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THE GEOMORPHOLOGY, GEOLOGY AND HYDROGEOLOGY OF LAFAYETTE COUNTY, FLORIDA

By

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THE GEOMORPHOLOGY, GEOLOGY AND HYDROGEOLOGY OF LAFAYETTE COUNTY

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GEOMORPHOLOGY

Lafayette County lies within both the Northern and Central geomorphic zones of White (1970). The Northern Zone is described as broad highlands spanning from the east coast across the Florida Panhandle. The Central Zone generally consists of a series of valleys which separate coast-parallel ridges, however, none of the Central Zone ridges are located within the county. Accordingly, maximum elevations in Lafayette County lie within the Northern Zone. These elevations are in excess of 120 feet above mean sea-level - the National Geodetic Vertical Datum (NGVD). Lowest elevations (less than 25 feet NGVD) occur within the Suwannee River Basin along the southeast part of the county as well as along the Steinhatchee River in the southwest corner of the county.

The Gulf Coastal Lowlands is a major geomorphic province which lies within both the Northern and Central Zones and encompasses all of Lafayette County. This geomorphic province is typically a flat, sandy plain commonly incised by river and stream valleys. It also contains relict beach ridge deposits and wetlands. In Lafayette County, however, the only paleo-coastal feature is the relatively flat topography due to terracing by Plio-Pleistocene seas. Healy's (1975) map of Florida's terraces and shorelines indicates that most of the county lies within the elevation range of the Wicomico marine terrace (70-100 feet above NGVD).

Wetlands comprise roughly one half of Lafayette County (Figure 1). In addition to the flat, low-lying topography of the county, the location of these swampy areas is also controlled by hydrogeological factors. Refer to the **HYDROGEOLOGY** section for discussion of the relationship between hydrogeology and the wetlands of Lafayette County.

The most extensive wetlands are San Pedro Bay and Mallory Swamp. San Pedro Bay lies along the western margin of the county and Mallory Swamp lies in the south-central third of the county. Limited surface drainage of Mallory Swamp is toward the south and southwest where the waters eventually enter the Steinhatchee River in Dixie County via Eight Mile Creek. Drainage from Mallory Swamp into the Suwannee River is limited to one or two intermittent tributaries. San Pedro Bay is drained via tributaries of the Steinhatchee River including Reedy Creek, Wolf Creek, Owl Creek and Kettle Creek, all of which are located in southwestern Lafayette County. Headwaters of the Steinhatchee River itself originate in the clayey sands of central Lafayette county.

The Suwannee River comprises the entire eastern border of the county. The Suwannee River Valley extends three to five miles into Lafayette County and is floored by limestone. These Eocene limestones are observed in outcrop along the river, especially during the dry season. Due to artesian conditions within the Floridan aquifer system (see **HYDROGEOLOGY** section), numerous springs are located along both the Suwannee and Steinhatchee Rivers.

Springs of Lafayette County which flow into the Suwannee River include: Alan Mill Pond, Blue, Convict, Fletcher, Mearson, Owens, Perry, Ruth, Troy and Turtle Springs. Iron Spring and Steinhatchee Spring are associated with the Steinhatchee River. Of the 12 springs reported for Lafayette County, Troy Spring is the only one classified as a first magnitude spring (Rosenau, et al., 1977). This classification denotes that the spring has an average discharge greater than or equal to 100 cubic feet per second.

GEOLOGY

Lafayette County is underlain by several thousand feet of sedimentary rocks. The basement rocks beneath the region are comprised of Paleozoic (Ordovician through Devonian) quartz sandstones and shales (Applin, 1951) which are found at depths greater than 4000 feet below land surface (bls). These rocks have been penetrated by oil test wells and are part of the Paleozoic Suwannee Basin. The oldest geologic unit penetrated by water wells is the Eocene Avon Park Formation. The Eocene through Oligocene units comprise the upper portion of the Floridan aquifer system in the region - the county's main source for drinking

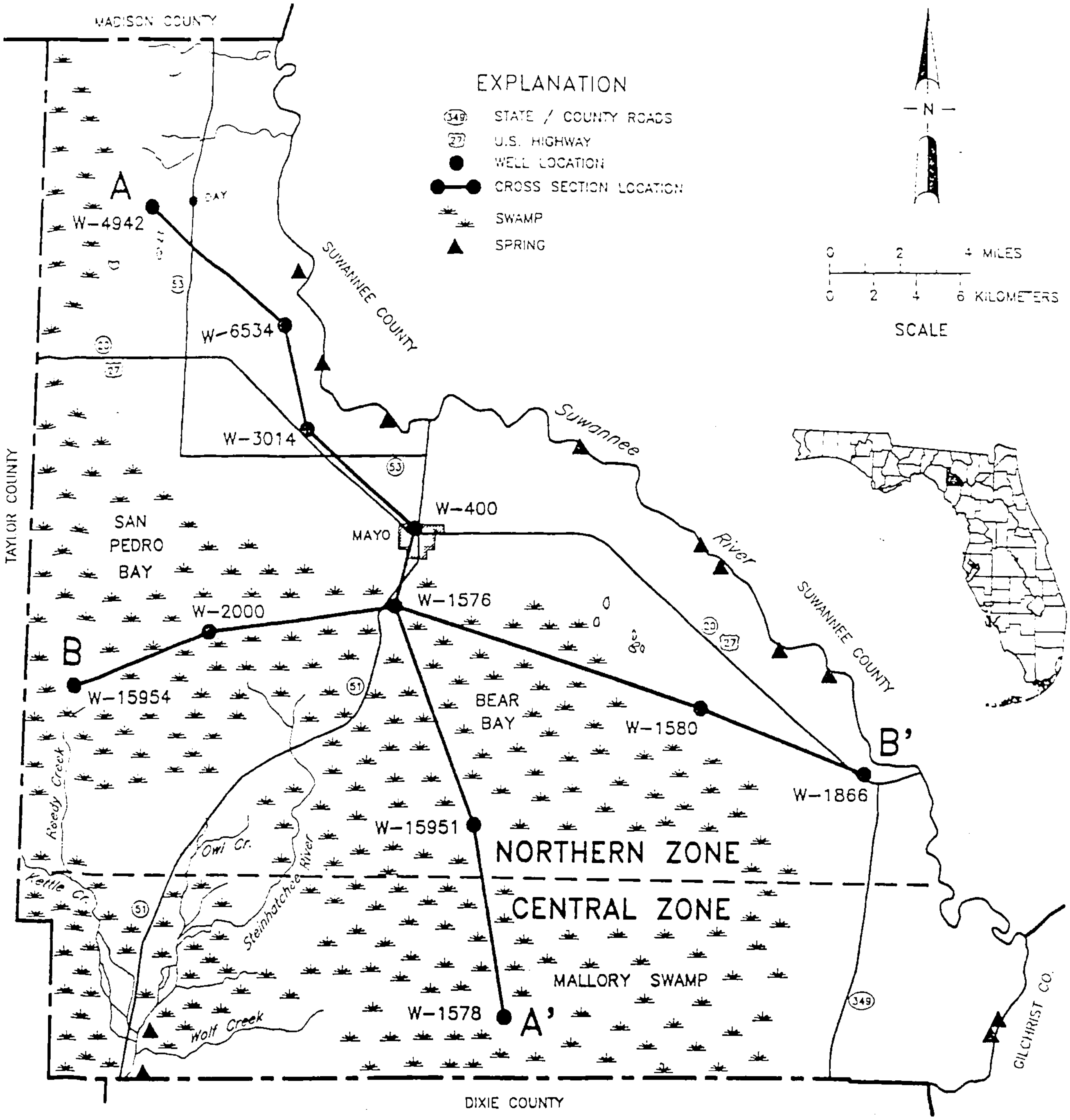

Figure 1. Lafayette County geomorphic features and geologic cross section locations.

water. The following summary of Lafayette County geology will be limited to these Eocene age and younger rocks. Figure 1 shows the location of geologic cross sections (Figures 2 and 3) depicting subsurface relationships of these geologic units. Interpretations in the cross sections are based on analysis of wells shown in Figure 1 in addition to data from wells not shown. Figure 4 is a generalized geologic map showing the extent of near-surface (20 feet bls or less) stratigraphic units.

Eocene Series

Avon Park Formation

The Avon Park Formation (Miller, 1986) underlies all of Lafayette County and generally consists of tan to buff dolostones and dolomitic limestones with occasional organic-rich laminations. This formation ranges in age from approximately 47 to 43 million years old (mya), which corresponds to the Middle Eocene Epoch. The Lower to Middle Eocene Oldsmar Limestone lies beneath the Avon Park Formation in Lafayette County at depths exceeding 900 feet bls. Examination of well cuttings indicates that the uppermost portion of the Avon Park Formation is typically a tan to grayish-orange sucrosic dolostone. The most diagnostic fossils recognized in cuttings are the foraminifera *Dictyoconus* sp. and *Coskinolina floridana*. A variety of echinoids is also found in this unit. The Avon Park Formation is fairly uniform in thickness beneath Lafayette County, ranging from 500 to 700 feet (Miller, 1986). It thickens to more than 800 feet in the south-bordering counties (Dixie and Gilchrist; Puri, et al., 1967). The top of the formation is between 110 to 160 feet bls and is unconformably overlain by the Ocala Limestone.

No samples were recovered from intervals at or very near the top of the Avon Park Formation in three wells utilized in this study. These intervals may be indicative of cavities formed from carbonate dissolution at the formation boundary. Alternatively, the lack of recovery may be the result of wash-out of unconsolidated, possibly organic-rich sediments which are occasionally found at this stratigraphic position.

Ocala Limestone

The Ocala Limestone, first named by Dall and Harris (1892), consists of white to light gray limestone with a diverse fossil assemblage. This formation is Late Eocene in age (approximately 40 to 38 mya) and contains characteristic fossils such as the foraminifera *Lepidocyclina* sp. and echinoids such as *Eupatagus antillarum*. Other fossils observed in the unit include pelecypods, bryzoans, gastropods and additional foraminifera such as *Nummulites*. The top of the Ocala Limestone is either a surface exposure or an unconformable contact with one of the following: the Suwannee Limestone, the Hawthorn Group or undifferentiated sands and clays. Accordingly, depths to the top of the formation range from 0 to approximately 90 feet bls. An analysis of well cuttings and core selected for this study suggests that the Ocala Limestone ranges in thickness from 70 to 160 feet.

Dolostones observed at the top of the Ocala Limestone may be part of the Steinhatchee Dolomite Member. Puri et al., (1967) describe the Steinhatchee Dolomite as a tan, granular, impure dolostone occurring in the basal position of the Crystal River Formation (upper Ocala Limestone) outcropping near Horseshoe Beach, Dixie County. Scott (personal communication, 1991), however, has observed dolostones similar in appearance, interbedded with and at the top of the upper Ocala Limestone in the region. He notes that other unpublished field studies have found Oligocene-age fossils within some of these dolostone lithologies. In order to better understand the age, occurrence and extent of the Steinhatchee Dolomite Member, further study is required.

Oligocene Series

Suwannee Limestone

The occurrence of the Lower Oligocene Suwannee Limestone (Cooke and Mansfield, 1936) beneath Lafayette County is sporadic. This unit, which ranges in age from 38 to 33 mya, is a thin discontinuous layer above the Ocala Limestone and is unconformably overlain by Hawthorn Group sediments. The lithology of the Suwannee Limestone as observed from well cuttings ranges from a light to tannish gray limestone to a tan sucrosic dolostone. Fossils in

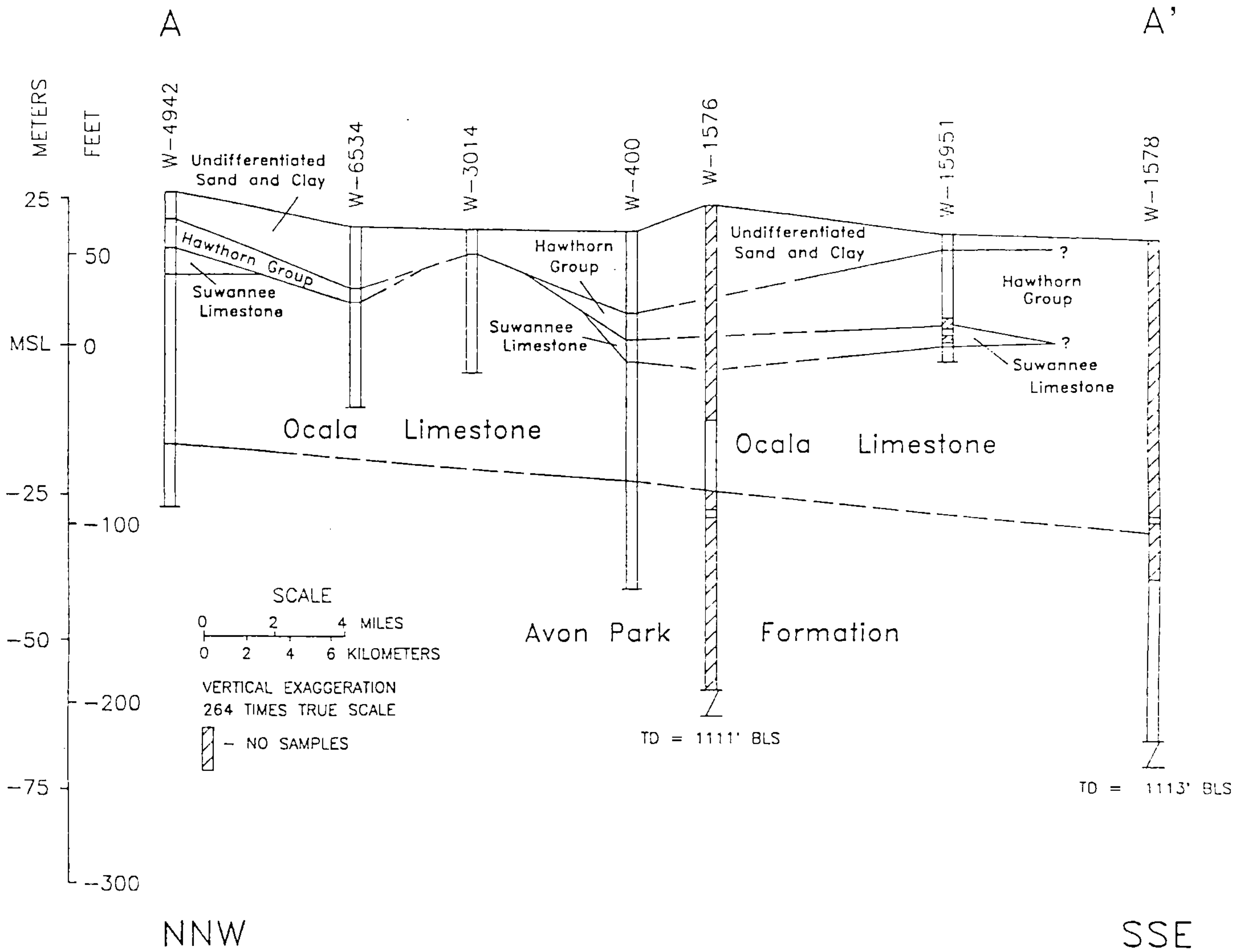

Figure 2. Geologic cross section A - A'.

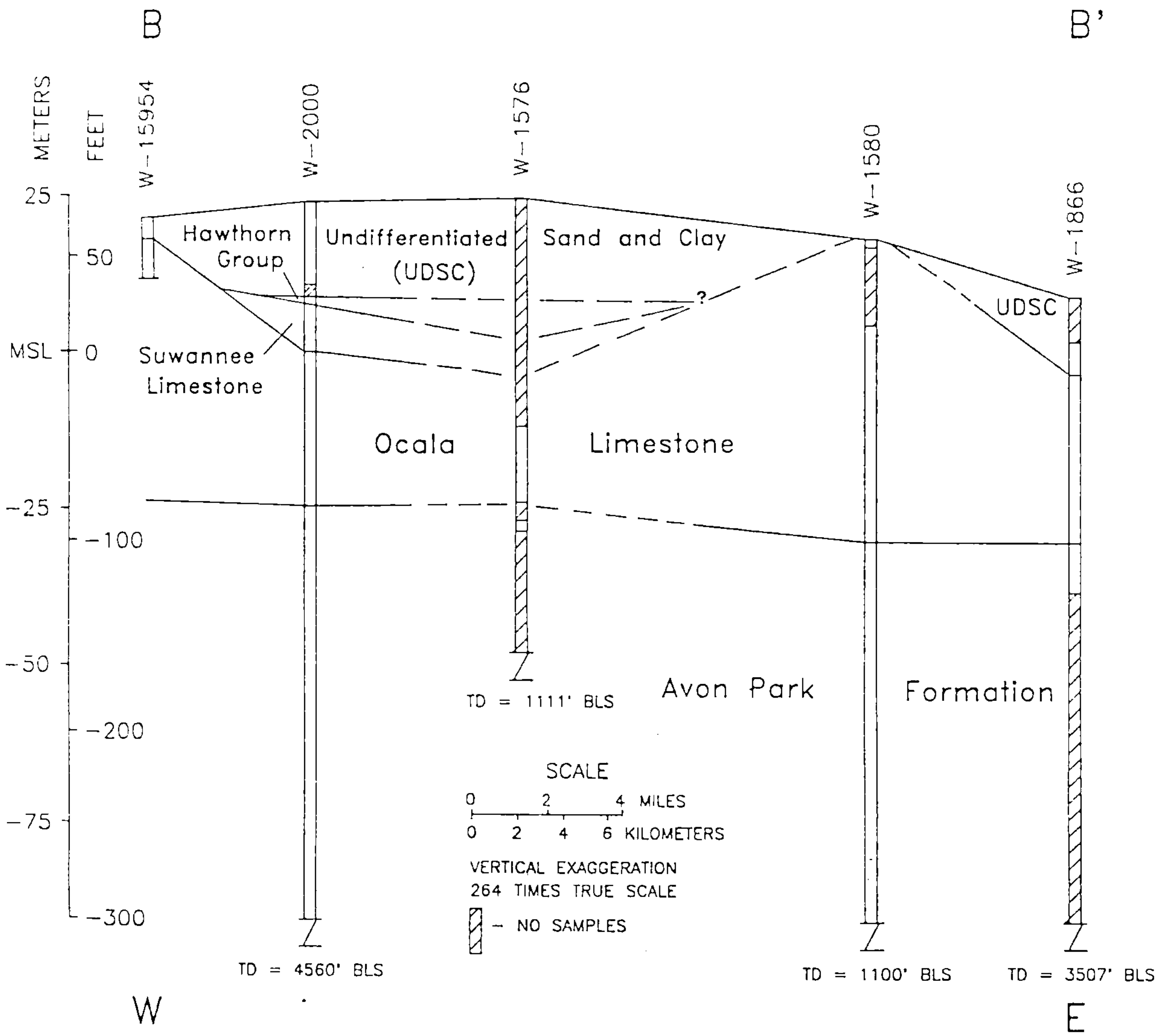

Figure 3. Geologic cross section B - B'.

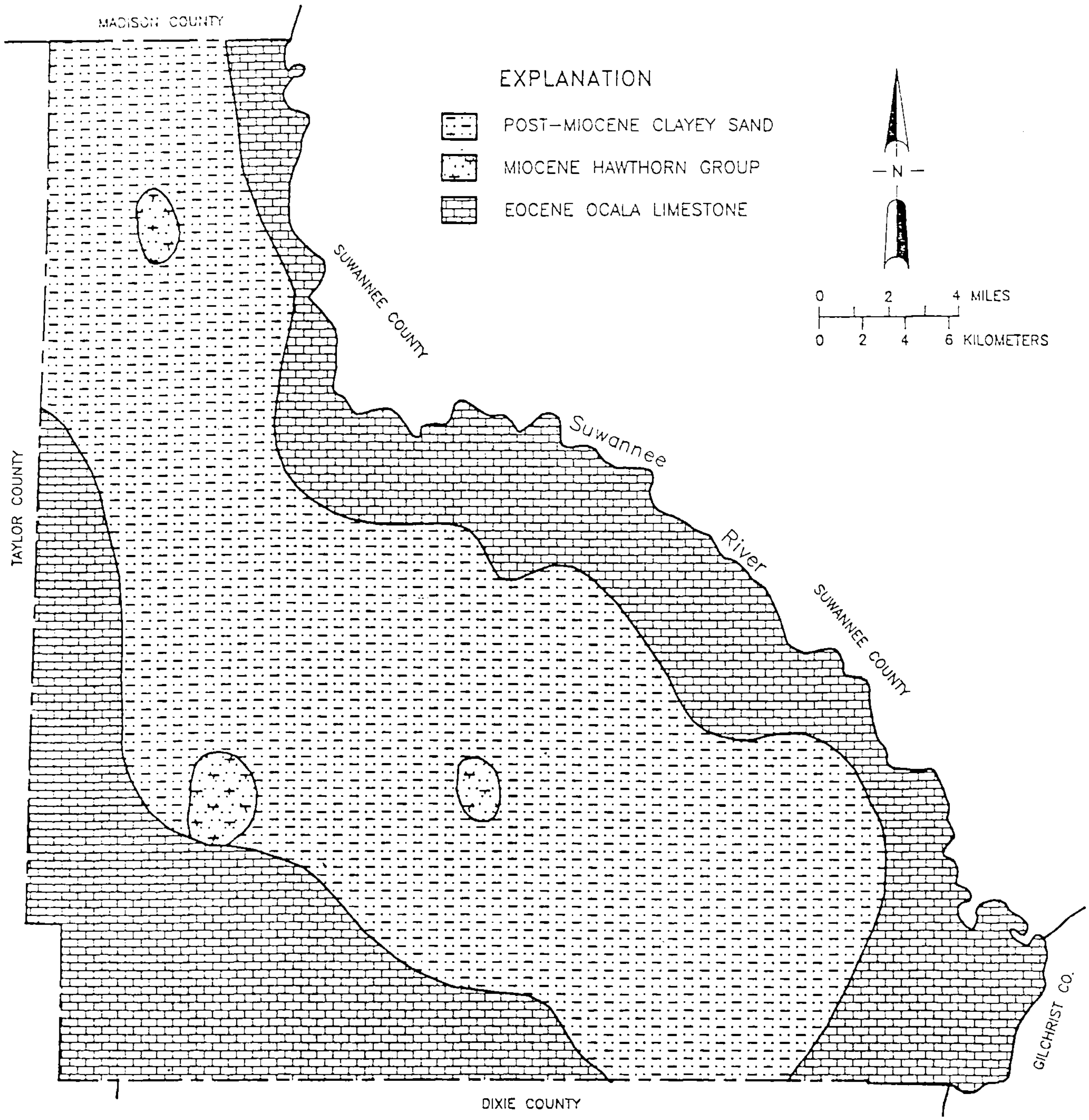

Figure 4. Geologic map of Lafayette County (modified from Knapp, 1978a, 1978b; Lloyd and Campbell, 1986). Map reflects geologic formations encountered less than or equal to 20 feet bls.

the unit include gastropods, pelecypods, echinoids (e.g. *Rhyncholampus gouldii*), abundant milliolids and other benthic foraminifera such as *Dictyoconus* sp. The top of the Suwannee Limestone is found between 30 and 80 feet bls. Thickness of the unit ranges from 0 to 25 feet. The formation erosionally pinches out to the northeast against the Ocala Limestone where the Ocala occurs as a stratigraphic high, cropping out in a band paralleling the Suwannee River (Figures 2 and 4). Toward the west-central part of the county, as evidenced by W-15954 (Figure 3), the formation is also absent. Existing data suggest that the extent of the Suwannee Limestone is limited to the central portion of the county.

Miocene Series

Hawthorn Group

Hawthorn Group sediments (Scott, 1988) are Miocene in age (approximately 25 to 5 mya) and generally consist of phosphatic siliciclastics (sands, silts and clays) and carbonates. In Lafayette County, the Hawthorn Group sediments are noticeably less fossiliferous than the underlying Eocene and Oligocene carbonates. Samples of Hawthorn in Lafayette County include lithologies of white sandy, phosphatic carbonate and very pale orange to light gray phosphatic clay. Some of the clayey lithologies could be considered "hard rock" phosphate. The subsurface extent of Hawthorn sediments approximately coincides with that of the underlying Suwannee Limestone. In limited areas, the Hawthorn Group may lie unconformably above the Ocala Limestone (Figure 2). Depth to the top of the Hawthorn Group, where present, ranges from 5 to 45 feet bls. Available data indicate that all of this unit is overlain by Post-Miocene sediments. Figure 4 shows three locations where Hawthorn Group sediments lie within 20 feet of land surface in the Northern geomorphic zone. The Hawthorn Group averages 20 feet thick and ranges from 0 to 40 feet thick in the subsurface of Lafayette County.

Post-Miocene Series

Undifferentiated Sands and Clays

The distribution of post-Miocene series (younger than 5 mya) clayey sands is shown in Figure 4. Deposits greater than 20 feet thick are limited to the central and western portions of the county. These sediments lie above either Hawthorn Group sediments, Suwannee Limestone, or Ocala Limestone (Figure 2 and 3) and are generally moderate yellowish brown to brown in color with variable amounts of organic material. Thicknesses range from 0 to 45 feet and average about 25 feet.

HYDROGEOLOGY

Ground water is water within the pore spaces of rocks and sediments in the subsurface. When these pore spaces are interconnected (permeable), ground water is free to flow under the influence of gravity or pressure. If the pore spaces are not present or not interconnected, such as in clay-rich strata, the flow of the ground water is restricted. These physical parameters of rocks as they relate to ground water movement and storage have given rise to a classification of hydrogeologic units in Florida (Southeastern Geological Society Ad Hoc Committee, 1986). In Lafayette County, the pertinent units include the surficial aquifer system, the intermediate confining unit and the Floridan aquifer system. An aquifer system is "a heterogeneous body of intercalated permeable and poorly permeable material that functions regionally as a water-yielding hydraulic unit" (Poland, et al., 1972).

The extent of the surficial aquifer system in the county has not been well defined. This aquifer system is a water-table aquifer (unconfined) within post-Miocene clayey sands of the central and western part of the county. In the San Pedro Bay area of adjacent Taylor County, a surficial (water table) aquifer system reaching maximum thicknesses of 50 feet has been reported (Burnson, 1982).

The intermediate confining unit, where present, is comprised of clayey Miocene (Hawthorn Group) sediments and in some cases the relatively clay-rich post-Miocene sediments. A map showing general hydrogeologic conditions of the region (Burnson, 1982) delineates a "Class II - semiconfined Floridan aquifer" which roughly corresponds to the distribution of clayey sands shown in Figure 4. Burnson's "Class II" area includes the central and western parts of Lafayette County and presumably the surficial aquifer system, which may in places lie above the confining unit. He also reports a thin (less than 5 feet thick) Miocene confining unit beneath the surficial aquifer system in the San Pedro Bay area of Taylor County.

As noted earlier, the Floridan aquifer system is the major source of drinking water in Lafayette County. The Floridan aquifer system underlies the entire county and is between approximately 1250 and 1475 feet thick (Miller, 1986). Depths to this aquifer system range from 0 to about 60 feet bls. Along the Suwannee River and the southern border of the county, the Floridan aquifer system is unconfined (Burnson, 1982; see also the extent of the Ocala Limestone, Figure 4). The uppermost geologic formations of this system include either the Suwannee Limestone (where present) or the Ocala Limestone.

The potentiometric surface of an aquifer system reflects the surface (or elevation) to which the ground water would rise due to hydrostatic pressure. When an aquifer system is confined by overlying impermeable beds, the potentiometric surface may be situated above land surface. Under such (artesian) conditions, if an unconfined path exists between the aquifer system and the surface, ground water will flow freely at land surface in the form of seeps and springs. As noted in the GEOMORPHOLOGY section and shown in Figure 1, numerous springs occur along the Suwannee and Steinhatchee Rivers, indicating that those ground waters are under some amount of pressure from within the Floridan aquifer system with respect to the river stage.

In addition to the presence of springs, the potentiometric surface is also one of the variables influencing the location and extent of wetlands in the county. Figure 4 shows that carbonates of the Floridan aquifer system comprise the majority of the bedrock in the region. Approximately half of the county lacks a significant aquifer confining unit (Burnson, 1982) and the potentiometric surface of the Floridan aquifer system is at or near land-surface elevation (Barr, 1987). These combined factors cause standing water conditions (i.e. wetlands) when drainage and evaporation do not counter the effect. In areas where wetlands lie above the intermediate confining unit (clayey sands) and the potentiometric surface is high, surficial waters are unable to infiltrate into the ground thus sustaining wetland conditions.

MINERAL AND ENERGY RESOURCES

Lafayette County has several potential geological resources, however, no commercial development of these resources currently is taking place (Spencer, 1989; Spencer, personal communication, 1991). Surficial deposits in the county include clayey sand, limestone, and peat. In the deep subsurface, test wells have been drilled in search for oil and gas.

Sand and Clay

Surficial sediment deposits in the county are largely comprised of clayey sands (Knapp, 1978a, 1978b; Figure 4). No commercial deposits of sand or clay are reported or mined. Small, localized borrow pits scattered throughout the county have likely been used for road fill. Bell (1924) notes that the underlying sediments (i.e. the Hawthorn Group) may contain thin localized layers of clay, however none are suitable for mining.

Limestone and Dolostone

Knapp (1978a, 1978b) shows surface exposures of limestone along the Suwannee River, and limestone and dolostone in the southwest corner of the county near the Steinhatchee River (Figure 4). Five limestone quarries are known to have been in operation in the county, however, none are active as of the writing of this report. The Dowling Pit, the most recently active, is located in the northeast corner of the county, adjacent to the Suwannee River (Schmidt, et al. 1979). The remaining quarry sites are also located along the Suwannee River and were probably developing product from the Ocala Limestone.

Peat

Localized peat deposits are associated with wetland regions of Lafayette County. In a statewide investigation of peat deposits, Davis (1946) collected peat from swamps in south-central Lafayette County (Mallory Swamp) and about 2 miles south-southwest of Mayo in Bear Bay. Griffin et al. (1982) report that no data is available for Lafayette County with respect to the occurrence of fuel grade peat deposits.

Oil and Gas

During the 1940's, the first oil and gas exploration wells (wildcats) were drilled in Lafayette County. To date, a total of eight wildcats have been drilled to depths ranging from 3507 to 10;077 feet bls. All of these wells were dry holes and were subsequently plugged. As our nation's energy resources and needs are reassessed, a renewed interest in the Paleozoic sediments beneath Lafayette County may lead to future drilling. In the near future, however, no drilling for oil and gas is proposed.

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