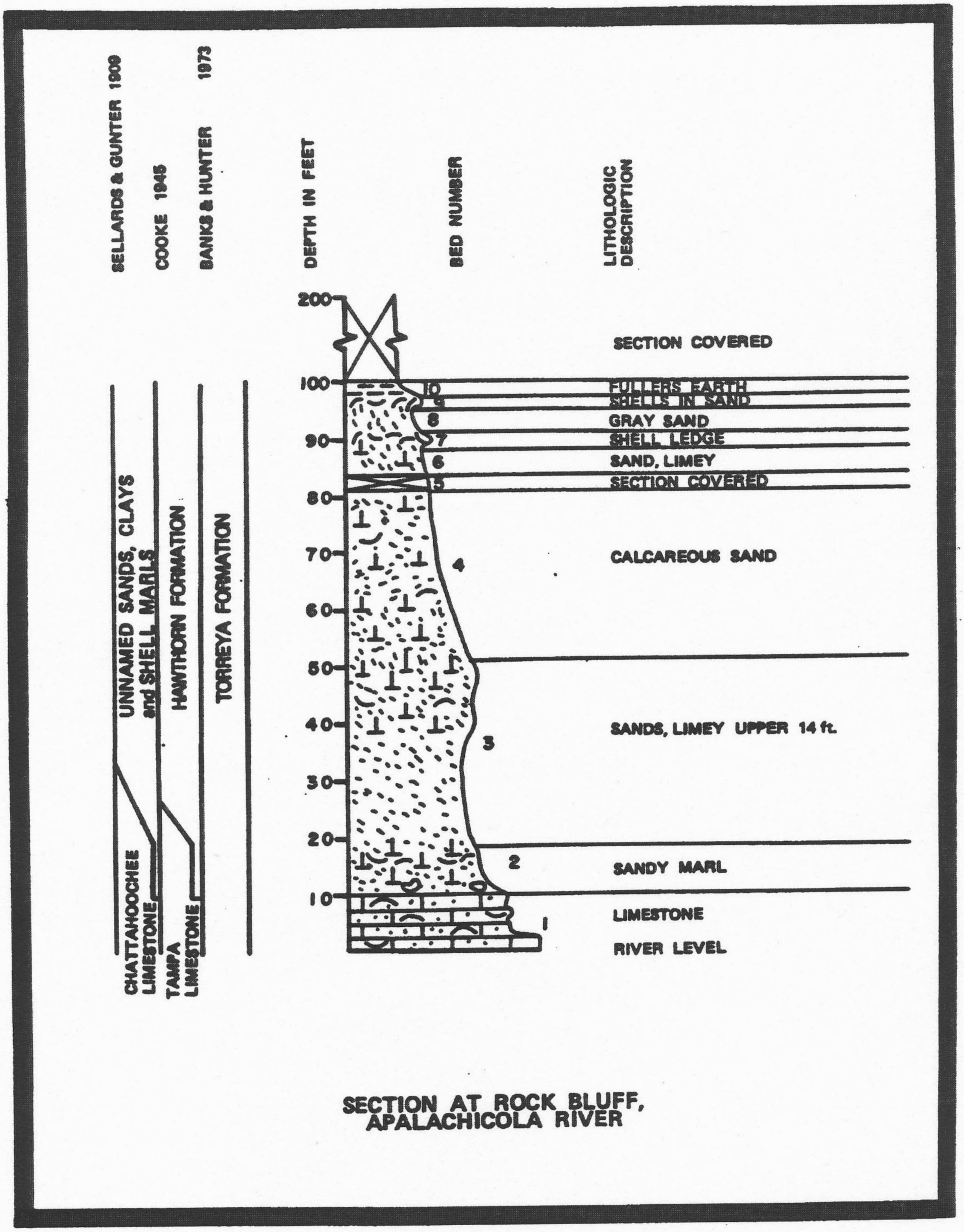

Figure 7 – Geologic section at Rock Bluff (From Schmidt, 1983).