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A FOSSIL HUNTER'S GUIDE TO THE GEOLOGY OF THE NORTHERN FLORIDA PENINSULA

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A Fossil Hunter's Guide to the Geology of the Northern Florida Peninsula

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The northern Florida peninsula extends, for the purposes of this paper, from Madison County eastward to Nassau County, and southward to a west-to-east line corresponding to the southern county boundaries of Pasco, Sumter, Lake, and Orange Counties. This region contains its own unique character, and is transitional from the hilly, topographic highlands of the panhandle to the low, flat terrain characteristic of southernmost Florida.

Based on the work of White (1970), the northern peninsula is generally subdivided into four broad geomorphic zones: the Northern Highlands, comprised of topographically higher uplands; the Gulf Coastal Lowlands, a flat, low-lying plain bordering the Gulf coast; the Central Highlands, a series of topographic ridges punctuated by elevationally-lower valleys, and the Atlantic Coastal Lowlands, a zone of low, flat topography bordering the east coast, and fringed by the persistent Atlantic Coastal Ridge system. Figure 1 is a geomorphic map of the northern peninsular region. For interested readers, White (1970) provides a more detailed discussion of many of the features mentioned herein.

The northwestern and north-central portions of the peninsula are comprised of elevational highlands of the Northern Highlands zone. These stream-dissected, gently-rolling hills are remnants of an extensive upland spanning the northern edge of the state and extending into southern Alabama and Georgia. In the northern peninsula, these highlands are typically elevationally-lower vestiges of the highest hills in the state, which are situated to the west in the north-central panhandle. Madison County contains the eastern end of the Tallahassee Hills subzone of the Northern Highlands, which extend to the Madison-Hamilton County line. To the east, the remaining hills generally become lower and more gently-rolling. At the eastern edge of the Northern Highlands is a relict marine feature, possibly a beach ridge, named the Trail Ridge. This ancient sand body is mined for both quartz sand and heavy minerals.

Bounding the southern and western edges of the Northern Highlands is a relict marine escarpment named the Cody Scarp. It forms the most persistent topographic break in the state and marks the former shoreline position of a high-standing Pleistocene sea. The Cody Scarp serves as a boundary between the Northern Highlands and the elevationally-lower Gulf Coastal Lowlands to the south and southwest.

The Gulf Coastal Lowlands ring much of Florida's Gulf coast. In general, this zone consists of a flat, sandy, gently sea ward-sloping plain associated with Pleistocene marine erosion. It is a region of pine flatwoods, moist hammocky terrain, and coastal salt marshes. Surface rivers and streams flow to the Gulf in channels incised in the limestone bedrock. Some connect through sinkholes with an extensive subsurface karst drainage system, comprised of interconnected water-filled sinks, caves, and springs.

Eocene and Oligocene limestones are near or at the surface over much of the lowlands area. These limestones are typically covered by a variably-thick veneer of Quaternary sands, clayey sands, and discontinuous shelly sands left behind by high-standing Pleistocene seas. Relict marine features such as sand bars, beach ridges, and dunes are still visible in many areas of the Gulf Coastal Lowlands. Numerous limestone and dolostone mines dot the lowlands region, and where accessible, offer invertebrate fossil collecting opportunities.

The Central Highlands collectively comprise a series of coast-parallel ridges and intervening valleys. In general, the various ridges and valleys, as the names imply, are differentiated primarily on elevation. Elevations along portions of higher ridges, such as the Brooksville Ridge reach 300 feet above mean sealevel. In the valleys, elevations between 50 and 100 feet above mean sealevel are typical.

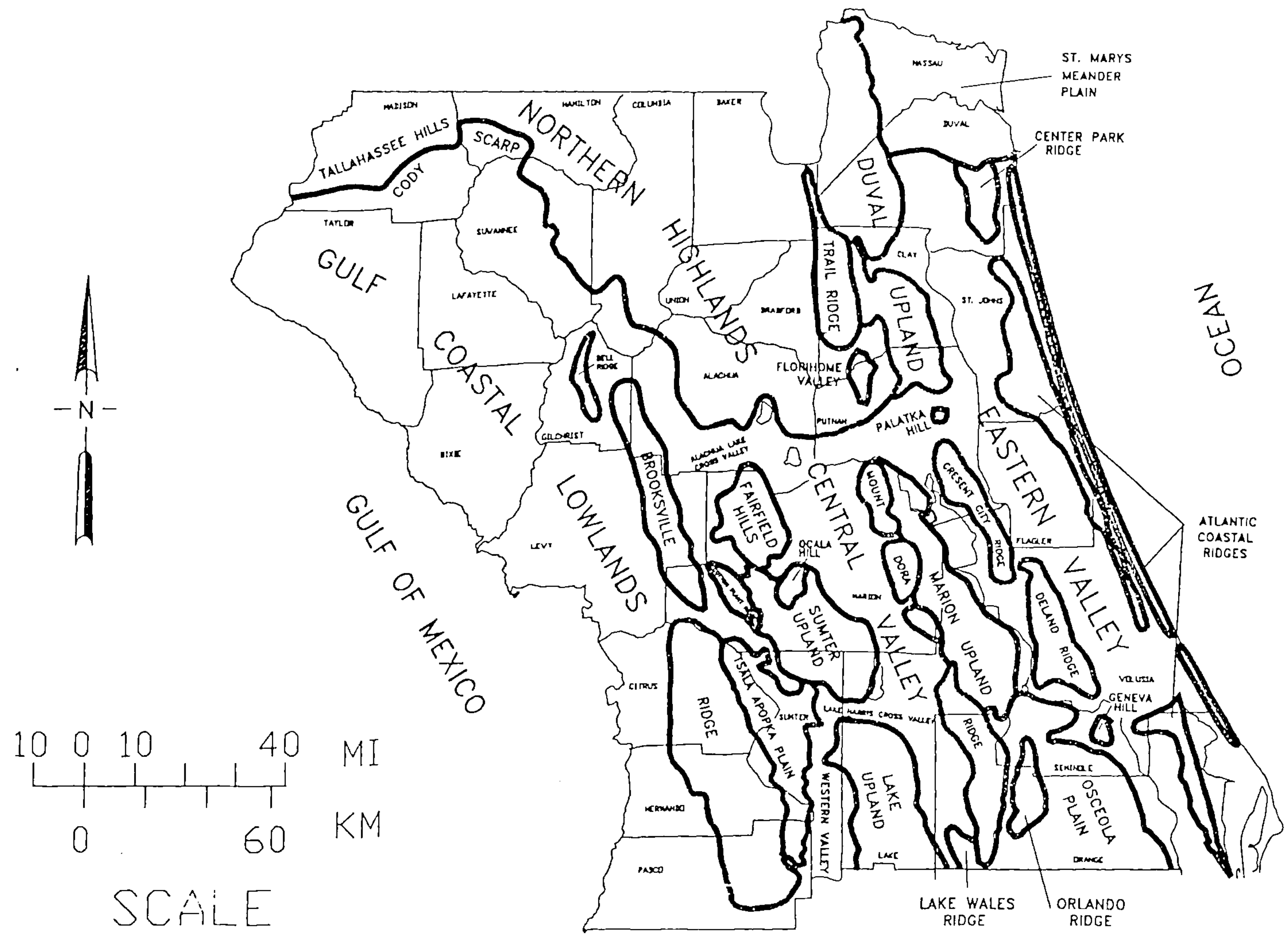

Figure 1. Geomorphic map of the northern Florida peninsula.
(modified from White, 1970)

Marine and fluvial erosion, coupled with karst dissolution of the carbonate bedrock, were major factors shaping the geomorphology of this region. In some areas, such as the Central Valley, lowering of the land surface likely occurred due to extensive dissolution of the underlying carbonate rocks. Carbonates are commonly very close to the land surface in the lowland valleys on the western side of the peninsula. Karst features, such as springs and large sinkhole lakes, occur throughout the Central Valley. Silver Springs, near Ocala is the larger of the numerous freshwater springs dotting the Central Valley area. Smaller springs, flowing crystal clear freshwater from the Ocala Limestone, provide popular swimming areas throughout the local Ocala National Forest. The valleys also typically contain the major surface water streams, such as the Oklawaha River, which snakes its way northward through central Marion County.

The shallow nature of the carbonate bedrock in areas such as portions of the Central Valley make them suitable regions for economic mining of limestone. A number of older mines are scattered over the Central Valley, especially in Marion County, north and south of the city of Ocala. A few still operate in the vicinity of Ocala.

Many of the topographic features in the Central Highlands were shaped, at least in part, by high-standing Miocene through Pleistocene seas. Elongate highlands such as the Brooksville and Mount Dora Ridges trend southeastward at nearly the same orientation as the modern peninsula. The ridges may have, at one time, been part of an extensive highland area subsequently divided by erosional and dissolutional valleys into discreet highland segments. These ridges are typically comprised of Miocene and Pliocene siliciclastic sediments, overlain by variably-thick Quaternary sands. Interior hills and ridges such as the Fairfield Hills and Marion Upland are comprised of essentially in-place, older sediments. Others, like the Brooksville Ridge, are built in part of sediments reworked from older formations by marine currents and wave activity.

The Atlantic Coastal Lowlands are comprised of several distinct geomorphic zones. Along the eastern edge of the northern Florida peninsula, the Eocene and Miocene formations dip, and hence deepen, to the northeast. Thick deposits of undifferentiated sands, clayey sands, and shell beds are the predominant near-surface sediments. At the northeastern corner of the state, the St. Mary's Meander Plain is, as its name implies, a low, flat fluvial plain shaped largely by the meandering of the St. Mary's and Nassau Rivers. Further south, the Eastern Valley comprises a generally flat, sandy region lying 25-30 feet above mean sealevel. Numerous relict beach ridges throughout the extent of the Eastern Valley suggest it may represent a Pleistocene beach ridge plain. Bordering the Atlantic edge of the Eastern Valley is a narrow ridge comprised of sand and shelly sands named the Atlantic Coastal Ridge. This ridge extends, with a few breaks, from east-central St. Johns County southward to the vicinity of the town of Homestead, in southern Dade County. Seaward of the ridge lie the sandy beaches, barrier islands, and lagoons of the Atlantic Coast.

Both the geomorphology and the geology of the northern Florida peninsula are strongly influenced by subsurface structural features. Figure 2 illustrates the major structures affecting this region. Perhaps the most significant is a broad, structurally

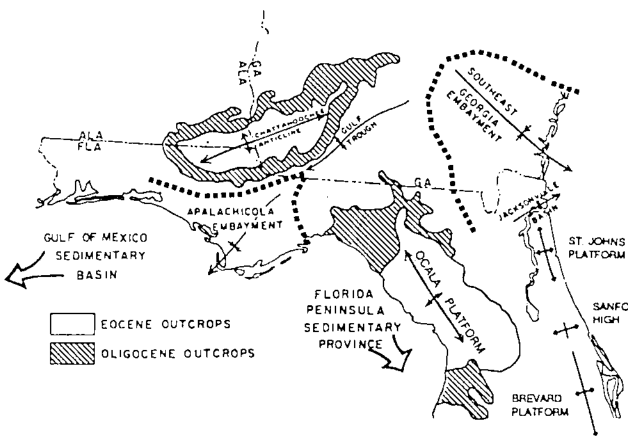

Figure 2. Geologic structures in northern Florida (from Schmidt, 1984 and Scott, 1988)

positive feature named the Ocala Platform (Scott, 1988), centered under the central Big Bend area. Cenozoic formations lap up onto the western flank of this feature, and dip northeastward off the eastern flank into a broad sedimentary basin named the Southeast

Georgia Embayment. The Ocala Platform brings Eocene carbonate rocks to the surface over the crest of the structure in Levy and Citrus Counties. Oligocene and Miocene units lap up onto the edges of the platform in a younger-outward concentric pattern. The shallow Eocene and Oligocene carbonates form extensive karst plains over much of the western portion of the northern peninsula. To the east the Oligocene sediments are absent. As the Eocene carbonates and overlying Miocene sediments dip away off the eastern flank of the platform, siliciclastic sediments become the predominant near surface sediments.

Three other positive structural features, situated along the eastern edge of the northern peninsula, also influence the Eocene and younger sediments. The Sanford High is located under Seminole and Volusia Counties; Ocala Limestone and Hawthorn Group sediments are missing from the crest of this feature, presumably due to erosion. The Avon Park Formation directly underlies the thick Plio-Pleistocene sediments in this area. The St. Johns Platform and Brevard Platform are low, broad ridges on the erosional surface of the Ocala Limestone. None of these features directly influence the surface geology.

Figure 3 is a generalized geologic map of the northern peninsula, and Figure 4 illustrates two cross sections through the area. The geologic map is constructed to show the extent of the formations as they occur within 20 feet of land surface. Each formation may be more extensive in the subsurface, but because each eventually dips below the arbitrary 20 foot depth or pinches out, their entire extent is hidden by shallower units shown on the map. Areas underlain by more than 20 feet of undifferentiated Quaternary sands are shown as white areas on the map.

Cross section A-A' in Figure 4 curves southward from Jefferson County, approximately following the eastern periphery of the Ocala Platform. This section shows the "high" attained by the top of the Eocene Ocala Limestone over the flank of the platform, as well as the on-lap of the Oligocene Suwannee Limestone at the western edge of the platform. Section B-B' trends southwest-to-northeast across the peninsula, illustrating the northeastward dip of the Eocene Avon Park Formation, the Ocala Limestone, and the overlying Miocene Hawthorn Group as they lap off the eastern edge of the Ocala Platform. A cursory comparison of Figures 1 and 3 reveals coincidence between many of the geomorphic zones and features and the areal extent of certain geologic units. For example, the Gulf Coastal Lowlands and the interior valleys are largely underlain by Eocene and Oligocene carbonates, while the Northern Highlands and many of the upland areas of the Central Highlands are comprised of Miocene or Pliocene siliciclastics.

The karst plain areas of the Big Bend coast are primarily composed of Middle Eocene to Oligocene marine limestones and dolostones. The oldest exposed rock in Florida, the Middle Eocene Avon Park Formation, occurs near the surface over the crest of the Ocala Platform in southern Levy and northern Citrus Counties. Here it is typically a cream to tan dolostone. The Upper Eocene Ocala Limestone unconformably overlies the Avon Park Formation, and comprises the bedrock over a broad area of the coastal Big Bend. It also floors many of the valleys of the western part of the Central Highlands zone. This white to cream-colored marine limestone typically contains abundant foraminifera, bryozoans, mollusks, and echinoids. It is mined in many of the counties situated over the Ocala Platform for use in cement and as roadbed material. Paleo-sinkholes and crevices encountered during mining may contain Pleistocene sediment fill, which has proven to be a source for excellent Pleistocene vertebrate material. Most of the karst plain areas in the Big Bend are overlain by undifferentiated sands of variable thickness. These sands may locally be thick enough to form mappable units.

The Oligocene Suwannee Limestone is brought to the surface along the northwestern flank of the Ocala Platform, in Taylor, Madison and Hamilton Counties, and at the southern edge of the platform in Pasco and Hernando Counties. It forms the shallow bedrock in most of Taylor County, and crops out along the Suwannee River between the towns of White Springs and Ellaville. This unit is also mined for roadbase material in Taylor, Hernando, and Pasco Counties. The Suwannee is typically a fossiliferous marine limestone containing

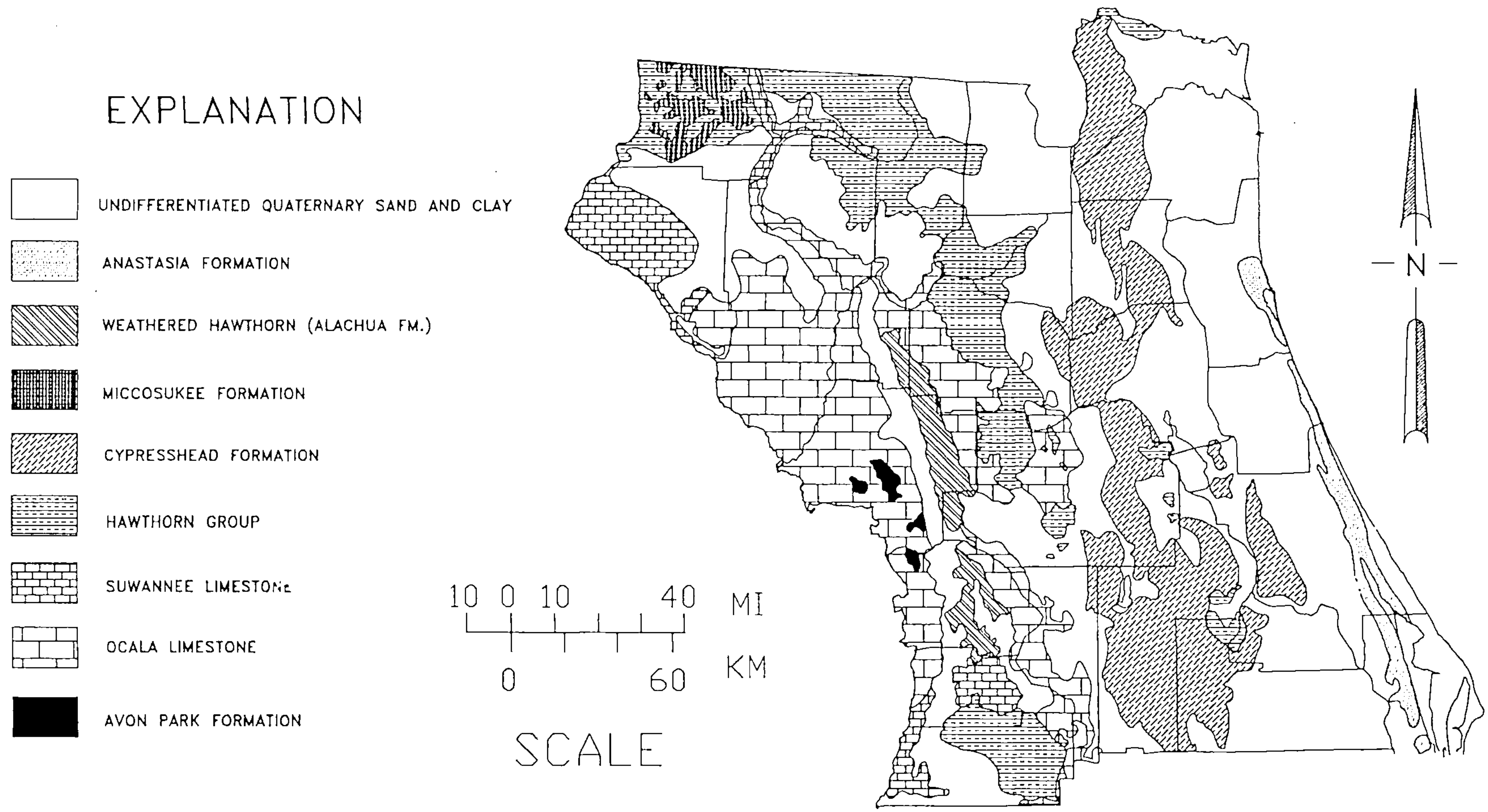

Figure 3. Geologic map of the northern Florida peninsula

(modified from Arthur, 1993; Campbell, 1992a-c; Campbell, 1993a-c; Campbell and Scott, 1992 and 1993; Rupert and Campbell, 1993; Rupert et al., 1993; Scott, 1992a-j; Scott, 1993a-d; Scott and Campbell, 1992)

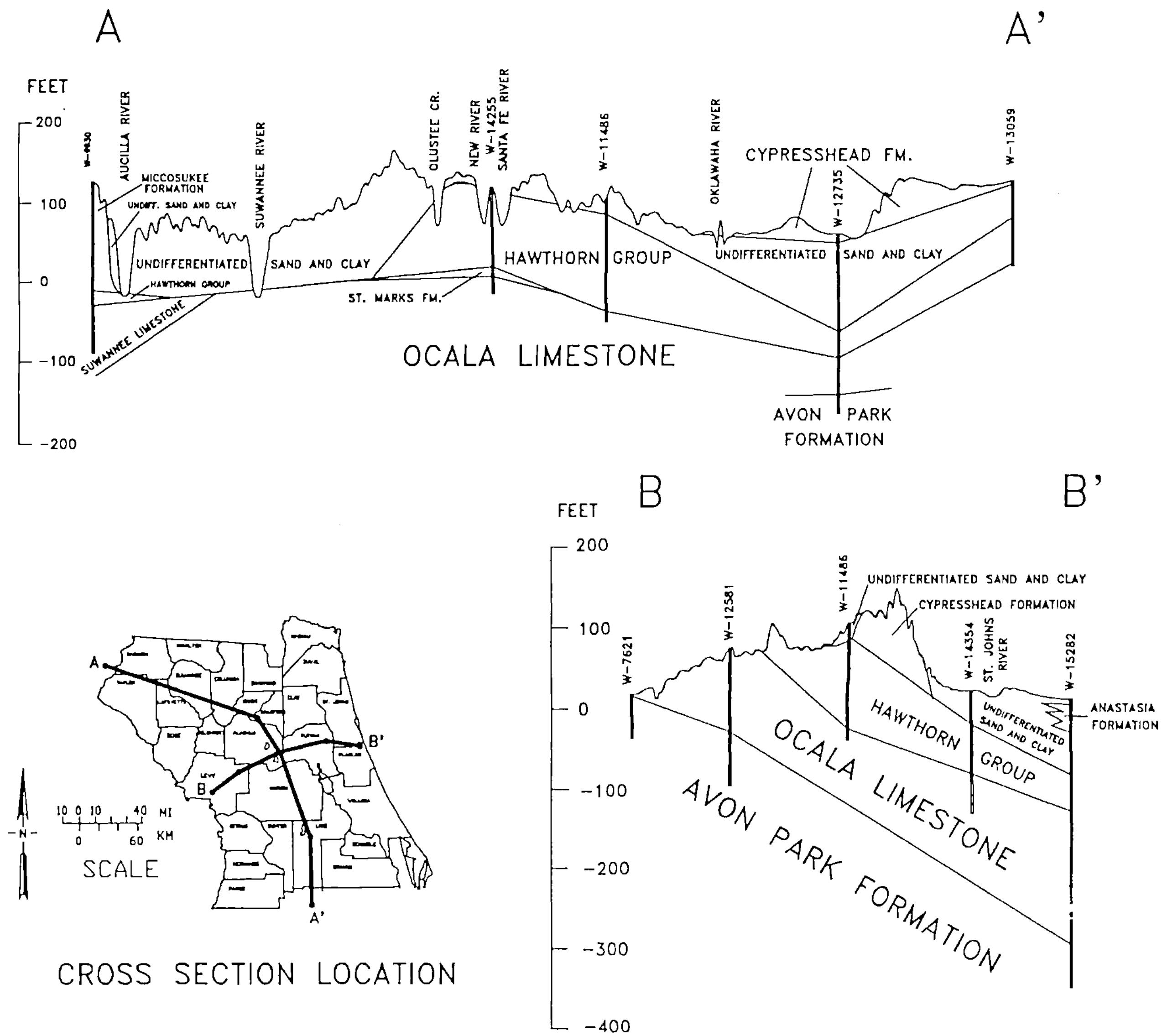

Figure 4. Geologic cross sections in the northern Florida peninsula.

mollusk molds and occasional specimens of the characteristic guide fossil echinoid *Ryncholampus gouldii*.

The Miocene Hawthorn Group overlies the Ocala Limestone and, where present, the Suwannee Limestone. It forms the hilly terrain of the Northern Highlands and comprises selected ridges in the Central Highlands, including the Fairfield Hills, Ocala Hill, and the southern end of the Brooksville Ridge. The Hawthorn is generally missing in the Gulf coastal portions of the northern peninsula, and dips and thickens under northeastern Florida. Commercial deposits of phosphate are mined from the Hawthorn in Hamilton County. Fullers earth clay, which is crushed to make cat litter, is also mined from the Hawthorn in central Marion County. Numerous vertebrate fossils have been found in Hawthorn sediments statewide. These range from shark teeth and dugong bones to horse fossils to the famous gomphotheres of the Moss Acres site in Marion County. The Hawthorn is commonly exposed in stream banks in the Northern Highlands zone, offering some easily-accessible fossil hunting sites.

Many of the ridges of the eastern part of the Central Highlands are comprised of the Pliocene Cypresshead Formation. This generally unfossiliferous unit consists primarily of clayey, gravelly sands, thought to be an ancient marginal marine deposit. The deeper water equivalent of the Cypresshead Formation is a molluskan-fossiliferous shelly sand named the Nashua Formation. The Nashua crops out in a small area along the St. John's River, near the town of Nashua in Putnam County.

A similar age unit, the Miccosukee Formation, caps hill tops in Madison County, at the eastern end of the Tallahassee Hills. As with the Cypresshead Formation, the clayey sands of the Miccosukee Formation are generally unfossiliferous, although Olsen (1963) reports one vertebrate fossil site in this unit in Jefferson County.

The northern portion of the Brooksville Ridge is comprised of interbedded clay, sand, and sandy clay of varying lithologic character, and containing vertebrate fossils ranging from Middle Miocene to Plio-Pleistocene in age. Older literature assigned these sediments to a unit named the Alachua Formation. These diverse sediments are now thought to represent weathered and/or reworked Hawthorn Group sediments (Scott, 1988).

Large areas of the eastern half of the northern Florida peninsula are mapped as undifferentiated Quaternary deposits, primarily sands and clays. These sediments attain substantial thicknesses as the older Eocene through Miocene units dip northeastward into the Southeast Georgia Embayment. Portions of the Atlantic Coastal Ridges, are formed of sands, shelly sands, and mollusk coquina of the Pleistocene Anastasia Formation. Anastasia coquina is comprised largely of fossil mollusk shells cemented together into a porous rock. It was quarried on Anastasia Island by the Spaniards and used to build the Castillo de San Marcos, a 17th century fort in St. Augustine. The Anastasia Formation crops out sporadically along the Atlantic coast. An excellent exposure is present on the beach at Washington Oaks State Park, south of Marineland in Flagler County.

Fossil Hunting Opportunities

Fossil collecting sites in the northern Florida peninsula are many and varied, but typically require diligent searching on the part of the fossil hunter. The region offers both invertebrate collecting, particularly in quarries and along river banks, and vertebrate fossils in river beds, on beaches and in sinkhole fill material from quarries. Figure 5 provides a generalized location map for some of the ideas presented here. Some additional detail is provided by Figure 6, a figure from Puri and Vernon (1964) showing classic geologic sites of the region. Keep in mind that the latter figure is 30 years old, and was prepared as a field trip guide. Much of the site ownership and access information is likely obsolete.

As with most of the state, many potential fossil sites are on private property, or else require traversing private property to get to them. Therefore, please use discretion and common sense when hunting, and respect the property rights of others. Always seek permission before entering anyone's land, posted or not. Once there, respect the integrity of the land, avoid destructive digging, and leave it as you found it. This will ensure continued

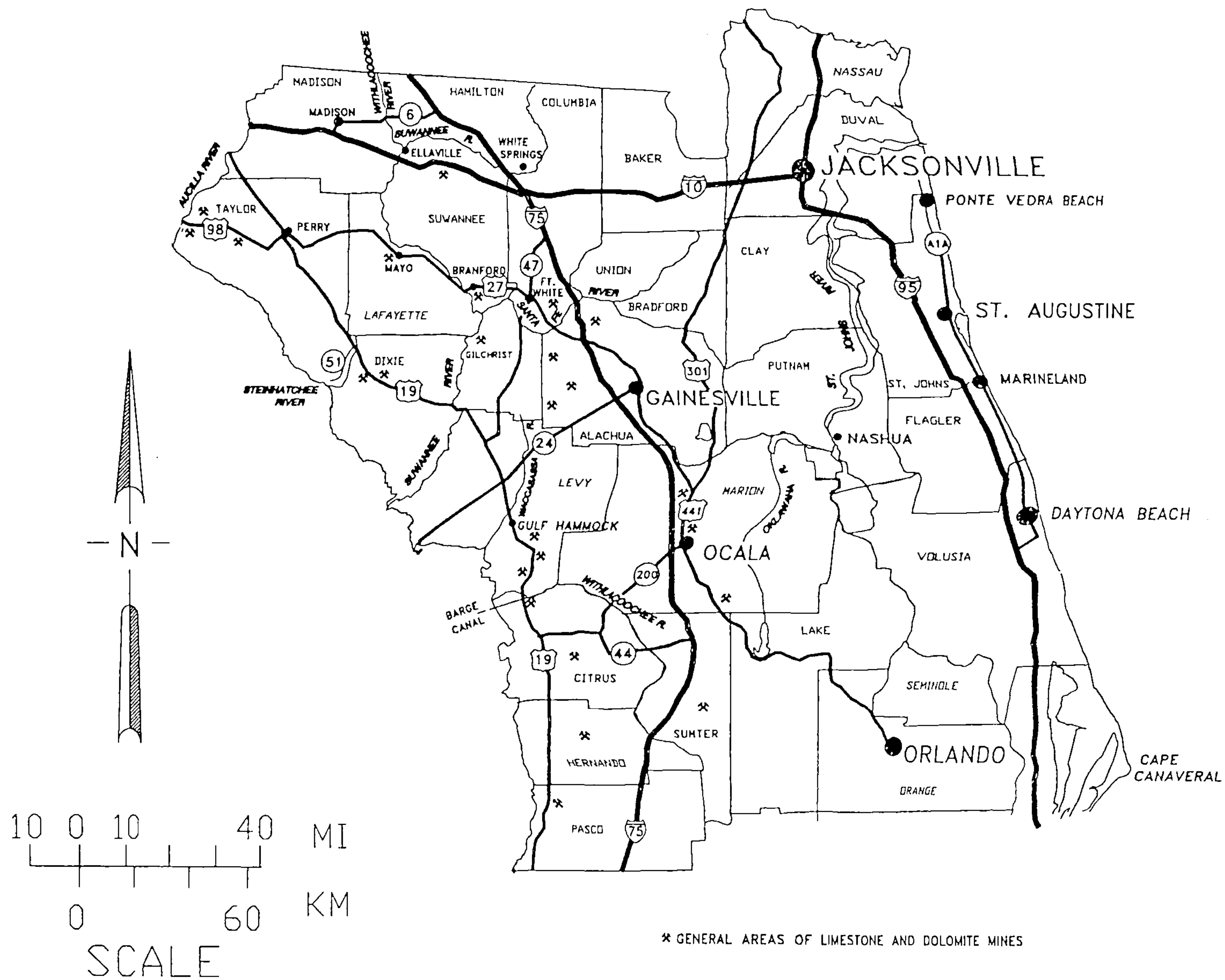

Figure 5. Generalized road and location map for fossil collecting sites described in text.

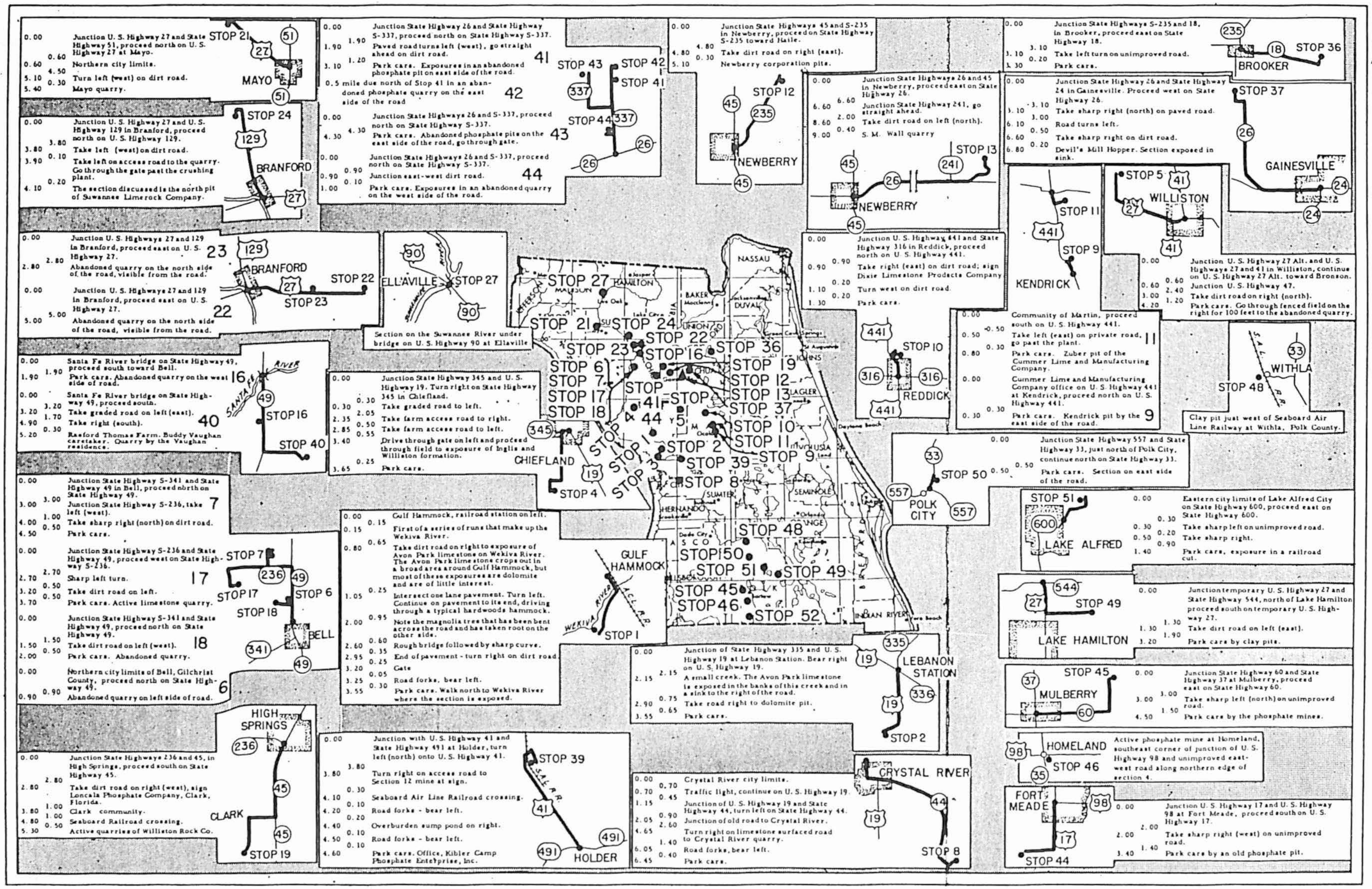

Figure 6. Classic geologic sites in the northern Florida peninsula (from Puri and Vernon, 1964).

future access to the sites, a very important consideration in these days of rapidly dwindling collecting areas.

For those seeking Eocene and Oligocene nvertebrates such as mollusks and echinoids, exposures of Ocala and Suwannee Limestones occur along stream banks and in quarries. At low water, Suwannee Limestone is accessible along the Suwannee River between the towns of White Springs and Ellaville (Hamilton and Suwannee Counties). Ocala Limestone crops out along parts of the lower portion of the Suwannee River, from approximately Mayo southward.

Quarries throughout the western part of the northern peninsula expose fossiliferous limestones and may offer potential collecting sites. A few are operating; others may be abandoned, overgrown, or water filled. There are no commercial fossil hunting quarries in the region. It is essential to get permission to enter any quarry from the landowner or operator, and to use adequate caution when hunting in quarries. Active mines may refuse entry to fossil hunters due to insurance and liability concerns. Others might allow access to non-working areas upon receipt of a signed liability waiver. As quarry ownership and status changes frequently, it is not generally feasible to direct collectors to any particular site.

Middle Eocene fossil echinoids, primarily *Periarchus lyelli floridanus*, and the seagrass *Lepidodendron* have been uncovered in the Avon Park Formation in quarries near Gulf Hammock in Levy County. This small region situated in southern Levy and northernmost Citrus Counties is the only area in the state where Avon Park Formation is close to the surface.

Invertebrate fossils are abundant in the Ocala Limestone quarries, scattered throughout the Gulf coast Big Bend counties, as well as both north and south of Ocala in Marion County, and in western Alachua, and southern Columbia and Suwannee Counties. Some of these quarries are easily visible from the road. Mollusks, echinoids and the large foraminifera *Lepidocyclina* are among the most abundant fossils in the Ocala Limestone. The fossils are typically locked in the rock matrix, requiring some tedious removal. It is not uncommon, however, to find loose fossils as well, especially the larger echinoids.

During dredging of the first leg of the ill-fated Cross-Florida Barge Canal, high dredge spoil piles were created along either side of the cut near U.S. Highway 19 in Citrus County. Fossils from the lower Ocala Limestone and Avon Park Formation were once quite common in these piles; today the piles are overgrown, and in some areas fenced off. A few clear areas remain, however, and are worth checking out.

The Miocene Hawthorn Group sediments sometimes yield rare invertebrate fossils, primarily mollusks, from the carbonate portions of the unit. There are also reports of silicified corals being found in the stream banks of the Withlacoochee River (between Madison and Hamilton Counties) near where the State Road 6 bridge crosses the river.

Fossiliferous portions of the late Tertiary and Quaternary sediments along the eastern portion of the northern peninsula also provide invertebrate collecting opportunities. Both old and new shell pits along the eastern half of the peninsula typically penetrate molluskan-fossiliferous units such as the Nashua Formation. Many of these pits are closed or are private. Another possibility is to check creeks and streams that may have cut down into these units in this area.

The northern Florida peninsula also offers the vertebrate fossil collector numerous opportunities. Although the Eocene and Oligocene limestones occasionally yield rare shark teeth or whale bones, it is the Miocene Hawthorn Group sediments and Pleistocene deposits that offer the richest finds. The Hawthorn Group sediments underlie the Northern Highlands, and comprise the core of isolated hills and ridges throughout the Central Highlands. Many of the vertebrate fossil discoveries occur along river and creek banks, where streams have cut downward into the sediments. Hawthorn exposures are common along the northern stretch of the Aucilla, Withlacoochee, Alapaha, and Suwannee Rivers, but numerous other smaller creeks dissect these sediments as well. One amateur collector found a Miocene long-beaked dolphin jaw in a small creek bank in downtown Gainesville. Manatee ribs are fairly common in Alachua County as well. While there are no well known public sites as such, the sheer area covered by Miocene sediments provides exceptional opportunities to the collector willing to wade local streams.

Weathered Hawthorn Group sediments, which include the Alachua Formation, are another source of finds. These sediments commonly occur as reworked paleo-sinkhole and channel fill materials in the underlying limestone. Perhaps the most famous such site is Thomas Farm in Gilchrist County, noted for its fossil horse fauna. The weathered Hawthorn sediments typically show a wide age range, likely owing to their reworking and redeposition through several epochs of geologic time. They are most commonly encountered west of the Northern Highlands in the Gilchrist-Alachua-Levy County area, where they may occupy karst depressions.

Younger Pliocene and Pleistocene vertebrate fossils are found primarily in two types of settings: in undifferentiated sinkhole fill material, usually discovered during mining in limerock quarries, and as streambed deposits. Some spectacular finds have come from the sediments filling ancient karst features, but finding such features in the walls of a quarry is somewhat of a hit or miss proposition. Better success is had by snorkeling or diving the numerous streams traversing the karst plain areas of the Gulf Coastal Lowlands. Here water has eroded Pliocene and Pleistocene land mammal material out of the sediments and deposited them in the gravel pockets on the streambed. Occasional Eocene shark teeth, eroded from the underlying limestone, may also be mixed in with the bottom material.

Brown (1988) describes four river sites in the area that he has worked with success; the first, the Steinhatchee, flows between Taylor and Dixie Counties. It is accessible via a small recreation area located off State Road 51. From Highway 19, turn south on S.R. 51 and proceed about 2 miles. Turn left on a dirt road, go about .3 miles, then take the right fork of the road for another mile to the park. Search the banks and bottom gravels above the falls for Pleistocene land animal and bird fossils, as well as Eocene shark teeth. A second river site is along the Santa Fe, which flows between Columbia, Alachua, and Gilchrist Counties. It may be entered at the State Road 47 bridge, 6 miles south of Ft. White. Search the gravel along the north bank, upstream of the bridge, for Eocene shark teeth and manatee teeth. The river may also be canoed by putting in at the U.S. 27 bridge and floating 10 miles to the S.R. 47 bridge. Similarly, the Wacasassa River my be explored by putting in at the S.R. 24 bridge and floating downstream to the U.S. 19 bridge. Finally, the other Withlacoochee River (there are two) between Citrus and Marion and Sumter Counties offers Pleistocene fossils in its streambed as well. One stretch allows canoe access at the S.R. 44 bridge in Sumter County and takeout at the S.R. 200 bridge in Marion County.

Vertebrate fossils are sometimes found in the undifferentiated Quaternary sediments along the eastern edge of the peninsula. An extensive bone bed, including a complete giant sloth skeleton, was accidentally discovered near Daytona Beach years ago. Such discoveries are typically found during excavation work, and surface sites are few to nil. Stream cuts may offer some potential finds, particularly in the upper portions of shell beds. Collectors have found vertebrate material along the Atlantic beaches, predominantly in the Ponte Vedra Beach area of St. Johns County. Brown (1988) advises parking at Mickler Landing, or off Highway A1A just south of this park, and checking both the surf zone and the shell piles on the beach. Collectors have, in the past, found vertebrate material in dredge spoil material along the St. Johns River.

There are undoubtedly numerous other possible fossil sites throughout the northern peninsula. The ones presented here are just a sampling of typical sites. Many of the same fossil hunting techniques that work elsewhere will work here as well. Check stream bottoms and banks, excavations, mines, and beaches. And be prepared to do some screen washing, particularly in the Miocene sediments.

If you travel to this part of the state, be sure the visit the Florida Museum of Natural History, located on the University of Florida campus in Gainesville. Signs along I-75 in Gainesville direct you to the proper exit. The museum features outstanding natural history displays, including a recently-revamped Florida fossil exhibit.

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